City of Bastrop Long Term Water Supply Planning Study

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Prepared for:

Prepared by:

K·FRIESE + ASSOCIATES
PUBLIC PROJECT ENGINEERING

1120 S. Capital of Texas Highway
CityView 2, Suite 100
Austin, Texas 78746
TBPE Firm #6535
P - 512.338.1704 F - 512.338.1784
kfriese.com

April 2013
Updated April 22, 2013

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City of Bastrop Long Term Water Supply Planning Study

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Executive Summary

The City of Bastrop (City) led a regional water supply study sponsored by a grant from the Texas Water Development Board (TWDB). The Bastrop Regional Water Facilities Planning Grant Study (Regional Study) was completed in October 2011 in cooperation with Bastrop County (County), Lost Pines Groundwater Conservation District (LPGCD), and the Lower Colorado River Authority (LCRA).

The Regional Study evaluated Colorado River surface water and Simsboro groundwater supply options to serve a large Regional Study Area for a thirty year period (2010-2040). The Regional Study Area was 80 square miles and contained the City and the City's expansive extraterritorial jurisdiction (ETJ). Following the completion of the Regional Study, the City desired to further evaluate long term water supply options for a refined geographical area. This report serves as documentation for the City of Bastrop 2010-2040 Long Term Water Supply Study (Study). The thirty year study period was segmented into five year periods to estimate population, water demands, water deficits, and evaluate water supply options and scenarios incrementally.

Population projection estimates used were based on the Capital Area Metropolitan Planning Organization (CAMPO) 2035 Plan. CAMPO developed county wide population projections for ten year increments from 2015 to 2035. Populations were then distributed amongst defined Traffic Analysis Zones (TAZ). Population projections were interpolated and extrapolated for the five year increments. The population summation of the TAZs within the Study boundary was used to estimate the water demands and deficits based on a per capita demand.

Currently, the City's water supply is produced from five (5) Alluvium wells at Fishermans's Park and one (1) Alluvium and one (1) Simsboro well at Bob Bryant Park. The available water supply from the Alluvium wells 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 for the Study period of 2010-2014. The City has observed diminished production capabilities during intense drought. Additionally, they have recently experienced diminished production caused by clogging of the media around the Fisherman's Park Alluvium wells. These issues result in uncertainty of the longevity of the existing supply, as such, only 50% of the existing Fisherman's Park Alluvium production capacity was considered as existing supply for the Study period of 2015-2024 and none was considered for 2025-2040. Only the facilities at Bob Bryant Park were considered as existing supply for 2025-2040 because of their recent installation.

Source diversification is desired to reduce the exposure caused by the Alluvium source which may be more susceptible to drought impacts than managed surface water available through contract with LCRA or regional deeper aquifer zones with higher yield wells. The following water supply options were evaluated:

- Lower Colorado River surface water – a firm water contract with the LCRA and a water treatment plant located on the west side of the City;
- Lower Colorado River surface water – a firm water contract with the LCRA and a water treatment plant located on Lake Bastrop;
- Aquifer Storage and Recover (ASR) – Lower Colorado River surface water firm water contract with the LCRA and a water treatment plant located on the west side of the City

and conjunctive use with aquifer storage recovery with the Simsboro aquifer groundwater;

- Simsboro groundwater – desired development zones in the Simsboro aquifer located north and east of the City;
- Third party water supply contract for Simsbroro water with three different potential purveyors: Jason Allen, Boy Scouts of America, and XS Ranch.

All of the options examined except for Jason Allen's well were evaluated as multi-phase projects. The Jason Allen project is a single well and not a long term strategy. An annual unit cost ($/1,000 gallons) was developed for each phase of each water supply scenario based on the annualized costs of proposed facilities required to supply an *average* annual project yield. The Study evaluated water supply options and did not consider or estimate costs for improvements to, or expansion of, the distribution system.

Amongst the scenarios evaluated, the Simsboro aquifer groundwater development either with a third party or independent is the least cost-intensive of the options. However, a conjunctive use or joint development scenario of both Colorado surface water and Simsboro groundwater would diversify the risks associated with drought, contamination, and regulatory availability. Prior to pursuing a third party option the City should obtain more information on the production, contracting and cost structure from the entity for further review of the option.

In order to meet immediate needs the City should pursue the development of a Simsboro well field either in cooperation with a third party or independently. While the Study scope and resulting evaluation of water supply option and cost estimates as developed is useful to help the City inform a vision for and plan for larger growth; the need for tools to assist the City with the immediate water supply planning for the existing service area is recognized.

Over the course of the Study the City is concurrently in the process of planning for short term water supply needs of the current service area. Recognizing this, we have worked to provide tools and information that are relevant to the City's efforts to plan for and address these immediate needs. In addition to the fulfillment of the above described Study scope, the Final Report will include implementation phasing and cost recommendations for a less aggressive growth rate limited to the existing service area.

1 Introduction

The City of Bastrop (City) completed a regional water supply study sponsored by a grant from the Texas Water Development Board (TWDB) in October 2011. The Bastrop Regional Water Facilities Planning Grant Study (Regional Study) was completed in collaboration with Bastrop County (County), Lost Pines Groundwater Conservation District (LPGCD), and the Lower Colorado River Authority (LCRA).

The Regional Study evaluated Colorado River surface water and Simsboro groundwater supply options to serve a large Regional Study Area for a thirty year period (2010-2040). The Regional Study Area was 80 square miles and contained the City and the City's expansive extraterritorial jurisdiction (ETJ). Following the completion of the Regional Study, the City desired to further evaluate long term water supply options for a refined geographical area to be served by the City.

Of the supply options considered in the Regional Study, the development of a Simsboro wellfield 10 miles northeast of the City was the lowest cost option available for the Regional Study Area. However, the uncertainties of groundwater regulation and the size of the facilities being considered for the Regional Study moved the City to contract for a long term water supply study that would guide their immediate planning efforts and reflect the growth they are faced with managing.

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). K Friese & Associates, Inc. (KFA) met with City staff and the Utility Committee to define the Study Area, shown in ***Figure 1-1***. The Study Area contains the City limits and surrounding areas where the group anticipates substantial population growth based on the transportation corridors and the potential occurrence of significant developments. These areas include the State Highway (SH) 71 corridor immediately west of the City and the SH 95 corridor between the City and XS Ranch Municipal Utility District (MUD). Locations of known large developments, Municipal Utility Districts (MUD), the Lost Pines Habitat Conservation Plan area (LPHCP), and state parks are all shown on the figure for reference and context of developing water supply options. ***Table 1-1*** shows a comparison of the City's current area within the water Certificate of Convenience and Necessity (CCN) and the Study Area. It can be seen that the Study Area is approximately five and half times larger than the size of the current water service area.

Table 1-1. Study Area Size

Area Description	Area (ac)	Area (sq. mi.)
City Limits	7,180	11.2
CCN	6,589	10.3
Study Area	35,005	54.7

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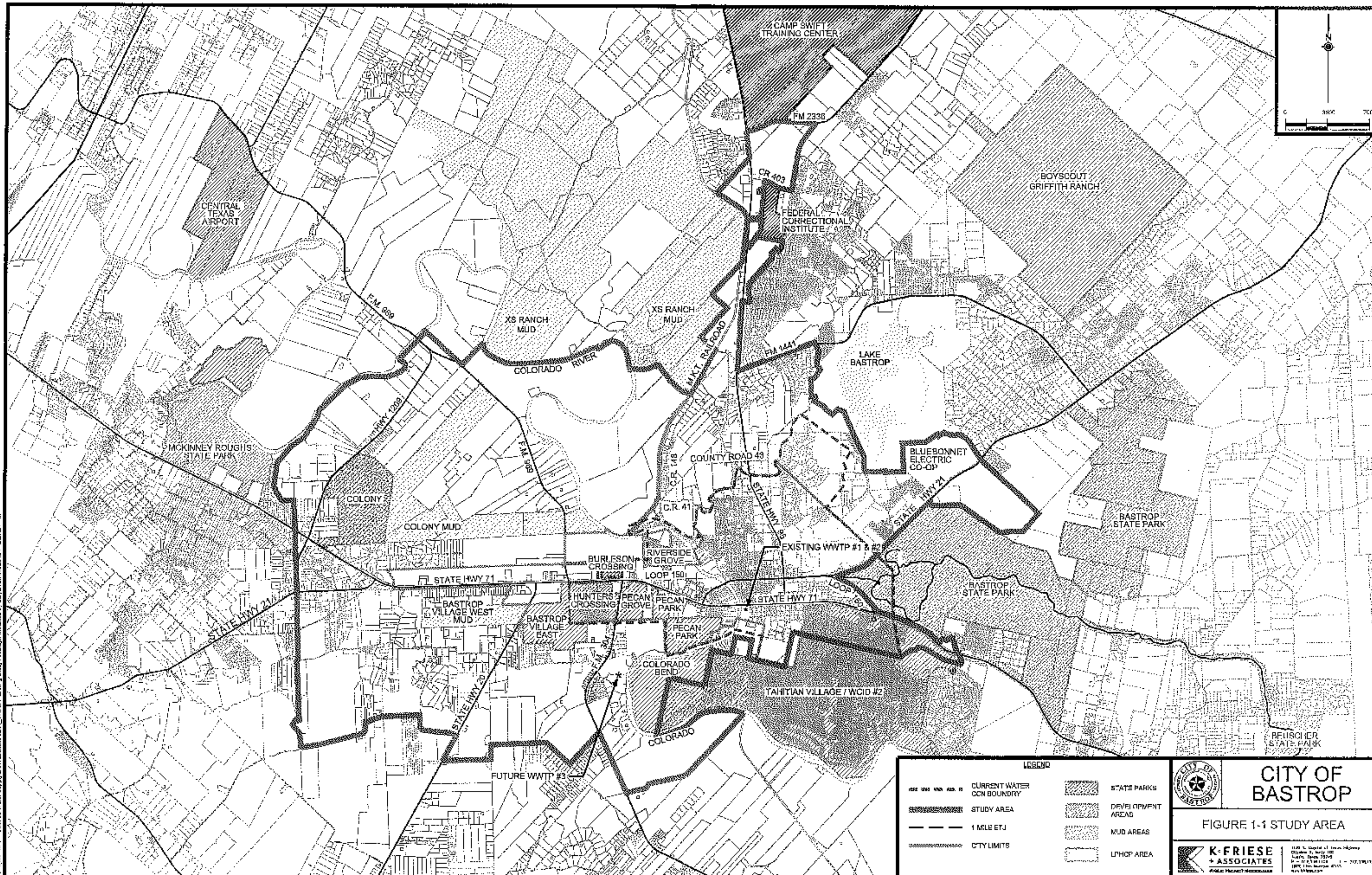


