# Bastrop Regional Water Facilities Planning Study

**TWDB Report No.** 1004831079
Prepared by
K Friese & Associates, Inc.

## Study Participants:

City of Bastrop
The State of Texas County of Bastrop
LCRA ENERGY • WATER • COMMUNITY SERVICES
Lost Pines Groundwater Conservation District

## Texas Water Development Board

P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231
**October 2011**

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# Texas Water Development Board

# Report No. *(Draft Report)*

# Bastrop Regional Water Supply Facilities Planning Study

INTERIM REVIEW

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**CHARLOTTE A. GILPIN, PE 99532 ON 10/17/11**

IT IS NOT TO BE USED FOR CONSTRUCTION PURPOSES.

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# Bastrop Regional Water Supply Facilities Planning Study

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# Executive Summary

The City of Bastrop (City) has partnered with Bastrop County (County), Lost Pines Groundwater Conservation District (LPGCD), and the Lower Colorado River Authority (LCRA), collectively the Study Participants, to complete the Texas Water Development Board (TWDB) Bastrop Regional Water Facilities Planning Grant Study (Study).

The purpose of this planning study is to evaluate water supplies and facilities necessary to serve the Study Area for a thirty year period (2010-2040). The Study Area is 80 square miles and contains the City and adjacent areas within the County where significant developments are planned or proposed. The Study also includes a secondary Extended Study Area which is a total of 195 square miles, encompasses the Study Area and extends to the western portion of Bastrop County to capture areas where growth is anticipated along the State Highway (SH) 71 and SH 130 corridors. The Extended Study Area generally correlates to the City's extraterritorial jurisdiction (ETJ).

Several sources of population projections were reviewed and evaluated for application within the Study. Ultimately, the population projections used were based on the Capital Area Metropolitan Planning Organization (CAMPO) 2035 Plan. CAMPO developed county wide population projections for ten year increments from 2010 to 2035. They then distributed the populations amongst defined Traffic Analysis Zones (TAZ). The study period was segmented into five year periods to evaluate water demands, water deficits, and water supply options and scenarios incrementally. Population projections were interpolated and extrapolated for the five year increments. The population summation of the TAZs within the Study boundaries was used to estimate the water demands and deficits based on a per capita demand. The City of Bastrop is the largest water user within the Study and Extended Study Area and as such, the City's average per capita usage planning criteria was used to develop the water demand and deficit projections.

The City is not required to have a water conservation plan (WCP) by either the Texas Commission on Environmental Quality or the TWDB. However, the City does have a WCP that was adopted May 11, 2010 and met with the TWDB's approval for this Study. The WCP was reviewed for the Study and recommendations for improvements to the plan and implementation of the plan were provided. Reductions in water demand as a result of a WCP were not accounted for in the demand deficit projections. Due to the recent nature of the City's WCP, documented data to substantiate long-term projections for reductions in water demand are not available.

Currently the City's water supply is produced from six (6) Alluvium wells. The available water supply is limited by the production capacity of the wells rather than the pumpage permitted by the LPGCD. Deficit projections for this Study utilize the available production capacity as existing supply. The City is looking to diversify the water supply sources used to meet the future deficit. Source diversification is desired to reduce the exposure caused by the Alluvium source which may be more susceptible to drought impacts than surface water or regional deeper aquifer zones with higher yield wells.

Lower Colorado River water, Simsboro groundwater and third party water supply from Aqua Water Supply Corporation (Aqua) were the three water supply sources evaluated for this Study.

A unit cost ($/1,000 gallons) was developed for each water supply scenario based on the annualized costs of proposed facilities required to supply an *average* annual project yield for the projected average annual 2040 Study Area deficit of 10,949 acre-feet per year. All facilities were sized to deliver the projected 2040 Study Area maximum daily delivery rate deficit of 26.8 million gallons per day (MGD).

The Study focused on water supply options and did not consider or estimate costs for improvements to, or expansion of, the distribution system. Each of the three water supply sources were evaluated as a single phase project implemented in 2015 to satisfy the projected 2040 deficit. The surface and groundwater options were also both evaluated as a three-phase implementation to more closely track the demand deficit projections. Supply availability and cost estimates were also developed for the Extended Study Area for a single phase implementation scenario for each of three water supply options. No implementation plans were evaluated for the Extended Study Area in light of the timeline for development and scope of development that seems suited to a regional system.

A joint surface water and ground water option was also evaluated for the Study Area. This option utilized a surface water treatment plant to meet the 2040 average annual demand for the first phase. Wellfield development to meet the 2040 peak day demand occurred in two subsequent phases.

A high level blending analysis reviewed the typical regional water quality characteristics of the lower Colorado River water, the Simsboro aquifer water and the existing Alluvium water. In summary, all three water sources are generally compatible with each other. Only basic treatments that would have been required independent of source blending are required. It should be noted that the blending analysis assumes complete mixing. While helpful for determining compatibility and necessary treatments for the Study, geographic locations of the new water sources will not support complete mixing prior to entry to the distribution system. Additionally, the geographic changes in sources entering the existing system may cause scaling built up over the years to be dislodged into the system. Prior to implementation of any water supply option, a more detailed blending analysis and pipe loop testing should be part of the feasibility study. The costs of treatment are a component of the cost estimate.

While increasing overall capital and project costs, multiple phases would reduce the net present value of expenditures. Additionally, phasing allows capital expenditures as growth materializes rather than significantly ahead of growth. Amongst the scenarios evaluated, the Simsboro groundwater development is the least cost-intensive of the options. However, a joint development scenario of both Colorado surface water and Simsboro groundwater will diversify the risks associated with drought, contamination, and regulatory availability.

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# 1 Introduction

The City of Bastrop (City) has partnered with Bastrop County (County), Lost Pines Groundwater Conservation District (LPGCD), and the Lower Colorado River Authority (LCRA), collectively the Study Participants, to complete the Texas Water Development Board (TWDB) Bastrop Regional Water Facilities Planning Grant Study (Study).

The purpose of this planning study is to evaluate water supplies and facilities necessary to serve the Study Area for a thirty year period (2010-2040). The Study Area, shown in ***Figure 1-1,*** contains the City and areas within the County where significant developments are planned or proposed. The Study also includes a secondary Extended Study Area which extends to the western portion of the County to capture areas where growth is anticipated along the State Highway (SH) 71 and SH 130 corridors. The Extended Study Area generally correlates to the City's extraterritorial jurisdiction (ETJ). The sizes of the Study Area and the Extended Study Area are listed in ***Table 1-1.***

**Table 1-1. Study Area Size**

| Area Description | Area (ac) |
|---|---|
| Study Area | 51,492 |
| Extended Study Area | 124,645 |

The City is one of the major water utilities in the County. The County currently has a relatively low population density, with the highest density concentrated in the City. Population in the rural and municipal areas of the County is increasing, particularly along the SH 71 corridor between the City and the Travis County line. Growth along SH 71 also is expected to be spurred by the SH 130 corridor. This area is transitioning from large lot rural development to higher density suburban type developments. During a recent Bastrop City Council Workshop on growth within the ETJ, it was noted that this growth area along the SH 71 corridor would be a likely candidate for incorporation into an annexation plan by the City. Similarly, the SH 95 corridor is expected to experience significant growth with the creation of a 10,000 acre XS Ranch Municipal Utility District (MUD), which is three times the size of the City. The XS Ranch MUD is approximately six miles north of the City and seven miles south from the City of Elgin along SH 95. Significant development is likely to be spurred on the SH 95 corridor south of Elgin as well.

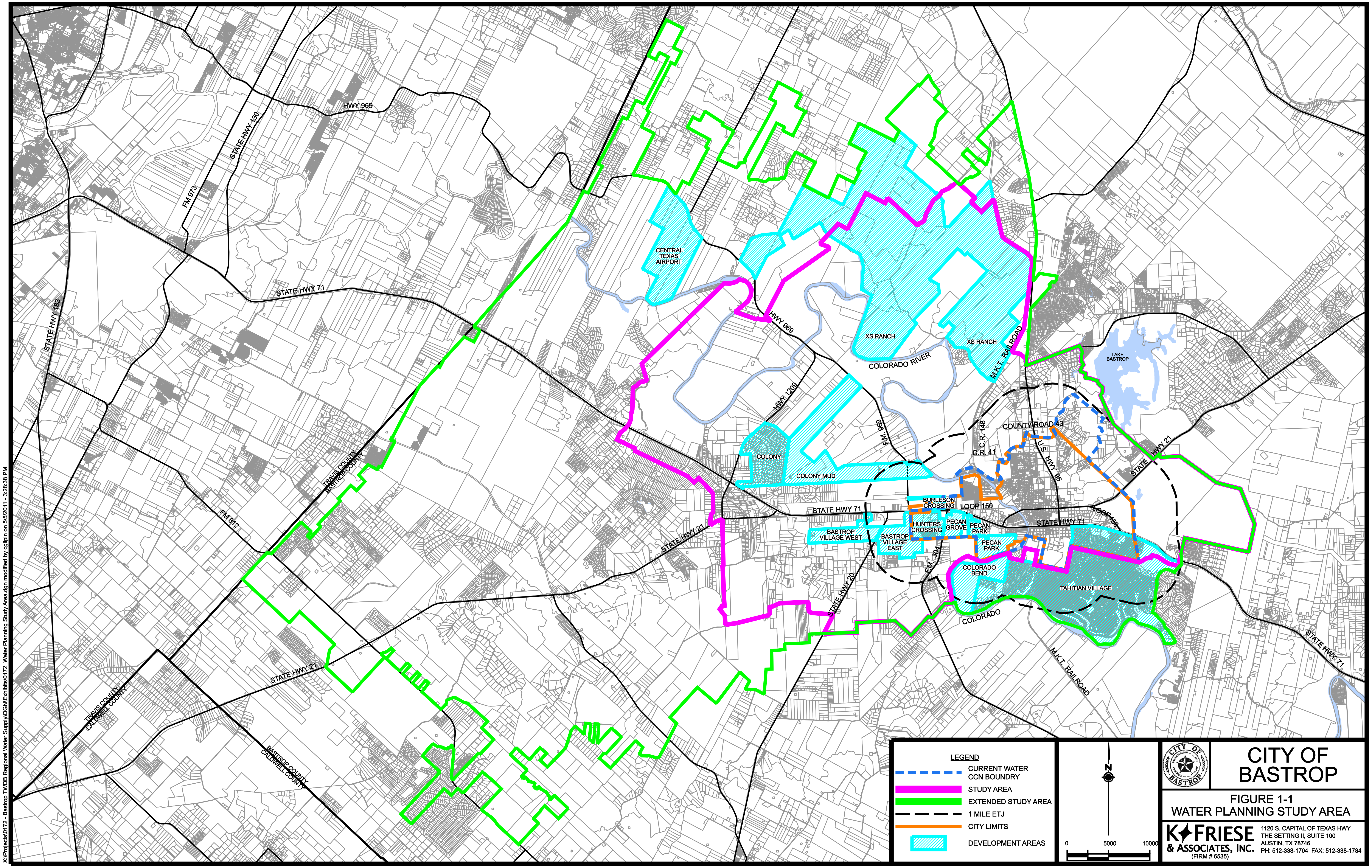


FIGURE 1-1
WATER PLANNING STUDY AREA

X:\Projects\0172 - Bastrop TWDB Regional Water Supply\DGN\Exhibits\0172_Water Planning Study Area.dgn modified by cgilpin on 5/5/2011 - 3:28:38 PM

# 2 Data Gathering

In cooperation with the Study Participants, geospatial data for Geographical Information Systems (GIS) mapping layers, population projections, and demand data were gathered. Descriptions of the data sources, the content, and how the data were utilized are documented within ***Appendix C.***

# 3 Population Projections

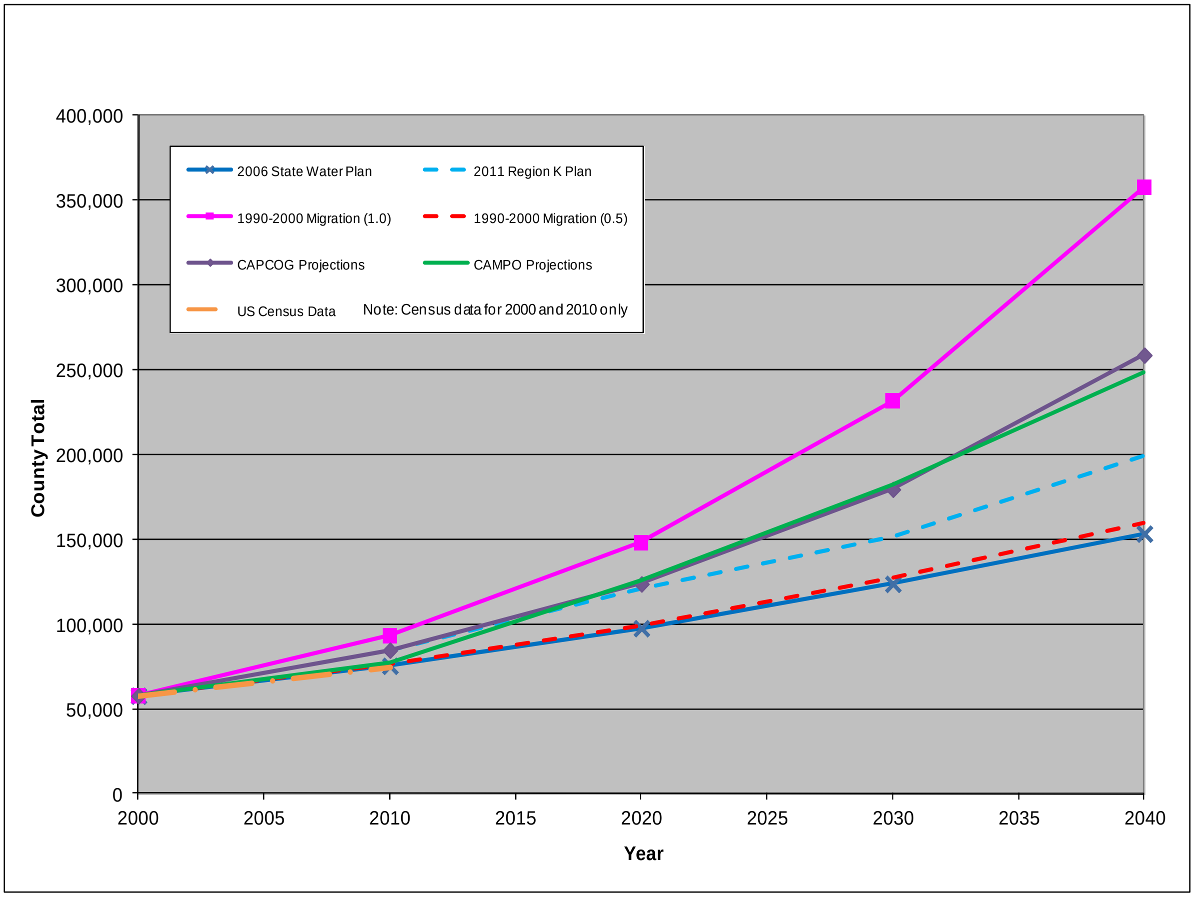
An objective for the Study is to identify population projections in the smallest geographical unit available to identify where demand will likely occur. County total population projections are available from the Texas State Data Center and Office, the TWDB, The Capital Area Council of Governments (CAPCOG), and the Capital Area Metropolitan Planning Organization (CAMPO). The CAPCOG and CAMPO data are based on an average of the State Demographers highest (1.0) and medium growth (0.5) migration scenarios (Capital Area Metropolitan Planning Organization, April 2010). The 1.0 scenario growth rate assumes the net migration stays at the same rate as was recorded from 1990 to 2000; while the 0.5 scenario growth rate assumes half of the net migration as was recorded from 1990 to 2000. The slight differences between the CAPCOG and CAMPO data are attributed to the difference in years selected for projection. The available county wide population data are compared in ***Table 3-1*** and ***Figure 3-1.*** By comparison, the total County population according to the 2010 US Census Data is 74,171 (http://2010.census.gov/2010census/data/). Although the 2010 Bastrop County census population estimate is lower than any of the projections shown in ***Table 3-1,*** the 2010 census data were not used within the Study to maintain consistency with the use of a projected data set. This makes the Study 2010 population projections conservative (i.e. at the higher range of population projections), however, not overly conservative as the census data are within 5 percent of the CAMPO projections.

**Table 3-1. County Population Projections**

| Source | 2000 | 2010 | 2020 | 2030 | 2040 |
|---:|---:|---:|---:|---:|---:|
| 2006 State Water Plan | 57,733 | 75,386 | 97,601 | 123,734 | 153,392 |
| 2011 Region K Plan | 57,733 | 84,449 | 120,739 | 151,364 | 199,548 |
| 1990-2000 Migration (1.0) | 57,733 | 93,054 | 148,002 | 231,789 | 357,683 |
| 1990-2000 Migration (0.5) | 57,733 | 76,145 | 99,333 | 127,178 | 159,792 |
| CAMPO Projections | 57,733 | 77,485 | 125,737 | 182,319 | 248,586 |
| CAPCOG Projections | 57,733 | 84,600 | 123,700 | 179,500 | 258,700 |

Notes: 1. CAMPO data for 2020, 2030, and 2040 are interpolated and extrapolated.

**Figure 3-1 County Population Projections**




For the 2011 Region K Water Plan (Texas Water Development Board, February 2010) population projections were developed for the water user groups (WUGs) or various water providers, within the County. Because the exact growth patterns within the County are not known, future population growth is allocated among the WUGs based on current population distribution ratios. There are thirteen WUGs identified within the County. The population projections from the 2011 Region K Water Plan for four WUGs are shown in ***Table 3-2***. These four WUGS are the largest WUGS located within the Extended Study Area.

**Table 3-2. 2011 Region K Plan Water User Group (WUG) Population Projections**

| Water User Group Name | 2010 | 2020 | 2030 | 2040 |
|---|---|---|---|---|
| AQUA WSC | 37,503 | 54,835 | 66,989 | 88,380 |
| CITY OF BASTROP | 8,890 | 12,475 | 15,920 | 21,003 |
| BASTROP COUNTY WCID #2 | 2,269 | 3,202 | 4,300 | 5,546 |
| COUNTY-OTHER (COLORADO BASIN) | 17,272 | 24,178 | 30,854 | 40,708 |

Notes: 1. Water Supply Corporation (WSC)
2. Water Control and Improvement District (WCID)
3. Table data from Appendix 2 of the 2011 Region K Water Plan.

The WUGs within the County are political subdivisions or unincorporated areas (County-Other); therefore the population data do not correlate well to the geographic boundaries of the defined regional Study Area and the Extended Study Area. Nor do the data meet the objective of identifying demand nodes and creating a water facilities plan. For this reason, the population projections used for this Study are the projections and geographical distributions prepared by CAMPO for the 2035 Regional Transportation Plan. The 2035 Regional Transportation plan was adopted by the CAMPO Board on May 24, 2010. The CAMPO population projections are distributed to Traffic Analysis Zones (TAZ), which are small geographic areas developed to analyze nodes of growth and activity. CAMPO developed the Demographic Allocation Tool to support their long range transportation planning process (CAMPO, April 2010). This tool is a methodology to distribute demographics such as population to the various TAZs. The TAZs are the smallest units of projected population distribution currently available for analysis; therefore this methodology yields the best available population data for the Study Area.

The population projections from the 2011 Region K Water Plan for the Bastrop WUG and the CAMPO 2005 to 2035 Master TAZ GIS database data within the City of Bastrop Certificate of Convenience and Necessity (CCN-2010) boundary are compared in ***Table 3-3***. These two areas are readily comparable in that they both aim to describe the City's service area. The comparison demonstrates that the CAMPO population projections are more conservative over the duration of the Study with respect to the effect on water demand.

**Table 3-3. Population Projections for the City of Bastrop Water Service Area**

| Source | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| 2011 Region K Plan | 8,890 | 10,683 | 12,475 | 14,198 | 15,920 | 18,462 | 21,003 |
| CAMPO | 8,020 | 8,672 | 13,935 | 19,198 | 25,245 | 31,291 | 37,338 |

Notes: 1. 2011 Region K Water Plan data for 2015, 2025, and 2035 are interpolated and extrapolated.
2. CAMPO data for 2020, 2030, and 2040 are interpolated and extrapolated.

The population projections for the Study Area were determined by clipping the CAMPO TAZ GIS shape file layer and database to the Study Area boundary. The acreage of the TAZs that fell within the Study Area boundary was then measured and added as an attribute field within the database for each TAZ. The percentage of the TAZ area that is located within the Study Area boundary was then calculated. That percentage was multiplied by the total population of the unmodified TAZ to estimate the population of the TAZ within the Study Area. Data for the years 2020, 2030 and 2040 were interpolated and extrapolated from the available 2015, 2025, and 2035 data. This process was repeated for the Extended Study Area.

Population is assumed to be evenly distributed within each TAZ. This may not accurately reflect development patterns; therefore population allocation to the Study Area(s) from a TAZ bisected by the study boundary may not be accurate either. However, TAZs which are not significantly contained (90 percent or more) within the study boundaries account for approximately 35 percent of both the Study and Extended Study Area. Appropriately locating population nodes and necessary water supply facilities within a TAZ remains a matter to be considered throughout the Study. The 2010 maps and the full database of analysis year, population, average annual demand, and maximum daily delivery rate are located in ***Appendix C3***.

The population projections used in this Study for the Study Area and Extended Study Area are presented within ***Table 3-4*** below. CAMPO population projections were derived for the years 2020 and 2030 by linear interpolation of the 2015, 2025 and 2035 data. The 2040 population projection was derived by linear extrapolation of the 2025 and 2035 data. The database contains the population data for each year of analysis as an attribute field for each TAZ. This information will be useful for the future task of identifying geographic locations of necessary water distribution facilities. This task is not within the scope of the Study.

**Table 3-4. Population Projections for the Study Areas**

| Area Description | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 15,692 | 20,375 | 31,886 | 43,397 | 59,643 | 75,890 | 92,137 |
| Extended Study Area | 30,571 | 41,372 | 58,204 | 75,037 | 96,955 | 118,874 | 140,793 |

# 4 Water Demand Projections

Estimated population projections discussed in Section 3 are the basis to project water demands for the potential service area to evaluate water supply options, size the raw water facilities, treatment facilities, and treated water transmission lines. A 30-year planning horizon is used, beginning in year 2010 and continuing to year 2040 in five year increments.

Water supply planning studies often express future water demand as a function of projected population and the average water use per person in gallons of water used per person per day (gpcd). Water suppliers calculate the water use per person based on the population and water use within their service area. The resulting water use per person accounts for residential and non-residential uses across the community and averages out peak daily and seasonal peaks. The water supply sources, however, are typically measured in acre-feet per year (ac-ft/yr). As such, once a gpcd factor is established for a service area, the projected demand is expressed in ac-ft/yr to support the water supply planning effort. In addition to the annual water supply considerations, facilities must be sized to meet fluctuations in the demand including the peak day use. For this reason, projected demands are converted using a peaking factor to the maximum daily rate expressed in millions of gallons per day (MGD). In summary the *average* water use per person (gpcd) is used to determine the average annual demand (ac-ft/yr) for water supply considerations which is then used to determine the *maximum* daily delivery rate (MGD) for facility sizing.

The 2011 Region K Water Plan municipal water demand projections for the WUGs are expressed in annual demands in ac-ft/yr. Rather than review the demands by WUG, the demand in per capita use of gallons of water used per person per day was calculated using the population projections and water demands as presented in Appendix 2A of the Water Plan. The water demand units of gpcd were used so that a direct comparison of the per capita water use could be made between the 2011 Region K Water Plan and local data. ***Table 4-1*** presents the 2011 Region K Water Plan demand projections converted to gpcd. The Region K Water Plan demand projections include reductions in the projected per capita use based on the goals associated with the implementation of various water conservation measures.

**Table 4-1. 2011 Region K Water Plan Demand (gpcd)**

| Water User Group Name | 2010 | 2020 | 2030 | 2040 | Average |
|---|---|---|---|---|---|
| AQUA WSC | 134 | 131 | 128 | 127 | 130 |
| CITY OF BASTROP | 200 | 196 | 194 | 192 | 195 |
| BASTROP COUNTY WCID #2 | 134 | 132 | 130 | 129 | 131 |
| COUNTY-OTHER (COLORADO BASIN) | 122 | 122 | 121 | 121 | 121 |

The City independently calculated the average daily water use within the City's service area at 155 gpcd based on eight years of population and water production and use data. The summary of this data is located in ***Appendix C2***. The City of Bastrop per capita usage is lower than the 2011 Region K Water Plan for the Bastrop WUG, but higher than the average for all of the WUGs shown in the ***Table 4-1*** (144.5 gpcd). 155 gpcd was used as the water demand assumption for this Study for all analysis years, except for projected water demands for the Aqua service area as discussed subsequently in this section. The Study does not consider reductions in gpcd demand which is a conservative approach but reasonable considering the variations among the Region Plan data. The maximum day demand utilized for the Study is based on Texas Commission on Environmental Quality (TCEQ) 290.45(b)(1)(D) Minimum Water System Capacity Requirements (TCEQ, 2004). This rule requires a system served by two or more wells to have a total capacity of 0.6 gallons per minute (gpm) per connection. The design criteria which were used in this Study are summarized in ***Table 4-2***.

**Table 4-2. City of Bastrop Water Demand Planning Assumptions**

| Criteria | | Units |
|---|---|---|
| Average Per Capita Usage | 155 | gpcd (gallongs per capita per day) |
| Average Per Capita Usage | 0.17 | ac-ft/yr/p (acre-feet/year/per person) |
| Population Correlation | 2.5 | People/SUE (Service Unit Equivalent) |
| Average Day Demand | 0.27 | gpm (gallons per minute) per SUE |
| Maximum Day Demand | 0.60 | gpm per SUE |
| Peak Hour Demand | 0.75 | gpm per SUE |

The population data allocated to the TAZs were used to estimate both the quantity and geographical distribution of water demands. The average demand for each TAZ was estimated by multiplying the TAZ population by the average per capita demand factors. The average demand for the Study Area and the Extended Study Area are summarized in ***Table 4-3***. The maximum delivery rate is estimated in ***Table 4-4***.

**Table 4-3. Projected Average Annual Demand (ac-ft/yr)**

| ***Year*** | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 2,725 | 3,538 | 5,536 | 7,535 | 10,356 | 13,177 | 15,998 |
| Extended Study Area | 5,308 | 7,184 | 10,106 | 13,029 | 16,835 | 20,641 | 24,446 |

**Table 4-4. Projected Maximum Daily Delivery Rate (MGD)**

| *Year* | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 5.5 | 7.1 | 11.1 | 15.1 | 20.8 | 26.4 | 32.1 |
| Extended Study Area | 10.7 | 14.4 | 20.3 | 26.1 | 33.8 | 41.4 | 49.1 |

The Aqua Water Supply Corporation's (Aqua) CCN covers the majority of the Study and Extended Study Area. So that demands within the Study and Extended Study Area are not over estimated, the demands were adjusted based on water usage for customers currently served by Aqua as of March 2011. Aqua provided the number of connections within the Study and Extended Study Area, summarized in ***Table 4-5***. The usage was estimated based on the criteria in ***Table 4-2*** to maintain consistency with the Study. The adjusted projected average annual demand and maximum daily delivery rate are shown in ***Table 4-6*** and ***Table 4-7,*** respectively. These are the demands utilized for the remainder of the Study to estimate water supply deficit. The 2010 TAZ maps and the full database of analysis year, population, average annual demand, and maximum daily delivery rate are located in ***Appendix C3***.

**Table 4-5. Aqua Service and Usage within the Study Area**

| | | |
|---|---|---|
| Study Area Connections | 1719 | Connections |
| Study Area Usage | 740 | ac-ft/yr |
| Study Area Usage | 1.5 | MGD |
| Extended Study Area Connections | 5329 | Connections |
| Extended Study Area Usage | 2295 | ac-ft/yr |
| Extended Study Area Usage | 4.6 | MGD |

**Table 4-6. Adjusted Projected Average Annual Demand (ac-ft/yr)[1]**

| *Year* | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 1,984 | 2,798 | 4,796 | 6,795 | 9,616 | 12,437 | 15,258 |
| Extended Study Area | 3,014 | 4,889 | 7,812 | 10,734 | 14,540 | 18,346 | 22,152 |

Notes: 1. Demand adjusted for existing Aqua customers.

**Table 4-7. Adjusted Projected Maximum Daily Delivery Rate (MGD)[1]**

| *Year* | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 4.0 | 5.6 | 9.6 | 13.6 | 19.3 | 25.0 | 30.6 |
| Extended Study Area | 6.0 | 9.8 | 15.7 | 21.5 | 29.2 | 36.8 | 44.4 |

Notes: 1. Demand adjusted for existing Aqua customers.

# 5 Existing Water Facilities

The City's existing water supply system consists of six operating Alluvium wells, the Willow Street Water Treatment Plant, the Loop 150 Tank Yard Facilities, distribution system piping and several pressure reducing stations. Refer to ***Figure 5-1*** for a map of the City's existing water system facilities.

Five of the Alluvium wells, Wells C, D, E, F and G are located on the east side of the Colorado River at Fisherman's Park. These wells pump into one of two ground storage tanks at the Willow Street facility. Wells C and F pump into Tank 1, Wells D and E supply Tank 2, while Well G can provide water to either tank. Manganese enters the system at Well C, requiring treatment to prevent discolored water from entering the distribution system. To reduce costs associated with sequestering manganese with polyphosphate, the City avoids using Well C when demand is low. The sixth Alluvium well, Well H, is located in Bob Bryant Park on the west side of the river. This well currently pumps directly into the distribution system. The City provided the current available well water supply which is summarized in ***Table 5-1.***

The Willow Street facility is located east and north of the wells, just west of Willow Street and south of Cedar Street. The facility includes two ground storage tanks, five high service pumps and chlorination and fluoridation equipment. From the Willow Street Plant, water is then pumped out of the tanks to the distribution system via two high service pump stations.

The Loop 150 Tank Yard Facilities are designed to maintain distribution system pressure and consist of a ground storage tank, a standpipe and an elevated storage tank, all of which provide elevated storage for the distribution system. The existing storage facilities are summarized in ***Table 5-2***.

**Table 5-1. City of Bastrop Available Water Supply Capacity**

| Well Description | | Max.Production Capacity | | | Permitted Capacity | | |
|---|---|---|---|---|---|---|---|
| | | 2010 (gpm) | 2010 (MGD) | 2010 (ac-ft/yr) | 2010 (gpm) | 2010 (MGD) | 2010 (ac-ft/yr) |
| Well C | Fisherman's Park on Willow St | 435 | 0.6 | 702 | 526 | 0.8 | 849 |
| Well D&E | Fisherman's Park on Willow St | 615 | 0.9 | 992 | 1,504 | 2.2 | 2,426 |
| Well F | Fisherman's Park on Willow St | 702 | 1.0 | 1,132 | 1,004 | 1.4 | 1,620 |
| Well G | Fisherman's Park on Willow St | 459 | 0.7 | 740 | 666 | 1.0 | 1,075 |
| Well H | Bob Bryant Park | 460 | 0.7 | 742 | 500 | 0.7 | 806 |
| **City Total** | | **2,671** | **3.8** | **4,309** | **4,201** | **6.0** | **6,776** |

**Table 5-2. Available Storage Capacity**

| Tank | Location | Diameter | Height | Overflow | Volume | |
|---|---|---|---|---|---|---|
| Tank 1 | Willow St. Plant | 84.25 feet | 12 feet | 371 feet | 0.50 | MG |
| Tank 2 | Willow St. Plant | 44 feet | 44 feet | 400 feet | 0.50 | MG |
| Tank 3 | Loop 150 Tank Yard | 46 feet | 16 feet | 535 feet | 0.20 | MG |
| Standpipe | Loop 150 Tank Yard | 46 feet | 80 feet | 600 feet | 1.00 | MG |
| Elev. Tank | Loop 150 Tank Yard | 40.85 feet | 25.5 feet | 655 feet | 0.25 | MG |
| **Total Storage Capacity:** | | | | | **2.45** | **MG** |

The water supply capacity presented in ***Table 5-1*** is based on the current production rates which are limited by various water quality and operational issues. Rather than the permitted withdrawal, the limited production capacity of the wells was used to estimate the projected water deficit which is presented in ***Table 5-3*** and ***Table 5-4***. The projected water supply deficit is calculated by subtracting current supply capacity (***Table 5-1***) from projected annual and daily water demands (***Table 4-6*** and ***Table 4-7***, respectively). Existing Aqua well production was treated as a third party source and not as existing water supply and is further discussed in ***Section 6.3***.

**Table 5-3. Projected Average Annual Deficit (ac-ft/yr)**

| ***Year*** | **2010** | **2015** | **2020** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|---|---|---|
| Study Area | 2,324 | 1,511 | -488 | -2,486 | -5,307 | -8,128 | -10,949 |
| Extended Study Area | 1,295 | -580 | -3,503 | -6,426 | -10,231 | -14,037 | -17,843 |

**Table 5-4. Projected Maximum Daily Delivery Rate Deficit (MGD)**

| ***Year*** | **2010** | **2015** | **2020** | **2025** | **2030** | **2035** | **2040** |
|---|---|---|---|---|---|---|---|
| Study Area | -0.1 | -1.8 | -5.8 | -9.8 | -15.4 | -21.1 | -26.8 |
| Extended Study Area | -2.2 | -6.0 | -11.8 | -17.7 | -25.3 | -33.0 | -40.6 |

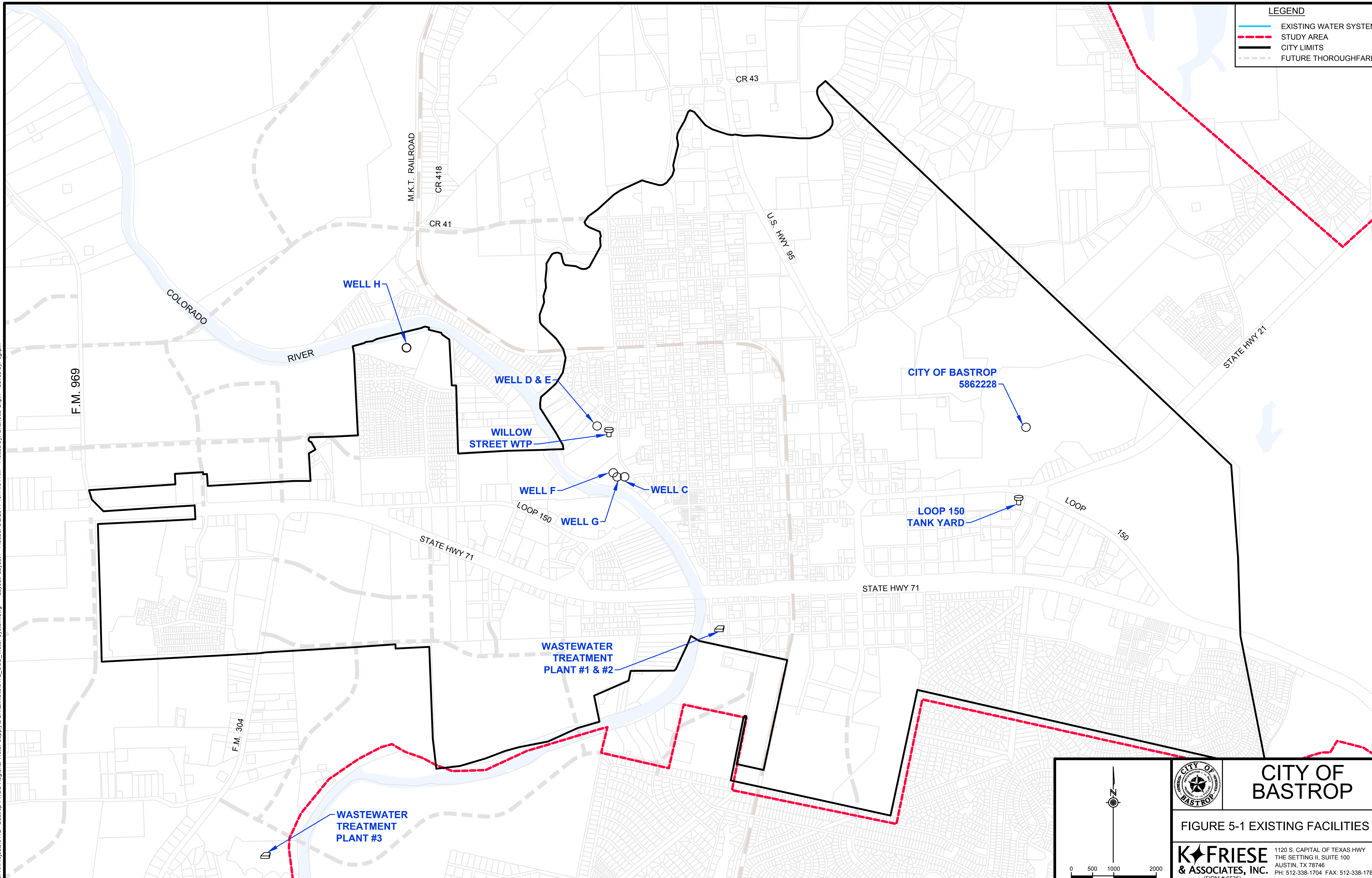



FIGURE 5-1 EXISTING FACILITIES

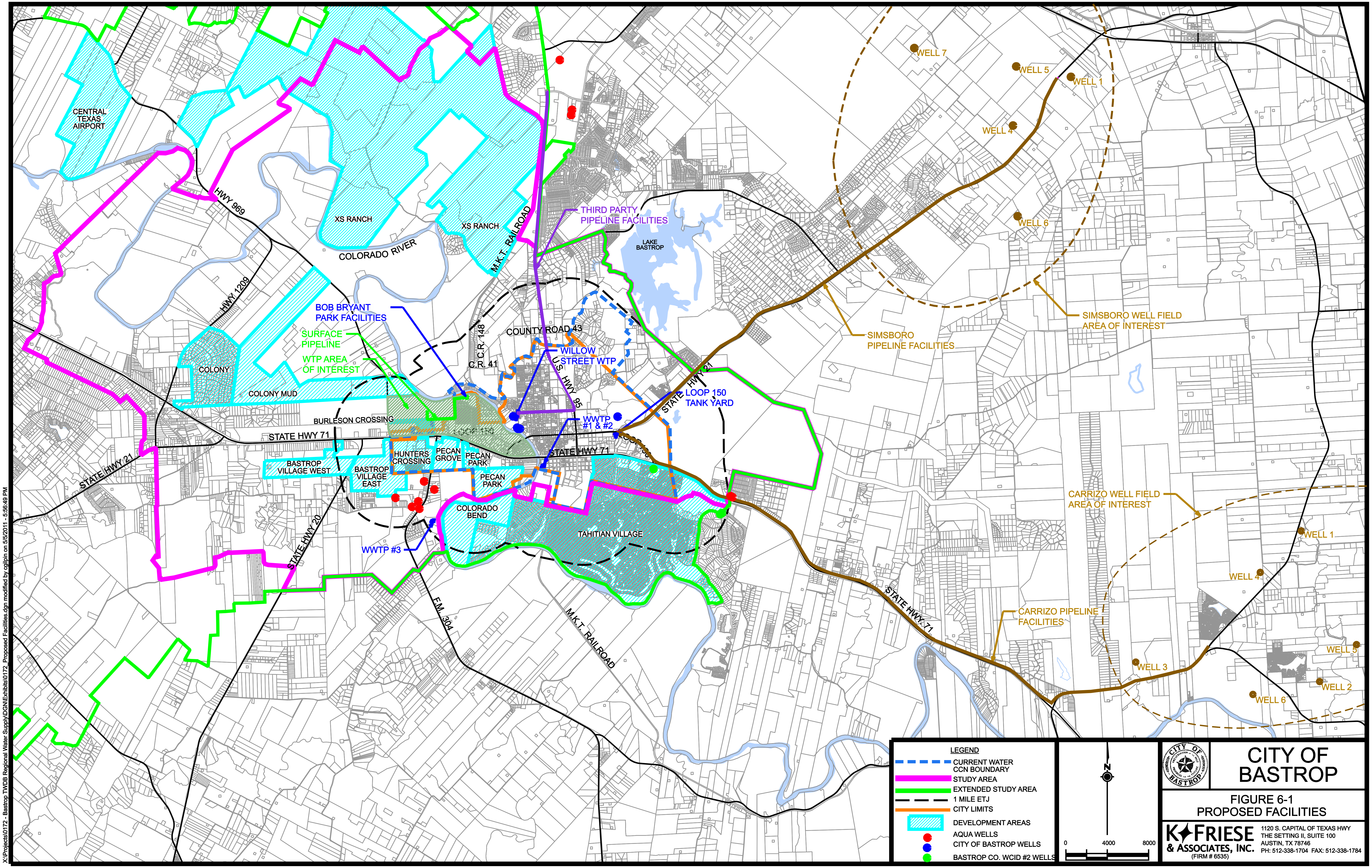
# 6 Water Source Options

Alluvium wells with production rates ranging from 400 gallons per minute (gpm) to 700 gpm are the City's sole current water source. The City is looking to diversify the water supply sources used to meet the future deficit. Source diversification is desired to reduce the exposure caused by the Alluvium source, which may be more susceptible to drought impacts than surface water or regional deeper aquifer zones with higher yield wells.

Three potential new water supply sources were analyzed for the Study: surface water from the lower Colorado River, groundwater from the Simsboro aquifer and a third party purchase of water from Aqua Water Supply Corporation (Aqua). A unit cost ($/1,000 gallons) was developed for each option based on the annualized costs of proposed facilities required to address the projected average annual 2040 Study Area deficit of 10,949 acre-feet. The annual costs include the estimated debt service, operations and maintenance costs, electrical costs based on average day demand and associated reservations or supply fees. The unit costs reflect the facilities required to develop the water supply source and transport the water to a delivery point within the City's existing distribution system. Improvements to, or expansion, of the water distribution system are not considered in this Study. Each of the water supply source options are discussed in greater detail in the following sections, followed by a summary of the cost comparisons.

Conceptual facility cost estimates were prepared to provide a concept level overview so that the three water supply alternatives may be quantitatively compared. Cost estimating procedures are based on the 2011 South Central Texas Regional Plan (SCTRWPG, 2010). The SCTRWPG unit costs are based on September 2008 dollars and have been adjusted to December 2010 values using the Engineering News Record's (ENR) Construction Cost Index (CCI) (ENR, 2011). The unit costs presented in ***Section 6*** and the cost summary comparison presented in ***Section 7*** are based on the assumption that each water supply would be developed to satisfy the estimated average annual 2040 Study Area deficit of 10,949 acre-feet in entirety in a single implementation phase. The water cost/reservation fees are the only phased element of the single implementation scenarios. The water rates and water fees used for the single implementation is an average of the rates and fees over three purchasing periods which are set equivalent to the phased implementation scenarios discussed in ***Section 8***. Meaning that the water rate or fee used to calculate the annual cost is the average of the water rate/fee and the reservation rate/fee for the three phases. The average is over these three phases: the 2015 phase which is based on the 2025 water demand, the 2025 phase which is based on the 2035 water demand and the 2035 phase which is based on the 2040 water demand. The detailed cost estimates are located in ***Appendix G***. The proposed facilities are shown on ***Figure 6-1***.

Final project costs will vary from the estimates prepared for this Study based on actual labor and material costs, market conditions, site conditions, final project definition, implementation schedule, and other variable factors. Further evaluation of defined projects is recommended prior to determination of specific implementation plans.




# CITY OF BASTROP

FIGURE 6-1
PROPOSED FACILITIES

K FRIESE & ASSOCIATES, INC. (FIRM # 6535)
1120 S. CAPITAL OF TEXAS HWY
THE SETTING II, SUITE 100
AUSTIN, TX 78746
PH: 512-338-1704 FAX: 512-338-1784

X:\Projects\0172 - Bastrop TWDB Regional Water Supply\DGN\Exhibits\0172_Proposed Facilities.dgn modified by cgilpin on 5/5/2011 - 5:56:49 PM

## 6.1 Surface Water Option

The surface water option is a proposed diversion of the lower Colorado River most likely contracted through the Lower Colorado River Authority (LCRA). A technical memorandum prepared by CH2M HILL discusses the availability of surface water supplies, water right considerations, proposed infrastructure, cost and permitting considerations, and potential environmental concerns related to a potential surface water project. The complete technical memorandum is located in ***Appendix D***. This section summarizes the findings.

During this Study, LCRA representatives confirmed that LCRA currently has 90,000 ac-ft/yr of water supply available through execution of a firm water contract which includes authorization for use of the bed and banks of the Colorado River for conveyance. Additionally, based on current operations and those anticipated in the future, releases could be made from the Highland Lakes system to meet the projected peak daily demands, eliminating the need for local storage facilities to “firm up” the supply (LCRA, 2010). Following a review of the surface water model, CH2M HILL determined that the water supply under such a contract would be reliable and available on a monthly basis during hydrological conditions similar to that of the 1950’s drought of record. It should be noted that this Study does not consider any drought-related needs of water rights holders, any environmental flow requirements that could result in diversion limitations, nor does it consider conditions worse than the drought of record which could affect water availability during extreme drought. Low flow conditions or release and delivery lags from the Highland Lakes may impact the need for local storage to prepare for daily flow or diversion rate fluctuations. Although the LCRA water management does account for these factors the purchases should remain aware of the potential impacts to the water supply. Additionally, the use of groundwater to supplement the system peaks would also be a factor to consider when evaluating local storage. With that in mind, local storage needs should be studied in greater detail during a feasibility study of the specific water supply scenario. A discussion on the LCRA contracting process is located in the technical memorandum located in ***Appendix D***.

Significant growth is anticipated west of the Colorado River along the SH 71 corridor, so the proposed water treatment plant (WTP) site was assumed to be located west of the river. A WTP development quadrant was defined and bounded by Farm to Market Road (FM) 969 to the west, SH 71 to the South, and the lower Colorado River to the north and east. Placing the WTP within this quadrant locates the new facilities upstream of the existing and proposed wastewater treatment plant’s discharge points (WWTP) and closer to the vicinity of anticipated demands, while avoiding costly river crossings for transmission pipes. The center point of this quadrant was assumed as a representative location for the WTP site and pipe line lengths were based on this assumption. Detailed analysis of land for site feasibility was not part this Study. In addition to the intake and WTP facilities, a transmission pipe line is required to deliver water from the WTP to the Bob Bryant Park facilities; which were assumed as the delivery point to the existing system due to the proximity to the WTP site.

The development of the cost estimate for the surface water option is based upon the following assumptions:

- An average delivery rate of 9.8 MGD and a peak day capacity of 26.8 MGD. All facilities are sized for the peak day rate;
- All pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- A river intake and diversion structure are included;
- 36-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed;
- 40-acres of land are acquired for the water treatment plant facilities;
- A 2.68 MG clear well is adjacent to the WTP. The clear well is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- Approximately 1.3 miles of 36-inch pipe from the WTP to the Bob Bryant Park facilities;
- All pipeline easements are 40-feet wide;
- Annual costs for water supply are based on LCRA current rates of $151 per ac-ft for firm water and $75 per ac-ft for reserved water. The water rate used for the 2015-2040 period is the average rate for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water and reservations rates for the 2015, 2025 and 2035 phases. Note that under a firm water contract the reservation fee is a guarantee of the water availability; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the surface water source and delivery to the existing system is $3.11 per 1,000 gallons of water ($1,015 per ac-ft). The detailed cost estimate is included in ***Appendix G***. It should be noted that this unit cost does not correlate to the unit cost presented in the CH2M HILL technical memorandum in ***Appendix D***. The variation is that the CH2M HILL report did not include costs for the transmission lines to the Bob Bryant Park facilities.

## 6.2 Groundwater Option

RW Harden & Associates, Inc. prepared a technical memorandum to explore and assess groundwater availability, groundwater quality, regulatory considerations, groundwater development options, and conceptual wellfield design. The complete technical memorandum is located in ***Appendix E***. This section summarizes the findings of that report as well as information obtained from the Lost Pines Groundwater Conservation District (LPGCD).

All of Bastrop County is contained within the LPGCD, which is part of the Groundwater Management Area (GMA) 12. GMAs were created "in order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions" (Texas Water Code §35.001). The GMAs manage groundwater for each aquifer by using groundwater models to identify Desired Future Conditions (DFC) and determine Managed Available Groundwater (MAG). GMA 12 is comprised of five districts with representatives from the districts within GMA 12 boundaries. Four of the five district votes are required for any changes or approvals of the models or the DFCs. Following approval of the DFCs by the GMA, the models are sent to the TWDB for review. The TWDB supports the GMAs in their planning process, is responsible for reviewing the reasonableness of the DFCs and provides districts with their MAGs. The MAGs will then be used by the regional water planning groups in their plans. The 2016 regional water plans will incorporate the GMA DFCs and MAGs, which presents an opportunity for greater regional coordination on future needs and conditions.

Both the Carrizo and Simsboro aquifers were reviewed as potential groundwater sources for this Study due to the high yield capability of wells located in these formations. Desired development zones for a wellfield capable of meeting the 2040 deficit for the Study Area (average delivery rate of 9.8 MGD and a peak day rate of 26.8 MGD) were identified for each aquifer. The Carrizo desired development zone is located east of the City near the Fayette and Lee County lines. The Simsboro desired development zone is located northeast of the City and south of the SH 21 and SH 290 intersection.

For the purposes of this Study, costs were developed only for the Simsboro groundwater supply option because the distance to the Carrizo development zone greatly increases the project costs. The approximate centroid of the Simsboro desired development area was used as the wellfield location from which costs were estimated. This corresponds roughly with the intersection of SH 21 and County Road (CR) 163 (Dixon Prairie Road). A transmission pipeline is required to deliver water from the wellfield to the Loop 150 Tank Yard, which was assumed as the delivery point to the existing system because of proximity.

The proposed well scenario described in the below assumptions was evaluated for compliance with DFCs using the model that was current at the time of the Study. A few of the LPGCD model inputs and assumptions should be noted. First, the model does not reflect permitted pumage but rather a percentage of the permitted pumage which represents typical withdrawals. In general the LPGCD has documented typical withdrawals as 25 percent to 30 percent of the permitted pumage. The LPGCD attributes the large differential between permitted and actual pumpage to TCEQ requirements for groundwater supply. Second, the modeled future pumpage projections are based on population and demand projections developed by the LPGCD which include some allotment for water exports.

In a phone interview with the General Manager, the LPGCD stated that they are required to issue permits as long as the DFC drawdown elevation is not violated. The district will monitor the Simsboro water level elevations relative to the currently established DFC drawdown of 237 feet using six monitoring wells. Due to the monitoring structure of issuing permits based on current "real time" water level elevations, and the disparity between the permitted and actual pumpage, the LPGCD recognizes that the conflict of permitted pumpage violating the DFC is likely. The district is planning revisions to their management plan to address how the DFC exceedance will be managed. A management strategy was not drafted at the time of the Study, however, the LPGCD has expressed that they intend to offer greater assurances to senior permit holders. "Senior permit holders" is a term used to describe those permits issued earlier in time than more recent, or "junior" permit holders. These are terms more commonly used to discuss surface water rights in Texas. The LPGCD expects to present these revisions to their board for consideration early in the fall of 2011, at which time there will be an opportunity for public comments.

Currently LPGCD has a production fee of $0.12 per 1,000 gallons and a reservation fee of $3.50 ac-ft/yr, however, these fees may change when the management plan is revised. The utility of reservation fees is uncertain considering the above described conflict in permits and DFCs. Further investigation of the permitting requirements is beyond the scope of this Study, however, recognizing the infancy of the process to establish DFC's and the associated uncertainties, the City is encouraged to pursue additional coordination with the LPGCD to explore and understand the potential regulatory constraints of groundwater supply within the district.

The development of the cost estimate for the Simsboro groundwater option is based upon the following assumptions:

- An average delivery rate of 9.8 MGD and a peak day capacity of 26.8 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- The wellfield is comprised of seven high yield wells each with production rate of 2,660 gpm;
- A total of 40-acres was acquired for all of the wells and it was assumed that groundwater ownership is transferred with the land acquired for the wellfield such that no additional costs for groundwater (other than regulatory permitting, production and reservation costs) are needed;
- Each well is assumed to have 7,500 feet of 15-inch pipe to the storage tank and treatment facilities;
- A 2.68 MG storage tank is located adjacent to the wellfield. The tank is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur in a single location adjacent to the storage tank prior to the wellfield water being transmitted to the City. Treatment costs were based on a recent cost study for oxidation and greensand filtration for the removal of manganese and iron. Each well was assumed to have the same average water quality properties discussed in ***Section 10***. If a pilot well indicates that the water is far outside of the average water quality parameters it is recommended to not pursue a well at that location;
- Approximately 10.5 miles of 36-inch pipe from the wellfield to the Loop 150 Tank Yard;
- All pipeline easements are 40-feet wide;
- A groundwater operation production fee of $0.12 per 1,000 gallons based on the LPGCD Resolution 2007-09-01 and $3.50 per ac-ft for reservation fees based on the effective July 15, 2009 rules. The operation production and the reservation fee used for the 2015-2040 period is the average fee for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water production and reservations fees for the 2015, 2025 and 2035 phases. Note that the LPGCD

reservation fees are a regulatory permitting fee and do not guarantee any amount of water; and

- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the Simsboro groundwater source and delivery to the existing system is $2.63 per 1,000 gallons of water ($855 per ac-ft). The detailed cost estimate is included in ***Appendix G***.

## 6.3 Third Party Option

At the time of this Study, there were two third parties which the City was aware of to consider as a water supply option. The City had evaluated purchasing water from the water purveyor End Op. However, contract terms and conditions could not be negotiated to the satisfaction of the City and the purchase was subsequently tabled. The second third party is Aqua. The City and Aqua entered into a 35 year agreement on October 12, 1993 for the acquisition of Aqua water supply facilities by the City as the City expands through annexation and seeks a transfer of CCN from Aqua to the City (Aqua Water Supply Corporation, 1993).

The agreement provides that Aqua shall retain the CCN in areas in which it has existing customers, meaning that a dual CCN would exist where Aqua maintains lines and customers. As discussed in ***Section 4***, the customers currently served by Aqua were not included within demand deficit projections.

Aqua has two wellfields in the vicinity of the City; one is located near SH 304 and Shiloh Road, the S wellfield, and the second is located near SH 95 and CR 403 near Camp Swift, the CS wellfield. Aqua has indicated to the City that the S wellfield does not have excess capacity to sell to the City. Therefore, the CS wellfield was considered as the source location for costing purposes. A new transmission pipe is required to deliver water from the SH 95 and CR 403 intersection to the Willow Street Water Treatment Plant. The treatment plant was assumed as the system integration point with the existing system due to the proximity to the Aqua CS wellfield.

Aqua has indicated that they are open to contracting to the City for a long-term water supply service. At the time of contracting Aqua and the City would negotiate a rate and impact fees. At the time of this study the rate or impact fees were not known. An assumption for a rate was determined by the City. An impact fee per demand deficit SUE was assumed based on the current Aqua Water Tariff Section 2.02.b for Non-Compliant Subdivisions requiring capacity reservation for a single SUE.

The development of the cost estimate for the Aqua third party option is based upon the following assumptions:

- An average delivery rate of 9.8 MGD and a peak day capacity of 26.8 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- The contract with Aqua will require water to be delivered at an appropriate water quality and the City will not need to provide any treatment;

- A 2.68 MG storage tank is located at the Camp Swift wellfield. The tank is of approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands. The tank is recommended to be a standpipe. The additional elevation is intended to overcome the peak day head loss to the Willow Street Water Plant and eliminate the need for a pump station adjacent to the tank;
- A pump station will not be required to transport water to the Willow Street Water Plant. The Camp Swift Wellfields at CR 403 (~460-feet) are approximately 90-feet higher in elevation than the Willow Street Plant Tank 1 overflow (371-feet). The static head difference is great enough to overcome the pipe friction head loss based on average day flows, but not the peak day flow head loss. This assumption that pumps are not required for the peak day are based on the scenario that the standpipe elevation is enough to overcome the peak day head loss and that the contract with Aqua requires water delivery to the standpipe at the required head;
- Approximately 6.75 miles of 36-inch pipe from the wellfield to the Willow Street Water Plant;
- Operation and maintenance costs were only assumed for the pipe line from the Aqua wellfield to the Willow Street facilities;
- An impact fee of $4,500 per SUE based on the current Aqua Water Tariff Section 2.02.b for Non-Compliant Subdivisions requiring capacity reservation for a single SUE. The water rate used for the 2015-2040 period is the average rate for phased purchasing development periods equivalent to the three phase implementation scenario. Meaning the impact fee used is the average of the fee for the 2015, 2025 and 2035 phases.;
- An assumed rate of $3.50 per 1,000 gallons was provided by the City for evaluation of this alternative. The water rate used for the 2015-2040 period is the average rate for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water rate for the 2015, 2025 and 2035 phases.; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the Aqua third party source and delivery to the existing system is $5.14 per 1,000 gallons of water ($1,674 per ac-ft). The detailed cost estimate is included in ***Appendix G***.

# 7 Cost Summary

Annual unit costs for the three water supply options were developed based on the assumptions described in ***Section 6***. The assumptions were standardized to enable a comparison among the relative costs of each option. A summary for the assumptions and the detailed cost estimates are located in **Appendix F** and ***Appendix G***, respectively. The costs estimates are summarized in 2010 dollars in ***Table 7-1***. The net present values (NPV) in millions of dollars for the three supply options are compared in ***Table 7-2.*** The NPV of capital, other projects, and annual costs in millions of dollars are compared in ***Figure 7-1***. The “Capital Costs” include water supply infrastructure costs. “Other Project Costs” include engineering, survey, environmental studies and mitigation costs, legal and land costs. The “Annual Costs” include debt service on the capital costs, operation and maintenance costs, energy pumping costs, and water usage and reservation rate costs. The net present value (NPV) calculations are based on a rate of 6% for the entire Study. The development of a Simsboro wellfield is the lowest cost option but also has significant uncertainty associated with the development due to the current regulatory environment.

**Table 7-1. Project Cost Summary – 2010 dollars**

| Water Supply Option: | Surface Water | Groundwater | Third Party |
|---|---|---|---|
| **Alternative Description** | **Colorado River diversion & WTP delivered to Bob Bryant Park** | **Simsboro well field delivered to the Loop 150 Tank Yard** | **Aqua water delivered to the Willow Street Plant** |
| **Year Improvements Constructed** | 2015 | 2015 | 2015 |
| **CapitalCosts** | $50,986,000 | $47,725,000 | $93,516,000 |
| **Other Project Costs** | $34,710,100 | $33,375,200 | $62,036,400 |
| **Total Project Costs** | $85,696,100 | $81,100,200 | $155,552,400 |
| **Annual Costs** | $11,109,000 | $9,365,000 | $18,334,000 |
| **Project Yield 2040 (ac-ft/yr)** | 10,949 | 10,949 | 10,949 |
| **Unit Cost $/1,000 gal** | $3.11 | $2.63 | $5.14 |
| **Unit Cost $/ac-ft** | $1,015 | $855 | $1,674 |

**Table 7-2. Project Cost Summary – NPV in Millions of Dollars**

| Water Supply Option: | Surface Water | Ground Water | Third Party |
|---|---|---|---|
| **Alternative Description** | **Colorado River diversion & WTP delivered to Bob Bryant Park** | **Simsboro well field delivered to the Loop 150 Tank Yard** | **Aqua water delivered to the Willow Street Plant** |
| **Year Improvements Constructed** | 2015 | 2015 | 2015 |
| **NPV CapitalCosts** | $38.1 | $35.7 | $69.9 |
| **NPV Other Project Costs** | $25.9 | $24.9 | $46.4 |
| **NPV Total Project Costs** | $64.0 | $60.6 | $116.2 |
| **NPV Annual Costs** | $142.0 | $119.7 | $234.4 |

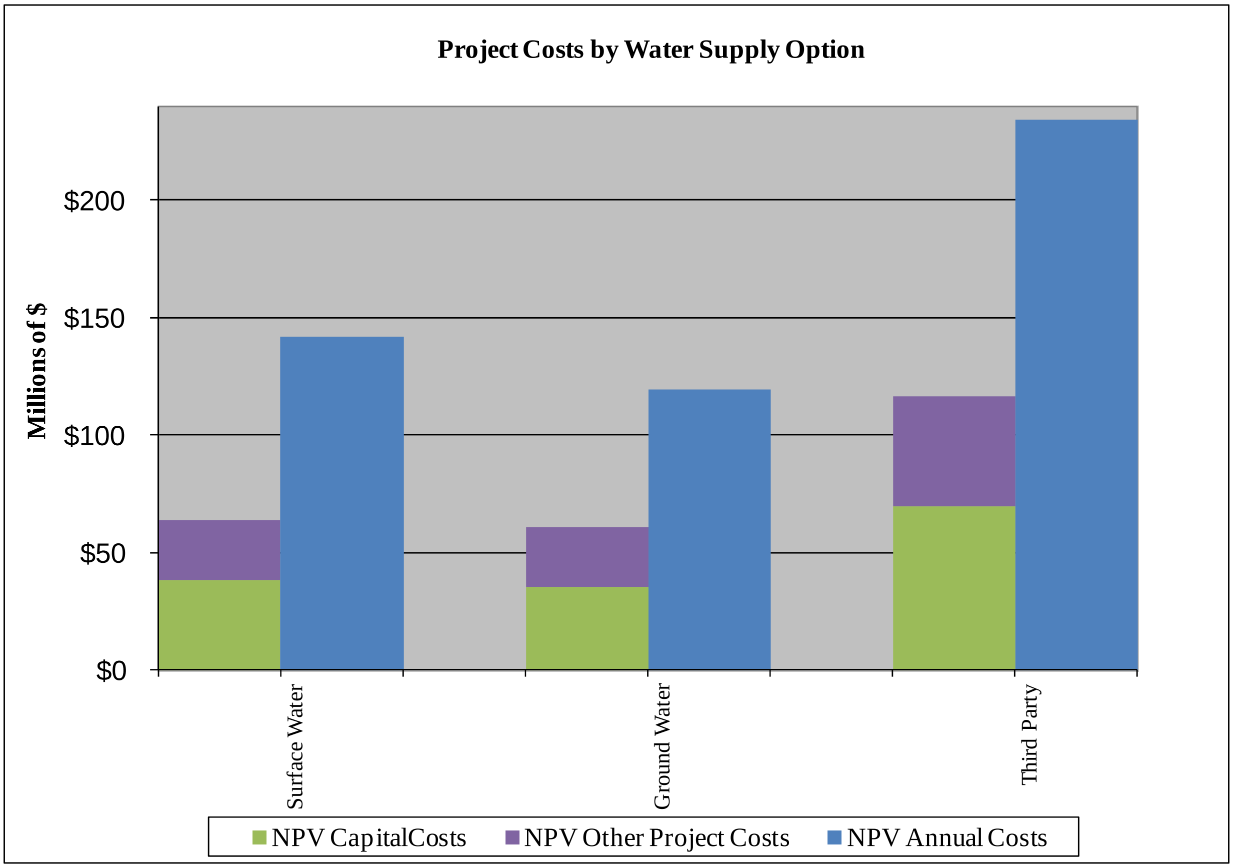



**Figure 7-1 NPV of Costs in Millions of Dollars**

# 8 Facility Implementation Plan Options

The cost analysis presented in ***Section 7*** allows the water supply source options to be compared on a fairly level quantitative baseline by evaluating the facilities for each source required to meet the project 2040 deficit (average delivery rate of 9.8 MGD and a peak day rate of 26.8 MGD). The development reality is that constructing facilities so far beyond the actual water demand is not likely to be fiscally feasible or desirable.

Due to inflation and project mobilization costs, total capital costs of facilities constructed over a phased schedule will likely be higher than a single project. However, total project cost on life cycle or net present value basis could be lower considering operations and maintenance cost savings and the ability to defer a portion of the capital cost to later years. In addition, there is less risk that the system capacity would exceed or trail actual water demand at any point in time, as facility planning could more readily adapted to actual growth in demand (CH2M HILL Technical Memorandum).

The phased implementation plans presented here are only in consideration of the Study Area peak day demand deficit. Additional evaluation of sources and phasing is required to meet the

Extended Study Area projected water demand deficit. This is discussed in Section 9. The implementation plan options for the Study Area are based on the following assumptions:

- The existing Alluvium wells continue to operate at the current production rates;
- All supply options have a 5-year lag time for design, permitting and construction of surface water and groundwater supply development. The phased supply implementation plans were limited to the evaluation of three-phases because more than three-phases within the 30-year study period are likely to begin to overlap each other to due to the duration of project development;
- Phasing scenarios for surface water implementation assume that the raw water intake, raw water transmission pipe, pump station, ground storage tank, treated water transmission pipe, land purchases, and permitting occur in the first surface water phase;
- Phasing scenarios for surface water implementation assume that the construction of pumps to convey water to the system delivery point, and water treatment plant capacity was assumed to occur in stages;
- Phasing scenarios for groundwater implementation assume that the well pump station facilities including all structures, ground storage tank, transmission pipe, land purchases and permitting occur in the first groundwater phase;
- The groundwater ownership is transferred with the land acquired for the wellfield and that no additional costs for groundwater (other regulatory permitting, production and reservation costs) are needed;
- Phasing scenarios for groundwater implementation assume that the construction of wells, treatment facilities and pumps to convey water to the system delivery point occur in stages;
- A groundwater operation production fee of $0.12 per 1,000 gallons based on the LPGCD Resolution 2007-09-01 and $3.50 per ac-ft for reservation fees based on the effective July 15, 2009 rules. Note that the LPGCD reservation fees are a regulatory permitting fee and do not guarantee any amount of water;
- Annual costs for surface water supply are based on LCRA current rates of $151 per ac-ft for firm water and $75 per ac-ft for reserved water. Note that under a firm water contract the reservation fee is a guarantee of the water availability; and
- Piping from the water supply source to the delivery point of the existing system was assumed to be constructed within the first phase.

## 8.1 Implementation Option – Third Party Interim Scenario

According to the demand estimates the Study Area currently faces a peak day deficit and will face an average day deficit in 2020. A project development schedule of five years has been estimated for the supply projects which include a two year design and permitting schedule and a three year construction schedule. Based on this assumption, bringing either the surface water or the groundwater supply online prior to 2015 is not feasible. The 2015 schedule is aggressive and final costs and feasibility options should be evaluated based on a project schedule determined by the City.

Recognizing the difficulties of the timing, the City has two options to meet the estimated demand deficits prior to the implementation of either a long term surface or groundwater supply strategy.

First, the City could invest in other supply options such as new Alluvium or Simsboro wells near the existing distribution system infrastructure. The associated risk is that the capital invested would not be available for future development of the chosen long term water supply strategy. Second, the City could contract with Aqua and risk paying high rates for water. An important consideration is that the interim supply is to satisfy peak day demands which may or may not be needed.

At the time of the Study the City was developing a Simsboro well at Bob Bryant Park with an estimate capacity of 400 gpm. The development began towards the end of the Study and as a result of the timing the well is not accounted for the in the existing supply or the demand deficit estimates presented within the Study. The City could continue to pursue similar projects.

Aqua has indicated that they are open to contracting to the City for a long-term water supply service with a rate and impact fee or a supplementary supply for emergency connect such as peak demands, pipe breaks or fire flows. The supplementary supply would not have an impact fee but would have a higher rate per 1,000 gallons than the long term option. Correspondence with Aqua has indicated that they would consider this three to five year interim supply strategy a short term supplementary supply. Although the assumed rate of $3.50 is higher than Aqua's current retail rate it is likely that the rate associated with this interim option may be higher.

The development of the interim option is based upon the assumption that the City will pursue a third party agreement with Aqua.

Aqua currently has an 8-inch line at the Loop 150 and Hwy 21 intersection which would need to be extended approximately 300 feet across the intersection to the Loop 150 Tank Yard. This line is fed by the CS wellfield and as previously discussed has significant capacity. Delivery to the Loop 150 Tank Yard interconnect is more likely to be limited by the pipe sizes and capacity than the production capacity of the wellfield source.

Aqua has an 8-inch line at Hasler Shores and Old Austin Highway which is served by the S Wellfield. The 8-inch line would need to be extended from this intersection approximately 4,400 linear feet to the Bob Bryant Park facilities. There is a small amount of excess production capacity at the S wellfield; however Aqua plans to increase the production capacity of the field by adding a well. Aqua has a site identified and a production permit for a new well, S-9, which is estimated to produce 1,000 to 1,200 gpm. The required raw water transmission line for this well is likely the critical path infrastructure for this interconnect and may require a year of lead time.

Aqua has preliminarily indicated that a likely peak demand of 1.8 MGD is available to be supplied in some combination of the delivery points and volumes. Regardless of which option the City chooses to pursue, Aqua will need time to run detailed models of the demands on their system to determine how much water they can supply at the various delivery points. Any third party supply scenario will also require time for the development of a contract. The cost estimate for this interim supply option is based on the following assumptions:

- The interim option will serve the peak day deficit from 2012 to 2015 (1.8 MGD or 1230 gpm). This assumes the contract and infrastructure can be in place by the summer of 2012 and that the contracted water will not be required past 2015 when other water supply facilities are assumed to be in place;
- Water from Aqua will be delivered to both the Bob Bryant Park facilities and the Loop 150 Tank Yard and as such, no tanks or pumps are required to convey the water supply to the distribution facilities;
- An assumed rate of $3.50 per 1,000 gallons was provided by the City for evaluation of this alternative;
- No impact fees were included due to the interim nature and minimal usage of this option. It should be noted that although the cost estimate only applies a cost to the water used to meet peak day demand for 2012 to 2015, a contract with Aqua will most likely require a base fee as well; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the interim third party source from Aqua is $3.60 per 1,000 gallons of water ($1,174 per ac-ft) based on the peak demand deficit in 2015. The approach to estimate the unit cost for the interim option was changed to use the peak demand deficit rather that the average demand deficit to estimate the unit cost because in this interim phase there is not average demand deficit. The cost for this interim phase is reflected in both the following surface water and groundwater phasing implementation plans as preceding the first phase of the surface water or groundwater implementation plans.

## 8.2 Implementation Option – Three-Phase Surface Water Scenario

The surface water supply option phased construction of the water treatment plant in increments of a 10 MGD unit in 2015, a 10 MGD unit in 2025, and a 6.8 MGD unit in 2035. The water cost and water reservation fees for these implementation phases track the demands and reservations of the following phase. Meaning that the water costs included in the annual costs for the 2015 phase account for the 2025 water demand, the water costs included in the annual costs for the 2025 phase account for the 2035 water demand and the water costs included in the annual costs for the 2035 phase account for the 2040 water demand. As part of the feasibility study for a specific implementation plan it is recommended that the City complete a year by year annual fiscal analysis of the options. For the remainder of the facilities, discussed in ***Section 6.1***, phasing assumptions were applied and the detailed cost estimates are in ***Appendix H***. ***Table 8-1*** and ***Table 8-2*** show the 2010 costs and the NPV costs of the implementation plan. The "Capital Costs" include water supply infrastructure costs. "Other Project Costs" include engineering, survey, environmental studies and mitigation costs, legal and land costs. The "Annual Costs" include debt service on the capital costs, operation and maintenance costs, energy pumping costs, and water usage and reservation rate costs. The net present value (NPV) calculations are based on a rate of 6%. The phased implementation results in higher capital costs in 2010 dollars, however, deferring these costs results in a lower NPV as compared to the single phase surface water implementation. ***Figure 8-1*** demonstrates how the phased surface water option tracks the demand curve more closely than a single implementation phase. The triggers for each phase are also shown in terms of SUEs.