FIGURE 1-1 STUDY AREA

2 Population Projections

The population projections for the Study Area are based on the Capital Area Metropolitan Planning Organization (CAMPO) population 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 based on 2000 census data and 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 distribute demographics such as population to the TAZs. (CAMPO, April 2010). The TAZs are the smallest geographic units of projected population distribution currently available for analysis; therefore this methodology yields the most tailored population data for the Study Area which does not follow the boundary of a political subdivision.

The TWDB released population projections for the water user groups (WUG) for use in the 2016 Region K Water Plan in late February 2013. These projections are based on Texas State Data Center (TSDC) Office of the State Demographer county-level population projections using the half migration rate scenario recommended for long term planning. A decrease in the County and City projections has occurred as compared to the 2011 Region K Water Plan data. A decrease was also observed in the 2010 census data. These WUG populations are for the political subdivision, and therefore the City limits.

In order to create a more direct comparison between the TWDB and CAMPO population projections, CAMPO population projections were estimated for both the City's current City Limit and CCN boundary. The population projections from these sources, compared in ***Table 2-1,*** demonstrate that the CAMPO population projections are more aggressive with respect to water demand. CAMPO population projections trend at an average of 4.55% growth rate for the City Limit area while the 2016 TWDB projections trend at an average of 3.05% growth rate for the 2010 to 2040 period.

In ***Figure 2-1*** population projections from the table are plotted against the City of Bastrop historical population data. The City's historical population data was obtained from the City's Water Conservation Plan and trends at an average growth rate of 3.05% over the period of 2005 to 2010. Growth rate is the single greatest factor in determining when the City will need to implement the next phase of the water supply and drives when costs are incurred. During the Regional Study it was discussed that the Utility Committee and the Staff did not feel comfortable limiting the City's planning efforts to the moderate TWDB population projections. For this reason, the Study parameters are to use the CAMPO projections for the Study Area to evaluate water supply options.

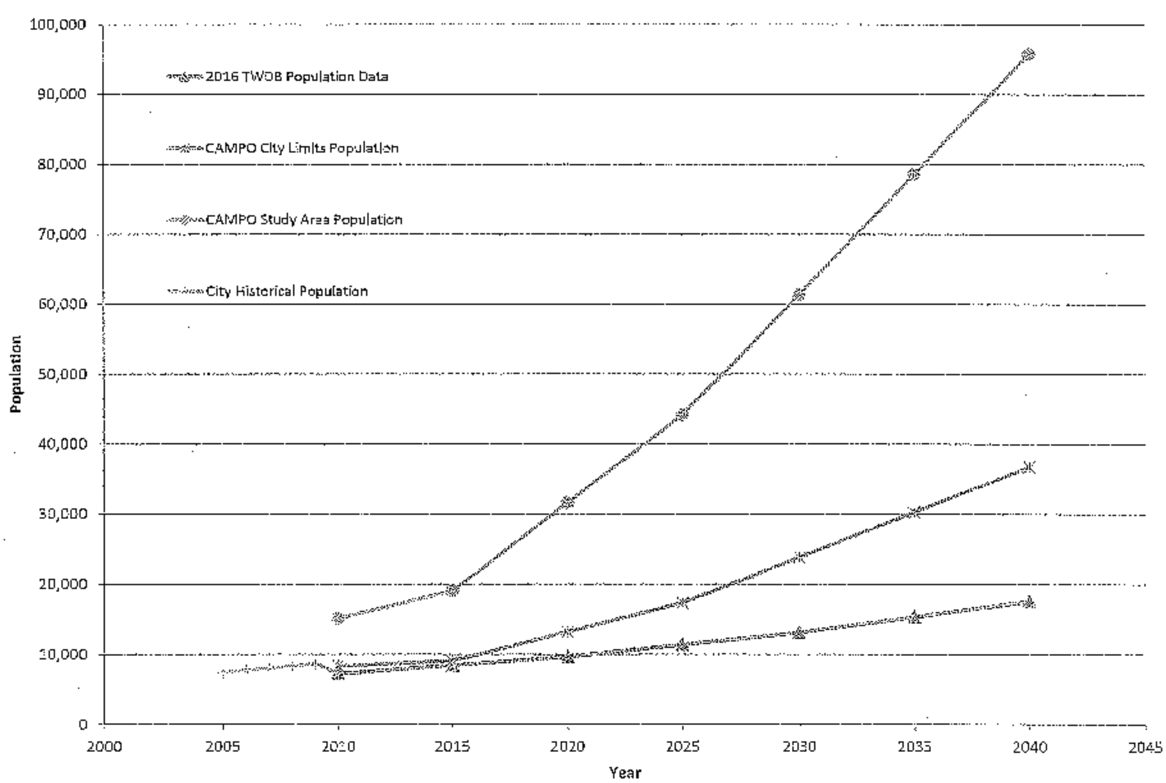
The actual population growth rate of the City will likely vary from the TWDB and the CAMPO projections. The variability of the growth rate is further discussed in ***Section 7***.

Table 2-1. Population Projections for the City of Bastrop Water Service Area

Source	Area Description	Area (ac)	2010	2015	2020	2025	2030	2035	2040
2011 State Water Plan	City Limits	5,693	8,890	10,683	12,475	14,198	15,920	18,462	21,003
2016 State Water Plan	City Limits	-	7,218	8,436	9,653	11,371	13,088	15,321	17,553
2012 Study (CAMPO 2035)	City Limits	7,180	8,306	9,043	13,197	17,350	23,819	30,288	36,756
2012 Study (CAMPO 2035)	CCN	6,589	8,020	8,672	13,935	19,198	25,245	31,291	37,338
2012 Study (CAMPO 2035)	Study Area	35,005	15,162	19,078	31,646	44,214	61,397	78,580	95,763

Notes: 1. 2011 and 2016 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.

Figure 2-1 Population Projection Comparison



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3 Water Demand Projections

Water demands were estimated for the 30-year planning horizon beginning in year 2010 and continuing to year 2040 in five year increments. The Study Area population projections discussed in ***Section 2*** are the basis for the water demand projections. 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 estimate 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 daily and seasonal peaks.

Water supply sources, however, are typically measured in larger units of 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 to the maximum day rate expressed in millions of gallons per day (MGD) using a peaking factor. 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* day delivery rate (MGD) for facility sizing.

The City independently calculated the average daily water use within the City's service area at 155 gpcd based on eleven years (2000-2011) of water production and population data. Of note is that the 2016 Region K Water Plan per capita usage for the City is 191 gpcd in the base year (2011) and will decrease annually based on natural replacement rates for adoption of water-efficient fixtures and appliances required by law. The City's gpcd data was used to estimate the water demand for the entire Study duration. The Study does not consider reductions in gpcd demand which is a conservative approach.

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. This equates to a peaking factor of 2.25. The design criteria which were used in this Study are summarized in ***Table 3-1***.

Table 3-1. City of Bastrop Water Demand Planning Assumptions

Criteria		Units
Average Per Capita Usage	155	gpcd (gallons per capita per day)
Population Correlation	2.5	People/SUE (Service Unit Equivalent)
Maximum Day Demand	0.60	gpm per SUE

The Study Area population projections were used to estimate the water demands based on the above criteria. The average water demands for the Study Area are summarized in ***Table 3-2***. The maximum day delivery rates are summarized in ***Table 3-3***.

Table 3-2. Projected Average Annual Demand (ac-ft/yr)

Year	2010	2015	2020	2025	2030	2035	2040
Study Area	2,633	3,313	5,495	7,677	10,661	13,644	16,628

Table 3-3. Projected Maximum Day Delivery Rate (MGD)

Year	2010	2015	2020	2025	2030	2035	2040
Study Area	5.3	6.6	11.0	15.4	21.4	27.4	33.4

The Aqua Water Supply Corporation's (Aqua) CCN covers the majority of the Study Area which is outside of the City's CCN. So that demands within the Study Area are not over estimated, the demands were adjusted based on water usage for customers within the Study Area currently located in Aqua's service area. These connections are summarized in ***Table 3-4***. The usage was estimated based on the criteria in ***Table 3-1*** to maintain consistency with the Study. The adjusted projected average annual demands and maximum day delivery rates are shown in ***Table 3-5*** and ***Table 3-6,*** respectively. These are the demands utilized for the remainder of the Study to estimate water supply deficit.

Table 3-4. Aqua Service and Usage within the Study Area

Aqua Study Area Connections	1500	Connections
Aqua Study Area Usage	646	ac-ft/yr
Aqua Study Area Usage	1.3	MGD

Table 3-5. Adjusted Projected Average Annual Demand (ac-ft/yr)[1]

Year	2010	2015	2020	2025	2030	2035	2040
Study Area	1,987	2,667	4,849	7,031	10,015	12,998	15,982

Notes: 1. Demand adjusted for existing Aqua customers.

Table 3-6. Adjusted Projected Maximum Day Delivery Rate (MGD)[1]

Year	2010	2015	2020	2025	2030	2035	2040
Study Area	4.0	5.4	9.7	14.1	20.1	26.1	32.1

Notes: 1. Demand adjusted for existing Aqua customers.

4 Existing Water Facilities and Water Deficit

The City's existing water supply system consists of five (5) Alluvium wells at Fishermans's Park, one (1) Alluvium and one (1) Simsboro well at Bob Bryant Park, the Willow Street Water Treatment Plant, the Loop 150 Tank Yard Facilities, distribution system piping and several pressure reducing stations. Refer to ***Figure 4-1*** for a map of the City's existing water system facilities.

The Fisherman's Park Alluvium wells, include wells C, D, E, F and G. These wells are located on the east side of the Colorado River and 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 Simsboro well, Well I, at Bob Bryant Park is currently being constructed and will be blended with Well H at a new tank and pump station at the Park. The City provided the current available maximum production capacity well water supply which is summarized in ***Table 4-1.*** Average production capacity was calculated by dividing the maximum production capacity by the peaking factor of 2.25.

Table 4-1. City of Bastrop Available Water Supply Capacity

Well Description	Avg. Production Capacity			Max. Production Capacity			Permitted Capacity		
	gpm	MGD	ac-ft/yr	gpm	MGD	ac-ft/yr	Gpm	MGD	ac-ft/yr
C	194	0.3	312	435	0.6	702	526	0.8	849
D&E	274	0.4	441	615	0.9	992	1,504	2.2	2,426
F	312	0.4	504	702	1.0	1,132	1,004	1.4	1,620
G	204	0.3	329	459	0.7	740	666	1.0	1,075
H	178	0.3	287	400	0.6	645	500	0.7	806
I	178	0.3	287	400	0.6	645	0	0.0	0
City Total	**1,340**	**1.9**	**2,161**	**3,011**	**4.3**	**4,857**	**4,201**	**6.0**	**6,776**

The Willow Street water treatment plant facility is located east and north of the wells, just west of Willow Street and south of Cedar Street. The facility includes the two ground storage tanks mentioned above, five high service pumps and chlorination and fluoridation equipment. From the Willow Street facility, 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 4-2***.

Table 4-2. Available Storage Capacity

Tank	Location	Diameter	Height	Overflow	Volume	
Tank 1	Willow St. Facilities	84.25 feet	12 feet	371 feet	0.50	MG
Tank 2	Willow St. Facilities	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
Tank 4	Bob Bryant	55 feet	16 feet	370 feet	0.29	MG
Total Storage Capacity:					**2.74**	**MG**

The water supply capacity presented in ***Table 4-1*** 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. Additionally, the City has observed diminished production capabilities for the Fisherman's Park Alluvium wells during intense drought and diminished production caused by clogging of the media around the wells. These issues result in uncertainty of the longevity of the existing Fisherman's Park Alluvium wells. For these reasons the percentage of the existing water supply considered as available is reduced over the duration of the Study period and the reliance on Fisherman's Park is conservatively phased out. 100% of the Fisherman's Park Alluvium production capacity is considered available from 2010- 2014; 50% from 2015-2024 and none from 2025-2040. Only the facilities at Bob Bryant Park were considered as existing supply for 2025-2040 period because they are new.

The projected water supply deficit, presented in ***Table 4-3*** and ***Table 4-4***, is calculated by subtracting supply capacity (***Table 4-1***) from projected annual and maximum day water demands (***Table 3-5*** and ***Table 3-6***, respectively).

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

Year	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2012 Study	174	-1,299	-3,481	-6,457	-9,441	-12,424	-15,408

Table 4-4. Projected Maximum Day Delivery Rate Deficit (MGD)

Year	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
2012 Study	0.3	-2.6	-7.0	-13.0	-18.9	-24.9	-30.9

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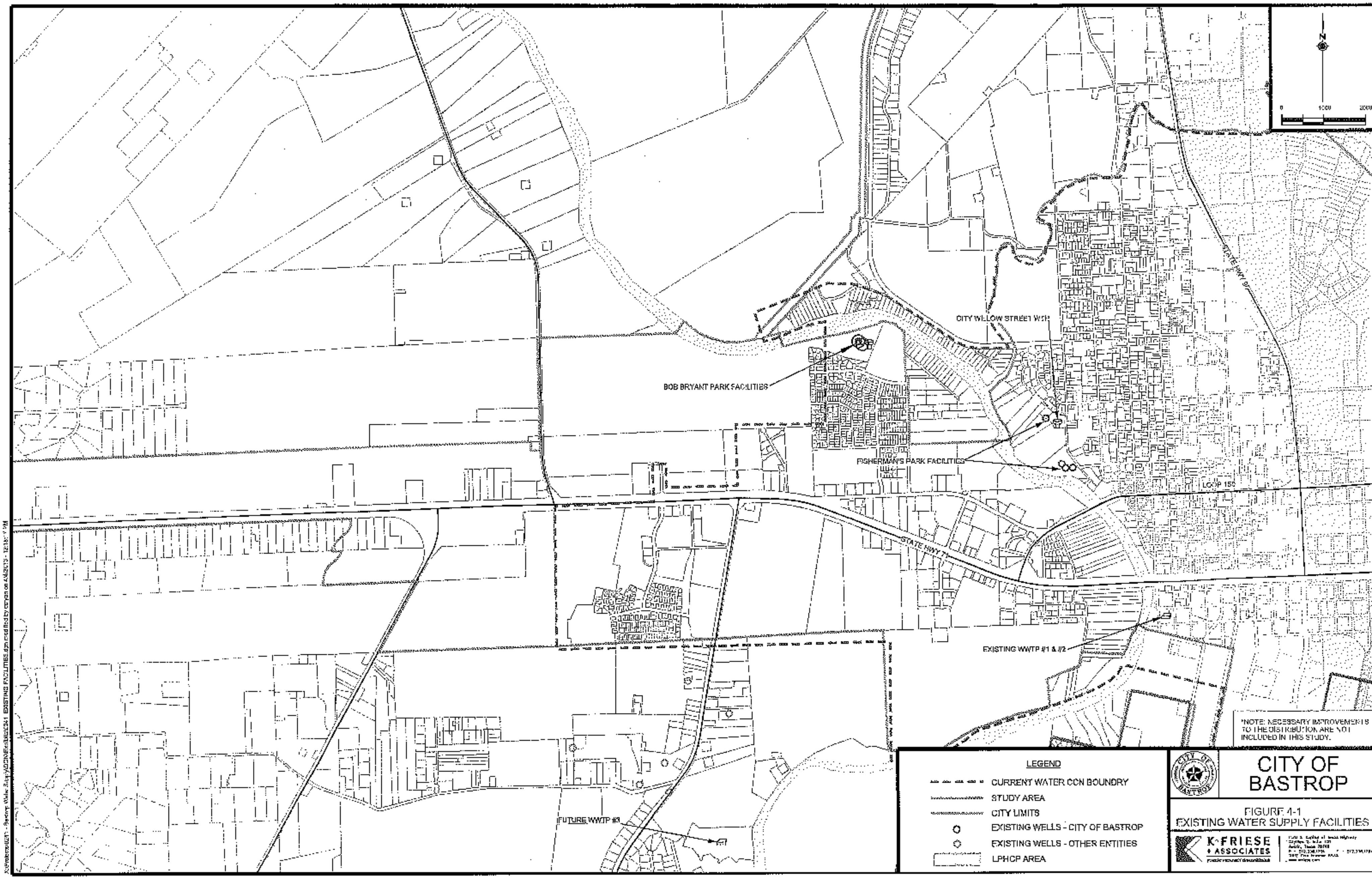


5 Water Source Options

Alluvium wells with production rates ranging from 400 gallons per minute (gpm) to 700 gpm are the City's 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. The purpose of this section of the report is to evaluate the delivery, phasing and implementation costs of the water supply options to meet the 2040 Study Area water supply deficit based on the CAMPO population projections. The following water supply options were evaluated:

- Lower Colorado River surface water – a firm water contract with the LCRA and a water treatment plant located on the west side of the City;
- Lower Colorado River surface water – a firm water contract with the LCRA and a water treatment plant located on Lake Bastrop;
- Aquifer Storage and Recover (ASR) - Lower Colorado River surface water firm water contract with the LCRA and a water treatment plant located on the west side of the City and conjunctive use with aquifer storage recovery with the Simsboro aquifer groundwater;
- Simsboro groundwater – desired development zones in the Simsboro aquifer located north and east of the City;
- Third party water supply contract for Simsbroro water with three different potential purveyors: Jason Allen, Boy Scouts of America, and XS Ranch.