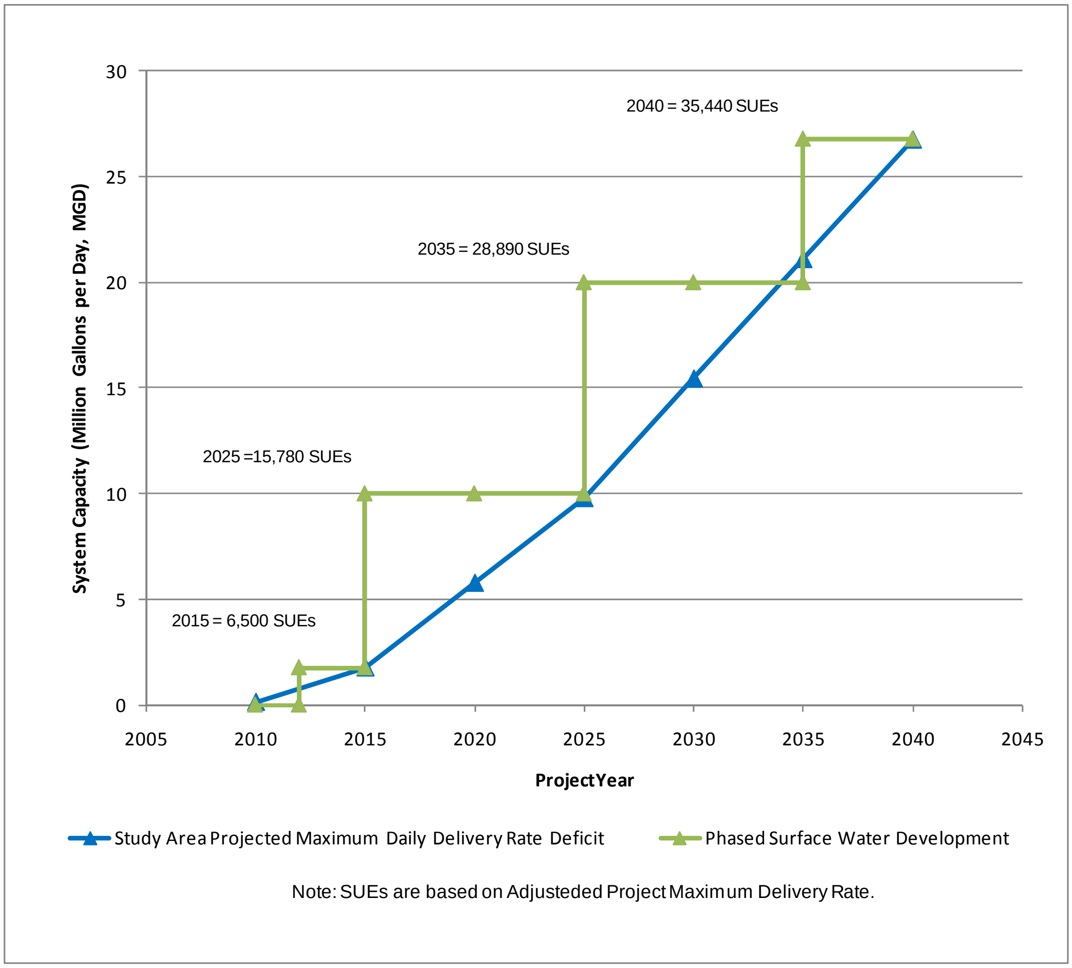



**Figure 8-1 Demand Deficit versus Surface Water Implementation**

**Table 8-1. Three-Phase Surface Water 2010 Costs**

| Water Supply Option: | Interim Third Party | Surface Water Phase 1 | Surface Water Phase 2 | Surface Water Phase 3 | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank Yard | Colorado River diversion & Phase 1 WTP delivered to Bob Bryant Park | Colorado River diversion & Phase 2 WTP delivered to Bob Bryant Park | Colorado River diversion & Phase 3 WTP delivered to Bob Bryant Park | Total of Surface Water |
| Year Improvements Constructed | 2012 | 2015 | 2025 | 2035 | - |
| CapitalCosts | $468,000 | $27,189,550 | $22,555,100 | $16,567,350 | $66,312,000 |
| Other Project Costs | $371,800 | $19,059,100 | $14,835,000 | $10,896,000 | $44,790,100 |
| Total Project Costs | $839,800 | $46,248,650 | $37,390,100 | $27,463,350 | $111,102,100 |
| Annual Costs | $2,323,000 | $6,111,000 | $5,494,000 | $4,137,000 | $15,742,000 |
| Project Yield (ac-ft/yr) | 1,979 | 2,486 | 5,642 | 2,821 | 10,949 |
| Unit Cost $/1,000 gal | $3.60 | $7.54 | $2.99 | $4.50 | $4.41 |
| Unit Cost $/ac-ft | $1,174 | $2,458 | $974 | $1,466 | $1,438 |

**Table 8-2. Three-Phase Surface Water NPV Costs (Millions $)**

| Water Supply Option: | Interim Third Party | Surface Water Phase 1 | Surface Water Phase 2 | Surface Water Phase 3 | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank Yard | Colorado River diversion & Phase 1 WTP delivered to Bob Bryant Park | Colorado River diversion & Phase 2 WTP delivered to Bob Bryant Park | Colorado River diversion & Phase 3 WTP delivered to Bob Bryant Park | Total of Surface Water |
| Year Improvements Constructed | 2012 | 2015 | 2025 | 2035 | - |
| SW NPV CapitalCosts | $0.4 | $20.3 | $9.4 | $3.9 | $33.6 |
| SW NPV Other Project Costs | $0.3 | $14.2 | $6.2 | $2.5 | $23.0 |
| SW NPV Total Project Costs | $0.7 | $34.6 | $15.6 | $6.4 | $56.6 |
| SW NPV Annual Costs | $6.2 | $74.6 | $52.7 | $17.4 | $144.7 |

## 8.3 Implementation Option – Three-Phase Groundwater Scenario

The groundwater supply option phases the wellfield development in increments of 11.5 MGD, 11.5 MGD, and 3.8 MGD. These peak production rates are based on the 2,660 gpm wells being constructed in groups of three wells in 2015, three wells in 2025 and the seventh well in 2035. The water operation and production fees and the water reservation fees for these implementation phases track the demands and reservations of the following phase. Meaning that the water costs included in the annual costs for the 2015 phase account for the 2025 water demand, the water costs included in the annual costs for the 2025 phase account for the 2035 water demand and the water costs included in the annual costs for the 2035 phase account for the 2040 water demand. As part of the feasibility study for a specific implementation plan it is recommended that the City complete a year by year annual fiscal analysis of the options. For the remainder of the facilities, discussed in ***Section 6.2,*** phasing assumptions were applied and the detailed cost estimates are in ***Appendix H***. ***Table 8-3*** and ***Table 8-4*** show the 2010 costs and the NPV costs of the implementation plan. The "Capital Costs" include water supply infrastructure costs. "Other Project Costs" include engineering, survey, environmental studies and mitigation costs, legal and land costs. The "Annual Costs" include debt service on the capital costs, operation and maintenance costs, energy pumping costs, and water usage and reservation rate costs. The net present value (NPV) calculations are based on a rate of 6%. The phased implementation does not result in a significant difference in 2010 dollars to be spent due to the way the wells can more easily be incrementally developed compared to a WTP. The phased well development and deferment of these capital expenditures does result in a lower NPV as compared to the single phase Simsboro implementation. ***Figure 8-2*** demonstrates how the phased groundwater option track the demand curve more closely than a single implementation phase. The triggers for each phase are also shown in terms of SUEs. These triggers match that shown for the three-phase surface water option because the SUE's represent the demand which occurs in 2015, 2025, 2035 and 2040 that would trigger the start of project development for the next water supply phase. These demands do not change based on the water supply options.

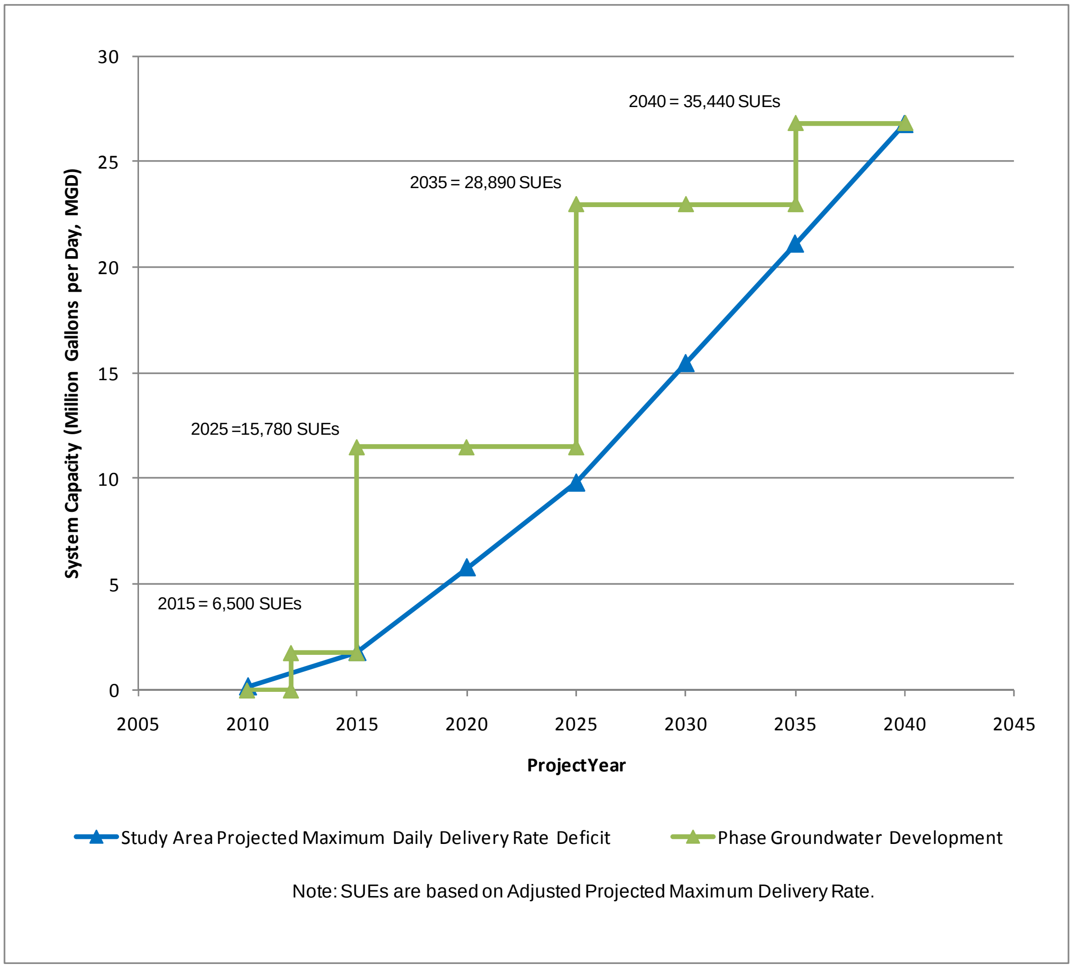



**Figure 8-2 Demand Deficit vs Groundwater Implementation**

**Table 8-3. Three-Phase Groundwater 2010 Costs**

| Water Supply Option: | Interim Third Party | Groundwater Phase 1 | Groundwater Phase 2 | Groundwater Phase 3 | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank Yard | Simsboro well field Phase 1 delivered to the Loop 150 Tank Yard | Simsboro well field Phase 2 delivered to the Loop 150 Tank Yard | Simsboro well field Phase 3 delivered to the Loop 150 Tank Yard | Total of Groundwater |
| **Year Improvements Constructed** | 2012 | 2015 | 2025 | 2035 | - |
| **CapitalCosts** | $468,000 | $26,484,875 | $14,815,500 | $6,466,400 | $47,766,775 |
| **Other Project Costs** | $371,800 | $18,980,100 | $10,110,800 | $4,408,300 | $33,499,200 |
| **Total Project Costs** | $839,800 | $45,464,975 | $24,926,300 | $10,874,700 | $81,265,975 |
| **Annual Costs** | $2,323,000 | $4,876,000 | $3,409,000 | $1,418,000 | $9,703,000 |
| **Project Yield (ac-ft/yr)** | 1,979 | 2,486 | 5,642 | 2,821 | 10,949 |
| **Unit Cost $/1,000 gal** | $3.60 | $6.02 | $1.85 | $1.54 | $2.72 |
| **Unit Cost $/ac-ft** | $1,174 | $1,961 | $604 | $503 | $886 |

**Table 8-4. Three-Phase Groundwater NPV Costs (Millions $)**

| Water Supply Option: | Interim Third Party | Groundwater Phase 1 | Groundwater Phase 2 | Groundwater Phase 3 | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank Yard | Simsboro well field Phase 1 delivered to the Loop 150 Tank Yard | Simsboro well field Phase 2 delivered to the Loop 150 Tank Yard | Simsboro well field Phase 3 delivered to the Loop 150 Tank Yard | Total of Groundwater |
| Year Improvements Constructed | 2012 | 2015 | 2025 | 2035 | - |
| GW NPV CapitalCosts | $0.4 | $19.8 | $6.2 | $1.5 | $27.5 |
| GW NPV Other Project Costs | $0.3 | $14.2 | $4.2 | $1.0 | $19.4 |
| GW NPV Total Project Costs | $0.7 | $34.0 | $10.4 | $2.5 | $46.9 |
| GW NPV Annual Costs | $6.2 | $62.1 | $33.0 | $6.0 | $101.2 |

## 8.4 Implementation Plan – Three-Phase Joint Surface and Groundwater Scenario

This joint surface water and groundwater supply option evaluates the cost benefit of implementing a combined strategy. The joint option evaluated assumes a 9.8 MGD surface WTP is constructed in 2015, three 2,660 gpm (11.5 MGD) Simsboro wells are constructed in 2025, and two 2,660 gpm (7.7 MGD) Simsboro wells are constructed in 2035. The WTP is sized to meet the 2040 average day demand, which is approximately equivalent to the 2025 maximum day delivery rate. In 2025 and 2035 phased wellfield developments are planned to meet the subsequent maximum day delivery rate.

The development of the cost estimate for the joint surface water and groundwater option is based upon the following assumptions:

- Capacity of the WTP is based on the 2040 average delivery rate of 9.8 MGD. All associated surface water facilities are also sized for the 2040 average day rate. *Note that the previous capacity analyzed for stand-alone option was the peak, or maximum, delivery rate*;
- All pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- A river intake and diversion structure are included;
- 24-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed;
- 40-acres of land were acquired for the water treatment plant facilities;
- A 1.0 MG clear well is adjacent to the WTP. The clear well is approximately 10 percent of the average day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- Approximately 1.3-miles of 24-inch pipe from the WTP to the Bob Bryant Park facilities;
- Annual costs for water supply are based on LCRA current rates of $151 per ac-ft for firm water; and

- The wellfield is comprised of five high yield wells each with production rate of 2,660 gpm implemented in two phases;
- A total of 40-acres was acquired for all of the wells and it was assumed that groundwater ownership is transferred with the land acquired for the wellfield such that no additional costs for groundwater (other than regulatory permitting, production and reservation costs) are needed;
- Each well is assumed to have 7,500 feet of 15-inch pipe to the storage tank and treatment facilities;
- A 2.0 MG storage tank is located adjacent to the wellfield. The tank is approximately 10 percent of the peak day delivery volume supplied by the wells and will balance hourly fluctuations and meet peak hour system demands;
- Chlorination and treatment for reduction of high metal ions is required for the groundwater. Treatment will occur in a single location adjacent to the storage tank prior to the wellfield water being transmitted to the City. Treatment costs were based on a recent cost study for oxidation and greensand filtration for the removal of manganese and iron. Each well was assumed to have the same average water quality properties discussed in ***Section 10***. If a pilot well indicates that the water is far outside of the average water quality parameters it is recommended to not pursue a well at that location;
- Approximately 10.5 miles of 36-inch pipe from the wellfield to the Loop 150 Tank Yard;
- All pipeline easements are 40-feet wide;
- A groundwater operation production fee of $0.12 per 1,000 gallons based on the LPGCD Resolution 2007-09-01 and $3.50 per ac-ft for reservation fees based on the effective July 15, 2009 rules;
- Annual costs for surface water supply are based on LCRA current rates of $151 per ac-ft for firm water and $75 per ac-ft in reservation fees;
- The water rate and fees used for the first surface water phase of the implementation are the same averages unit costs development for the single phase surface and groundwater implementation scenarios; and
- Distribution system improvements are not assessed for this Study.

Detailed cost estimates are in ***Appendix H***. ***Table 8-5*** and ***Table 8-6*** show the 2010 costs and the NPV costs of the implementation plan option. The unit costs presented are based on the ratio of the project yield in average day demand and the annual costs. The entire average day demand for the study period is met entirely by the surface WTP and since the groundwater is used to satisfy the peak demand only, a unit price for each of the groundwater phases is not presented. The "Capital Costs" include water supply infrastructure costs. "Other Project Costs" include engineering, survey, environmental studies and mitigation costs, legal and land costs. The "Annual Costs" include debt service on the capital costs, operation and maintenance costs, energy pumping costs, and water usage and reservation rate costs. The net present value (NPV) calculations are based on a rate of 6%.

***Figure 8-3*** demonstrates how the phased surface and groundwater option track the demand curve more closely than a single implementation phase. The triggers for each phase are also shown in terms of SUEs. These triggers match that shown for the three-phase surface water and groundwater options because the SUE's represent the demand which occurs in 2015, 2025, 2035 and 2040 that would trigger the start of project development for the next water supply phase. These demands do not change based on the water supply options.

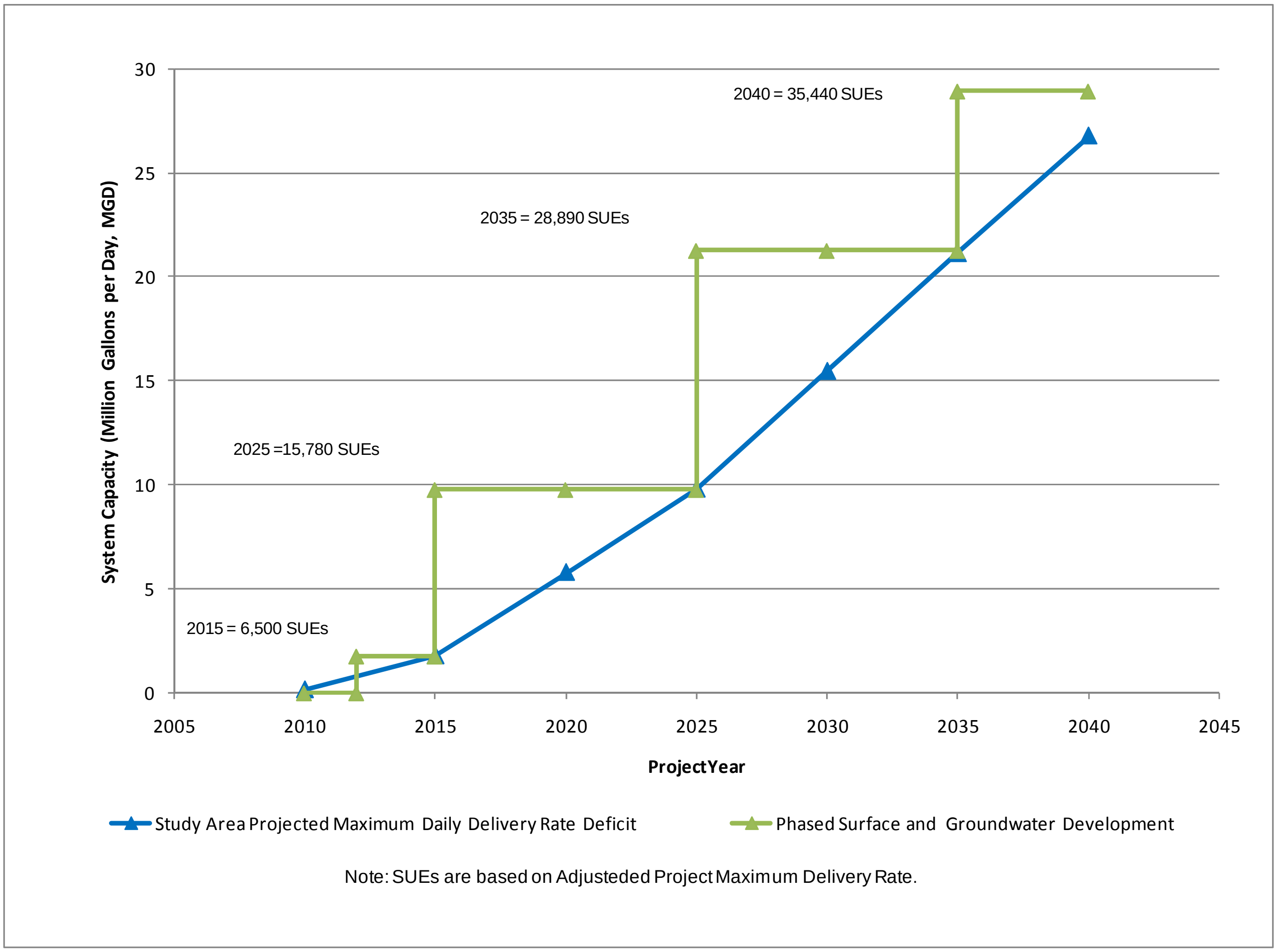



**Figure 8-3 Demand Deficit vs Joint Surface and Groundwater Implementation**

**Table 8-5. Three-Phase Surface and Groundwater 2010 Costs**

| Water Supply Option: | Interim Third Party | Surface Water | Groundwater Phase 1 | Groundwater Phase 2 | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank | Colorado River diversion & WTP delivered to Bob Bryant Park | Simsboro well field delivered to the Loop 150 Tank Yard | Simsboro well field delivered to the Loop 150 Tank Yard | Total of Surface and Groundwater |
| Year Improvements Constructed | 2012 | 2015 | 2025 | 2035 | - |
| CapitalCosts | $468,000 | $28,000,000 | $28,182,600 | $10,710,400 | $66,893,000 |
| Other Project Costs | $371,800 | $19,593,100 | $20,096,100 | $7,306,600 | $46,995,800 |
| Total Project Costs | $839,800 | $47,593,100 | $48,278,700 | $18,017,000 | $113,888,800 |
| Annual Costs | $2,323,000 | $7,911,000 | $12,739,000 | $2,508,000 | $23,158,000 |
| Project Yield 2040 (ac-ft/yr) | 1,979 | 10,949 | 0 | 0 | 10,949 |
| Unit Cost $/1,000 gal | $3.60 | $2.22 | - | - | $6.49 |
| Unit Cost $/ac-ft | $1,174 | $723 | - | - | $2,115 |

**Table 8-6. Three-Phase Surface and Groundwater NPV Costs (Millions $)**

| Water Supply Option: | Interim Third | Surface Water | Ground Water | Groundwater | |
|---|---|---|---|---|---|
| Alternative Description | Aqua water delivered to the Bob Bryant and Loop 150 Tank | Colorado River diversion & WTP delivered to Bob Bryant Park | Simsboro well field delivered to the Loop 150 Tank Yard | Simsboro well field delivered to the Loop 150 Tank Yard | Total of Surface and Groundwater |
| Year Improvements Constructed | 2012 | 2015 | 2025 | 2035 | - |
| NPV CapitalCosts | $0.4 | $21 | $12 | $2 | $35.2 |
| NPV Other Project Costs | $0.3 | $15 | $8 | $2 | $24.7 |
| NPV Total Project Costs | $0.7 | $36 | $20 | $4 | $59.9 |
| NPV Annual Costs | $6.2 | $101 | $105.5 | $10.6 | $217.2 |

# 9 Extended Study Area

The Extended Study Area expands beyond the Study Area reaching west to the Bastrop and Travis County line and north approximately midway between Bastrop and Elgin. The area is approximately two and a half times greater than the Study Area. Water supply options and costs evaluated for the Extended Study Area follow the same methodology outlined in ***Sections 6 and 7*** for the Study Area. A unit cost ($/1,000 gallons) was developed for the lower Colorado surface water, Simsboro ground water, and Aqua third party water supply option based on the annualized capital costs of proposed facilities required to address the projected average annual 2040 Extended Study Area deficit of 17,843 acre-feet. The unit costs reflect the facilities required to develop the water supply source and transport the water to delivery points within the City's existing distribution system previously identified in ***Section 6***. Improvements to or expansion of the water distribution system are not considered in this Study.

Each of the water supply source options are discussed in greater detail in the following sections followed by a summary of the cost comparisons.

## 9.1 Surface Water Option

Referring to ***Section 6.1***, the firm water available for contract with LCRA is great enough to meet the demands of the 2040 Extended Study Area. The need for local storage facilities to meet peak demands remains an issue to be reviewed with a feasibility study. The development of the cost estimate for the surface water option is based upon the following assumptions:

- An average delivery rate of 15.9 MGD and a peak day capacity of 40.6 MGD. All facilities are sized for the peak day rate;
- All pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- A river intake and diversion structure are included;
- 48-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed;
- 60-acres of land were acquired for the water treatment plant facilities;
- A 4.06 MG clear well is adjacent to the WTP. The clear well is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- Approximately 1.3 miles of 48-inch pipe from the WTP to the Bob Bryant Park facilities;
- All pipeline easements are 40-feet wide;
- Annual costs for water supply are based on LCRA current rates of $151 per ac-ft for firm water and $75 per ac-ft for reserved water. The water rate used for the 2015-2040 period is the average rate for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water and reservations rates for the 2015, 2025 and 2035 phases. Note that under a firm water contract the reservation fee is a guarantee of the water availability; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the surface water source and delivery to the existing system is $2.62 per 1,000 gallons of water ($853 per ac-ft). The detailed cost estimate is included in ***Appendix I***.

## 9.2 Groundwater Option

For the purposes of this Study, the well yields were assumed to remain the same and more wells were added to the wellfield to meet the 2040 Extended Study Area demand. The development of the cost estimate for the Simsboro groundwater option is based upon the following assumptions:

- An average delivery rate of 15.9 MGD and a peak day capacity of 40.6 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- The wellfield is comprised of 11 high yield wells each with production rate of 2,660 gpm;
- A total of 60-acres was acquired for all of the wells and it was assumed that groundwater ownership is transferred with the land acquired for the wellfield such that no additional

costs for groundwater (other than regulatory permitting, production and reservation costs) are needed;

- Each well is assumed to have 7,500 feet of 15-inch pipe to the storage tank and treatment facilities;
- A 4.06 MG storage tank is located adjacent to the wellfield. The tank is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur in a single location adjacent to the storage tank prior to the wellfield water being transmitted to the City. Treatment costs were based on a recent cost study for oxidation and greensand filtration for the removal of Manganese and Iron. Each well was assumed to have the same average water quality properties discussed in ***Section 10***. If a pilot well indicates that the water is far outside of the average water quality parameters it is recommended to not pursue a well at that location;
- Approximately 10.5 miles of 48-inch pipe from the wellfield to the Loop 150 Tank Yard;
- All pipeline easements are 40-feet wide;
- A groundwater operation production fee of $0.12 per 1,000 gallons based on the LPGCD Resolution 2007-09-01 and $3.50 per ac-ft for reservation fees based on the effective July 15, 2009 rules. The operation production and the reservation fee used for the 2015-2040 period is the average fee for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water production and reservations fees for the 2015, 2025 and 2035 phases. Note that the LPGCD reservation fees are a regulatory permitting fee and do not guarantee any amount of water; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the Simsboro groundwater source and delivery to the existing system is $2.32 per 1,000 gallons of water ($756 per ac-ft). The detailed cost estimate is included in ***Appendix I***.

## 9.3 Third Party Option

The development of the cost estimate for the Aqua third party option is based upon the following assumptions:

- An average delivery rate of 15.9 MGD and a peak day capacity of 40.6 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities between 5 and 7 feet per second during peak day flows;
- The contract with Aqua will require water to be delivered at an appropriate water quality and the City will not need to provide any treatment;
- A 4.06 MG storage tank is located at the CS wellfield. The tank is of approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;

- A pump station will not be required to transport water to the Willow Street Water Plant. The CS Wellfields at CR 403 (~460-feet) are approximately 90-feet higher in elevation than the Willow Street Plant Tank 1 overflow (371-feet). The static head difference is great enough to overcome the pipe friction head loss based on average day flows and the peak day flow head loss. This assumption that pumps are not required for the peak day are based on the scenario that the standpipe elevation is enough to overcome the peak day head loss and that the contract with Aqua requires water delivery to the standpipe at the required head;
- Approximately 6.75 miles of 48-inch pipe from the wellfield to the Willow Street Water Plant;
- Operation and maintenance costs were only assumed for the pipe line from the Aqua wellfield to the Willow Street facilities;
- An impact fee of $4,500 per SUE based on the current Aqua Water Tariff Section 2.02.b for Non-Compliant Subdivisions requiring capacity reservation for a single SUE. The water rate used for the 2015-2040 period is the average rate for phased purchasing development periods equivalent to the three phase implementation scenario. Meaning the impact fee used is the average of the fee for the 2015, 2025 and 2035 phases.;
- An assumed rate of $3.50 per 1,000 gallons was provided by the City for evaluation of this alternative. The water rate used for the 2015-2040 period is the average rate for phased purchasing in periods equivalent to the three phase implementation scenario. Meaning the rate used is the average of the water rate for the 2015, 2025 and 2035 phases.; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the Aqua third party source and delivery to the existing system is $5.35per 1,000 gallons of water ($1,742 per ac-ft). The detailed cost estimate is included in ***Appendix I***.

## 9.4 Cost Summary

A summary for the assumptions and the detailed cost estimates are located in ***Appendix I***. The costs estimates are summarized in 2010 dollars in ***Table 9-1***. The net present value (NPV) in millions of dollars for the three supply options are compared in ***Table 9-2.*** The NPV of capital, other projects, and annual costs in millions of dollars are compared in ***Figure 9-1***. The unit costs for all three options are slightly lower than the unit costs for the Study Area due to the economies of scale. However, the comparative results amongst the three options are the same. Similar to the Study Area, for the Extended Study Area the development of a Simsboro wellfield is the lowest cost option but also has significant uncertainty associated with the development due to the current regulatory environment.

## Table 9-1. Project Cost Summary – 2010 dollars

| Water Supply Option: | Surface Water | Groundwater | Third Party |
|---|---|---|---|
| **Alternative Description** | **Colorado River diversion & WTP delivered to Bob Bryant Park** | **Simsboro well field delivered to the Loop 150 Tank Yard** | **Aqua water delivered to the Willow Street Plant** |
| **Year Improvements Constructed** | 2015 | 2015 | 2015 |
| **CapitalCosts** | $70,972,000 | $64,549,000 | $148,619,000 |
| **Other Project Costs** | $48,056,300 | $45,063,500 | $98,276,400 |
| **Total Project Costs** | $119,028,300 | $109,612,500 | $246,895,400 |
| **Annual Costs** | $15,214,000 | $13,488,000 | $31,091,000 |
| **Project Yield 2040 (ac-ft/yr)** | 17,843 | 17,843 | 17,843 |
| **Unit Cost $/1,000 gal** | $2.62 | $2.32 | $5.35 |
| **Unit Cost $/ac-ft** | $853 | $756 | $1,742 |

## Table 9-2. Project Cost Summary – NPV in Millions of Dollars

| Water Supply Option: | Surface Water | Ground Water | Third Party |
|---|---|---|---|
| **Alternative Description** | **Colorado River diversion & WTP delivered to Bob Bryant Park** | **Simsboro well field delivered to the Loop 150 Tank Yard** | **Aqua water delivered to the Willow Street Plant** |
| **Year Improvements Constructed** | 2015 | 2015 | 2015 |
| **NPV CapitalCosts** | $53.0 | $48.2 | $111.1 |
| **NPV Other Project Costs** | $35.9 | $33.7 | $73.4 |
| **NPV Total Project Costs** | $88.9 | $81.9 | $184.5 |
| **NPV Annual Costs** | $194.5 | $172.4 | $397.4 |

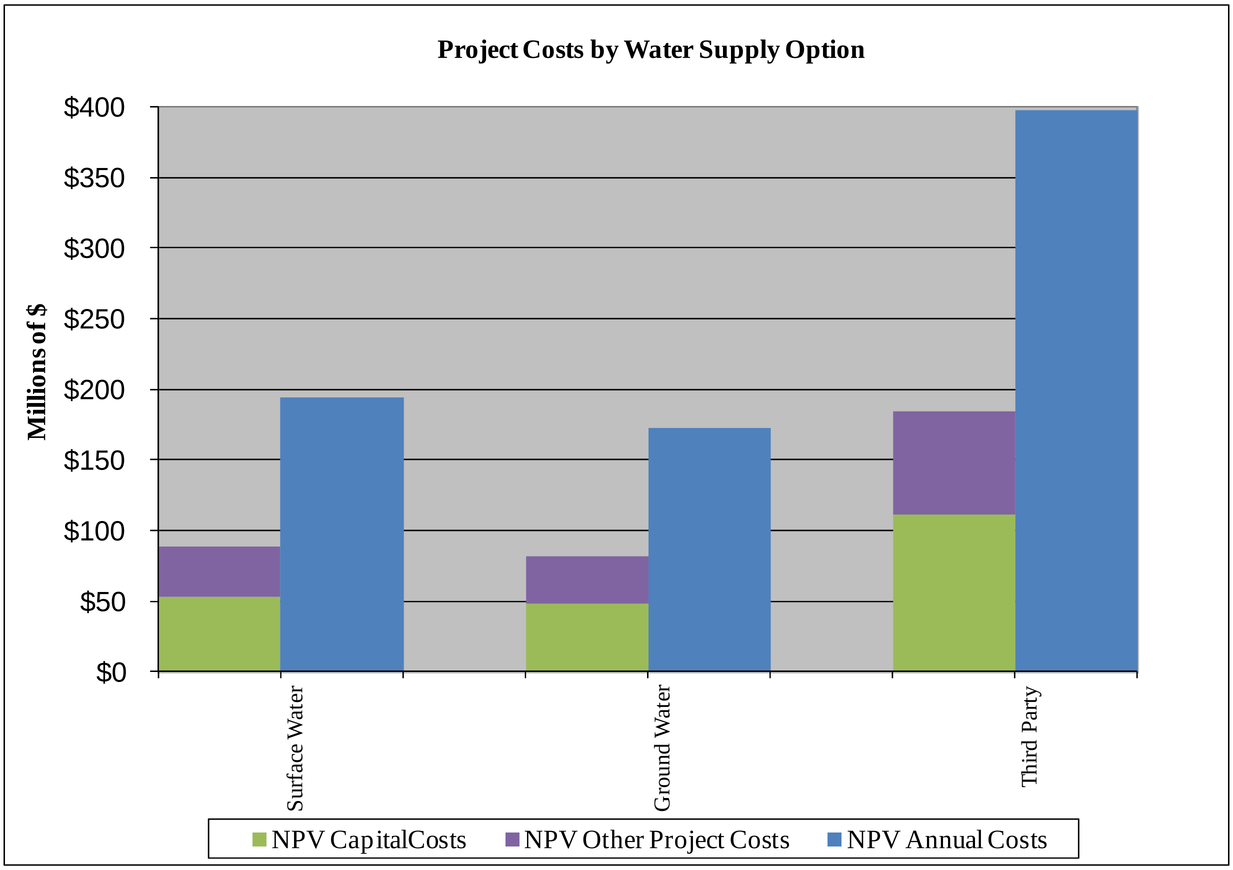



**Figure 9-1 NPV of Costs in Millions of Dollars**

# 10 Blending Assessment

Each water source has different chemical characteristics. The impacts of the multiple water sources distributed within the same water system must be understood to protect the system and mitigate any undesirable effects of blending the sources. Therefore, a high-level blending assessment of the three water supply sources was performed to provide a preliminary overview of source compatibility, necessary treatments to achieve water quality goals, and to mitigate corrosive potential. The full discussion of the blending assessment is located in ***Appendix J*** and a summary of thr findings follows.

TCEQ public drinking water standards (TAC 30 Chapter 290) were used to set water quality goals. Various sources with water quality data on existing supply sources including the TWDB, the Railroad Commission and the City of Austin were used to estimate average water quality parameters for each water source. The water quality goals and average water quality for the potential water supply sources within the County are shown in ***Table 10-1***. These average characteristics were used for the blending analysis. A detailed blending analysis of the actual source water should occur prior to implementation of a water supply plan.

**Table 10-1. Water Quality Goals and Source Characteristics**

| Constituent | Goal | TCEQ Standard | Alluvium Average | Simsboro Average | Raw Colorado Average |
|---|---|---|---|---|---|
| TDS (mg/L) | < 500 | 1000 | 454.2 | 497 | 353 |
| pH | 6.5-8.5 | 6.5-8.5 | 7.3 | 7.3 | 8.1 |
| Total Alkalinity (mg/L) | > 100 | - | 251.2 | 195.9 | 165.7 |
| Temperature (C°) | - | - | 22.7 | 25.5 | 21.2 |
| Iron (mg/L) | 0.3 | 0.3 | 0.078 | 2.582 | 0.099 |
| Manganese (mg/L) | 0.05 | 0.05 | 0.046 | 0.15 | 0.013 |
| Calcium (mg/L) | - | - | 106.2 | 68 | 53.5 |
| Magnesium (mg/L) | - | - | 26.2 | 13.8 | 22 |
| Chloride (mg/L) | < 250 | 300 | 48.8 | 89.5 | 58.8 |
| Sulfate (mg/L) | < 250 | 300 | 67 | 87.4 | 46.5 |
| Nitrate (mg/L) | 10 | 10 | 17 | 0.7 | 1.5 |
| **Corrosion Properties** | | | | | |
| Ryznar Index (RI) | 6.5 to 7.0 | - | 6.77 | 7.32 | 6.93 |
| Langelier Saturation Index (LI) | Slightly > 0 | - | 0.26 | -0.01 | 0.58 |
| Calcium Carbonate Precipitation Potential (CCPP) | 4 to 10 mg/L as CaCO3 | - | 22.33 | -0.04 | 13.2 |
| Larsons Ratio (LR) | Alk/(Cl- + SO42-) > 5 | - | 1.8 | 0.9 | 1.3 |

As shown, all constituents are within the TCEQ primary standard limit with the exception of the nitrate concentrations, which are greater than 10 milligrams per liter (mg/L). Elevated nitrate concentrations were evident in six of the County Alluvium wells within the available databases utilized for this Study. One of which was constructed by the City in 1950 and has since been plugged. None of the existing City Alluvium wells have reported elevated nitrate concentrations.

A total water volume of 15 million gallons per day was considered for the blending assessment. Referring to ***Table 4-6*** and ***Table 4-7***, this volume is roughly equivalent to the Extended Study Area average annual water demand for the year 2040. As with the new water source development, the three blending scenarios evaluated assume that the existing Alluvium wells will continue to be a source at the same current production rate. The remainder of the 15 MGD is assumed to be newly developed water sources according to the ratios listed in ***Table 10-2***. The results of the blending analysis are shown in ***Table 10-3***.

**Table 10-2. Water Source Blending Ratios**

| | Existing Bastrop Alluvial Wells MGD | Simsboro Wells MGD | Colorado River Water MGD | Total Volume Water MGD |
|---|---|---|---|---|
| Scenario 1 | 3.85 | 11.15 | 0 | 15.00 |
| Scenario 2 | 3.85 | 0 | 11.15 | 15.00 |
| Scenario 3 | 3.85 | 5.58 | 5.58 | 15.00 |

**Table 10-3. Blended Water Quality Results**

| Constituent | Goal | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|
| TDS (mg/L) | < 500 | 486 | 379 | 432 |
| pH | 6.5-8.5 | 7.30 | 7.23 | 7.28 |
| Total Alkalinity (mg/L) | > 100 | 210.10 | 173.70 | 7.28 |
| Temperature (C°) | - | 24.80 | 21.59 | 21.59 |
| Iron (mg/L) | 0.3 | 1.90 | 0.09 | 1.01 |
| Manganese (mg/L) | 0.05 | 0.120 | 0.021 | 0.072 |
| Calcium (mg/L) | - | 77.80 | 67.00 | 72.40 |
| Magnesium (mg/L) | - | 17.00 | 23.10 | 20.00 |
| Chloride (mg/L) | < 250 | 79.10 | 56.20 | 67.60 |
| Sulfate (mg/L) | < 250 | 82.20 | 51.80 | 57.00 |
| Nitrate (mg/L) | 10 | 4.90 | 5.50 | 5.20 |
| **Corrosion Properties** | | | | |
| Ryznar Index (RI) | 6.5 to 7.0 | 7.15 | 7.54 | 7.33 |
| Langelier Saturation Index (LI) | Slightly > 0 | 0.07 | -0.16 | -0.03 |
| Calcium Carbonate Precipitation Potential (CCPP) | 4 to 10 mg/L as CaCO3 | 4.99 | -8.13 | -1.05 |
| Larsons Ratio (LR) | Alk/(Cl- + SO42-) > 5 | 1.10 | 1.30 | 1.20 |

Scenario 1 assumes the blending of Simsboro and Alluvium water. Chlorination and "green sand filters" are necessary treatments for the Simsboro water to treat the elevated iron and manganese levels common in the aquifer. These treatments are recommended to occur at the wellfield prior to the water being transmitted to the distribution system. Treatment at the source simplifies the facilities planning within the distribution system. The chlorination and metal ion treatment is minimal enough relative to the total operation and maintenance (O&M) costs of the wells such that no additional costs were factored into the cost estimates presented in ***Section 7***. Water quality characteristics vary widely within the Simsboro and it is recommended that a sample well which yields water outside the average range presented in ***Table 10-1*** not be pursued for a water supply source without further evaluation of the increased O&M costs.

Scenario 2 assumes the blending of lower Colorado River surface water and Alluvium water. Conventional coagulation-flocculation-sedimentation-filtration and chlorination process is necessary for the surface water at the WTP. Prior to implementation of a surface water scenario, a thorough water chemistry analysis is necessary to evaluate the risks of disinfection byproducts developing. Additionally, the lower Colorado River water and the Scenario 2 blended water are slightly corrosive and will require a pH modification treatment such as the addition of sodium hydroxide at the plant to stabilize the water prior to entering the distribution system. Although the sodium hydroxide treatment is not part of conventional WTP, the costs are minimal enough relative to the total O&M costs such that no additional costs were factored into the cost estimates presented in ***Section 7***.

Scenario 3 assumes equal blending of half Simsboro and half lower Colorado River water with the existing Alluvium water. All of the treatments described for Scenario 1 and 2 will be required under this scenario.

In summary, all three water sources are generally compatible with each other. Only basic treatments that would have been required independent of source blending are required. It should be noted that the blending analysis assumes complete mixing. While helpful for determining compatibility and necessary treatments for the Study, this is not a physical reality based on the geographic locations of the new water sources. Additionally the geographic changes in sources entering the existing system may cause scaling built up over the years in the existing distribution system mains to be dislodged into the system. Prior to implementation of any water supply option, a more detailed blending analysis and pipe loop testing should be part of the feasibility study.

# 11 Water Conservation

An entity is required to prepare a Water Conservation Plan (WCP) if the entity has more than 3,300 connections, is a surface water user of 1,000 acre-feet a year or more, or has received more than $500,000 of financial assistance from the TWDB. This is mandated by the Texas Administrative Code (TAC) 30 Chapter 288 (A), (TCEQ, 2008) and TAC 31 Chapter 363, Subchapter A (TWDB, 2008). At this time, the City is not required to submit a WCP to TCEQ or TWDB because the City does not surpass these thresholds.

The City did, however, voluntarily prepare and adopt a WCP following the requirements of TAC 288.2 Water Conservation Plans for Municipal Uses by Public Water Suppliers. The City adopted the WCP by City Ordinance (2010-8) on May 11, 2010 and filed copies with TCEQ, the TWDB, and the Region K Planning Group on May 24, 2010.

Aside from these thresholds, the TWDB grant contract for this Study requires that the City develop a WCP. The TWDB reviewed the City's WCP under 363.15 (TWDB, 2008). After finding that the plan substantially meets the requirements, the TWDB issued approval via e-mail on March 23, 2011. No comments or revisions were required with the approval; however, the TWDB did provide suggestions for improvement. The TWDB approval e-mail, the City's WCP and the accompanying Drought Contingency Plan can be found in ***Appendix K***. The major elements for a WCP required by the state rules are listed below followed by a brief description of City's WCP component and recommendations on how the City's WCP may be improved with the next revision. Additionally, LCRA requires wholesale customers to have a conservation and drought management plan that demonstrate compliance with LCRA's conservation plans. The LCRA conservation requirements have not been reviewed in detail for this Study and should be reviewed at the time a surface water contract is considered with LCRA. The TWDB suggestions are incorporated within the recommendations presented below.

- Official Adoption of the WCP: The City's WCP was adopted by City Ordinance (2010-8) on May 11, 2010. ***Recommendation:*** Designate a staff member to be the City's Water Conservation Coordinator (WCC). The WCC would be responsible for coordinating conservation efforts across all city departments and initiate program efforts such as public education campaigns. It should be noted that the LCRA does require a WCC to be appointed and serve as a single point of contact for the entities water conservation efforts.

- Regional Water Planning Group Coordination: The City provided a copy of the adopted WCP to the Region K Planning Group May 24, 2010. ***Recommendation:*** Continue to actively coordinate with the Region K Planning Group to ensure that the City's utility profile and conservation goals are accurately incorporated within the Regional Water Plan.

- <u>A utility profile:</u> The City's utility profile includes appropriate information regarding population and customer data, water use data, water supply system data, and wastewater system data. ***<u>Recommendation:</u>*** The utility profile should be updated based on an assessment of the previous five-year and ten-year targets and any other new or updated information; such as the well at Bob Bryant Park and the new population projections. When the City is subject 288.2.(c), it is required that the WCP be updated every five years to coincide with the regional water planning group planning cycle.

- <u>Conservation goals:</u> The City's WCP contains 5- and 10-year goals for reduction in per capita water use as well as water loss programs. The City's WCP contains the following conservation strategies:
    - Cost-based rate structure – The city uses a tiered (increasing block) rate structure;
    - Wastewater reuse – The city currently uses treated wastewater for treatment plant wash down. ***<u>Recommendation:</u>*** Evaluate other opportunities for wastewater reuse;
    - Water loss control accounting and remediation program – The City administers leak detection and repair programs. ***<u>Recommendation:</u>*** The conservation strategy is recommended to be revised to include specific time schedules. Specifics may include percentages of the system that are tested annually or nominal amount of old pipe length that is replaced annually;
    - Metering device(s) and monitoring program – The city is updating all metering devices to electronic meters on a two year program. ***<u>Recommendation:</u>*** The replacement and preventative maintenance strategy is recommended to include specific actions and time schedules. The records management system can assist in monitoring meters to track and flag high users or changes in typical usage patterns;
    - Record management system – The city administers a record management system that accounts for water production, sales, consumption and loses. ***<u>Recommendation:</u>*** Goals should be established to amend the record management system to include all data listed under 288.2(a)(2)(B);
    - Public education – The city lists several education outreach campaigns. ***<u>Recommendation:</u>*** A WCC should perform a review of education strategies to focus more resources on those efforts which provide the highest impact. Share the annual water conservation report on the City's website;
    - Wholesale water supply contract conservation requirements – If surface water is contracted through LCRA, the city will be subject LCRA's WCP requirements.
    - Adoption of water-conversing ordinances – The city has adopted the International Plumbing Code. ***<u>Recommendation:</u>*** Evaluate implementation of water-conserving ordinances such as irrigation system ordinances and permitting requirements, year round mandatory watering schedules, or landscape ordinances;
    - Landscape water management – The city lists encouraged landscape practices. ***<u>Recommendation:</u>*** The list of encouraged landscape strategies should be

coordinated with the Planning and Development Department to assist with public awareness and encouragement. Water conservation landscape strategies should also be coordinated with any future revisions to the landscape ordinance to enforce the conservation efforts;

- Performance measures and reporting – ***Recommendation:*** The performance measures and reporting should be outlined in greater detail and include triggers and a resulting course of action; and
- Implementation and enforcement – The Water and Wastewater Department is responsible for enforcing the WCP. ***Recommendation:*** Identify parties responsible for enforcement, such as a WCC or a code enforcement officer. Reference the Drought Contingency Plan which outlines violations and penalties.

# 12 Regional Coordination and Financial Resources

Section 4.7.1.9 of the 2011 Region K Water Plan identifies pumping additional water from alluvium as the only water management strategy applied to the City of Bastrop. For this reason, it is recommended that the City of Bastrop proceed with an amendment to the Regional Water Plan to incorporate other desired water management strategies such as surface water supply from the lower Colorado River and Simsboro groundwater.

The development of new water supplies and the improvements to and expansion of the distribution system is a large fiscal responsibility. There are several financial assistance programs available to support communities in meeting these responsibilities. Most of these programs require that community water supply strategies are consistent with or specifically recommended within the Region Water Plan documents. Additionally, the programs require lead time for the community to prepare applications and may have specific application cycles. The following section of the Study provides an overview of the recommended coordination efforts and the available financial assistant programs.

Processing an amendment now will allow the City to be eligible for certain financial programs available through the TWDB. In addition to processing the amendment now, the City should plan to participate in the 2016 cycle of the State Water Plan. This cycle will be unique in the collaboration and coordination efforts with the GMAs. Participation in the regional planning group will provide the City with a process to become aware of regional issues, find opportunities for regional coordination, express concerns, and a voice to see that the approved regional water plan substantially correlates with the City's water planning efforts.

The LPGCD stated they are in the process of beginning to draft a revised water management plan. The City is encouraged to participate in public hearing process to gain understanding of the permitting and operation management within the district. This public hearing process is a valuable mechanism for the City to voice concerns or support various management strategies and policies.

## 12.1 Amending an Approved Regional Water Plan

The following summary on how to process an amendment is guidance provided by the TWDB and does not cover all procedural and substantive requirements applicable to water plan amendments. The summary should not be used as a substitute for the regulations as written. Consult the Texas Water Code, Chapter 16, and Texas Administrative Code Title 31, Chapter 357 for complete regulations. The TWDB recommends that regional water planning groups or political subdivisions with legal questions regarding changes to the regional water plans should consult with their own attorneys or the Texas Attorney General's Office.

A political subdivision of the state of Texas in the regional water planning area may request an amendment from the regional water planning group on the basis of changed conditions or new information. Per 31 TAC § 357.11(f)(g). Any amendment proposed must meet rules and guidelines for development of a regional water plan. The regional water planning group may ask the political subdivision requesting the amendment to pay for study costs related to the request. Limited TWDB funds may be available to pay for plan amendments. Unsolicited proposals requesting TWDB funding for an amendment may be submitted at any time using the standard grant application instruction sheet. Allocation of funds requires Board approval and is variable depending on the extent of the scope of work presented with the request and the availability of funds.

The amendment to add new water management strategies for the City of Bastrop may be processed as a minor amendment if it will incorporate changes to the Regional Water Plan that do not:

- result in over allocation of an existing or planned source of water;
- relate to a new reservoir;
- have a significant effect on instream flows, environmental flows, or freshwater flows to bays and estuaries;
- have a significant substantive impact on water planning or previously adopted management strategies; or
- delete or change any legal requirements of a plan.

The Minor Amendment process requires the following:

- A political subdivision asks the regional water planning group to make an amendment. Amendment materials are prepared in accordance with TWDB rules and guidance, and a request for a "minor amendment determination" is submitted to the chair of the regional planning group and the TWDB executive administrator;
- The executive administrator reviews the request and responds within 30 days;
- If the executive administrator determines the amendment is a "minor amendment" the regional water planning group considers the request and takes action to pursue the amendment at one of its regular public meetings. This meeting requires at least a 14-day notice. The regional water planning group considers public comments and may adopt the amendment at the meeting;
- The planning group has 180 days from the date of the submittal to consider the request and the timing is largely dependent upon the meeting schedule.

- If the regional water planning group adopts the amendment then they submit the adopted minor amendment materials to the TWDB executive administrator;
- The TWDB reviews the adopted minor amendment and, if acceptable, approves it at its next regular Board meeting;
- The TWDB amends the state water plan to incorporate the minor amendment.

Note that the planning group may, at its discretion, accept or reject the proposed amendment. The political subdivision may petition the TWDB executive administrator for agency review if the political subdivision is not satisfied with the planning group's decision;

- The executive administrator may ask the regional water planning group to make a revision;
- If the revision is not made within 90 days, the matter is presented to the TWDB board, which can order a revision to the regional water plan and state water plan on the basis of changed conditions or new information;

If the amendment is ruled to be a major amendment rather than a minor, the process is very similar however; there are greater requirements for notices for the public hearings and comment periods. (Texas Water Development Board, AARWP, December 2010)

## 12.2 Financial Assistance Programs

The following section describes financial assistance programs that are support through the TWDB. The availability of funds in each program may vary depending on the program cycle and appropriations. Contact the TWDB for fund availability. Referring to ***Section 11***, a water conservation and drought contingency plan is required when financial assistance greater than $500,000 is received.

### *12.2.1 Drinking Water State Revolving Fund*

The Drinking Water State Revolving Fund provides loans for drinking water projects at interest rates lower than those offered by commercial markets and principal forgiveness for planning, designing, and constructing water supply infrastructure. This is a federally subsidized program. Loans can be used for planning, designing, and constructing projects to upgrade or replace water supply infrastructure, to correct exceedances of Safe Drinking Water Act drinking water standards, to consolidate water supplies, and to purchase capacity in water systems. Drinking Water State Revolving Fund loan proceeds can also be used to purchase land integral to the project. The program also has disadvantaged community funds that provide additional subsidies for applicants meeting the program criteria.

Each year, the TWDB notifies all known potential entities of the availability of funding and timelines for the upcoming cycle. Prospective loan applicants are asked to submit project information that describes their existing water facilities, facility needs, the nature of the project being considered, and project cost estimates. The TCEQ rates potential Drinking Water State Revolving Fund loan applicants' projects using information contained in their files. This information is used to rate each proposed project and place prospective projects in priority order on the project priority list in the Intended Use Plan. A fundable projects list is established, and available funds are distributed in accordance with the funding order specified in the Intended Use

Plan. All applicants on the fundable projects list will be notified and invited to submit complete applications within three months of the date of the invitation letter. The fundable projects list is revised as projects decline or funding becomes available. Invitations are then sent to the next eligible applicant on the list. All applicants are encouraged to schedule a pre-application conference that will guide them through the Drinking Water State Revolving Fund application process. (Texas Water Development Board, DWSRF April 2011)

The Intended Use Plan is complete through FY 2012. The Intended Use Plan does not extend beyond FY 2012 as funds for the next cycle have not been appropriated. In order to be eligible for the program the City of Bastrop needs to take measures to submit a project information form for the FY 2013 cycle.

#### *12.2.2 Texas Water Development Fund*

The Texas Water Development Fund is a streamlined state loan program that does not receive federal subsidies. The State program includes loans for water supply, water quality enhancement, flood control, and municipal solid waste. This fund enables the TWDB to fund multiple eligible components in one loan as authorized under Texas Water Code § 17, Subchapter L.

The Texas Water Development Fund provides financing for acquiring, improving, or constructing water-related projects such as water wells, retail distribution and wholesale transmission lines, pumping facilities, storage reservoirs and tanks, and water treatment plants. The fund provides financing for the purchase of water rights. It also provides financing for wastewater collection and treatment projects and flood control projects. Water supply projects must be consistent with the 2007 State Water Plan.

Applicants are required to schedule a pre-application conference. A complete application is due on the first business day of the month preceding the month during which the application is to be considered by TWDB's overseeing Board. (Texas Water Development Board, TWDF, June 2011)

#### *12.2.3 State Participation Program*

The State Participation Program enables the TWDB to assume a temporary ownership interest in a regional project when the local sponsors are unable to assume debt for the optimally sized facility. The program is authorized under Texas Water Code § 16, Subchapters E and F, and governed by TWDB rules in Texas Administrative Code Title 31 § 363, Subchapters A and J. The TWDB may acquire ownership interest in the water rights or a co-ownership interest of the property and treatment works. The loan repayments that would have been required had the assistance been from a loan are deferred. Ultimately, the cost of the funding repaid to the TWDB is based upon purchase payments, which allow the TWDB to recover its principal and interest costs and issuance expenses. The loan repayments that would have been required had the assistance been from a conventional loan are deferred.

The program is intended to allow for optimization of regional projects through limited State participation where the benefits can be documented, and where such development is unaffordable without State participation. The goal is to allow for the "right sizing" of projects in consideration of future growth. On new water supply and state water plan projects the TWDB can fund as much as 80 percent of costs, provided that the applicant finances at least 20 percent of the total project cost from sources other than the State Participation account and that at least 20 percent of the total capacity of the proposed project serves existing needs. On other State Participation projects, the TWDB can fund as much as 50 percent of costs, provided that the applicant finances at least 50 percent of the total project cost from sources other than the State Participation account and that at least 50 percent of the total capacity of the proposed project serves existing needs.

All applicants are encouraged to schedule a pre-application conference that will guide them through the State Participation Program application process. The applicant must submit an engineering feasibility report and environmental information, as well as general, fiscal, and legal information to the TWDB's Project Finance office. As the earlier projects repurchase the TWDB's interest, additional funds become available for future projects. (Texas Water Development Board, SPP, April 2011)

### *12.2.4 State Water Plan Funding*

State Water Plan Funding was established in response to the 2007 State Water Plan estimate that regional and local water supply entities will need to spend $30.7 billion between 2007 and 2060 to meet the state's additional water supply needs. The Texas Legislature's 2007 and 2009 appropriations enabled issuance of over $1.2 billion in bonds for State Water Plan projects. These projects must be recommended water management strategies in the most recent TWDB approved regional water plan and approved State Water Plan. Each of the various sources of water plan funding—the Water Infrastructure Fund, the Water Infrastructure Fund-Deferred, the Water Infrastructure Fund-Rural, the State Participation Program, and the Economically Distressed Areas Program—offer below-market financing options, depending on the type of project or applicant.

The Water Infrastructure Fund offers loans for up to 20 years at 2 percent below the TWDB's cost of funds for the planning, design, and construction of State Water Plan projects. The Water Infrastructure Fund-Deferred allows an applicant to defer payments for up to 10 years for projects with significant planning, design, and permitting requirements. The Water Infrastructure Fund-Rural offers up to 50 percent grant funding and 0 percent interest loans to finance State Water Plan projects in rural areas. The Economically Distressed Areas Program also offers grants for water plan projects.

Applicants are required to schedule a pre-application conference to discuss the project's eligibility. An application consists of general, fiscal, legal, engineering, and environmental information. Abridged applications are due on February 1 and August 1 of each year. The TWDB will prioritize projects if there is more than one project competing for the funds. Applications are prioritized in March and September of each year. The prioritization criteria are in TWDB Rules at the Texas Administrative Code Title 31 §§ 363.1208, 363.1007. The TWDB meets to consider applications for financial assistance. If the application is approved, the TWDB will extend a one-year commitment. (Texas Water development Board, SWPF, April 2011)

### *12.2.5 Rural Assistance Fund*

The TWDB administers the Rural Water Assistance Fund, created in 2001 by the 77th Texas Legislature. The program is authorized under Texas Water Code § 15, Subchapter R, and governed by TWDB rules in Texas Administrative Code Title 31 § 384. The fund is designed to assist small rural utilities to obtain low-cost financing for water and wastewater projects. Terms for loan repayment are flexible, depending on the applicant's needs. The TWDB offers tax-exempt, attractive interest rate loans with long-term finance options. Eligible borrowers are defined as "rural political subdivisions" (31 Texas Administrative Code § 384.2). They include nonprofit water supply corporations, water districts, or municipalities serving a population of 10,000 or less, or counties in which no urban area has a population exceeding 50,000. Rural political subdivisions that otherwise qualify for federal financing are also eligible to apply for funding.

Rural Water Assistance Fund loans may be used to fund water-related capital construction projects such as line extensions and overhead storage. Funds may also be used to purchase well fields and to purchase or lease rights to produce groundwater. Water quality enhancement projects such as wastewater collection and treatment projects are also eligible to receive funding. The costs of planning, design, and construction are all eligible for funding. The fund may also be used to enable a rural utility to obtain water or wastewater service supplied by a larger utility or to finance the consolidation or regionalization of a neighboring utility.

All applicants are encouraged to schedule a pre-application conference that will guide them through the State Participation Program application process. The relationship of the project to the state water plan is a factor in evaluation of the application. A complete application is due on the first business day of the month preceding the month during which the application is to be considered by the TWDB governing Board. The Board usually meets in Austin once every month to consider financial assistance applications.

### *12.2.6 Research and Planning Fund Grants*

Through its Research and Planning Fund, the TWDB provides financial assistance to individuals and political subdivisions to do research and feasibility studies in practical solutions to water-related problems. Collectively, the TWDB has awarded more than $60 million in research and planning grants. Three categories are eligible for funding through the Research and Planning Fund: Regional Water Supply and Wastewater Facilities Planning, Water Research, and Flood Protection Planning (not discussed here). This study was funded by a Regional Water Supply Facilities Planning grant.

Regional Water Supply and Wastewater Facilities Planning grants are awarded to political subdivisions, including cities, counties, special districts, and nonprofit water supply corporations, to prepare plans to develop regional water supply facilities and wastewater facilities. A regional facility is a system that incorporates two or more service areas or serves an area involving two or more political subdivisions.

Water Research Grants are awarded for research dedicated to significantly enhancing the proper planning, management, conservation, development, or protection of Texas' water resources. Grants have been awarded to investigate a plumbing retrofit program, the reuse of surface water to increase the dependable water supply of a reservoir, watershed yield augmentation, groundwater protection and recharge, and nonpoint source pollution control.

Grants for regional and flood protection planning are limited to 50 percent of the total cost of the project; however, the TWDB may provide as much as 75 percent of the total cost to political subdivisions that have unemployment rates exceeding the state average by 50 percent or more and have per capita income that is 65 percent or less of the state average. For water research projects, the TWDB may award grants for as much as 100 percent of the cost. (Texas Water Development Board, October 2010)

### 12.3 Other Resources

For more information on financial programs, contact the TWDB at (512) 463-7847. Additional information on financial programs is available on the TWDB Web site at www.twdb.state.tx.us/financial/programs.

Financial assistance programs from other agencies is also available on the TWDB Web site at www.twdb.state.tx.us/assistance/financial/in_infrastructure/fin_links/infrastructure_links.asp.

Information on other federal funding opportunities can be found at www.grants.gov.

## 13 Stakeholder Involvement

A series of public meetings was held to present updates of the Study as it progressed and solicit stakeholder feedback. The TWDB awarded the grant to the City in March of 2010 and a public meeting to kick off the project was held Tuesday September 16, 2010 at the Bastrop City Hall. Public meeting #2 was held January 18, 2011 to review the first phase of the project which included data collection, population projections and water demand projections. Public meeting #3 was held May 25, 2011 to review the second phase of the project which included development of water supply options and implementation scenarios, preparation of cost estimates to evaluate water supply implementation scenarios, a high level blending analysis to evaluate the impacts of the scenarios and a review of the City's existing water conservation plan. Public meeting #4 was held September 20, 2011 following submission of the final draft report to the TWDB on August 29, 2011. The final phase included the evaluation of a joint water supply implementation scenario and evaluation of the water supply options for the Extended Study Area. No members of the public were present thirty minutes after the start of the meeting and the meeting was adjourned.

During this period two copies of final draft report were available for public comment. One copy was located at the Bastrop City Hall and the other was at the Bastrop Public Library. Both copies of the report were stored with public comments forms and consultant contact information. The public comment period was open until October 14, 201, however no comments were received. A summary of the public meetings and the sign-in sheets are located in ***Appendix L***.

# 14 Summary and Recommendation

The objective of the Study was to identify and evaluate new water supply sources for the Bastrop area. As the City anticipates population growth and increased water demands they need to develop a water supply strategy to meet these demands. Several risk factors need to be considered when making a final decision on which water supply strategy to pursue. Factors to consider include drought resiliency, regulatory uncertainty, estimated capital and annual costs, net present value (NPV) and timing of capital expenditures.

Currently, the City of Bastrop's sole water source is shallow Alluvium wells. It was directed by the City that source diversification is desired to reduce the exposure caused by the Alluvium source, which may be more susceptible to drought impacts or contamination than surface water or groundwater from deeper wells. Therefore, additional Alluvium wells were not considered as a potential source. The management plan of the regulatory entity is seminal in forecasting source availability. Although operation or reservation permits for Simsboro wells may be issued by the Lost Pines Groundwater Conservation District (LPGCD), there is no accompanying guarantee that the water will be available. As the groundwater management districts work to establish the regulatory framework to support the new desired future conditions (DFC) and managed available groundwater (MAG) there is significant uncertainty associated with the regulatory environment. At the conclusion of this Study, the LPGCD is currently beginning the process of amending their management plan in consideration of the new state groundwater planning efforts. The LPGCD expects to present the revised management plan to their board for consideration early in the fall of 2011, at which time there will be an opportunity for public comments. In contrast, the Lower Colorado River Authority (LCRA) firm water contracts are a guarantee that the contracted surface water will be available during the drought of record. The LCRA is mandated to manage the supply availability.

Cost estimates for single-phase and multi-phase implementation options were developed to evaluate and compare the water supply options including lower Colorado River surface water, Simsboro groundwater, and third party supply from Aqua Water Supply Corporation (Aqua).

All implementation options reviewed in previous sections are summarized with a total unit price based on the ratio of the 2040 average day demand (10,949 ac-ft/yr) and the total annual costs in ***Table 14-1***. The "Capital Costs" include water supply infrastructure costs. "Other Project Costs" include engineering, survey, environmental studies and mitigation costs, legal and land costs. The "Annual Costs" include debt service on the capital costs, operation and maintenance costs, energy pumping costs, and water production/usage or permit fees and reservation fees. The total unit prices and NPV shown in the ***Table 14-1 and Table 14-2***, respectively, provide a reasonable and direct comparison of the various options evaluated. Note this Study evaluates water supply options and facilities implementation scenarios only and does not speak to the planning, facilities, and costs required for the distribution facilities. These factors should also be considering in developing a long term water plan.

Of the supply options considered, the development of a Simsboro wellfield is the lowest cost option available for the Study Area when considering either the single or three-phase implementation. Pending the resulting LPCGD management plan and existing regulatory uncertainties, joint implementation options may be preferable to diversify risks. The joint option evaluated with the Study considers contracting firm water rights with LCRA now, while the rights are available, and pursuing the permitting and reservation of a Simsboro wellfield to be constructed in the future. Depending upon the LPGCD management strategies the City may consider developing the groundwater option first while pursuing a contract with LCRA to reserve surface water. A joint development option would diversify the water supply sources and distribute drought susceptibility, permitting and water rights risks.

Additional supply options available that were not reviewed as part of this Study scope include varying phasing scenarios, constructing a Simsboro wellfield prior to the surface water treatment plant, and aquifer storage and recovery (ASR). LCRA has an ASR option for the Bastrop area in the October 2010 Water Supply Resource Plan. This contemplates constructing an intake structure to pump water from the Colorado River when flows are high and injecting the water into the Alluvium. The stored water can then be pumped out at a later time when the water is needed. The detailed evaluation of strategy phasing and source water combinations, including ASR, are beyond the scope of this Study and warrant future analysis.

**Table 14-1. Total 2010 Cost Comparison**

| Water Supply Option: | Surface Water | Surface Water | Groundwater | Groundwater | Third Party | Surface & Groundwater |
|---|---|---|---|---|---|---|
| **Alternative Description** | **Single Phase Implementation** | **Multiple Phase Implementation** | **Single Phase Implementation** | **Multiple Phase Implementation** | **Single Phase Implementation** | **Multiple Phase Implementation** |
| **Year Improvements Constructed** | 2015 | 2015, 2025, 2035 | 2015 | 2015, 2025, 2035 | 2015 | 2015, 2025, 2035 |
| **CapitalCosts** | $50,986,000 | $66,312,000 | $47,725,000 | $47,766,775 | $93,516,000 | $66,893,000 |
| **Other Project Costs** | $34,710,100 | $44,790,100 | $33,375,200 | $33,499,200 | $62,036,400 | $46,995,800 |
| **Total Project Costs** | $85,696,100 | $111,102,100 | $81,100,200 | $81,265,975 | $155,552,400 | $113,888,800 |
| **Annual Costs** | $11,109,000 | $15,742,000 | $9,365,000 | $9,703,000 | $18,334,000 | $23,158,000 |
| **Project Yield 2040 (ac-ft/yr)** | 10,949 | 10,949 | 10,949 | 10,949 | 10,949 | 10,949 |
| **Unit Cost $/1,000 gal** | $3.11 | $4.41 | $2.63 | $2.72 | $5.14 | $6.49 |
| **Unit Cost $/ac-ft** | $1,015 | $1,438 | $855 | $886 | $1,674 | $2,115 |

**Table 14-2. Total NPV Cost Comparison (Millions $)**

| Water Supply Option: | Surface Water | Surface Water | Groundwater | Groundwater | Third Party | Surface & Groundwater |
|---|---|---|---|---|---|---|
| **Alternative Description** | **Single Phase Implementation** | **Multiple Phase Implementation** | **Single Phase Implementation** | **Multiple Phase Implementation** | **Single Phase Implementation** | **Multiple Phase Implementation** |
| **Year Improvements** | 2015 | 2015, 2025, 2035 | 2015 | 2015, 2025, 2035 | 2015 | 2015, 2025, 2035 |
| **NPV CapitalCosts** | $38.1 | $33.6 | $35.7 | $27.5 | $69.9 | $35.2 |
| **NPV Other Project Costs** | $25.9 | $23.0 | $24.9 | $19.4 | $46.4 | $24.7 |
| **NPV Total Project Costs** | $64.0 | $56.6 | $60.6 | $46.9 | $116.2 | $59.9 |
| **NPV Annual Costs** | $142.0 | $144.7 | $119.7 | $101.2 | $234.4 | $217.2 |

## Appendix A Acknowledgements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## Appendix B Acronyms and Conversions

**Acronyms**

| | |
|---|---|
| Ac-ft/yr | acre-feet per year |
| CAMPO | Capital Area Metropolitan Planning Organization |
| CAPCOG | The Capital Area Council of Governments |
| CCI | Construction Cost Index |
| CCN | Convenience and Necessity |
| FY | Fiscal Year |
| DFC | Desired Future Condition |
| ENR | Engineering News Record's |
| ETJ | Extraterritorial Jurisdiction |
| GIS | Geographic Information System |
| GMA | Goundwater Management Area |
| gpm | gallons per minute |
| gpd | gallons per day |
| gpcd | gallons per capita per day |
| LCRA | Lower Colorado River Authority |
| LPGCD | Lost Pines Groundwater Conservation District |
| MAG | Managed Available Groundwater |
| MGD | millions of gallons per day |
| mg/L | milligrams per liter |
| SCTRWPG | South Central Texas Regional Plan |
| SH | State Highway |
| SUE | Service Unit Equivalent |
| TAC | Texas Administrative Code |
| TAZ | Traffic Analysis Zones |
| TCEQ | Texas Commission on Environmental Quality |
| TWDB | Texas Water Development Board |
| WCID | Water Control and Improvement District |
| WSC | Water Supply Corporation |
| WUG | water user group |

**Conversions**

| | | |
|---|---|---|
| 1 acre-foot | = | 325,851 gallons |
| 1 cubic foot | = | 7.48 gallons |
| 1 gallon | = | 3.79 liters |

## Appendix C Data Inventory

### Bastrop County

Bastrop County Development Services provided GIS layers for mapping including: Address Points, City Limits, Contours (2-ft), Lost Pines Habitat Conservations Plan boundary, MUD boundaries, WCID Boundaries, County Parcels, and Roadway Network. These GIS files were obtained September 2010.

### Bastrop Independent School District

Henry Gideon, BISD Chief Operations Officer (512-321-2292 hgideon@bastrop.isd.tenet.edu) provided a copy of the BISD 2008 demographic study (Bastrop Independent School District. Spring 2008. *Bastrop ISD Demographic Study*.) Mr. Gideon stated that BISD has commissioned their demographer to complete a new report which will be completed in the Spring of 2010.

### Bluebonnet Electric

Vance M. Hamilton, Bluebonnet Electric Cooperative Economic Development Lead provided Bluebonnet data from their Economic Development Website:
www.bluebonnetregion.com/economic-indicators/population-demographics

### Capital Area Metropolitan Planning organization (CAMPO)

2035 Traffic Analysis Zones: CAMPO initiated a project in 2007 for allocating the CAMPO-approved County controlled totals of demographics to the traffic analysis zone level for travel demand modeling purposes. The main objectives for developing this tool were to provide a GIS-based quantitative tool for scenario planning; to be integrated with the current travel demand model; and to have the capability of producing replicable results. This data were used for estimating population for the Study.
http://www.campotexas.org/programs_gis.php

### Lost Pines Groundwater Conservation District

Data for non-exempt well permits. PDF format received November 15, 2010.
Data for well permit status. Excel format received December 20, 2010.
Database for all LPGCD wells. MDB format received December 20, 2010.

### Lower Colorado River Authority

Lower Colorado River Authority. (June 2010) *DRAFT Water Supply Resource Plan.*
Lower Colorado River Authority. (2010) *Water Contract Rules.*

### Texas Water Development Board

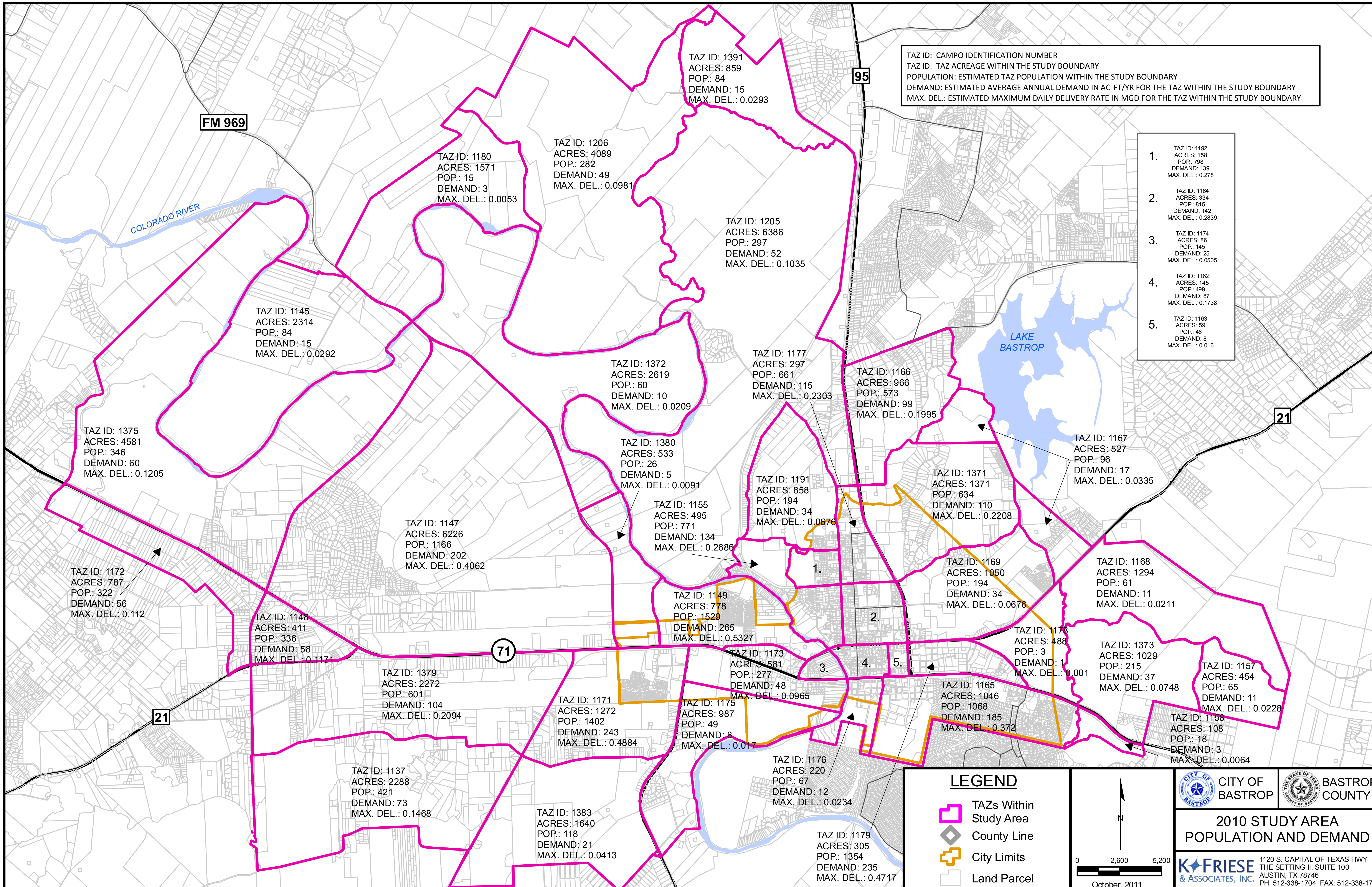
Texas Water Development Board. (February 2010). *Initially Prepared 2011 Region K Water Plan for the Lower Colorado Regional Water Planning Group.*

# Appendix C2 City of Bastrop Per Capita Water Usage Data

# CITY OF BASTROP
## DAILY AVERAGE OF WATER PRODUCTION IN MILLION GALLONS AND GALLONS PER CAPITA PER DAY (GPCD)

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | AVERAGE | Ac-ft-d | POPULATION | GPCD | GPCD | GPCD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2002** | 0.943 | 0.910 | 0.962 | 1.153 | 1.479 | 1.449 | 1.242 | 1.551 | 1.336 | 1.123 | 1.142 | 1.010 | **1.192** | **3.7** | **6,814** | **175** | | |
| **2003** | 1.009 | 0.963 | 0.974 | 1.317 | 1.474 | 1.328 | 1.362 | 1.592 | 1.320 | 1.147 | 1.032 | 1.028 | **1.212** | **3.7** | **7,031** | **172** | | |
| **2004** | 0.960 | 0.961 | 0.986 | 1.055 | 1.145 | 1.056 | 1.249 | 1.243 | 1.249 | 0.933 | 0.852 | 0.906 | **1.050** | **3.2** | **7,215** | **145** | | |
| **2005** | 0.814 | 0.807 | 0.793 | 0.975 | 1.017 | 1.420 | 1.410 | 1.500 | 1.610 | 1.194 | 1.114 | 1.032 | **1.141** | **3.5** | **7,449** | **153** | | |
| **2006** | 1.083 | 0.807 | 1.045 | 1.192 | 1.274 | 1.421 | 1.414 | 1.766 | 1.585 | 1.291 | 1.177 | 1.059 | **1.260** | **3.9** | **7,845** | **161** | | |
| **2007** | 1.016 | 1.052 | 1.103 | 1.007 | 1.101 | 1.140 | 1.051 | 1.235 | 1.251 | 1.273 | 1.061 | 1.002 | **1.108** | **3.4** | **7,968** | **139** | | |
| **2008** | 0.992 | 1.012 | 1.007 | 1.160 | 1.482 | 1.985 | 1.718 | 1.583 | 1.568 | 1.371 | 1.200 | 1.060 | **1.345** | **4.1** | **8,374** | **161** | | |
| **2009** | 0.975 | 1.056 | 1.113 | 1.123 | 1.329 | 1.836 | 2.042 | 1.850 | 1.302 | 1.002 | 0.950 | 0.891 | **1.289** | **4.0** | **8,694** | **148** | | |
| **2010** | 0.902 | 0.838 | 0.913 | 1.092 | 1.341 | 1.331 | 1.235 | 1.677 | 1.281 | 1.359 | 1.195 | 1.148 | **1.193** | **3.7** | **8,753** | **136** | | |
| **AVG.** | **0.966** | **0.934** | **0.988** | **1.119** | **1.294** | **1.441** | **1.414** | **1.555** | **1.389** | **1.188** | **1.080** | **1.015** | **1.199** | **3.7** | **7,794** | **155** | **149** | **149** |

# Appendix C3 TAZ Data Summary and Maps


TAZ ID: CAMPO IDENTIFICATION NUMBER
TAZ ID: TAZ ACREAGE WITHIN THE STUDY BOUNDARY
POPULATION: ESTIMATED TAZ POPULATION WITHIN THE STUDY BOUNDARY
DEMAND: ESTIMATED AVERAGE ANNUAL DEMAND IN AC-FT/YR FOR THE TAZ WITHIN THE STUDY BOUNDARY
MAX. DEL.: ESTIMATED MAXIMUM DAILY DELIVERY RATE IN MGD FOR THE TAZ WITHIN THE STUDY BOUNDARY
1. TAZ ID: 1192 ACRES: 158 POP.: 798 DEMAND: 139 MAX. DEL.: 0.278
2. TAZ ID: 1164 ACRES: 334 POP.: 815 DEMAND: 142 MAX. DEL.: 0.2839
3. TAZ ID: 1174 ACRES: 86 POP.: 145 DEMAND: 25 MAX. DEL.: 0.0505
4. TAZ ID: 1162 ACRES: 145 POP.: 499 DEMAND: 87 MAX. DEL.: 0.1738
5. TAZ ID: 1163 ACRES: 59 POP.: 46 DEMAND: 8 MAX. DEL.: 0.016
FM 969
95
21
71
COLORADO RIVER
LAKE BASTROP
TAZ ID: 1391 ACRES: 859 POP.: 84 DEMAND: 15 MAX. DEL.: 0.0293
TAZ ID: 1206 ACRES: 4089 POP.: 282 DEMAND: 49 MAX. DEL.: 0.0981
TAZ ID: 1180 ACRES: 1571 POP.: 15 DEMAND: 3 MAX. DEL.: 0.0053
TAZ ID: 1205 ACRES: 6386 POP.: 297 DEMAND: 52 MAX. DEL.: 0.1035
TAZ ID: 1145 ACRES: 2314 POP.: 84 DEMAND: 15 MAX. DEL.: 0.0292
TAZ ID: 1372 ACRES: 2619 POP.: 60 DEMAND: 10 MAX. DEL.: 0.0209
TAZ ID: 1177 ACRES: 297 POP.: 661 DEMAND: 115 MAX. DEL.: 0.2303
TAZ ID: 1166 ACRES: 966 POP.: 573 DEMAND: 99 MAX. DEL.: 0.1995
TAZ ID: 1375 ACRES: 4581 POP.: 346 DEMAND: 60 MAX. DEL.: 0.1205
TAZ ID: 1380 ACRES: 533 POP.: 26 DEMAND: 5 MAX. DEL.: 0.0091
TAZ ID: 1167 ACRES: 527 POP.: 96 DEMAND: 17 MAX. DEL.: 0.0335
TAZ ID: 1191 ACRES: 858 POP.: 194 DEMAND: 34 MAX. DEL.: 0.0676
TAZ ID: 1371 ACRES: 1371 POP.: 634 DEMAND: 110 MAX. DEL.: 0.2208
TAZ ID: 1155 ACRES: 495 POP.: 771 DEMAND: 134 MAX. DEL.: 0.2686
TAZ ID: 1147 ACRES: 6226 POP.: 1166 DEMAND: 202 MAX. DEL.: 0.4062
TAZ ID: 1172 ACRES: 787 POP.: 322 DEMAND: 56 MAX. DEL.: 0.112
TAZ ID: 1169 ACRES: 1050 POP.: 194 DEMAND: 34 MAX. DEL.: 0.0676
TAZ ID: 1168 ACRES: 1294 POP.: 61 DEMAND: 11 MAX. DEL.: 0.0211
TAZ ID: 1149 ACRES: 778 POP.: 1529 DEMAND: 265 MAX. DEL.: 0.5327
TAZ ID: 1148 ACRES: 411 POP.: 336 DEMAND: 58 MAX. DEL.: 0.1171
TAZ ID: 1178 ACRES: 488 POP.: 3 DEMAND: 1 MAX. DEL.: 0.001
TAZ ID: 1373 ACRES: 1029 POP.: 215 DEMAND: 37 MAX. DEL.: 0.0748
TAZ ID: 1173 ACRES: 581 POP.: 277 DEMAND: 48 MAX. DEL.: 0.0965
TAZ ID: 1157 ACRES: 454 POP.: 65 DEMAND: 11 MAX. DEL.: 0.0228
TAZ ID: 1379 ACRES: 2272 POP.: 601 DEMAND: 104 MAX. DEL.: 0.2094
TAZ ID: 1165 ACRES: 1046 POP.: 1068 DEMAND: 185 MAX. DEL.: 0.372
TAZ ID: 1171 ACRES: 1272 POP.: 1402 DEMAND: 243 MAX. DEL.: 0.4884
TAZ ID: 1175 ACRES: 987 POP.: 49 DEMAND: 8 MAX. DEL.: 0.017
TAZ ID: 1158 ACRES: 108 POP.: 18 DEMAND: 3 MAX. DEL.: 0.0064
TAZ ID: 1176 ACRES: 220 POP.: 67 DEMAND: 12 MAX. DEL.: 0.0234
TAZ ID: 1137 ACRES: 2288 POP.: 421 DEMAND: 73 MAX. DEL.: 0.1468
TAZ ID: 1383 ACRES: 1640 POP.: 118 DEMAND: 21 MAX. DEL.: 0.0413
TAZ ID: 1179 ACRES: 305 POP.: 1354 DEMAND: 235 MAX. DEL.: 0.4717
LEGEND
TAZs Within Study Area
County Line
City Limits
Land Parcel
N
0 2,600 5,200
October, 2011
CITY OF BASTROP
BASTROP COUNTY
2010 STUDY AREA POPULATION AND DEMAND
K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY
THE SETTING II, SUITE 100
AUSTIN, TX 78746
PH: 512-338-1704 FAX: 512-338-1784

| TAZ | SA ACRES | SA %AREA | SA POP05 | SA POP08 | SA POP10 | SA AAD10 | SA MDD10 | SA POP15 | SA AAD15 | SA MDD15 | SA POP20 | SA AAD20 | SA MDD20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1126 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1127 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1128 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1129 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1130 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1134 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1135 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1136 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1137 | 2288 | 59% | 380 | 380 | 421 | 73 | 0.15 | 445 | 77 | 0.16 | 469 | 81 | 0.16 |
| 1138 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1145 | 2314 | 32% | 82 | 82 | 84 | 15 | 0.03 | 144 | 25 | 0.05 | 158 | 27 | 0.06 |
| 1147 | 6226 | 100% | 601 | 922 | 1166 | 202 | 0.41 | 1942 | 337 | 0.68 | 3455 | 600 | 1.20 |
| 1148 | 411 | 100% | 301 | 301 | 336 | 58 | 0.12 | 341 | 59 | 0.12 | 342 | 59 | 0.12 |
| 1149 | 778 | 100% | 1450 | 1448 | 1529 | 265 | 0.53 | 1589 | 276 | 0.55 | 1616 | 281 | 0.56 |
| 1150 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1155 | 495 | 100% | 697 | 749 | 771 | 134 | 0.27 | 786 | 136 | 0.27 | 2274 | 395 | 0.79 |
| 1157 | 454 | 13% | 65 | 65 | 65 | 11 | 0.02 | 72 | 13 | 0.03 | 72 | 13 | 0.03 |
| 1158 | 108 | 2% | 15 | 17 | 18 | 3 | 0.01 | 22 | 4 | 0.01 | 23 | 4 | 0.01 |
| 1162 | 145 | 100% | 482 | 481 | 499 | 87 | 0.17 | 512 | 89 | 0.18 | 516 | 90 | 0.18 |
| 1163 | 59 | 100% | 47 | 47 | 46 | 8 | 0.02 | 46 | 8 | 0.02 | 46 | 8 | 0.02 |
| 1164 | 334 | 100% | 729 | 787 | 815 | 142 | 0.28 | 840 | 146 | 0.29 | 898 | 156 | 0.31 |
| 1165 | 1046 | 30% | 859 | 933 | 1068 | 185 | 0.37 | 1404 | 244 | 0.49 | 2400 | 417 | 0.84 |
| 1166 | 966 | 90% | 546 | 546 | 573 | 99 | 0.20 | 587 | 102 | 0.20 | 592 | 103 | 0.21 |
| 1167 | 527 | 9% | 95 | 95 | 96 | 17 | 0.03 | 101 | 18 | 0.04 | 101 | 17 | 0.04 |
| 1168 | 1294 | 10% | 59 | 59 | 61 | 11 | 0.02 | 73 | 13 | 0.03 | 80 | 14 | 0.03 |
| 1169 | 1050 | 100% | 156 | 156 | 194 | 34 | 0.07 | 203 | 35 | 0.07 | 1420 | 246 | 0.49 |
| 1171 | 1272 | 100% | 506 | 1155 | 1402 | 243 | 0.49 | 1451 | 252 | 0.51 | 1472 | 256 | 0.51 |
| 1172 | 787 | 22% | 317 | 317 | 322 | 56 | 0.11 | 350 | 61 | 0.12 | 350 | 61 | 0.12 |
| 1173 | 581 | 100% | 267 | 266 | 277 | 48 | 0.10 | 279 | 48 | 0.10 | 280 | 49 | 0.10 |
| 1174 | 86 | 100% | 141 | 141 | 145 | 25 | 0.05 | 149 | 26 | 0.05 | 150 | 26 | 0.05 |
| 1175 | 987 | 22% | 41 | 41 | 49 | 8 | 0.02 | 48 | 8 | 0.02 | 145 | 25 | 0.05 |
| 1176 | 220 | 14% | 63 | 63 | 67 | 12 | 0.02 | 362 | 63 | 0.13 | 810 | 141 | 0.28 |
| 1177 | 297 | 100% | 579 | 627 | 661 | 115 | 0.23 | 683 | 119 | 0.24 | 1017 | 176 | 0.35 |
| 1178 | 488 | 100% | 0 | 3 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 |
| 1179 | 305 | 100% | 383 | 794 | 1354 | 235 | 0.47 | 1413 | 245 | 0.49 | 1438 | 250 | 0.50 |
| 1180 | 1571 | 45% | 15 | 15 | 15 | 3 | 0.01 | 60 | 10 | 0.02 | 67 | 12 | 0.02 |
| 1191 | 858 | 100% | 163 | 182 | 194 | 34 | 0.07 | 191 | 33 | 0.07 | 2310 | 401 | 0.80 |
| 1192 | 158 | 100% | 766 | 766 | 798 | 139 | 0.28 | 829 | 144 | 0.29 | 844 | 146 | 0.29 |
| 1205 | 6386 | 97% | 273 | 273 | 297 | 52 | 0.10 | 2828 | 491 | 0.99 | 2970 | 516 | 1.03 |
| 1206 | 4089 | 24% | 278 | 278 | 282 | 49 | 0.10 | 395 | 69 | 0.14 | 458 | 79 | 0.16 |
| 1208 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1369 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1371 | 1371 | 94% | 554 | 597 | 634 | 110 | 0.22 | 670 | 116 | 0.23 | 3215 | 558 | 1.12 |
| 1372 | 2619 | 100% | 35 | 35 | 60 | 10 | 0.02 | 56 | 10 | 0.02 | 84 | 15 | 0.03 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA

STUDY AREA

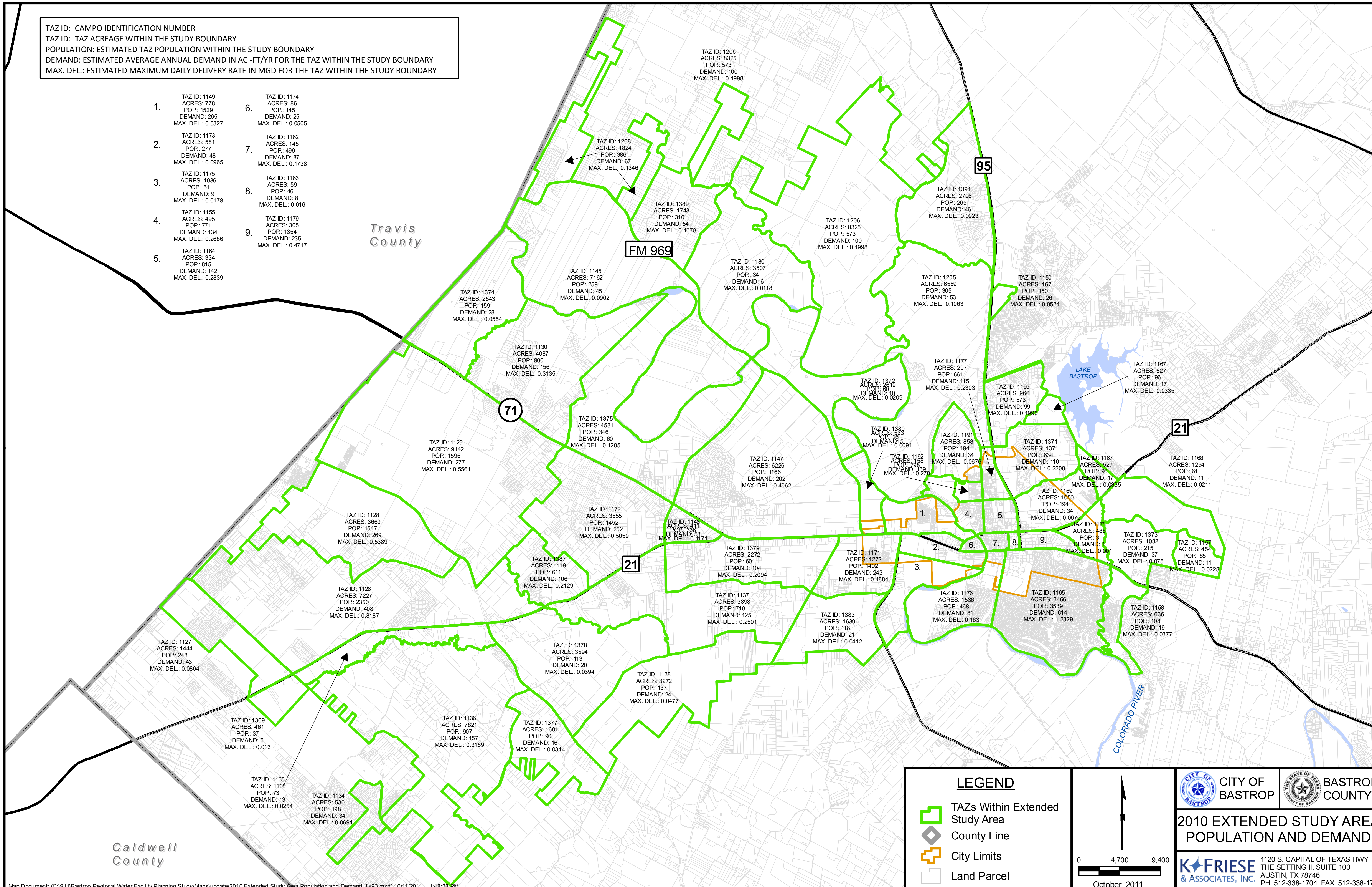
| TAZ | SA ACRES | SA %AREA | SA POP05 | SA POP08 | SA POP10 | SA AAD10 | SA MDD10 | SA POP15 | SA AAD15 | SA MDD15 | SA POP20 | SA AAD20 | SA MDD20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1373 | 1029 | 82% | 211 | 211 | 215 | 37 | 0.07 | 226 | 39 | 0.08 | 228 | 40 | 0.08 |
| 1374 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1375 | 4581 | 100% | 317 | 317 | 346 | 60 | 0.12 | 386 | 67 | 0.13 | 418 | 73 | 0.15 |
| 1377 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1378 | 10 | 0% | 0 | 0 | 0 | 0 | 0.00 | 1 | 0 | 0.00 | 1 | 0 | 0.00 |
| 1379 | 2272 | 100% | 528 | 528 | 601 | 104 | 0.21 | 630 | 109 | 0.22 | 741 | 129 | 0.26 |
| 1380 | 533 | 100% | 13 | 19 | 26 | 5 | 0.01 | 23 | 4 | 0.01 | 85 | 15 | 0.03 |
| 1383 | 1640 | 36% | 87 | 103 | 118 | 21 | 0.04 | 127 | 22 | 0.04 | 232 | 40 | 0.08 |
| 1387 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1389 | 0 | 0% | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1391 | 859 | 27% | 85 | 85 | 84 | 15 | 0.03 | 107 | 19 | 0.04 | 110 | 19 | 0.04 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
STUDY AREA

| TAZ | SA POP25 | SA AAD25 | SA MDD25 | SA POP30 | SA AAD30 | SA MDD30 | SA POP35 | SA AAD35 | SA MDD35 | SA POP40 | SA AAD40 | SA MDD40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1126 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1127 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1128 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1129 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1130 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1134 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1135 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1136 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1137 | 492 | 86 | 0.17 | 516 | 90 | 0.18 | 539 | 94 | 0.19 | 562 | 98 | 0.20 |
| 1138 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1145 | 172 | 30 | 0.06 | 185 | 32 | 0.06 | 197 | 34 | 0.07 | 210 | 36 | 0.07 |
| 1147 | 4968 | 863 | 1.73 | 8129 | 1411 | 2.83 | 11290 | 1960 | 3.93 | 14451 | 2509 | 5.03 |
| 1148 | 343 | 60 | 0.12 | 357 | 62 | 0.12 | 371 | 64 | 0.13 | 385 | 67 | 0.13 |
| 1149 | 1642 | 285 | 0.57 | 3833 | 666 | 1.34 | 6024 | 1046 | 2.10 | 8215 | 1426 | 2.86 |
| 1150 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1155 | 3762 | 653 | 1.31 | 3916 | 680 | 1.36 | 4070 | 707 | 1.42 | 4224 | 733 | 1.47 |
| 1157 | 73 | 13 | 0.03 | 76 | 13 | 0.03 | 79 | 14 | 0.03 | 83 | 14 | 0.03 |
| 1158 | 24 | 4 | 0.01 | 29 | 5 | 0.01 | 34 | 6 | 0.01 | 39 | 7 | 0.01 |
| 1162 | 519 | 90 | 0.18 | 525 | 91 | 0.18 | 530 | 92 | 0.18 | 536 | 93 | 0.19 |
| 1163 | 46 | 8 | 0.02 | 45 | 8 | 0.02 | 44 | 8 | 0.02 | 43 | 7 | 0.02 |
| 1164 | 955 | 166 | 0.33 | 1307 | 227 | 0.46 | 1658 | 288 | 0.58 | 2010 | 349 | 0.70 |
| 1165 | 3397 | 590 | 1.18 | 3481 | 604 | 1.21 | 3565 | 619 | 1.24 | 3649 | 634 | 1.27 |
| 1166 | 596 | 104 | 0.21 | 609 | 106 | 0.21 | 622 | 108 | 0.22 | 636 | 110 | 0.22 |
| 1167 | 100 | 17 | 0.04 | 103 | 18 | 0.04 | 105 | 18 | 0.04 | 108 | 19 | 0.04 |
| 1168 | 88 | 15 | 0.03 | 100 | 17 | 0.04 | 113 | 20 | 0.04 | 126 | 22 | 0.04 |
| 1169 | 2636 | 458 | 0.92 | 3094 | 537 | 1.08 | 3552 | 617 | 1.24 | 4010 | 696 | 1.40 |
| 1171 | 1493 | 259 | 0.52 | 1661 | 288 | 0.58 | 1828 | 317 | 0.64 | 1996 | 346 | 0.70 |
| 1172 | 351 | 61 | 0.12 | 357 | 62 | 0.12 | 363 | 63 | 0.13 | 369 | 64 | 0.13 |
| 1173 | 280 | 49 | 0.10 | 1172 | 203 | 0.41 | 2064 | 358 | 0.72 | 2956 | 513 | 1.03 |
| 1174 | 150 | 26 | 0.05 | 148 | 26 | 0.05 | 146 | 25 | 0.05 | 144 | 25 | 0.05 |
| 1175 | 241 | 42 | 0.08 | 310 | 54 | 0.11 | 380 | 66 | 0.13 | 449 | 78 | 0.16 |
| 1176 | 1258 | 219 | 0.44 | 1939 | 337 | 0.68 | 2619 | 455 | 0.91 | 3300 | 573 | 1.15 |
| 1177 | 1350 | 234 | 0.47 | 1575 | 273 | 0.55 | 1799 | 312 | 0.63 | 2024 | 351 | 0.71 |
| 1178 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 |
| 1179 | 1463 | 254 | 0.51 | 2241 | 389 | 0.78 | 3018 | 524 | 1.05 | 3796 | 659 | 1.32 |
| 1180 | 75 | 13 | 0.03 | 83 | 14 | 0.03 | 91 | 16 | 0.03 | 99 | 17 | 0.03 |
| 1191 | 4428 | 769 | 1.54 | 7296 | 1267 | 2.54 | 10163 | 1765 | 3.54 | 13031 | 2263 | 4.54 |
| 1192 | 858 | 149 | 0.30 | 1734 | 301 | 0.60 | 2610 | 453 | 0.91 | 3486 | 605 | 1.21 |
| 1205 | 3111 | 540 | 1.08 | 4843 | 841 | 1.69 | 6576 | 1142 | 2.29 | 8309 | 1443 | 2.89 |
| 1206 | 520 | 90 | 0.18 | 597 | 104 | 0.21 | 673 | 117 | 0.23 | 750 | 130 | 0.26 |
| 1208 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1369 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1371 | 5760 | 1000 | 2.01 | 6361 | 1104 | 2.22 | 6961 | 1209 | 2.43 | 7562 | 1313 | 2.63 |
| 1372 | 112 | 19 | 0.04 | 128 | 22 | 0.04 | 144 | 25 | 0.05 | 160 | 28 | 0.06 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
STUDY AREA

| TAZ | SA POP25 | SA AAD25 | SA MDD25 | SA POP30 | SA AAD30 | SA MDD30 | SA POP35 | SA AAD35 | SA MDD35 | SA POP40 | SA AAD40 | SA MDD40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1373 | 230 | 40 | 0.08 | 228 | 40 | 0.08 | 226 | 39 | 0.08 | 224 | 39 | 0.08 |
| 1374 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1375 | 450 | 78 | 0.16 | 478 | 83 | 0.17 | 506 | 88 | 0.18 | 534 | 93 | 0.19 |
| 1377 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1378 | 1 | 0 | 0.00 | 1 | 0 | 0.00 | 1 | 0 | 0.00 | 1 | 0 | 0.00 |
| 1379 | 852 | 148 | 0.30 | 1253 | 218 | 0.44 | 1654 | 287 | 0.58 | 2055 | 357 | 0.72 |
| 1380 | 147 | 26 | 0.05 | 154 | 27 | 0.05 | 160 | 28 | 0.06 | 167 | 29 | 0.06 |
| 1383 | 336 | 58 | 0.12 | 660 | 115 | 0.23 | 985 | 171 | 0.34 | 1309 | 227 | 0.46 |
| 1387 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1389 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 | 0 | 0 | 0.00 |
| 1391 | 113 | 20 | 0.04 | 119 | 21 | 0.04 | 125 | 22 | 0.04 | 131 | 23 | 0.05 |



TAZ ID: CAMPO IDENTIFICATION NUMBER
TAZ ID: TAZ ACREAGE WITHIN THE STUDY BOUNDARY
POPULATION: ESTIMATED TAZ POPULATION WITHIN THE STUDY BOUNDARY
DEMAND: ESTIMATED AVERAGE ANNUAL DEMAND IN AC -FT/YR FOR THE TAZ WITHIN THE STUDY BOUNDARY
MAX. DEL.: ESTIMATED MAXIMUM DAILY DELIVERY RATE IN MGD FOR THE TAZ WITHIN THE STUDY BOUNDARY
1. TAZ ID: 1149 ACRES: 778 POP.: 1529 DEMAND: 265 MAX. DEL.: 0.5327
2. TAZ ID: 1173 ACRES: 581 POP.: 277 DEMAND: 48 MAX. DEL.: 0.0965
3. TAZ ID: 1175 ACRES: 1036 POP.: 51 DEMAND: 9 MAX. DEL.: 0.0178
4. TAZ ID: 1155 ACRES: 495 POP.: 771 DEMAND: 134 MAX. DEL.: 0.2686
5. TAZ ID: 1164 ACRES: 334 POP.: 815 DEMAND: 142 MAX. DEL.: 0.2839
6. TAZ ID: 1174 ACRES: 86 POP.: 145 DEMAND: 25 MAX. DEL.: 0.0505
7. TAZ ID: 1162 ACRES: 145 POP.: 499 DEMAND: 87 MAX. DEL.: 0.1738
8. TAZ ID: 1163 ACRES: 59 POP.: 46 DEMAND: 8 MAX. DEL.: 0.016
9. TAZ ID: 1179 ACRES: 305 POP.: 1354 DEMAND: 235 MAX. DEL.: 0.4717
Travis County
Caldwell County
TAZ ID: 1206 ACRES: 8325 POP.: 573 DEMAND: 100 MAX. DEL.: 0.1998
TAZ ID: 1208 ACRES: 1824 POP.: 386 DEMAND: 67 MAX. DEL.: 0.1346
TAZ ID: 1389 ACRES: 1743 POP.: 310 DEMAND: 54 MAX. DEL.: 0.1078
TAZ ID: 1391 ACRES: 2706 POP.: 265 DEMAND: 46 MAX. DEL.: 0.0923
TAZ ID: 1145 ACRES: 7162 POP.: 259 DEMAND: 45 MAX. DEL.: 0.0902
TAZ ID: 1180 ACRES: 3507 POP.: 34 DEMAND: 6 MAX. DEL.: 0.0118
TAZ ID: 1205 ACRES: 6559 POP.: 305 DEMAND: 53 MAX. DEL.: 0.1063
TAZ ID: 1150 ACRES: 167 POP.: 150 DEMAND: 26 MAX. DEL.: 0.0524
TAZ ID: 1374 ACRES: 2543 POP.: 159 DEMAND: 28 MAX. DEL.: 0.0554
TAZ ID: 1130 ACRES: 4087 POP.: 900 DEMAND: 156 MAX. DEL.: 0.3135
TAZ ID: 1177 ACRES: 297 POP.: 661 DEMAND: 115 MAX. DEL.: 0.2303
TAZ ID: 1372 ACRES: 2819 POP.: 60 DEMAND: 10 MAX. DEL.: 0.0209
TAZ ID: 1166 ACRES: 966 POP.: 573 DEMAND: 99 MAX. DEL.: 0.1995
TAZ ID: 1167 ACRES: 527 POP.: 96 DEMAND: 17 MAX. DEL.: 0.0335
LAKE BASTROP
TAZ ID: 1375 ACRES: 4581 POP.: 346 DEMAND: 60 MAX. DEL.: 0.1205
TAZ ID: 1129 ACRES: 9142 POP.: 1596 DEMAND: 277 MAX. DEL.: 0.5561
TAZ ID: 1380 ACRES: 533 POP.: 26 DEMAND: 5 MAX. DEL.: 0.0091
TAZ ID: 1191 ACRES: 858 POP.: 194 DEMAND: 34 MAX. DEL.: 0.0676
TAZ ID: 1371 ACRES: 1371 POP.: 634 DEMAND: 110 MAX. DEL.: 0.2208
TAZ ID: 1147 ACRES: 6226 POP.: 1166 DEMAND: 202 MAX. DEL.: 0.4062
TAZ ID: 1192 ACRES: 158 POP.: 798 DEMAND: 139 MAX. DEL.: 0.278
TAZ ID: 1167 ACRES: 527 POP.: 96 DEMAND: 17 MAX. DEL.: 0.0335
TAZ ID: 1168 ACRES: 1294 POP.: 61 DEMAND: 11 MAX. DEL.: 0.0211
TAZ ID: 1169 ACRES: 1060 POP.: 194 DEMAND: 34 MAX. DEL.: 0.0676
TAZ ID: 1128 ACRES: 3669 POP.: 1547 DEMAND: 269 MAX. DEL.: 0.5389
TAZ ID: 1172 ACRES: 3555 POP.: 1452 DEMAND: 252 MAX. DEL.: 0.5059
TAZ ID: 1148 ACRES: 471 POP.: 336 DEMAND: 58 MAX. DEL.: 0.1171
TAZ ID: 1178 ACRES: 488 POP.: 3 DEMAND: 1 MAX. DEL.: 0.001
TAZ ID: 1373 ACRES: 1032 POP.: 215 DEMAND: 37 MAX. DEL.: 0.075
TAZ ID: 1157 ACRES: 454 POP.: 65 DEMAND: 11 MAX. DEL.: 0.0228
TAZ ID: 1387 ACRES: 1119 POP.: 611 DEMAND: 106 MAX. DEL.: 0.2129
TAZ ID: 1379 ACRES: 2272 POP.: 601 DEMAND: 104 MAX. DEL.: 0.2094
TAZ ID: 1171 ACRES: 1272 POP.: 1402 DEMAND: 243 MAX. DEL.: 0.4884
TAZ ID: 1126 ACRES: 7227 POP.: 2350 DEMAND: 408 MAX. DEL.: 0.8187
TAZ ID: 1137 ACRES: 3898 POP.: 718 DEMAND: 125 MAX. DEL.: 0.2501
TAZ ID: 1383 ACRES: 1639 POP.: 118 DEMAND: 21 MAX. DEL.: 0.0412
TAZ ID: 1176 ACRES: 1536 POP.: 468 DEMAND: 81 MAX. DEL.: 0.163
TAZ ID: 1165 ACRES: 3466 POP.: 3539 DEMAND: 614 MAX. DEL.: 1.2329
TAZ ID: 1158 ACRES: 636 POP.: 108 DEMAND: 19 MAX. DEL.: 0.0377
TAZ ID: 1127 ACRES: 1444 POP.: 248 DEMAND: 43 MAX. DEL.: 0.0864
TAZ ID: 1378 ACRES: 3594 POP.: 113 DEMAND: 20 MAX. DEL.: 0.0394
TAZ ID: 1138 ACRES: 3272 POP.: 137 DEMAND: 24 MAX. DEL.: 0.0477
TAZ ID: 1369 ACRES: 461 POP.: 37 DEMAND: 6 MAX. DEL.: 0.013
TAZ ID: 1136 ACRES: 7821 POP.: 907 DEMAND: 157 MAX. DEL.: 0.3159
TAZ ID: 1377 ACRES: 1681 POP.: 90 DEMAND: 16 MAX. DEL.: 0.0314
TAZ ID: 1135 ACRES: 1108 POP.: 73 DEMAND: 13 MAX. DEL.: 0.0254
TAZ ID: 1134 ACRES: 530 POP.: 198 DEMAND: 34 MAX. DEL.: 0.0691
95
FM 969
71
21
21
COLORADO RIVER
LEGEND
TAZs Within Extended Study Area
County Line
City Limits
Land Parcel
N
0 4,700 9,400
October, 2011
CITY OF BASTROP
BASTROP COUNTY
2010 EXTENDED STUDY AREA POPULATION AND DEMAND
K FRIESE & ASSOCIATES, INC.
1120 S. CAPITAL OF TEXAS HWY THE SETTING II, SUITE 100 AUSTIN, TX 78746 PH: 512-338-1704 FAX: 512-338-1784
Map Document: (C:\911\Bastrop Regional Water Facility Planning Study\Maps\update\2010 Extended Study Area Population and Demand_fix93.mxd) 10/11/2011 -- 1:48:38 PM

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
EXTENDED STUDY AREA

| TAZ | ESA ACRES | ESA %AREA | ESA POP05 | ESA POP08 | ESA POP10 | ESA AAD10 | ESA MDD10 | ESA POP15 | ESA AAD15 | ESA MDD15 | ESA POP20 | ESA AAD20 | ESA MDD20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1126 | 7227 | 97% | 2245 | 2244 | 2350 | 408 | 0.82 | 2849 | 495 | 0.99 | 2863 | 497 | 1.00 |
| 1127 | 1444 | 28% | 178 | 208 | 248 | 43 | 0.09 | 271 | 47 | 0.09 | 273 | 47 | 0.10 |
| 1128 | 3669 | 85% | 1497 | 1496 | 1547 | 269 | 0.54 | 1663 | 289 | 0.58 | 1677 | 291 | 0.58 |
| 1129 | 9142 | 97% | 1438 | 1548 | 1596 | 277 | 0.56 | 1988 | 345 | 0.69 | 2006 | 348 | 0.70 |
| 1130 | 4087 | 100% | 737 | 908 | 900 | 156 | 0.31 | 2403 | 417 | 0.84 | 2427 | 421 | 0.85 |
| 1134 | 530 | 8% | 196 | 196 | 198 | 34 | 0.07 | 232 | 40 | 0.08 | 233 | 41 | 0.08 |
| 1135 | 1108 | 100% | 70 | 70 | 73 | 13 | 0.03 | 106 | 18 | 0.04 | 106 | 18 | 0.04 |
| 1136 | 7821 | 75% | 919 | 920 | 907 | 157 | 0.32 | 981 | 170 | 0.34 | 1002 | 174 | 0.35 |
| 1137 | 3898 | 100% | 647 | 647 | 718 | 125 | 0.25 | 758 | 132 | 0.26 | 799 | 139 | 0.28 |
| 1138 | 3272 | 49% | 120 | 120 | 137 | 24 | 0.05 | 175 | 30 | 0.06 | 213 | 37 | 0.07 |
| 1145 | 7162 | 100% | 255 | 255 | 259 | 45 | 0.09 | 445 | 77 | 0.16 | 489 | 85 | 0.17 |
| 1147 | 6226 | 100% | 601 | 922 | 1166 | 202 | 0.41 | 1942 | 337 | 0.68 | 3455 | 600 | 1.20 |
| 1148 | 411 | 100% | 301 | 301 | 336 | 58 | 0.12 | 341 | 59 | 0.12 | 342 | 59 | 0.12 |
| 1149 | 778 | 100% | 1450 | 1448 | 1529 | 265 | 0.53 | 1589 | 276 | 0.55 | 1616 | 281 | 0.56 |
| 1150 | 167 | 7% | 150 | 150 | 150 | 26 | 0.05 | 159 | 28 | 0.06 | 159 | 28 | 0.06 |
| 1155 | 495 | 100% | 697 | 749 | 771 | 134 | 0.27 | 786 | 136 | 0.27 | 2274 | 395 | 0.79 |
| 1157 | 454 | 13% | 65 | 65 | 65 | 11 | 0.02 | 72 | 13 | 0.03 | 72 | 13 | 0.03 |
| 1158 | 636 | 10% | 90 | 102 | 108 | 19 | 0.04 | 130 | 23 | 0.05 | 135 | 23 | 0.05 |
| 1162 | 145 | 100% | 482 | 481 | 499 | 87 | 0.17 | 512 | 89 | 0.18 | 516 | 90 | 0.18 |
| 1163 | 59 | 100% | 47 | 47 | 46 | 8 | 0.02 | 46 | 8 | 0.02 | 46 | 8 | 0.02 |
| 1164 | 334 | 100% | 729 | 787 | 815 | 142 | 0.28 | 840 | 146 | 0.29 | 898 | 156 | 0.31 |
| 1165 | 3466 | 100% | 2847 | 3091 | 3539 | 614 | 1.23 | 4652 | 808 | 1.62 | 7956 | 1381 | 2.77 |
| 1166 | 966 | 90% | 546 | 546 | 573 | 99 | 0.20 | 587 | 102 | 0.20 | 592 | 103 | 0.21 |
| 1167 | 527 | 9% | 95 | 95 | 96 | 17 | 0.03 | 101 | 18 | 0.04 | 101 | 17 | 0.04 |
| 1168 | 1294 | 10% | 59 | 59 | 61 | 11 | 0.02 | 73 | 13 | 0.03 | 80 | 14 | 0.03 |
| 1169 | 1050 | 100% | 156 | 156 | 194 | 34 | 0.07 | 203 | 35 | 0.07 | 1420 | 246 | 0.49 |
| 1171 | 1272 | 100% | 506 | 1155 | 1402 | 243 | 0.49 | 1451 | 252 | 0.51 | 1472 | 256 | 0.51 |
| 1172 | 3555 | 100% | 1433 | 1432 | 1452 | 252 | 0.51 | 1581 | 275 | 0.55 | 1583 | 275 | 0.55 |
| 1173 | 581 | 100% | 267 | 266 | 277 | 48 | 0.10 | 279 | 48 | 0.10 | 280 | 49 | 0.10 |
| 1174 | 86 | 100% | 141 | 141 | 145 | 25 | 0.05 | 149 | 26 | 0.05 | 150 | 26 | 0.05 |
| 1175 | 1036 | 23% | 43 | 43 | 51 | 9 | 0.02 | 51 | 9 | 0.02 | 152 | 26 | 0.05 |
| 1176 | 1536 | 100% | 438 | 437 | 468 | 81 | 0.16 | 2528 | 439 | 0.88 | 5653 | 981 | 1.97 |
| 1177 | 297 | 100% | 579 | 627 | 661 | 115 | 0.23 | 683 | 119 | 0.24 | 1017 | 176 | 0.35 |
| 1178 | 488 | 100% | 0 | 3 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 |
| 1179 | 305 | 100% | 383 | 794 | 1354 | 235 | 0.47 | 1413 | 245 | 0.49 | 1438 | 250 | 0.50 |
| 1180 | 3507 | 100% | 34 | 34 | 34 | 6 | 0.01 | 133 | 23 | 0.05 | 151 | 26 | 0.05 |
| 1191 | 858 | 100% | 163 | 182 | 194 | 34 | 0.07 | 191 | 33 | 0.07 | 2310 | 401 | 0.80 |
| 1192 | 158 | 100% | 766 | 766 | 798 | 139 | 0.28 | 829 | 144 | 0.29 | 844 | 146 | 0.29 |
| 1205 | 6559 | 100% | 280 | 280 | 305 | 53 | 0.11 | 2905 | 504 | 1.01 | 3050 | 530 | 1.06 |
| 1206 | 8325 | 50% | 566 | 565 | 573 | 100 | 0.20 | 804 | 140 | 0.28 | 932 | 162 | 0.32 |
| 1208 | 1824 | 32% | 338 | 384 | 386 | 67 | 0.13 | 442 | 77 | 0.15 | 444 | 77 | 0.15 |
| 1369 | 461 | 8% | 37 | 37 | 37 | 6 | 0.01 | 46 | 8 | 0.02 | 46 | 8 | 0.02 |
| 1371 | 1371 | 94% | 554 | 597 | 634 | 110 | 0.22 | 670 | 116 | 0.23 | 3215 | 558 | 1.12 |
| 1372 | 2619 | 100% | 35 | 35 | 60 | 10 | 0.02 | 56 | 10 | 0.02 | 84 | 15 | 0.03 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
EXTENDED STUDY AREA

| TAZ | ESA ACRES | ESA %AREA | ESA POP05 | ESA POP08 | ESA POP10 | ESA AAD10 | ESA MDD10 | ESA POP15 | ESA AAD15 | ESA MDD15 | ESA POP20 | ESA AAD20 | ESA MDD20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1373 | 1032 | 82% | 212 | 212 | 215 | 37 | 0.08 | 227 | 39 | 0.08 | 229 | 40 | 0.08 |
| 1374 | 2543 | 100% | 157 | 157 | 159 | 28 | 0.06 | 176 | 31 | 0.06 | 176 | 30 | 0.06 |
| 1375 | 4581 | 100% | 317 | 317 | 346 | 60 | 0.12 | 386 | 67 | 0.13 | 418 | 73 | 0.15 |
| 1377 | 1681 | 43% | 94 | 94 | 90 | 16 | 0.03 | 108 | 19 | 0.04 | 108 | 19 | 0.04 |
| 1378 | 3594 | 100% | 112 | 112 | 113 | 20 | 0.04 | 193 | 34 | 0.07 | 233 | 40 | 0.08 |
| 1379 | 2272 | 100% | 528 | 528 | 601 | 104 | 0.21 | 630 | 109 | 0.22 | 741 | 129 | 0.26 |
| 1380 | 533 | 100% | 13 | 19 | 26 | 5 | 0.01 | 23 | 4 | 0.01 | 85 | 15 | 0.03 |
| 1383 | 1639 | 36% | 87 | 103 | 118 | 21 | 0.04 | 127 | 22 | 0.04 | 232 | 40 | 0.08 |
| 1387 | 1119 | 100% | 347 | 598 | 611 | 106 | 0.21 | 696 | 121 | 0.24 | 705 | 122 | 0.25 |
| 1389 | 1743 | 96% | 305 | 305 | 310 | 54 | 0.11 | 352 | 61 | 0.12 | 364 | 63 | 0.13 |
| 1391 | 2706 | 85% | 268 | 268 | 265 | 46 | 0.09 | 336 | 58 | 0.12 | 346 | 60 | 0.12 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
EXTENDED STUDY AREA

| TAZ | ESA POP25 | ESA AAD25 | ESA MDD25 | ESA POP30 | ESA AAD30 | ESA MDD30 | ESA POP35 | ESA AAD35 | ESA MDD35 | ESA POP40 | ESA AAD40 | ESA MDD40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1126 | 2878 | 500 | 1.00 | 2968 | 515 | 1.03 | 3059 | 531 | 1.07 | 3150 | 547 | 1.10 |
| 1127 | 275 | 48 | 0.10 | 333 | 58 | 0.12 | 391 | 68 | 0.14 | 450 | 78 | 0.16 |
| 1128 | 1691 | 294 | 0.59 | 1946 | 338 | 0.68 | 2202 | 382 | 0.77 | 2457 | 427 | 0.86 |
| 1129 | 2024 | 351 | 0.71 | 2512 | 436 | 0.88 | 3001 | 521 | 1.05 | 3489 | 606 | 1.22 |
| 1130 | 2450 | 425 | 0.85 | 2465 | 428 | 0.86 | 2479 | 430 | 0.86 | 2494 | 433 | 0.87 |
| 1134 | 235 | 41 | 0.08 | 233 | 40 | 0.08 | 231 | 40 | 0.08 | 230 | 40 | 0.08 |
| 1135 | 106 | 18 | 0.04 | 109 | 19 | 0.04 | 112 | 19 | 0.04 | 115 | 20 | 0.04 |
| 1136 | 1023 | 178 | 0.36 | 1038 | 180 | 0.36 | 1054 | 183 | 0.37 | 1069 | 186 | 0.37 |
| 1137 | 839 | 146 | 0.29 | 879 | 153 | 0.31 | 918 | 159 | 0.32 | 958 | 166 | 0.33 |
| 1138 | 252 | 44 | 0.09 | 301 | 52 | 0.11 | 350 | 61 | 0.12 | 399 | 69 | 0.14 |
| 1145 | 532 | 92 | 0.19 | 572 | 99 | 0.20 | 611 | 106 | 0.21 | 651 | 113 | 0.23 |
| 1147 | 4968 | 863 | 1.73 | 8129 | 1411 | 2.83 | 11290 | 1960 | 3.93 | 14451 | 2509 | 5.03 |
| 1148 | 343 | 60 | 0.12 | 357 | 62 | 0.12 | 371 | 64 | 0.13 | 385 | 67 | 0.13 |
| 1149 | 1642 | 285 | 0.57 | 3833 | 666 | 1.34 | 6024 | 1046 | 2.10 | 8215 | 1426 | 2.86 |
| 1150 | 160 | 28 | 0.06 | 163 | 28 | 0.06 | 167 | 29 | 0.06 | 170 | 29 | 0.06 |
| 1155 | 3762 | 653 | 1.31 | 3916 | 680 | 1.36 | 4070 | 707 | 1.42 | 4224 | 733 | 1.47 |
| 1157 | 73 | 13 | 0.03 | 76 | 13 | 0.03 | 79 | 14 | 0.03 | 83 | 14 | 0.03 |
| 1158 | 141 | 24 | 0.05 | 171 | 30 | 0.06 | 202 | 35 | 0.07 | 233 | 40 | 0.08 |
| 1162 | 519 | 90 | 0.18 | 525 | 91 | 0.18 | 530 | 92 | 0.18 | 536 | 93 | 0.19 |
| 1163 | 46 | 8 | 0.02 | 45 | 8 | 0.02 | 44 | 8 | 0.02 | 43 | 7 | 0.02 |
| 1164 | 955 | 166 | 0.33 | 1307 | 227 | 0.46 | 1658 | 288 | 0.58 | 2010 | 349 | 0.70 |
| 1165 | 11260 | 1955 | 3.92 | 11538 | 2003 | 4.02 | 11816 | 2052 | 4.12 | 12094 | 2100 | 4.21 |
| 1166 | 596 | 104 | 0.21 | 609 | 106 | 0.21 | 622 | 108 | 0.22 | 636 | 110 | 0.22 |
| 1167 | 100 | 17 | 0.04 | 103 | 18 | 0.04 | 105 | 18 | 0.04 | 108 | 19 | 0.04 |
| 1168 | 88 | 15 | 0.03 | 100 | 17 | 0.04 | 113 | 20 | 0.04 | 126 | 22 | 0.04 |
| 1169 | 2636 | 458 | 0.92 | 3094 | 537 | 1.08 | 3552 | 617 | 1.24 | 4010 | 696 | 1.40 |
| 1171 | 1493 | 259 | 0.52 | 1661 | 288 | 0.58 | 1828 | 317 | 0.64 | 1996 | 346 | 0.70 |
| 1172 | 1584 | 275 | 0.55 | 1612 | 280 | 0.56 | 1640 | 285 | 0.57 | 1668 | 290 | 0.58 |
| 1173 | 280 | 49 | 0.10 | 1172 | 203 | 0.41 | 2064 | 358 | 0.72 | 2956 | 513 | 1.03 |
| 1174 | 150 | 26 | 0.05 | 148 | 26 | 0.05 | 146 | 25 | 0.05 | 144 | 25 | 0.05 |
| 1175 | 253 | 44 | 0.09 | 326 | 57 | 0.11 | 398 | 69 | 0.14 | 471 | 82 | 0.16 |
| 1176 | 8777 | 1524 | 3.06 | 13523 | 2348 | 4.71 | 18268 | 3172 | 6.36 | 23014 | 3996 | 8.02 |
| 1177 | 1350 | 234 | 0.47 | 1575 | 273 | 0.55 | 1799 | 312 | 0.63 | 2024 | 351 | 0.71 |
| 1178 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 | 3 | 1 | 0.00 |
| 1179 | 1463 | 254 | 0.51 | 2241 | 389 | 0.78 | 3018 | 524 | 1.05 | 3796 | 659 | 1.32 |
| 1180 | 168 | 29 | 0.06 | 186 | 32 | 0.06 | 204 | 35 | 0.07 | 222 | 39 | 0.08 |
| 1191 | 4428 | 769 | 1.54 | 7296 | 1267 | 2.54 | 10163 | 1765 | 3.54 | 13031 | 2263 | 4.54 |
| 1192 | 858 | 149 | 0.30 | 1734 | 301 | 0.60 | 2610 | 453 | 0.91 | 3486 | 605 | 1.21 |
| 1205 | 3195 | 555 | 1.11 | 4975 | 864 | 1.73 | 6754 | 1173 | 2.35 | 8534 | 1482 | 2.97 |
| 1206 | 1060 | 184 | 0.37 | 1215 | 211 | 0.42 | 1371 | 238 | 0.48 | 1526 | 265 | 0.53 |
| 1208 | 446 | 77 | 0.16 | 497 | 86 | 0.17 | 548 | 95 | 0.19 | 599 | 104 | 0.21 |
| 1369 | 46 | 8 | 0.02 | 60 | 10 | 0.02 | 75 | 13 | 0.03 | 89 | 15 | 0.03 |
| 1371 | 5760 | 1000 | 2.01 | 6361 | 1104 | 2.22 | 6961 | 1209 | 2.43 | 7562 | 1313 | 2.63 |
| 1372 | 112 | 19 | 0.04 | 128 | 22 | 0.04 | 144 | 25 | 0.05 | 160 | 28 | 0.06 |

2005 to 2040 BASTROP REGIONAL STUDY POPULATION AND DEMAND DATA
EXTENDED STUDY AREA

| TAZ | ESA POP25 | ESA AAD25 | ESA MDD25 | ESA POP30 | ESA AAD30 | ESA MDD30 | ESA POP35 | ESA AAD35 | ESA MDD35 | ESA POP40 | ESA AAD40 | ESA MDD40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1373 | 231 | 40 | 0.08 | 229 | 40 | 0.08 | 227 | 39 | 0.08 | 225 | 39 | 0.08 |
| 1374 | 175 | 30 | 0.06 | 243 | 42 | 0.08 | 311 | 54 | 0.11 | 379 | 66 | 0.13 |
| 1375 | 450 | 78 | 0.16 | 478 | 83 | 0.17 | 506 | 88 | 0.18 | 534 | 93 | 0.19 |
| 1377 | 108 | 19 | 0.04 | 110 | 19 | 0.04 | 112 | 20 | 0.04 | 115 | 20 | 0.04 |
| 1378 | 273 | 47 | 0.10 | 292 | 51 | 0.10 | 310 | 54 | 0.11 | 329 | 57 | 0.11 |
| 1379 | 852 | 148 | 0.30 | 1253 | 218 | 0.44 | 1654 | 287 | 0.58 | 2055 | 357 | 0.72 |
| 1380 | 147 | 26 | 0.05 | 154 | 27 | 0.05 | 160 | 28 | 0.06 | 167 | 29 | 0.06 |
| 1383 | 336 | 58 | 0.12 | 660 | 115 | 0.23 | 984 | 171 | 0.34 | 1308 | 227 | 0.46 |
| 1387 | 713 | 124 | 0.25 | 709 | 123 | 0.25 | 705 | 122 | 0.25 | 701 | 122 | 0.24 |
| 1389 | 377 | 65 | 0.13 | 421 | 73 | 0.15 | 465 | 81 | 0.16 | 509 | 88 | 0.18 |
| 1391 | 356 | 62 | 0.12 | 375 | 65 | 0.13 | 394 | 68 | 0.14 | 413 | 72 | 0.14 |

## Appendix D CH2M HILL Surface Water Source Technical Memorandum

# City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation

PREPARED FOR: K. Friese & Associates, Inc.

PREPARED BY: CH2M HILL

COPIES: File

DATE: October 14, 2011 (revised)

## Introduction

The City of Bastrop has partnered with Bastrop County, Lost Pines Groundwater Conservation District (LPGCD), and the Lower Colorado River Authority (LCRA) to complete the Texas Water Development Board (TWDB) Bastrop Regional Water Facilities Planning Grant Study. As part of this effort, the City of Bastrop ("the City") is conducting a water supply study to evaluate new sources and facilities necessary to meet water demands for a thirty year period (2010 to 2040). The City anticipates increased demands due to both population growth and the potential annexation of growing areas within its extraterritorial jurisdiction (ETJ). The project study area consists of the City of Bastrop and areas within the county where significant development is planned (**Exhibit 1**). In addition, the project considers the estimated demands associated with an extended study area, which includes the western portion of the county and areas along the State Highway (SH) 71 and SH 130 corridors, where significant growth is anticipated.

The purpose of this technical memorandum is to explore the potential to meet the City's future water demands or projected supply deficits with surface water diverted from the lower Colorado River. This memorandum documents the evaluation of a potential supply project to use surface water from the Colorado River to meet projected needs within the study area. The sections that follow discuss the availability of surface water supplies; proposed infrastructure and associated implementation, cost and permitting considerations; and potential environmental concerns related to a potential surface water project. The proposed facilities and costs discussed in this document are limited to the intake, conveyance and treatment of raw surface water so that the proposed project can be readily compared with alternative supply options (e.g. development of additional groundwater sources or contract with a third party). Potential improvements to, or expansion of, the treated water distribution system are not considered in this study.

# Background

During previous tasks in this regional study, information regarding existing water supplies and projected future water demands (annual and maximum daily demands) within the study area were prepared by others and provided to CH2M HILL to use as planning assumptions. This section summarizes CH2M HILL's understanding of the information provided and the assumptions used in development of a conceptual water supply project. The primary source of the City's existing water supply is groundwater extracted from lower Colorado River alluvium. In 2010, the City's water system had an estimated operational capacity of 4,154 acre-feet per year (ac-ft/yr) and a maximum delivery rate of 3.7 million gallons per day (MGD).

As presented in **Exhibit 2**, future demands in the study area are expected to increase from approximately 1,984 ac-ft/yr in 2010 to 15,258 ac-ft/yr in 2040. Similarly, peak day demands are projected to increase from 4.0 MGD to 30.6 MGD over the same period (**Exhibit 3**). (Note that the current peak day demands are greater than the City's existing maximum delivery rate.) Average annual water demands in the extended service area are expected to increase to 22,152 ac-ft/yr by 2040, with a peak day demand of 44.4 MGD in the same year (Exhibits 2 and 3). **Appendix A** provides the detailed water demand projections for both the study area and extended study area throughout the project period.

**Exhibit 4** presents a summary of the anticipated average annual water supply deficit for both the study area and extended study area. **Exhibit 5** provides the projected peak day demand deficit. The supply deficits presented in Exhibits 4 and 5 were calculated by subtracting the City's existing water supply volumes from the projected water demands in the study and extended study areas. Other water supplies within the study area or extended area could potentially reduce the apparent deficit.

EXHIBIT 1
Study Area and Extended Study Area
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

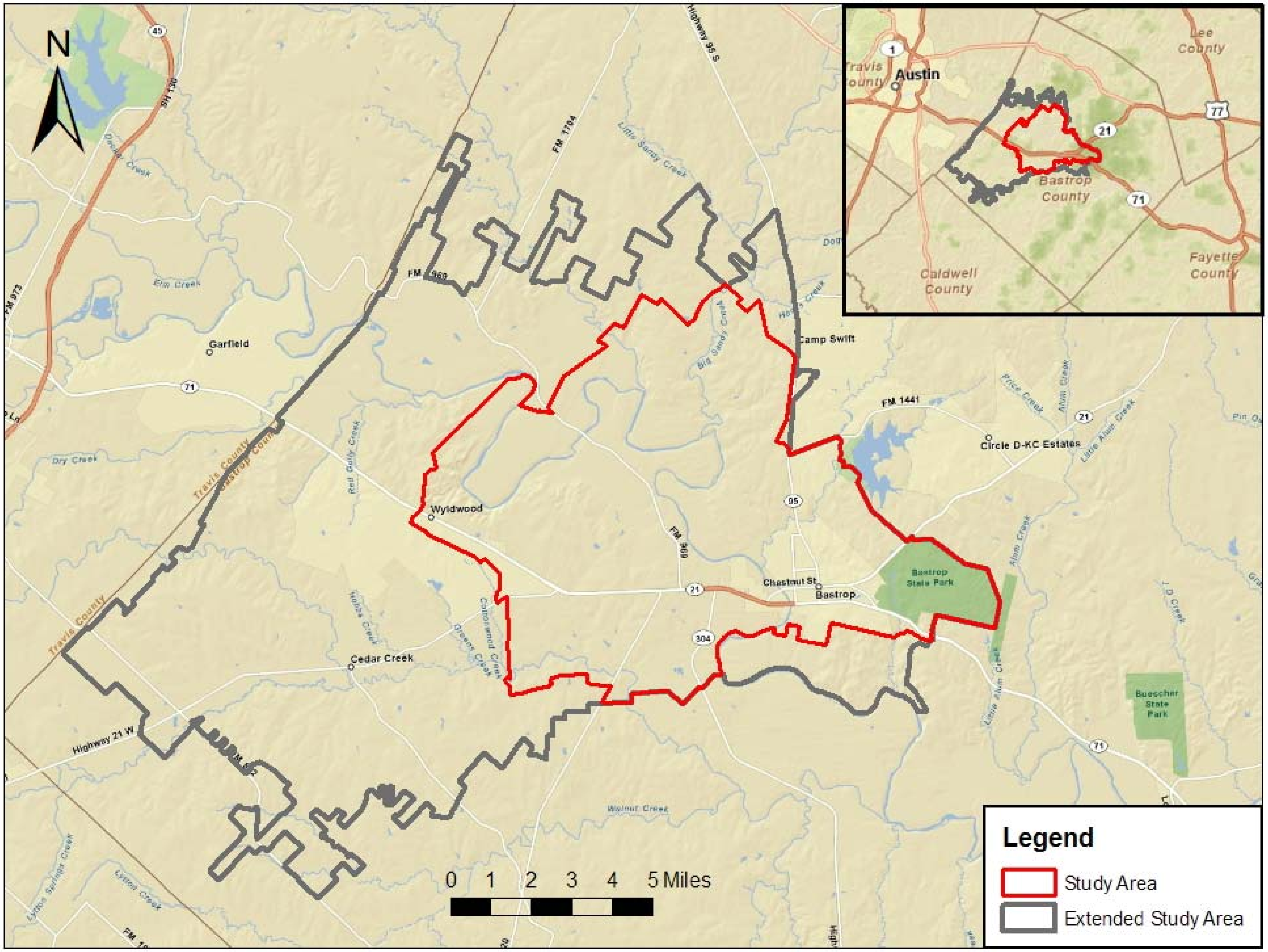


EXHIBIT 2
Projected Average Annual Demand (acre-feet per year)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

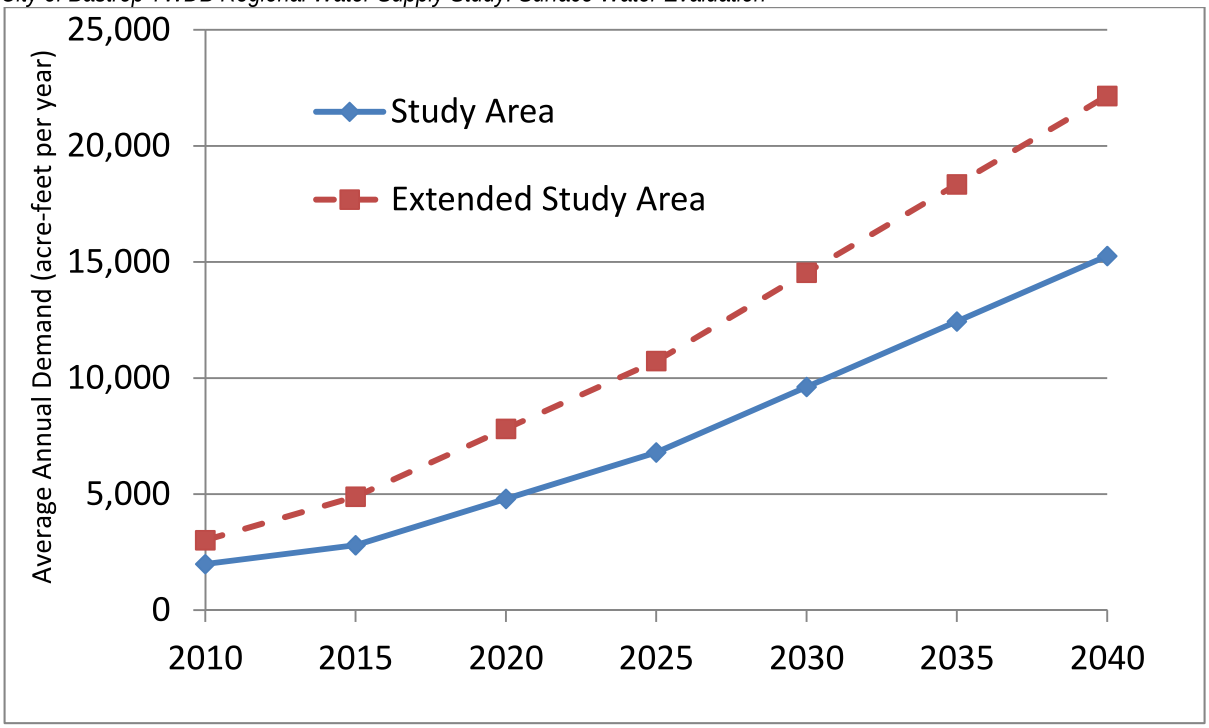



EXHIBIT 3
Projected Peak Day Demand (million gallons per day)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

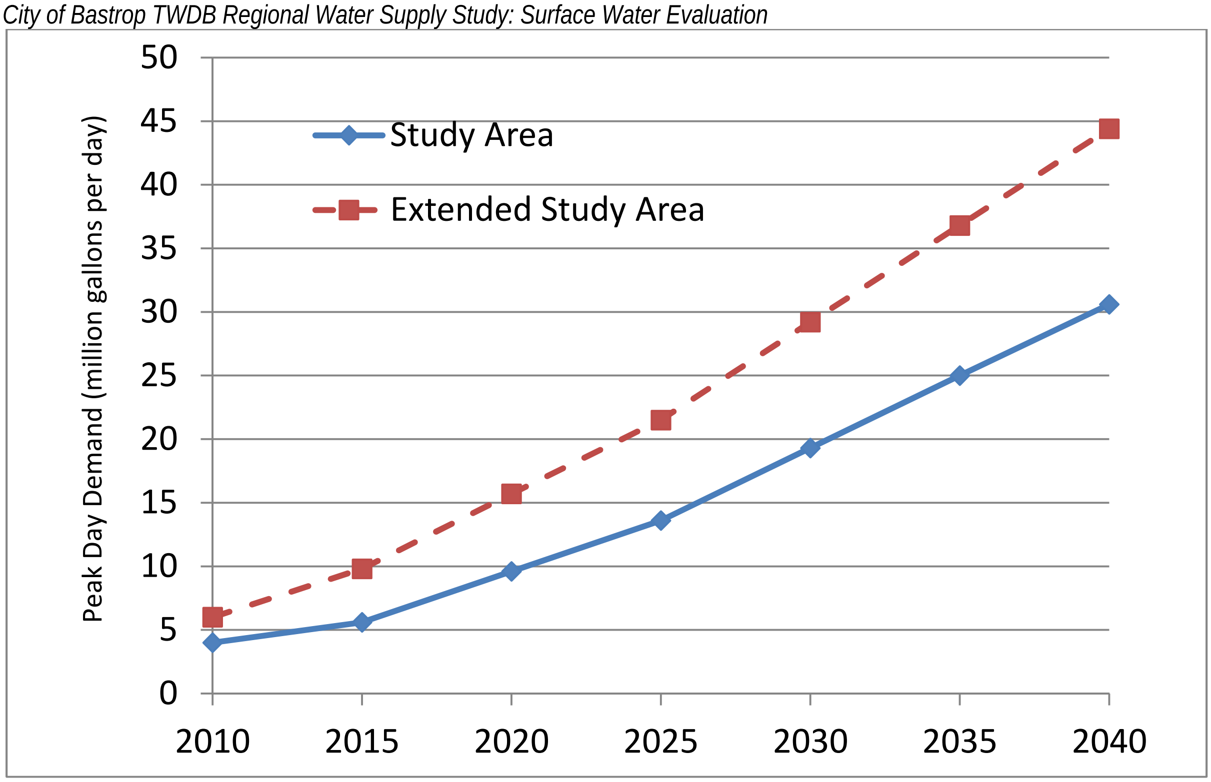


EXHIBIT 4
Projected Average Annual Water Supply Deficit (acre-feet per year)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Year | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | (2,324)[1] | (1,511)[1] | 488 | 2,486 | 5,307 | 8,128 | 10,949 |
| Extended Study Area | (1,295) | 580 | 3,503 | 6,426 | 10,231 | 14,037 | 17,843 |

1. Numbers in parentheses denote a surplus.

*Source: K Friese and Associates*

EXHIBIT 5
Projected Peak Day Water Supply Deficit (MGD)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Year | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 0.1 | 1.8 | 5.8 | 9.8 | 15.4 | 21.1 | 26.8 |
| Extended Study Area | 2.2 | 6.0 | 11.8 | 17.7 | 25.3 | 33.0 | 40.6 |

*Source: Source: K Friese and Associates*

For facility planning and costing purposes, the 2040 annual and peak daily water demands (i.e., deficits compared with current water supply used by the City of Bastrop) were used for facility sizing and cost-estimating purposes. As noted, the actual peak day and annual volumes required to meet the projected water demands within the study and extended study areas may be reduced if water supplies currently available to other suppliers in the area are utilized to meet future water needs.

# Surface Water Availability

The ability of the City to use surface water diverted from the lower Colorado River to meet future demands is dependent on the volume of water estimated to be available for use. Availability is a function of both flows in the river available for "instantaneous" and annual diversion and legal authorization to divert the water.

## Surface Water Flows

Daily surface water flows in the lower Colorado River are measured at U.S. Geological Survey (USGS) Gage 08159200 in Bastrop. As shown in **Exhibit 6** (on page 9), USGS Gage 08159200 is located in the river at Water Street, just downstream of the SH 71 bridge over the lower Colorado River (Latitude 30°06'16", Longitude 97°19'09") (USGS 2009). This USGS gage is jointly maintained and operated by LCRA and USGS. The period of record for this gage spans from March 1960 to present. From water year (WY)[1] 1960 to WY 2009, flow at the gage averaged 2,214 cubic feet per second (cfs) annually, and 90 percent of daily flows exceeded 270 cfs (**Exhibit 7**). Both the lowest daily mean (75 cfs) and annual seven-day minimum (84 cfs) for the gage occurred in WY 1964 (USGS 2009).

EXHIBIT 7
Summary Statistics for Daily Flows in the Lower Colorado River at Bastrop, TX, USGS Gage 08159200 in Cubic Feet per Second (cfs)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| | Calendar Year 2008 | | Water Year 2009 | | Water Years 1960-2009 | |
|---|---|---|---|---|---|---|
| Annual Total | 357,165 | | 349,603 | | | |
| Annual Mean | 976 | | 958 | | 2,214 | |
| Highest Annual Mean | | | | | 9,073 | 1992 |
| Lowest Annual Mean | | | | | 828 | 1964 |
| Highest Daily Mean | 2,770 | April 28 | 2,110 | Sept. 13 | 65,800 | Dec. 22, 1991 |
| Lowest Daily Mean | 149 | Nov. 21 | 149 | Nov. 21 | 75 | April 1, 1964 |
| Annual Seven-Day Minimum | 185 | Nov. 20 | 185 | Nov. 20 | 84 | Oct. 19, 1964 |
| Maximum Peak Flow | | | 3,870 | Sept. 23 | 79,600 | Oct. 29, 1960 |
| Maximum Peak Stage | | | 6.82 | Sept. 23 | 37.48 | Dec. 22, 1991 |
| Annual Runoff (acre-feet) | 708,400 | | 693,400 | | 1,604,000 | |
| 10 Percent Exceeds | 1,830 | | 2,040 | | 4,170 | |
| 50 Percent Exceeds | 1,060 | | 741 | | 1,480 | |
| 90 Percent Exceeds | 217 | | 201 | | 270 | |

Source: USGS 2009.

During WY 2009 (Oct. 2008 to Sept. 2009), a recent drought year, flows at the Bastrop gage averaged 958 cfs, less than half of the annual average for the period of record. In contrast, both the lowest daily mean (149 cfs) and annual seven-day minimum (185 cfs) for the year were more than twice the equivalent values for the period of record (USGS 2009). These

[1] A Water Year is a 12-month period that spans from October to September. For example, Water Year 1960 is equivalent to the calendar period from October 1, 1959 to September 30, 1960.

values suggest that, given LCRA's current operations, flows in the lower Colorado River are consistently sufficient to meet the study area maximum delivery rate deficit of 41.5 cubic feet per second (cfs) or 26.8 MGD in 2040, even under dry conditions representative of recent years.[2] Further, the lowest daily mean of WY 2009 is more than twice the 62.8 cfs (40.6 MGD) maximum delivery rate deficit associated with serving the extended study area.

Flow volumes in the lower Colorado River at Bastrop are largely influenced by releases made by LCRA upstream at Mansfield Dam (Lake Travis) and at Tom Miller Dam (Lake Austin). A substantial change in operations that would alter reservoir release rates or timing would alter historical flow patterns.

## Water Rights and Contractual Considerations

The diversion, impoundment or use of surface water requires authorization from the Texas Commission on Water Quality. A new diversion, if obtainable, would result in a very junior water right. Such a new right would be a "run of river" right meaning that diversion rates and frequency would be limited by the needs of senior water right holders and environmental flow requirements. Such junior flows would require significant storage capacity to "firm up" the rights to ensure reliability during the drought of record.

As an alternative, the City of Bastrop could enter into a firm water contract with the LCRA, a wholesale water provider. LCRA currently is authorized to divert and use approximately 1.5 million ac-ft/yr of surface water stored in the Lake Buchannan and Lake Travis reservoir system (LCRA, 2011b). The reservoir system provides a combined firm yield of 445,000 ac-ft/yr. Additional water downstream increase the estimated firm supply to approximately 600,000 ac-ft/yr. These firm supplies are provided to LCRA's customers, primarily for municipal and industrial uses in accordance with LCRA's June 2010 "Water Contract Rules" and provisions in a "firm water contract. LCRA estimates that currently 90,000 ac-ft/yr of firm water is available for new customers and uses (LCRA, 2010).

As part of this study, LCRA was consulted to determine the feasibility of obtaining a firm water supply contract to meet the City's projected 2040 demands for the extended study area (i.e., maximum delivery rate of 68.7 cfs (44.4 MGD) and up to 22,152 ac-ft/yr). Representatives from LCRA confirmed that currently approximately 90,000 acre-ft/yr of firm water supply available through execution of a firm water contract. Additionally, based on current operations and those anticipated in the future, releases could be made to meet the projected peak daily demands (LCRA, 2010). Based on surface water modeling, the water supply under such a contract would be reliable and available on a monthly basis during hydrological conditions similar to that of the 1950's drought of record, although conditions worse than the drought of record could affect availability during extreme drought. Because the water would be "firmed up" by LCRA, no additional storage would be required by Bastrop provide a firm supply during a repeat of hydrological conditions consistent with the drought of record.

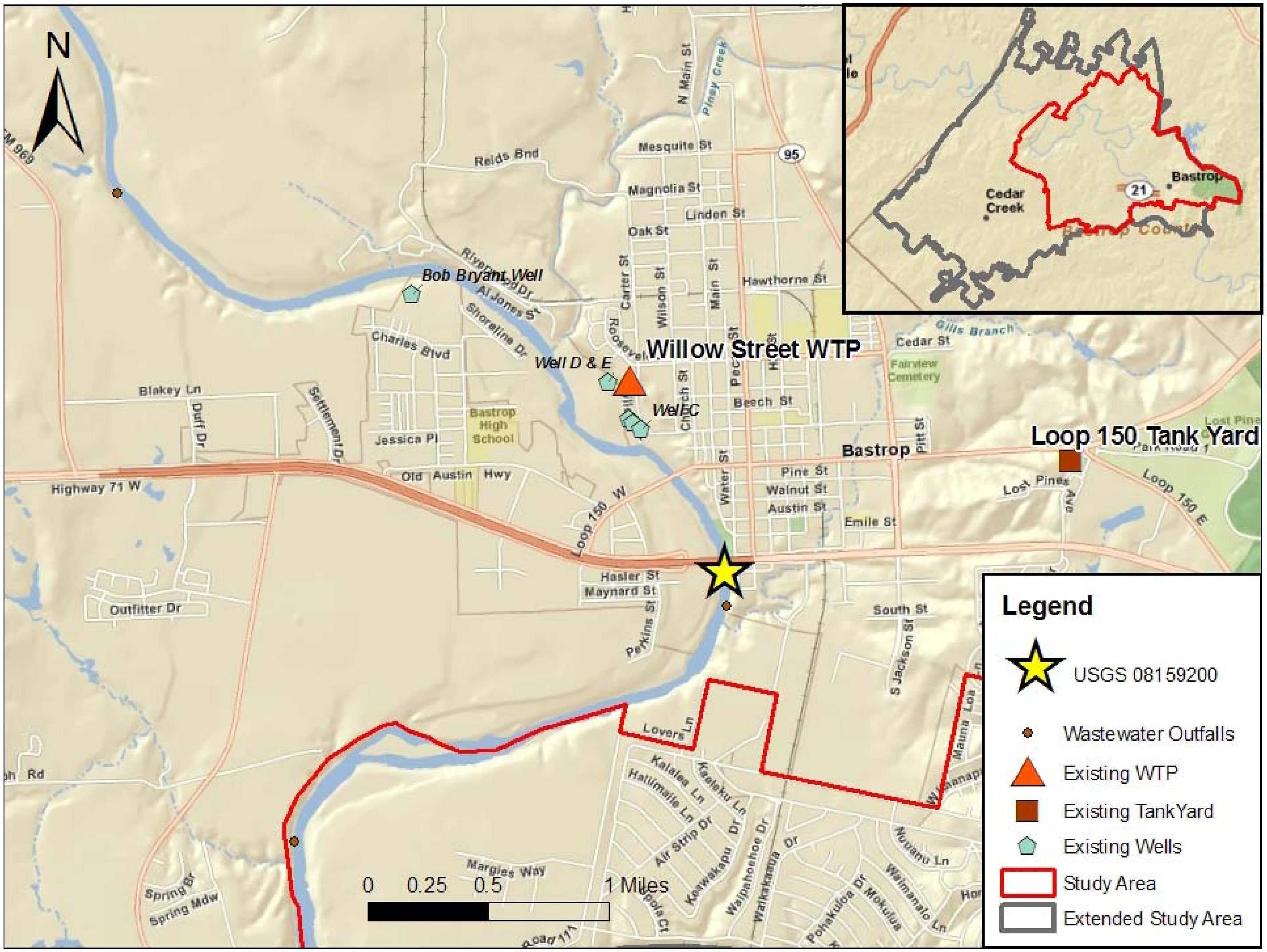
LCRA reported that authorization to use the bed and banks of the Colorado River for conveyance of firm water from the Buchannan and Travis reservoir system for subsequent diversion downstream is included in their existing water rights (LCRA, 2010). The provisions of the LCRA water rights were not independently verified in this study.