Currently none of the third party options evaluated have the capacity to meet the 2040 Study Area water supply deficit. Further, while the Boy Scouts of America and XS Ranch options have potential for development for multiple wells the Jason Allen option is a single well development and is not a long term water supply strategy.

The amount of time needed to develop any of the following water supply options must be considered in the planning and implementation of the option selected by the City. To design, construct, and obtain permits for a surface water treatment plant typically takes 3-4 years. Although a well field can be developed in a shorter amount of time, it still requires 1-2 years. According to the demand deficits presented in ***Section 4***, additional supply is needed before any of the presented options can be designed, permitted and built. Therefore, the City needs to secure a short term water supply source. The amount of short term supply needed varies based upon the long term strategy selected. The supply strategy sections below identify the amount of the short term water gap on each of the respective figures.

Recalling that the CAMPO population projections for Study Area are nearly twice that of the population for the current CCN, the following sections overestimate the amount of short term supply needed. While meeting the scope of services to complete an analysis of the Study Area water supply deficits based on CAMPO populations is discussed in the remainder of ***Section 5***. The need for a more relevant set of tools for immediate planning is recognized and further discussed in ***Section 7***.

All discussion of options and costs are based on the CAMPO population projections for the study area and the corresponding deficit presented in ***Section 4***. The unit cost ($/1,000 gallons) developed for each option below is based on the annualized costs of proposed facilities required to address the projected average annual 2040 Study Area deficit of 15,408 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 the nearest delivery point within the City's existing distribution system. Each of the water supply source options are discussed in greater detail in the following sections, followed by a summary of the cost comparisons. New east-west and north-south transmission mains will be needed to transport the new water from each supply source to the remainder of the distribution system, however, the size and cost of these improvements were not included in the scope of this Study. The cost estimate assumptions are presented in ***Appendix F***.

Conceptual facility cost estimates were prepared to provide a concept level overview so that the 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 March 2013 values using the Engineering News Record's (ENR) Construction Cost Index (CCI) (ENR, 2013). This conversion ratio along with other cost estimating assumptions are presented in ***Appendix E***.

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.

5.1 Surface Water Options

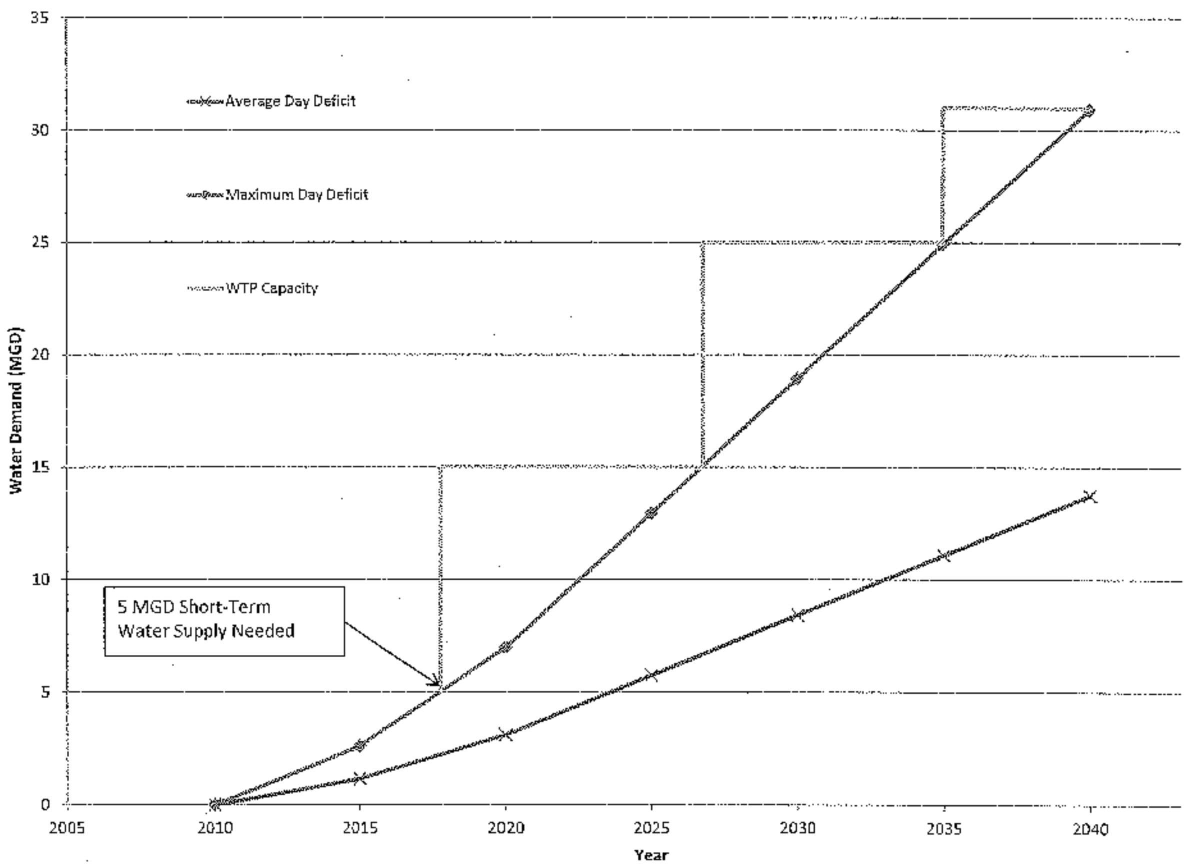
The two surface water options include a water treatment plant (WTP) diverting water either from the lower Colorado River directly or from Lake Bastrop. Water supply would be contracted through the Lower Colorado River Authority (LCRA). A technical memorandum prepared by CH2M HILL discusses the conceptual design of the WTP, and includes a construction cost estimate and yearly operation and maintenance (O&M) costs for the plant. These costs have been incorporated into a comprehensive cost estimate for the water supply option. The complete technical memorandum is located in ***Appendix C***. This section summarizes the findings.

Plant configuration was selected based on the water quality data presented in the Regional Study. It was assumed that the raw water quality of Lake Bastrop is the same as that of the Colorado River. Plant capacity and phasing was based on the demand projections discussed in ***Section 4***. It typically takes 3-4 years to design, permit, and construct a WTP, therefore it is anticipated that the earliest the plant could produce water is 2017 or 2018. The City should secure a short-term supply of approximately 5 MGD to supply the deficit expected in 2017. The 2040 peak day deficit is 31 MGD; therefore the plant must provide 26 MGD in 2040. It is recommended that this plant be built in 2 phases of approximately 10 MGD with the final phase of about 5 MGD to more closely track the projected demand. The implementation of each phase depends on growth in the study area; however, the first 10 MGD phase of the plant should be constructed as soon as possible. The second and third phases would be needed in 2026 and 2035, respectively. ***Figure 5-1*** shows the projected supply needs and the proposed plant phasing.

A vendor-supplied package treatment plant is not recommended because those facilities are typically only available in sizes of 2 MGD or less. Since the phases are significantly larger than 2 MGD, it is not feasible to use a package plant. In addition, package plants provide mixing, flocculation, sedimentation, and filtration only. Other units, such as pre-treatment and clearwells, would still be required to deal with the turbidity and other Colorado River surface water quality factors. Refer to ***Appendix C*** for information on all the units proposed for the surface water treatment plant.

The conceptual WTP configuration includes a liquid ammonium sulfate injection system that would convert residual chlorine from free chlorine to chloramines to prevent the formation of disinfection byproducts. Since the demand projections assume that some portion of water will continue to be supplied by groundwater, it should be noted that a similar system will be needed at the existing wells for compatibility.

Figure 5-1 Surface Water Treatment Plant Capacity



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5.1.1 Colorado River Water Treatment Plant

The LCRA January 2013 quarterly operations report states that LCRA currently has approximately 76,000 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. 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.

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 bound 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 (WWTP) discharge points. 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 water line along Highway 71; which was assumed as the delivery point to the existing system due to the proximity to the WTP site. The proposed facilities are shown on ***Figure 5-2***.

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

- All intake and pipeline facilities are sized for the peak day of 26 MGD;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- A river intake and a diversion structure are included;
- Approximately 0.15 miles of 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 in two 10 MGD phases and one 5 MGD phase;
- 30-acres of land are acquired for the water treatment plant and intake facilities;
- Each phase of the plant includes 2 clearwells of 0.5 million gallons each 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 0.6 miles of 36-inch pipe from the WTP to the distribution system;
- A disinfection system at the existing wells to convert chloramines;
- 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 phase is the design production for the phase. Note that under a firm water contract, the reservation fee is a contract for the water available in conditions that do not exceed the drought of record; and
- Distribution system improvements are not assessed for this Study.