[2] Note that this does not consider any additional, drought-related needs of water rights holders or any environmental flow requirements downstream of the Bastrop gage that could result in diversion limitations.

Based on historical gaged flow data and the information provided by LCRA, water would be available for diversion to also meet the peak requirements as a firm water customer. However, releases will be constrained by the travel time required between the Mansfield and Tom Miller Dams and the City of Bastrop, which has been estimated at 30 to 48 hours (LCRA, 2011a). This suggests that a small amount of storage in the diversion and treatment system would be prudent to enhance reliability during peak demand periods. Such storage will be addressed in more detail in the Proposed Facilities section of this technical memorandum.

LCRA has published rules regarding the process for securing a firm water contract. The process involves an optional meeting with LCRA staff to discuss the desired contract; submittal of an application that specifies location, rates, annual volume of the contract and other pertinent information; technical review by LCRA staff to ensure compliance with the rules; public notice of the proposed contract; and, finally, approval by the General Manager (or his designee) or the LCRA Board of Directors, as may be required. Wholesale customers must have conservation and drought management plans that demonstrate compliance with LCRA's conservation plans and/or state requirements. Application processing fees are also required by the current rules. The rules and contract are subject to change from time to time; therefore, the City should review the current rules and contract form that may be in effect at the time a contract may be desired.

EXHIBIT 6
Location of USGS Gage 08159200
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*



# Proposed Facilities

As described in the previous section, a review of surface water availability in the lower Colorado River indicates that surface water could potentially be utilized to meet the estimated 2040 water demands in the extended study area. If the City of Bastrop decides to provide surface water to meet the water demands of its customers, the City would need to expand its water supply system to address the necessary capacity. For the purpose of this study, proposed facilities have been sized to address the estimated annual 2040 study area deficit of 10,949 acre-feet. Facilities needed would include:

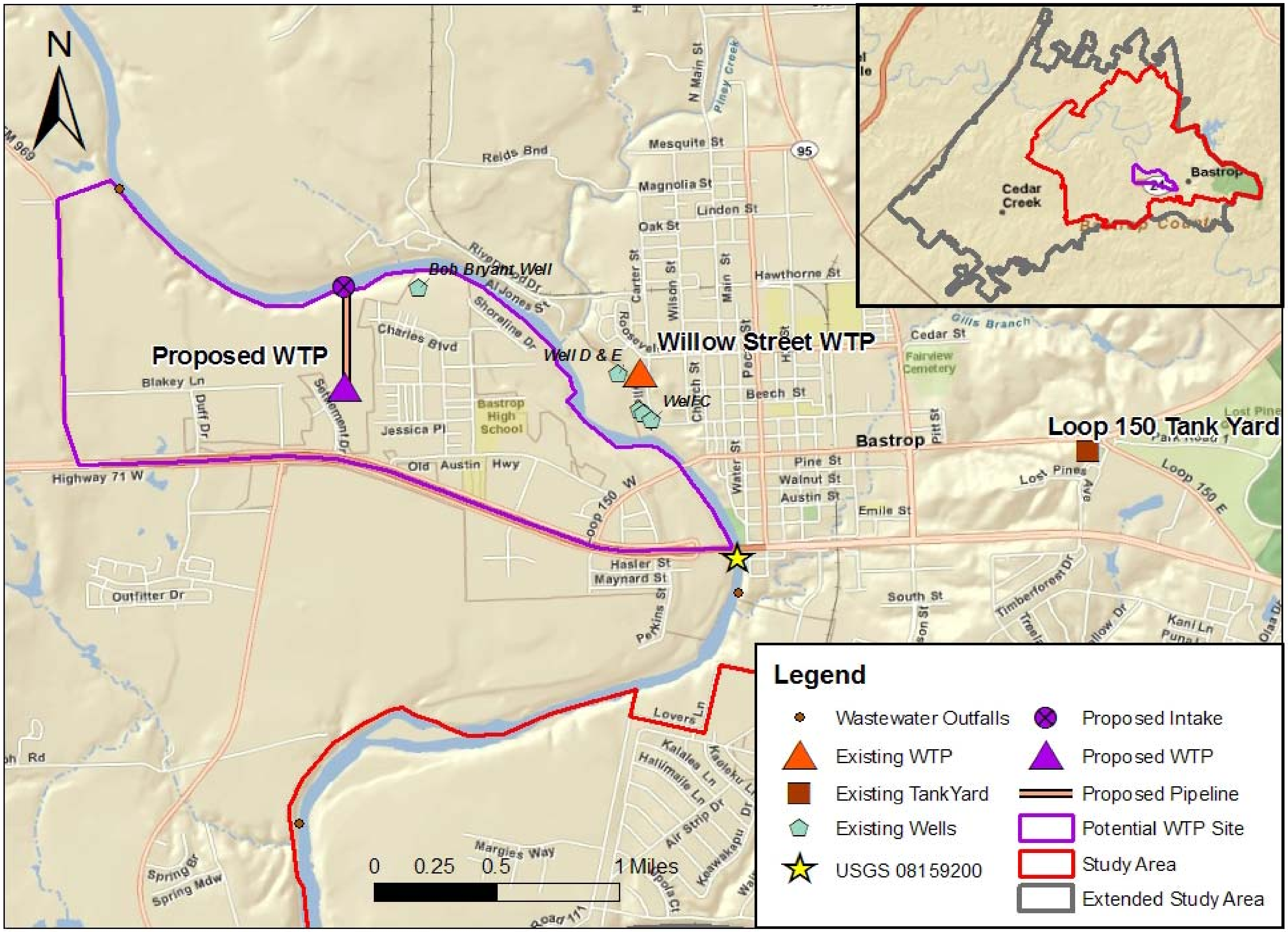
- Intake and diversion structure (average delivery rate of 9.8 MGD and a peak day capacity of 26.8 MGD)
- Raw water conveyance system from the intake to a surface water treatment plant(average delivery rate of 9.8 MGD and a peak day capacity of 26.8 MGD)
- Surface water treatment plant (26.8 MGD capacity)
- Distribution system for treated water is needed, but not assessed for this study

Several potential locations for a new water treatment plant exist; more in-depth study would be required to select an optimal plant site. Generally, based on the location of the existing water treatment plant and the anticipated growth in Bastrop County, the plant should fall within the quadrant bounded by Farm to Market Road (FM) 969 to the west, SH 71 to the south, and the lower Colorado River to the north and east. For the purposes of this study, the center point of this quadrant was used as a representative location for the water treatment plant site, as shown in **Exhibit 8**.

The raw water intake facility and intake pump station will be located in proximity to the proposed water treatment plant and upstream of the City's current wastewater outfall location. The required pump station size is estimated at 320 horsepower (hp)[3]. The assumed location for the intake is immediately upstream from Bob Bryant Park as illustrated in Exhibit 8. Approximately 2,240 feet of 36 inch pipeline would deliver the raw surface water from the intake site to the proposed water treatment plant, elevation 320 and 370 feet, respectively. Sufficient velocity in the pipeline would be required to minimize operational issues associated with sedimentation management, particularly during low flows. The pipeline diameter is based on a design rate that would maintain velocities between 5 and 7 feet per second during peak day flows. Selected pipeline material should be appropriate for the soil and topography of South Central Texas.

3 Assumes a pump efficiency of 75 percent and an elevation change of 50 feet.

EXHIBIT 8
Proposed Conceptual Intake and Water Treatment Plant Location for Evaluation and Cost-Estimating Purposes
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*



Other potential sites for the raw water intake that appear feasible include locations near the Loop 150 West bridge or the SH 71 bridge. These locations would allow for placement of the transmission pipeline in parallel with existing roadways (i.e., Loop 150 West or SH 71). While these alternative sites may provide advantages with respect to securing land easements, they would pose additional challenges of increased pipe length and cost, as well as potential traffic interruptions during construction. Determination of the optimum intake site and pipeline alignment would be required if a surface water option is pursued.

Because LCRA confirmed availability of a firm water supply to meet the assumed maximum delivery rate deficit projection for the study area, CH2M HILL assumed that no additional storage would be required from a water supply perspective. Further, onsite storage at the water treatment plant required under Texas Commission on Environmental Quality requirements is estimated to be sufficient to address potential diversion interruptions due to estimated travel time from Tom Miller and/or Mansfield dams. **Exhibit 9** presents a summary of proposed surface water supply system facilities.

A surface water treatment plant with a treatment capacity of 26.8 MGD would be required to treat raw surface water diverted from the lower Colorado River to drinking water standards. As water quality in the lower Colorado River is typical of Texas surface waters, the water treatment plant would more than likely be a traditional plant. Components of the water treatment plant include coagulant and polymer addition, rapid mix, flocculation, settling, filtration, and disinfection with chlorine (SCTRWPG, 2010). A 2.7 million gallon (MG) ground storage tank would also be provided at the water treatment plant. At 10 percent of the peak day delivery volume, the proposed tank capacity would be twice that required by the state in rule 290.45(b) (2) (D), (TCEQ, 2004) and would serve to balance hourly fluctuations and meet peak hour system demands.

EXHIBIT 9
Proposed Surface Water Supply System Facilities
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Facility | Capacity |
|---|---|
| Surface Water Intake | 26.8 million gallons per day |
| Raw Water Pipeline | 36 inches (2,240 feet) |
| Raw Water Pump Station | 320 horsepower |
| Ground Storage Tank | 2.7 million gallons |
| Surface Water Treatment Plant | 26.8 million gallons per day |

# Estimated Project Cost

The cost of the proposed surface water supply project was estimated using cost estimation procedures described in the 2011 South Central Texas Regional Plan (SCTRWPG, 2010). These costs are based on September 2008 dollars and have been adjusted to December 2010 values using the Engineering News Record's (ENR) Construction Cost Index (CCI) (ENR, 2011). The total project cost, based on a single-phase implementation, is estimated at $ 79.6 million, which includes a 30 percent contingency factor. Capital costs are annualized to reflect estimates of yearly debt service costs. These estimated annual capital costs are summed with estimated operations and maintenance costs for the project to estimate total annual costs. On a unit cost basis, this equates to an estimated annual cost of $ 883 per ac-ft ($2.71 per 1,000 gallons) of treated surface water. This does not include firm water costs, which are an additional $ 151 per ac-ft based on 2011 LCRA rates and depending on the volume of water actually diverted in a given year[4]. Total unit costs, including firm water costs[5], amount to $1,034 per ac-ft ($3.17 per 1,000 gallons). **Exhibit 10** summarizes the total, annual, and unit costs associated with constructing and operating the surface water supply facilities described in the previous section in a single implementation phase. Detailed estimated cost assumptions are provided in **Appendix B**.

The cost estimates presented herein have been prepared to provide cost estimates for a conceptual surface water diversion and treatment project for comparison with other available water supply options using information available at the time of the estimate. The costing methodology performed for regional water purposes provides a consistent method by which to cost the relative costs of water supply options. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project definition, implementation schedule, continuity of personnel and engineering, and other variable factors. Therefore, the final actual project costs are likely to vary from the estimate presented herein. Due to these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

4 Firm water rates have been established for 2011 at $151.00 per ac-ft/yr. by the LCRA Board. LCRA firm water contract rules provide that wholesale customers pay the full rate for water actually diverted and a "reservation fee" of $75.50, or 50 percent of firm water rate, for that volume of water reserved under the contract, but not diverted. Actual costs may vary during the actual project operation.

5 Firm water costs are calculated assuming diversion of the full project capacity (10,949 ac-ft) at a cost of $151 per ac-ft. Note that the unit cost of firm water would be lower when the diversion volume is less than full capacity.

EXHIBIT 10
Cost of Conceptual Surface Water Project
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Item | Cost[1,2] |
|---|---|
| Transmission Facilities (total of 2,240 feet of pipeline, 1 pump station, and 1 intake) | $6,237,000 |
| Water Treatment Plant (26.8 MGD) | $41,149,000 |
| **Total Capital** | $47,386,000 |
| | |
| Contingency (30%) | $14,216,000 |
| Engineering and Geotechnical | $9,477,000 |
| Land and Easement Acquisition, Surveying and Mapping | $528,000 |
| Environmental and Water Rights Permitting | $561,000 |
| Interest During Construction | $7,471,714 |
| **Total Project Cost** | $79,639,714 |
| | |
| Debt Service | $5,786,000 |
| Operations and Maintenance | $3,834,000 |
| Water Costs (LCRA 2011 Firm Water Rates[3]) ($151/ac-ft * 10,949 ac-ft) | $1,653,000 |
| Power Costs ($.06 per kilowatt hour [kWh]) | $49,000 |
| | |
| **Total Annual Costs** | $11, 322,000 |
| | |
| Project Yield (in ac-ft/yr) | 10,949 |
| Unit Cost of Water ($/ac-ft) | $1,034 |
| Unit Cost of Water ($/1,000 gal) | $3.17 |

1. Cost source is South Central Texas Regional Water Plan (SCTRWPG 2010).
2. Costs adjusted to December 2010 dollars using the construction cost index from Engineering News Record (ENR 2011).
3. Firm water rates have been established for 2011 at $151.00 per ac-ft/yr by the LCRA Board. LCRA firm water contract rules provide that wholesale customers pay the full rate for water actually diverted and a “reservation fee” of $75.50, or 50 percent of the firm water rate, for that volume of water reserved under the contract, but not diverted. Actual costs may vary during the actual project operation.

# Implementation Alternatives

The cost of the proposed surface water supply facilities will be dependent, in part, on the project implementation schedule. As shown in the previous section, one approach is to construct all facilities at full capacity at one time. However, due to uncertainty in the City's population projections and annexation schedule, as well as the long-term nature of the projected demand increase, a phased implementation approach may more closely align with capital expenditures with actual water demands within the study area. Due to inflation and project mobilization costs, total capital costs of facilities constructed over a phased schedule will likely be higher than a single project. However, total project cost on life cycle or net present value bases could be lower considering operations and maintenance cost savings and the ability to defer a portion of the capital cost to later years. In addition, there is less risk that the system capacity would exceed or trail actual water demand at any point in time, as facility planning could more readily adapt to actual growth in demand.

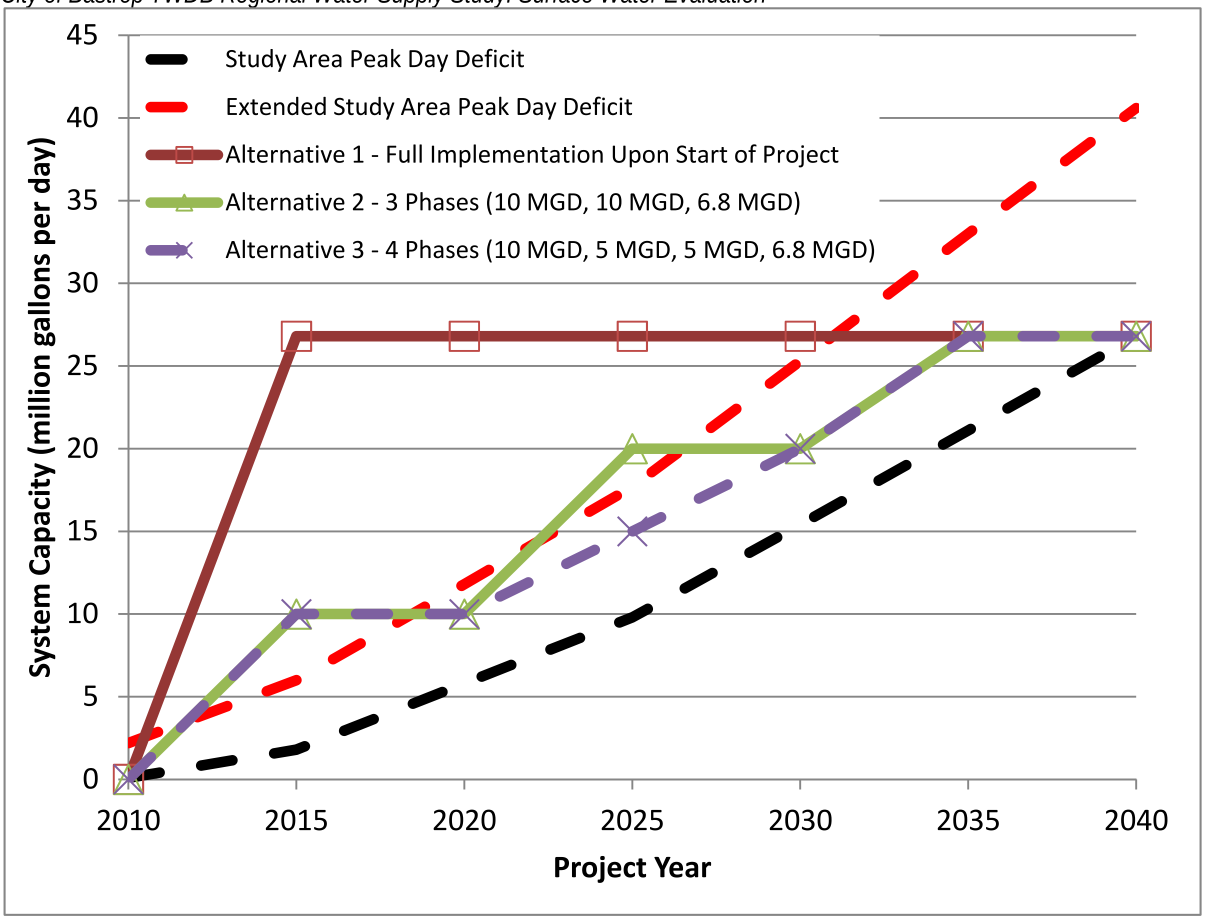
**Exhibit 11** compares the system capacity associated with three project implementation alternatives to projected peak day demands for both the study area and extended study area:

- Alternative 1, the system's full 26.8 MGD capacity is implemented at one time with proposed facilities sized as previously described.
- Alternative 2, the same capacity is implemented in three phases: 10 MGD, 10 MGD, and 6.8 MGD.
- Alternative 3 presents the capacity associated with four phases: 10 MGD, 5 MGD, 5 MGD, and 6.8 MGD.

For the phased alternatives, items such as the raw water intake, ground storage tank, land purchases, and permitting were assumed to be completed in Phase 1 of the project. However, the construction of pipeline, pump, and water treatment plant capacity was assumed to occur in stages. While a significant amount of the capital costs associated with these facilities will be required during the initial phase, it is estimated that as much as 40 percent of the associated capital costs could be deferred to later stages of the project implementation by using a phased approach.

The water supply system capacity associated with each of the three project implementation alternatives is sufficient to meet projected study area deficits through 2040. Further, the system capacity associated with Alternative 1 would meet the projected water needs of the extended study area until 2030. Alternative 2 would provide adequate capacity for the extended study area through 2025, with a slight deficit in 2020, but, by 2030, the system would not be able to meet the projected water demand deficit for the larger area. The system capacity associated with Alternative 3 would be insufficient to meet extended study area deficits throughout the study period, with the exception of 2015. The proposed surface water project could be paired with alternative supply strategies, such as further development of groundwater resources, to achieve a water supply system capable of meeting the extended study area deficit associated with any of the proposed implementation alternatives. Conjunctive management of supplies from the City's alluvium wells or a potential groundwater supply project could optimize facility sizing and operation to reduce overall water supply system capital and operational costs. Alternatively, the design capacity of the proposed surface water system facilities could be expanded to meet the extended study area deficit without supplemental supply sources.

EXHIBIT 11
Comparison of Surface Water System Capacities for Various Implementation Schedules
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*



# Permitting Considerations

Various permits will be required to develop a new surface water diversion from the lower Colorado River, as well as to guarantee water rights. Anticipated permits for a project of this nature would possibly include the permits and authorizations listed in **Exhibit 12**.

EXHIBIT 12
Required Permits for Development of a Surface Water Supply Source
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Name | Granting Agency |
|---|---|
| Surface Water Diversion and Use Permit[6] | Texas Commission on Environmental Quality |
| Clean Water Act Section 404/ Rivers and Harbors Act Section 10 Permit (dredge and fill permit) | Army Corps of Engineers |
| Sand, Gravel and Marl Permit | Texas Parks and Wildlife Department |
| Sand and Gravel Removal Permits | Texas General Land Office |
| Easement for Use of State Land | Texas General Land Office |
| Potable Drinking Water Permit | Texas Commission on Environmental Quality |
| Texas Pollutant Discharge Elimination System (General Construction Stormwater Permit) | Texas Commission on Environmental Quality |
| Various Permits | Local Municipalities (City of Bastrop and any other that may be created in the City's ETJ) and Bastrop County |
| Local Regulatory Floodplain | Floodplain Administrator |

Permitting could require various studies including:

- Biological assessment or habitat mitigation plan
- Environmental studies/assessment
- Cultural and archaeological resource surveys and potential mitigation

[6] LCRA reported that authorization to use the bed and banks of the Colorado River for conveyance of firm water from the Buchannan and Travis reservoir system for subsequent diversion downstream is included in their existing water rights (LCRA, 2010). The provisions of the LCRA water rights were not independently verified in this study.

# Environmental Considerations

This section identifies protected species, protected lands such as wildlife refuges and state and national parks, and Unique Water Bodies in the general area of the proposed project. The task included the review of the state and federal threatened and endangered species county listings (Texas Parks and Wildlife Department), national parks (National Park Service, U.S. Department of the Interior), National Wildlife Refuges (U.S. Fish and Wildlife Service), state parks (Texas Parks and Wildlife), wetlands (National Wetland Inventory), and stream segments having Wild and Scenic River (National Wildlife and Scenic River System) or Unique Stream or Unique Reservoir designations (TWDB). In most cases, agency websites were used to gather applicable information.

Threatened and endangered species listings include all the threatened, endangered, and special species in Bastrop County. Special species lists are comprised of species, subspecies, and varieties that are federally listed; proposed to be federally listed; have federal candidate status; are state listed; or carry a global conservation status indicating a species is critically imperiled, very rare, vulnerable to extirpation, or uncommon. As shown in **Exhibit 13**, there are 35 threatened or endangered species that have been observed within Bastrop County.

EXHIBIT 13
Threatened and Endangered Species in Bastrop County
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Common Name | Scientific Name | Summary of Habitat Preference | Listing Entity | | Potential Occurrence in County |
|---|---|---|---|---|---|
| | | | USFWS | TPWD | |
| Austin blind salamander | *Eurycea waterlooensis* | Mostly restricted to subterranean cavities of the Edwards Aquifer | C | | Resident |
| Barton Springs salamander | *Eurycea sosorum* | Outlets of Barton Springs segment of the Edwards Aquifer | LE | E | Resident |
| Houston toad | *Bufo houstonensis* | Endemic; sandy substrate, water in pools, ephemeral pools, stock tanks | LE | E | Resident |
| Jollyville Plateau salamander | *Eurycea tonkawae* | Springs and waters of some caves north of the Colorado River | C | | Resident |
| Pedernales River springs salamander | *Eurycea sp. 6* | Endemic; known only from springs | | | Resident |
| Bandit Cave spider | *Cicurina bandida* | Subterrestrial | | | |
| Bone Cave harvestman | *Texella reyesi* | Endemic to a few small caves in Travis and Williamson counties | LE | | Resident |

EXHIBIT 13
Threatened and Endangered Species in Bastrop County
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Common Name | Scientific Name | Summary of Habitat Preference | Listing Entity | | Potential Occurrence in County |
|---|---|---|---|---|---|
| | | | USFWS | TPWD | |
| Reddell harvestman | *Texella reddelli* | Endemic to a few small caves in Travis and Williamson counties | LE | | Resident |
| Tooth Cave Pseudoscorpion | *Tartarocreagris texana* | Small limestone caves of the Edwards Plateau | LE | | |
| Tooth Cave Spider | *Neoleptoneta myopica* | Very small, cave-adapted, sedentary spider | LE | | |
| Warton's cave meshweaver | *Cicurina wartoni* | Very small, cave-adapted spider | C | | |
| American Peregrine Falcon | *Falco peregrinus anatum* | Tall cliff eyries; lake shores, coastlines, barrier islands | DL | E | Nesting/ migrant |
| Artic Peregrine Falcon | *Falco peregrinus tundrius* | Open country, cliffs | DL | T | Migrant |
| Bald Eagle | *Haliaeetus leucocephalus* | Large bodies of water with nearby resting sites | DL | T | Migrant |
| Black-capped Vireo | *Vireo atricapilla* | Semi-open broad-leaved shrublands | LE | E | Nesting/Migrant |
| Golden-cheeked Warbler | *Dendroica chrysoparia* | Woodlands with oak and old juniper | LE | E | Nesting/Migrant |
| Henslow's Sparrow | *Ammodramus henslowii* | Weedy fields, cut over areas; bare ground for running and walking | | | Nesting/migrant |
| Interior Least Tern | *Sterna antillarum athalassos* | Inland river sandbars for nesting and shallow water for foraging | LE | E | Nesting/Migrant |
| Mountain Plover | *Charadrius montanus* | Non-breeding - shortgrass plains and bare dirt | | | Nesting/migrant |
| Peregrine Falcon | *Falco peregrinus* | Open country, cliffs | DL | E T | Nesting/ migrant |
| Western Burrowing Owl | *Athene cunicularia hypugae* | Open grasslands, prairie, plains, savanna; sometimes open area such as vacant lots | | | |
| Whooping Crane | *Grus americana* | Potential migrant | LE | E | Migrant |
| Wood Stork | *Mycteria americana* | Forages in prairie ponds, ditches, and shallow standing water formally nested in TX | | T | Migrant |
| A crayfish | *Cambarellus texanus* | Shallow water, benthic, prefers standing water of ditches in which there is emergent vegetation | | | Resident |

EXHIBIT 13
Threatened and Endangered Species in Bastrop County
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Common Name | Scientific Name | Summary of Habitat Preference | Listing Entity | | Potential Occurrence in County |
|---|---|---|---|---|---|
| | | | USFWS | TPWD | |
| An amphipod | *Stygobromus russelli* | Subterranean waters, usually caves and limestone aquifers | | | Resident |
| Balcones Cave amphipod | *Stygobromus balconies* | Subaquatic | | | Resident |
| Blue sucker | *Cycleptus elongates* | Channels and flowing pools with a moderate current | | T | |
| Guadalupe bass | *Micropterus treculii* | Clear flowing streams | | | Resident |
| Cave myotis bat | *Myotis velifer* | Roosts colonially in caves | | | Resident |
| Elliot's short-tailed shrew | *Blarina hylophaga* | Sandy area in live oak mottes, grassy area with loblolly pine overstory and Post oak stands | | | |
| Plains spotted skunk | *Spilogale putorius* | Prefers wooded, brushy area and tallgrass prairie, fields, prairies, croplands, fence rows, forest edges | | | Resident |
| Red wolf | *Canis rufus* | Extirpated; formally throughout eastern half of Texas in brushy and forested areas and coastal prairies | LE | E | |
| Creeper (squawfoot) | *Strophittus undulates* | Small to large streams, prefers gravel or gravel and mud in flowing water; Colorado, Guadalupe, San Antonio River basins | | | Resident |
| False spike mussel | *Quincuncina mitchelli* | Substrates of cobble and mud, with water lilies present; Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins | | | Resident |
| Pistolgrip | *Tritogonia verrucosa* | Stable substrate, rock, hard mud, silt, and soft bottoms, often buried deeply; east and central Texas, Red through San Antonio River basins | | | Resident |

Source: Texas parks and Wildlife; updated November 2008

DL/PDL- Federally Delisted/ Proposed for Delisting

E, T – State Listed Endangered/ Threatened

LE/LT – Federally Listed Endangered/ Threatened

NL – Not Federally Listed

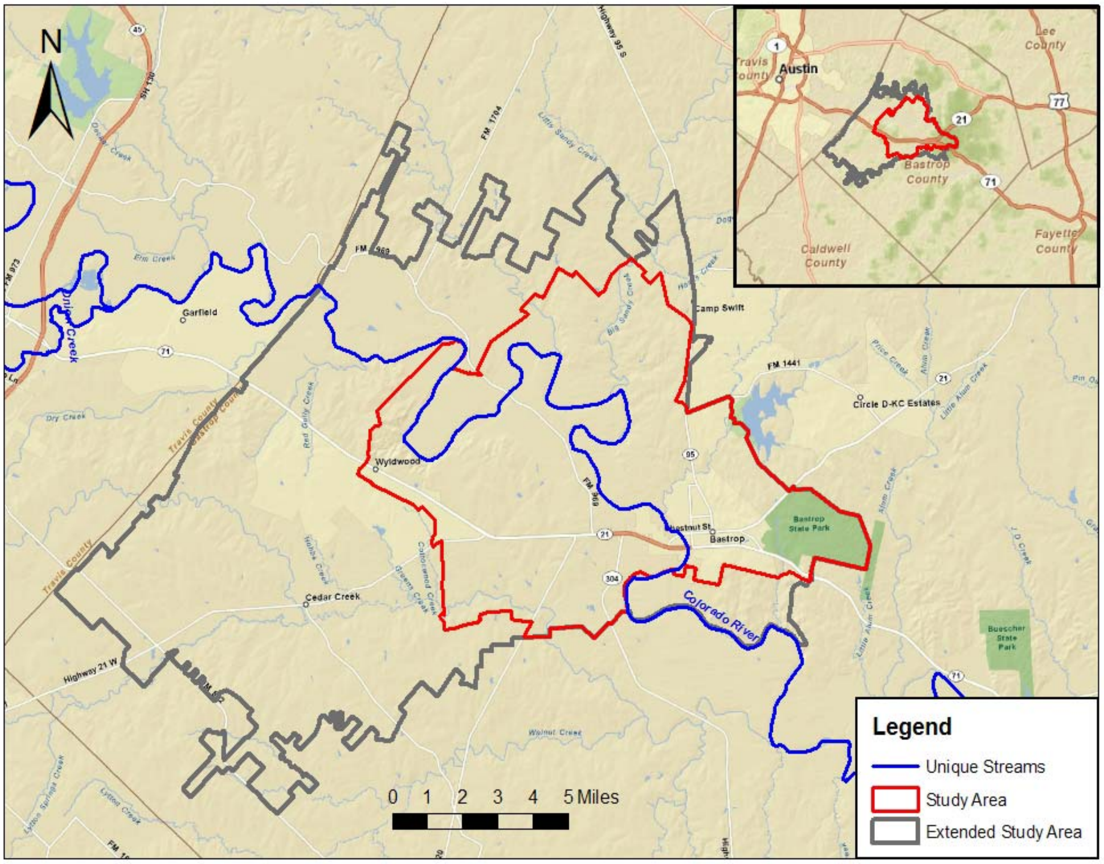
T/SA – Federally Listed Threatened by Similarity of Appearance

Unique stream segments are those identified for their ecological significance while Unique Reservoir sites have been distinguished as having particular value as a reservoir site. While Unique Reservoir Sites do not occur in the county, there are segments of the Colorado River that were identified in the 2006 Region K Water Plan as warranting consideration as ecologically unique stream segments due to the following attributes:

- High water quality/exceptional aquatic life/high aesthetic value - exceptional aquatic life use (TNRCC, 1996)
- Threatened or endangered species/unique communities - Blue sucker (SOC/State Threatened) (Mosier and Ray, 1992)

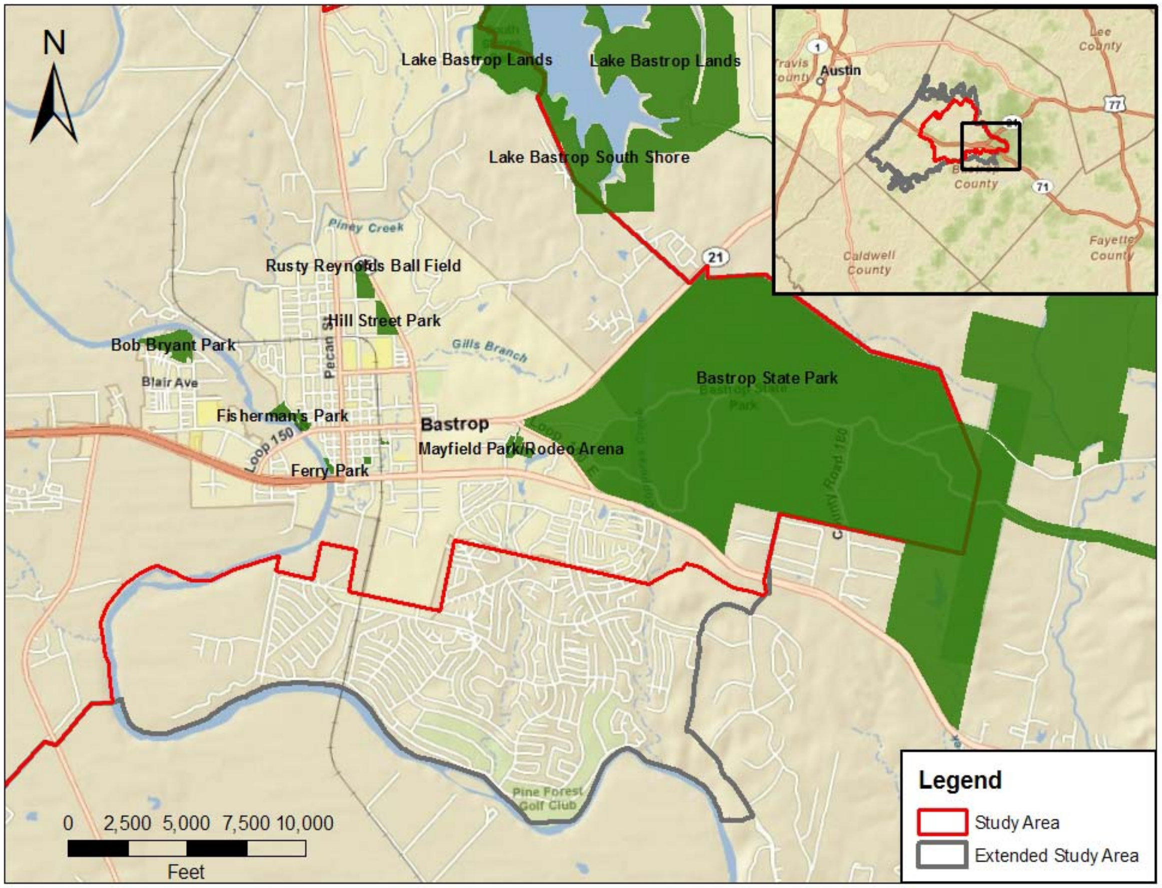
**Exhibit 14** shows parts of the Colorado River identified in the 2006 Region K plan as warranting consideration as ecologically significant or unique stream segments near the study area. These segments have not been designated as ecologically unique by the Texas Legislature.

EXHIBIT 14
Streams Segments in Bastrop County Identified for Consideration as Ecologically Significant or Unique: Colorado River Segments 1428 and 1434
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*




Wetlands areas lie at the interface between marine/freshwater and terrestrial habitats and exhibit unique ecological value. These boundaries have been identified through the cooperation of state and local groups and compiled into the National Wetlands Inventory. While wetlands may occur in the area, wetland maps of the area were not readily available. Regarding protected and sensitive lands, there are no wildlife refuges or national parks in Bastrop County. Bastrop State Park is within the study area, as are Bob Bryant Park, Ferry Park, Fisherman's Park, Hill Street Park, Lake Bastrop Lands, Mayfield Park, and Rusty Reynolds Ball Field (**Exhibit 15**). Regarding protected water bodies in the study area, there are no "wild and scenic rivers" (National Park Service).

EXHIBIT 15
Parks in Bastrop County near Proposed Facilities Site
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*



# Conclusion

The City of Bastrop is anticipating a substantial increase in water demands over the next 30 years. Communications with LCRA and a review of historical flows in the lower Colorado River suggest that sufficient surface water is available to supplement the City's existing alluvial groundwater supply and offset the projected water supply deficit of both the study area and the extended study area. Development of a new surface water supply source to meet the study area deficit would require the construction and operation of a raw water intake, a 320 hp pump station, 2,240 feet of 36-inch pipeline, and a new 26.8 MGD water treatment plant. The total estimated capital cost for this project, if initially constructed to full capacity, is $79.6 million. Including operations, maintenance, and firm water costs, this equates to an annualized cost of $1,034 per ac-ft/yr ($3.17 per 1,000 gallons). Note these costs do not include system integration or other potential improvements to or expansion of the treated water distribution system. Potential cost escalations associated with future construction are also not included.

Alternatively, the surface water supply project may be implemented in phases, increasing the system's capacity by either 5 MGD or 10 MGD at a time. While phased implementation could be more capital intensive, total life cycle project cost could be lower considering operations and maintenance savings and the fact that a portion of the capital cost is deferred to later years. Further, phasing decreases the risk that the water supply system would be overbuilt (or lag) due to differences between the actual and projected water demands as the estimates can be updated at some frequency based on actual changes. Note, however, that phased implementation may limit the ability of the system to meet the extended study area deficit unless phasing is conducted to meet those projected water demands.

As another alternative, it could be advantageous for the City to supplement the proposed surface water supply system in conjunction with supplies from groundwater sources which may be developed. For example, surface water from the lower Colorado River could be used to meet baseload demands, and groundwater sources could provide a less expensive and reliable means of meeting peak demands, as well as mitigating any potential challenges associated with the variable timing of available streamflow.

This study is intended to assist the City of Bastrop with evaluating options for future water supply within its service area and the surrounding region. The evaluation is part of a larger Regional Water Supply Study providing information to enable the City and the study partners to compare the cost and implementation alternatives of multiple water sources. Further detailed technical analysis will be required to optimize water supply options and facility requirements.

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# Appendix A: Projected Demands

The tables that follow (**Exhibits A1 and A2**) show the projected average annual and peak day demands associated with project study area and extended study area.

EXHIBIT A1
Projected Average Annual Demand (acre-feet per year)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Year | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 1,984 | 2,798 | 4,796 | 6,795 | 9,616 | 12,437 | 15,258 |
| Extended Study Area | 3,014 | 4,889 | 7,812 | 10,734 | 14,540 | 18,346 | 22,152 |

EXHIBIT A2
Projected Maximum Delivery Rate (MGD)
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| Year | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 4.0 | 5.6 | 9.6 | 13.6 | 19.3 | 25.0 | 30.6 |
| Extended Study Area | 6.0 | 9.8 | 15.7 | 21.5 | 29.2 | 36.8 | 44.4 |

# Appendix B: Estimated Project Costs

EXHIBIT B1
Detailed Surface Water Supply Project Cost Estimate
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| | Quantity | Unit | Unit Cost | Extension[1,2] |
|---|---|---|---|---|
| **Transmission Facilities** | | | | |
| **Intake** | 1 | LS | $1,140,366 | $1,140,000 |
| **Raw Surface Water Pipeline** | 2240 | LF | $239 | $534,000 |
| **Raw Water Pump Station to Water Treatment Plant** | | | | |
| **Pump Station** | 1 | LS | $2,280,733 | $2,281,000 |
| **Electrical Hookup** | 320 | HP | $141 | $50,000 |
| **Water Storage Tank** | 1 | LS | $2,231,584 | $2,232,000 |
| **Total Transmission Facilities Capital** | | | | **$6,237,000** |
| **Water Treatment Plant** | | | | |
| **Water Treatment Plant** | 1 | LS | $41,149,000 | $41,149,000 |
| **Total Water Treatment Capital** | | | | **$41,149,000** |
| **Total Capital** | | | | **$47,386,000** |
| **Engineering, Legal Costs, and Contingency** | | | | |
| **Engineering** | 15% | | | $7,108,000 |
| **Legal Costs** | 5% | | | $2,369,000 |
| **Contingency** | 30% | | | $14,216,000 |
| **Total Engineering, Legal Costs, and Contingency** | | | | **$23,693,000** |
| **Land and Easement Acquisition** | | | | |
| **Easement Cost - Pipeline** | 2 | ac | $9,115 | $19,000 |
| **Land Cost - Intake** | 10 | ac | $9,115 | $91,000 |
| **Land Cost - Treatment Plant** | 40 | ac | $9,115 | $365,000 |
| **Surveying - Pipeline** | 10% | 0 | $534,000 | $53,000 |
| **Total Land and Easement Acquisition** | | | | **$528,000** |
| **Environmental and Archaeology Studies and Mitigation** | | | | |
| **Water Rights Permitting** | 1 | LS | $500,000 | $500,000 |
| **404 Permitting - Engineering** | 1 | LS | $50,000 | $50,000 |
| **Pipeline Environmental and Archaeology** | 2240 | LF | $4.95 | $11,000 |
| **Total Environmental and Archaeology Studies and Mitigation** | | | | **$561,000** |

EXHIBIT B1
Detailed Surface Water Supply Project Cost Estimate
*City of Bastrop TWDB Regional Water Supply Study: Surface Water Evaluation*

| | Quantity | Unit | Unit Cost | Extension[1,2] |
|---|---|---|---|---|
| **Interest during Construction** | | | | |
| **Loan Rate** | 6% | | | |
| **Rate of Return** | 4% | | | |
| **Duration (years)** | 3 | | | |
| **Total Interest Accrued Less Earned during Construction** | | | | **$7,471,714** |
| **Total Project Cost** | | | | **$79,639,714** |
| **Annual Project Costs** | | | | |
| **Debt Service (6%, 30 yrs)** | | | | $5,786,000 |
| **Operations and Maintenance** | | | | |
| **Pipeline and Tank O&M** | 1% | | | $28,000 |
| **Treatment Facility O&M** | 1 | LS | $3,719,746 | $3,720,000 |
| **All Other Facility O&M** | 2.50% | | | $86,000 |
| **Total O&M** | | | | **$3,834,000** |
| **Water Costs (LCRA 2011 Firm Water Rates[3])** | 10,949 | ac-ft | $151 | **$1,653,000** |
| **Pumping Energy Costs** | 784,732 | kWh | $0.06 | $49,000 |
| **Total Annual Cost** | | | | **$11,322,000** |
| | | | | |
| **Project Annual Yield to City (in million gallons)** | | | | **3,568** |
| **Project Annual Yield to City (acre-feet)** | | | | **10,949** |
| **Unit Cost of Water ($/ac-ft)** | | | | **$1,034** |
| **Unit Cost of Water ($/1000 gal)** | | | | **$3.17** |

1. Cost source is South Central Texas Regional Water Plan (SCTRWPG 2010).
2. Costs adjusted to December 2010 dollars using the construction cost index from Engineering News Record (ENR 2011).
3. Firm water costs have been established for 2011 at $151.00 per ac-ft/yr by the LCRA Board. LCRA firm water contract rules provide that wholesale customers pay the full rate for water actually diverted and a “reservation fee” of $75.50 for that volume of water reserved under the contract, but not diverted. Actual costs may vary during the actual project operation.

**Appendix E RW Harden Groundwater Source Technical Memorandum**

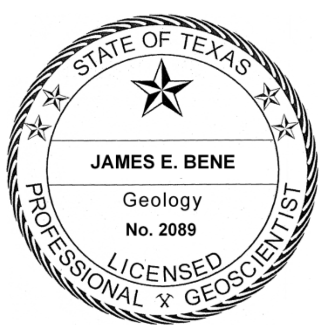
# EVALUATION OF GROUNDWATER RESOURCES IN THE BASTROP COUNTY REGION, TEXAS


**Prepared By:**

**R.W. Harden & Associates, Inc.**



**April 2011**


The seal appearing on this document was authorized by James E. Bené, P.G. 2089 on April 8, 2011.

# EVALUATION OF GROUNDWATER RESOURCES IN THE BASTROP COUNTY REGION, TEXAS

## Introduction

As part of an assessment of the water supply options available to the residents of Bastrop County (Bastrop), R.W. Harden & Associates, Inc. (RWH&A) has performed a general evaluation of the groundwater resources, regulations, and development alternatives in the Bastrop region.

For this study, RWH&A compiled available groundwater and well information from various published and unpublished reports, maps, and from data distributed by the United States Geological Survey (USGS), the University of Texas Bureau Of Economic Geology (BEG), the Texas Water Development Board (TWDB), Railroad Commission of Texas (RCT), and RWH&A files. As part of the evaluation of groundwater regulation in the Bastrop area, RWH&A reviewed the rules, management plans, and general activities of the Lost Pines Groundwater Conservation District (LPGCD).

This study was accomplished through focusing on several tasks described below:

- ***Physical Availability of Groundwater*** – Using available information and computer models of the major aquifers in Central Texas, the general physical availability of groundwater in the Bastrop region was assessed.
- ***Groundwater Quality*** **–** Using data obtained from RWH&A files and databases distributed by the TWDB, groundwater chemical constituents in the Bastrop region were tabulated and summarized.
- ***Regulatory Affects on Groundwater Availability*** – Using information distributed by the LPGCD and Groundwater Management Area 12 (GMA 12), the general availability of groundwater from a regulatory standpoint was assessed.
- ***General Groundwater Development Options*** – Using the results of the previous analyses, practical groundwater development options available to the City of Bastrop were summarized.

## Hydrogeology and Groundwater Availability

While some groundwater can be produced from many of the geologic formations underlying the study area, the Colorado River Alluvium (Alluvium), the Carrizo Formation (Carrizo), and the Wilcox Formation Group (Wilcox) are the most accessible and prolific sources of groundwater in the Bastrop region. Though very productive in some areas, the Alluvium is not considered a regional source because the aquifer exists in a relatively thin and narrow band along the Colorado River. Conversely, the Carrizo and Wilcox are much larger-scale resources, with footprints extending throughout eastern

Texas. Figure 1 shows the extent of the Alluvium, Carrizo, and Wilcox aquifer outcrops in the study area. The general geologic and hydrologic description of each aquifer is as follows:

- **Colorado River Alluvium** – a thin, heterogeneous band of sand and gravel deposited by the Colorado River. The Alluvium is the City of Bastrop's current source of fresh water.
- **Carrizo Formation –** a comparatively homogenous, sand-rich formation that is regionally a very productive aquifer. As shown in Figure 1, the Carrizo crops out in the eastern part of the City of Bastrop; as a result, large well yields may only be obtained in downdip portions of the aquifer east of the city.
- **Wilcox Group** – thick package of sediments comprised of three member formations:
    1. ***Calvert Bluff Formation* –** a thick unit (>1,000 feet) composed of several relatively thin sand zones confined by thick clay and silt sequences. Although typically considered a relatively impermeable confining zone to both the overlying Carrizo and underlying Simsboro, good yields can be obtained from wells in some areas where sufficiently thick, saturated sand layers exist.
    2. ***Simsboro Formation* –** productive, regional, sand-rich formation. The Simsboro typically yields good quality water at high rates throughout much of Central Texas. However, only mineralized, methane-rich groundwater has been obtained by test wells within the limits of the City of Bastrop thus far.
    3. ***Hooper Formation*** – like the Calvert Bluff, the Hooper is commonly comprised of thinner, silty production zones confined by clay layers. Because of its relative depth and lesser permeability, the Hooper is generally utilized only in western areas of the County where other sources are not available.

The following sections provide more detailed discussions of the properties of these aquifers in the study area.

## Colorado River Alluvium

Figure 1 shows the extents of the Alluvium in the Bastrop region. At this time, the City of Bastrop obtains all of its water supply from six wells completed in the Alluvium at Fisherman's and Bob Bryant Parks, both of which are within the city limits. These wells withdraw groundwater percolating through relatively thin sand and gravel layers deposited by the Colorado River. Wells penetrating the Alluvium are reasonably productive; the existing City of Bastrop wells produce at rates ranging from about 300 to 700 gallons per minute (gpm) each. Because the productive Alluvium zones are comparatively permeable and shallow (less than about 60 feet in depth), wells are inexpensive to construct and may be closely spaced because water level declines resulting from pumpage are restricted to areas very near the pumping wells. However, due to its shallow depth, the Alluvium may be more susceptible to contamination from surface sources and is potentially less drought resistant than deeper, regional aquifer zones.

## Carrizo Aquifer

The Carrizo is primarily comprised of beds of sand, silt, and clay that dip toward the Gulf Coast at about 100 to 200 feet per mile. The thickness ranges from about 500 feet in Gonzales County to about 300 feet in the Bastrop area. As shown in Figure 1, the Carrizo outcrops in a northeast-southwest trending band in the region. Groundwater flows in the pore spaces between the individual sediment grains that make up the formation. The productive aquifer zones within the Carrizo are generally composed of coarser-grained sediments such as sand and gravel, while the clay and silt-rich zones inhibit flow and typically act as groundwater confining units. The productivity of the aquifer is generally very good; typical well yields range from a few hundred gallons per minute (gpm) near outcrop zones to over 2,000 gpm for wells completed in downdip zones.

## Wilcox Group

Throughout most of Central Texas, the Wilcox Group is comprised of three distinct geologic formations (from shallowest to deepest): the Calvert Bluff, Simsboro, and Hooper Formations. However, in areas south of the Colorado River the boundaries between the three component formations are typically not distinct and the general label "Wilcox" is used. A cross-sectional diagram showing the general subsurface structure of the Carrizo-Wilcox is shown in Figure 2.

The total thickness of the Wilcox typically ranges between 1,500 and 2,500 feet in the study area, with several potential aquifer zones usually present at various depths at any given location. The Simsboro is generally preferred as a production target because the relatively thick, sand-rich zones comprising this formation allow for greater well yields. The aquifer zones within the Calvert Bluff and Hooper Formations are typically utilized in areas where: 1) well yields and water quality of the shallower Calvert Bluff are adequate, 2) the Simsboro is not present, or 3) the Simsboro contains poor quality water.

The productivity of the Wilcox aquifer zones varies widely. Yields ranging from a few hundred gpm to over 2,000 gpm are common for wells completed in the Simsboro. For the Calvert Bluff and the Hooper, well production rates are usually limited to 500 gpm or less and are dependent on the depth, saturated thickness, and permeability of the aquifer zones encountered.

## Groundwater Quality

The groundwater quality of the Alluvium, Carrizo, and Wilcox aquifers was evaluated in Bastrop and surrounding counties using information obtained from the Texas Water Development Board (TWDB), the Railroad Commission of Texas (RCT), and RWH&A files. This evaluation focused on the reported concentration of the most common chemical constituents in groundwater and compared these to primary and/or secondary state drinking water standards for public supplies established in Texas Administrative Code (30 TAC, Chapter 290, Subchapter F).

Groundwater recharge in the study area occurs primarily through downward percolation of precipitation in outcrop areas to deeper aquifer zones. Typically, groundwater becomes more mineralized as it travels farther through the aquifer, although this process is strongly influenced by various factors including the chemical makeup of the sediments, the hydraulic properties of the aquifer, hydraulic boundary conditions, and interformational leakage between aquifer zones. As a result, the quality of the groundwater produced can vary significantly depending on the location of the well and its depth of completion.

The concentration of total dissolved solids (TDS) is often used as a general indicator for the extent of groundwater mineralization. For reference, water with TDS concentrations of less than 1,000 mg/l are considered "fresh" by the Texas Commission on Environmental Quality (TCEQ). Figures 3 through 7 show the distribution of total dissolved solids (TDS) concentrations of groundwater samples obtained from wells in the Bastrop region.

The following sections provide discussions of the water quality analyses for wells producing from the target aquifers in the study area. For each aquifer two tables are included: a summary of water quality on a regional scale and water quality for wells within Bastrop County. These tables include the recorded minimum, maximum, and average concentrations of TDS, pH, temperature, alkalinity, iron and manganese, and the most common cations and anions found in groundwater including sodium, calcium, magnesium, chloride, sulfate, and bicarbonate. Also included is the concentration of dissolved nitrate, which is associated with methemoglobinemia (blue baby syndrome) and typically indicates aquifer recharge by water that has interacted with nitrogen-rich surface water sources (septic tanks, fertilizer application, livestock feces, etc.).

### Colorado River Alluvium Water Quality

In general, water produced from the Alluvium is fresh, although the reported analyses suggest that interaction with surface sources of nitrogen may have occurred. As shown in Table 1, of the 95 wells analyzed, only about 4% have TDS concentrations above the secondary public supply standard of 1,000 mg/l. Iron and manganese concentrations are based on values from one well and do not exceed limits. Nitrate concentrations are above maximum contaminant levels in 71% of wells, chloride concentrations are elevated in one well and sulfate is elevated in three of the wells.

**Table 1: Alluvium Groundwater Quality (Regional)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 296.6 | 4051.0 | 597.6 | 95 | 1000 | 4 | 4% |
| pH** | 4.4 | 8.4 | 7.4 | 90 | 6.5-8.5 | 1 | 1% |
| Total Alkalinity (mg/L)** | 0.0 | 440.0 | 299.6 | 95 | -- | -- | -- |
| Temperature (C°)** | 16.0 | 29.0 | 21.9 | 36 | -- | -- | -- |
| Iron (mg/L)* | 0.078 | 0.078 | 0.078 | 1 | 0.30 | 0 | 0% |
| Manganese (mg/L)* | 0.046 | 0.046 | 0.046 | 1 | 0.05 | 0 | 0% |
| Calcium (mg/L)** | 26.0 | 580.0 | 123.9 | 95 | -- | -- | -- |
| Magnesium (mg/L)** | 5.6 | 303.0 | 26.8 | 95 | -- | -- | -- |
| Sodium (mg/L)** | 9.0 | 279.0 | 51.1 | 95 | -- | -- | -- |
| Chloride (mg/L)** | 10.0 | 351.0 | 66.7 | 95 | 300 | 1 | 1% |
| Sulfate (mg/L)** | 4.0 | 2020.0 | 86.9 | 95 | 300 | 3 | 3% |
| Bicarbonate (mg/L)** | 0.0 | 537.0 | 365.7 | 95 | -- | -- | -- |
| Nitrate (mg/L)** | 0.4 | 480.0 | 45.5 | 94 | 10 | 67 | 71% |

Includes analyses from wells located in Bastrop, Fayette, and Travis Counties.

* Based on data from Bastrop public supply well BB-PW1

**Based on data from Bastrop well BB-PW1 and Texas Water Development Board records

Table 2 provides a summary of the results of chemical analyses performed on Alluvium groundwater produced from wells within Bastrop County. As shown, the concentrations of all of the primary ions are below public supply standards, while nitrate concentrations greater than 10 mg/l (the TCEQ primary standard limit) were evident in six of the wells sampled. Of the wells with reportedly elevated nitrate levels, one was constructed by the City of Bastrop in 1950 and has since been plugged. No other elevated nitrate concentrations were reported from any of the City of Bastrop's other Alluvium wells in the past.

**Table 2: Alluvium Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 340.4 | 739.0 | 454.2 | 13 | 1000 | 0 | 0% |
| pH** | 4.4 | 8.2 | 7.3 | 13 | 6.5-8.5 | 1 | 8% |
| Total Alkalinity (mg/L)** | 0.0 | 363.5 | 251.2 | 13 | -- | -- | -- |
| Temperature (C°)** | 21.0 | 25.0 | 22.7 | 3 | -- | -- | -- |
| Iron (mg/L)* | 0.078 | 0.078 | 0.078 | 1 | 0.30 | 0 | 0% |
| Manganese (mg/L)* | 0.046 | 0.046 | 0.046 | 1 | 0.05 | 0 | 0% |
| Calcium (mg/L)** | 43.0 | 272.4 | 106.2 | 13 | -- | -- | -- |
| Magnesium (mg/L)** | 8.0 | 111.8 | 26.2 | 13 | -- | -- | -- |
| Sodium (mg/L)** | 9.0 | 151.0 | 41.3 | 13 | -- | -- | -- |
| Chloride (mg/L)** | 13.0 | 176.0 | 48.8 | 13 | 300 | 0 | 0% |
| Sulfate (mg/L)** | 15.0 | 241.0 | 67.0 | 13 | 300 | 0 | 0% |
| Bicarbonate (mg/L)** | 0.0 | 475.8 | 309.4 | 13 | -- | -- | -- |
| Nitrate (mg/L)** | 1.1 | 78.0 | 17.0 | 13 | 10 | 6 | 46% |

* Based on data from Bastrop public supply well BB-PW1

**Based on data from Bastrop well BB-PW1 and Texas Water Development Board records

## Carrizo Water Quality

Regionally, Carrizo groundwater is primarily fresh in updip areas toward the northeast, but trends toward more mineralized water in wells in southwestern downdip portions of the aquifer. As shown in Table 3, of the 153 wells analyzed in the Bastrop region, 7% have average TDS concentrations above state public supply standards. Nitrate is above maximum contaminant levels in about 4% of wells and sulfate and chloride concentrations exceed public supply standards in about 3% of the wells sampled. Iron concentrations are high and exceed standards in all six wells sampled. It should be noted that iron and manganese concentration data was found only from wells on the CRWA-Wells Ranch property and do not necessarily represent regional trends, although elevated iron and manganese concentrations are likely in neutral to acidic Carrizo groundwater. Iron does not constitute a health hazard; however, staining and other unwanted effects can result from elevated iron levels. TCEQ regulations limit iron concentrations in public supplies to less than 0.3 mg/l, necessitating blending or treatment (typically relatively simple and inexpensive) for many public water systems that utilize Carrizo groundwater.

**Table 3: Carrizo Groundwater Quality (Regional)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 41 | 2027 | 356 | 153 | 1000 | 10 | 7% |
| pH** | 4 | 9 | 7 | 146 | 6.5-8.5 | 46 | 31% |
| Total Alkalinity (mg/L)** | 0 | 1214 | 167 | 152 | -- | -- | -- |
| Temperature (C°)*** | 20 | 51 | 29 | 118 | -- | -- | -- |
| Iron (mg/L)* | 0.609 | 2.360 | 1.051 | 6 | 0.30 | 6 | 100% |
| Manganese (mg/L)* | 0.019 | 0.041 | 0.030 | 6 | 0.05 | 0 | 0% |
| Calcium (mg/L)** | 1 | 195 | 28 | 152 | -- | -- | -- |
| Magnesium (mg/L)** | 0 | 63 | 7 | 153 | -- | -- | -- |
| Sodium (mg/L)** | 2 | 844 | 90 | 153 | -- | -- | -- |
| Chloride (mg/L)** | 3 | 437 | 53 | 153 | 300 | 4 | 3% |
| Sulfate (mg/L)** | 0 | 374 | 54 | 153 | 300 | 4 | 3% |
| Bicarbonate (mg/L)** | 0 | 1469 | 204 | 150 | -- | -- | -- |
| Nitrate (mg/L)** | 0 | 83 | 2 | 151 | 10 | 6 | 4% |

Includes analyses from wells located in Bastrop, Burleson, Caldwell, Fayette, Gonzales, Guadalupe, Lee, and Milam Counties.

* Based on data from Canyon Regional Water Authority - Wells Ranch public supply wells

**Based on data from Canyon Regional Water Authority - Wells Ranch public supply wells and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

Table 4 provides a summary of the results of chemical analyses performed on Carrizo groundwater from wells within Bastrop County. As shown, the concentrations of all the primary ions but sulfate are below public supply standards, while nitrate concentrations greater than 10 mg/l (the TCEQ primary standard limit) were evident in one of the wells sampled. Iron and manganese concentrations are not typically included in groundwater analyses performed by the TWDB and no records pertaining to these constituents were available for Bastrop County.

**Table 4: Carrizo Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L) | 66.0 | 1032.0 | 312.3 | 23 | 1000 | 1 | 4% |
| pH | 4.3 | 8.8 | 6.6 | 23 | 6.5-8.5 | 14 | 61% |
| Total Alkalinity (mg/L) | 0.0 | 301.8 | 85.1 | 23 | -- | -- | -- |
| Temperature (C°) | 20.0 | 32.0 | 24.9 | 13 | -- | -- | -- |
| Calcium (mg/L) | 1.2 | 180.0 | 30.2 | 23 | -- | -- | -- |
| Magnesium (mg/L) | 0.4 | 49.0 | 9.2 | 23 | -- | -- | -- |
| Sodium (mg/L) | 10.0 | 150.0 | 56.7 | 23 | -- | -- | -- |
| Chloride (mg/L) | 6.1 | 178.0 | 47.6 | 23 | 300 | 0 | 0% |
| Sulfate (mg/L) | 4.4 | 374.0 | 84.2 | 23 | 300 | 1 | 4% |
| Bicarbonate (mg/L) | 0.0 | 362.0 | 101.3 | 23 | -- | -- | -- |
| Nitrate (mg/L) | 0.0 | 55.0 | 2.8 | 23 | 10 | 1 | 4% |

All constituent values based on data from Texas Water Development Board records

## Wilcox Water Quality

Wilcox water quality is generally fresher in updip zones, and typically varies between the three component formations. Regionally, Simsboro groundwater is usually less mineralized than that found in the Calvert Bluff or Hooper. However, test drilling indicates that the Simsboro beneath the City of Bastrop is relatively mineralized, with total dissolved solids (TDS) concentrations ranging from about 1,000 milligrams per liter (mg/l) to over 2,000 mg/l in deeper portions of the formation. Previous testing also indicates that there are significant amounts of dissolved methane and carbon dioxide dissolved in the groundwater water produced from the Simsboro underlying the City of Bastrop. The cause of the increased mineralization and gas components of the Simsboro are unknown, but examination of geophysical logs in the area suggests that faulting may have vertically offset the aquifer sediments, hydraulically isolating the Simsboro beneath the city from other portions of the aquifer. If this is the case, the decreased flow through faulted areas serves to inhibit the downdip flow of fresher water from outcrop areas, while also trapping dissolved gasses that have percolated updip from deeper portions of the aquifer.

### *Calvert Bluff Water Quality*

The Calvert Bluff contains mostly fresh water in the northeast portion of the study region but trends to more mineralized water in the central and southwestern part of the region (Figure 5). As shown in Table 5, of the 210 wells analyzed, 27% have TDS concentrations above the secondary public supply standards. Nitrate concentrations are above maximum contaminant levels in 8% of wells, chloride concentrations are elevated above secondary public supply standards in 21% of wells, and sulfate is elevated in 13% of wells. The pH concentrations are beyond standards in 11% of wells, and iron and manganese are above standards in the majority of the wells sampled. It should be noted that iron and manganese concentrations were found only from wells on or surrounding the Three Oaks Mine property, and do not necessarily represent regional trends. The average concentrations of all but iron and manganese do not exceed standards.

**Table 5: Calvert Bluff Groundwater Quality (Regional)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 118.4 | 6503.1 | 926.9 | 210 | 1000 | 57 | 27% |
| pH** | 4.8 | 8.8 | 7.5 | 198 | 6.5-8.5 | 21 | 11% |
| Total Alkalinity (mg/L)** | 0.0 | 1704.9 | 268.1 | 210 | -- | -- | -- |
| Temperature (C°)** | 17.0 | 34.0 | 23.8 | 123 | -- | -- | -- |
| Iron (mg/L)* | 0.263 | 240.417 | 21.044 | 24 | 0.30 | 23 | 96% |
| Manganese (mg/L)* | 0.016 | 9.967 | 1.215 | 24 | 0.05 | 21 | 88% |
| Calcium (mg/L)** | 1.0 | 988.0 | 107.9 | 210 | -- | -- | -- |
| Magnesium (mg/L)** | 0.0 | 301.4 | 29.4 | 210 | -- | -- | -- |
| Sodium (mg/L)** | 8.3 | 1510.0 | 171.5 | 210 | -- | -- | -- |
| Chloride (mg/L)** | 5.0 | 2286.9 | 224.8 | 210 | 300 | 44 | 21% |
| Sulfate (mg/L)** | 0.0 | 1760.8 | 175.5 | 210 | 300 | 28 | 13% |
| Bicarbonate (mg/L)** | 0.0 | 2080.6 | 321.8 | 210 | -- | -- | -- |
| Nitrate (mg/L)*** | 0.0 | 1020.0 | 10.6 | 172 | 10 | 13 | 8% |

Includes analyses from wells located in Bastrop, Burleson, Caldwell, Gonzales, Guadalupe, Lee, and Milam Counties.

* Based on data from The Railroad Commission of Texas quarterly water quality reports for the Three Oaks Mine

**Based on data from The Railroad Commission of Texas and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

Within Bastrop County, of the 62 wells analyzed 26% have TDS concentrations above public supply standard, 31% of wells have elevated chloride concentrations, and 24% of wells have elevated sulfate concentrations (Table 6). The pH concentrations are beyond standards in 16% of the wells and, as regionally, iron and manganese concentrations exceed limits in the majority of the wells sampled. The average concentrations of all but iron and manganese are below standards.

**Table 6: Calvert Bluff Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 118.4 | 6503.1 | 990.7 | 62 | 1000 | 16 | 26% |
| pH** | 5.0 | 8.4 | 7.3 | 60 | 6.5-8.5 | 9 | 15% |
| Total Alkalinity (mg/L)** | 0.0 | 517.9 | 233.5 | 62 | -- | -- | -- |
| Temperature (C°)** | 20.7 | 31.0 | 24.4 | 39 | -- | -- | -- |
| Iron (mg/L)* | 0.263 | 240.417 | 27.318 | 17 | 0.30 | 16 | 94% |
| Manganese (mg/L)* | 0.016 | 9.967 | 1.547 | 17 | 0.05 | 14 | 82% |
| Calcium (mg/L)** | 2.4 | 861.1 | 122.3 | 62 | -- | -- | -- |
| Magnesium (mg/L)** | 1.0 | 301.4 | 38.6 | 62 | -- | -- | -- |
| Sodium (mg/L)** | 14.0 | 549.7 | 136.9 | 62 | -- | -- | -- |
| Chloride (mg/L)** | 11.0 | 36590.0 | 2096.0 | 62 | 300 | 19 | 31% |
| Sulfate (mg/L)** | 6.0 | 1760.8 | 268.3 | 62 | 300 | 15 | 24% |
| Bicarbonate (mg/L)** | 0.0 | 632.0 | 279.2 | 62 | -- | -- | -- |
| Nitrate (mg/L)*** | 0.0 | 4.0 | 0.5 | 44 | 10 | 0 | 0% |

* Based on data from The Railroad Commission of Texas quarterly water quality reports for the Three Oaks Mine

**Based on data from The Railroad Commission of Texas and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

***Simsboro Water Quality***

As shown in Table 7, of the 122 wells analyzed, 5% have TDS concentrations above the secondary public supply standards. Nitrate concentrations are above maximum contaminant levels in 4% of wells, chloride concentrations are elevated above secondary public supply standards in 5% of wells, and sulfate is elevated in 2% of wells. The pH concentrations are above standards in 17% of the wells and iron and manganese exceed limits in the majority of the wells. It should be noted that iron and manganese concentrations were found only from wells on or surrounding the Three Oaks Mine property and do not necessarily represent regional trends. The average concentration of all but the iron and manganese constituents are below standards and water in this aquifer is mostly fresh with few scattered wells showing elevated TDS concentrations (Figure 6).

**Table 7: Simsboro Groundwater Quality (Regional)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 77.0 | 1985.0 | 437.9 | 122 | 1000 | 6 | 5% |
| pH** | 5.5 | 8.7 | 7.2 | 120 | 6.5-8.5 | 20 | 17% |
| Total Alkalinity (mg/L)** | 16.5 | 558.3 | 162.7 | 121 | -- | -- | -- |
| Temperature (C°)** | 16.0 | 34.8 | 24.2 | 77 | -- | -- | -- |
| Iron (mg/L)* | 0.222 | 8.868 | 2.270 | 12 | 0.30 | 11 | 92% |
| Manganese (mg/L)* | 0.015 | 0.380 | 0.127 | 12 | 0.05 | 9 | 75% |
| Calcium (mg/L)** | 4.0 | 382.0 | 62.4 | 121 | -- | -- | -- |
| Magnesium (mg/L)** | 1.0 | 83.0 | 13.4 | 121 | -- | -- | -- |
| Sodium (mg/L)** | 5.3 | 400.1 | 69.4 | 121 | -- | -- | -- |
| Chloride (mg/L)** | 6.6 | 610.0 | 93.7 | 122 | 300 | 6 | 5% |
| Sulfate (mg/L)** | 2.0 | 928.0 | 67.3 | 122 | 300 | 2 | 2% |
| Bicarbonate (mg/L)** | 20.2 | 655.0 | 195.3 | 121 | -- | -- | -- |
| Nitrate (mg/L)*** | 0.0 | 18.0 | 1.2 | 105 | 10 | 4 | 4% |

Includes analyses from wells located in Bastrop, Caldwell, Guadalupe, Lee, Milam, and Williamson Counties.

* Based on data from The Railroad Commission of Texas quarterly water quality reports for the Three Oaks

**Based on data from The Railroad Commission of Texas and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

As discussed previously in this report, Simsboro groundwater beneath the City of Bastrop is relatively mineralized when compared to Simsboro groundwater from other areas. Previous investigations found TDS concentrations in the Simsboro ranged from about 1,000 milligrams per liter (mg/l) to over 2,000 mg/l depending on the depth of the production interval. In addition, testing and sampling of Simsboro test wells in the Bastrop city limits indicate the presence of significant concentrations of dissolved gasses including methane and carbon dioxide. Within Bastrop County as a whole, only 5% of the 59 wells analyzed exhibited TDS concentrations above public supply standards, 4% of wells have nitrate concentrations above maximum contaminant levels, 3% of wells have chloride concentrations exceeding secondary public supply standards, and one well has an elevated sulfate concentration (Table 8). The pH is above standards in 14% of wells and, again, the majority of the wells have elevated iron and manganese concentrations.

## Table 8: Simsboro Groundwater Quality (Bastrop County)

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 133.1 | 1985.0 | 497.0 | 59 | 1000 | 3 | 5% |
| pH** | 5.7 | 8.7 | 7.3 | 58 | 6.5-8.5 | 8 | 14% |
| Total Alkalinity (mg/L)** | 16.9 | 558.3 | 195.9 | 58 | -- | -- | -- |
| Temperature (C°)** | 21.0 | 34.8 | 25.5 | 30 | -- | -- | -- |
| Iron (mg/L)* | 0.222 | 8.868 | 2.582 | 9 | 0.30 | 8 | 89% |
| Manganese (mg/L)* | 0.015 | 0.380 | 0.150 | 9 | 0.05 | 7 | 78% |
| Calcium (mg/L)** | 4.0 | 382.0 | 68.0 | 58 | -- | -- | -- |
| Magnesium (mg/L)** | 1.9 | 83.0 | 13.8 | 58 | -- | -- | -- |
| Sodium (mg/L)** | 16.2 | 400.1 | 84.1 | 58 | -- | -- | -- |
| Chloride (mg/L)** | 7.5 | 580.0 | 89.5 | 59 | 300 | 2 | 3% |
| Sulfate (mg/L)** | 5.0 | 928.0 | 87.4 | 59 | 300 | 1 | 2% |
| Bicarbonate (mg/L)** | 20.5 | 655.0 | 232.9 | 58 | -- | -- | -- |
| Nitrate (mg/L)*** | 0.0 | 11.0 | 0.7 | 49 | 10 | 2 | 4% |

* Based on data from The Railroad Commission of Texas quarterly water quality reports for the Three Oaks Mine

**Based on data from The Railroad Commission of Texas and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

### *Hooper Water Quality*

Regionally, Hooper groundwater is generally fresh in the northeastern portion of the study area but becomes more mineralized trending southwest (Figure 7). As shown in Table 9, of the 140 wells analyzed, 18% show average TDS concentrations above the secondary public supply standards. Nitrate concentrations are above maximum contaminant levels in 9% of wells, chloride is high in 14% of wells, and sulfate is elevated in 10% of wells. No records pertaining to iron and manganese constituents were available for the region.

## Table 9: Hooper Groundwater Quality (Regional)

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L) | 106.0 | 4413.0 | 692.4 | 140 | 1000 | 25 | 18% |
| pH | 5.5 | 8.6 | 7.4 | 132 | 6.5-8.5 | 6 | 5% |
| Total Alkalinity (mg/L) | 9.0 | 796.7 | 249.9 | 140 | -- | -- | -- |
| Temperature (C°) | 15.0 | 37.0 | 23.4 | 84 | -- | -- | -- |
| Calcium (mg/L) | 1.0 | 514.0 | 82.4 | 140 | -- | -- | -- |
| Magnesium (mg/L) | 0.4 | 215.0 | 20.6 | 140 | -- | -- | -- |
| Sodium (mg/L) | 14.0 | 695.0 | 137.6 | 140 | -- | -- | -- |
| Chloride (mg/L) | 11.0 | 970.0 | 158.6 | 140 | 300 | 20 | 14% |
| Sulfate (mg/L) | 2.0 | 1788.0 | 112.6 | 140 | 300 | 14 | 10% |
| Bicarbonate (mg/L) | 11.0 | 972.3 | 304.0 | 140 | -- | -- | -- |
| Nitrate (mg/L) | 0.0 | 85.6 | 3.7 | 129 | 10 | 12 | 9% |

Includes analyses from wells located in Bastrop, Caldwell, Gonzales, Guadalupe, Lee, Milam, and Williamson Counties.

All constituent values based on data from Texas Water Development Board records

Within Bastrop County, 13% of the 30 wells analyzed exhibited average TDS concentrations above public supply standards, 14% of wells have nitrate concentrations above maximum contaminant levels and 6% of wells have chloride concentrations exceeding secondary public supply standards (Table 10). The average concentration of each constituent is below standards; however, depending on location, produced water may have to be treated or mixed with better quality water to reach acceptable constituent levels.

**Table 10: Hooper Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L) | 183.5 | 1411.0 | 590.0 | 31 | 1000 | 4 | 13% |
| pH | 6.6 | 8.6 | 7.6 | 30 | 6.5-8.5 | 1 | 3% |
| Total Alkalinity (mg/L) | 92.4 | 762.0 | 258.7 | 31 | -- | -- | -- |
| Temperature (C°) | 22.0 | 26.0 | 24.5 | 13 | -- | -- | -- |
| Calcium (mg/L) | 3.4 | 222.0 | 59.8 | 31 | -- | -- | -- |
| Magnesium (mg/L) | 0.4 | 68.0 | 12.9 | 31 | -- | -- | -- |
| Sodium (mg/L) | 24.0 | 465.0 | 139.7 | 31 | -- | -- | -- |
| Chloride (mg/L) | 21.0 | 550.0 | 125.2 | 31 | 300 | 2 | 6% |
| Sulfate (mg/L) | 5.0 | 285.0 | 69.7 | 31 | 300 | 0 | 0% |
| Bicarbonate (mg/L) | 112.8 | 886.0 | 313.0 | 31 | -- | -- | -- |
| Nitrate (mg/L) | 0.0 | 21.0 | 2.8 | 29 | 10 | 4 | 14% |

All constituent values based on data from Texas Water Development Board records

## Regulatory Affects on Groundwater Availability

Conflicts and controversy have surrounded the issue of groundwater ownership and regulation in Texas for many years. In 1949, Texas lawmakers perceived the need for groundwater management in some areas of the State, and enacted legislation enabling the formation of localized groundwater conservation districts. About 100 districts have been created since that time (many within the past 10 years), which now form a patchwork of regulatory entities throughout much of the State. These groundwater conservation districts obtain their authority to regulate groundwater through Chapter 36 of the Texas Water Code; legislation that was initially relatively brief, but has been significantly increased in length and complexity by various additions and modifications ratified in numerous legislative sessions. As a result, the statute is oftentimes vague or ambiguous and subject to a wide range of interpretations of key sections by both groundwater regulators and users alike.

Although many of the aquifers in Texas are regional in extent, the areas covered by individual districts are typically relatively small, with the majority encompassing just one or two counties. Although some aspects of local-scale regulation may be desirable, this piecemeal approach (relative to common aquifer extents) has led to a regulatory system characterized by inconsistent and conflicting rules and management plans that apply to the same aquifer or same aquifer subdivision.

In 2005, a legislative modification of Chapter 36 (known as House Bill 1763) attempted to impose some regional continuity on the current management system through the creation of Groundwater Management Areas (GMA). Representing relatively large subdivisions of the State, the selection of GMA boundaries acknowledged the extents of major aquifers while incorporating the political (primarily county) boundaries employed almost exclusively by groundwater districts. GMAs are governed by boards comprised of representatives from the groundwater districts that lie within the boundaries of the individual GMAs. In essence, a GMA is an association of districts that share at least one common aquifer.

As part of the effort to encourage a regional perspective from groundwater districts, House Bill 1763 requires that each GMA generate a set of "Desired Future Conditions" (DFC) for each aquifer within its boundaries. These DFCs were submitted to the TWDB by September 2010, who then used them to determine the "Managed Available Groundwater" (MAG) for use in each GMA. Groundwater districts appear to be required to grant groundwater withdrawal permits up to the MAG values generated by the TWDB. Although the regulatory significance of a MAG is not clearly defined in Chapter 36, most districts assume that the MAGs represent production caps for each aquifer in a GMA. However, this is far from certain as policy is still evolving and the issue has not been decided in any court case.

Recent experience throughout Texas indicates that the majority of the GMAs are effectively "reverse-engineering" their DFCs to correspond to predetermined estimates of groundwater usage. GMA-12, which encompasses Bastrop County, appears to have followed this trend. Typically, this method of reverse-engineering entails:

1. Compiling a list of potential future pumpage locations (users) and rates;

2. Inputting the pumpage estimates into an aquifer model;

3. Using the water levels output by the model as DFC criteria.

Ironically, reverse-engineering DFCs is likely the most straightforward method for a GMA to ensure that the MAG values ultimately returned by the TWDB conform (or appear to conform) to their production goals. However, use of this procedure introduces inflexibility and uncertainty in two fundamental ways:

- Determining future pumping limits by forecasting groundwater use is essentially equivalent to pre-permitting groundwater pumpage. Because DFCs are based on the results of models in which the pumpage has been specified in advance, only those users whose future withdrawals are included in the groundwater model will be able to conform to the water levels (DFCs) output by the model. New well fields or changes in the rates or locations of the predicted pumpage will ultimately result in non-conformance with a DFC produced in this manner.
- Groundwater models are generally based on the best information available at the time of their construction, but there are always errors in the output results. In addition, new, more accurate data are continuously collected that can significantly alter the model predictions. For these reasons, real-world aquifer response to pumpage may be very different than the effects forecasted by a groundwater model. If and when this proves to be the case, the amount of groundwater "legally" available for use will either rise or fall, necessitating re-allocation of resources in the future.

New groundwater production from Bastrop County is not currently recognized by GMA-12 as a potential future use. Therefore, the water level declines that would result from new pumpage in the county are not represented in results of any groundwater simulations conducted by GMA-12. Consequently, if water levels output from simulations that incorporate only currently anticipated pumpage are used by GMA-12 as DFCs, future requests for groundwater production permits might be rejected because the additional declines will exceed those defined in the DFCs. It should be noted that the question of ownership of groundwater and the extent of the regulatory power of groundwater districts is currently being debated. Clarity may be provided in the upcoming Texas Supreme Court ruling on the case (Edwards Aquifer Authority vs. Day & McDaniel, No. 08-0964), which investigates these issues.

Comparing the GMA-12 DFC model pumpage inputs (Revision 7b) with known permitted pumpage in the LPGCD, it is possible to estimate the amount of groundwater water available for new development in Bastrop and Lee counties from a permitting standpoint. Table 11 lists the current permitted pumpage in the LPGCD and the pumpage allocated to the district in 2010 in the GMA-12 model. As shown, the pumpage permitted within the LPGCD exceeds the pumpage included in the GMA-12 DFC model run until at least after 2060. In other words, permitted groundwater production currently surpasses and will continue to exceed the MAG within the district for at least the next 50 years. As a result, the potential for obtaining permits for development of additional groundwater resources within Bastrop County is uncertain at this time.

Examination of Table 11 highlights another potential problem with the DFC reverse-engineering method described above; the pumpage inputs assembled by many GMAs in the state for inclusion in DFC/MAG model runs often do not accurately reflect the production permits currently issued by their member districts. This appears to be true for GMA-12, where the pumpage locations, rates, and implementation schedules selected for the DFC/MAG model run seem to have been derived by means other than tabulating current and predicted groundwater production permits. Unfortunately, the reasons for this are unclear and documentation of the methodology used by GMA-12 to compile the model pumpage inputs is not currently available.

**Table 11. Carrizo-Wilcox: LPGCD Permitted Pumpage vs. GMA-12 DFC/MAG Model Pumpage**

| Year | LPGCD Permitted Pumpage (ac-ft/yr) [1] | GMA-12 Revision 7B Model Pumpage (ac-ft/yr) [2] | Difference (ac-ft/yr) |
|---|---|---|---|
| 2010 | 58,439 | 39,253 | -19,186 |
| 2020 | 58,439 | 43,566 | -14,873 |
| 2030 | 58,439 | 44,063 | -14,376 |
| 2040 | 58,439 | 48,295 | -10,144 |
| 2050 | 58,439 | 54,304 | -4,135 |
| 2060 | 58,439 | 55,770 | -2,669 |

1) Values originate from LPGCD permitted pumpage files received on 10/05/2010 and do not include wells from Alluvium, Sparta, or unknown aquifers.

2) Values represent summations of pumpage assigned to non-dry model cells with centroids (nodes) within the boundary of the LPGCD.

In summary, groundwater regulation in Texas is in a state of flux, and will probably not stabilize for several years. Groundwater production in the Bastrop area is subject to the rules and management plans promulgated by the LPGCD and neighboring districts, but it is unclear how these rules and plans should be interpreted or how the current regulatory framework may be altered during the ongoing DFC/MAG process described above. For these reasons, it must be stressed that this evaluation is based on RWH&A's current assessment of the regulatory conditions and physical practicality affecting groundwater availability, and that any changes in the management policies sanctioned by GMA-12 or its various member districts could significantly alter the conclusions contained herein.

## Local Groundwater Regulation

There is ongoing debate concerning the regulatory significance of a MAG. Chapter 36 of the Texas Water Code states that groundwater districts must allow pumpage up to MAG values, but it is not clear whether a district may issue permits in excess of a MAG if it wishes. However, it is commonly assumed that the MAG received by the LPGCD from the GMA-12 is the maximum amount of permitted and exempt pumpage the district can authorize.

The LPGCD regulates well construction and groundwater permits in Bastrop and Lee Counties. The following summarizes the pertinent portions of the LPGCD rules with regard to groundwater development.

1. ***Well Construction and Operating Permits –*** Users are required to obtain permits from the LPGCD to construct (non-exempt) wells and to produce groundwater from them. Compilation of district permit applications for larger-scale projects is typically a complex and time-consuming process in which the applicant must submit various engineering, hydrogeologic, and planning data including property/lease maps, groundwater modeling results, details of the methods and materials to be used in the proposed wells and transmission systems, regional water planning group documents, etc.

2. ***Allowable Production –*** Groundwater allocation is regulated by the LPGCD in a very general sense. The current rules do not include a definitive formula or method of allocating groundwater to users in the district, instead the following general statement that production is to be managed through consideration of aquifer water levels is included:

   > *"Rule 6.1 Maximum allowable production from aquifers in district. To protect and to assure the sustainability of the water supplies available from the aquifers, enabling all citizens of the district to have access to groundwater to provide for their health, safety and welfare, the district shall consider water levels and water level changes in or associated with a groundwater reservoir or aquifer within the district."*

   The rules also discuss general protocol by which the LPGCD may decrease the allocated production. The pertinent steps are: 1) investigation of water level declines by the general manager and presentation of the findings at a public hearing, 2) adoption of a district board resolution to define areas of decline, and 3) users are directed by the LPGCD to reduce withdrawals within the decline areas.

3. ***Well Spacing –*** Wells in the Carrizo or Simsboro aquifers capable of producing up to and including 500 gpm must have a minimum spacing of 1,500 feet from other districts wells, wells capable of producing from 501 to 1,000 gpm must have a minimum spacing of 2,500 feet, and wells capable of producing over 1,000 gpm must have a minimum spacing of 5,000 feet. An exemption to this rule may be granted by the district board under specific conditions.

4. ***Reservation Permits –*** A Reservation Permit reserves a site for future well development and gives the applicant all protections applicable to an operating permit. The Reservation Permit is granted for a five year term but can be extended for two additional terms. This permit is beneficial because it allows water development at a future time while being subject to the spacing restrictions at the time of the initial application. However any new requirements stated in the approved Management Plan will apply when the water development is commenced.

As discussed above, the LPGCD does not have clear rules in effect that permit a landowner to predict the amount of production that might be allowed by the District. The current rules give LPGCD authority to deny new operating permits based on their Management Plan, the availability of groundwater, and whether the production is beneficial, proportional to population in a specific geographic area, and is required by a statutory, regulatory, or legal obligation.

## General Groundwater Development Options

Bastrop will require additional water supplies incrementing to a maximum daily demand of 26.8 MGD (30,043 acre feet per year) by 2040 to meet the demands associated with increasing population over the next thirty years. Development of additional groundwater supplies represents a potential strategy to fulfill future demands, and the Carrizo and Simsboro aquifers are the best options for development in the region. Potential well field designs and costs were produced for the two aquifers and were evaluated for probable benefits and shortfalls. Using groundwater modeling, hydrogeologic data, and regulatory information, two well field options for developing enough supply to meet future demands were generated. Although many factors affecting the desirability of various development options were explored, the proximity of the well field to the City of Bastrop (the assumed delivery point), aquifer productivity, hydraulic boundaries, and water quality were considered the main factors affecting the desirability of an individual groundwater development scenario.

In the study area, relatively impermeable formations lie beneath and above the Carrizo and Simsboro aquifers. These vertical confining layers, in combination with the regional slope of the aquifers results in groundwater that is under (artesian) pressure in downdip zones. In these areas, water levels rise above the top of the aquifer within a well bore. As a result, groundwater may be produced from artesian zones without desaturation of the aquifer pore spaces.

In this study, estimated aquifer transmissivity and “available drawdown” were the primary factors used to determine potential well productivity in the region. The term transmissivity is used as a measure of the aquifer’s ability to conduct water to wells and is a function of the saturated thickness and permeability of the aquifer sediments. The vertical distance between the non-pumping (static) water level in a well and the desired maximum pumping level is known as the available drawdown. Well yields are directly proportional to the amount of available drawdown at the well site. In other words, a well located in an area with twice the available drawdown will be able to produce water at two times the rate. As discussed above, groundwater pressure increases to the southwest due to the dip of the formations and the vertical confining formations. Consequently, available drawdown increases to the southeast allowing for larger-capacity wells further downdip. For this study, it was assumed that desaturation of an aquifer near a well bore is undesirable. Consequently, for the well yield calculations presented herein, it is assumed that the available drawdown at a particular well is the vertical distance between the static water level and the top of the aquifer production zone at the site.

Figure 8 shows the potential Carrizo and Simsboro well field areas developed for this study. According to hydrogeologic data for the two aquifers within the proposed well areas (Figure 8), both aquifers will yield a similar amount of water. The estimated transmissivity in the Carrizo is generally larger than that of the Simsboro in the respective development areas; however, available drawdown is greater in the Simsboro development area. This relationship results in similar pumping scenarios for each of the aquifers.

## Regional Aquifer Water Level Trends

Long-term changes in aquifer water levels affect groundwater availability and well yields in the Bastrop region. Water level measurements recorded by the Texas Water Development Board (TWDB) indicate that regional trends in aquifer water levels vary in the Carrizo-Wilcox system. Carrizo water levels have generally remained steady or shown moderate declines (10 to 20 feet) over the majority of Central Texas in the last half-century. In more southern counties such as Atascosa, Frio and Wilson Counties, the Carrizo is much more heavily utilized as an agricultural supply. Correspondingly, records indicate that larger declines (up to about 100 feet) in Carrizo groundwater water levels have occurred in those counties.

In general, Wilcox aquifer water levels have remained steady in Bastrop County over the past 50 years, while varying declines were measured in counties to the north of Bastrop (Brazos, Burleson, Milam, Lee, and Robertson). These declines are due primarily to ongoing pumpage to supply municipal use, agricultural use, and by mining operations in the region. The recorded water level reductions range up a maximum of about 250 feet in Simsboro wells located in Brazos County (largely due to the municipal use by the cities of Bryan and College Station).

## Groundwater Modeling and Predicted Declines

In order to estimate the aquifer response to the proposed water development, groundwater modeling was conducted using the Central Carrizo-Wilcox-Queen City-Sparta Groundwater Availability Model (GAM) distributed by the TWDB. Figures 9 and 10 show the groundwater declines in the Carrizo and Simsboro aquifers due to development from the proposed well fields over the next 30 years. An average 60,000 gallon per day per foot (gpd/ft) transmissivity was used for the Carrizo aquifer and a 45,000 gpd/ft transmissivity was used for the Simsboro. The pumping rates chosen for each decade are based on the assumed deficits stated in Table 12. The gallons per minute rate is based on seven wells (Figure 11) pumping one-seventh of the overall deficit.

**Table 12. Maximum Daily Deficit for the City of Bastrop in years 2010-2040**

| Year | Deficit (MGD) | Deficit (acre-ft/yr) | Pumping Rate Per Well (gpm) |
|---|---|---|---|
| 2010-2020 | 5.8 | 6,502 | 575 |
| 2020-2030 | 15.4 | 17,263 | 1530 |
| 2030-2040 | 26.8 | 30,043 | 2660 |

## Well Design

The well field layouts for the Carrizo and Simsboro aquifers were chosen to maximize production rates, minimize distance from source to delivery point, and target the best water quality regions while complying with the LPGCD rules for water wells.

Figure 11 shows the available drawdown of the aquifers and the locations and layouts of the two well fields. Wells were placed in a location within reasonable proximity to the City of Bastrop delivery point while maximizing available drawdown (Figure 11). As discussed above, the LPGCD rules place some constraints on the location for both well fields, and some adjustments to the specific location of each well were necessary to maintain proper offsets from existing LPGCD wells.

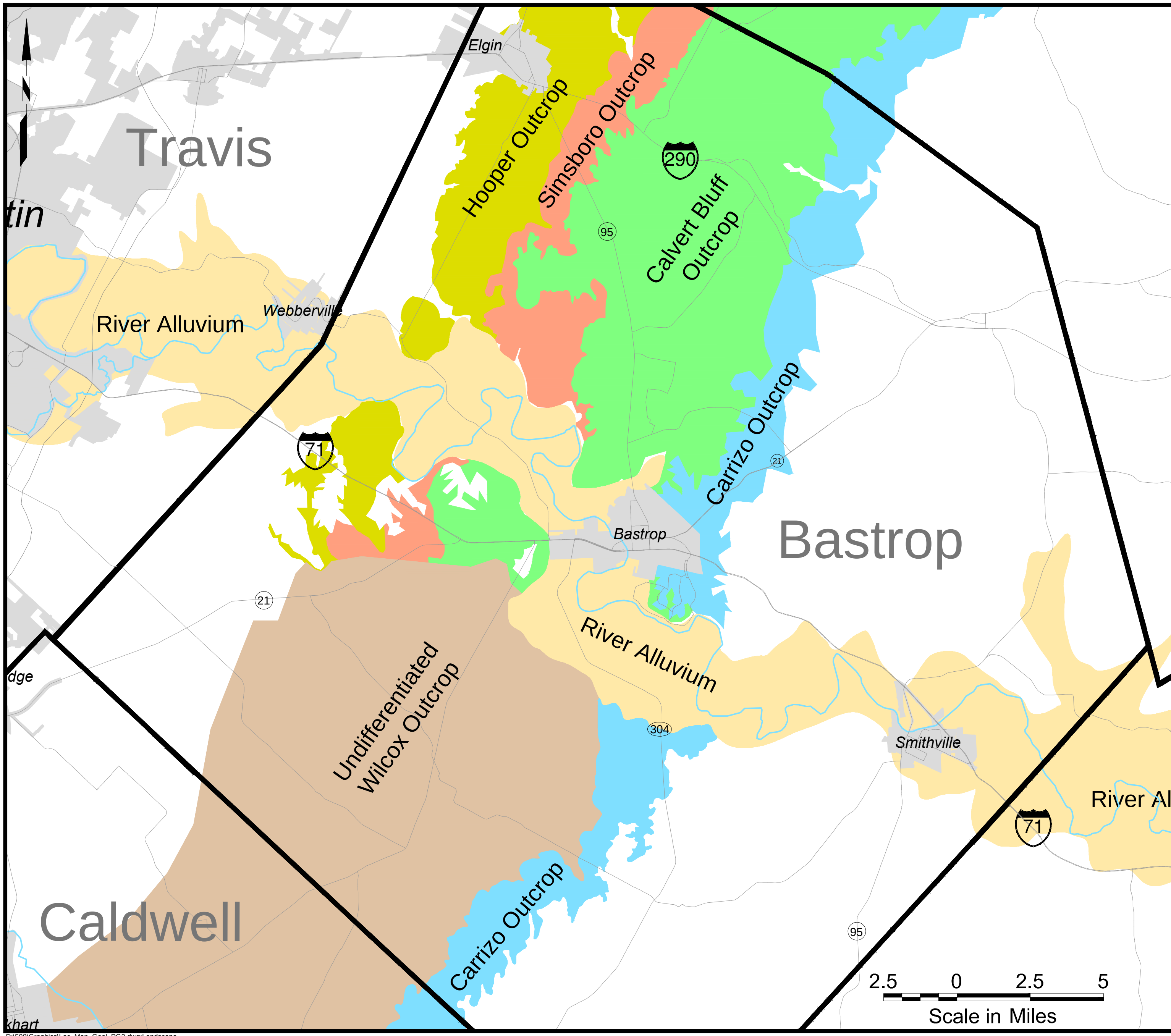
For general reference, Table 13 shows the estimated water quality at the proposed well field sites. The values were interpolated from regional data in Bastrop and surrounding counties because no data is available at the sites. As shown in Table 13, with the exception of pH, all constituents fall below TCEQ limits. Iron and manganese were not included due to lack of data within reasonable proximity to the well areas.

**Table 13. Estimated General Water Quality For Proposed Well Fields**

| Constituent | TCEQ Standard | Carrizo Well Field | Simsboro Well Field |
|---|---|---|---|
| TDS (mg/L) | 1000 | 479 | 248 |
| pH | 6.5-8.5 | 8.96 | 7.8 |
| Total Alkalinity (mg/L) | -- | 197 | 166 |
| Temperature ( C° ) | -- | 33 | 33.8 |
| Calcium (mg/L) | -- | 3 | 25 |
| Magnesium (mg/L) | -- | 1 | 4 |
| Sodium (mg/L) | -- | 187 | 67 |
| Chloride (mg/L) | 300 | 55 | 11 |
| Sulfate (mg/L) | 300 | 120 | 40 |
| Bicarbonate (mg/L) | -- | 215 | 195 |
| Nitrate (mg/L) | 10 | 0.46 | 0.01 |

## Study Limitations and Uncertainty

This study provides only preliminary groundwater development scenarios for the Bastrop region. It should be noted that the hydrogeologic interpretations and well field modeling employed herein are based on available information.  Specific aquifer testing at proposed development areas will present more definitive data, allowing for more accurate estimates of well yields, costs, and layouts.  In addition, future changes in groundwater regulation may also impact the feasibility of the development options provided in this study.

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Bastrop County, TX

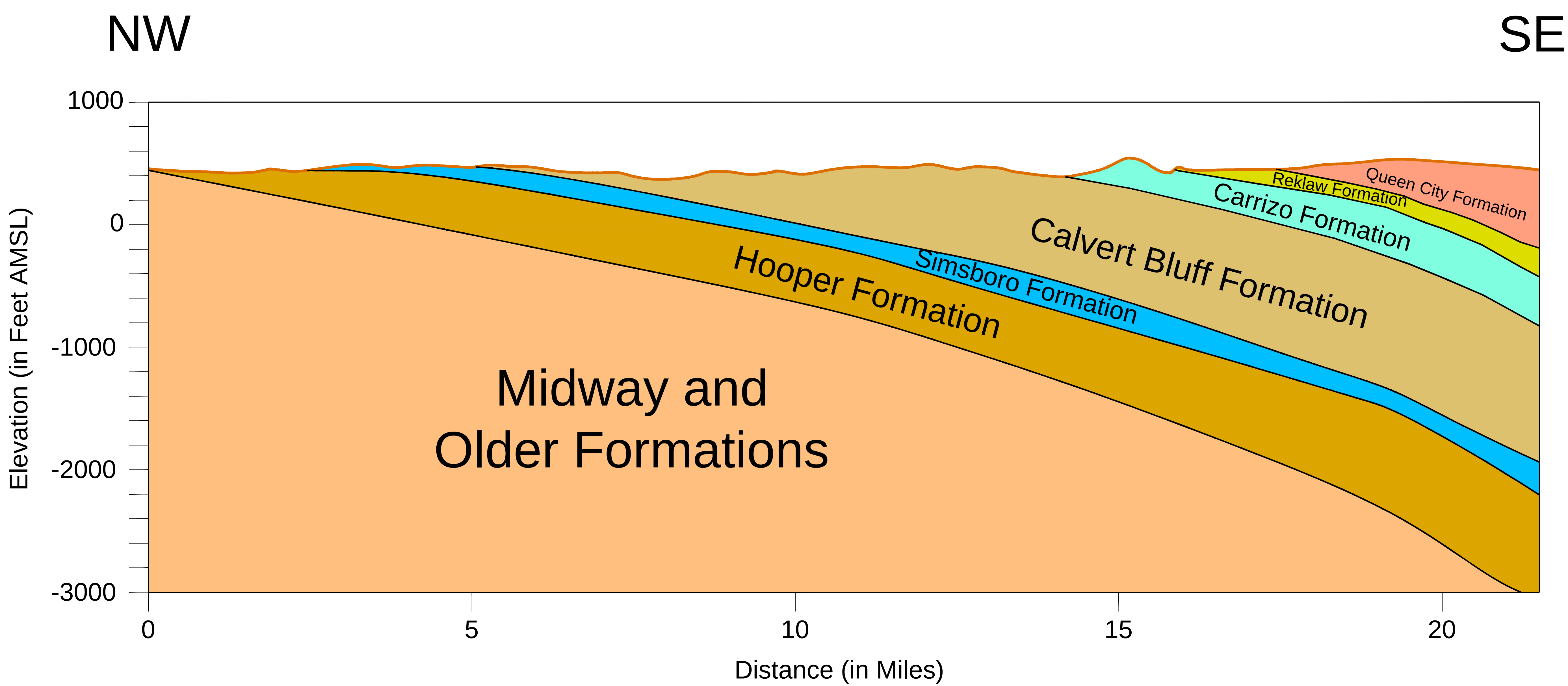
Figure 1

**Regional Aquifer Outcrops**

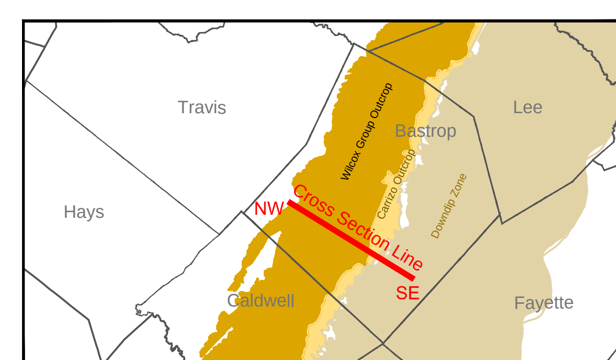
*R. W. Harden & Associates, Inc.*
*Hydrologists - Geologists - Engineers*

D:\598\Graphics\Loc_Map_Geol_PG2.dwg:Landscape

Jan 05, 2011




**Cross-section Overview**



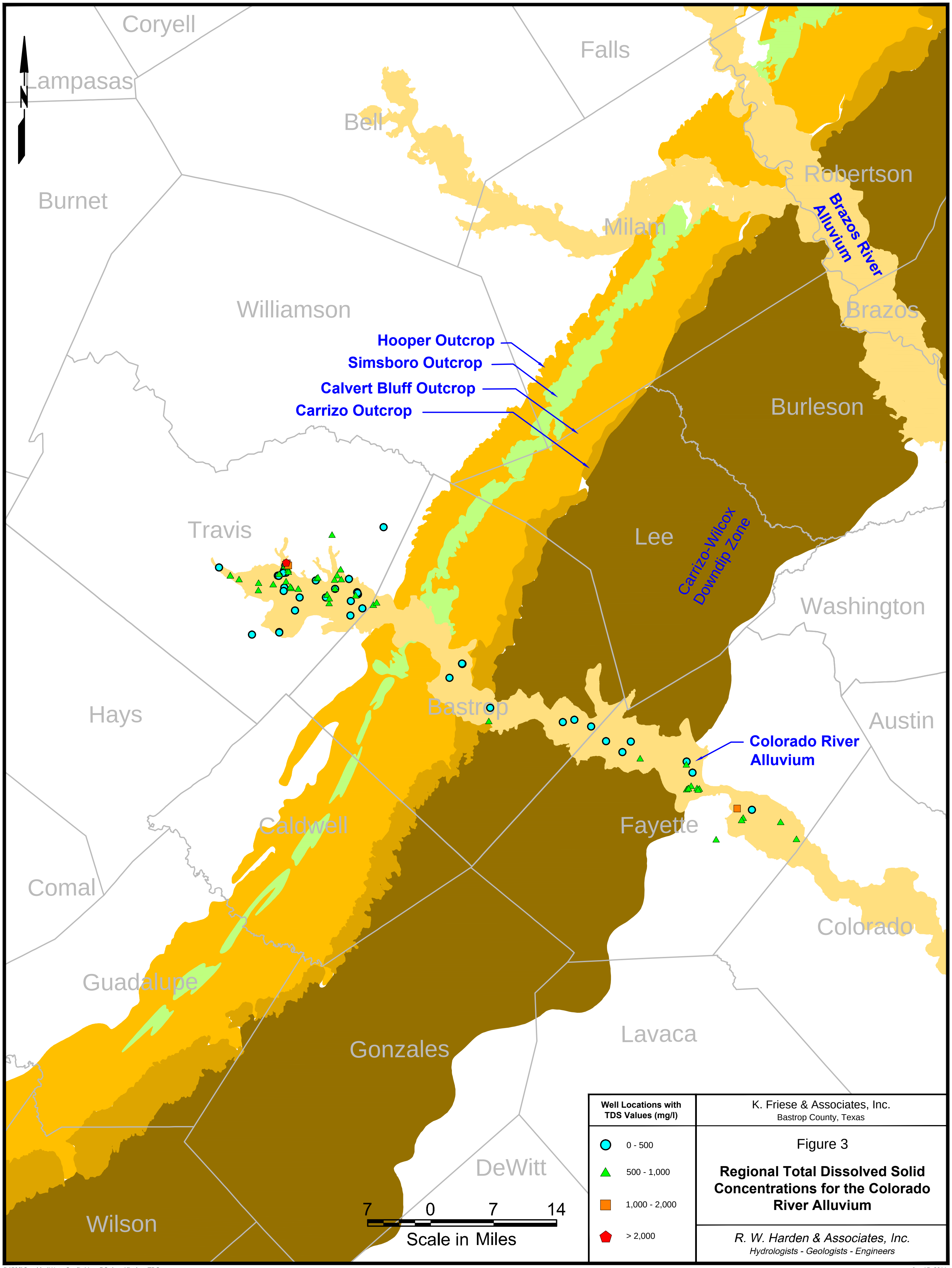

City of Bastrop
Bastrop County, Texas

Figure 2
**Geologic Cross-Section of the Bastrop Region**

*R. W. Harden & Associates, Inc.*
*Hydrologists - Geologists - Engineers*

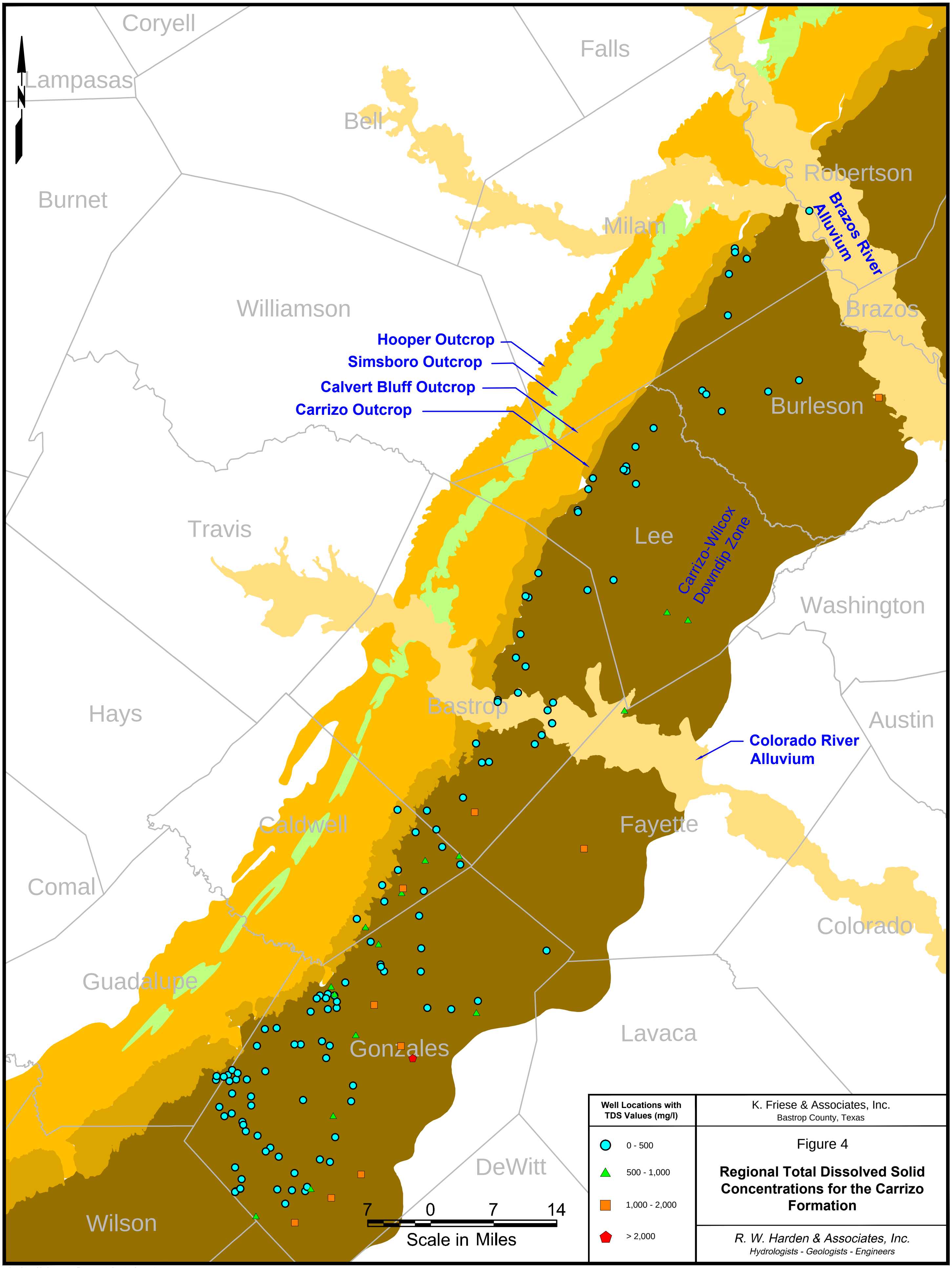
D:\598\Graphics\AQ_Overview_XSect_MR2.dwg:Landscape

Apr 08, 2011



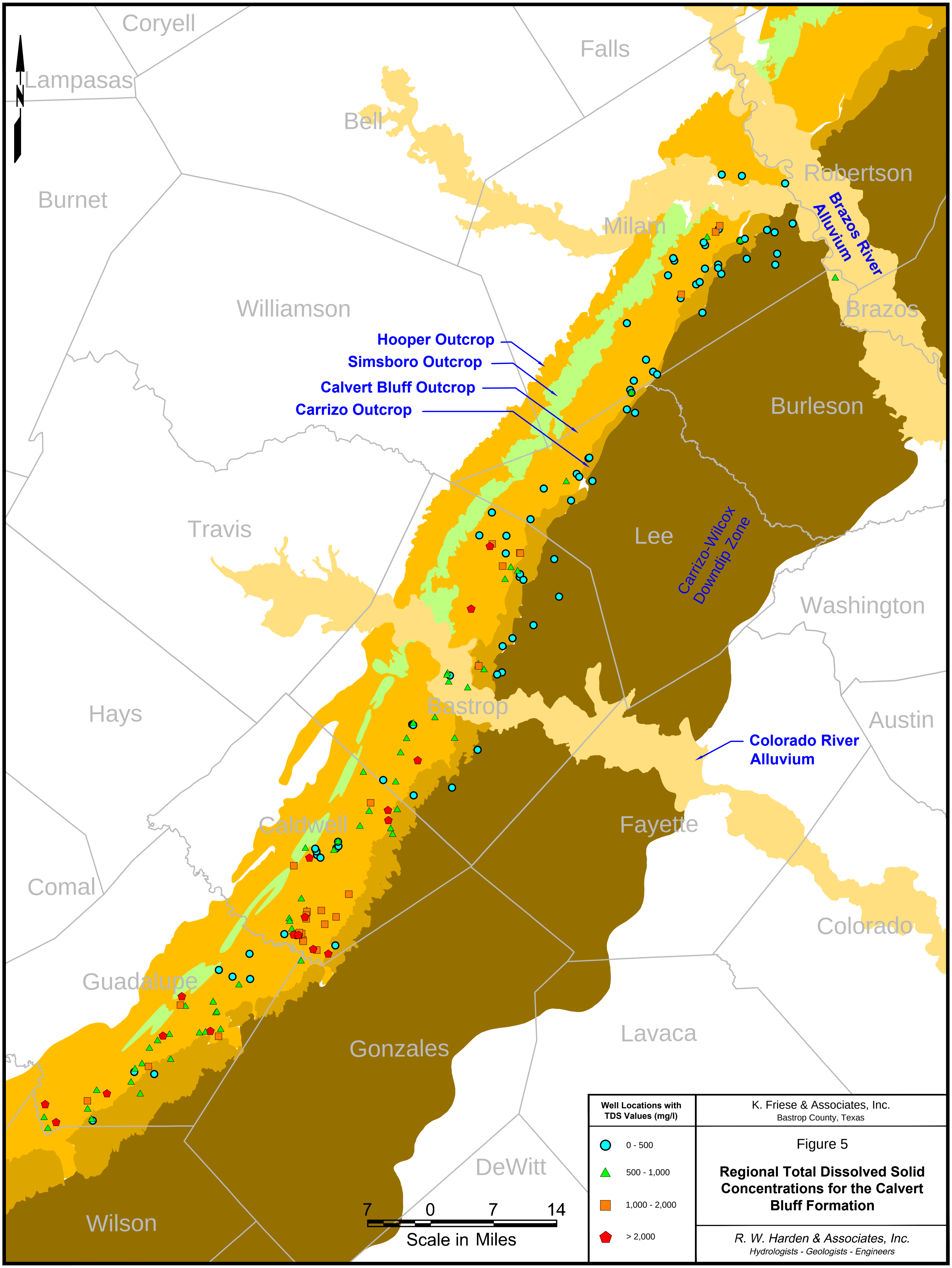

D:\598\Graphics\WaterQualityMap_PG.dwg:Alluvium TDS

Jan 15, 2011



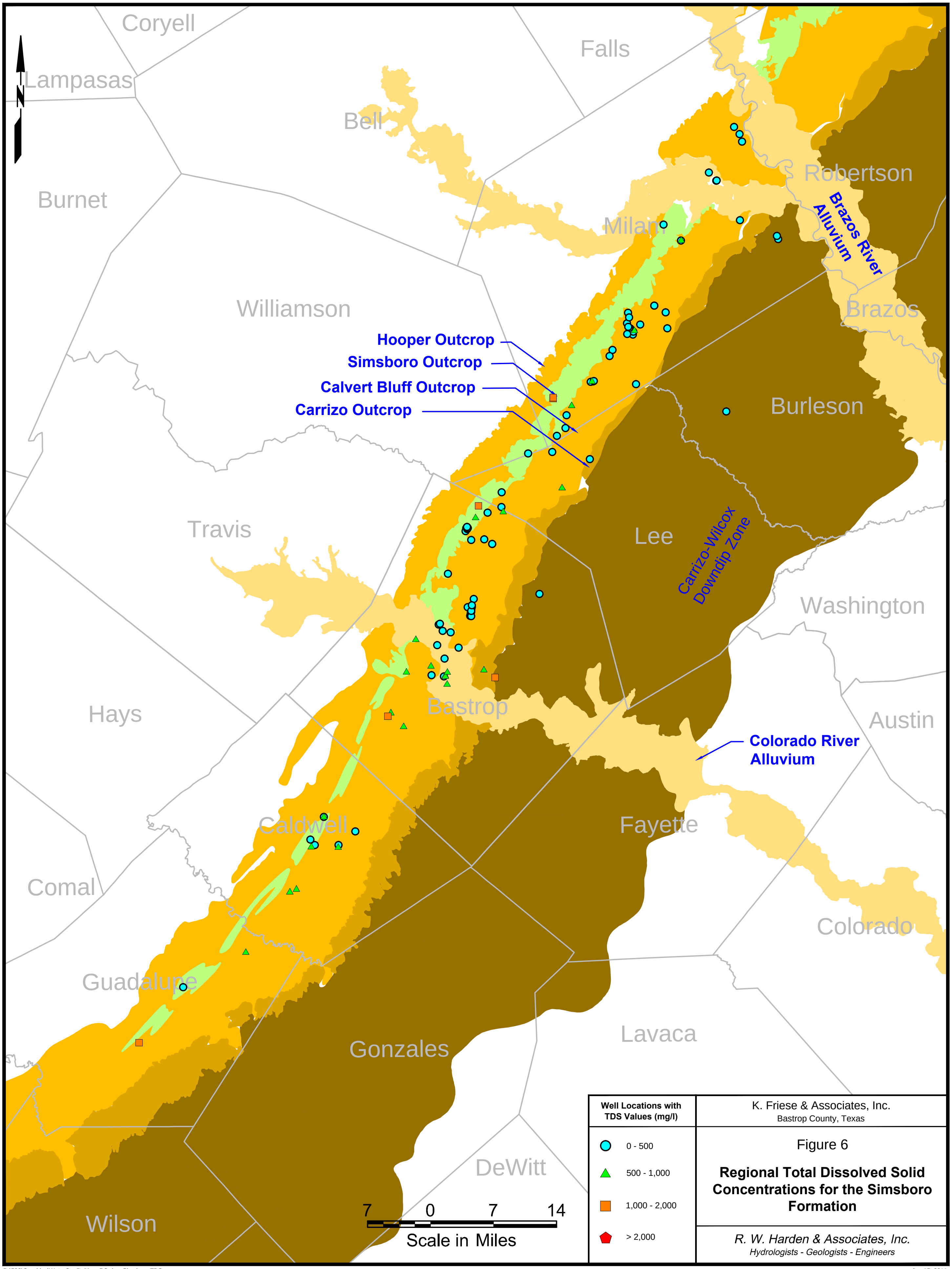

D:\598\Graphics\WaterQualityMap_PG.dwg:Carrizo TDS

Jan 15, 2011




D:\598\Graphics\WaterQualityMap_PG.dwg:Calvert Bluff TDS

Jan 15, 2011



Coryell
Lampasas
Falls
Bell
Burnet
Robertson
Milam
Brazos River Alluvium
Williamson
Brazos
Hooper Outcrop
Simsboro Outcrop
Calvert Bluff Outcrop
Carrizo Outcrop
Burleson
Travis
Lee
Carrizo-Wilcox Downdip Zone
Washington
Hays
Bastrop
Austin
Colorado River Alluvium
Caldwell
Fayette
Comal
Colorado
Guadalupe
Gonzales
Lavaca
DeWitt
Wilson
7 0 7 14
Scale in Miles
Well Locations with TDS Values (mg/l)
0 - 500
500 - 1,000
1,000 - 2,000
> 2,000
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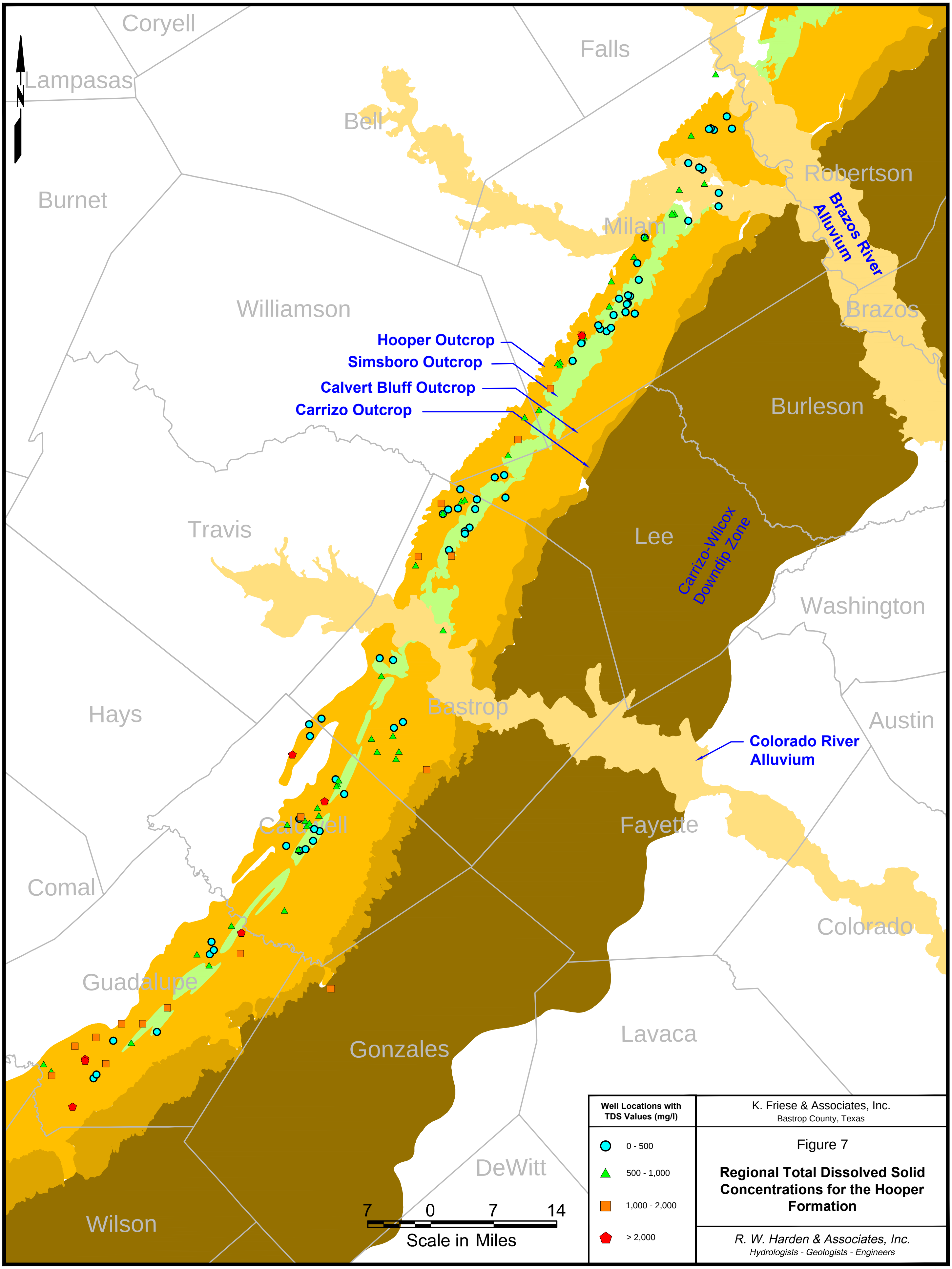
Bastrop County, Texas
Figure 6
Regional Total Dissolved Solid Concentrations for the Simsboro Formation
R. W. Harden & Associates, Inc.
Hydrologists - Geologists - Engineers
D:\598\Graphics\WaterQualityMap_PG.dwg:Simsboro TDS
Jan 15, 2011




D:\598\Graphics\WaterQualityMap_PG.dwg:Hooper TDS

Jan 15, 2011

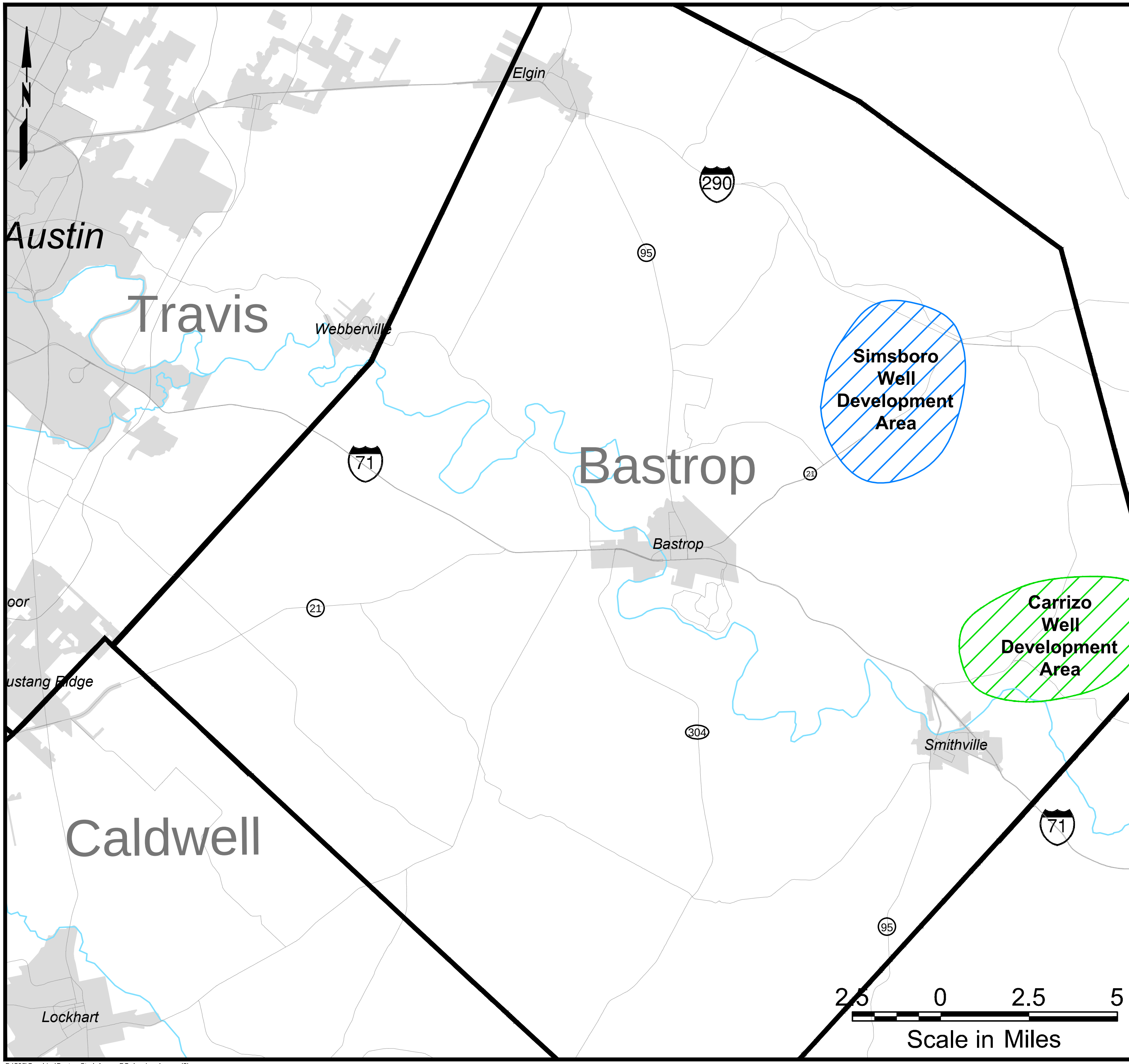



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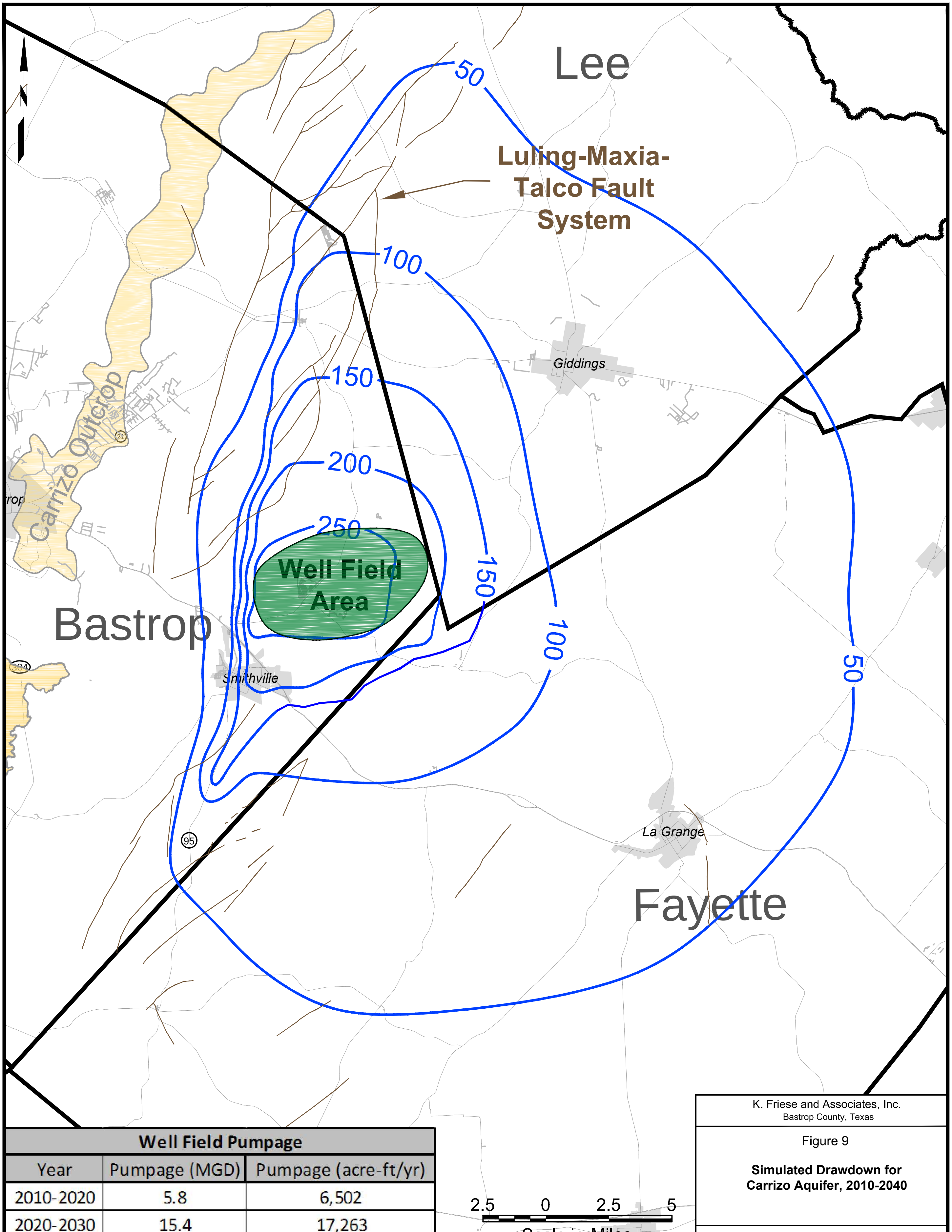
**Figure 8**

**Potential Well Development Areas**

*R. W. Harden & Associates, Inc.*
*Hydrologists - Geologists - Engineers*

D:\598\Graphics\BastropStudyAreas_PG.dwg:Landscape (2)

Jan 05, 2011




| Well Field Pumpage | | |
|---|---|---|
| Year | Pumpage (MGD) | Pumpage (acre-ft/yr) |
| 2010-2020 | 5.8 | 6,502 |
| 2020-2030 | 15.4 | 17,263 |
| 2030-2040 | 26.8 | 30,043 |

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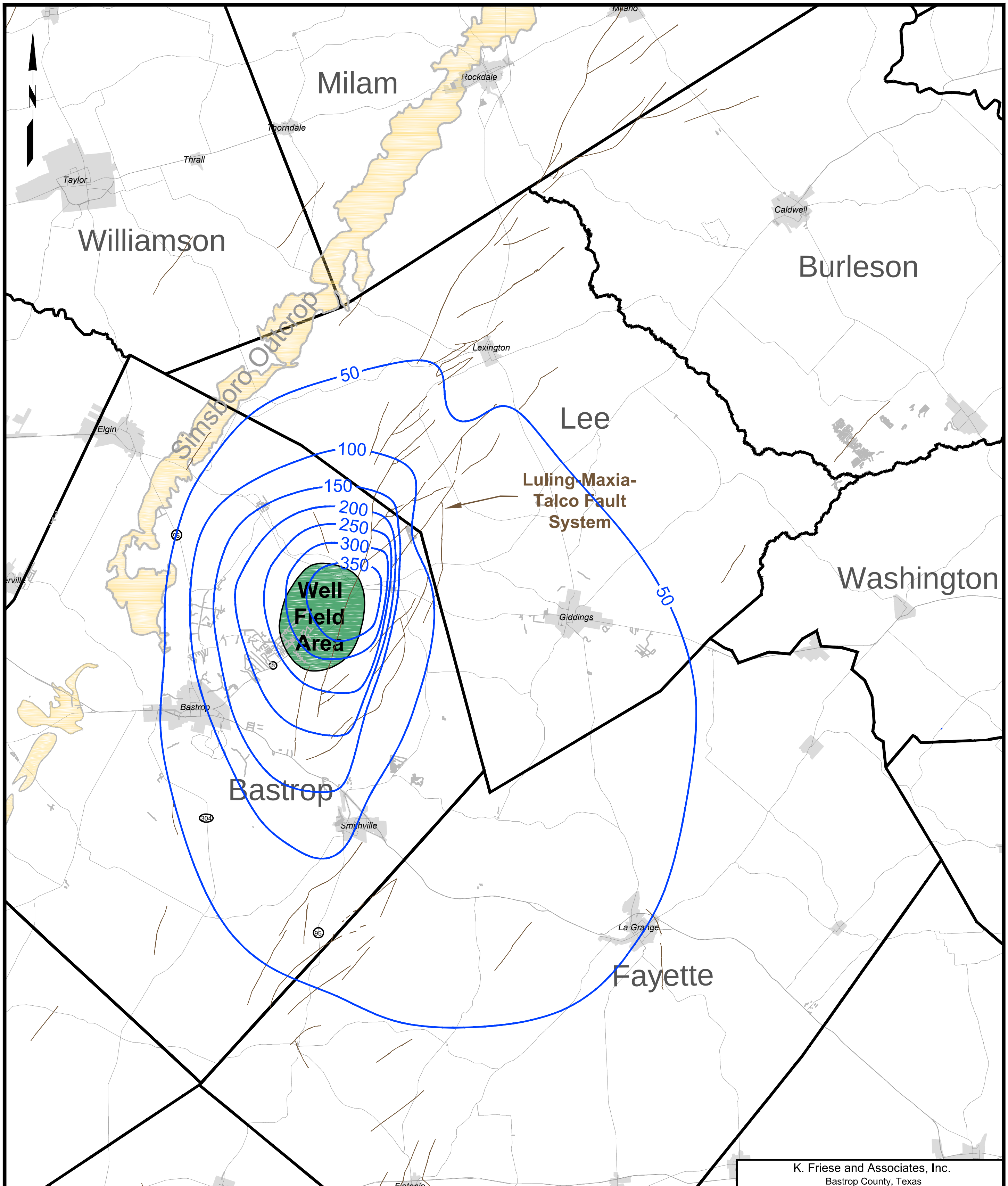
Figure 9

**Simulated Drawdown for Carrizo Aquifer, 2010-2040**

*R. W. Harden & Associates, Inc.*
*Hydrologists - Geologists - Engineers*

D:\598\DataWorkup\Well Field Layout\WellField_Model_GAM.dwg:Carrizo2040P _Rev2

Apr 12, 2011




| Well Field Pumpage | | |
|---|---|---|
| Year | Pumpage (MGD) | Pumpage (acre-ft/yr) |
| 2010-2020 | 5.8 | 6,502 |
| 2020-2030 | 15.4 | 17,263 |
| 2030-2040 | 26.8 | 30,043 |

K. Friese and Associates, Inc.
Bastrop County, Texas

Figure 10

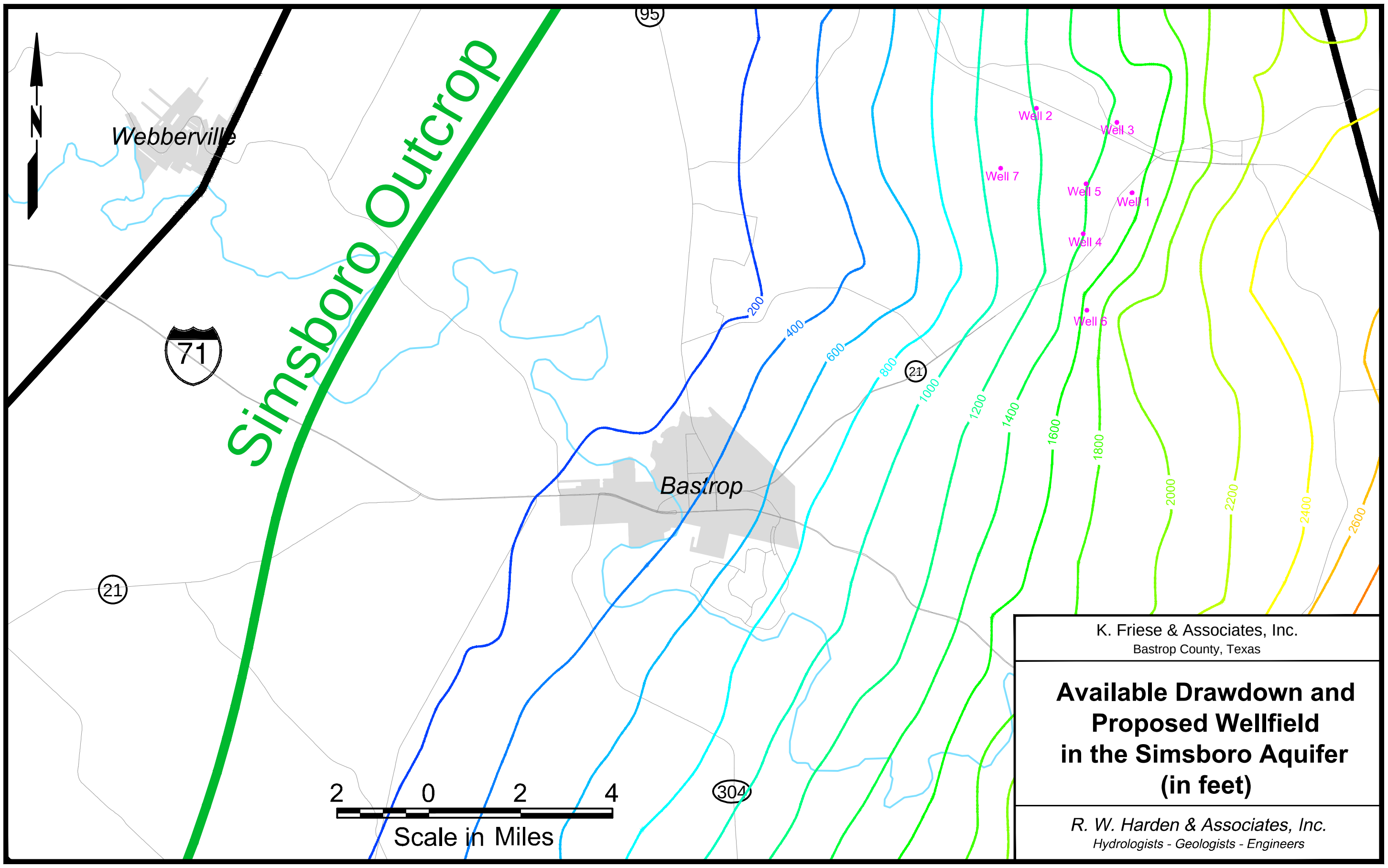
**Simulated Drawdown for Simsboro Aquifer, 2010-2040**

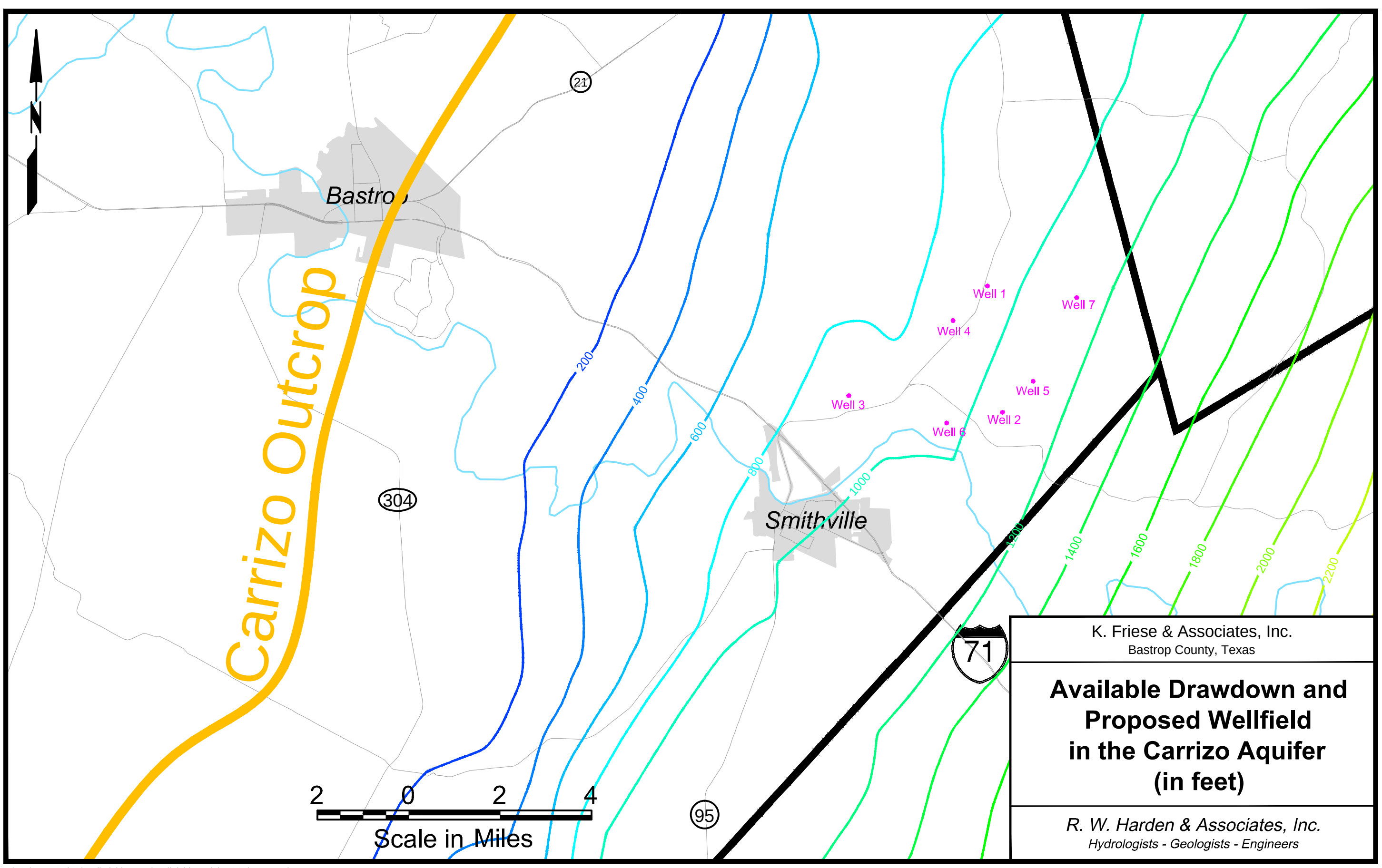
*R. W. Harden & Associates, Inc.*
*Hydrologists - Geologists - Engineers*

D:\598\DataWorkup\Well Field Layout\WellField_Model_GAM.dwg:Sims2040P _Rev2

Apr 12, 2011

Figure 11. Wellfield Layouts and Available Drawdowns



# Appendix F Cost Estimate Assumptions

**Bastrop Regional Water Supply Facilities Planning Study**

| | | |
|---|---|---|
| Initial year of analysis period | 2010 | |
| Ending year of analysis period | 2040 | |
| Study Period | 30 | |
| Loan rate | 6% | |
| Debt Service Period | 30 | years |
| Rate of Return | 4% | |
| Assume value of loan invested over construction duration | 50% | |
| Assume construction duration | 3 | years |
| Assume investment for portion of construction duration | 50% | |
| Engineering News Record Construction Cost Index September 2008 | 8557.00 | |
| Engineering News Record Construction Cost Index December 2010 | 8952.40 | |
| Adjustment Ratio | 1.05 | |
| Engineering | 15 | % |
| Legal Costs | 5 | % |
| Contingency | 30 | % |
| Easement Costs | $ 9,115 | /ac |
| Environmental and Mitigation -Pipelines | $4.95 | /LF |
| Pipeline Easement Width | 40 | ft |
| Third Party Water Rate | $ 3.50 | /1,000 gallons |
| Third Party Water Impact Fee | $ 4,500.00 | /SUE |
| Unit cost of energy | $ 0.06 | / kwh |
| Electrical hookup | $ 142.00 | /hp |
| Pump Efficiency | 85% | |
| Motor Efficiency | 92% | |

**Notes on Unit Costs:**

1 Cost source is the South Central Texas Regional Water Plan (SCTRWPG 2010).
2 The SCTRWPG 2010 presents costs in September 2008 dollars.
3 Costs adjusted to February 2011 dollars using Engineering News Record Construction Cost Index.
4 Third Party water rate provided by the City of Bastrop March 21, 2010.
5 Third Party water impact fee provided by Aqua WSC Tariff Section 2.02.1 Non-Compliant Subdivision 5/8" System Development Fee.

**Water Demand Deficit**

| Projected Average Annual Deficit | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Year*** | ***2010*** | ***2015*** | ***2020*** | ***2025*** | ***2030*** | ***2035*** | ***2040*** |
| Study Area (ac-ft/year) | **2,324** | **1,511** | **-488** | **-2,486** | **-5,307** | **-8,128** | **-10,949** |
| Study Area (1,000 gal/year) | 757,291 | 492,362 | -158,866 | -810,095 | -1,729,265 | -2,648,434 | -3,567,604 |
| Study Area (MGD) | 2.1 | 1.3 | -0.4 | -2.2 | -4.7 | -7.3 | -9.8 |
| Study Area (gpm) | 1,441 | 937 | -302 | -1,541 | -3,290 | -5,039 | -6,788 |
| Study Area (cfs) | 3 | 2 | -1 | -3 | -7 | -11 | -15 |
| Extended Study Area (ac-ft/year) | **1,295** | **-580** | **-3,503** | **-6,426** | **-10,231** | **-14,037** | **-17,843** |
| Extended Study Area (1,000 gal/year) | 421,991 | -189,052 | -1,141,343 | -2,093,634 | -3,333,681 | -4,573,728 | -5,813,775 |
| Extended Study Area (MGD) | 1.2 | -0.5 | -3.1 | -5.7 | -9.1 | -12.5 | -15.9 |

| Projected Maximum Daily Delivery Rate Deficit | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Year*** | ***2010*** | ***2015*** | ***2020*** | ***2025*** | ***2030*** | ***2035*** | ***2040*** |
| Study Area (ac-ft/year) | -152 | -1,979 | -6,472 | -10,964 | -17,305 | -23,645 | -29,986 |
| Study Area (1,000 gal/year) | -49,429 | -644,899 | -2,108,638 | -3,572,377 | -5,638,357 | -7,704,336 | -9,770,316 |
| Study Area (MGD) | **-0.1** | **-1.8** | **-5.8** | **-9.8** | **-15.4** | **-21.1** | **-26.8** |
| Study Area (gpm) | -94 | -1,227 | -4,012 | -6,797 | -10,727 | -14,658 | -18,589 |
| Study Area (cfs) | 0 | -3 | -9 | -15 | -24 | -33 | -41 |
| Extended Study Area (MGD) | **-2.2** | **-6.0** | **-11.8** | **-17.7** | **-25.3** | **-33.0** | **-40.6** |
| Extended Study Area (gpm) | -1,528 | -4,141 | -8,213 | -12,286 | -17,589 | -22,891 | -28,194 |
| Extended Study Area (cfs) | -3 | -9 | -18 | -27 | -39 | -51 | -63 |

# *Appendix A*
# *Cost Estimation Procedures*
# *South Central Texas Region*

The cost estimates of this study are expressed in three major categories: (1) construction costs or capital (structural) costs, (2) other (non-structural) project costs, and (3) annual costs. Construction costs are the direct costs incurred in constructing facilities, such as those for materials, labor, and equipment. "Other" project costs include expenses associated with implementation activities of the project, such as costs for engineering, legal counsel, land acquisition, contingencies, environmental studies and mitigation, and interest during construction. Capital costs and other project costs comprise the total project cost. Operation and maintenance (O&M), energy costs, and debt service payments are examples of annual costs. Major components that may be part of a preliminary cost estimate are listed in Table A-1. Cost estimating procedures used in the technical evaluation of water management strategies for the South Central Texas Region are summarized in the following sections.

***Table A-1.***
***Major Project Cost Categories***

| *Cost Elements* | |
|---|---|
| *Capital Costs (Structural Costs)* | *Other Project Costs (Non-Structural Costs)* |
| 1. Pump Stations<br>2. Pipelines<br>3. Water Treatment Plants<br>4. Water Storage Tanks<br>5. Off-Channel Reservoirs<br>6. Well Fields<br>a. Public<br>b. Irrigation<br>c. ASR Wells<br>7. Dams and Reservoirs<br>8. Relocations<br>9. Water Distribution System Improvements<br>10. Other Items | 1. Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)<br>2. Land and Easements<br>3. Environmental - Studies and Mitigation<br>4. Interest During Construction<br><br>***Annual Project Costs***<br>1. Debt Service<br>2. Operation and Maintenance (excluding pumping energy)<br>3. Pumping Energy Costs<br>4. Purchase Water Cost (if applicable) |

## *A.1 Capital Costs*

Capital costs for elements of a water management strategy are determined from reliable cost information. Cost tables are a useful method for estimating the construction costs for a project element quickly and efficiently. Cost tables have been created for planning cost estimates and are presented and discussed throughout this section. The cost tables report all-inclusive costs to construct. For example, the pump station cost table values include the building, pumps, control equipment, all other materials, labor, and installation costs.

The costs for a project element are typically computed by applying a unit cost from the cost tables to a specific unit quantity. Estimates are reported to the nearest thousand dollars. If previous cost estimates are used, a ratio of the Engineering News Record's Construction Cost Index (ENR CCI)[1] values is applied to update the cost to September 2008. For example, based on an average of the monthly index value September 2008 the representative index value would be 8557. The ENR CCI values are based on construction costs, including labor and materials, averaged over 20 cities. The index measures how much it would cost to purchase a hypothetical package of goods and services compared to what it was in a base year. The index values are reported monthly from 1977 to present. Average annual index values are reported from 1908 to 1976.

Capital cost data and cost estimating procedures are presented and discussed for pumping stations, pipeline, water treatment plants, storage tanks, off-channel reservoirs, well fields, dams and reservoirs, relocations, water distribution system improvements, and settling basins.