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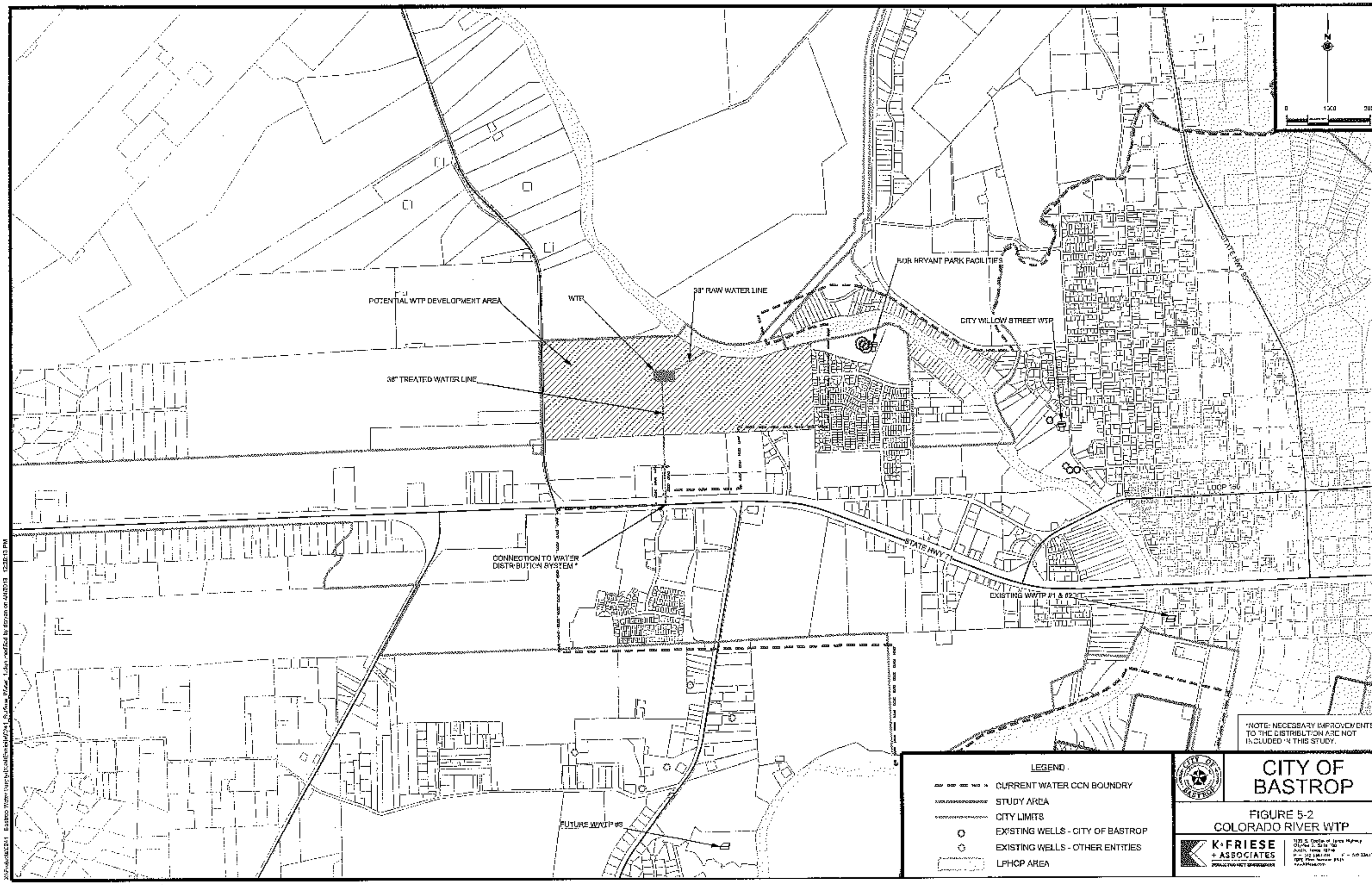

The resulting annual unit cost for developing the surface water source and delivery to the existing system for each phase is shown in ***Table 5-1***. The detailed cost estimate is included in ***Appendix F***. It should be noted that this unit cost does not correlate to the unit cost presented in the CH2M HILL technical memorandum in ***Appendix C***. The variation is that the CH2M HILL report did not include costs for the transmission lines to the distribution system and the intake facilities.

Table 5-1 Annual Unit Costs for Colorado River Water Treatment Plant

Phase	Project Delivery Costs			
Colorado River WTP Phase 1	$7.86	/1,000 gal	$2,559.98	/ac-ft
Colorado River WTP Phase 2	$6.44	/1,000 gal	$2,097.92	/ac-ft
Colorado River WTP Phase 3	$6.11	/1,000 gal	$1,991.23	/ac-ft

5.1.2 Lake Bastrop Water Treatment Plant

The second surface water option explores the possibility of the City contracting with LCRA for excess capacity in the Colorado River intake that delivers water to Lake Bastrop. The City would construct a surface water treatment plant on the southern shore of Lake Bastrop and deliver treated water to the distribution system at the Loop 150 Tank Yard. WTP capacity and phasing proposed is identical to that of the Colorado River Plant as the demands and plant configuration needs have not changed. The lengths for the raw water line and the treated water transmission line as well as the horsepower for the raw water facilities are different because of the location of the plant and the delivery point to the distribution system. Proposed facilities and pipeline routes are shown on ***Figure 5-3***.

LCRA has an intake on the Colorado River that delivers water to Lake Bastrop. It is permitted for 10,750 acre-feet per year of water for industrial use through a Certificate of Adjudication. LCRA has indicated that there is currently no excess capacity in the intake during peak summer needs which renders this option infeasible. However, LCRA currently has a groundwater permit application under review by the Lost Pines Groundwater Conservation District (LPGCD). LCRA is applying for a 10,000 ac-ft/yr industrial permit to supply the cooling water for the power plant.

If this permit were to be approved, there may be some amount of water available for contract with the LCRA. Pending a decision on the permit the City may explore either surface water or groundwater contracts with the LCRA. Since both the permit for the intake on the Colorado River and groundwater from LPGCD are for industrial use, either/both of those permits would need to be modified for municipal use. LCRA's groundwater permit application has been contested, so at this point, it is difficult to determine when and if additional water supply may be available for Bastrop from Lake Bastrop.

In ***Figure 5-3***, it can be seen that the potential WTP development area and the associated pipelines are located within the Lost Pines Habitat Conservation Plan (LPHCP) area which is intended to preserve the Houston Toad. In order to construct any facilities in the LPHCP area,

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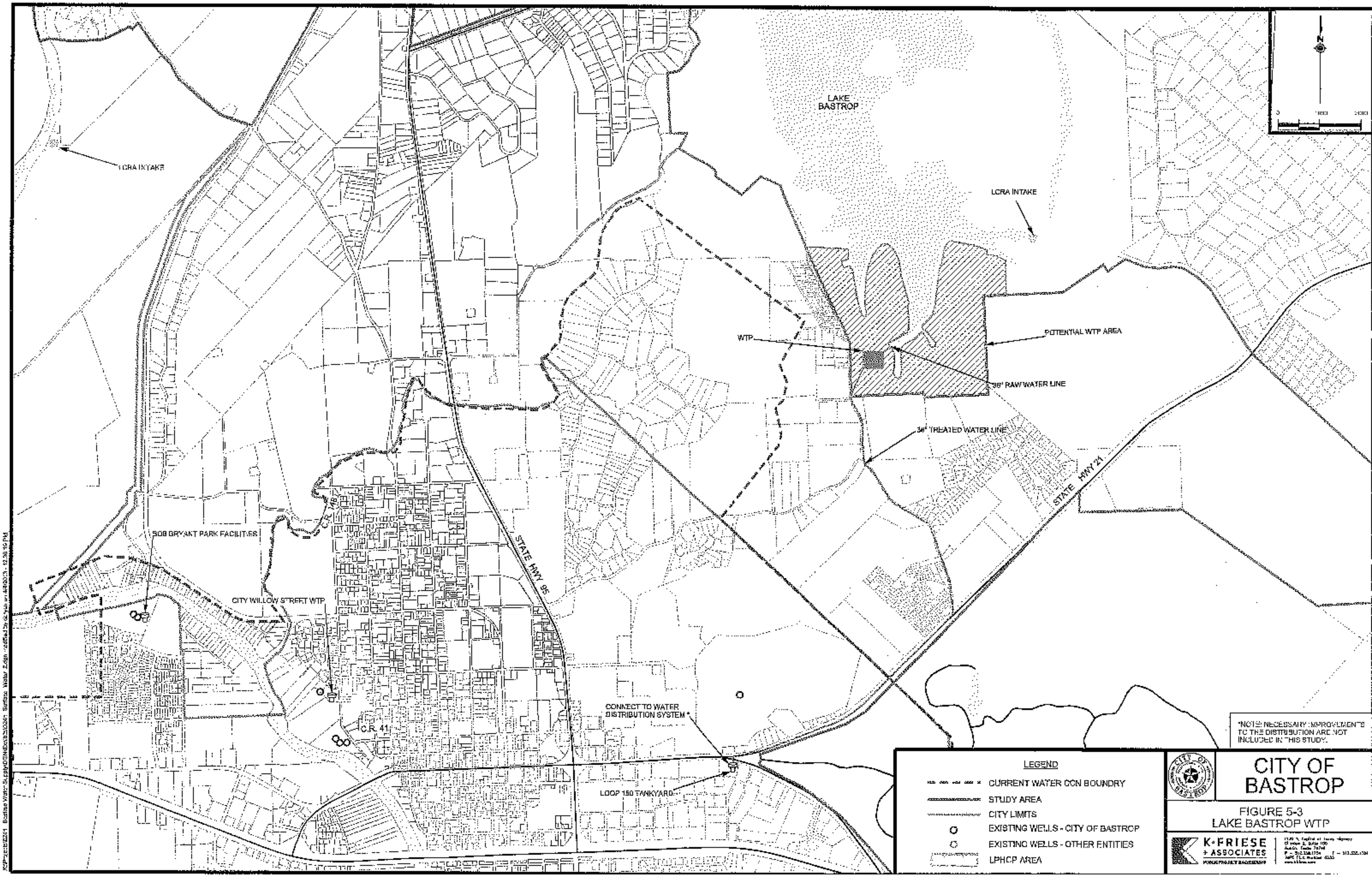

FIGURE 5-3
LAKE BASTROP WTP

the City would be required to obtain an incidental take authorization from US Fish and Wildlife Service (USFWS). A joint USFWS Incidental Take permit (TE-078366-0) is held by the LCRA, Aqua Water Supply Corporation (Aqua), Bluebonnet Electric Cooperative, Inc, and the City of Austin Electric Utility Department (Austin Energy). The permit authorizes Houston toad taking (kill, harm, harass) by these entities while providing best management practices for the maintenance and construction activities. The permit does not cover other activities of other entities such as the City.

Should the LCRA groundwater permit be approved it is recommended that the City pursue discussions with LCRA regarding the possibility of constructing a surface water treatment plant using Lake Bastrop water as the supply or the possibility of contracting for the permitted groundwater. The geographical proximity of this option with possible access to both surface water and Simsboro wells has potential for greater diversification of the City's water supply while sharing distribution infrastructure.

As mentioned previously, the WTP is identical to that sited off of the Colorado River. Therefore, the development of the cost estimate is based on the same assumptions with one exception: the length of 36-inch transmission main from the Lake Bastrop WTP to the Loop 150 Tank Yard is approximately 2.6 miles long.

The resulting annual unit cost for developing the surface water source and delivery to the existing system is shown in ***Table 5-2***. The detailed cost estimate is included in ***Appendix F***. It should be noted that this unit cost does not correlate to the unit cost presented in the CH2M HILL technical memorandum in ***Appendix*** C. The variation is that the CH2M HILL report did not include costs for the transmission lines to the distribution system and the intake facilities.

Table 5-2 Annual Unit Costs for Lake Bastrop Water Treatment Plant

Phase	Project Delivery Costs			
Lake Bastrop WTP Phase 1	$8.07	/1,000 gal	$2,630.89	/ac-ft
Lake Bastrop WTP Phase 2	$6.55	/1,000 gal	$2,133.28	/ac-ft
Lake Bastrop WTP Phase 3	$6.19	/1,000 gal	$2,018.43	/ac-ft

5.2 Aquifer Storage and Recovery Option

This option describes implementation of the conventional surface water treatment plant described in ***Section 5.1*** used in conjunction with an Aquifer Storage and Recovery (ASR) system. Surplus treated water from the WTP will be injected into the Simsboro Aquifer through ASR wells during low demand periods (typically 9 months in length) and withdrawn to meet demand during peak periods (during hot, dry summer months typically 3 months). R.W. Harden & Associates, Inc. (RWHA) prepared a technical memorandum evaluating the ASR option in terms of the effects of the ASR system on water quality and quantity in the Simsboro Aquifer, the regulatory discussion of the ASR system, and preliminary estimates of costs associated with the ASR system. RWHA's technical memorandum can be found in ***Appendix D***. This section summarizes that information.

In order for ASR to be a feasible water supply solution three general conditions must be met:

- the available annual supply of surface water must be greater than the average daily needs;
- there must be an aquifer with suitable hydraulic conditions for injection and withdrawal in the vicinity; and
- the quality of the excess treated water must be compatible with the existing aquifer water quality and its ultimate use.

All three of these conditions are thought to be met by the proposed surface water plant and the Simsboro Aquifer in the vicinity of the proposed plant. Although the RWHA memo discusses three ASR options incorporating up to three wells, the Study only examines the option of three ASR wells which has the greatest capacity of the alternatives RWHA explored.

The Simsboro Aquifer is generally productive throughout Central Texas and often supports wells with production rates in excess of 1,000 gpm. However, the Simboro wells drilled within the City limits have either low production rates or are believed to have a high potential to produce mineralized water that is undesirable for municipal supplies without treatment. It should be noted that the cause of the atypical groundwater quantity and quality found at the Bob Bryant Simsboro well has not been definitively determined, but may be the result of hydraulic isolation of that portion of the aquifer by faulting or other structural boundaries. If this is the case, then the aquifer response to ASR injection and withdrawal cycles may differ from the information included in this Study. It should be noted that an ASR system is proposed at the location of the Colorado River WTP (as opposed to the Lake Bastrop WTP) because of the atypical Simsboro aquifer water quality anticipated in the this vicinity. In general, an ASR system under the LPGCD production and spacing rules would not provide a benefit beyond a traditional well field unless it is implemented within an area of poor water quality.

In the first few years of operation, the ASR system will be primed by injecting substantially more water than is extracted, which will displace mineralized water creating a fresh water zone around the well bore. Some mixing of the fresh and native groundwater will occur at the perimeters of the fresh water zone and it is estimated that about five percent of the water injected will become too mineralized for use.

Construction and operation of an ASR system requires approval from the LPGCD for the groundwater well and the Texas Commission on Environmental Quality (TCEQ) to inject water into an underground system and use the ASR system for public water supply. LPGCD does not have any rules or policies specifically for ASR systems; therefore it was assumed that all rules pertaining to a typical well installation would apply to the ASR system as well. The assumption of operating under typical local groundwater regulations is based on precedent of two ASR systems in Texas which do not operate under special regulations established by their local groundwater district but rather follow the standard management rules. LPGCD rules state that wells which produce in excess of 1,000 gpm must be spaced at least 5,000 feet from other wells. For this study, wells for options with more than one well were limited to 1,000 gpm to use the reduced well spacing of 2,500 feet.

TCEQ approvals for an ASR system are reviewed on a case-by-case basis. Since the process is not standardized, multiple conversations with TCEQ staff and subsequent alterations to submitted materials would be necessary. Therefore, it is difficult to estimate exactly how long the permitting process through TCEQ may be, however it is estimated to take between 2-4 years.

Since the ASR option includes construction of a WTP to provide the excess water that is injected into the aquifer, a short-term water supply must be obtained. As with the surface water plants discussed in ***Section 5.1***, it is assumed that the ASR system will be operational in the 2017 timeframe, so a 5 MGD short-term supply was assumed.

The capacity of the ASR system is limited by the amount of water able to be injected and withdrawn from the Aquifer which is governed by the hydraulic characteristics of the aquifer. As mentioned previously, excess water is injected over a period of roughly nine months, while water is produced for approximately three months. For a single well, data on the Simsboro in the vicinity of the proposed plant indicates that 470 gpm of water can be injected, while 1,500 gpm can be withdrawn. If more than one well is utilized, these numbers decrease somewhat. Approximately 310 gpm per well can be injected and 1,000 gpm per well is produced. The production limit for more than one well is a regulatory limit related to spacing of subsequent wells. The capacity of the three well option is 3,000 gpm which corresponds to 4.3 MGD, which is only 14% of the 31 MGD supply needed in 2040.

This option assumes 5 MGD from the short-term supply, 4.3 MGD from the ASR wells, and 20 MGD from two phases of the WTP discussed in ***Section 5.1***, providing 29.3 MGD of the 31 MGD deficit in 2040. ***Figure 5-4*** shows the capacity of the ASR system with regards to the 2040 demands. It should be noted that 2017 to 2026 includes the priming of the ASR system. For the first two years, 2017 and 2018, no water is extracted from the aquifer, while during the remaining years until 2026 increasingly more water is extracted until reaching the 3,000 gpm limit.