### *A.1.1 Pumping Stations*

Intake and transmission pump station construction costs vary according to the discharge and pumping head requirement, and structural requirements for housing the equipment and providing proper flow conditions at the pump suction intake. The cost tables provided herein are based on the station size (in horsepower) necessary to deliver the peak flow rate. Pump station costs are listed in millions of dollars in Table A-2 for a range of horsepower requirements. The costs include those for pumps, housing, motors, electric control, site work, and all materials needed. The costs in Table A-2 were estimated using generalized cost data related to station horsepower from actual construction costs of equipment installed. The cost for an intake

[1] ENR: Engineering News Record, http://www.enr.com/.

***Table A-2.***
***Pumping Station Construction Costs* (Without Intake Structures)***

| *Pump Station (HP)* | *Pump Station Cost ($-millions)* | *Pump Station (HP)* | *Pump Station Cost ($-millions)* |
|---|---|---|---|
| < 300 | 2.07 | 6,000 | 11.29 |
| 300 | 2.07 | 7,000 | 12.27 |
| 400 | 2.62 | 8,000 | 13.19 |
| 1,000 | 4.29 | 9,000 | 14.05 |
| 2,000 | 6.24 | 10,000 | 14.87 |
| 3,000 | 7.76 | 15,000 | 18.51 |
| 4,000 | 9.07 | 20,000 | 21.63 |
| 5,000 | 10.23 | > 20,000 | See Note |

*Values are current as of September 2008.
**NOTE: Pump Stations larger than 20,000 HP necessitate an individual cost estimate.**

structure is included when pumping from a raw water source, such as a river or reservoir. Based on costs of actual projects, the intake structure cost is estimated as 50 percent of the intake pump station cost. The cost of bringing power to each pump station is estimated as $135/HP, with a minimum cost of $50,000. Power connection costs are calculated for each pump station and for well pumps. Costs for pump stations located at water treatment plants are included in the capital cost table for water treatment plants (Table A-5).

### *A.1.2 Pipelines*

Pipeline construction costs are influenced by pipe materials, bedding requirements, geologic conditions, urbanization, terrain, and special crossings. For technical evaluation of water management strategies, pipeline costs are obtained from Table A-3, which shows unit costs based on the pipe diameters from 12-inches to 120-inches, soil type, and level of urban development. In the case of a high-pressure pipeline (>150 psi), the unit cost is increased by 13 percent for the length of pipe designated as high-pressure class pipe. The unit costs listed in Table A-3 represent the installed cost of the pipeline and appurtenances, such as markers, valves, thrust restraint systems, corrosion monitoring and control equipment, air and vacuum valves, blow-off valves, erosion control, revegetation of right-of-way, fencing, and gates.

**Table A-3.**
**Pipeline Unit Construction Cost within Various Soil Environments***

| Pipe Diameter (inches) | Soil | | Combination Rock and Soil | | Rock | |
|---|---|---|---|---|---|---|
| | Rural ($/ ft) | Urban ($/ ft) | Rural ($/ ft) | Urban ($/ ft) | Rural ($/ ft) | Urban ($/ ft) |
| 12 | 51 | 80 | 62 | 96 | 75 | 113 |
| 14 | 57 | 91 | 71 | 109 | 86 | 127 |
| 16 | 64 | 102 | 80 | 123 | 94 | 140 |
| 18 | 72 | 112 | 89 | 134 | 105 | 153 |
| 20 | 82 | 119 | 94 | 144 | 112 | 166 |
| 24 | 110 | 135 | 105 | 162 | 136 | 202 |
| 27 | 132 | 155 | 119 | 184 | 163 | 240 |
| 30 | 155 | 173 | 134 | 203 | 190 | 281 |
| 33 | 179 | 201 | 155 | 239 | 222 | 331 |
| 36 | 204 | 228 | 178 | 273 | 248 | 372 |
| 42 | 256 | 291 | 224 | 348 | 315 | 468 |
| 48 | 312 | 361 | 277 | 433 | 370 | 554 |
| 54 | 371 | 441 | 336 | 525 | 435 | 654 |
| 60 | 434 | 521 | 399 | 620 | 500 | 749 |
| 64 | 478 | 578 | 443 | 688 | 545 | 815 |
| 66 | 501 | 609 | 469 | 728 | 570 | 852 |
| 72 | 571 | 700 | 538 | 835 | 645 | 970 |
| 78 | 645 | 799 | 605 | 954 | 740 | 1,107 |
| 84 | 723 | 905 | 697 | 1,079 | 837 | 1,251 |
| 90 | 804 | 1,023 | 787 | 1,219 | 946 | 1,415 |
| 96 | 888 | 1,148 | 885 | 1,370 | 1,063 | 1,566 |
| 102 | 977 | 1,275 | 981 | 1,520 | 1,175 | 1,763 |
| 108 | 1,068 | 1,409 | 1,085 | 1,680 | 1,302 | 1,952 |
| 114 | 1,164 | 1,549 | 1,190 | 1,849 | 1,430 | 2,144 |
| 120 | 1,263 | 1,698 | 1,307 | 2,024 | 1,568 | 2,349 |
| 132 | 1,600 | 2,144 | 1,648 | 2,560 | 1,984 | 2,960 |
| 144 | 1,900 | 2,546 | 1,957 | 3,040 | 2,356 | 3,515 |

* * Values as of September 2008.
**NOTE: Add 13 percent to unit price for length of pipe with pressure class > 150 psi.**

Additional costs are included for pipeline installation when crossing roads, streams, or rivers. Some form of trenchless technology will likely be used to install the pipeline when obstructions (e.g., larger streams, major roads, railways, rivers, and structures) are encountered. The two trenchless technologies included herein are: (1) pipe jacking utilizing boring and/or tunnel techniques to excavate the soil, and (2) horizontal directional drilling. Table A-4 shows costs that are used to estimate pipeline borings and tunneling.

***Table A-4.***
***Crossing Costs with Boring or Tunneling Construction****

| *Pipe Diameter (inches)* | *Tunneling Cost ($/inch diameter/ft)* |
|---|---|
| ≤48 | 23 |
| 54 | 22 |
| 60 | 21 |
| 66 | 20 |
| 72 | 19 |
| 78 | 18 |
| ≥84 | 17 |

* Values current as of September 2008.

### *A.1.3 Water Treatment Plants*

Water treatment plant construction costs shown in Table A-5 are based on plant capacity for seven different types or levels of treatment. It is not the intent of these cost estimating procedures to establish an exact treatment process, but rather to estimate the cost of a general process appropriate for bringing the source water quality to the required standard of the receiving system (i.e., potable water distribution system, a stream in an aquifer recharge zone, or an aquifer injection well). Table A-6 gives a description of the processes involved in each treatment level. The costs in Table A-5 include costs for all processes required, site work, buildings, storage tanks, sludge handling and disposal, clearwell, pumps, and equipment. The costs assume pumping through the plant as follows: Levels 2 through 6 treatment plants include raw water pumping into the plant for a total pumping head of 100 feet, and finished water pumping for 300 feet of total head. Levels 0 and 1 treatments include only finished water pumping at 300 feet of head.

**Table A-5.**
**Water Treatment Plant Construction Costs***

| Capacity (MGD) | Level 0 Capital Cost ($) | Level 1 Capital Cost ($) | Level 2 Capital Cost ($) | Level 3 Capital Cost ($) | Level 4 Capital Cost ($) | Level 5 Capital Cost ($) | Level 6 Capital Cost ($) |
|---|---|---|---|---|---|---|---|
| 1 | 61,901 | 806,582 | 4,086,505 | 5,064,198 | 8,630,163 | 3,028,033 | 4,796,619 |
| 10 | 186,773 | 3,356,695 | 10,986,401 | 19,659,747 | 33,563,470 | 16,011,061 | 24,907,583 |
| 50 | 550,941 | 9,748,927 | 27,768,136 | 66,497,646 | 103,889,408 | 59,046,648 | 91,510,915 |
| 75 | 737,715 | 14,065,482 | 35,760,670 | 95,408,275 | 143,846,718 | 84,637,548 | 133,447,835 |
| 100 | 909,884 | 17,232,725 | 42,472,587 | 115,648,118 | 191,795,088 | 111,461,099 | 173,040,039 |
| 150 | 1,226,889 | 26,371,758 | 54,939,241 | 173,469,377 | 287,691,962 | 163,420,005 | 251,782,301 |
| 200 | 1,519,242 | 30,367,288 | 61,333,081 | 213,945,378 | 383,590,175 | 214,695,594 | 329,224,921 |

* Values current as of September 2008.

### A.1.4 Storage Tanks

Ground storage tanks may be used for stand-alone storage, as part of a distribution system, or as part of a pumping station. The construction costs for storage tanks are listed in Table A-7 as cost per million gallons of capacity. A storage tank should be included at each transmission pump station along a pipeline. It is assumed that storage tanks at these stations will provide storage for 5 percent of the daily flow.

### A.1.5 Off-Channel Reservoirs

An off-channel reservoir is a reservoir located away from a main river channel that receives little or no natural inflow. Off-channel reservoirs are built by placing a dam across a minor tributary or by constructing a ring dike that has no associated tributary. The capacity of these reservoirs is typically used for storing water that is pumped from another location, such as a nearby river. Because natural inflow is an insignificant factor, spillway requirements are minimal. The values in Table A-8 are used for a construction cost estimate for an off-channel reservoir. In this regional water plan, the cost of ring dikes is used for all off-channel reservoirs.

## Table A-6.
## Water Treatment Level Descriptions

| | |
|---|---|
| **Level 0:** | Disinfection Only - This treatment process will be used for groundwater with no contaminants that exceed the regulatory limits. Assumes groundwater does not require treatment for taste and odor reduction and groundwater is stable and requires no treatment for corrosion stabilization. With this treatment, the groundwater is suitable for public water system distribution, aquifer injection, or delivery to the recharge zone. |
| **Level 1:** | Groundwater Treatment - This treatment process will be used for groundwater to lower the iron and manganese content and to disinfect. The process includes application of an oxidant and addition of phosphate to sequester iron and manganese. Chlorine disinfection is the final treatment. With this treatment, the groundwater is suitable for public water system distribution, aquifer injection, or delivery to the recharge zone. |
| **Level 2:** | Direct Filtration Treatment - This treatment process will be used for treating groundwater from sources where iron, manganese, or other constituent concentrations exceed the regulatory limit and require filtration for solids removal. Assumes turbidity and taste and odor levels are low. In the direct filtration process, low doses of coagulant and polymer are used and settling basins are not required as all suspended solids are removed by filters. The process includes alum and polymer addition, rapid mix, flocculation, filtration, and disinfection. Water treatment with this process is suitable for aquifer injection or for delivery to the recharge zone. |
| **Level 3:** | Surface Water Treatment - This treatment process will be used for treating all surface water sources to be delivered to a potable water distribution system. The process includes coagulant and polymer addition, rapid mix, flocculation, settling, filtration, and disinfection with chlorine. This treatment process also applies for difficult to treat groundwater containing high concentrations of iron (greater than 3 mg/l) and manganese requiring settling before filtration. |
| **Level 4:** | Reclaimed Water Treatment - This process will be used for treatment where wastewater effluent is to be reclaimed and delivered to a supply system or injected to an aquifer. The concept includes increased treatment of wastewater effluent by phosphorous removal, storage in a reservoir, blending with surface runoff from the reservoir catchment, followed by conventional water treatment. Phosphorous will be removed from the effluent by lime softening including lime feed, rapid mix, flocculation, settling, recarbonation, and filtration. The final treatment assumes ozonation, activated carbon, addition of coagulant and polymer, rapid mix, flocculation, sedimentation, second application of ozone, filtration and disinfection with chlorine. This treatment results in water than can be delivered to a public water system for distribution or injection to the aquifer. |
| **Level 5:** | Brackish Groundwater Desalination - Note: This treatment cost does not include pretreatment for solids removal prior to RO membranes. For desalination of a surface water or groundwater containing high solids concentrations, additional solids removal treatment should be included in addition to desalination. (Example: add level 3 treatment costs for a turbid surface water source). This treatment process will be used for treatment of groundwater with total dissolved solids (TDS) exceeding the regulatory limit of 1,000 mg/l. Costs are based on reverse osmosis (RO) membrane desalination of a groundwater with 3,000 mg/l of TDS to lower the treated water TDS below the regulatory limit. The desalination concept includes minimal pretreatment (cartridge filtration, antiscalent addition, acid addition), reverse osmosis membrane system, and disinfection with chlorine. Costs assume desalination concentrate will be discharged to surface water adjacent to treatment plant. With this treatment, the groundwater is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone. |
| **Level 6:** | Seawater Desalination - Note: This treatment cost does not include pretreatment for solids removal prior to RO membranes. For desalination of a surface water or groundwater containing high solids concentrations, additional solids removal treatment should be included in addition to desalination. (Example - For desalination of seawater with an intake located on the coast drawing turbid water, cost estimate should include Level 3 treatment plus Level 6). This treatment process will be used for treatment of seawater with total dissolved solids (TDS) exceeding the regulatory limit of 1,000 mg/l. Costs are based on reverse osmosis (RO) membrane desalination of a water with 32,000 mg/l of TDS to lower the treated water TDS below the regulatory limit. The desalination concept includes minimal pretreatment (cartridge filtration, antiscalent addition, acid addition), reverse osmosis membrane system, and disinfection with chlorine. Costs assume desalination concentrate will be discharged to surface water adjacent to treatment plant. With this treatment, the ground water is suitable for public water system distribution, aquifer injection, and delivery to the recharge zone. |

**Table A-7.**
**Ground Storage Tank Construction Costs***

| Tank Volume (MG) | Cost ($) |
|---|---|
| 0.01 | 22,777 |
| 0.05 | 79,050 |
| 0.10 | 133,984 |
| 0.50 | 455,545 |
| 1.00 | 777,106 |
| 2.00 | 1,313,041 |
| 4.00 | 2,277,724 |
| 6.00 | 3,081,627 |
| 7.50 | 3,617,562 |
| 9.00 | 4,153,497 |

* Values current as of September 2008.

**Table A-8.**
**Off Channel Storage Construction Costs***

| Storage Volume (ac-ft) | Off-Channel Reservoir – Ring Dike (Flat) Capital Cost ($) | Off-Channel Reservoir – Rolling Capital Cost ($) | Off-Channel Reservoir – Canyons Capital Cost ($) |
|---|---|---|---|
| 500 | $3,870,784 | $5,416,950 | $5,416,950 |
| 1,000 | $5,419,365 | $7,605,944 | $7,605,944 |
| 2,500 | $8,491,988 | $11,949,244 | $11,949,244 |
| 4,000 | $10,706,620 | $15,079,732 | $15,274,239 |
| 5,000 | $11,954,776 | $16,844,061 | $17,417,971 |
| 10,000 | $16,851,907 | $23,766,391 | $25,188,984 |
| 12,500 | $18,825,419 | $26,556,045 | $28,270,633 |
| 15,000 | $20,609,611 | $29,078,085 | $31,218,277 |
| 17,500 | $22,250,345 | $31,397,341 | $34,031,918 |
| 19,000 | $23,178,787 | $32,709,738 | $35,907,752 |
| 20,000 | $23,777,503 | $33,556,052 | $36,845,559 |
| 22,000 | $24,931,611 | $35,187,440 | $38,855,397 |
| 25,000 | $26,568,473 | $37,501,221 | $41,535,034 |

* Values current as of September 2008.

### A.1.6 Well Fields

The construction costs for public water supply wells are summarized in Table A-9. The costs include well completion, pumps, and other necessary facilities, such as access roads, fencing, and site improvements. The costs for irrigation wells are estimated to be 55 percent of public water supply well costs. Aquifer storage and recovery (ASR) well costs are estimated using the values represented in Table A-10.

**Table A-9.**
**Public and Irrigation Well Construction Costs**

**Table A-9(a): Public Supply Well Construction Costs***

| Well Depth (ft) | Well Capacity (gpm) | | | | | |
|---|---|---|---|---|---|---|
| | 100 | 175 | 350 | 700 | 1000 | 1800 |
| 150 | $111,207 | $168,820 | $288,065 | $325,581 | $405,971 | $593,548 |
| 300 | $150,062 | $214,374 | $342,998 | $392,572 | $485,021 | $687,337 |
| 500 | $194,276 | $267,968 | $407,311 | $468,943 | $577,470 | $799,883 |
| 700 | $234,472 | $316,202 | $464,924 | $538,615 | $660,540 | $899,031 |
| 1000 | $308,163 | $404,631 | $572,111 | $665,899 | $814,621 | $1,083,929 |
| 1500 | $431,428 | $553,353 | $748,969 | $878,934 | $1,069,190 | $1,389,412 |
| 2000 | $554,693 | $700,735 | $925,828 | $1,091,968 | $1,325,099 | $1,696,235 |

* Values current as of September 2008.

**Table A-9(b): Irrigation Well Construction Costs***

| Well Depth (ft) | Well Capacity (gpm) | | | | | |
|---|---|---|---|---|---|---|
| | 100 | 175 | 350 | 700 | 1000 | 1800 |
| 150 | $61,633 | $95,128 | $162,120 | $186,237 | $235,811 | $340,319 |
| 300 | $81,730 | $121,925 | $198,296 | $234,472 | $297,444 | $415,350 |
| 500 | $101,828 | $152,741 | $237,151 | $286,725 | $364,436 | $502,439 |
| 700 | $117,906 | $175,519 | $270,647 | $330,940 | $423,389 | $577,470 |
| 1000 | $154,081 | $226,433 | $340,319 | $422,049 | $539,955 | $724,852 |
| 1500 | $215,714 | $313,522 | $455,545 | $573,451 | $732,891 | $968,703 |
| 2000 | $276,007 | $397,932 | $570,771 | $723,512 | $927,168 | $1,213,893 |

* Values current as of September 2008.

**Table A-10.**
**ASR Well Construction Costs***

| Well Depth (ft) | Well Capacity (gpm) | | | | | |
|---|---|---|---|---|---|---|
| | 100 | 175 | 350 | 700 | 1000 | 1800 |
| 150 | $123,265 | $190,257 | $330,940 | $373,815 | $466,264 | $687,337 |
| 300 | $162,120 | $235,811 | $385,873 | $440,807 | $545,314 | $782,465 |
| 500 | $206,335 | $290,745 | $450,185 | $517,177 | $639,103 | $893,672 |
| 700 | $247,870 | $338,979 | $509,138 | $586,849 | $720,833 | $994,160 |
| 1000 | $320,221 | $427,408 | $614,986 | $714,133 | $874,914 | $1,177,717 |
| 1500 | $444,826 | $574,790 | $791,844 | $927,168 | $1,129,483 | $1,483,200 |
| 2000 | $566,751 | $722,173 | $968,703 | $1,140,202 | $1,385,392 | $1,790,023 |

* Values current as of September 2008.

### *A.1.7 Dams and Reservoirs*

Construction costs for dams and reservoirs are handled individually. Since each reservoir site is unique, costs are based on the specific project requirements. Items included in the estimate consist of the capital (structural) and "other" (non-structural) costs listed in Table A-1. Previous cost estimates are updated to September 2008 prices, using the ENR CCI.

### *A.1.8 Relocations*

Large-scale projects, such as reservoirs, may require the use of lands that contain existing improvements or facilities such as utilities, roads, homes, businesses, and cemeteries. The cost estimating procedures account for either the cost of relocation or outright purchase of these types of improvements and facilities. Because the type of improvements and facilities needing relocation vary significantly from project to project, estimating the costs for relocation items is addressed on an individual project basis.

### *A.1.9 Water Distribution System Improvements*

Introducing treated water to a city or other entity may require improvements to the entity's water distribution system, which is comprised of piping, valves, storage tanks, pump stations, and other equipment used to distribute water throughout the entity's service area.

Cost estimate guidelines were developed specifically for distribution system improvements for the City of San Antonio during the Trans-Texas Water Program, which was completed in 1996. These costs were obtained from a 1991 Black and Veatch report to the San

Antonio City Water Board entitled *"Report on Master Plan for Water Works Improvements"* and include estimated costs for improvements to San Antonio's distribution system to convey treated water from the proposed Applewhite project. For strategies producing up to 50-MGD the annual costs were estimated at $1,327,000 per MGD of capacity (September 2008). Above 50-MGD capacity, the unit cost is estimated at $819,915 per MGD (September 2008).

#### *A.1.10 Stilling Basins*

If a water management strategy involves discharging into a water body or perhaps into a recharge structure, it may require a stilling basin. Stilling basin costs, when applicable, were estimated as $3,025 per cfs discharge.

## *A.2 Other Project Costs*

As previously mentioned, "other" (non-structural) project costs are costs incurred in order to implement a project. These include costs for engineering, legal counsel, financing, contingencies, land, easements, surveying and legal fees for land acquisition, environmental and archaeology studies, permitting, mitigation, and interest during construction. These costs are added to the capital costs to obtain the total project cost. The major components of these costs are described below.

### *A.2.1 Engineering, Legal, Financing, and Contingencies*

A percentage applied to the capital costs is used to calculate a combined cost that includes engineering, financial, legal services, and contingencies. The contingency allowance accounts for unforeseen costs and for variances in design elements. In accordance with TWDB guidelines, the percentages used are 30 percent of the total construction costs for pipelines and 35 percent for all other facilities.

### *A.2.2 Land Acquisition*

Land-related costs for a project can typically be divided into two categories: (1) land purchase costs and (2) easement costs. Land areas acquired for various facility types are considered based upon previous project experience. Two types of easements are usually acquired for pipeline construction – temporary and permanent. Permanent easements are those in which the pipeline will reside once constructed. These permanent easements provide access for maintenance and protection from other parallel underground utilities. Temporary easements provide extra working space during construction for equipment movement, material storage, and related construction activities. Pipeline easement costs are estimated using a value of $8,712 per acre ($0.20 per sq-ft), based in large part on recent experience with the Mary Rhodes Pipeline extending from Lake Texana to Corpus Christi. The pipeline area considered in the acquisition cost includes a permanent easement width of 30 to 40 feet, depending upon the pipe size. This value includes costs for the temporary easement.

Land costs vary significantly with location and economic factors. Land costs in Texas are estimated using *"Rural Land Values in the Southwest"*, by Charles E. Gilliland, published biannually by the Real Estate Center at Texas A&M University, College Station, Texas. Other sources of land values, such as county appraisal district records, are also utilized. The land acquisition area estimated for reservoirs includes the acreage inundated by the 100-year or standard project flood.

### A.2.3 Surveying and Legal Fees

Ten percent (10 percent) is added to the total land and easement costs to account for surveying and legal fees associated with land acquisition, except for reservoirs and large well fields. The surveying cost for reservoirs is estimated at $50 per acre of inundation.

### A.2.4 Environmental and Archaeology Studies, Permitting, and Mitigation

Costs for environmental studies, permitting, and mitigation, as well as archaeological recovery are project-dependent and are estimated on an individual basis using information available and the judgment of qualified professionals. In the case of reservoir strategies, environmental studies and mitigation costs were generally based on 100 percent of the land value for the acreage purchased. The environmental studies and mitigation costs for pipelines were estimated at $25,000 per mile of pipeline.

### A.2.5 Interest During Construction

Interest during construction (IDC) is calculated as the cost of interest on the borrowed amount less the return on the proportion of borrowed money invested during construction. In accordance with TWDB guidelines, IDC is calculated as the total of interest accrued at the end of the construction period using a 6 percent annual interest rate on total borrowed funds, less a 4 percent rate of return on investment of unspent funds.

## A.3 Annual Costs

Annual costs are those that the project owner can expect to incur if the project is implemented. These costs include repayment of borrowed funds (debt service), operation and maintenance costs of the project facilities, pumping power costs, and water purchase costs, when applicable.

### A.3.1 Debt Service

Debt service is the estimated annual payment that can be expected for repayment of borrowed funds based on the total project cost (present worth), an assumed finance rate, and the finance period in years. As specified in TWDB Exhibit B, Section 1.71, debt service for all projects was calculated assuming an annual interest rate of 6 percent and a repayment period of 40 years for reservoir projects and 30 years for all other projects. The debt service factor of 0.06646 or 0.07265 for 40- or 30-year repayment periods is applied, respectively, to the total estimated project costs.

### A.3.2 Operation and Maintenance

Operation and maintenance (O&M) costs for dams, pump stations, pipelines, and well fields (excluding pumping power costs) include labor and materials required to operate the facilities and provide for regular repair and/or replacement of equipment. In accordance with TWDB guidelines, O&M costs are calculated at 1 percent of the total estimated construction costs for pipelines, distribution, facilities, tanks and wells, at 1.5 percent of the total estimated construction costs for dams and reservoirs, and at 2.5 percent for intake and pump stations.

Water treatment plant O&M is estimated using Table A-11. The O&M costs listed in Table A-11 include labor, materials, replacement of equipment, process energy, building energy, chemicals, and pumping energy.

***Table A-11.***
***Operation and Maintenance Costs for Water Treatment Plants****

| *Capacity (MGD)* | *Level 0 O&M Cost ($)* | *Level 1 O&M Cost ($)* | *Level 2 O&M Cost ($)* | *Level 3 O&M Cost ($)* | *Level 4 O&M Cost ($)* | *Level 5 O&M Cost ($)* | *Level 6 O&M Cost ($)* |
|---|---|---|---|---|---|---|---|
| 1 | 28,137 | 160,513 | 287,663 | 396,016 | 559,382 | 340,319 | 797,203 |
| 10 | 83,472 | 894,878 | 1,198,351 | 1,547,218 | 4,156,043 | 2,639,480 | 6,993,953 |
| 50 | 313,522 | 3,356,695 | 5,114,428 | 6,328,737 | 18,380,564 | 12,339,905 | 33,804,105 |
| 75 | 453,401 | 5,114,428 | 7,671,643 | 9,846,159 | 28,769,933 | 18,328,980 | 50,418,093 |
| 100 | 591,806 | 6,312,779 | 9,748,927 | 12,306,115 | 38,358,482 | 24,412,784 | 66,485,310 |
| 150 | 865,267 | 10,228,857 | 14,384,900 | 17,580,627 | 57,538,392 | 36,324,401 | 97,825,323 |
| 200 | 1,136,048 | 11,986,724 | 19,179,911 | 22,854,992 | 76,718,303 | 48,169,023 | 128,937,554 |

* Values current as of September 2008..

### *A.3.3 Pumping Energy Costs*

In accordance with TWDB guidelines, power costs are calculated on an annual basis using the appropriate calculated power load and a power rate of $0.06 per kWh. The amount of energy consumed is based on the pumping horsepower required.

### *A.3.4 Purchase of Water*

The purchase cost, if applicable, is included if the water management strategy involves purchase of raw or treated water from an entity or a landowner. This cost varies by source.

## *A.4 Cost Estimate Presentation*

For each individual water management strategy total capital costs, total project costs, and total annual costs are presented. The level of detail is dependent on the characteristics of the water management strategy. Additionally, a summary is calculated, showing the cost per unit of water provided by the management strategy, reported as costs per acft and cost per 1,000 gallons of water developed. The individual management strategy cost tables specify the point within the region at which the cost applies (e.g., raw water at the lake, treated water at the municipal and industrial demand center, or elsewhere as appropriate).

# Appendix G Detailed Cost Estimates

**Water Supply Option: Surface Water**

Description:

Single Phase Implementation for purpose of meeting Study Area 2040 peak day demand.

Diversion, water treatment plant and connection to existing system at the Bob Bryant Park.

## Capital Costs

### Transmission Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Intake | 1 | LS | $ | 1,140,366 | /EA | $ | 1,140,000 |
| Raw Surface Water Pipeline | 2,240 | LF | $ | 236 | $/LF | | 528,000 |
| Raw Water Pump Station to Water Treatment Plant | | | | | | | |
| Pump Station | 320 | hp | $ | 2,280,733 | /EA | $ | 2,281,000 |
| Electrical Hookup | 320 | hp | $ | 142 | /hp | $ | 50,000 |
| Water Storage Tank | 2.68 | MG | $ | 1,716,862 | /EA | $ | 1,717,000 |
| Total Transmission Facilities | | | | | | $ | 5,716,000 |

### Water Treatment Plant

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Treatment Plant | 26.8 | MGD | $ | 41,149,094 | /EA | $ | 41,149,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 41,149,000 |

### Treated Pipeline Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | 36 | in | - | | - | | - |
| Length of RURAL pipe | - | feet | $ | 186 | $/LF | | - |
| Length of Urban pipe | 6,670 | feet | $ | 286 | $/LF | $ | 1,905,000 |
| Length of Tunneling | - | feet | $ | 24 | $/inch diameter/ft | $ | - |
| Total Pipeline Facilities | | | | | | $ | 1,905,000 |

### System Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Pump Station | 200 | hp | $ | 2,165,650 | /EA | $ | 2,166,000 |
| Electrical Hookup | 200 | hp | $ | 142 | /hp | $ | 50,000 |
| Total System Facilities | | | | | | $ | 2,216,000 |

| | | |
|---|---|---|
| **Total Capital** | **$** | **50,986,000** |

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | 15 | % | $ | 50,986,000 | | $ | 7,648,000 |
| Legal Costs | 5 | % | $ | 50,986,000 | | $ | 2,549,000 |
| Contingency | 30 | % | $ | 50,986,000 | | $ | 15,296,000 |
| Total Engineering Costs | | | | | | $ | 25,493,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Raw Water Pipeline | 2 | ac | $ | 9,115 | $/ac | $ | 19,000 |
| Land Cost - Intake | 10 | ac | $ | 9,115 | $/ac | $ | 91,000 |
| Land Cost - Treatment Plant | 40 | ac | $ | 9,115 | $/ac | $ | 365,000 |
| Easement Acquisition Cost - Treated Water Pipeline | 6 | ac | $ | 9,115 | $/ac | $ | 56,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 531,000 | | $ | 53,100 |
| Total Land and Easement Costs | | | | | | $ | 584,100 |

### Environmental Studies and Mitigation

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Rights Permitting | 1 | LS | $ | 500,000 | /EA | $ | 500,000 |
| 404 Permitting - Engineering | 1 | LS | $ | 50,000 | /EA | $ | 50,000 |
| Environmental and Mitigation - Pipelines | 8,910 | LF | | $4.95 | $/LF | $ | 44,000 |
| Total Environmental Costs | | | | | | $ | 594,000 |

### Interest During Construction

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 50,986,000 | $ | 9,059,000 |
| Return on Investment | 1.5 | YR | 25,493,000 | $ | (1,020,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ | 8,039,000 |

| | | |
|---|---|---|
| **Total Other Project Costs** | **$** | **34,710,100** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 85,696,100 | | $ | 6,226,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 4,150,000 | | $ | 42,000 |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ | 5,587,000 | | $ | 140,000 |
| Operation and Maintenance - Treatment Facilities | 26.8 | MGD | $ | 3,719,746 | /EA | $ | 3,720,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 781,354 | kWh | $ | 0.06 | /kWh | $ | 47,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 284,129 | kWh | $ | 0.06 | /kWh | $ | 17,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 10,949 | ac-ft | $ | 84 | ac-ft | $ | 917,000 |
| (Average of the Production and Reservation rates for a phased 2015, 2025, 2035 purchase) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **11,109,000** |

**Project Unit Cost**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Project Yield to the City | 3,567,604 | 1,000 gal | $ | 3.11 | $/1,000 gal | $ | 11,109,000 |
| Project Yield to the City | 10,949 | ac-ft/year | $ | 1,015 | $/ac-ft | $ | 11,109,000 |

**Water Supply Option: Groundwater**

Description:

Single Phase Implementation for purpose of meeting Study Area 2040 peak day demand.

Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.

**Capital Costs**

**Pipeline Facilities**

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | | 36 | in | | - | - | - |
| Length of RURAL pipe | | 46,625 | feet | $ | 186 | /LF | $ 8,683,000 |
| Length of Urban pipe | | 9,240 | feet | $ | 286 | /LF | $ 2,639,000 |
| Length of Tunneling | | 400 | feet | $ | 24 | /inch diameter/ft | $ 347,000 |
| Total Pipeline Facilities | | | | | | | $ 11,669,000 |

**Well Facilities**

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Well 1 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 2 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 3 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 4 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 5 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 6 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 7 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Electrical Hookup | | 4,375 | hp | $ | 142 | /hp | $ 621,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | 52,500 | feet | $ | 79 | /LF | $ 4,147,000 |
| Treatment Facilities | | 7 | well | $ | 1,704,028 | /EA | $ 11,928,000 |
| Total Well Facilities | | | | | | | $ 29,709,000 |

**System Facilities**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Water Storage Tank | 2.68 | MG | $ | 1,716,862 | /EA | $ 1,717,000 |
| Pump Station | 1,000 | hp | $ | 4,488,231 | /EA | $ 4,488,000 |
| Electrical Hookup | 1,000 | hp | $ | 142 | /hp | $ 142,000 |
| Total System Facilities | | | | | | $ 6,347,000 |

| | |
|---|---|
| **Total Capital** | **$ 47,725,000** |

**Other Project Costs**

**Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)**

| | | Quantity | Unit | | Unit Cost | Total Cost |
|---|---|---|---|---|---|---|
| Engineering | | 15 | % | $ | 47,725,000 | $ 7,159,000 |
| Legal Costs | | 5 | % | $ | 47,725,000 | $ 2,386,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ | 21,000 | $ 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ | 28,000 | $ 28,000 |
| Contingency | | 30 | % | $ | 47,725,000 | $ 14,318,000 |
| Total Engineering Costs | | | | | | $ 23,912,000 |

**Land and Easements**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 100 | ac | $ | 9,115 | /ac | $ 907,000 |
| Land Acquisition Cost - Well Field | 40 | ac | $ | 9,115 | /ac | $ 365,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ | 1,272,000 | | $ 127,200 |
| Total Land and Easement Costs | | | | | | $ 1,399,200 |

**Environmental Studies and Mitigation**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 108,765 | LF | $ | 4.95 | /LF | $ 539,000 |
| Total Environmental Costs | | | | | | $ 539,000 |

**Interest During Construction**

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 47,725,000 | $ 8,480,000 |
| Return on Investment | 1.5 | YR | 23,862,500 | $ (955,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ 7,525,000 |

| | |
|---|---|
| **Total Other Project Costs** | **$ 33,375,200** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ 81,100,200 | | $ 5,892,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ 43,237,000 | | $ 432,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ 4,488,000 | | $ 112,000 |
| Operation and Maintenance - Treatment Facilities | 7 | well | $ 293,565 | /EA | $ 2,055,000 |
| Pumping Energy Costs - Well 1 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 2 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 3 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 4 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 5 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 6 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 7 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Field to System | 497,225 | kWh | $ 0.06 | /kWh | $ 30,000 |
| Water Production Costs (LPGCD 2007-09-01 resolution) | 3,567,604 | 1,000 gal | $ 0.05 | /1,000 gal | $ 165,000 |
| (Average of the Production and Reservation permit fees for the phased 2015, 2025, 2035 usage) | | | | | |
| **Total Annual Costs** | | | | | **$ 9,365,000** |

**Project Unit Cost**

| | | | | | |
|---|---|---|---|---|---|
| Project Yield to the City | 3,567,604 | 1,000 gal | $ 2.63 | /1,000 gal | $ 9,365,000 |
| Project Yield to the City | 10,949 | ac-ft/year | $ 855 | /ac-ft | $ 9,365,000 |

**Water Supply Option: Third Party Purchase**

Description:

Single Phase Implementation for purpose of meeting Study Area 2040 peak day demand.

Purchase water from Aqua Water Supply Camp Swift well field at Hwy 95 and CR 403 Pereshing

Pipeline from Camp Swift well field to Willow Street Treatment Plant

**Capital Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Inside diameter of pipe | 36 | in | - | - | - |
| Length of RURAL pipe | 18,674 | feet | $ 186 | /LF | 3,478,000 |
| Length of Urban pipe | 18,790 | feet | $ 286 | /LF | $ 5,367,000 |
| Length of Tunneling | 300 | feet | $ 24 | /inch diameter/ft | $ 260,000 |
| Total Pipeline Facilities | | | | | $ 9,105,000 |

**System Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Water Storage Tank - Stand Pipe | 2.68 | MG | $ 1,716,862 | /EA | $ 1,717,000 |
| Pump Station | 160 | hp | $ 2,165,650 | /EA | $ 2,166,000 |
| Electrical Hookup | 160 | hp | $ 142 | /hp | $ 50,000 |
| Water Impact Fee | 30,990 | SUE | $ 2,596.90 | /SUE | $ 80,478,000 |
| (Average of impact fee for phased 2015, 2025, 2035 purchase) | | | | | |
| Total System Facilities | | | | | $ 84,411,000 |

**Total Capital** — **$ 93,516,000**

**Other Project Costs**

**Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)**

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Engineering | 15 | % | $ 93,516,000 | $ 14,027,000 |
| Legal Costs | 5 | % | $ 93,516,000 | $ 4,676,000 |
| Contingency | 30 | % | $ 93,516,000 | $ 28,055,000 |
| Total Engineering Costs | | | | $ 46,758,000 |

**Land and Easements**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Easement Acquisition Cost | 34 | ac | $ 9,115 | /ac | $ 314,000 |
| Surveying and Legal - Pipeline | 10 | % | $ 314,000 | | $ 31,400 |
| Total Land and Easement Costs | | | | | $ 345,400 |

**Environmental Studies and Mitigation**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 37,764 | LF | $ 4.95 | /LF | $ 187,000 |
| Total Environmental Costs | | | | | $ 187,000 |

**Interest During Construction**

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 93,516,000 | $ 16,616,000 |
| Return on Investment | 1.5 | YR | 46,758,000 | $ (1,870,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ 14,746,000 |

**Total Other Project Costs** — **$ 62,036,400**

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ 155,552,400 | | $ 11,301,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ 91,350,000 | | $ 914,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ 2,166,000 | | $ 54,000 |
| Pumping Energy Costs | 0 | kWh | $ 0.06 | /kWh | $ - |
| Water Costs | 3,567,604 | 1,000 gal | $ 1.70 | /1,000 gal | $ 6,065,000 |
| (Average of water cost for phased 2015, 2025, 2035 purchase) | | | | | |

**Total Annual Costs** — **$ 18,334,000**

**Project Unit Cost**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Project Yield to the City | 3,567,604 | 1,000 gal | $ 5.14 | /1,000 gal | $ 18,334,000 |
| Project Yield to the City | 10,949 | ac-ft/year | $ 1,674 | /ac-ft | $ 18,334,000 |

# Appendix H Phased Implementation Detailed Cost Estimates

**Water Supply Option: Interim Third Party Purchase**

Description:

Purchase water from Aqua Water Supply at two interconnects.
Pipeline extensions at Hasler Shores and Loop 150.

## Capital Costs

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Inside diameter of pipe | 8 | in | | - | - | - |
| Length of Urban pipe - Hasler Shores to Bob Bryant | 4,400 | feet | $ | 95 | /LF | $ 419,000 |
| Length of Urban pipe - Loop 150 Connection | 100 | feet | $ | 95 | /LF | $ 10,000 |
| Length of Tunneling - Loop 150 Connection | 200 | feet | $ | 24 | /inch diameter/ft | $ 39,000 |
| Total Pipeline Facilities | | | | | | $ 468,000 |
| **Total Capital** | | | | | | **$ 468,000** |

## Other Project Costs

**Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Engineering | 15 | % | $ | 468,000 | | $ 70,000 |
| Legal Costs | 5 | % | $ | 468,000 | | $ 23,000 |
| Contingency | 30 | % | $ | 468,000 | | $ 140,000 |
| Total Engineering Costs | | | | | | $ 233,000 |

**Land and Easements**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Easement Acquisition Cost | 4 | ac | $ | 9,115 | /ac | $ 38,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 38,000 | | $ 3,800 |
| Total Land and Easement Costs | | | | | | $ 41,800 |

**Environmental Studies and Mitigation**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 4,700 | LF | | $4.95 | /LF | $ 23,000 |
| Total Environmental Costs | | | | | | $ 23,000 |

**Interest During Construction**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | | 468,000 | | $ 83,000 |
| Return on Investment | 1.5 | YR | | 234,000 | | $ (9,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ 74,000 |
| **Total Other Project Costs** | | | | | | **$ 371,800** |

## Annual Project Costs

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 839,800 | | $ 61,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 468,000 | | $ 5,000 |
| Water Costs | 644,899 | 1,000 gal | $ | 3.50 | /1,000 gal | $ 2,257,000 |
| **Total Annual Costs** | | | | | | **$ 2,323,000** |

## Project Unit Cost

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Project Yield to the City | 644,899 | 1,000 gal | $ | 3.60 | /1,000 gal | $ 2,323,000 |
| Project Yield to the City | 1,979 | ac-ft/year | $ | 1,174 | /ac-ft | $ 2,323,000 |

**Water Supply Option: Phased Surface Water Implementation**

Description:

Phased Implementation o f surface water diversion, water treatment plant and connection to existing system.

Phase 1 - Constructed in 2015 based on 2025 demand deficit.

**Capital Costs**

**Transmission Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Intake | 1 | LS | $ | 1,140,366 | /EA | $ | 1,140,000 |
| Raw Surface Water Pipeline | 2,240 | LF | $ | 236 | /LF | | 528,000 |
| Raw Water Pump Station to Water Treatment Plant | | | | | | | |
| Pump Station | 35% | of the Single Phase Implementation Costs | | | | $ | 798,350 |
| Electrical Hookup | 35% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Water Storage Tank | 2.68 | MG | $ | 1,716,862 | /EA | $ | 1,717,000 |
| Total Transmission Facilities | | | | | | $ | 4,233,350 |

**Water Treatment Plant**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Treatment Plant | 10 | MGD | $ | 20,568,180 | /EA | $ | 20,568,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 20,568,000 |

**Treated Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | 36 | in | - | | - | | - |
| Length of RURAL pipe | - | feet | $ | 186 | $/LF | | - |
| Length of Urban pipe | 6,670 | feet | $ | 286 | $/LF | $ | 1,905,000 |
| Length of Tunneling | - | feet | $ | 24 | $/inch diameter/ft | $ | - |
| Total Pipeline Facilities | | | | | | $ | 1,905,000 |

**System Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Pump Station | 20% | of the Single Phase Implementation Costs | | | | $ | 433,200 |
| Electrical Hookup | 20% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Total System Facilities | | | | | | $ | 483,200 |

**Total Capital** **$** **27,189,550**

**Other Project Costs**

**Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | 15 | % | $ | 27,189,550 | | $ | 4,078,000 |
| Legal Costs | 5 | % | $ | 27,189,550 | | $ | 1,359,000 |
| Contingency | 30 | % | $ | 27,189,550 | | $ | 8,157,000 |
| Total Engineering Costs | | | | | | $ | 13,594,000 |

**Land and Easements**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Raw Water Pipeline | 2 | ac | $ | 9,115 | $/ac | $ | 19,000 |
| Land Cost - Intake | 10 | ac | $ | 9,115 | $/ac | $ | 91,000 |
| Land Cost - Treatment Plant | 40 | ac | $ | 9,115 | $/ac | $ | 365,000 |
| Easement Acquisition Cost - Treated Water Pipeline | 6 | ac | $ | 9,115 | $/ac | $ | 56,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 531,000 | | $ | 53,100 |
| Total Land and Easement Costs | | | | | | $ | 584,100 |

**Environmental Studies and Mitigation**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Rights Permitting | 1 | LS | $ | 500,000 | /EA | $ | 500,000 |
| 404 Permitting - Engineering | 1 | LS | $ | 50,000 | /EA | $ | 50,000 |
| Environmental and Mitigation - Pipelines | 8,910 | LF | | $4.95 | $/LF | $ | 44,000 |
| Total Environmental Costs | | | | | | $ | 594,000 |

**Interest During Construction**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | | 27,189,550 | | $ | 4,831,000 |
| Return on Investment | 1.5 | YR | | 13,594,775 | | $ | (544,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 4,287,000 |

**Total Other Project Costs** **$** **19,059,100**

**Annual Project Costs**

| Pipeline Facilities | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 46,248,650 | | $ | 3,360,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 4,150,000 | | $ | 42,000 |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ | 2,371,550 | | $ | 59,000 |
| Operation and Maintenance - Treatment Facilities | 10 | MGD | $ | 1,618,712 | /EA | $ | 1,619,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 213,097 | kWh | $ | 0.06 | /kWh | $ | 13,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 71,032 | kWh | $ | 0.06 | /kWh | $ | 4,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 2,486 | ac-ft | $ | 151.00 | ac-ft | $ | 375,000 |
| Water Costs (LCRA 2011 Reservation Water Rates) | 8,463 | ac-ft | $ | 75.50 | ac-ft | $ | 639,000 |
| (Production 2015 to 2040 and Reservation 2015 to 2025) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **6,111,000** |

| Project Unit Cost | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Yield to the City | 810,095 | 1,000 gal | $ | 7.54 | $/1,000 gal | $ | 6,111,000 |
| Project Yield to the City | 2,486 | ac-ft/year | $ | 2,458 | $/ac-ft | $ | 6,111,000 |

**Water Supply Option: Phased Surface Water Implementation**

Description:

Phased Implementation o f surface water diversion, water treatment plant and connection to existing system.

Phase 2 - Constructed in 2025 based on 2035 demand deficit.

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | |
| **Transmission Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Raw Water Pump Station to Water Treatment Plant | | | | | | | |
| Pump Station | 40% | of the Single Phase Implementation Costs | | | | $ | 912,400 |
| Electrical Hookup | 40% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Total Transmission Facilities | | | | | | $ | 962,400 |
| **Water Treatment Plant** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Water Treatment Plant | 10 | MGD | $ | 20,568,180 | /EA | $ | 20,568,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 20,568,000 |
| **System Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Pump Station | 45% | of the Single Phase Implementation Costs | | | | $ | 974,700 |
| Electrical Hookup | 45% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Total System Facilities | | | | | | $ | 1,024,700 |
| **Total Capital** | | | | | | **$** | **22,555,100** |
| **Other Project Costs** | | | | | | | |
| **Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Engineering | 15 | % | $ | 22,555,100 | | $ | 3,383,000 |
| Legal Costs | 5 | % | $ | 22,555,100 | | $ | 1,128,000 |
| Contingency | 30 | % | $ | 22,555,100 | | $ | 6,767,000 |
| Total Engineering Costs | | | | | | $ | 11,278,000 |
| **Interest During Construction** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Interest Payment on Loan | 3 | YR | | 22,555,100 | | $ | 4,008,000 |
| Return on Investment | 1.5 | YR | | 11,277,550 | | $ | (451,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 3,557,000 |
| **Total Other Project Costs** | | | | | | **$** | **14,835,000** |
| **Annual Project Costs** | | | | | | | |
| **Pipeline Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Debt Service | 30 | YR | $ | 37,390,100 | | $ | 2,716,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | - | | $ | - |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ | 1,887,100 | | $ | 47,000 |
| Operation and Maintenance - Treatment Facilities | 10 | MGD | $ | 1,618,712 | /EA | $ | 1,619,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 568,257 | kWh | $ | 0.06 | /kWh | $ | 34,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 213,097 | kWh | $ | 0.06 | /kWh | $ | 13,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 5,642 | ac-ft | $ | 151.00 | ac-ft | $ | 852,000 |
| Water Costs (LCRA 2011 Reservation Water Rates | 2,821 | ac-ft | $ | 75.50 | ac-ft | $ | 213,000 |
| (Production 2025 to 2040 and Reservation 2025 to 2035) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **5,494,000** |
| **Project Unit Cost** | | | | | | | |
| Project Yield to the City | 1,838,340 | 1,000 gal | $ | 2.99 | $/1,000 gal | $ | 5,494,000 |
| Project Yield to the City | 5,642 | ac-ft/year | $ | 974 | $/ac-ft | $ | 5,494,000 |

**Water Supply Option: Phased Surface Water Implementation**

Description:

Phased Implementation o f surface water diversion, water treatment plant and connection to existing system.

Phase 3 - Constructed in 2035 based on 2040 demand deficit.

| | Quantity | Unit | | Unit Cost | | Total Cost | |
|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | |
| **Transmission Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Pump Station | 25% | of the Single Phase Implementation Costs | | | | $ | 570,250 |
| Electrical Hookup | 25% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Total Transmission Facilities | | | | | | $ | 620,250 |
| **Water Treatment Plant** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Water Treatment Plant | 6.8 | MGD | $ | 15,138,855 | /EA | $ | 15,139,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 15,139,000 |
| **System Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Pump Station | 35% | of the Single Phase Implementation Costs | | | | $ | 758,100 |
| Electrical Hookup | 35% | of the Single Phase Implementation Costs | | | | $ | 50,000 |
| Total System Facilities | | | | | | $ | 808,100 |
| **Total Capital** | | | | | | **$** | **16,567,350** |
| **Other Project Costs** | | | | | | | |
| **Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Engineering | 15 | % | $ | 16,567,350 | | $ | 2,485,000 |
| Legal Costs | 5 | % | $ | 16,567,350 | | $ | 828,000 |
| Contingency | 30 | % | $ | 16,567,350 | | $ | 4,970,000 |
| Total Engineering Costs | | | | | | $ | 8,283,000 |
| **Interest During Construction** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Interest Payment on Loan | 3 | YR | | 16,567,350 | | $ | 2,944,000 |
| Return on Investment | 1.5 | YR | | 8,283,675 | | $ | (331,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 2,613,000 |
| **Total Other Project Costs** | | | | | | **$** | **10,896,000** |
| **Annual Project Costs** | | | | | | | |
| **Pipeline Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | Total Cost | |
| Debt Service | 30 | YR | $ | 27,463,350 | | $ | 1,995,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | - | | $ | - |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ | 1,328,350 | | $ | 33,000 |
| Operation and Maintenance - Treatment Facilities | 10 | MGD | $ | 1,618,712 | /EA | $ | 1,619,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 781,354 | kWh | $ | 0.06 | /kWh | $ | 47,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 284,129 | kWh | $ | 0.06 | /kWh | $ | 17,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 2,821 | ac-ft | $ | 151.00 | ac-ft | $ | 426,000 |
| Water Costs (LCRA 2011 Reservation Water Rates) | - | ac-ft | $ | 75.50 | ac-ft | $ | - |
| (Production 2035 to 2040 and Reservation 2035 to 2040) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **4,137,000** |
| **Project Unit Cost** | | | | | | | |
| Project Yield to the City | 919,170 | 1,000 gal | $ | 4.50 | $/1,000 gal | $ | 4,137,000 |
| Project Yield to the City | 2,821 | ac-ft/year | $ | 1,466 | $/ac-ft | $ | 4,137,000 |

**Water Supply Option: Phased Ground Water Implementation**

Description:

Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.

Phase 1 constructed in 2015 based on 2025 demand deficit.

## Capital Costs

### Pipeline Facilities

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | | 36 | in | | - | - | - |
| Length of RURAL pipe | | 46,625 | feet | $ | 186 | /LF | $ 8,683,000 |
| Length of Urban pipe | | 9,240 | feet | $ | 286 | /LF | $ 2,639,000 |
| Length of Tunneling | | 400 | feet | $ | 24 | /inch diameter/ft | $ 347,000 |
| Total Pipeline Facilities | | | | | | | $ 11,669,000 |

### Well Facilities

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Well 1 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 2 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 3 | 2660 gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Electrical Hookup | | 1,875 | hp | $ | 142 | /hp | $ 266,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | 22,500 | feet | $ | 79 | /LF | $ 1,777,000 |
| Treatment Facilities | | 3 | well | $ | 1,704,028 | /EA | $ 5,112,000 |
| Total Well Facilities | | | | | | | $ 12,732,000 |

### System Facilities

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Water Storage Tank | 2.68 | MG | $ | 1,716,862 | /EA | $ 1,717,000 |
| Pump Station | 7% | of the Single Phase Implementation Costs | | | | $ 316,875 |
| Electrical Hookup | 7% | of the Single Phase Implementation Costs | | | | $ 50,000 |
| Total System Facilities | | | | | | $ 2,083,875 |

**Total Capital** **$ 26,484,875**

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | | Quantity | Unit | | Unit Cost | Total Cost |
|---|---|---|---|---|---|---|
| Engineering | | 15 | % | $ | 26,484,875 | $ 3,973,000 |
| Legal Costs | | 5 | % | $ | 26,484,875 | $ 1,324,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ | 21,000 | $ 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ | 28,000 | $ 28,000 |
| Contingency | | 30 | % | $ | 26,484,875 | $ 7,945,000 |
| Total Engineering Costs | | | | | | $ 13,291,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 72 | ac | $ | 9,115 | /ac | $ 656,000 |
| Land Acquisition Cost - Well Field | 40 | ac | $ | 9,115 | /ac | $ 365,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ | 1,021,000 | | $ 102,100 |
| Total Land and Easement Costs | | | | | | $ 1,123,100 |

### Environmental Studies and Mitigation

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 78,765 | LF | $4.95 | /LF | $ 390,000 |
| Total Environmental Costs | | | | | $ 390,000 |

### Interest During Construction

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 26,484,875.0 | $ 4,706,000 |
| Return on Investment | 1.5 | YR | 13,242,437.5 | $ (530,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ 4,176,000 |

**Total Other Project Costs** **$ 18,980,100**

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 45,464,975 | | $ | 3,303,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 26,168,000 | | $ | 262,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ | 316,875 | | $ | 8,000 |
| Operation and Maintenance - Treatment Facilities | 3 | well | $ | 293,565 | /EA | $ | 881,000 |
| Pumping Energy Costs - Well 1 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 2 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 3 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Field to System | 71,004 | kWh | $ | 0.06 | /kWh | $ | 4,000 |
| Water Production Permit Fees (LPGCD 2007-09-01 resolution) | 810,095 | 1,000 gal | $ | 0.12 | /1,000 gal | $ | 97,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | 8,463 | ac-ft | $ | 3.50 | /ac-ft | $ | 30,000 |
| (Production 2015 to 2040 and Reservation 2015 to 2025) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **4,876,000** |

**Project Unit Cost**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Project Yield to the City | 810,095 | 1,000 gal | $ | 6.02 | /1,000 gal | $ | 4,876,000 |
| Project Yield to the City | 2,486 | ac-ft/year | $ | 1,961 | /ac-ft | $ | 4,876,000 |

**Water Supply Option: Phased Ground Water Implementation**

Description:

Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.
Phase 2 constructed in 2025 based on 2035 demand deficit.

## Capital Costs

### Well Facilities

| | | | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| Well 4 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 5 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 6 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Electrical Hookup | | | 1,875 | hp | $ | 142 | /hp | $ | 266,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | | 22,500 | feet | $ | 79 | /LF | $ | 1,777,000 |
| Treatment Facilities | | | 3 | well | $ | 1,704,028 | /EA | $ | 5,112,000 |
| Total Well Facilities | | | | | | | | $ | 12,732,000 |

### System Facilities

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Pump Station | 45% | of the Single Phase Implementation Costs | | $ | 2,019,600 |
| Electrical Hookup | 45% | of the Single Phase Implementation Costs | | $ | 63,900 |
| Total System Facilities | | | | $ | 2,083,500 |

| | | |
|---|---|---|
| **Total Capital** | **$** | **14,815,500** |

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | | 15 | % | $ | 14,815,500 | $ | 2,222,000 |
| Legal Costs | | 5 | % | $ | 14,815,500 | $ | 741,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ | 21,000 | $ | 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ | 28,000 | $ | 28,000 |
| Contingency | | 30 | % | $ | 14,815,500 | $ | 4,445,000 |
| Total Engineering Costs | | | | | | $ | 7,457,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 21 | ac | $ | 9,115 | /ac | $ | 188,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ | 188,000 | | $ | 18,800 |
| Total Land and Easement Costs | | | | | | $ | 206,800 |

### Environmental Studies and Mitigation

| | Quantity | Unit | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 22,500 | LF | $4.95 | /LF | $ | 111,000 |
| Total Environmental Costs | | | | | $ | 111,000 |

### Interest During Construction

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 14,815,500.0 | $ | 2,632,000 |
| Return on Investment | 1.5 | YR | 7,407,750.0 | $ | (296,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ | 2,336,000 |

| | | |
|---|---|---|
| **Total Other Project Costs** | **$** | **10,110,800** |

## Annual Project Costs

### Pipeline Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 24,926,300 | | $ | 1,811,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 12,795,900 | | $ | 128,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ | 2,019,600 | | $ | 50,000 |
| Operation and Maintenance - Treatment Facilities | 3 | well | $ | 293,565 | /EA | $ | 881,000 |
| Pumping Energy Costs - Well 4 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 5 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 6 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Field to System | 284,014 | kWh | $ | 0.06 | /kWh | $ | 17,000 |
| Water Production Permit Fees (LPGCD 2007-09-01 resolution) | 1,838,340 | 1,000 gal | $ | 0.12 | /1,000 gal | $ | 221,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | 2,821 | ac-ft | $ | 3.50 | /ac-ft | $ | 10,000 |
| (Production 2025 to 2040 and Reservation 2025 to 2035) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **3,409,000** |

**Project Unit Cost**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Yield to the City | 1,838,340 | 1,000 gal | $ | 1.85 | /1,000 gal | $ | 3,409,000 |
| Project Yield to the City | 5,642 | ac-ft/year | $ | 604 | /ac-ft | $ | 3,409,000 |

**Water Supply Option: Phased Ground Water Implementation**

Description:

Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.
Phase 3 constructed in 2035 based on 2040 demand deficit.

**Capital Costs**

**Well Facilities**

| | | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|
| Well 7 | 2660 gpm | 1560 | ft- depth | $ 1,859,150 | /EA | $ 1,859,000 |
| Electrical Hookup | | 625 | hp | $ 142 | /hp | $ 89,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | 7,500 | feet | $ 79 | /LF | $ 592,000 |
| Treatment Facilities | | 1 | well | $ 1,704,028 | /EA | $ 1,704,000 |
| Total Well Facilities | | | | | | $ 4,244,000 |

**System Facilities**

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Pump Station | 48% | of the Single Phase Implementation Costs | | $ 2,154,240 |
| Electrical Hookup | 48% | of the Single Phase Implementation Costs | | $ 68,160 |
| Total System Facilities | | | | $ 2,222,400 |

| | |
|---|---|
| **Total Capital** | **$ 6,466,400** |

**Other Project Costs**

**Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)**

| | | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|---|
| Engineering | | 15 | % | $ 6,466,400 | $ 970,000 |
| Legal Costs | | 5 | % | $ 6,466,400 | $ 323,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ 21,000 | $ 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ 28,000 | $ 28,000 |
| Contingency | | 30 | % | $ 6,466,400 | $ 1,940,000 |
| Total Engineering Costs | | | | | $ 3,282,000 |

**Land and Easements**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 7 | ac | $ 9,115 | /ac | $ 63,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ 63,000 | | $ 6,300 |
| Total Land and Easement Costs | | | | | $ 69,300 |

**Environmental Studies and Mitigation**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 7,500 | LF | $4.95 | /LF | $ 37,000 |
| Total Environmental Costs | | | | | $ 37,000 |

**Interest During Construction**

| | Quantity | Unit | Unit Cost | Total Cost |
|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 6,466,400.0 | $ 1,149,000 |
| Return on Investment | 1.5 | YR | 3,233,200.0 | $ (129,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ 1,020,000 |

| | |
|---|---|
| **Total Other Project Costs** | **$ 4,408,300** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ 10,874,700 | | $ 790,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ 4,312,160 | | $ 43,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ 2,154,240 | | $ 54,000 |
| Operation and Maintenance - Treatment Facilities | 1 | well | $ 293,565 | /EA | $ 294,000 |
| Pumping Energy Costs - Well 7 | 1,618,189 | kWh | $ 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Field to System | 497,025 | kWh | $ 0.06 | /kWh | $ 30,000 |
| Water Production Permit Fees (LPGCD 2007-09-01 resolution) | 919,170 | 1,000 gal | $ 0.12 | /1,000 gal | $ 110,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | 0 | ac-ft | $ 3.50 | /ac-ft | $ - |
| (Production 2035 to 2040 and Reservation 2035 to 2040) | | | | | |
| **Total Annual Costs** | | | | | **$ 1,418,000** |

**Project Unit Cost**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Project Yield to the City | 919,170 | 1,000 gal | $ 1.54 | /1,000 gal | $ 1,418,000 |
| Project Yield to the City | 2,821 | ac-ft/year | $ 503 | /ac-ft | $ 1,418,000 |

**Water Supply Option: Joint Surface and Groundwater - Phase 1 Surface Water**

Description:

Single Phase Implementation of a Surface Water Treatement Plant in 2015 for purpose of meeting Study Area 2040 average day demand.
Diversion, water treatment plant and connection to existing system at the Bob Bryant Park.

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | |
| **Transmission Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Intake | 1 | LS | $ | 1,082,825 | /EA | $ | 1,083,000 |
| Raw Surface Water Pipeline | 2,240 | LF | $ | 140 | $/LF | | 313,000 |
| Raw Water Pump Station to Water Treatment Plant | | | | | | | |
| Pump Station | 120 | hp | $ | 2,165,650 | /EA | $ | 2,166,000 |
| Electrical Hookup | 120 | hp | $ | 142 | /hp | $ | 50,000 |
| Water Storage Tank | 1 | MG | $ | 813,014 | /EA | $ | 813,000 |
| Total Transmission Facilities | | | | | | $ | 4,425,000 |
| **Water Treatmant Plant** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Water Treatment Plant | 9.8 | MGD | $ | 20,228,848 | /EA | $ | 20,229,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 20,229,000 |
| **Treated Pipeline Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Inside diameter of pipe | 24 | in | | - | - | | - |
| Length of RURAL pipe | - | feet | $ | 110 | $/LF | | - |
| Length of Urban pipe | 6,670 | feet | $ | 169 | $/LF | $ | 1,130,000 |
| Length of Tunneling | - | feet | $ | 24 | $/inch diameter/ft | $ | - |
| Total Pipeline Facilities | | | | | | $ | 1,130,000 |
| **System Facilities** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Pump Station | 80 | hp | $ | 2,165,650 | /EA | $ | 2,166,000 |
| Electrical Hookup | 80 | hp | $ | 142 | /hp | $ | 50,000 |
| Total System Facilities | | | | | | $ | 2,216,000 |
| **Total Capital** | | | | | | **$** | **28,000,000** |

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Other Project Costs** | | | | | | | |
| **Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Engineering | 15 | % | $ | 28,000,000 | | $ | 4,200,000 |
| Legal Costs | 5 | % | $ | 28,000,000 | | $ | 1,400,000 |
| Contingency | 30 | % | $ | 28,000,000 | | $ | 8,400,000 |
| Total Engineering Costs | | | | | | $ | 14,000,000 |
| **Land and Easements** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Easement Acquisition Cost - Raw Water Pipeline | 2 | ac | $ | 9,115 | $/ac | $ | 19,000 |
| Land Cost - Intake | 10 | ac | $ | 9,115 | $/ac | $ | 91,000 |
| Land Cost - Treatment Plant | 40 | ac | $ | 9,115 | $/ac | $ | 365,000 |
| Easement Acquisition Cost - Treated Water Pipeline | 6 | ac | $ | 9,115 | $/ac | $ | 56,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 531,000 | | $ | 53,100 |
| Total Land and Easement Costs | | | | | | $ | 584,100 |
| **Environmental Studies and Mitigation** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Water Rights Permitting | 1 | LS | $ | 500,000 | /EA | $ | 500,000 |
| 404 Permitting - Engineering | 1 | LS | $ | 50,000 | /EA | $ | 50,000 |
| Environmental and Mitigation - Pipelines | 8,910 | LF | | $4.95 | $/LF | $ | 44,000 |
| Total Environmental Costs | | | | | | $ | 594,000 |
| **Interest During Construction** | | | | | | | |
| | Quantity | Unit | | Unit Cost | | | Total Cost |
| Interest Payment on Loan | 3 | YR | | 28,000,000 | | $ | 4,975,000 |
| Return on Investment | 1.5 | YR | | 14,000,000 | | $ | (560,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 4,415,000 |
| **Total Other Project Costs** | | | | | | **$** | **19,593,100** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 47,593,100 | | $ | 3,458,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 2,256,000 | | $ | 23,000 |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ | 5,415,000 | | $ | 135,000 |
| Operation and Maintenance - Treatment Facilities | 9.8 | MGD | $ | 3,291,516 | /EA | $ | 3,292,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 852,386 | kWh | $ | 0.06 | /kWh | $ | 51,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 568,257 | kWh | $ | 0.06 | /kWh | $ | 34,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 10,949 | ac-ft | $ | 84 | ac-ft | $ | 917,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | 19,037 | ac-ft | $ | 0.05 | /ac-ft | $ | 1,000 |
| **Total Annual Costs** | | | | | | **$** | **7,911,000** |

**Project Unit Cost**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Project Yield to the City | 3,567,604 | 1,000 gal | $ | 2.22 | $/1,000 gal | $ | 7,911,000 |
| Project Yield to the City | 10,949 | ac-ft/year | $ | 723 | $/ac-ft | $ | 7,911,000 |

**Water Supply Option: Joint Surface and Groundwater - Phase 2 Groundwater**

Description:

First phase of the groundwater development for purpose of meeting Study Area 2035 peak day demand.
Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.

## Capital Costs

### Pipeline Facilities

| | | | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | | | 36 | in | | - | | $ | - |
| Length of RURAL pipe | | | 46,625 | feet | $ | 186 | /LF | $ | 8,683,000 |
| Length of Urban pipe | | | 9,240 | feet | $ | 286 | /LF | $ | 2,639,000 |
| Length of Tunneling | | | 400 | feet | $ | 24 | /inch diameter/ft | $ | 347,000 |
| Total Pipeline Facilities | | | | | | | | $ | 11,669,000 |

### Well Facilities

| | | | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| Well 1 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 2 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 3 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Electrical Hookup | | | 1,875 | hp | $ | 142 | /hp | $ | 266,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | | 22,500 | feet | $ | 79 | /LF | $ | 1,777,000 |
| Treatment Facilities | | | 3 | well | $ | 1,704,028 | /EA | $ | 5,112,000 |
| Total Well Facilities | | | | | | | | $ | 12,732,000 |

### System Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Storage Tank | 2 | MG | $ | 1,373,714 | /EA | $ | 1,374,000 |
| Pump Station | 52% | of the Single Phase Implementation Costs | | | | $ | 2,333,760 |
| Electrical Hookup | 52% | of the Single Phase Implementation Costs | | | | $ | 73,840 |
| Total System Facilities | | | | | | $ | 3,781,600 |

| | | |
|---|---|---|
| **Total Capital** | **$** | **28,182,600** |

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | | 15 | % | $ | 28,182,600 | $ | 4,227,000 |
| Legal Costs | | 5 | % | $ | 28,182,600 | $ | 1,409,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ | 21,000 | $ | 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ | 28,000 | $ | 28,000 |
| Contingency | | 30 | % | $ | 28,182,600 | $ | 8,455,000 |
| Total Engineering Costs | | | | | | $ | 14,140,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 72 | ac | $ | 9,115 | /ac | $ | 656,000 |
| Land Acquisition Cost - Well Field | 40 | ac | $ | 9,115 | /ac | $ | 365,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ | 1,021,000 | | $ | 102,100 |
| Total Land and Easement Costs | | | | | | $ | 1,123,100 |

### Environmental Studies and Mitigation

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 78,765 | LF | $ | 4.95 | /LF | $ | 390,000 |
| Total Environmental Costs | | | | | | $ | 390,000 |

### Interest During Construction

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 28,182,600.0 | $ | 5,007,000 |
| Return on Investment | 1.5 | YR | 14,091,300.0 | $ | (564,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ | 4,443,000 |

| | | |
|---|---|---|
| **Total Other Project Costs** | **$** | **20,096,100** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ | 48,278,700 | | $ | 3,507,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 25,848,840 | | $ | 258,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ | 2,333,760 | | $ | 58,000 |
| Operation and Maintenance - Treatment Facilities | 3 | well | $ | 293,565 | /EA | $ | 881,000 |
| Pumping Energy Costs - Well 1 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 2 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Well 3 | 1,618,189 | kWh | $ | 0.06 | /kWh | $ | 97,000 |
| Pumping Energy Costs - Field to System | 284,129 | kWh | $ | 0.06 | /kWh | $ | 17,000 |
| Water Production Permit Fees (LPGCD 2007-09-01 resolution) | 4,136,732 | 1,000 gal | $ | 0.12 | /1,000 gal | $ | 496,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | 2,065,980 | ac-ft | $ | 3.50 | /ac-ft | $ | 7,231,000 |
| **Total Annual Costs** | | | | | | **$** | **12,739,000** |

**Project Unit Cost**

| | | | | | | |
|---|---|---|---|---|---|---|
| Project Yield to the City | 0 | 1,000 gal | - | /1,000 gal | $ | 12,739,000 |
| Project Yield to the City | 0 | ac-ft/year | - | /ac-ft | $ | 12,739,000 |

**Water Supply Option: Joint Surface and Groundwater - Phase 3 Groundwater**

Description:

Second phase of the groundwater development for purpose of meeting Study Area 2040 peak day demand.

Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.

| | | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | | |
| **Well Facilities** | | | | | | | | |
| Well 4 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Well 5 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ 1,859,000 |
| Electrical Hookup | | | 1,250 | hp | $ | 142 | /hp | $ 177,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | | 15,000 | feet | $ | 79 | /LF | $ 1,185,000 |
| Treatment Facilities | | | 2 | well | $ | 1,704,028 | /EA | $ 3,408,000 |
| Total Well Facilities | | | | | | | | $ 8,488,000 |
| **System Facilities** | | | | | | | | |
| Pump Station | | | 48% | of the Single Phase Implementation Costs | | | | $ 2,154,240 |
| Electrical Hookup | | | 48% | of the Single Phase Implementation Costs | | | | $ 68,160 |
| Total System Facilities | | | | | | | | $ 2,222,400 |
| **Total Capital** | | | | | | | | **$ 10,710,400** |
| **Other Project Costs** | | | | | | | | |
| **Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)** | | | | | | | | |
| Engineering | | | 15 | % | $ | 10,710,400 | | $ 1,607,000 |
| Legal Costs | | | 5 | % | $ | 10,710,400 | | $ 536,000 |
| TCEQ Permitting | (assumes uncontested permit) | | 1 | LS | $ | 21,000 | | $ 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | | 1 | LS | $ | 28,000 | | $ 28,000 |
| Contingency | | | 30 | % | $ | 10,710,400 | | $ 3,213,000 |
| Total Engineering Costs | | | | | | | | $ 5,405,000 |
| **Land and Easements** | | | | | | | | |
| Easement Acquisition Cost - Pipeline | | | 14 | ac | $ | 9,115 | /ac | $ 126,000 |
| Surveying and Legal - Pipeline & Well Field | | | 10 | % | $ | 126,000 | | $ 12,600 |
| Total Land and Easement Costs | | | | | | | | $ 138,600 |
| **Environmental Studies and Mitigation** | | | | | | | | |
| Environmental and Mitigation - Pipelines | | | 15,000 | LF | $ | 4.95 | /LF | $ 74,000 |
| Total Environmental Costs | | | | | | | | $ 74,000 |
| **Interest During Construction** | | | | | | | | |
| Interest Payment on Loan | | | 3 | YR | | 10,710,400.0 | | $ 1,903,000 |
| Return on Investment | | | 1.5 | YR | | 5,355,200.0 | | $ (214,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | | | $ 1,689,000 |
| **Total Other Project Costs** | | | | | | | | **$ 7,306,600** |
| **Annual Project Costs** | | | | | | | | |
| **Pipeline Facilities** | | | | | | | | |
| Debt Service | | | 30 | YR | $ | 18,017,000 | | $ 1,309,000 |
| Operation and Maintenance - Pipeline & System Facilities | | | 1 | % | $ | 8,556,160 | | $ 86,000 |
| Operation and Maintenance - Pump Station Facilities | | | 2.5 | % | $ | 2,154,240 | | $ 54,000 |
| Operation and Maintenance - Treatment Facilities | | | 2 | well | $ | 293,565 | /EA | $ 587,000 |
| Pumping Energy Costs - Well 4 | | | 1,618,189 | kWh | $ | 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Well 5 | | | 1,618,189 | kWh | $ | 0.06 | /kWh | $ 97,000 |
| Pumping Energy Costs - Field to System | | | 497,225 | kWh | $ | 0.06 | /kWh | $ 30,000 |
| Water Production Permit Fees (LPGCD 2007-09-01 resolution) | | | 2,065,980 | 1,000 gal | $ | 0.12 | /1,000 gal | $ 248,000 |
| Water Reservation Permit Fees (LPGCD 7-15-09 rules) | | | 0 | ac-ft | $ | 3.50 | /ac-ft | $ - |
| **Total Annual Costs** | | | | | | | | **$ 2,508,000** |
| **Project Unit Cost** | | | | | | | | |
| Project Yield to the City | | | 0 | 1,000 gal | | - | /1,000 gal | $ 2,508,000 |
| Project Yield to the City | | | 0 | ac-ft/year | | - | /ac-ft | $ 2,508,000 |

# Appendix I Extended Study Area Detailed Cost Estimates

**Water Supply Option: Surface Water**

Description:

Single Phase Implementation for purpose of meeting Extended Study Area 2040 peak day demand.

Diversion, water treatment plant and connection to existing system at the Bob Bryant Park.