Figure 5-4 ASR System Capacity

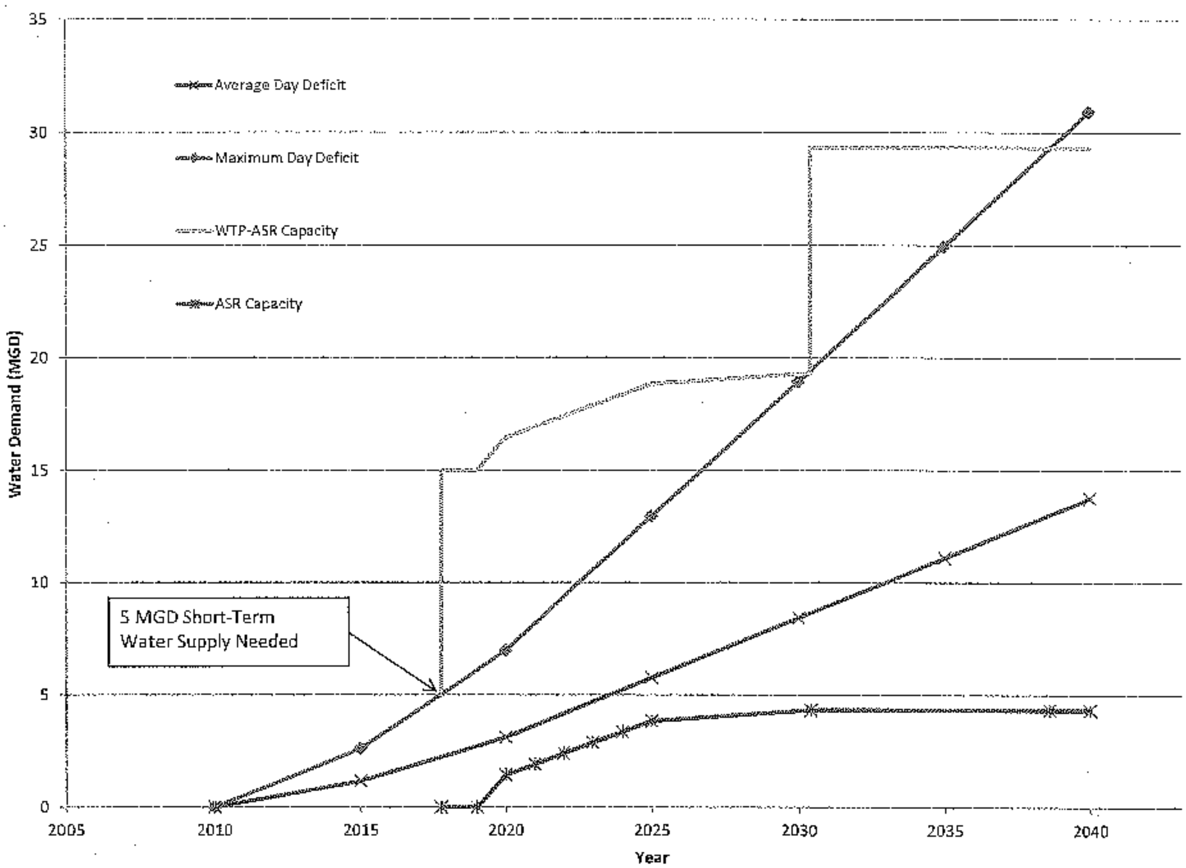

Figure 5-5 shows the proposed WTP, raw water lines, treated water lines, and the proposed ASR wells. The development of the cost estimate for the ASR option is based upon the following assumptions:

- All intake facilities are sized for the peak day of 20 MGD;
- Treated water facilities are sized for 24.3 MGD:
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- A river intake and a diversion structure are included;
- Approximately 0.15 miles of 30-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed in two 10 MGD phases;
- 20-acres of land are acquired for the water treatment plant and intake facilities;
- Each phase of the plant includes 2 clearwells of 0.5 MG each 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 0.6 miles of 36-inch pipe from the WTP to the distribution system;
- A disinfection system at the existing wells to convert chloramines;
- All pipeline easements are 40-feet wide;

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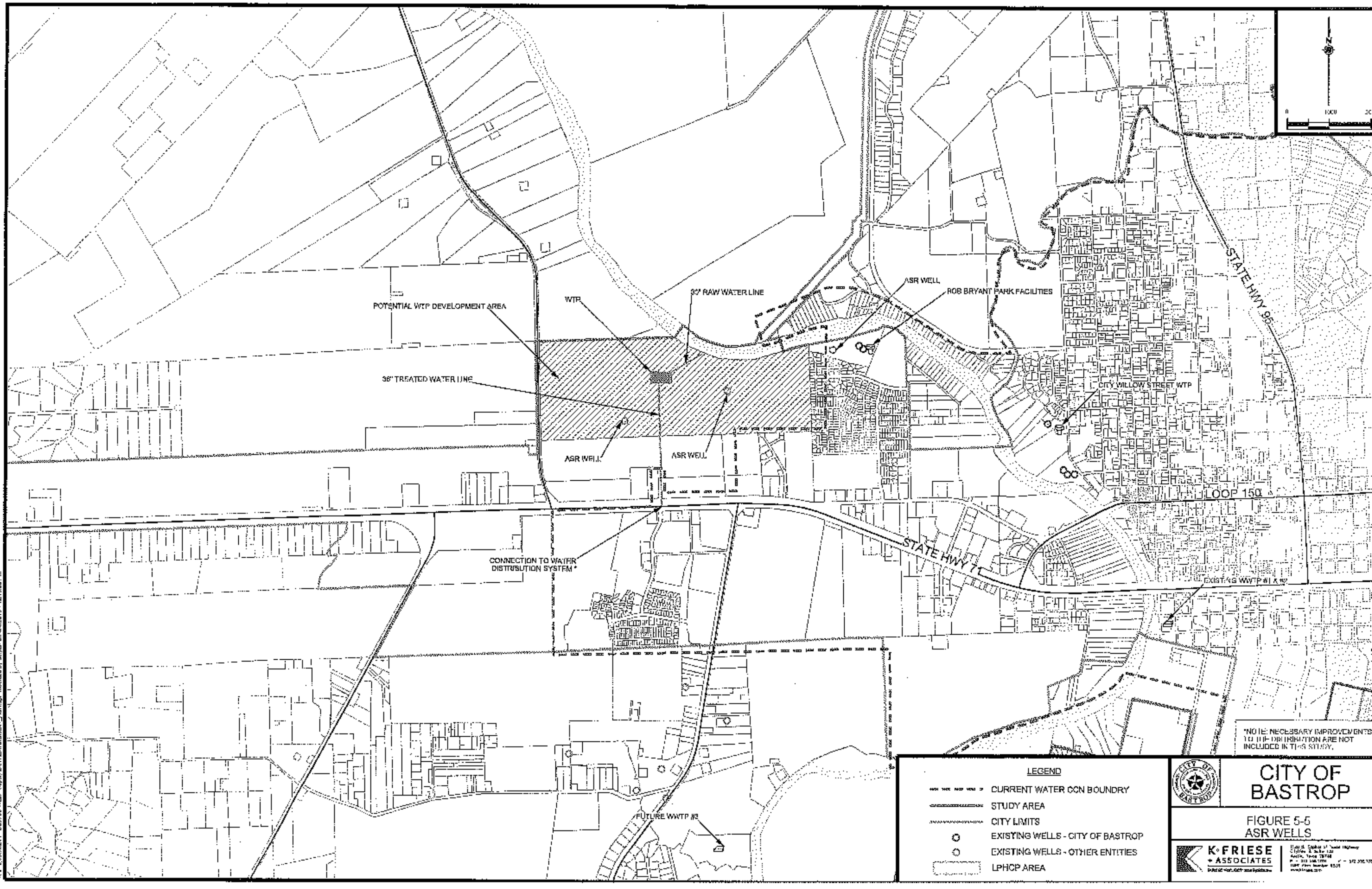


- Each of the three ASR wells can produce 1,000 gpm:
- 2-acres of land are acquired for the ASR wells;
- No fees are paid to LPGCD for water that is withdrawn from the ASR wells, since that is treated water that was injected;
- Annual costs for water supply are based on LCRA current rates of $151 per ac-ft for firm water and $75 per ac-ft for reserved water. The water rate used for the phase is the design production for the phase. Note that under a firm water contract, the reservation fee is a contract for the water available in conditions that do not exceed the drought of record; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the surface water - ASR water source and delivery to the existing system is shown in ***Table 5-3***. The detailed cost estimate is included in ***Appendix F***.