## Capital Costs

### Transmission Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Intake | 1 | LS | $ | 1,457,891 | /EA | $ | 1,458,000 |
| Raw Surface Water Pipeline | 2,240 | LF | $ | 371 | $/LF | | 832,000 |
| Raw Water Pump Station to Water Treatment Plant | | | | | | | |
| Pump Station | 460 | hp | $ | 2,915,781 | /EA | $ | 2,916,000 |
| Electrical Hookup | 460 | hp | $ | 142 | /hp | $ | 65,000 |
| Water Storage Tank | 4.06 | MG | $ | 2,408,204 | /EA | $ | 2,408,000 |
| Total Transmission Facilities | | | | | | $ | 7,679,000 |

### Water Treatmant Plant

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Treatment Plant | 40.6 | MGD | $ | 58,054,844 | /EA | $ | 58,055,000 |
| Total Water Treatment Plant Facilities | | | | | | $ | 58,055,000 |

### Treated Pipeline Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | 48 | in | | - | - | | - |
| Length of RURAL pipe | - | feet | $ | 290 | $/LF | | - |
| Length of Urban pipe | 6,670 | feet | $ | 453 | $/LF | $ | 3,022,000 |
| Length of Tunneling | - | feet | $ | 24 | $/inch diameter/ft | $ | - |
| Total Pipeline Facilities | | | | | | $ | 3,022,000 |

### System Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Pump Station | 220 | hp | $ | 2,165,650 | /EA | $ | 2,166,000 |
| Electrical Hookup | 220 | hp | $ | 142 | /hp | $ | 50,000 |
| Total System Facilities | | | | | | $ | 2,216,000 |

| | | |
|---|---|---|
| **Total Capital** | **$** | **70,972,000** |

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | 15 | % | $ | 70,972,000 | | $ | 10,646,000 |
| Legal Costs | 5 | % | $ | 70,972,000 | | $ | 3,549,000 |
| Contingency | 30 | % | $ | 70,972,000 | | $ | 21,292,000 |
| Total Engineering Costs | | | | | | $ | 35,487,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Raw Water Pipeline | 2 | ac | $ | 9,115 | $/ac | $ | 19,000 |
| Land Cost - Intake | 10 | ac | $ | 9,115 | $/ac | $ | 91,000 |
| Land Cost - Treatment Plant | 60 | ac | $ | 9,115 | $/ac | $ | 547,000 |
| Easement Acquisition Cost - Treated Water Pipeline | 6 | ac | $ | 9,115 | $/ac | $ | 56,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 713,000 | | $ | 71,300 |
| Total Land and Easement Costs | | | | | | $ | 784,300 |

### Environmental Studies and Mitigation

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Rights Permitting | 1 | LS | $ | 500,000 | /EA | $ | 500,000 |
| 404 Permitting - Engineering | 1 | LS | $ | 50,000 | /EA | $ | 50,000 |
| Environmental and Mitigation - Pipelines | 8,910 | LF | | $4.95 | $/LF | $ | 44,000 |
| Total Environmental Costs | | | | | | $ | 594,000 |

### Interest During Construction

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | | 70,972,000 | | $ | 12,610,000 |
| Return on Investment | 1.5 | YR | | 35,486,000 | | $ | (1,419,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 11,191,000 |

| | | |
|---|---|---|
| **Total Other Project Costs** | **$** | **48,056,300** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ 119,028,300 | | $ 8,647,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ 6,262,000 | | $ 63,000 |
| Operation and Maintenance - Pump Station & Intake Facilities | 2.5 | % | $ 6,540,000 | | $ 164,000 |
| Operation and Maintenance - Treatment Facilities | 40.6 | MGD | $ 3,719,746 | /EA | $ 3,720,000 |
| Pumping Energy Costs - Raw Water Pump Station Average Day | 1,207,547 | kWh | $ 0.06 | /kWh | $ 72,000 |
| Pumping Energy Costs - Treated Pump Station Average Day | 426,193 | kWh | $ 0.06 | /kWh | $ 26,000 |
| Water Costs (LCRA 2011 Firm Water Rates) | 17,843 | ac-ft | $ 141 | ac-ft | $ 2,522,000 |
| (Average of the Production and Reservation rates for a phased 2015, 2025, 2035 purchase) | | | | | |
| **Total Annual Costs** | | | | | **$ 15,214,000** |

**Project Unit Cost**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Project Yield to the City | 5,813,775 | 1,000 gal | $ 2.62 | $/1,000 gal | $ 15,214,000 |
| Project Yield to the City | 17,843 | ac-ft/year | $ 853 | $/ac-ft | $ 15,214,000 |

**Water Supply Option: Groundwater**

Description: Single Phase Implementation for purpose of meeting Extended Study Area 2040 peak day demand.
Well field located at SH 21 and CR 163 (Dixon Prairie Road) and connection to existing system at the Loop 150 tank yard.

## Capital Costs

### Pipeline Facilities

| | | | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| Inside diameter of pipe | | | 48 | in | | - | - | | - |
| Length of RURAL pipe | | | 46,625 | feet | $ | 290 | /LF | $ | 13,512,000 |
| Length of Urban pipe | | | 9,240 | feet | $ | 453 | /LF | $ | 4,186,000 |
| Length of Tunneling | | | 400 | feet | $ | 24 | /inch diameter/ft | $ | 462,000 |
| Total Pipeline Facilities | | | | | | | | $ | 18,160,000 |

### Well Facilities

| | | | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|
| Well 1 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 2 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 3 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 4 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 5 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 6 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 7 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 8 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 9 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 10 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Well 11 | 2660 | gpm | 1560 | ft- depth | $ | 1,859,150 | /EA | $ | 1,859,000 |
| Electrical Hookup | | | 6,875 | hp | $ | 142 | /hp | $ | 976,000 |
| Length of RURAL pipe - 15" well headworks spaced 7,500 feet | | | 82,500 | feet | $ | 79 | /LF | $ | 6,517,000 |
| Treatment Facilities | | | 7 | well | $ | 1,704,028 | /EA | $ | 11,928,000 |
| Total Well Facilities | | | | | | | | $ | 39,870,000 |

### System Facilities

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Water Storage Tank | 4.06 | MG | $ | 2,408,204 | /EA | $ | 2,408,000 |
| Pump Station | 830 | hp | $ | 3,993,201 | /EA | $ | 3,993,000 |
| Electrical Hookup | 830 | hp | $ | 142 | /hp | $ | 118,000 |
| Total System Facilities | | | | | | $ | 6,519,000 |

| | |
|---|---|
| **Total Capital** | **$ 64,549,000** |

## Other Project Costs

### Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)

| | | Quantity | Unit | | Unit Cost | | Total Cost |
|---|---|---|---|---|---|---|---|
| Engineering | | 15 | % | $ | 64,549,000 | $ | 9,682,000 |
| Legal Costs | | 5 | % | $ | 64,549,000 | $ | 3,227,000 |
| TCEQ Permitting | (assumes uncontested permit) | 1 | LS | $ | 21,000 | $ | 21,000 |
| LPGCD Permitting | (assumes uncontested permit) | 1 | LS | $ | 28,000 | $ | 28,000 |
| Contingency | | 30 | % | $ | 64,549,000 | $ | 19,365,000 |
| Total Engineering Costs | | | | | | $ | 32,323,000 |

### Land and Easements

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Easement Acquisition Cost - Pipeline | 127 | ac | $ | 9,115 | /ac | $ | 1,158,000 |
| Land Acquisition Cost - Well Field | 60 | ac | $ | 9,115 | /ac | $ | 547,000 |
| Surveying and Legal - Pipeline & Well Field | 10 | % | $ | 1,705,000 | | $ | 170,500 |
| Total Land and Easement Costs | | | | | | $ | 1,875,500 |

### Environmental Studies and Mitigation

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| Environmental and Mitigation - Pipelines | 138,765 | LF | $ | 4.95 | /LF | $ | 687,000 |
| Total Environmental Costs | | | | | | $ | 687,000 |

### Interest During Construction

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Interest Payment on Loan | 3 | YR | 64,549,000 | $ | 11,469,000 |
| Return on Investment | 1.5 | YR | 32,274,500 | $ | (1,291,000) |
| Total Interest Accrued Less Earned During Construction | | | | $ | 10,178,000 |

| | |
|---|---|
| **Total Other Project Costs** | **$ 45,063,500** |

**Annual Project Costs**

**Pipeline Facilities**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Debt Service | 30 | YR | $ 109,612,500 | | $ 7,963,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ 60,556,000 | | $ 606,000 |
| Operation and Maintenance - Pump Station Facilities | 2.5 | % | $ 3,993,000 | | $ 100,000 |
| Operation and Maintenance - Treatment Facilities | 11 | well | $ 293,565 | /EA | $ 3,229,000 |
| Pumping Energy Costs - Well 1 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 2 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 3 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 4 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 5 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 6 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 7 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 8 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 9 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 10 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Well 11 | 1,684,919 | kWh | $ 0.06 | /kWh | $ 101,000 |
| Pumping Energy Costs - Field to System | 568,257 | kWh | $ 0.06 | /kWh | $ 34,000 |
| Water Production Costs (LPGCD 2007-09-01 resolution) | 5,813,775 | 1,000 gal | $ 0.08 | /1,000 gal | $ 445,000 |
| (Average of the Production and Reservation permit fees for the phased 2015, 2025, 2035 usage) | | | | | |
| **Total Annual Costs** | | | | | **$ 13,488,000** |

**Project Unit Cost**

| | Quantity | Unit | Unit Cost | | Total Cost |
|---|---|---|---|---|---|
| Project Yield to the City | 5,813,775 | 1,000 gal | $ 2.32 | /1,000 gal | $ 13,488,000 |
| Project Yield to the City | 17,843 | ac-ft/year | $ 756 | /ac-ft | $ 13,488,000 |

**Water Supply Option: Third Party Purchase**

Description:

Single Phase Implementation for purpose of meeting Study Area 2040 peak day demand.

Purchase water from Aqua Water Supply Camp Swift well field at Hwy 95 and CR 403 Pereshing

Pipeline from Camp Swift well field to Willow Street Treatment Plant

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Capital Costs** | | | | | | | |
| **Pipeline Facilities** | | | | | | | |
| Inside diameter of pipe | 48 | in | | - | | - | - |
| Length of RURAL pipe | 18,674 | feet | $ | 290 | /LF | | 5,412,000 |
| Length of Urban pipe | 18,790 | feet | $ | 453 | /LF | $ | 8,512,000 |
| Length of Tunneling | 300 | feet | $ | 24 | /inch diameter/ft | $ | 347,000 |
| Total Pipeline Facilities | | | | | | $ | 14,271,000 |
| **System Facilities** | | | | | | | |
| Water Storage Tank - Stand Pipe | 4.06 | MG | $ | 2,408,204 | /EA | $ | 2,408,000 |
| Water Impact Fee | 47,000 | SUE | $ | 2,807.23 | /SUE | $ | 131,940,000 |
| (Average of impact fee for phased 2015, 2025, 2035 purchase) | | | | | | | |
| Total System Facilities | | | | | | $ | 134,348,000 |
| **Total Capital** | | | | | | **$** | **148,619,000** |

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Other Project Costs** | | | | | | | |
| **Engineering (Design, Bidding and Construction Phase Services, Geotechnical, Legal, Financing, and Contingencies)** | | | | | | | |
| Engineering | 15 | % | $ | 148,619,000 | | $ | 22,293,000 |
| Legal Costs | 5 | % | $ | 148,619,000 | | $ | 7,431,000 |
| Contingency | 30 | % | $ | 148,619,000 | | $ | 44,586,000 |
| Total Engineering Costs | | | | | | $ | 74,310,000 |
| **Land and Easements** | | | | | | | |
| Easement Acquisition Cost | 34 | ac | $ | 9,115 | /ac | $ | 314,000 |
| Surveying and Legal - Pipeline | 10 | % | $ | 314,000 | | $ | 31,400 |
| Total Land and Easement Costs | | | | | | $ | 345,400 |
| **Environmental Studies and Mitigation** | | | | | | | |
| Environmental and Mitigation - Pipelines | 37,764 | LF | $ | 4.95 | /LF | $ | 187,000 |
| Total Environmental Costs | | | | | | $ | 187,000 |
| **Interest During Construction** | | | | | | | |
| Interest Payment on Loan | 3 | YR | | 148,619,000 | | $ | 26,406,000 |
| Return on Investment | 1.5 | YR | | 74,309,500 | | $ | (2,972,000) |
| Total Interest Accrued Less Earned During Construction | | | | | | $ | 23,434,000 |
| **Total Other Project Costs** | | | | | | **$** | **98,276,400** |

| | Quantity | Unit | | Unit Cost | | | Total Cost |
|---|---|---|---|---|---|---|---|
| **Annual Project Costs** | | | | | | | |
| **Pipeline Facilities** | | | | | | | |
| Debt Service | 30 | YR | $ | 246,895,400 | | $ | 17,937,000 |
| Operation and Maintenance - Pipeline & System Facilities | 1 | % | $ | 148,619,000 | | $ | 1,486,000 |
| Water Costs | 5,813,775 | 1,000 gal | $ | 2.01 | /1,000 gal | $ | 11,668,000 |
| (Average of water cost for phased 2015, 2025, 2035 purchase) | | | | | | | |
| **Total Annual Costs** | | | | | | **$** | **31,091,000** |
| **Project Unit Cost** | | | | | | | |
| Project Yield to the City | 5,813,775 | 1,000 gal | $ | 5.35 | /1,000 gal | $ | 31,091,000 |
| Project Yield to the City | 17,843 | ac-ft/year | $ | 1,742 | /ac-ft | $ | 31,091,000 |

# Appendix J CH2M HILL Water Source Blending Technical Memorandum

# City of Bastrop TWDB Regional Water Supply Study: Conceptual Water Source Blending Assessment

**PREPARED FOR:** K. Friese and Associates

**PREPARED BY:** CH2M HILL

**DATE:** April 29, 2011 (revised)

**PROJECT NUMBER:** 410909

As part of the City of Bastrop TWDB Regional Water Supply Study, CH2M HILL has performed a water quality blending assessment on potential alternative water supply options to meet forecast water needs within the project study area. The analysis considered the use of Bastrop's existing well water combined with Simsboro groundwater and treated Colorado River surface water. This memorandum describes the results of that analysis. The following water sources and blending ratios, provided by K Friese and Associates, were evaluated:

1. Alluvial (based on current supply ~2700 gallons per minute (gpm)) and remainder groundwater from the Simsboro aquifer;
2. Alluvial (based on current supply ~2700 gpm) and remainder surface water from the Colorado River; and
3. Alluvial (based on current supply ~2700 gpm) and 50 percent groundwater from the Simsboro aquifer and 50 percent surface water from the Colorado River.

The blending assessment is based on a total water supply quantity of approximately 15 million gallons per day (MGD). This total water quantity was selected to approximate the anticipated adjusted maximum daily delivery rate for the extended study area before 2015, or the average annual demand between 2030 and 2035. This represents a reasonable future condition for system planning that is not too far in the future, yet is far enough off that it allows adequate time to be incorporated into long term capital improvements planning.

## Water Quality Goals

Drinking water quality standards are established by the US Environmental Protection Agency (USEPA) as authorized by the 1974 Safe Drinking Water Act as amended. Enforcement of these standards has been delegated to the State of Texas and is administered by the Texas Commission on Environmental Quality (TCEQ). Regulations have been established by each agency and are the basis for the water quality goals for key constituents established for this assessment. These goals, as defined based on requirements in Texas Administrative Code, Title 30 Chapter 290 and the Code of Federal Regulations, Title 40, are presented in **Exhibit 1**.

**EXHIBIT 1**
Water Quality Goals

| Constituent | Goal | TCEQ Standard | USEPA Standard |
|---|---|---|---|
| TDS (milligrams per liter (mg/L)) | <500 | 1000 | 500 |
| pH | 6.5-8.5 | 6.5-8.5 | 6.5 – 8.5 |
| Total Alkalinity (mg/L) | >100 | - | - |
| Calcium (mg/L) | - | - | - |
| Magnesium (mg/L) | - | - | - |
| Iron (mg/L) | 0.30 | 0.30 | 0.30 |
| Manganese (mg/L) | 0.05 | 0.05 | 0.05 |
| Chloride (mg/L) | <250 | 300 | 250 |
| Sulfate (mg/L) | <250 | 300 | 250 |
| Nitrate (mg/L) | 10 | 10 | 10 |
| **Corrosion Properties*** | **Slightly Scale Forming** | | |
| Ryznar Index (RI) | 6.5 to 7.0 | - | - |
| Langelier Saturation Index (LI) | Slightly > 0 | - | - |
| Calcium Carbonate Precipitation Potential (CCPP) | 4 to 10 mg/L as $CaCO_3$ | - | - |
| Larsons Ratio (LR) | $Alk/(Cl^- + SO_4^{2-}) > 5$ | - | - |

* *No TCEQ or USEPA drinking water standards have been established for these constituents*

The water quality goals in Exhibit 1 reflect TCEQ standards (30 TAC 290) unless USEPA requirements are more stringent. The water quality levels required by TCEQ for Total Dissolved Solids (TDS), chloride, and sulfate can result in gastrointestinal problems for those not accustomed to water at those higher levels, and the City of Bastrop's current water supply is more in line with the USEPA standards at this time. For this reason it is recommended that Bastrop continue to maintain that similar level of quality. Regarding the corrosive potential of the water, it is recommended that treated water be slightly scale forming. This will prevent the water from corroding and damaging components of the distribution system, while forming a light layer of protective scale within the system. No regulatory standards have been established for corrosion properties recommended as treatment goals for this analysis.

The balance of this memorandum characterizes the quality of the raw water sources available to the City of Bastrop, and the anticipated result of blending the waters in the ratios defined previously.

# Assessment Approach

To evaluate potential effects or issues associated with blending various source waters, CH2M HILL analyzed chemical characteristics of each water separately, and then estimated the resulting water characteristics if the waters were blended at the ratios described previously. Water chemistry changes resulting from treatment and the corrosion analysis were calculated using the Water Blending!PRO™ by ChemSW®, Inc. Other parameters and constituents that are mixed, but not modified, during treatment were predicted using a simple mass balance approach. It was assumed for the calculations that all mixing was thorough and complete.

Several corrosion indices exist for evaluating various waters. These do not directly measure water corrosivity, because such a direct measure does not exist. Rather, these indicators quantify a water's tendency to deposit calcium carbonate ($CaCO_3$) scale, recognizing that corrosion a complex process that depends on both the water's chemical characteristics and the distribution system. The most commonly used index is the Langelier Saturation Index. The Langelier Saturation Index is calculated as the difference between the measured (or actual) pH in water and the hypothetical pH (pHs) the water would have if it were in equilibrium with solid CaCO3 at the existing concentrations of bicarbonate ion (HCO3-) and calcium ion (Ca2+). A Langelier Saturation Index value greater than zero indicates that a water is slightly scale-forming.

# Raw Water Quality

The historical range of raw water quality of the various water sources being considered is presented in **Exhibit 2**. Each of the water sources is subsequently discussed.

Historically, groundwater sample results in the Bastrop area do not indicate arsenic or radiochemical levels with exceedances beyond regulatory limits. Therefore, these constituents are not commonly analyzed for water supplies in this area. However, in some groundwater sources nationally, naturally occurring arsenic, radium, perchlorate, chromium VI and the other constituents of note are observed in aquifer formations that have high iron and manganese content. Emerging regulatory standards in other states have established more stringent water quality limits for these constituents than those in 30 TAC 290. While the data review indicated compliance with existing standards in Texas, additional testing prior to final design is recommended to confirm if additional treatment or varied blending ratios should be considered during planning for phased implementation. It is recommended that the testing focus on specific wells or areas that would be an attractive water supply.

**EXHIBIT 2**

Water Quality from Alluvial Wells, Simsboro Wells, Colorado River and Treated Colorado River Sources

| Constituent | Goal | TCEQ Standard | Raw Alluvial Wells | | | Raw Simsboro | | | Raw Colorado | | | Treated Colorado* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Avg | Min | Max | Avg | Min | Max | Avg | Min | Max | Avg |
| TDS (mg/L) | <500 | 1000 | 340.4 | 739.0 | 454.2 | 133.1 | 1985.0 | 497.0 | 341 | 365 | 353 | | | 353 |
| pH | 6.5-8.5 | 6.5-8.5 | 4.4 | 8.2 | 7.3 | 5.7 | 8.7 | 7.3 | 7.1 | 9.0 | 8.1 | | | 7.2 |
| Total Alkalinity (mg/L) | >100 | -- | 0.0 | 363.5 | 251.2 | 16.9 | 558.3 | 195.9 | 114.0 | 225.0 | 165.7 | | | 147.0 |
| Calcium (mg/L) | - | - | 43.0 | 272.4 | 106.2 | 4.0 | 382.0 | 68.0 | 53.5 | 53.5 | 53.5 | | | 53.5 |
| Magnesium (mg/L) | - | - | 8.0 | 111.8 | 26.2 | 1.9 | 83.0 | 13.8 | 22.0 | 22.0 | 22.0 | | | 22.0 |
| Iron (mg/L) | 0.30 | 0.30 | 0.078 | 0.078 | 0.078 | 0.222 | 8.868 | 2.582 | 0.038 | 0.249 | 0.099 | | | 0.10 |
| Manganese (mg/L) | 0.05 | 0.05 | 0.046 | 0.046 | 0.046 | 0.015 | 0.380 | 0.150 | 0.008 | 0.024 | 0.013 | | | 0.013 |
| Chloride (mg/L) | <250 | 300 | 13.0 | 176.0 | 48.8 | 7.5 | 580.0 | 89.5 | 20.8 | 204.0 | 58.8 | | | 58.8 |
| Sulfate (mg/L) | <250 | 300 | 15.0 | 241.0 | 67.0 | 5.0 | 928.0 | 87.4 | 15.0 | 101.0 | 46.5 | | | 46.5 |
| Nitrate (mg/L) | 10 | 10 | 1.1 | 78.0 | 17.0 | 0.0 | 11.0 | 0.7 | 0.3 | 8.8 | 1.5 | | | 1.5 |
| **Corrosion Properties** | **Slightly Scale Forming** | | | | | | | | | | | | | |
| Ryznar Index (RI) | 6.5 to 7.0 | - | | | 6.77 | | | 7.32 | | | 6.93 | | | 7.92 |
| Langelier Saturation Index (LI) | Slightly > 0 | - | | | 0.26 | | | -0.01 | | | 0.58 | | | -0.36 |
| Calcium Carbonate Precipitation Potential (CCPP) | 4 to 10 mg/L as $CaCO_3$ | - | | | 22.33 | | | -0.04 | | | 13.20 | | | -16.28 |
| Larsons Ratio (LR) | Alk/($Cl^-$ + $SO_4^{2-}$) > 5 | - | | | 1.8 | | | 0.9 | | | 1.3 | | | 1.0 |
| Temperature (C°) | | | 21.0 | 25.0 | 22.7 | 21.0 | 34.8 | 25.5 | 4.3 | 31.5 | 21.2 | 4.3 | 31.5 | 21.2 |

**Surface waters must be treated, and this treatment impacts water chemistry parameters that affect corrosion potential. For this reason it was assumed that Colorado River water underwent conventional treatment as described in the text.*

*Data Sources: Data obtained from or provided by K Friese and Associates, and City of Austin. (Original data and data sources are included as Appendix A).*

## Raw Alluvial Water

Existing water supply data in Exhibit 2 and Appendix A-1 show that the City of Bastrop alluvial wells have met all water quality goals except for nitrate; demonstrating the overall quality of the current raw water source. As identified in Appendix A-1, nitrate levels greater than 10 mg/L were observed in six of the Bastrop County wells sampled. Of these, one belongs to the City of Bastrop, constructed in 1950. This well has since been plugged, and is no longer in use. With regard to corrosion potential, the water appears to be slightly scale-forming based on the Langelier Saturation Index.

## Simsboro Aquifer Water

Raw water from Simsboro aquifer wells in Bastrop County, on average, meets water quality goals except for iron and manganese. Iron and manganese are found at fairly high levels which will require treatment to remove or limit blending with the existing alluvial wells. In terms of scale-forming potential, the water on average appears to be fairly neutral based on the Langelier Saturation Index, and similar to the existing alluvial wells that are only slightly scale-forming.

Of particular note regarding the Simsboro water is the wide range of water quality as presented in Exhibit 2. It appears, however, that these extreme values are a more localized effect, manifesting in specific wells in the aquifer. Therefore, the conclusions drawn regarding Simsboro are based on average water quality data, recognizing that there is a chance of hitting a "hot spot" with extremely high temperature or high TDS water for these wells. If a well appears to produce water of this type, it is recommended that that well not be utilized, and that water from more typical Simsboro wells be utilized as a water source for the City of Bastrop.

## Colorado River Water

Raw water diverted from the Colorado River would require surface water treatment to meet drinking water standards, as TCEQ requires that all surface waters be treated. The raw water quality data in Exhibit 2 were used to estimate the impact of treatment on the various parameters. The resulting treated water quality characteristics are also presented in Exhibit 2. To project the quality of treated water, it was assumed that:

- conventional coagulation-flocculation-sedimentation-filtration process;
- alum was added as a coagulant at 30 mg/L; and
- chlorine was added at 4 mg/L as a disinfectant.

This type of treatment is expected to mainly impact alkalinity and pH, which affects the corrosive quality of the water but has little impact on other parameters of concern such as iron and manganese. Treated Colorado River water is expected to be slightly corrosive; therefore, it may require additional chemical addition or proper blending ratios to result in slightly scale-forming blended water when mixed with existing alluvial wells.

Treatment of Colorado River water would also have to carefully evaluate the potential to form disinfection byproducts such as trihalomethanes (THMs) or haloacetic acids (HAAs), which can be formed when water's organic carbon reacts with free chlorine in the distribution system or at the treatment plant. Further analysis would be required to confidently predict the risk of this occurring, but if this is the case the treatment plant could be designed to use an alternative disinfection chemical such as chloramines. Chloramine has been used successfully by other municipalities to reduce disinfection by-products (DBP) formation in treated Colorado River water.

# Blending Assessment

The chemistry of blending water from the City of Bastrop's existing wells with the new water sources described above was evaluated. Assumed flow rates for each of the blending scenarios are presented in **Exhibit 3**. Anticipated water quality resulting from these blending scenarios is presented in **Exhibit 4**. Blending chemistry was predicted through use of Water Blending!PRO™ by ChemSW®, Inc.

**EXHIBIT 3**
Blending Scenarios

| | Bastrop Alluvial Wells, MGD | Simsboro Wells in Bastrop, MGD | Treated Colorado River Water, MGD |
|---|---|---|---|
| Scenario 1 | 3.85* | 11.15 | 0 |
| Scenario 2 | 3.85 | 0 | 11.15 |
| Scenario 3 | 3.85 | 5.575 | 5.575 |

* Approximately 2700 gpm

**Exhibit 4** compares the anticipated water quality of each blended water with the water quality goals established in **Exhibit 1**. For each blended water, parameters at risk of violating the goals are identified, and options are presented that can bring the blended water into compliance with the water quality goals.

In general, the water quality of the Simsboro and treated Colorado River water dominate the blending scenarios, because these waters are blended in significantly higher quantities than the existing alluvial sources. In addition, these water sources both require treatment beyond what is needed for the alluvial wells. Each blend is discussed in more detail below.

**EXHIBIT 4**
Results of Blending Model

| Constituent | Goal | Existing Alluvial Wells | Scenario 1 (Alluvial/Sims) | Scenario 2 (Alluvial/Colorado) | Scenario 3 (Alluvial/Colorado/Sims) |
|---|---|---|---|---|---|
| | | Avg | Avg | Avg | Avg |
| TDS (mg/L) | <500 | 454.2 | 486 | 379 | 432 |
| pH | 6.5-8.5 | 7.3 | 7.30 | 7.23 | 7.28 |
| Total Alkalinity (mg/L) | >100 | 251.2 | 210.1 | 173.7 | 191.9 |
| Calcium (mg/L) | - | 106.2 | 77.8 | 67.0 | 72.4 |
| Magnesium (mg/L) | - | 26.2 | 17.0 | 23.1 | 20.0 |
| Iron (mg/L) | 0.30 | 0.078 | 1.9 | 0.09 | 1.01 |
| Manganese (mg/L) | 0.05 | 0.046 | 0.12 | 0.021 | 0.072 |
| Chloride (mg/L) | <250 | 48.8 | 79.1 | 56.2 | 67.6 |
| Sulfate (mg/L) | <250 | 67.0 | 82.2 | 51.8 | 67.0 |
| Nitrate (mg/L) | 10 | 17.0 | 4.9 | 5.5 | 5.2 |
| **Corrosion Properties** | **Slightly Scale Forming** | | | | |
| Ryznar Index (RI) | 6.5 to 7.0 | 6.77 | 7.15 | 7.54 | 7.33 |
| Langelier Saturation Index (LI) | Slightly > 0 | 0.26 | 0.07 | -0.16 | -0.03 |
| Calcium Carbonate Precipitation Potential (CCPP) | 4 to 10 mg/L as $CaCO_3$ | 22.33 | 4.99 | -8.13 | -1.05 |
| Larsons Ratio (LR) | Alk/($Cl^-$ + $SO_4^{2-}$) > 5 | 1.8 | 1.1 | 1.3 | 1.2 |
| Temperature (C°) | | 22.7 | 24.80 | 21.585 | 21.585 |

## Scenario 1 (Alluvial and Simsboro)

Blending scenario 1 assumes a source water mix of approximately 3.85 MGD (approximately 2,700 gpm) from the existing alluvial wells blended with 11.15 MGD of groundwater from the Simsboro aquifer. Key parameters of concern for this scenario are the same as for the raw Simsboro water: iron and manganese. Because these constituents exceed the water quality goals, additional treatment will be required to reduce the levels of these constituents prior to the use of this water for drinking. There are several treatment options for the treatment of iron and manganese including oxidation processes like aeration, ozonation, permanganate addition, chlorination, and chlorine dioxide addition and/or adsorption processes like ion exchange resins, "green sand" filters, and pyrolusite media. Each treatment or combination of treatments has advantages and disadvantages in regard to cost, removal efficiency, waste stream generation, etc.

Other parameters are expected to meet the water quality goals, so are not of concern assuming that the well produces water of "average" quality and is not drawing from a particular high TDS or high nitrate location. With the blended water, TDS and nitrate levels on average are expected to meet the water quality goal. However, if an alluvial well with high nitrate levels or Simsboro well with high TDS is used then these goals would only be met if the waters are truly mixed. If not mixed, water in localized portions of the distribution system would still see elevated levels. It would be important to design the distribution system so that water from each source is not isolated, as this would not take advantage of the mixing.

The blended water shows an expected Langelier Saturation Index of 0.26, so is likely to be slightly scale forming.

## Scenario 2 (Alluvial and Treated Colorado River Water)

Blending scenario 2 assumes a source water mix of approximately 3.85 MGD (approximately 2,700 gpm) from the existing alluvial wells blended with 11.15 MGD of surface water from the lower Colorado River. Use of surface water would require, at a minimum, conventional treatment as described previously. A disinfectant chemical would have to be carefully selected to minimize production of disinfection by-products. The blended water would result in nitrate levels within allowable standards, assuming that no wells are located in a nitrate "hot spot" (the data indicates that these "hot spots" can exist within Bastrop County alluvial wells). Depending on how the alluvial and surface water are distributed within the distribution system, it may be beneficial to blend the waters prior to treatment, and treat them together at the treatment facility to reduce taste, odor, and other variations.

The blend of waters is expected to have a Langelier Saturation Index of -0.16, so would be slightly corrosive without additional modification. Often adjustments can be made to a water's pH and alkalinity through the addition of sodium hydroxide to make it a more stable water and not corrosive.

### Scenario 3 (Alluvial plus Additional Sources at 50 Percent Simsboro and 50 Percent Treated Colorado River)

Blending scenario 3 assumes a source water mix of approximately 3.85 MGD (approximately 2,700 gpm) from the existing alluvial wells blended with 5.575 MGD of groundwater from the Simsboro aquifer and 5.575 MGD surface water from the lower Colorado River. This scenario would result in water that requires treatment as surface water, plus additional specialized treatment for removal of iron and manganese. For this reason, it appears that the treatment required to provide water under this scenario would require more complex treatment than the other two options. From a compatibility standpoint, the blend at these ratios is projected to produce a stable water that is very similar in water quality to the current alluvial water used by the City of Bastrop. With the treatment noted above, the blended water would meet all of the quality goals listed.

The degree of complexity and relative cost implications for treatment requirements resulting from these three sources would require more detailed analysis. An evaluation of the costs and risks of the overall source water location, treatment siting and design, and distribution would be required to optimize design and cost factors.

## Discussion and Recommendations for Further Evaluation

Careful consideration should be made to determine if the distribution system would result in a true blend of the waters, or if local areas will be served primarily by one of the water sources. Depending on how the blending occurs in the distribution system it may be beneficial to treat all of the blended water together, or it may alternately be beneficial to treat either the Simsboro aquifer or the Colorado River water separately prior to blending. Based upon these results, the following observations can be made:

1. Of all the sources, the alluvial water requires the least amount of treatment.
2. Blending the various sources in the quantities available does not eliminate the need for treatment.
3. Surface water from the Colorado River must be treated per TCEQ and USEPA requirements to remove pathogens and turbidity; however, even with treatment it is very compatible with the other sources.
4. Simsboro aquifer groundwater data in the Bastrop area consistently indicates high levels of iron and manganese. The iron and manganese will need to be reduced by treatment prior to pumping into the distribution system. The other general water quality constituents are very compatible with the other water sources.
5. To verify water quality, perform additional water quality testing for any specific wells or areas that would be an attractive water supply.

# Appendix A - Water Quality Data

**Draft Table A-1: Alluvium Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 340.4 | 739.0 | 454.2 | 13 | 1000 | 0 | 0% |
| pH** | 4.4 | 8.2 | 7.3 | 13 | 6.5-8.5 | 1 | 8% |
| Total Alkalinity (mg/L)** | 0.0 | 363.5 | 251.2 | 13 | -- | -- | -- |
| Temperature (C°)** | 21.0 | 25.0 | 22.7 | 3 | -- | -- | -- |
| Iron (mg/L)* | 0.078 | 0.078 | 0.078 | 1 | 0.30 | 0 | 0% |
| Manganese (mg/L)* | 0.046 | 0.046 | 0.046 | 1 | 0.05 | 0 | 0% |
| Calcium (mg/L)** | 43.0 | 272.4 | 106.2 | 13 | -- | -- | -- |
| Magnesium (mg/L)** | 8.0 | 111.8 | 26.2 | 13 | -- | -- | -- |
| Sodium (mg/L)** | 9.0 | 151.0 | 41.3 | 13 | -- | -- | -- |
| Chloride (mg/L)** | 13.0 | 176.0 | 48.8 | 13 | 300 | 0 | 0% |
| Sulfate (mg/L)** | 15.0 | 241.0 | 67.0 | 13 | 300 | 0 | 0% |
| Bicarbonate (mg/L)** | 0.0 | 475.8 | 309.4 | 13 | -- | -- | -- |
| Nitrate (mg/L)** | 1.1 | 78.0 | 17.0 | 13 | 10 | 6 | 46% |

* Based on data from Bastrop public supply well BB-PW1

**Based on data from Bastrop well BB-PW1 and Texas Water Development Board records

**Draft TableA-2: Simsboro Groundwater Quality (Bastrop County)**

| Constituent | Min | Max | Average | Number of Wells | TCEQ Standard | Number of Wells Exceeding Standards | Percent of Wells Exceeding Standards |
|---|---|---|---|---|---|---|---|
| TDS (mg/L)** | 133.1 | 1985.0 | 497.0 | 59 | 1000 | 3 | 5% |
| pH** | 5.7 | 8.7 | 7.3 | 58 | 6.5-8.5 | 8 | 14% |
| Total Alkalinity (mg/L)** | 16.9 | 558.3 | 195.9 | 58 | -- | -- | -- |
| Temperature (C°)** | 21.0 | 34.8 | 25.5 | 30 | -- | -- | -- |
| Iron (mg/L)* | 0.222 | 8.868 | 2.582 | 9 | 0.30 | 8 | 89% |
| Manganese (mg/L)* | 0.015 | 0.380 | 0.150 | 9 | 0.05 | 7 | 78% |
| Calcium (mg/L)** | 4.0 | 382.0 | 68.0 | 58 | -- | -- | -- |
| Magnesium (mg/L)** | 1.9 | 83.0 | 13.8 | 58 | -- | -- | -- |
| Sodium (mg/L)** | 16.2 | 400.1 | 84.1 | 58 | -- | -- | -- |
| Chloride (mg/L)** | 7.5 | 580.0 | 89.5 | 59 | 300 | 2 | 3% |
| Sulfate (mg/L)** | 5.0 | 928.0 | 87.4 | 59 | 300 | 1 | 2% |
| Bicarbonate (mg/L)** | 20.5 | 655.0 | 232.9 | 58 | -- | -- | -- |
| Nitrate (mg/L)*** | 0.0 | 11.0 | 0.7 | 49 | 10 | 2 | 4% |

* Based on data from The Railroad Commission of Texas quarterly water quality reports for the Three Oaks Mine (Lee and Milam Counties)

**Based on data from The Railroad Commission of Texas and Texas Water Development Board records

*** Based on data from Texas Water Development Board records

## Appendix A-3 COLORADO RIVER AT LOOP 150 SOUTH OF BASTROP (12462)

http://waterquality.lcra.org/events.aspx

| | Minimum | Average | Maximum |
|---|---|---|---|
| Depth (m) | 0.3 | 0.35 | 1.8 |
| DAYS SINCE PRECIP | 0.0 | 4.1 | 18.0 |
| STREAM FLOW INST-CFS | 49 | 1563 | 10938 |
| FLOW MEASUREM METHOD | 1 | 1 | 2 |
| STREAM FLOW SEVERITY | 2 | 3.1 | 5 |
| REDOX ORP MV | 0.2 | 316 | 487 |
| DO MG/L | 5.4 | 8.9 | 18.8 |
| DO SATUR PERCENT | 69.4 | 101.0 | 141 |
| PH SU | 7.1 | 8.1 | 9.0 |
| PRESENT WEATHER USE CODE | 2 | 2.4 | 3 |
| CNDUCTVY FIELD MICROMHO | 337 | 591 | 909 |
| STREAM FLOW EST CFS | 302 | 1072 | 2000 |
| WATER TEMP CENT | 4.3 | 21.2 | 31.5 |
| TRANSP SECCHI METERS | 0.03 | 0.59 | 1.74 |
| TURBIDTY FIELD NTU | 1.8 | 23 | 335 |
| TURB TRBIDMTR HACH FTU | 0.8 | 25.2 | 95 |

| | | | |
|---|---|---|---|
| WIND INTENSIT CODE | 1 | 1.6 | 2 |
| E COLI IDEXX MPN100ML | 6 | 233 | 4900 |
| E. COLI #/100 ML | 0 | 100 | 1100 |
| FEC COLI MFM-FCBR # /100ML | 0 | 100 | 2000 |
| T ALK CACO3 MG/L | 114 | 166 | 225 |
| BOD 5 DAY MG/L | 1 | 1.8 | 4 |
| T ORG C C MG/L | 2.00 | 3.65 | 8.00 |
| COD LOWLEVEL MG/L | 5 | 11 | 28 |
| CHLORIDE CL MG/L | 20.8 | 58.8 | 204.0 |
| CHLRPHYL A UG/L CORRECTD | 0.0 | 3.1 | 33.7 |
| CHLRPHYL A-PHYTO CHFLUG/L | 0.6 | 1.6 | 3.2 |
| HARDNESS DISS.CAL MG/L | 201 | 226 | 271 |
| TOT HARD CACO3 MG/L | 196 | 208 | 224 |
| N03-N TOTAL MG/L | 0.25 | 1.5 | 8.8 |
| NO2-N TOTAL MG/L | 0.01 | 0.04 | 0.44 |
| N02&N03 N-TOTAL MG/L | 0.06 | 2.0 | 8.9 |

| | | | |
|---|---|---|---|
| NH3-N TOTAL MG/L | 0.01 | 0.07 | 0.6 |
| TOT KJEL N MG/L | 0.07 | 0.64 | 3.63 |
| O-P DISS FIELDFIL MG/L | 0.02 | 0.48 | 4.66 |
| PHPHTN-A FLR MTHD UG/L | 0.5 | 0.9 | 1.2 |
| PHEOPHTN A UG/L | 0.2 | 2.0 | 10.0 |
| PHOS-T P-WET MG/L | 0.04 | 0.58 | 5.36 |
| RESIDUE BASED ON CON.MG/L | 251 | 299 | 366 |
| RESIDUE TOT NFLT MG/L | 1 | 28 | 330 |
| RESIDUE VOL NFLT MG/L | 1 | 5 | 22 |
| RESIDUE DISS-180 MG/L | 201 | 344 | 542 |
| SULFATE SO4 MG/L | 15 | 47 | 101 |
| MACRO- PHYTE BED (%) | 0 | 2 | 10 |
| ALUMINUM AL,DISS UG/L | 9 | 9 | 9 |
| BARIUM BA,DISS UG/L | 67.1 | 67.1 | 67.1 |
| CALCIUM CA,DISS MG/L | 53.5 | 53.5 | 53.5 |
| CHROMIUM CR,DISS UG/L | 16.9 | 16.9 | 16.9 |

Appendix A-4

## City of Austin's Green WTP Raw and Treated Water Quality Characteristics

| Parameter | Units | Sampling Frequency | Raw Water Average | Raw Water Maximum | Raw Water Minimum | Tap Water Average | Tap Water Maximum | Tap Water Minimum |
|---|---|---|---|---|---|---|---|---|
| 2,4 D | MG/L | one/year | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| 2,4,5 TP | MG/L | one/year | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| ACTINOMYCETES | CFU/1ML | weekly | 2.13 | 19 | 0 | 0.1 | 1 | 0 |
| AMMONIA-NITROGEN (NH3-N) | MG/L | twice/week | 0.07 | 0.26 | 0 | 0.46 | 0.88 | 0.06 |
| ANTIMONY (SB) | MG/L | one/year | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| ARSENIC | MG/L | one/year | | 0.0024 | <0.002 | <0.002 | <0.002 | <0.002 |
| BARIUM (BA) | MG/L | once/quarter | 13.45 | 74 | 0.04 | 0.01 | 0.0099 | 0.0099 |
| BERYLLIUM (BE) | UG/L | once/quarter | | | | | | |
| BLUE-GREEN PLANKTON | ORG/ML | daily | 113.42 | 571 | 0 | | | |
| CADMIUM (CD) | UG/L | once/quarter | 1.33 | 2 | 1 | <0.0002 | <0.0002 | <0.0002 |
| CALCIUM (CA) | MG/L | daily | 57.64 | 101 | 37 | 18.09 | 26 | 14 |
| CALCIUM HARDNESS | MG/L | daily | 144.14 | 252 | 92 | 45.33 | 123 | 36 |
| CARBONATE ALKALINITY (P-ALK) | MG/L | daily | 0.03 | 24 | 0 | 26.69 | 39 | 17 |
| CHLORIDE (CL) | MG/L | twice/month | 41.72 | 51.2 | 28.9 | 50.79 | 71.5 | 32.8 |
| CHROMIUM (CR) | MG/L | one/year | <0.008 | <0.008 | <0.008 | <0.008 | <0.008 | <0.008 |
| CONDUCTIVITY | UMHOS/CM | twice/month | 535.2 | 582 | 501 | 364.31 | 478 | 46 |
| COPPER (CU) | UG/L | once/quarter | 3.2 | 10 | 0.005 | 0 | 0.0047 | 0.0047 |
| DIATOMS | ORG/ML | daily | 128.24 | 2305 | 0 | | | |
| ECOLI(N+M) | COL/100ML | daily | 257.48 | 6000 | 0 | | | |
| ENDRIN | MG/L | one/year | <0.0004 | <0.0004 | <0.0004 | <0.0004 | <0.0004 | <0.0004 |
| FECAL COLIFORM | COL/100ML | daily | 249.77 | 4360 | 0 | | | |
| FLAGELLATE | ORG/ML | daily | 3255.04 | 306162 | 53 | | | |
| FLUORIDE (F) | MG/L | daily | 0.23 | 0.35 | 0.15 | 0.83 | 1.38 | 0.2 |
| GREEN PLANKTON | ORG/ML | daily | 57.65 | 1304 | 0 | | | |
| IRON (FE) | UG/L | once/quarter | 99 | 249 | 38 | 33.25 | 72 | 10 |
| LEAD (PB) | MG/L | once/quarter | | | | | | |
| LINDANE | MG/L | one/year | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| MAGNESIUM (MG) | MG/L | daily | 19.04 | 32 | 0 | 15.96 | 20 | 7 |
| MANGANESE (MN) | UG/L | once/quarter | 12.63 | 24 | 8 | <0.005 | <0.005 | <0.005 |
| MEMBRANE HPC (MHPC) | | | | | | 86.48 | 352 | 14 |
| MERCURY (HG) | MG/L | one/year | <0.00013 | <0.00013 | <0.00013 | <0.00013 | <0.00013 | <0.00013 |
| METHOXYCHLOR | MG/L | one/year | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| NICKEL (NI) | MG/L | once/quarter | 0.01 | 0.0089 | 0.0089 | 0.01 | 0.006 | 0.006 |
| NITRATE-NITROGEN (NO3-N) | MG/L | twice/month | 0.42 | 0.65 | 0.22 | 0.47 | 1.52 | 0.01 |
| PH | | daily | 7.92 | 8.6 | 7.3 | 9.95 | 10.5 | 9.5 |
| PHOSPHATE (PO4) | MG/L | three/week | 0.07 | 0.72 | 0 | 1.07 | 1.65 | 0.38 |
| PLANKTON | ORG/ML | daily | 3567.43 | 306812 | 632 | | | |
| SELENIUM (SE) | MG/L | one/year | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 |
| SILICA | MG/L | twice/month | 9.44 | 10.6 | 8.8 | 8.94 | 14.5 | 5.7 |
| SILVER (AG) | MG/L | one/year | <0.006 | <0.006 | <0.006 | <0.006 | <0.006 | <0.006 |
| SODIUM (NA) | MG/L | twice/month | 20.93 | 25 | 15.9 | 27.65 | 36.5 | 16.6 |
| SULFATE (SO4) | MG/L | twice/month | 28.8 | 32 | 25 | 40.09 | 58 | 23 |
| TASTE AND ODOR T/O | TON | daily | 4.28 | 33 | 4 | 0.03 | 3 | 0 |
| TEMPERATURE | DEG C | daily | 25 | 25 | 25 | 20.5 | 26 | 15 |
| TOTAL ALKALINITY (ALK) | MG/L | daily | 176.75 | 272 | 60 | 61.7 | 87 | 42 |
| TOTAL COLIFORM | COL/100ML | daily | 868.72 | 25000 | 0 | 0.01 | 4 | 0 |
| TOTAL DISSOLVED SOLIDS (TDS) | MG/L | once/week | 353 | 365 | 341 | 180 | 185 | 175 |
| TOTAL HARDNESS | MG/L | daily | 222.24 | 319 | 152 | 110.84 | 140 | 86 |
| TOTAL ORGANIC CARBON (TOC) | MG/L | daily | 2.99 | 12.04 | 1.29 | 2.02 | 14.7 | 0.46 |
| TOTAL SOLIDS | MG/L | once/week | 334.83 | 437 | 233 | 225.38 | 367 | 99 |
| TOXAPHENE | MG/L | one/year | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| TURBIDITY | NTU | daily | 3.57 | 55 | 0.8 | 0.18 | 1.36 | 0 |
| UV254 | CM-1 | three/week | 0.05 | 0.086 | 0.042 | 0.04 | 0.046 | 0.026 |
| ZINC (ZN) | UG/L | once/quarter | 17 | 38 | 5 | 7.5 | 10 | 5 |

Data from January 1, 1991 to August 10, 1995 except once per year data is from 1993 to 1995

Daily is actually week days only

Water Source - Town Lake

Data Source: City of Austin Water Laboratory Data

# Appendix K Water Conservation Plan

**TWDB Approval of the City of Bastrop Water Conservation Plan**

**From:** Adolph Stickelbault [mailto:Adolph.Stickelbault@twdb.state.tx.us]
**Sent:** Tuesday, April 05, 2011 8:17 AM
**To:** Charlotte Gilpin
**Subject:** RE: Bastrop TWDB Regional Water Supply Facilities Study- Water Conservation Plan

Yes you may include that email.

The City of Bastrop's water conservation plan substantially meets the TWDB requirements for the water conservation plan..It is approved.

ALS

Adolph L. Stickelbault
Urban Water Conservation Specialist
Texas Water Development Board
1700 N Congress
P.O. Box 13231(mailing)
Austin, TX 78711
512-936-2391 (tel)
512-936-0816 (fax)

**From:** Adolph Stickelbault [mailto:Adolph.Stickelbault@twdb.state.tx.us]
**Sent:** Wednesday, March 23, 2011 11:01 AM
**To:** Charlotte Gilpin
**Subject:** Re: Bastrop TWDB Regional Water Supply Facilities Study- Water Conservation Plan

Charlotte,
Typically, I would not even review a plan for under $500,000.....under Chapter 363.15 of the Texas Administrative Code, conservation plans are not required...however, I do understand that it is in the Scope of Work. Usually when I review a plan required under 363.15, I do a write-up for the Board. However, I will not do a write up in this case (under $500,000).

Since I won't do a write up, the plan is approved. If you want to improve the plan, I suggest a section on A. Schedule of Implementation and,

B. A method for tracking the implementation and effectiveness of the plan...these two item are in the TWDB rules.

Adolph

as always, contact me if you have questions.

Adolph L. Stickelbault
Urban Water Conservation Specialist
Texas Water Development Board
1700 N Congress
P.O. Box 13231(mailing)
Austin, TX 78711
512-936-2391 (tel)
512-936-0816 (fax)

CHAPTER 13 UTILITIES

## ARTICLE 13.10 WATER CONSERVATION PLAN

### Division 1. Generally

#### Sec. 13.10.001 Adopted

That the city water conservation plan is made part hereof, and the same is hereby, adopted as the official policy of the city. In addition to filing with the Texas Commission on Environmental Quality, a copy of the wastewater conservation plan shall be maintained in the city's files and placed on the city website in order that the public may have ready access to the plan.

#### Sec. 13.10.002 Introduction and objectives

(a) Water supply has always been a key issue in the development of the state. In recent years, the increasing population and economic development in the Texas Water Development Board Lower Colorado Regional Water Planning Group (Region K) have led to growing demands for water. Additional supplies to meet higher demands are becoming increasingly expensive and difficult to develop. Therefore, it is imperative that we make efficient use of existing supplies and make them last as long as possible. This will delay the need for new supplies, minimize the environmental impacts associated with developing new supplies, and delay the high cost of additional water supply development.

(b) Recognizing the need for efficient use of existing water supplies, the Texas Commission on Environmental Quality (TCEQ) has developed guidelines and requirements governing the development of water conservation plans for public water suppliers. The TCEQ rules governing development of water conservation plans for public water suppliers are contained in title 30, part 1, chapter 288, subchapter A, rule 288.2 of the Texas Administrative Code. For the purpose of these rules, a water conservation plan is defined as:

> "A strategy or combination of strategies for reducing the volume of water withdrawn from a water supply source, for reducing the loss or waste of water, for maintaining or improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water. A water conservation plan may be a separate document identified as such or may be contained within another management document(s)."

(c) The city has adopted this water conservation plan pursuant to TCEQ guidelines and requirements. The objectives of this water conservation plan are:

(1) To reduce water consumption.

(2) To reduce the loss and waste of water.

(3) To identify the level of water reuse.

(4) To improve efficiency in the use of water.

(5) To extend the life of current water supplies/facilities by reducing the rate of growth in demand.

#### Secs. 13.10.003–13.10.030 Reserved

## Division 2. Utility Profile

### Sec. 13.10.031 Summary

The following is a brief summary of the city's utility profile. A detailed summary may be found in appendix A of Ordinance 2010-8.

### Sec. 13.10.032 Population and customer data

(a) The city's water and wastewater department manages a water distribution service area over 10 square miles in area and serves a population of approximately 8,700 people. The city provides drinking water to its customers through a network of approximately 66 miles of transmission and distribution lines and 2,747 connections.

(b) The official U.S. Census population count for the city in 2000 was 5,340, an increase of 32 percent from the 1990 Census. Population projections for the city, based on the number of connections over the last five years, forecasts the city's population to reach 9,094 in 2010 and 10,425 in 2020 slightly higher than what is projected by the state water development board. In comparison, the city's water consumption peak day demand is expected to increase to almost 2.4 MGD in 2010 and over 2.7 MGD in 2020.

### Sec. 13.10.033 Water use data

(a) Table 1 below summarizes key water use statistics for 2004–2009. Average per person usage is given in gallons per capita per day (gpcd). Average and peak daily water demand is given in million gallons per day (MGD). The peak day to average day ratio varies between 1.54 and 1.97, meaning that peak day demand is not quite twice the average demand.

(b) The peak demand for the city is 2.278 MGD, reached in the 2008–2009 fiscal year. During high demand periods when large volumes of water are being pumped from the aquifer, the production capacity of the wells is reduced due to declining water levels of the aquifer. The city's water production and pumping system capacity is currently 2.6 MGD; however, there is a new water well coming on line in the summer of 2010 that will increase capacity to over 3.1 MGD.

Table 1: Municipal Water Demand 2004–2009

| | | | | | |
|---|---|---|---|---|---|
| Fiscal year | 2004–2005 | 2005–2006 | 2006–2007 | 2007–2008 | 2008–2009 |
| | | | | | |
| Peak GPCD | 305 | 278 | 211 | 274 | 262 |
| | | | | | |
| Annual average GPCD | 155 | 166 | 137 | 159 | 151 |
| | | | | | |
| Peak day (MGD) | 2.268 | 2.152 | 1.703 | 2.271 | 2.278 |
| | | | | | |
| Average day (MGD) | 1.150 | 1.287 | 1.106 | 1.323 | 1.311 |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Peaking factor | 1.97 | 1.67 | 1.54 | 1.72 | 1.74 |
| | | | | | |
| Water production capacity* | 1.9 | 1.9 | 2.6 | 2.6 | 2.6 |
| | | | | | |

*A new water well will be added in the summer of 2010 that will increase capacity by 0.576 MGD.

**Sec. 13.10.034 Water production and delivery system**

(a) The city utilizes ground water for its public water supply and has developed its own water production facilities.

(b) The city has five ground water wells located near the Colorado River which withdraw water from an alluvium of the Colorado River. A sixth well will be coming on line in the summer of 2010. The city's water distribution system includes three ground storage tanks, a standpipe, and an elevated storage tank providing a total storage capacity of 2,475,000 gallons.

**Sec. 13.10.035 Wastewater collection and treatment system**

Raw wastewater in the city travels through a network of over 50 miles of wastewater collection lines and numerous lift stations to two wastewater treatment plants. The wastewater treatment plants serve a population of approximately 8,700 people with an average daily discharge between 0.650 and 0.700 MGD and a design capacity of 1.4 MGD.

**Secs. 13.10.036–13.10.060 Reserved**

## Division 3. Conservation Goals

## Part I. In General

**Sec. 13.10.061 Purpose**

The purpose of this water conservation plan is to reduce long-term demand on limited water resources by encouraging more efficient water use practices in the city. Its primary goals are to reduce peak seasonal water demand and reduce the peaking factor on the water production and delivery system. Under the authority of the water and wastewater department, the city will implement and enforce the conservation plan.

**Sec. 13.10.062 Peak demands**

(a) TCEQ rules require the city to have the capacity to meet escalating peak daily demands, which, as shown in table 1 on the previous page, can be almost twice the average demand. Thus, reducing those peak demands will allow the city to defer expenditures for production facilities and provide for more efficient use of available water resources.

(b) The city aims to reduce peak demand through two methods: (1) programs targeted at reducing peak per capita demand, and (2) programs aimed at reducing the peaking factor. Table 2 outlines projected targets for reducing per capita demand and peaking factor. The state water conservation implementation task force recommends that municipalities set goals of reducing per capita consumption by one percent each year. The goals proposed in this plan are structured based on this recommendation with the ultimate goal of reducing per capita consumption by 10 percent over the next 10 years.

| Table 2: Municipal Per Capita Water Use Goals | | | |
|---|---|---|---|
| | | | |
| Fiscal year | 2008–2009 | 2013–2014 | 2018–2019 |
| | | | |
| Peak GPCD | 262 | 249 | 236 |
| | | | |
| Annual average GPCD | 151 | 151 | 151 |
| | | | |
| Peaking factor | 1.74 | 1.65 | 1.56 |

**Sec. 13.10.063 City's water loss**

(a) In any system, water loss may occur due to leaks, line breaks, meter inaccuracies, theft, and other issues. The city monitors water production and water billing on a monthly basis and tracks system water loss on a percentage basis.

(b) Over the last five years the city's water loss has varied between 15 and 22 percent. At a minimum the city's goal for unaccounted for water use is to not exceed 15 percent and to continue to investigate ways to improve water accountability and reduce unaccounted for water to an ultimate goal of 10 percent or less.

**Sec. 13.10.064 Periodic evaluation of plan**

The goals outlined above are designed to be achieved within 5 to 10 years of the date of adoption of this plan. The city will periodically evaluate the plan in accordance with state and federal regulations to determine the extent, if any, that the plan needs modification.

**Secs. 13.10.065–13.10.090 Reserved**

## Part II. Strategies

**Sec. 13.10.091 Water rate structure**

(a) The city utilizes an inclining water rate structure to encourage customers to reduce both peak and overall water usage, while fairly allocating cost of service to each customer class. Under an inclining rate structure, the rate per thousand increases as the amount of water used increases. The current rate structure charges a minimum monthly service charge based on meter size plus a fee based on consumption. The following is the current water rate structure:

| Residential & Commercial (within city limits) | |
|---|---|
| | |
| Meter Size | Minimum Charge |

| | |
|---|---|
| | |
| 3/4" | $19.89 |
| | |
| 1" | $33.81 |
| | |
| 1-1/2" | $57.02 |
| | |
| 2" | $84.86 |
| | |
| 3" | $125.97 |
| | |
| 4" | $182.99 |
| | |
| 6" | $474.71 |
| | |

Plus the following consumption charges

| | |
|---|---|
| | |
| 0–3,000 gallons | $2.04 per 1,000 gallons |
| | |
| 3,001–5,000 gallons | $2.18 per 1,000 gallons |
| | |
| 5,001–10,000 gallons | $2.31 per 1,000 gallons |
| | |
| 10,001–20,000 gallons | $2.44 per 1,000 gallons |
| | |
| 20,001–50,000 gallons | $2.64 per 1,000 gallons |
| | |
| Over 50,000 gallons | $2.77 per 1,000 gallons |

Residential & Commercial (outside city limits)

| | |
|---|---|
| | |
| Meter Size | Minimum Charge |
| | |
| 3/4" | $29.84 |
| | |

| | |
|---|---|
| 1" | $50.72 |
| | |
| 1-1/2" | $85.53 |
| | |
| 2" | $127.30 |
| | |
| 3" | $238.68 |
| | |
| 4" | $363.99 |
| | |
| 6" | $712.06 |
| | |

| Plus the following consumption charges | |
|---|---|
| | |
| 0–3,000 gallons | $2.97 per 1,000 gallons |
| | |
| 3,001–5,000 gallons | $3.17 per 1,000 gallons |
| | |
| 5,001–10,000 gallons | $3.37 per 1,000 gallons |
| | |
| 10,001–20,000 gallons | $3.57 per 1,000 gallons |
| | |
| 20,001–50,000 gallons | $3.87 per 1,000 gallons |
| | |
| Over 50,000 gallons | $4.07 per 1,000 gallons |

(b) This rate structure will be reviewed on a regular basis to ensure that the rates adequately recover cost of service and meet the goals of the plan.

**Sec. 13.10.092 Wastewater reuse**

The goal for the city's water reuse program is to reduce peak demand on the potable (drinking) water system by switching nonpotable uses of water to reuse water. As part of its program, the city uses treated wastewater effluent for washdown at the treatment plant and for chlorination. The average amount of water reused each month is 1,728,000 gallons.

**Sec. 13.10.093 Water loss control measures**

(a) The goal of the city's water loss control program is to not exceed 15 percent and to ultimately reduce unaccounted for water to a level of 10% or below. Unaccounted for water includes unbilled authorized usage and unbilled unauthorized usage. Unbilled authorized usage includes water used for fighting fires, flushing lines, etc. Unbilled unauthorized usage includes water lost to leaks, theft, etc. In some cases, the age of some of the distribution lines may be contributing to both the unbilled authorized and unauthorized usages. Due to their age, these lines are typically scheduled for more frequent flushing; and because of their age, these lines generally have a higher probability of leaking. However, in order to meet the goals set forth, the city has several programs in place, including routine water audits, a program of leak detection and repair, and meter testing and accuracy.

(b) The water and wastewater department generates a monthly water loss report that compares metered production with metered consumption, as well as accounted for and unaccounted for losses. This report provides an effective tracking system of water loss. The city will also complete a detailed water system audit following state water development board (TWDB) guidelines at least once each year. TWDB rules only require this audit to be submitted once every five years. The water system audit determines the volume of actual water loss, the identification of water loss sources, the status and condition of primary water meters, an analysis of water line breaks, an evaluation of underground leakage potential, and provides recommendations for meter replacement.

**Sec. 13.10.094 Leak detection and repair**

The city administers leak detection and repair programs for its water distribution system. Each year, the city tests one-fourth of its water system and repairs any leaks as they are found. Thus, the entire water system is tested every four years. Additionally, the city has a program that features a work order prioritization system for leaks needing repair and an inventory of equipment and materials needed to promptly repair all detected or reported leaks. The city also has a rehabilitation program to upgrade its aging water distribution system and address high volume leak areas. This program is based on findings in monthly water loss reports and the leak detection programs described above.

**Sec. 13.10.095 Universal metering**

(a) The ability to meter all water distribution and consumption uses allows the city to closely monitor actual water use, water losses, and prevent unauthorized use. All service connections in the city are metered. All production wells, pumping stations, interconnections, irrigation, swimming pools, parks, and municipal structures operated by the city are also metered. Within two years, the city is planning on upgrading its entire meter system to electronic metering for higher accuracy.

(b) Meters at water production pump stations are calibrated and tested annually in accordance with American Water Works Association (AWWA) standards to provide a minimum accuracy of plus or minus five percent (5%).

(c) The city will continue to provide a preventive maintenance program for its water meters, wherein regular scheduled testing, repairs, and replacement are performed in accordance with American Water Works Association (AWWA) standards.

**Sec. 13.10.096 Records management system**

The city administers a comprehensive record management system that accounts for water use characteristics throughout the water system and allows for the separation of aggregate water sales and water usage characteristics into customer-specific categories. The system is configured to provide the following water use information:

(1) Water production.

(2) Water sales.

(3) Water consumption.

(4) Water losses.

**Sec. 13.10.097 Public education program**

The city public education program makes thousands of contacts, both direct and indirect, every year through presentations, community fairs, plant tours, utility bill inserts, newspaper and radio ads, and the city's website. The city promotes water conservation issues by informing the public in the following ways:

(1) Making water conservation information available to new customers.

(2) Making residential water audits available to all customers.

(3) Providing water conservation information to all customers upon request and through the city's website.

(4) Coordinating educational presentations, lectures, and demonstrations for schools, civic groups, and the general public.

(5) Providing exhibits at public events held throughout the year.

(6) Publishing water conservation information on a regular basis in the city's utility bill insert or other written form.

(7) Providing book covers with a water conservation message for Bastrop ISD students.

(8) Participating in community environmental education activities with local organizations to promote water conservation education.

(9) Supporting annual events and demonstrations relating to water conservation and environmental issues that affect water supply and quality.

(10) Selling ECO kits to customers.

**Sec. 13.10.098 Wholesale water supply contracts**

The city will, as part of contracts for sale of water to any other entity reselling water, require that entity to adopt applicable provisions of the city's water conservation plan or have a plan in effect previously adopted and meeting the basic requirements of 30 TAC section 288. These provisions will be through contractual agreement prior to the sale of any water to the water reseller.

**Sec. 13.10.099 Plumbing code and retrofit program**

(a) The city has adopted the International Plumbing Code, which requires the use of water saving, ultra-low flow (ULF) fixtures to be installed in new construction and in the replacement of plumbing in existing structures.

(b) The city educates the residents, plumbers, and contractors on the benefits of retrofitting existing facilities with water saving devices through its public education program. In addition, the city is evaluating the feasibility and cost effectiveness of implementing an ultra-low flow (ULF) rebate program or similar incentive program that would offer cash rebates or other incentives to water customers that replace old toilets, showerheads, and other fixtures with new ULF models.

**Sec. 13.10.100 Landscape water management**

The city provides information about the methods and benefits of water conserving landscaping practices and devices through public education to homeowners, business owners, landscape architects and designers, and irrigation professionals. The following methods are encouraged:

(1) The use of XeriscapeTM and water wise landscaping techniques, including drought tolerant plants and grasses for landscaping new homes and commercial areas.

(2) The use of drip irrigation systems when possible or other water conserving irrigation systems that utilize efficient sprinklers and considerations given to prevailing winds.

(3) Making sure that ornamental fountains and similar water features are designed to recycle water and use minimal amounts of water.

(4) Working with area landscape supply businesses and nurseries to encourage them to sell locally adapted, drought tolerant plants and grasses along with efficient irrigation systems, and to promote use of the materials through demonstrations and advertisements.

**Sec. 13.10.101 Performance measures and reporting**

The city will compile an annual report on the water conservation plan, to include the following:

(1) Summary of public information issued in the previous year.

(2) Report on meter testing program.

(3) Summary of water loss control program.

(4) Effectiveness of water conservation plan in reducing peak and overall water consumption.

(5) Per capita water consumption for the previous calendar year.

(6) Implementation progress and status of plan.

**Sec. 13.10.102 Coordination**

Recognizing that each city has similar water systems and customer bases and similar needs for water conservation, the city will provide copies of the water conservation plan to the Texas Water Development Board Lower Colorado Regional Water Planning Group (Region K).

(Ordinance 2010-8 adopted 5/11/10)

# APPENDIX A
# UTILITY PROFILE

# UTILITY PROFILE

## I. Population and Customer Data

A. Population and Service Area Data

1. Attached is a copy of the service-area map and Certificate of Convenience and Necessity (CCN).
2. Service area size (square miles): 10.31 sq. mi.
3. Current population of service area: 8,700 (estimated)
4. Current population served:

   Water: 8,700

   Wastewater: ~~8,700~~ 8,204

5. Population served by water utility for the previous five years:

| Year | Population |
|---|---|
| 2005 | 7443 |
| 2006 | 7753 |
| 2007 | 8053 |
| 2008 | 8300 |
| 2009 | 8694 |

6. Projected population for service area in the following decades:

| Year | Population |
|---|---|
| 2010 | 9,094 |
| 2020 | 10,425 |
| 2030 | 12,180 |
| 2040 | 13,926 |
| 2050 | 15,663 |

7. Future population estimates were based on the number of connections over the previous five years and projecting out the number of future connections. It was assumed there were an average of three persons per connection. It should be noted these projections are slightly higher than those of the Texas Water Development Board (see attached).

B. Active Connections

1. Current number of active connections. Check whether multi-family service is counted as Residential __X__ or Commercial ____

| Treated water users: | Metered | Not-metered | Total |
|---|---|---|---|
| Residential | 2184 | 0 | 2184 |
| Commercial | 563 | 0 | 563 |

2. List the net number of new connections per year for most recent three years:

| Year | 2007 | 2008 | 2009 |
|---|---|---|---|
| Residential | 88 | -3 | 22 |
| Commercial | -36 | 17 | 24 |

C. High Volume Customers

List annual water use for the five highest volume customers *(indicate if treated or raw water delivery).*

| Customer | | Use (1,000gal./yr.) | Treated/Raw Water |
|---|---|---|---|
| (1) | Texas Parks & Wildlife | 8,125.0 | Treated |
| (2) | Bastrop Country Law Center | 6,511.0 | Treated |
| (3) | Lakeside Hospital | 4,951.5 | Treated |
| (4) | Arbors Apartments | 4,562.5 | Treated |
| (5) | Pine Point Apartments | 3,090.6 | Treated |

## II. Water Use Data For Service Area

A. Water Accounting Data

1. Amount of water use for previous five years (in 1,000 gal.):

Please indicate: Diverted Water 0

Treated Water 2,158,806

| Month | 2008 | 2007 | 2006 | 2005 | 2004 |
|---|---|---|---|---|---|
| January | 30,742 | 31,486 | 33,560 | 25,224 | 29,771 |
| February | 29,352 | 29,465 | 22,601 | 22,601 | 27,870 |
| March | 31,220 | 34,196 | 32,402 | 23,803 | 30,552 |
| April | 34,786 | 30,217 | 35,772 | 29,251 | 31,654 |
| May | 45,939 | 34,135 | 39,489 | 31,535 | 35,481 |
| June | 59,547 | 34,213 | 42,639 | 42,608 | 31,674 |
| July | 53,271 | 32,595 | 43,839 | 43,724 | 38,728 |
| August | 49,061 | 38,294 | 54,734 | 46,492 | 38,534 |
| September | 47,032 | 37,541 | 47,544 | 48,299 | 37,470 |
| October | 42,509 | 39,475 | 40,026 | 37,010 | 28,917 |
| November | 35,986 | 32,891 | 35,303 | 33,425 | 25,550 |
| December | 32,874 | 31,076 | 32,831 | 32,001 | 28,079 |
| Total | 492,229 | 405,584 | 460,740 | 415,973 | 384,280 |

The figures on the previous page were determined from a master meter located at the system entry point from the water plant.

2. Amount of water (in 1,000 gallons) delivered (sold) as recorded by the following account types for the past five years.

| Year | Residential | Commercial | Total Sold |
|---|---|---|---|
| 2008 | 228,974 | 196,770 | 425,744 |
| 2007 | 158,873 | 153,258 | 312,131 |
| 2006 | 205,654 | 183,912 | 389,566 |
| 2005 | 180,320 | 169,749 | 350,069 |
| 2004 | 156,408 | 158,299 | 314,708 |

3. List previous five years records for water loss (the difference between water diverted (or treated) and water delivered (or sold))

| Year | Amount (in 1,000gal.) | % Loss |
|---|---|---|
| 2008 | 66,485 | 13.5 |
| 2007 | 93,453 | 23.0 |
| 2006 | 71,174 | 15.4 |
| 2005 | 65,904 | 15.8 |
| 2004 | 69,572 | 18.1 |

4. Municipal water use for previous five years:

| Year | Population | Total Water Diverted or Pumped for Treatment (1,000 gal.) |
|---|---|---|
| 2008 | 8694 | 492,229 |
| 2007 | 8300 | 405,584 |
| 2006 | 8053 | 460,740 |
| 2005 | 7753 | 415,973 |
| 2004 | 7443 | 384,280 |

B. Projected Water Demands

Population projection and existing water use can be used to determine the projected future water demand for the next 10 years. In 2008, the estimated population was 8,694 persons; and in 2018, the estimated population is predicted to be 10,073 persons. Based on the 2008 demand of 151 gallons per person per day, the projected water demand in 2018 will be 555 million gallons per year.

## III. Water Supply System Data

A. Water Supply Sources

List all current water supply sources and the amounts authorized with each:

| | Source | Amount Authorized |
|---|---|---|
| Surface Water: | N/A | N/A |
| Groundwater: | Alluvium from Colorado River | 5,455 acre-feet |
| Contracts: | N/A | N/A |
| Other: | N/A | N/A |

B. Treatment and Distribution System

1. Design daily capacity of system: 2.6 MGD
2. Storage Capacity: Elevated: 1.250 MGD Ground: 1.225 MGD
   Total: 2.475 MGD
3. If surface water, do you recycle filter backwash to the head of the plant? N/A
4. See the attached water system layout. Included are the number of treatment plants, wells, and storage tanks and a sketch of the system layout.

## IV. WASTEWATER SYSTEM DATA

A. Wastewater System Data

1. Design capacity of wastewater treatment plant(s): 1.4 MGD
2. Is treated effluent used for irrigation on-site _No_, off-site _No_, plant washdown _Yes_, or chlorination/dechlorination _Yes_?
   If yes, approximately 1,728,000 gallons per month.
3. See the attached wastewater system layout. The system discharges into the Colorado River and is permitted under TCEQ Permit Number WQ0011076-001. The owner of the plant is the City of Bastrop and it is operated by the City of Bastrop Water and Wastewater Department.

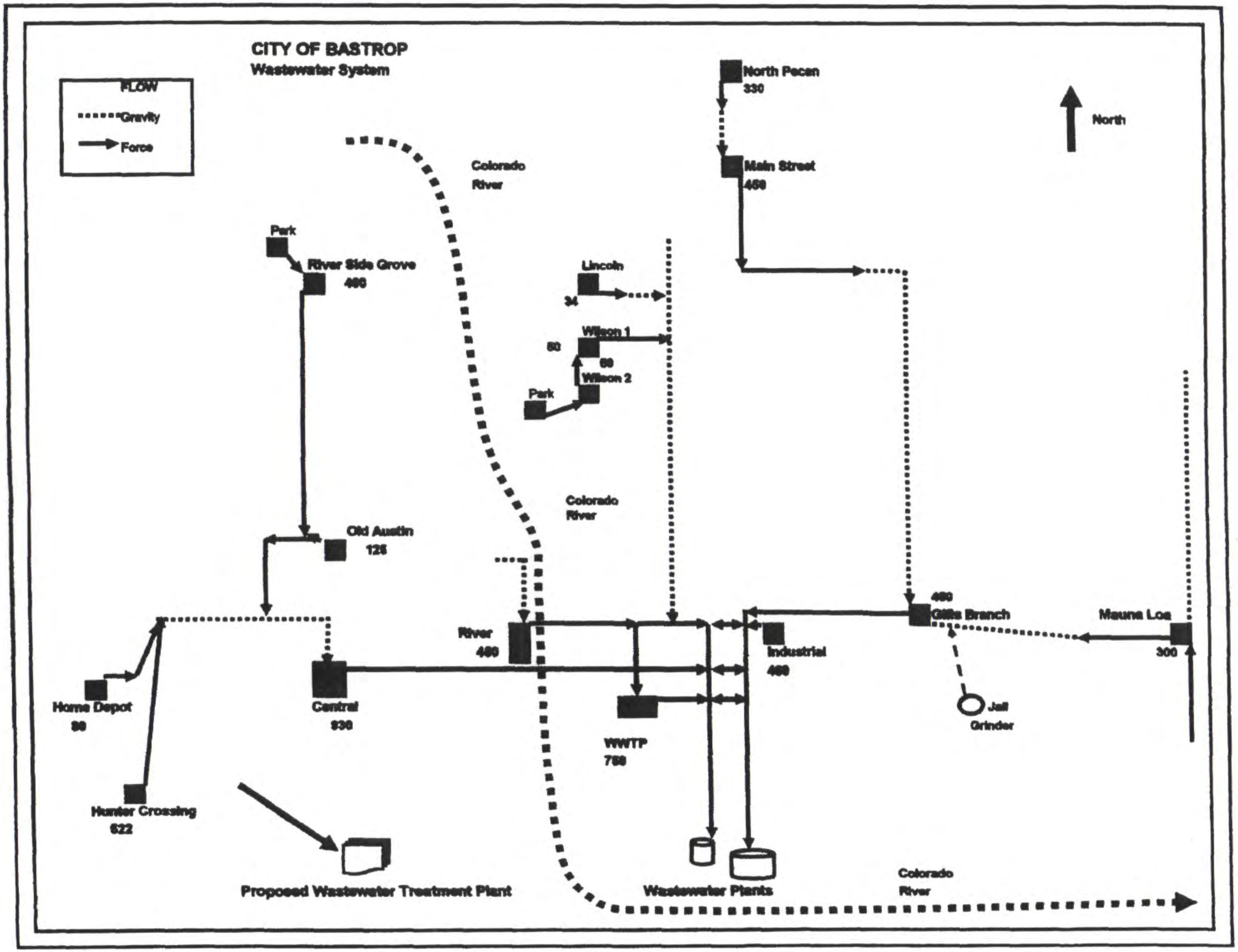
5% septic tanks

B. Wastewater Data for Service Area

1. Percent of water service area served by wastewater system: ~~100%~~ 95%

2. Monthly volume treated for previous three years (in 1,000 gallons):

| Month | 2008 | 2007 | 2006 |
|---|---|---|---|
| January | 19,778 | 22,901 | 20,613 |
| February | 18,908 | 16,783 | 18,769 |
| March | 21,514 | 26,397 | 21,742 |
| April | 20,430 | 21,087 | 21,138 |
| May | 21,240 | 22,661 | 21,715 |
| June | 20,040 | 23,730 | 28,667 |
| July | 19,995 | 26,102 | 19,831 |
| August | 20,863 | 23,095 | 18,000 |
| September | 20,580 | 21,090 | 18,283 |
| October | 20,429 | 20,057 | 19,809 |
| November | 19,820 | 20,430 | 17,256 |
| December | 20,367 | 20,646 | 19,883 |
| Total | 243,964 | 264,979 | 245,706 |



CITY OF BASTROP
Wastewater System
FLOW
Gravity
Force
North
North Pecan
330
Main Street
Colorado River
Park
River Side Grove
Lincoln
34
Wilson 1
Wilson 2
Park
Colorado River
Old Austin
River
Gills Branch
Mauna Loa
300
Industrial
Home Depot
Central
WWTP
Jail Grinder
Hunter Crossing
622
Proposed Wastewater Treatment Plant
Wastewater Plants
Colorado River

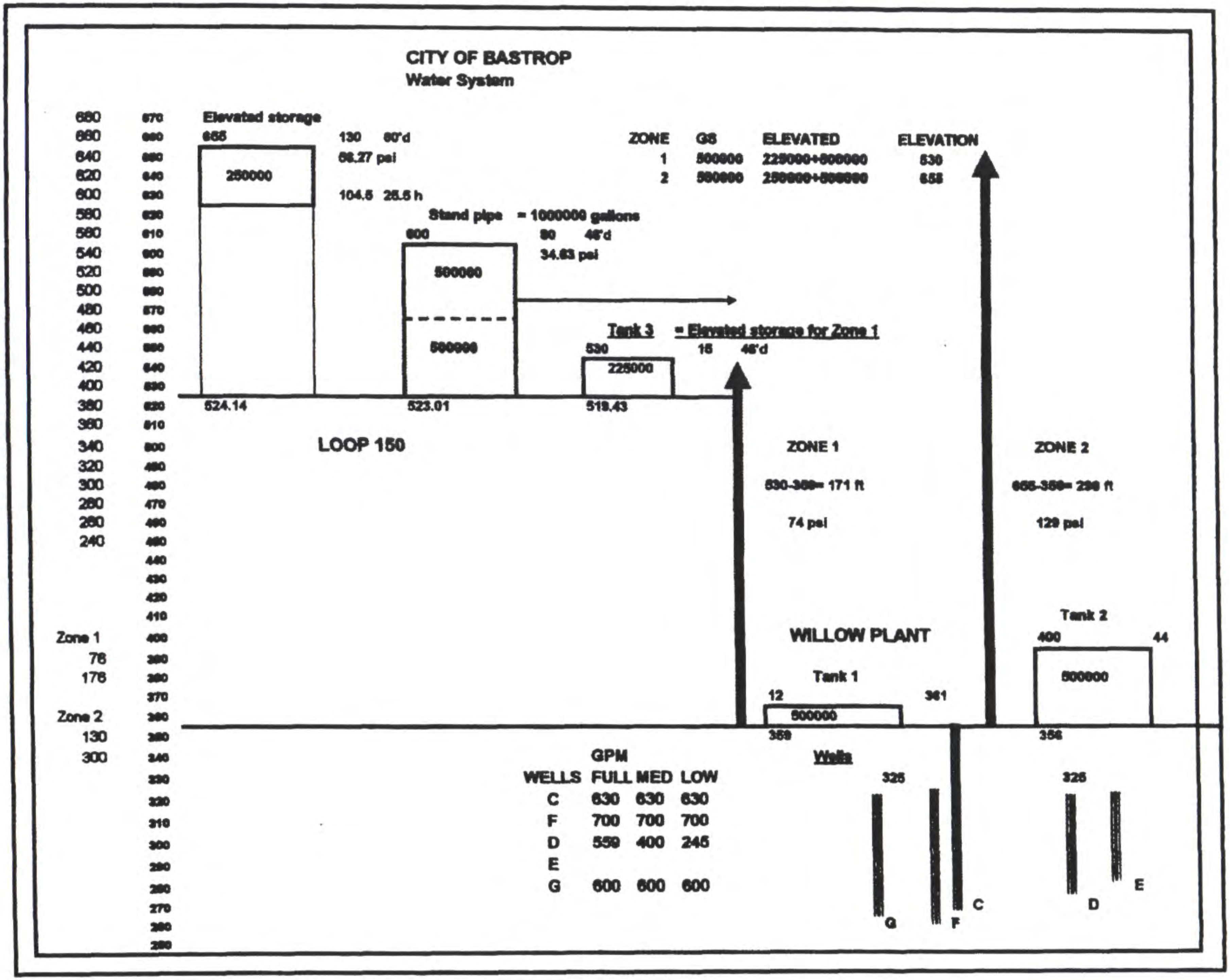
## CITY OF BASTROP

## TREATMENT AND DISTRIBUTION SYSTEM

| Well | gpm Installed | GOOD | DOWN |
|---|---|---|---|
| C | 500 | 550 | 550 |
| F | 1200 | 700 | 700 |
| D | 700 | 480 | 150 |
| E | 700 | 550 | 150 |
| G | 600 | 600 | 600 |
| gpm | 3,700 | 2,880 | 2,150 |
| MGD | 5.328 | 4.1472 | 3.096 |

| High Service | | Full |
|---|---|---|
| 1 | 400 | |
| 2 | 500 | 500 |
| 3 | 750 | 750 |
| 4 | 800 | 800 |
| 5 | 800 | 800 |
| | 3,250 | 2,850 |
| | 4.68 | 4.104 |

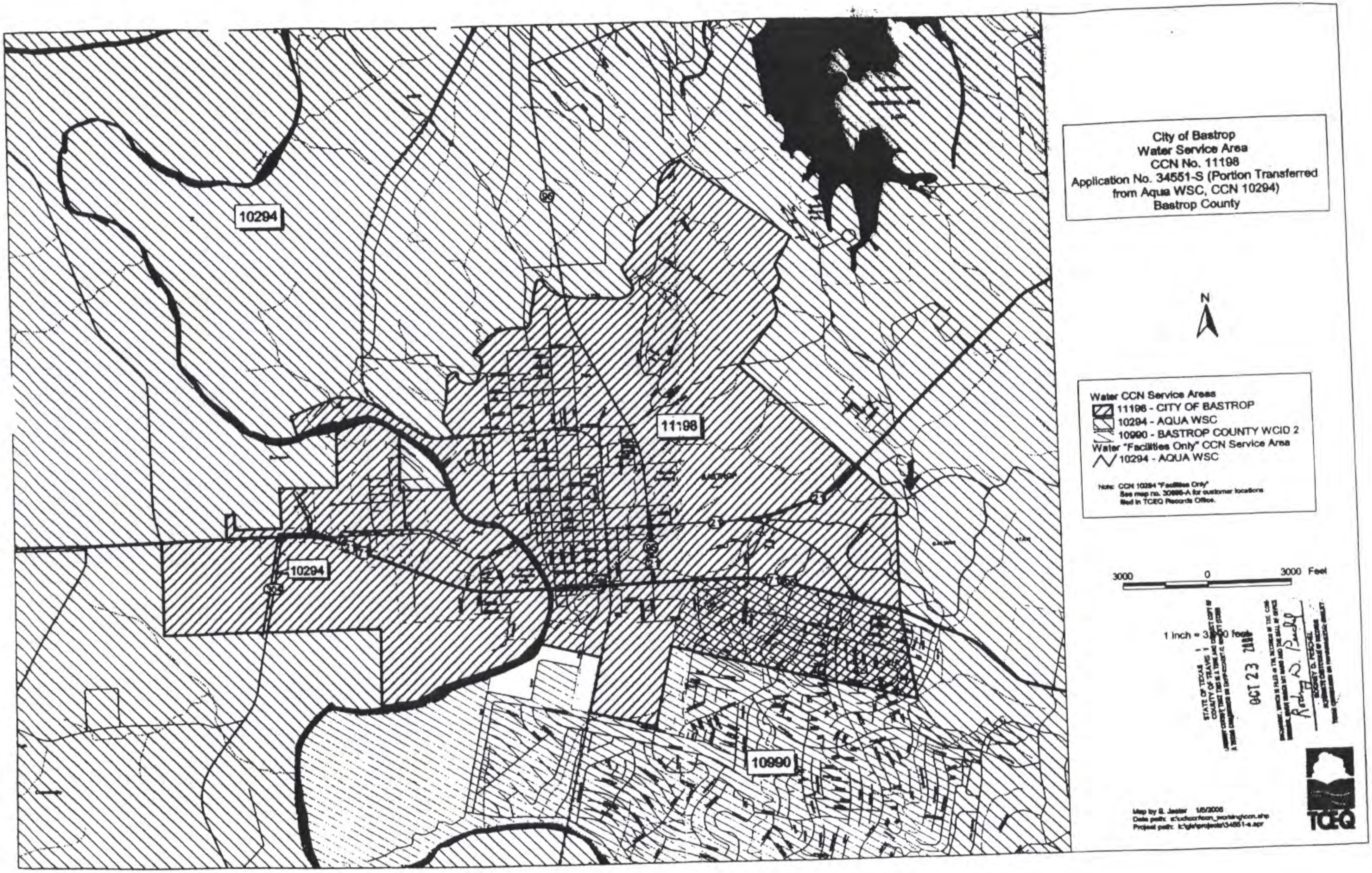
| Tanks | Gallons | Ground | Elevated |
|---|---|---|---|
| 1 | 500,000 | 500,000 | |
| 2 | 500,000 | 500,000 | |
| 3 | 250,000 | | 250,000 |
| SP | 1,000,000 | | 1,000,000 |
| ET | 225,000 | | 225,000 |
| | 2,475,000 | 1,000,000 | 1,475,000 |

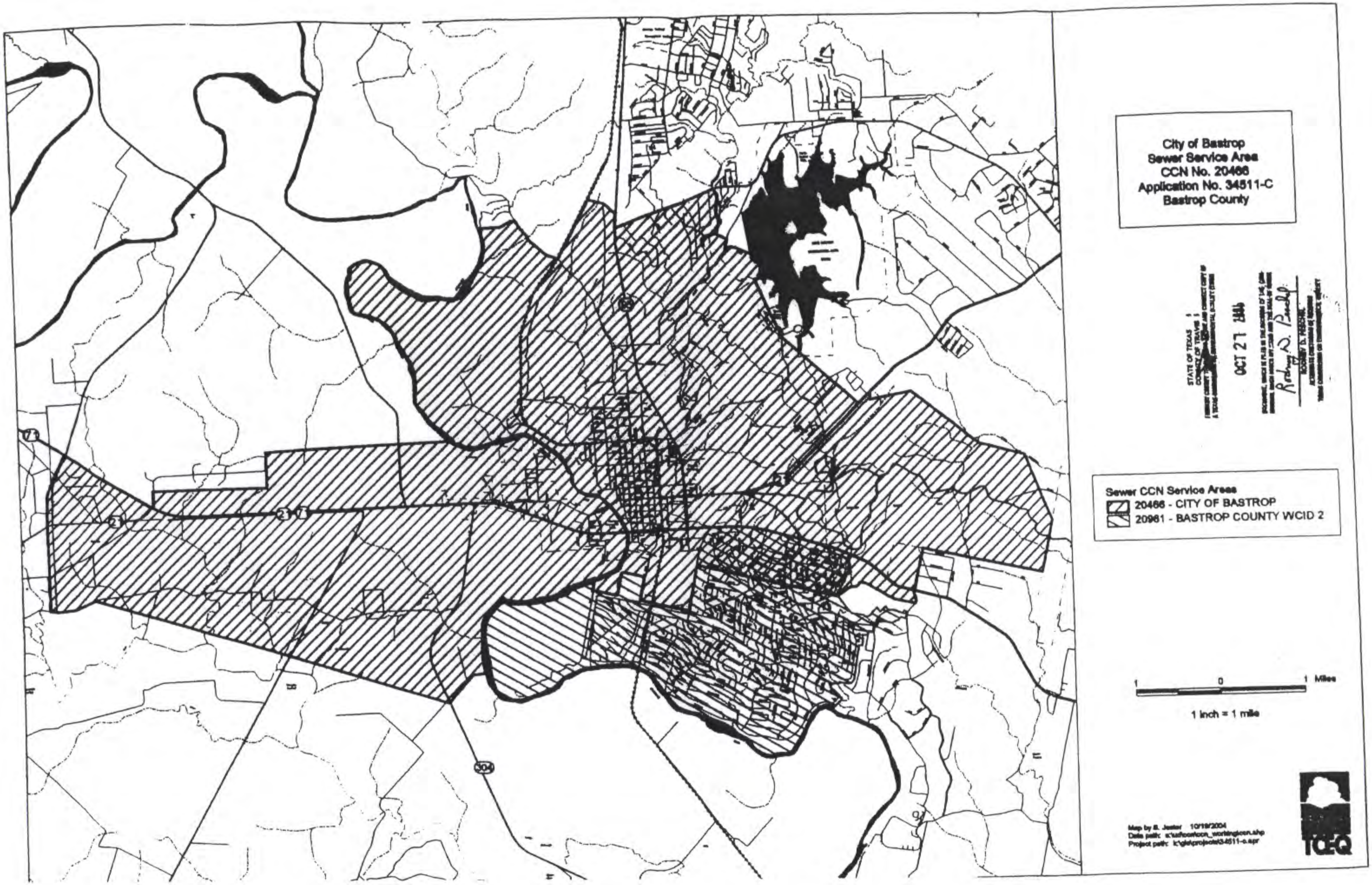


CITY OF BASTROP
Water System
Elevated storage
655
130 60'd
68.27 psi
250000
104.5 25.5 h
Stand pipe = 1000000 gallons
600
80 46'd
34.63 psi
500000
500000
Tank 3 = Elevated storage for Zone 1
530
15 46'd
225000
524.14
523.01
519.43
LOOP 150
ZONE GS ELEVATED ELEVATION
1 500000 225000+500000 530
2 500000 250000+500000 655
ZONE 1
530-359= 171 ft
74 psi
ZONE 2
655-356= 299 ft
129 psi
WILLOW PLANT
Tank 1
12
361
500000
359
Tank 2
400
44
500000
356
Wells
325
325
GPM
WELLS FULL MED LOW
C 630 630 630
F 700 700 700
D 559 400 245
E
G 600 600 600
G
F
C
D
E
Zone 1
76
176
Zone 2
130
300

# Texas Water Development Board
## 2006 Regional Water Plan
## City Population Projections for 2000 - 2060

| CITY NAME | P2000 Census | P2010 | P2020 | P2030 | P2040 | P2050 | P2060 |
|---|---|---|---|---|---|---|---|
| ABERNATHY | 2,839 | 3,105 | 3,329 | 3,480 | 3,554 | 3,565 | 3,494 |
| ABILENE | 115,926 | 124,607 | 130,220 | 132,820 | 133,514 | 130,943 | 126,835 |
| ADDISON | 14,166 | 17,919 | 20,534 | 22,358 | 23,629 | 24,515 | 25,133 |
| AGUA DULCE | 737 | 737 | 737 | 737 | 737 | 737 | 737 |
| ALAMO | 14,760 | 20,915 | 28,107 | 36,163 | 44,880 | 54,400 | 64,166 |
| ALAMO HEIGHTS | 7,319 | 7,671 | 8,039 | 8,148 | 8,239 | 8,331 | 8,423 |
| ALBANY | 1,921 | 2,011 | 2,116 | 2,096 | 1,982 | 1,744 | 1,464 |
| ALEDO | 1,726 | 2,612 | 3,473 | 4,426 | 5,264 | 6,165 | 7,162 |
| ALICE | 19,010 | 20,512 | 21,899 | 22,792 | 23,181 | 23,017 | 22,524 |
| ALLEN | 43,554 | 88,000 | 101,647 | 119,646 | 125,617 | 128,145 | 129,215 |
| ALPINE | 5,786 | 6,320 | 6,742 | 6,929 | 7,055 | 7,398 | 7,474 |
| ALTO | 1,190 | 1,290 | 1,404 | 1,502 | 1,592 | 1,681 | 1,786 |
| ALTON | 4,384 | 12,342 | 15,513 | 19,064 | 22,907 | 27,104 | 31,411 |
| ALVARADO | 3,288 | 3,595 | 3,957 | 4,337 | 4,752 | 5,267 | 5,899 |
| ALVIN | 21,413 | 23,231 | 25,123 | 26,935 | 28,605 | 30,375 | 32,223 |
| ALVORD | 1,007 | 1,157 | 1,280 | 1,399 | 1,517 | 1,651 | 1,806 |
| AMARILLO | 173,627 | 188,004 | 203,497 | 217,987 | 234,486 | 252,493 | 267,324 |
| AMES | 1,079 | 1,140 | 1,207 | 1,271 | 1,334 | 1,403 | 1,480 |
| AMHERST | 791 | 834 | 887 | 933 | 968 | 963 | 950 |
| ANAHUAC | 2,210 | 2,405 | 2,623 | 2,825 | 3,000 | 3,178 | 3,360 |
| ANDREWS | 9,652 | 10,519 | 11,247 | 11,754 | 12,232 | 12,453 | 12,701 |
| ANGLETON | 18,130 | 18,951 | 19,805 | 20,623 | 21,377 | 22,176 | 23,010 |
| ANNA | 1,225 | 6,720 | 12,000 | 18,000 | 24,000 | 32,000 | 50,000 |
| ANNETTA | 1,108 | 1,579 | 1,972 | 2,289 | 2,564 | 2,856 | 3,176 |
| ANNETTA SOUTH | 555 | 708 | 836 | 939 | 1,028 | 1,123 | 1,227 |
| ANSON | 2,556 | 2,608 | 2,672 | 2,668 | 2,627 | 2,550 | 2,451 |
| ANTHONY | 3,850 | 4,586 | 5,422 | 6,156 | 6,789 | 7,422 | 8,055 |
| ANTON | 1,200 | 1,291 | 1,347 | 1,380 | 1,381 | 1,327 | 1,262 |
| ARANSAS PASS | 8,138 | 9,851 | 11,663 | 13,337 | 14,792 | 16,101 | 17,304 |
| ARCHER CITY | 1,848 | 2,022 | 2,200 | 2,345 | 2,390 | 2,307 | 2,223 |
| ARCOLA | 1,048 | 2,500 | 2,750 | 3,025 | 3,328 | 3,661 | 4,026 |
| ARGYLE | 2,365 | 7,081 | 11,935 | 14,983 | 16,550 | 18,282 | 20,000 |
| ARLINGTON | 332,969 | 390,000 | 453,656 | 485,000 | 500,000 | 510,000 | 515,000 |
| ARP | 901 | 965 | 1,013 | 1,061 | 1,109 | 1,189 | 1,295 |
| ASHERTON | 1,342 | 1,440 | 1,536 | 1,596 | 1,602 | 1,567 | 1,490 |
| ASPERMONT | 1,021 | 1,017 | 985 | 937 | 877 | 823 | 771 |
| ATHENS | 11,297 | 13,588 | 16,343 | 19,657 | 23,643 | 28,438 | 34,204 |
| ATLANTA | 5,745 | 5,849 | 6,085 | 6,322 | 6,557 | 6,557 | 6,557 |
| AUBREY | 1,500 | 3,300 | 5,375 | 8,755 | 11,767 | 15,814 | 21,252 |
| AURORA | 853 | 1,096 | 1,295 | 1,489 | 1,680 | 1,896 | 2,147 |
| AUSTIN | 656,562 | 791,015 | 977,749 | 1,155,004 | 1,314,890 | 1,480,590 | 1,634,578 |
| AZLE | 9,600 | 12,108 | 16,795 | 23,473 | 31,060 | 38,682 | 45,362 |
| BAILEY'S PRAIRIE | 694 | 744 | 795 | 844 | 889 | 938 | 988 |
| BAIRD | 1,623 | 1,623 | 1,623 | 1,623 | 1,623 | 1,623 | 1,623 |
| BALCH SPRINGS | 19,375 | 21,083 | 22,564 | 23,849 | 24,963 | 25,930 | 26,768 |
| BALCONES HEIGHTS | 3,016 | 3,327 | 3,670 | 3,909 | 4,154 | 4,414 | 4,674 |
| BALLINGER | 4,243 | 4,379 | 4,871 | 5,243 | 5,654 | 5,974 | 6,274 |
| BALMORHEA | 527 | 627 | 730 | 815 | 885 | 949 | 1,000 |
| BANDERA | 957 | 1,056 | 1,179 | 1,307 | 1,411 | 1,499 | 1,586 |
| BANGS | 1,620 | 1,691 | 1,746 | 1,761 | 1,761 | 1,761 | 1,761 |
| BARDWELL | 583 | 838 | 1,075 | 1,308 | 1,546 | 1,813 | 2,107 |
| BARTLETT | 1,675 | 1,825 | 1,947 | 2,070 | 2,172 | 2,262 | 2,349 |
| BARTONVILLE | 1,093 | 5,000 | 10,000 | 14,000 | 16,500 | 17,500 | 18,000 |
| BASTROP | 5,340 | 6,515 | 7,994 | 9,734 | 11,708 | 14,208 | 17,337 |
| BAY CITY | 18,667 | 19,921 | 21,292 | 22,126 | 22,586 | 22,521 | 22,316 |
| BAYOU VISTA | 1,644 | 1,816 | 1,964 | 2,052 | 2,088 | 2,114 | 2,131 |
| BAYTOWN | 66,430 | 68,772 | 71,106 | 73,380 | 75,581 | 77,775 | 79,971 |
| BEACH CITY | 1,645 | 2,358 | 3,153 | 3,892 | 4,532 | 5,182 | 5,848 |
| BEASLEY | 590 | 701 | 815 | 955 | 1,099 | 1,288 | 1,504 |
| BEAUMONT | 113,866 | 113,866 | 113,866 | 113,866 | 113,866 | 113,866 | 113,866 |
| BECKVILLE | 752 | 790 | 806 | 820 | 831 | 840 | 846 |
| BEDFORD | 47,152 | 50,001 | 52,395 | 54,407 | 56,098 | 57,519 | 58,713 |
| BEE CAVE VILLAGE | 656 | 948 | 1,339 | 1,700 | 1,926 | 2,165 | 2,411 |


City of Bastrop
Water Service Area
CCN No. 11198
Application No. 34551-S (Portion Transferred from Aqua WSC, CCN 10294)
Bastrop County
10294
11198
10294
10990
N
Water CCN Service Areas
11198 - CITY OF BASTROP
10294 - AQUA WSC
10990 - BASTROP COUNTY WCID 2
Water "Facilities Only" CCN Service Area
10294 - AQUA WSC
Note: CCN 10294 "Facilities Only"
See map no. 30886-A for customer locations
filed in TCEQ Records Office.
3000
0
3000 Feet
STATE OF TEXAS
COUNTY OF TRAVIS
OCT 23
Map by S. Jester 1/6/2006
Data path: a:\udcon\ccn_working\ccn.shp
Project path: k:\gis\projects\34551-s.apr
TCEQ



City of Bastrop
Sewer Service Area
CCN No. 20466
Application No. 34511-C
Bastrop County
OCT 27 2004
Sewer CCN Service Areas
20466 - CITY OF BASTROP
20961 - BASTROP COUNTY WCID 2
1 0 1 Miles
1 inch = 1 mile
10/19/2004
TCEQ

# APPENDIX B

# CITY ORDINANCE

**ORDINANCE NO. 2010- 8**

**AN ORDINANCE OF THE CITY OF BASTROP, TEXAS ADOPTING A WATER CONSERVATION PLAN IN ACCORD WITH TEXAS COMMISSION ON ENVIRONMENTAL QUALITY REGULATIONS; PROVIDING SEVERABILITY AND AN EFFECTIVE DATE.**

---

WHEREAS, the City of Bastrop, Texas recognizes that the amount of water available to the City and its water utility customers is limited and subject to depletion during periods of extended drought; and

WHEREAS, the City recognizes that natural limitations due to drought conditions and other acts of God cannot guarantee an uninterrupted water supply for all purposes; and

WHEREAS, Section 288.2 of the Texas Administrative Code sets forth Texas Commission on Environmental Quality guidelines and requirements governing the development of water conservation plans for public water suppliers; and

WHEREAS, in accord with Section 288.2 of the Texas Administrative Code the City has devised a strategy or combination of strategies for reducing the volume of water withdrawn from its water supply source, for maintaining and improving the efficiency in the use of water, for increasing the recycling and reuse of water, and for preventing the pollution of water; and

WHEREAS, as authorized under law, and in the best interests of the citizens of Bastrop, Texas, the City Council adopts the attached Water Conservation Plan, dated March 2010.

**NOW THEREFORE, BE IT ORDAINED BY THE CITY OF BASTROP TEXAS:**

PART 1.

That the City of Bastrop Texas Water Conservation Plan attached hereto as Exhibit "A" and made part hereof for all purposes be, and the same is hereby, adopted as the official policy of the City. In addition to filing with the Texas Commission on Environmental Quality, a copy of this Water Conservation Plan shall be maintained in the City's files and placed on the City website in order that the public may have ready access to the Plan.

PART 2.

That all ordinances that are in conflict with the provisions of this ordinance be, and the same are hereby, repealed and all other ordinances of the City not in conflict with the provisions of this ordinance shall remain in full force and effect.

PART 3.

Should any paragraph, sentence, subdivision, clause, phrase, or section of this ordinance be adjudged or held to be unconstitutional, illegal or invalid, the same shall not affect the validity of this ordinance as a whole or any part or provision thereof, other than the part so declared to be invalid, illegal or unconstitutional.

PART 4.

This Ordinance shall take effect upon the date of final passage noted below, or when all applicable hearing and publication requirements, if any, are satisfied in accordance with the City's Charter, Code of Ordinances, and the laws of State of Texas.

READ and ACKNOWLEDGED on the first reading on the 27th day of April 2010.

PASSED AND APPROVED on the second reading on the 11th day of May 2010.

APPROVED:

Mayor Terry Orr

ATTEST:

Teresa Valdez, City Secretary

APPROVED AS TO FORM:
Jo-Christy Brown
City Attorney

# APPENDIX C

# TRANSMITTAL LETTER

# TO TWDB REGION K

CITY OF
EST. 1837
BASTROP
Water & Wastewater
Department

300 Water St.
P.O. Box 427
Bastrop, Texas 78602

512-321-2124 Main
512-303-2390 Metro
512-321-3941 24-Hrs
512-332-0279 Fax

baswater@cityofbastrop.org

Harvesting, recycling and conserving water is every individual's right, responsibility and duty.
Together, we can make a difference.

James Miller
Director

May 24, 2010

Region K Water Planning Group
c/o Jaime Burke, P.E.
AECOM
400 West 15th Street, Suite 500
Austin, Texas 78701

Dear Mr. Burke:

In accordance with Section 288.2 of the Texas Administrative Code, the City of Bastrop adopted a revised Water Conservation Plan, approved by City Council, on May 11, 2010.

This Plan was drafted and prepared for the City by BEFCO Engineering, Inc. in March 2010 and replaces our previous Water Conservation Plan that you have on record.

I am attaching a copy of the Plan to this letter and will be submitting copies to TWDB and TCEQ as well.

If you have any questions or comments, please contact me at (512) 321-2124.

Sincerely,

James Miller
Director
Water / Wastewater
City of Bastrop

Attachments: City of Bastrop, Texas Water Conservation Plan (Exhibit A)
City of Bastrop Ordinance No. 2010-8 (Appendix B)
Transmittal Letters to TWDB and Region K (Appendix C)

Cc: Texas Water Development Board c/o John Sutton
TCEQ – Resource Protection Team MC - 160

CITY OF
EST. 1837
BASTROP
**Water & Wastewater**
**Department**

300 Water St.
P.O. Box 427
Bastrop, Texas 78602

512-321-2124 Main
512-303-2390 Metro
512-321-3941 24-Hrs
512-332-0279 Fax

baswater@cityofbastrop.org

Harvesting, recycling and conserving water is every individual's right, responsibility and duty. Together, we can make a difference.

**James Miller**
**Director**

May 24, 2010

Texas Water Development Board
Attention: John Sutton
P.O. Box 13231
Austin, Texas 78711-3231

Dear Mr. Sutton:

In accordance with Section 288.2 of the Texas Administrative Code, the City of Bastrop adopted a revised Water Conservation Plan, approved by City Council, on May 11, 2010.

This Plan was drafted and prepared for the City by BEFCO Engineering, Inc. in March 2010 and replaces our previous Water Conservation Plan that you have on record.

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Sincerely,

James Miller
Director
Water / Wastewater
City of Bastrop

Attachments: City of Bastrop, Texas Water Conservation Plan (Exhibit A)
City of Bastrop Ordinance No. 2010-8 (Appendix B)
Transmittal Letters to TWDB and Region K (Appendix C)

Cc: Region K Water Planning Group c/o Jaime Burke
TCEQ – Resource Protection Team MC - 160

CITY OF
EST. 1837
BASTROP
**Water & Wastewater**
**Department**

**300 Water St.**
**P.O. Box 427**
**Bastrop, Texas 78602**

**512-321-2124 Main**
**512-303-2390 Metro**
**512-321-3941 24-Hrs**
**512-332-0279 Fax**

**baswater@cityofbastrop.org**

**Harvesting, recycling and conserving water is every individual's right, responsibility and duty. Together, we can make a difference.**

**James Miller**
**Director**

May 24, 2010

TCEQ
Resource Protection Team
MC – 160
P.O. Box 13087
Austin, Texas 78711-3087

Dear Sir(s):

In accordance with Section 288.2 of the Texas Administrative Code, the City of Bastrop adopted a revised Water Conservation Plan, approved by City Council, on May 11, 2010.

This Plan was drafted and prepared for the City by BEFCO Engineering, Inc. in March 2010 and replaces our previous Water Conservation Plan that you have on record.

I am attaching a copy of the Plan to this letter and will be submitting copies to TWDB and Region K as well.

If you have any questions or comments, please contact me at (512) 321-2124.

Sincerely,

James Miller
Director
Water / Wastewater
City of Bastrop

Attachments: City of Bastrop, Texas Water Conservation Plan (Exhibit A)
City of Bastrop Ordinance No. 2010-8 (Appendix B)
Transmittal Letters to TWDB and Region K (Appendix C)

Cc: Texas Water Development Board c/o John Sutton
Region K Water Planning Group c/o Jaime Burke

CHAPTER 13 UTILITIES

## ARTICLE 13.06 DROUGHT CONTINGENCY PLAN

### Sec. 13.06.001 Introduction

Safe, high quality drinking water is a precious resource in the Bastrop region. This drought contingency plan (the "plan") requires that the available resources of the city be put to the most beneficial use possible. The plan also requires that the waste, unreasonable use, or unreasonable method of use of water be prevented and that conservation of water be extended with a view to reasonable and beneficial use in the interests of public health and welfare of the Bastrop community. This plan has been coordinated with the Lower Colorado Region (Region K) Water Planning Group.

### Sec. 13.06.002 Declaration of policy, purpose, and intent

(a) In order to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, and to protect and preserve public health, welfare, and safety and minimize the adverse impacts of water supply shortage or other water supply emergency conditions, the city hereby adopts the following regulations and restrictions on the delivery and consumption of water.

(b) Water uses regulated or prohibited under this plan are considered to be nonessential uses; continuation of such uses during times of water shortage or other emergency water supply conditions are deemed to constitute a waste of water which subjects the offender(s) to penalties as defined in section 13.06.011 of this plan.

### Sec. 13.06.003 Public education

The city will periodically provide the public with information about water conservation and drought conditions, including information about the conditions under which each stage of the plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information will be provided by means of paid advertisements, public notices, press releases and/or utility bill inserts.

### Sec. 13.06.004 Coordination with regional water planning groups

The service area of the city is located within the Lower Colorado Region and the city has provided a copy of this plan to the Region K Water Planning Group.

### Sec. 13.06.005 Authorization

The city manager is hereby authorized and directed to implement the applicable provisions of this plan upon determination that such implementation is necessary to protect public health, safety, and welfare. The city manager shall have authority to initiate or terminate drought or other water supply emergency response measures as described in this plan. This plan shall also be referenced in, and become an appendix to, the City of Bastrop Emergency Management Plan, Annex L; Utilities.

### Sec. 13.06.006 Application

The provisions of this plan shall apply to all persons, customers, and property utilizing water provided by the city. The terms "person" and "customer" as used in the plan include individuals, corporations, partnerships, associations, and all other legal entities. Utilization of a water source other than city potable water is exempt from the provisions of this plan.

**Sec. 13.06.007 Permanent water restrictions**

This section establishes permanent water conservation regulations and applies year-round regardless of drought stage.

(1) Landscape irrigation using automatic in-ground or hose-end sprinkler systems is prohibited between the hours of 10:00 a.m. and 6:00 p.m.

(2) The time restrictions do not apply to:

(A) The irrigation of commercial plant nurseries.

(B) Irrigation using reclaimed water or other nonpotable water sources.

(C) New landscape installation during planting and the first ten (10) days after planting.

(D) The testing of new irrigation systems or systems that are under repair.

(E) Irrigation using a hand-held bucket or hose equipped with a positive shut-off valve, pressure washer system, or other device that automatically shut off water flow when the hose is not being held by the water user.

(F) Irrigation by drip irrigation or soaker hoses.

(3) The following constitute a waste of water and are prohibited:

(A) Washing sidewalks, walkways, driveways, parking lots, tennis courts, patios or other hard-surfaced areas except with a pressure-washing system or to alleviate immediate health or safety hazards.

(B) Allowing water to run off a property or allowing water to pond or pool in the street, parking lot or sidewalk.

(C) Operating an irrigation system with sprinkler heads that are broken or out of adjustment.

(D) Failure to repair a controllable leak(s) within a reasonable time period after having been given notice directing the repair of such leak(s).

(4) Ornamental fountains or ponds for aesthetic of scenic purposes must be equipped with a recirculation device. This restriction does not apply to ornamental fountains or ponds that use reclaimed water, nonpotable water, or water provided by sources other than the city.

(5) Use of water for the irrigation of golf course greens, tees and fairways is permitted only on designated watering days as outlined in section 13.06.010 of this plan. Such irrigation shall only occur from 12:00 midnight to 10:00 a.m. and from 6:00 p.m. to midnight. These restrictions do not apply to the irrigation of any golf course that uses reclaimed water or other nonpotable water sources.

**Sec. 13.06.008 Definitions**

For the purposes of this plan, the following definitions shall apply:

*Aesthetic water use*. Water used for ornamental or decorative purposes such as fountains, reflecting pools, and water gardens.

*Commercial and institutional water use*. Water use which is integral to the operations of commercial and nonprofit establishments and governmental entities such as retail establishments, hotels and motels, restaurants, and office buildings.

*Conservation*. Those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses.

*Customer*. Any person, company, or organization using water supplied by the City of Bastrop.

*Daily water demand*. The total amount of water pumped or otherwise released into distribution system(s) for customer use. Expressed in gallons, which are metered in a given 24-hour period (gallons per day).

*Declaration of disaster*. That action taken by the mayor, as authorized by the City of Bastrop emergency management basic plan and the Texas Disaster Act of 1975, when the mayor determines that the public health, safety, and welfare may be threatened by a disastrous event, or the imminent threat of such an event.

*Director*. The director of water and wastewater, City of Bastrop, Texas.

*Domestic water use*. Water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

*Drip irrigation*. Also known as trickle irrigation or micro-irrigation is an irrigation method which minimizes the use of water and fertilizer by allowing water to drip slowly to the roots of plants through a network of valves, pipes, tubing, and emitters.

*Even number address*. Street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

*Hose-end sprinkler*. Designed to screw into a standard hose and rest on the ground wherever you drag it and set it down; it then delivers water in a spray pattern in the immediate area.

*Industrial water use*. The use of water in processes designed to convert materials of lower value into forms having greater usability and value.

*Landscape irrigation use*. Water used for the irrigation and maintenance of landscaped areas, whether publicly or privately owned, including residential and commercial lawns, gardens, golf courses, parks, and rights-of-way and medians.

*Nonessential water use*. Water uses that are neither essential nor required for the protection of public, health, safety, and welfare, including:

(1) Irrigation of landscape areas, including parks, athletic fields, and gold courses, except otherwise provided under this plan;

(2) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;

(3) Use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;

(4) Use of water to wash down buildings or structures for purposes other than immediate fire

protection;

(5) Flushing gutters or permitting water to run or accumulate in any gutter or street;

(6) Use of water to fill, refill, or add indoor or outdoor swimming pools or Jacuzzi-type pools;

(7) Use of water in a fountain or pond for aesthetic water use or scenic purposes except where necessary to support aquatic life;

(8) Failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and

(9) Use of water from hydrants for construction purposes or any other purposes other than fire fighting.

*Odd numbered address*. Street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9.

*Total production capability*. The total net aggregate amount of water that can be produced from all water wells capable of supplying water to the system in any given 24-hour period.

*Trigger*. A threshold level to be used as an initiation or termination point for actions based on certain mathematical criteria.

**Sec. 13.06.009 Criteria for initiation and termination of drought response stages**

(a) Daily water demand will be monitored for emergency conditions by the city manger or his designee. Trigger conditions will be based on an emergency situation caused by a natural disaster, equipment or system failure, natural or manmade contamination, high daily average water demand, or any other condition that substantially and negatively affects the city's potable water supply. The city manager, on recommendations of the water/wastewater director shall determine when conditions warrant initiation or termination of each stage of the plan.

(b) The triggering criteria described below are based on a statistical analysis of the vulnerability of the water source under drought of record condition, and on known system capacity limits.

(1) Stage 1 trigger–Mild water shortage conditions/water awareness.

(A) Requirements for initiation. Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on certain nonessential water uses, provided in section 13.06.010 of this plan, when daily water demand exceeds 85% of total production capability for three (3) consecutive days or water demand approaches a reduced delivery capacity for all or part of the system, and the city manager determines that no circumstances exist that will decrease the demand except conservation by customers.

(B) Requirements for termination. Stage 1 of the plan may be terminated or rescinded when stage 1 conditions no longer exist for a period of three (3) consecutive days and would be unlikely to recur upon termination, or until such time as determined by the city manager.

(2) Stage 2 trigger–Moderate water shortage conditions/water watch.

(A) Requirements for initiation. Customers shall be required to comply with the requirements and restrictions on certain nonessential water uses provided in section

13.06.010 of this plan when the daily water demand exceeds 90% of total production capability for three (3) consecutive days, and that response measures required by stage 1 trigger–mild water shortage conditions/water awareness have been implemented, and the city manager determines that no circumstances exist that will decrease the demand below the stage 2 trigger except conservation by customers.

(B) Requirements for termination. Stage 2 of the plan may be terminated or rescinded when stage 2 conditions no longer exist for a period of three (3) consecutive days and would be unlikely to recur upon termination, as determined by the city manager. Upon termination of stage 2, stage 1 becomes operative.

(3) Stage 3 trigger–Critical water shortage conditions/water warning.

(A) Requirements for initiation. Customers shall be required to comply with the requirements and restrictions on certain nonessential water uses provided in section 13.06.010 of this plan when the daily water demand exceeds 95% of total production capability for three (3) consecutive days, and that response measures required by stage 2 trigger–moderate water shortage conditions/water watch have been implemented, and the city manager determines that no circumstances exist that will decrease the demand below the stage 3 trigger except conservation by customers.

(B) Requirements for termination. Stage 3 of the plan may be terminated or rescinded when stage 3 conditions no longer exist for a period of three (3) consecutive days and would be unlikely to recur upon termination, as determined by the city manager. Upon termination of stage 3, stage 2 becomes operative.

(4) Stage 4 trigger–Emergency water shortage conditions/water emergency.

(A) Requirements for initiation. Customers shall be required to comply with the requirements and restrictions for stage 4 of this plan when the city manager determines that a water supply emergency exists based on:

(i) Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service;

(ii) Natural or manmade contamination of the water supply sources(s); or

(iii) Daily water demand equals 100% of the total production capability for three (3) consecutive days.

(B) Requirements for termination. Stage 4 of the plan may be terminated or rescinded when stage 4 conditions no longer exist for a period of three (3) consecutive days and would be unlikely to recur upon termination, as determined by the city manager. Upon termination of stage 4, the city manager may impose requirements of stage 1, 2, or 3 of the plan if circumstances exist that require continued abatement to the effects of the emergency water shortage condition.

**Sec. 13.06.010 Drought response stages**

The city manager or his/her designee shall monitor water supply and/or demand conditions on a daily basis and, in accordance with the triggering criteria set forth in section 13.06.009 of this plan, shall determine if conditions exist that would trigger any of the designated drought stages, and if so, shall implement the following notification procedures:

(1) Notification of the public. The city manager shall notify the public by means of:

(A) Publication in a newspaper of general circulation, and/or direct mail to customers;

(B) Public service announcements; or

(C) Signs posted in public places.

(2) Additional notification. The city manager shall notify directly, or cause to be notified directly, the following individuals and entities:

(A) Mayor/Members of the city council.

(B) Fire chief.

(C) City and/or county emergency management coordinator(s).

(D) County judge.

(E) State disaster district/department of public safety.

(F) TNRCC (required when mandatory restrictions are imposed).

(G) Major water users.

(H) Critical water users; i.e. hospitals, clinics and nursing homes.

(I) City department heads.

(3) Stage 1 response–Mild water shortage conditions/water awareness.

(A) Goal. To raise public awareness of water demand conditions and achieve a voluntary reduction in daily water demand to 85% or less of the total production capability.

(B) Supply management measures. The city manager shall implement supply management measures that include reduction in flushing of water mains, visually inspect lines and repair leaks on a daily basis, monthly review of customer use/consumption records and follow-up on any that have unusually high usage, as well as conservation of incidental water usage at water and wastewater plants. Activities shall be implemented which include increased monitoring of meters, gauges, water levels in tanks, and water well production data.

(C) Voluntary water use restrictions. Water customers are requested to voluntarily limit the use of water for nonessential purposes and to practice water conservation:

(i) Restricted days/hours. Water customers are requested to voluntarily limit the irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems to Sundays and Thursdays for customers with an address ending in an even number (0, 2, 4, 6, or 8), and Saturdays and Wednesdays for water customers with an address ending in an odd number (1, 3, 5, 7, or 9), and to irrigate landscapes only during the hours prior to 8:00 a.m. and the hours after 8:00 p.m. on designated watering days. However, irrigation of landscaped areas is permitted at any time if it is by means of a hand-held hose, a faucet-filled bucket or watering can of five (5) gallons or less, or drip irrigation system.

(ii) All general operations of the city shall adhere to the permanent water use restrictions prescribed for stage 2 of the plan.

(iii) Water customers are requested to practice water conservation and to minimize or discontinue water use for nonessential purposes.

(4) Stage 2 response–Moderate water shortage conditions/water watch.

(A) Goal. Achieve a reduction in daily water demand to 90% or less of the total production capability.

(B) Supply management measures. The city manager shall implement supply management measures that discontinue flushing of water mains, irrigation of public landscaped areas and all water usage at water and wastewater plants not required for direct operations of the facilities.

(C) Mandatory water use restrictions. Under threat of penalty for violation, the following water use restrictions shall apply to all city water utility customers:

(i) Restricted days/hours. Irrigation of landscaped areas with hose-end sprinklers or automatic irrigation systems shall be limited to Sundays and Thursdays for customers with an address ending in an even number (o, 2, 4, 6, or 8), and Saturdays and Wednesdays for water customers with an address ending in an odd number (1, 3, 5, 7, or 9), and to irrigate landscapes only during the hours prior to 8:00 a.m. and the hours after 8:00 p.m. on designated watering days. However, irrigation of landscaped areas is permitted at any time if it is by means of a hand-held hose, a faucet-filled bucket or watering can of five (5) gallons or less, or drip irrigation system.

(ii) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is prohibited except on designated watering days during the hours prior to 10:00 a.m. and the hours after 8:00 p.m. Such washing, when allowed, shall be done with a faucet-filled bucket or a hand-held hose equipped with a positive shutoff nozzle. Vehicle washing may be done at any time on the immediate premises of a commercial car wash or commercial service station. Further, such washing may be exempted from these regulations if the health, safety, and welfare of the public is contingent upon frequent vehicle cleansing, such as garbage trucks and vehicles used to transport food and perishables.

(iii) Use of water to fill, refill, or add to any indoor or outdoor swimming pools, wading pools, or Jacuzzi-type pools is prohibited except on designated watering days during the hours prior to 8:00 a.m. and the hours after 8:00 p.m.

(iv) Use of water from hydrants shall be limited to fire fighting, related activities, or other activities necessary to maintain public health, safety, and welfare, except that use of water from designated fire hydrants for construction purposes may be allowed under special permit from the city manager.

(v) Use of water for the irrigation of athletic fields or golf course greens, tees, and fairways is prohibited except on designated watering days during the hours prior to 8:00 a.m. and the hours after 8:00 p.m. However, if the athletic field or golf course utilizes a water source other than that provided by the city, the facility shall not be subject to these regulations.

(vi) The following uses of water are defined as nonessential and are prohibited:

a. Use of water to wash down any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;

b. Use of water to wash down buildings or structures for purposes other than immediate fire protection;

c. Use of water for dust control;

d. Flushing gutters or permitting water to run or accumulate in any gutter or street; and

e. Failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s).

(5) Stage 3 response–Critical water shortage conditions/water warning.

(A) Goal. Achieve a reduction in daily water demand to 95% or less of the total production capability.

(B) Supply management measures. The city manager shall implement supply management measures that discontinue flushing of water mains, irrigation of public landscaped areas and all water usage at water and wastewater plants not required for direct operations of the facilities. Water usage at all city buildings shall be restricted to health, sanitation, cleanliness or firefighting purposes.

(C) Mandatory water use restrictions. Under threat of penalty for violation, the following water use restrictions shall apply to all city water utility customers.

(i) Restricted days/hours. Irrigation of landscaped areas by means of hand-held hoses, hand-held buckets or drip irrigation shall be limited to designated watering days, as outlined in phase 2 of this plan and between the hours of 4:00 a.m. and 8:00 a.m. and between 8:00 p.m. and midnight. The use of hose-end sprinklers or automatic sprinkler systems are prohibited at all times.

(ii) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle not occurring on the premises of a commercial car wash and commercial service stations and not in the immediate interest of public health, safety and welfare is prohibited. Further, such vehicle washing at commercial car washes and commercial service stations shall occur only between the hours of 6:00 a.m. and 6:00 p.m.

(iii) The filling, refilling, or adding of water to indoor or outdoor swimming pools, wading pools, and Jacuzzi-type pools is prohibited.

(iv) Operation of any ornamental fountain or pond for aesthetic or scenic purposes is prohibited except where necessary to support aquatic life or where such fountains or ponds are equipped with a recirculation system.

(v) No new, additional, expanded, or increased-in-size water service connections, meters, service lines, pipeline extensions, mains, or water service facilities of any kind shall be approved or installed for such time as this drought response stage or a higher-numbered stage shall be in effect.

(vi) Use of water from hydrants shall be limited to fire fighting, related activities, or other activities necessary to maintain public health, safety, and welfare. Use of water from fire hydrants for construction purposes is prohibited.

(vii) Use of water for the irrigation of athletic fields or golf course greens, tees, and fairways is prohibited. However, if the athletic field or golf course utilizes a water source other than that provided by the city, the facility shall not be subject to these regulations.

(viii) All nonessential uses of water as defined in stage 2 of this plan are prohibited.

(6) Stage 4 response–Emergency water shortage conditions/water emergency.

(A) Goal. Achieve a reduction in daily water demand sufficient to assure the water system for the protection of public health, safety, and welfare until the stage 4 trigger criteria(s) can be abated.

(B) Supply management measures. The city manager shall implement supply management measures that discontinue flushing of water mains, irrigation of public landscaped areas and all water usage at water and wastewater plants not required for direct operations of the facilities. Water usage at all city buildings shall be restricted to health, sanitation, cleanliness or firefighting purposes.

(C) Mandatory water use restrictions. Under threat of penalty for violation, all requirements of stage 3 shall remain in effect during stage 4 except:

(i) Irrigation of landscaped areas is absolutely prohibited.

(ii) Use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle is absolutely prohibited.

(iii) Curtailment of service to persons shown to be of violation of prohibited uses of water may be ordered by the city manager, if the city manager determines that such curtailment would not be detrimental to the public health, safety, and welfare, and determines that such curtailment would benefit the mitigation of stage 4 conditions.

(7) Stage 5 response–Water allocation. In the event that water shortage conditions threaten public health, safety, and welfare due to the duration, type, effect or magnitude of such conditions, and a declaration of disaster has been issued relating to such conditions, the city manager is hereby authorized to allocate water according to the following plan. In addition to other restrictions required in stage 2, 3, or 4 response, a monthly water allocation may be established by the city manager for single-family residential water customers.

(A) Single-family residential customers. The allocation to residential water customers residing in a single-family dwelling shall be as follows:

| Persons per Household | Gallons per Month |
|---|---|
| 1 or 2 | 4,500 |
| 3 or 4 | 5,500 |
| 5 or 6 | 6,500 |

| | |
|---|---|
| 7 or 8 | 7,500 |
| 9 or 10 | 8,500 |
| 11 or more | 10,000 |

"Household" means the residential premises served by the customer's meter. "Persons per household" includes only those persons currently physically residing at the premises and expected to reside there for the entire billing period. It shall be assumed that a particular customer's household is comprised of two (2) persons unless the customer notifies the city of a greater number of persons per household on a form prescribed by the city manager. It shall be the customer's responsibility to go to the city offices to complete and sign the form claiming more than two (2) persons per household. When the number of persons per household increases so as to place the customer in a different allocation category, the customer may notify the city on such form and the change will be implemented in the next practicable billing period. If the number of persons in a household is reduced, the customer shall notify the city in writing. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of persons in a household or fails to timely notify the city of a reduction in the number of persons in a household shall be subject to penalties set forth in section 13.06.011 of this plan. Residential water customers shall pay the following surcharge:

125% of the normal and routine charge for water billed in excess of allocation.

(B) Master-metered multifamily residential customers. In addition to other restrictions in stage 2, 3 or 4 responses, a monthly water allocation may be established by the city manager for master-metered multifamily water customers. The allocation to a customer billed from a master meter which jointly measures water to multiple permanent residential dwelling units (e.g., apartments, mobile homes) shall be allocated 6,000 gallons per month for each dwelling unit. A dwelling unit may be claimed under this provision whether it is occupied or not. Any person who knowingly, recklessly, or with criminal negligence falsely reports the number of dwelling units served by a master meter shall be subject to penalties set forth in section 13.06.011 of this plan. Customers billed from a master meter under this provision shall pay the following monthly surcharge:

125% of the normal and routine charges for water billed in excess of allocation.

(C) Commercial customers. In addition to other restrictions in stage 2, 3 or 4 responses, a monthly water allocation may be established by the city manager for each commercial customer. The commercial customer's allocation shall be no less than 75 percent of the customer's usage for corresponding month's billing period for the previous 12 months. If the customer's billing history is shorter than 12 months, the monthly average for the period for which there is a record shall be used for any monthly period for which no history exists. However, a customer for which 75 percent of the monthly usage is less than 6,000 gallons, shall be allocated 6,000 gallons. Upon request of a customer or at the initiative of the city manager, the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the customer's normal water usage or (2) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the city council. Nonresidential commercial customers shall pay the following surcharges:

150% of the normal and routine charges for water billed in excess of allocation.

(D) Industrial customers. In addition to other restrictions in stage 2, 3 or 4 responses, a monthly water allocation may be established by the city manager for each industrial customer, which uses water for processing purposes. The industrial customer's allocation shall be no less than 85 percent of the customer's water usage baseline. However, a customer of which 85 percent of the monthly usage is less than 6,000 gallons, shall be allocated 6,000 gallons. The industrial customer's water use baseline will be computed on the average water use for the three month period ending prior to the date of implementation of stage 2 of the plan. If the industrial water customer's billing history is shorter than 3 months, the monthly average for the period for which there is a record shall be used. Upon request of the customer or at the initiative of the city manager, the allocation may be reduced or increased if, (1) the designated period for baseline calculation does not accurately reflect the customer's normal water usage, (2) the customer has added or is in the process of adding significant additional processing capacity, (3) the customer has shut down or significantly reduced the production of a major processing unit, (4) the customer has previously implemented significant permanent water conservation measures such that the ability to further reduce water use is limited, or (5) if other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the city council. Industrial customers shall pay the following surcharges:

150% of the normal and routine charges for water billed in excess of allocation.

**Sec. 13.06.011 Enforcement**

(a) No person shall knowingly or intentionally allow the use of water from the city for residential, commercial, industrial, agricultural, governmental, or any other purpose in a manner contrary to any provision of this plan, or in an amount in excess of that permitted by the drought response stage in effect at the time pursuant to action taken in accordance with provisions of this plan.

(b) Any person who violates this plan is guilty of a class C misdemeanor and, upon conviction shall be punished by a fine of not less than fifty dollars ($50.00) and not more than five hundred dollars ($500.00). Each day that one or more of the provisions in this plan is violated shall constitute a separate offense. If a person is convicted of two or more distinct violations of this plan, the city manager shall, upon due notice to customer, be authorized to discontinue water service to the premises where such violations occur. Services discontinued under such circumstances shall be restored only upon payment of a reconnection charge, hereby established at $25.00, and any other costs incurred by the city in discontinuing service. In addition, suitable assurance must be given to the city manager that the same action shall not be repeated while the plan is in effect. Compliance with this plan may also be sought through injunctive relief in the district court.

(c) Any person, including a person classified as a water customer of the city, in apparent control of the property where a violation occurs or originates shall be presumed to be the violator, and proof that the violation occurred on the person's property shall constitute a rebuttable presumption that the person in apparent control of the property committed the violation, but any such person shall have the right to show that he/she did not commit the violation.

(d) Any police officer, code compliance official, building official or other city employee designated by the city manager, may issue a citation to a person he/she reasonably believes to be in violation of this article. The citation shall be prepared in duplicate and shall contain the name and address of the alleged violator, if known, the offense charged, and shall direct him/her to appear in the municipal court on the date shown on the citation for which the date shall not be less than three (3) days nor more than five (5) days from the date the citation was issued. The alleged violator shall be served a copy of the citation. Service of the citation shall be complete upon delivery of the citation to the alleged violator, to an agent or employee of a violator, or to a person over fourteen (14) years of age who is a member of the violator's immediate family or is a resident of the violator's residence. The alleged violator shall appear in municipal court to enter a plea of guilty or not guilty for the violation of this plan. If the alleged violator fails to appear in municipal court, a warrant for his/her arrest may be issued. A summons to appear may be issued in lieu of an arrest warrant. These cases shall be expedited and given preferential setting in municipal court before all other cases.

**Sec. 13.06.012 Variances**

(a) The city manager may, in writing, grant temporary variance for existing water uses otherwise prohibited under this plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the health, sanitation, or fire protection for the public or the person requesting such variance and if one or more of the following conditions are met:

(1) Compliance with this plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the plan is in effect.

(2) Alternative can be implemented which will achieve the same level of reduction in water use.

(b) Persons requesting an exemption from the provisions of this article shall file a petition for variance with the city within five (5) days after the plan or particular drought response stage has been invoked. All petitions for variances shall be reviewed by the city manager and shall include the following:

(1) Name and address of the petitioner(s).

(2) Purpose of water use.

(3) Specific provision(s) of the plan from which the petitioner is requesting relief.

(4) Detailed statement as to how the specific provision of the plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if the petitioner complies with this article.

(5) Description of the relief requested.

(6) Period of time for which the variance is sought.

(7) Alternative water use restrictions or other measures the petitioner is taking or proposes to take to meet the intent of this plan and the compliance date.

(8) Other pertinent information.

(c) Variances granted by the city manager shall be subject to the following conditions, unless waived or modified:

(1) Variances granted shall include a timetable for compliance.

(2) Variances granted in a particular stage shall expire upon advancing to a more restrictive stage of the plan.

(3) Petitioners shall promptly display the variance granted where it can be read by the general public at all location(s) for which the variance applies, and make said variance available to the public.

(4) Variances granted may be rescinded or revoked by the city manager if the petitioner fails to

meet specific requirements set forth in the variance. The variance will automatically expire when the plan is no longer in effect.

(5) No variance shall be retroactive or otherwise justify any violation of this plan occurring prior to the issuance of the variance.

(Ordinance 2009-32 adopted 11/10/09)

# Appendix L Stakeholder Involvement

K FRIESE
& ASSOCIATES, INC.

**MEETING MINUTES**

| | |
|---|---|
| Date: | September 16, 2010 |
| Time: | 5:30 p.m. |
| Subject: | TWDB Bastrop Regional Water Supply Study |
| Location: | Bastrop City Hall Council Chambers, 904 Main Street, Bastrop, Texas |

Project Team Introductions. Exchange of contact list.

Reviewed Project Scope and Objectives.

David Meesey suggested provided all participants an in-kind tracking worksheet now.

David Meesey will provided a copy of the executed of TWDB to the City and KFA.

No members of the public attended.

K✦FRIESE
& ASSOCIATES, INC.

**BASTROP REGIONAL WATER FACILITY PLANNING STUDY**

SIGN IN SHEET – THURSDAY September 16, 2010

| NAME | ORGANIZATION | PHONE | E-MAIL |
|---|---|---|---|
| James Miller | City of Bastrop | (512) 848-5953 | jmiller@cityofbastrop.org |
| Karen Friese | K FRIESE & ASSOC | (512) 338-1704 | kfriese@kfriese.com |
| Rachel Clampffer | Bastrop County | 512 581 7176 | rachel.clampffer@co.bastrop.tx.us |
| Susan Butler | CH2M HILL | (512) 453-1980 | sbutler@ch2m.com |
| Martina Bluem | LCRA | (512) 473-3200 | Martina.Bluem@lcra.org |
| David Wheelock | LCRA | 512-469-6822 | DAVID.WHEELOCK@LCRA.ORG |
| Tom Owens | KFA | (512) 338-1704 | TOWENS@KFRIESE.COM |
| Josh Grimes | LPGCD | (512) 801-4748 | joshuagrimes@sbcglobal.net |
| DAVID MEESEY | TWDB | 512) 936-0852 | david.meesey@TWDB.STATE.TX.US |
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K✦FRIESE
& ASSOCIATES, INC.

## MEETING AGENDA

| | |
|---|---|
| Date: | January 18, 2011 |
| Time: | 5:30 p.m. |
| Subject: | TWDB Bastrop Regional Water Supply Study |
| Location: | Bastrop City Hall Council Chambers, 1311 Chestnut Street, Bastrop, Texas |

- Charlotte presented status on study and the power point presentation.
- David Wheelock asked what the water supply rates represented. ie permit limits?
- David Wheelock point out that LPGCD permits on max pumping rate not annual average.
- James Miller indicated he things all the well are permitted at 1,000 gpm.
- KFA will confirm permitted limits.
- Address question on why City does not use maximum permitted limit.
- Martina asked if we had compared LCRA populations verses CAPCOG.
    - We have note to date.
    - KFA will update the report and compare LCRA county projections against CAPCOG for Tech Memo 2.
- Julie Hart asked if Aqua supplies were accounted for?
    - Not to date.
    - We will be meeting with Aqua and considering the 3rd party supplies.
    - Deficit and or demand numbers may be adjusted as a result of this information.
- Julie voiced concern that population projections are low and that she wants to compare to the 2010 census numbers in April.
- James Miller reviewed population project per TCEQ calculations. 2010 population of 8700.
- Attendees requested a copy of the meeting presentation.

**<u>Future Meetings</u>**

1. Announcements in the Bastrop Advertiser.

K✦FRIESE
& ASSOCIATES, INC.

Public meeting #2

**BASTROP REGIONAL WATER FACILITY PLANNING STUDY**

SIGN IN SHEET – Tuesday January 18, 2011

| NAME | ORGANIZATION | PHONE | E-MAIL |
| --- | --- | --- | --- |
| Mike Talbot | | | |
| Julie Hart | | | |
| David Meesy | | | |
| Martina Bluem | | | |
| David Wheelock | | | |
| James Miller | | | |
| Susan Butler | | | |
| Tom Owens | | | |
| Karen Friese | | | |
| Charlotte Gilpin | | | |
| ED DICKENS | | | ED.DICKENS@YAHOO.COM VICEPRESIDENT@RIVERSIDEGROVE.BASTROP.ORG |
| Paula Pate | | | paula_pate@sbcglobal.net |
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K✦FRIESE
& ASSOCIATES, INC.

**MEETING MINUTES**

| | |
|---|---|
| Date: | May 25, 2011 |
| Time: | 6:30 p.m. |
| Subject: | TWDB Bastrop Regional Water Supply Study |
| Location: | Bastrop City Hall Council Chambers, 1311 Chestnut Street, Bastrop, Texas |

- Charlotte presented status on study and the power point presentation.
- Steve Box wanted to acknowledge the distinction between the physical availability of water and the regulatory availability.
- Joe Cooper reviewed the permitting process regarding order of submittal. No totally "first come, first serve". That if there is an obligation based on a CCN and the application is administratively complete that moves to the front; but will remain behind similar applications.
- David Meesey commented that the next presentation should contain a recommended course of action. Possibly review an implementation of combination surface and ground water.
- Attendees requested a copy of the meeting presentation.

**Future Meetings**

1. Expect final meeting at the end of June.

2. Announcements in the Bastrop Advertiser.

May 25, 2011
Bastrop Regional Water Study
Sign-In Sheet

| | |
|---|---|
| Susan Butler | CH2M Hill |
| Martina Bluem | LCRA |
| Steve Box | Env. Stewardship |
| Mike Talbot | City Bastrop |
| James Miller | COB |
| [illegible] | KFA |
| Tom Owens | KFA |
| David Fleming | Aqua WSC |
| Joe Cooper | LPGCD |
| Rick Arnic | LCRA |
| James Bene' | RW Harden |
| David Meesey | TWDB |

K✦FRIESE
& ASSOCIATES, INC.

**MEETING MINUTES**

| | |
|---|---|
| Date: | September 20, 2011 |
| Time: | 7:00 p.m. |
| Subject: | TWDB Bastrop Regional Water Supply Study |
| Location: | Bastrop City Hall Council Chambers, 1311 Chestnut Street, Bastrop, Texas |

- Copy of report on file since August 30, 2011 Bastrop City Hall and Bastrop Public Library.
- No public in attendance by 7:30; meeting adjourned.
- Deadline for public comments October 15, 2011.
- Final report will be submitted to TWDB no later than October 28, 2011.

**Appendix M Works Cited**


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South Central Texas Regional Water Planning Group (SCTRWPG, 2010). *South Central Texas Regional Water Plan, Volume II Technical Evaluations of Water Management Strategies.*

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# Appendix N Report Comments and Responses

**Texas Water Development Board**
P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.state.tx.us
Phone (512) 463-7847, Fax (512) 475-2053

COPY

received
10-5-11

September 28, 2011

Michael H. Talbot
City Manager
City of Bastrop
P. O. Box 427
Bastrop, Texas 78602

Regional Water Facility Planning Grant Contract between the Texas Water Development Board (TWDB) and the City of Bastrop (CITY); TWDB Contract No. 1004831079, Draft Report Comments

Dear Mr. Talbot:

Staff members of the TWDB have completed a review of the draft report prepared under the above-referenced contract. ATTACHMENT I provides the comments resulting from this review. As stated in the TWDB contract, the City will consider incorporating draft report comments from the EXECUTIVE ADMINISTRATOR as well as other reviewers into the final report. In addition, the City will include a copy of the EXECUTIVE ADMINISTRATOR'S draft report comments in the Final Report.

The TWDB looks forward to receiving one (1) electronic copy of the entire Final Report in Portable Document Format (PDF) and six (6) bound double-sided copies. The City shall also submit one (1) electronic copy of any computer programs or models, and, if applicable, an operations manual developed under the terms of this Contract.

If you have any questions concerning the contract, please contact David Meesey, the TWDB's designated Contract Manager for this project at (512) 936-0852.

Sincerely,

Carolyn L. Brittin
Deputy Executive Administrator
Water Resources Planning and Information

Enclosures

c: David Meesey, TWDB

Attachment 1

TWDB Comments on Bastrop Regional Water Supply Facility Plan Report

TWDB Contract #1004831079

**Level 1 comments:**

1. Please include a summary of all public meetings held on this project and any other public participation activities in the final report.

2. Appendix D, page 7, paragraph 4: the second sentence states "LCRA currently has an estimated 1.5 million acre-feet/year of **firm** water..." This appears to be a storage total since the combined firm yield of the system is 445,000 acre-feet/year. Please correct the figure as appropriate.

3. Appendix D, page 21, paragraph 1: the second sentence states "While Unique Reservoir Sites do not occur in the county, there are segments of the Colorado River that are designated as unique segments due to the following attributes..." The sites listed have not been recommended for designation as unique stream segments in the Region K regional water plan in accordance with 31 TAC 357.8, or designated by the Texas Legislature under §16.051, Texas Water Code. Please correct this reference.

4. Page 12, paragraph states that there are thirteen water user groups (WUGS) in the county, and presents population projections for four. The WUGS listed are all of the municipal WUGS only. Please consider clarifying that these are municipal WUGS.

5. In section three, traffic analysis zones are used to develop population and water demand projections. Please consider including a map of these zones for the entire study area and a table with a list of the zones, their population, water demands and the WUGS they overlap.

**Level 2 comments:**

1. In Section 4, please consider providing the average water demand for Bastrop over the 30-year planning horizon from 2010 through 2040 from the Region K plan.

2. Page 15, paragraph one states that Bastrop independently calculated the average daily water use within the city's service area at 155 gpcd based on eight years of population and water use data. Please consider including this data in a table in this section.

K✦FRIESE
& ASSOCIATES, INC.

# MEMORANDUM

**PROJECT:** Bastrop Regional Water Facilities Planning Study
**SUBJECT:** Review Comments and Responses on Draft Final Report
**DATE:** October 17, 2011

Following are the comments and responses to comments from the TWDB and the LCRA on the Bastrop Regional Water Facilities Planning Study Draft August 2011 Report:

1. TWDB: Please include a summary of all public meetings held on this project and any other public participation activities in the final report.
   a. Meeting minutes and sign in sheets from all public meetings are now included as Appendix L.

2. TWDB: Appendix D, page 7, paragraph 4: the second sentence states "LCRA currently has an estimated 1.5 million acre-feet/year offIrm water..." This appears to be a storage total since the combined firm yield of the system is 445,000 acre-feet/year. Please correct the figure as appropriate.
   a. Thank you for the comment. The text was modified to clarify that 1.5 million acre-feet per year of surface water is authorized to be diverted and used from the reservoir system but that the combined firm yield is 445,000 acre-feet per year. No figure accompanied the text.

3. TWDB: Appendix D, page 21, paragraph I: the second sentence states "While Unique Reservoir Sites do not occur in the county, there are segments of the Colorado River that are designated as unique segments due to the following attributes ..." The sites listed have not been recommended for designation as unique stream segments in the Region K regional water plan in accordance with 31 TAC 357.8, or designated by the Texas Legislature under §16.051, Texas Water Code. Please correct this reference.
   a. The text was modified to clarify that the 2006 Region K Plan identified the segments as warranting consideration as ecologically significant segments; however, they have not been so designated. Exhibit 14 was also modified to reflect the clarification.

4. TWDB: Page 12, paragraph states that there are thirteen water user groups (WUGS) in the county, and presents population projections for four. The WUGS listed are all of the municipal WUGS only. Please consider clarifying that these are municipal WUGS.
   a. The text has been updated to clarify the municipal WUGS were used for comparison.

5. TWDB: In section three, traffic analysis zones are used to develop population and water demand projections. Please consider including a map ofthese zones for the entire study area and a table with" a list of the zones, their population, water demands and the WUOS they overlap.
   a. The TAZ maps and tables are now referenced in Section 3 and included as Appendix C3.

6. TWDB: In Section 4, please consider providing the average water demand for Bastrop over the 30-year planning horizon from 20 I0 through 2040 from the Region K plan.

a. The water demand for the City of Bastrop CCN does not correlate to the Study Area geographically so presenting this data may add more confusion as to the differences in the data. For requested comparison purposes the data below is provided:

| Area Population | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
|---|---|---|---|---|---|---|---|
| Study Area | 15,692 | 20,375 | 31,886 | 43,397 | 59,643 | 75,890 | 92,137 |
| Region K Bastrop WUG | 8,890 | | 12,475 | | 15,920 | | 21,003 |
| Area Demand (ac-ft/yr) | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 |
| Study Area | 1,984 | 2,798 | 4,796 | 6,795 | 9,616 | 12,437 | 15,258 |
| Region K Bastrop WUG | 1,992 | | 2,739 | | 3,459 | | 4,517 |

7. TWDB: Page 15, paragraph one states that Bastrop independently calculated the average daily water use within the city's service area at 155 gpcd based on eight years of population and water use data. Please consider including this data in a table in this section.
    a. The table of data provided by the City of Bastrop is now referenced in the text and is included as Appendix C2.

1. LCRA: Section 6.1 Surface Water Option, pg 23 - We note that the surface water supply option is a phased implementation and includes phasing the purchase of surface water from LCRA (Section 6, pg 20 and a couple of other places). LCRA would encourage the methods in the study be modified to estimate the cost to purchase all surface water needed for the planning horizon of the project. Making a long term decision for investment in infrastructure and for planning water supply also requires committing the water supply. LCRA encourages you to consider that one of the costs of a surface water project is to commit to reserving all water needed for the planning horizon and to enter into a long term contract for that water. This provides assurance to the purchaser that the water will be available when needed and helps meet the long term planning for the purchaser. From the LCRA's perspective, it allows us to plan for the water demand with some assurance that the demand is based on the customer's anticipated needs and provides a revenue stream to support the infrastructure that creates the supply, as well as provides a more sound basis for our long term planning.
    a. The Study does consider and include reservation fees in development of the cost estimate. The tenth bullet of Section 6.1 explains this. Section 6 was revised to clarify this.

2. LCRA: Section 6.1 Surface Water Option – on pg 22 it states that the study does not consider drought-related needs of water rights holders, environmental flow requirements, or conditions worse than the drought of record. Buying water from LCRA as contemplated by this option means that water would be diverted by Bastrop under LCRA's water rights, and Bastrop would not need to be concerned with needs of other water rights holders or environmental flow requirements – as those responsibilities are LCRA's as holder of the water right.
    a. The text was revised to indicate that while these factors are considered by LCRA in development of LCRA's water management plan the end user should be aware of these factors and how they impact contracted water supply via LCRA's management plan.

3. LCRA: In Appendix D – Surface Water Technical Memo- it states that LCRA has an estimated 1.5 million acft/yr of firm water supply. That is not correct, LCRA has the right to divert up to 1,500,000 acft/yr from the Highland Lakes, but this quantity is not firm. Under our state-approved Water Management Plan, LCRA is required to estimate the firm yield of the Highland Lakes and that value is

approximately 445,000 acft/yr. LCRA also has other water rights downstream of the Highland Lakes that increase our firm yield to a higher value. LCRA currently estimates that our total firm supply is 600,000 acft/yr.

a. Thank you for the comment. The text was modified to clarify that 1.5 million acre-feet per year of surface water is authorized to be diverted and used from the reservoir system but that the combined firm yield is 445,000 acre-feet per year.

**MEMORANDUM** CH2MHILL®

# Subject: Bastrop Regional Water Facilities Planning Study - Review Comments and Responses on Draft Final Report

**PREPARED FOR: Charlotte Gilpin, K Freise and Associates**

**PREPARED BY: Susan Butler**

**DATE: October 14, 2011**

CH2M Hill was asked to address three comments on the Draft Report regarding Appendix D. The comments and our responses are summarized below. Accompanying this memorandum are a redlined and a clean copy of Appendix D showing the proposed changes to the text. Please let us know if these proposed changes address the comments.

| Commenter | Comment | Response |
|---|---|---|
| TWDB | 2. Appendix D, page 7, paragraph 4: the second sentence states "LCRA currently has an estimated 1.5 million acre-feet/year of firm water..." This appears to be a storage total since the combined firm yield of the system is 445,000 acre-feet/year. Please correct the figure as appropriate. | Thank you for the comment. The text was modified to clarify that 1.5 million acre-feet per year of surface water is authorized to be diverted and used from the reservoir system but that the combined firm yield is 445,000 acre-feet per year.<br>No figure accompanied the text. |
| TWDB | 3. Appendix D, page 21, paragraph I: the second sentence states "While Unique Reservoir Sites do not occur in the county, there are segments of the Colorado River that are designated as unique segments due to the following attributes ..." The sites listed have not been recommended for designation as unique stream segments in the Region K regional water plan in accordance with 31 TAC 357.8, or designated by the Texas Legislature under §16.051, Texas Water Code. Please correct this reference. | The text was modified to clarify that the 2006 Region K Plan identified the segments as warranting consideration as ecologically significant segments; however, they have not been so designated. Exhibit 14 was also modified to reflect the clarification. |
| LCRA | In Appendix D – Surface Water Technical Memo- it states that LCRA has an estimated 1.5 million acft/yr of firm water supply. That is not correct, LCRA has the right to divert up to 1,500,000 acft/yr from the Highland Lakes, but this quantity is not firm. Under our state-approved Water Management Plan, LCRA is required to estimate the firm yield of the Highland Lakes and that value is approximately 445,000 acft/yr. LCRA also has other water rights downstream of the Highland Lakes that increase our firm yield to a higher value. LCRA currently estimates that our total firm supply is 600,000 acft/yr. | Thank you for the comment. The text was modified to clarify that 1.5 million acre-feet per year of surface water is authorized to be diverted and used from the reservoir system but that the combined firm yield is 445,000 acre-feet per year. |