Table 5-3 Annual Unit Costs for ASR System

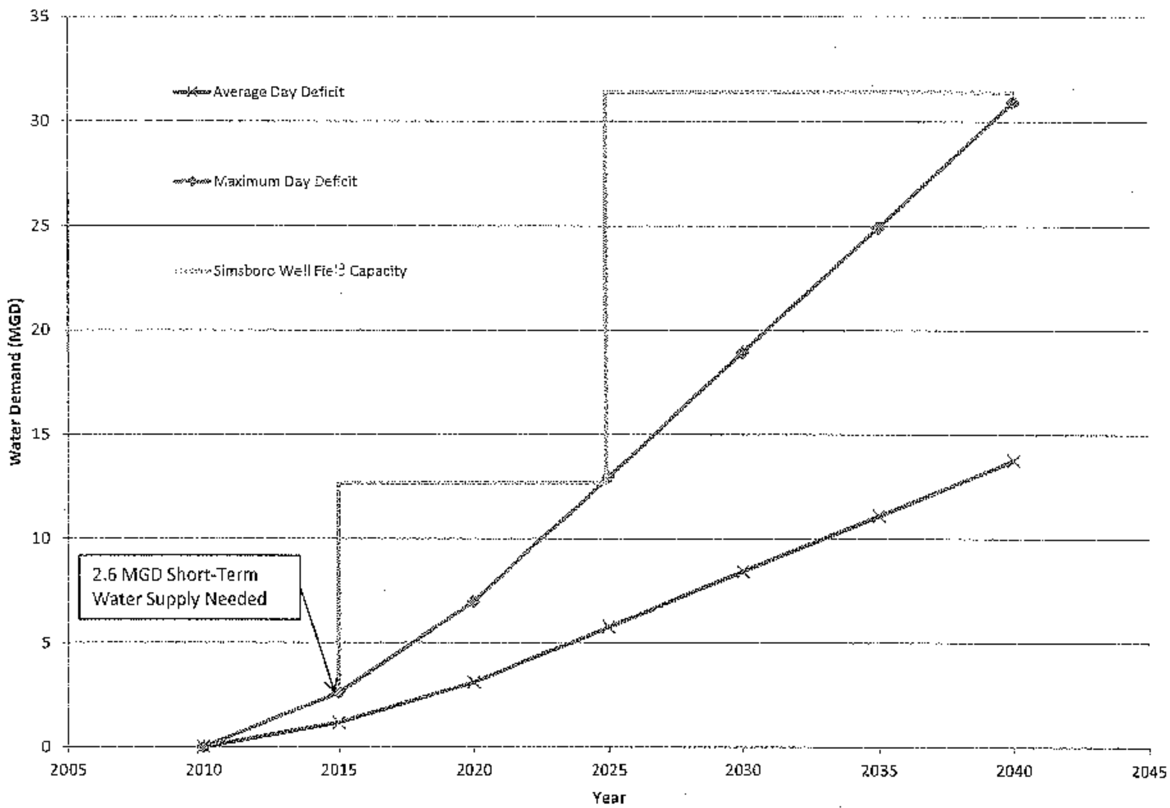
Phase	Project Delivery Costs			
ASR Phase 1	$5.58	/1,000 gal	$1,818.78	/ac-ft
ASR Phase 2	$5.33	/1,000 gal	$1,738.07	/ac-ft

5.3 Simsboro Groundwater Option

RWHA's technical memorandum also included sizing of the potential development from the Simsboro aquifer, an assessment of the potential permitting process for this groundwater development, and an estimate of probable costs for this development. The complete technical memorandum is located in ***Appendix* D**. This section summarizes the findings of that report.

This option includes two phases of wells, where all wells are assumed to produce a maximum of 1,000 gpm. As with the other options, it will take 1-2 years to permit and construct the wells; therefore requiring a 2.6 MGD short-term supply to meet the demand during the interim period. An initial phase of seven wells and a subsequent phase with thirteen wells, for a total of twenty wells are required to meet projected 2040 demands. Although the annual unit cost estimates are based upon this phasing, in actuality, each well would be constructed as it is needed and triggered by the demand curve. 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. ***Figure 5-6*** shows the projected needs and the two phases of well production.

Figure 5-6 Simsboro Well Capacity



All Simsboro groundwater options assume that 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 annual costs were included into the cost estimates. 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 the Regional Study (Regional Study Table 10-1) not be pursued for a water supply source without further evaluation of the increased O&M costs. Of note is that the Simsboro well at Bob Bryant did not require any treatment because the water from the test well did not include elevated levels of iron and manganese.

Each well constructed must be permitted through LPGCD. The current rules do not include a definitive formula or method of allocating groundwater to users in the district. The submittal of an application is a complex process in which the applicant must provide various engineering, hydrogeologic, and planning data. The planning, design, permitting and construction process is expected to take 1-2 years. LPGCD reviews the application for completeness and technical accuracy. Applications may be formally contested by affected stakeholders and LPGCD. The amount of effort required to provide professional support during the permitting process can vary significantly.

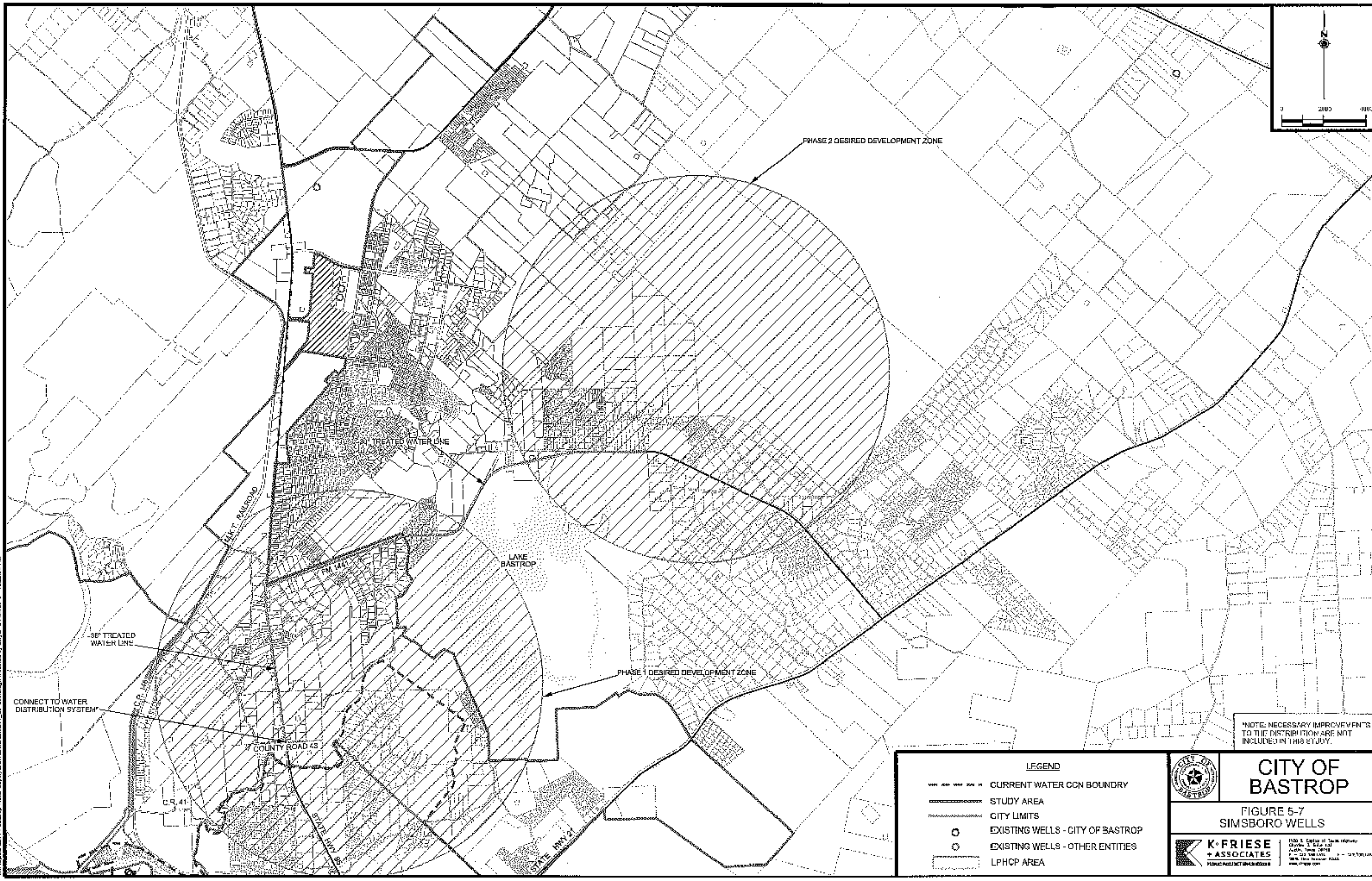
According to LPGCD rules that became effective on January 1, 2013, once the permit for a well is approved, it is effective for five years. A permitted well must be completed within 180 day of permit issuance or the permit will be automatically terminated. If water is not being used from a permitted well within 24 months from the date of completion, the permit will be automatically terminated. A permit may be renewed by applying for a renewal prior to the expiration of the permit. This regulatory framework does not allow for the City to secure water for long term future needs.

It should also be noted that permitted groundwater production in LPGCD currently surpasses the Managed Available Groundwater (MAG) which is typically assumed to represent maximum production allowable for the adopted Desired Future Conditions (DFC) to be held. The permitted production is projected to exceed the MAG limits for at least the next 50 years, which is the limit of the current studies. In addition, LPGCD recently lifted a moratorium on permits that had been in effect since 2010. There is a backlog of permit applications requesting production for more than 100,000 acre-feet per year. There is a large degree of uncertainty with regards to groundwater permitting in the LPGCD.

Figure 5-7 shows the location of the desired development zone for the proposed wells and the transmission pipelines that will deliver the water from the approximate location of the well field head works to the City distribution system at SH 95 and CR 43.

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

- An average delivery rate of 9.9 MGD and a peak day capacity of 28.8 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- The Phase 1 well field is comprised of seven wells each with a production rate of 1,000 gpm. In addition, there is a 1 million gallon storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- The Phase 2 well field is comprised of fourteen wells each with a production rate of 1,000 gpm and a 2 MG storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- A total of 11-acres will be acquired for all of the wells and it is assumed that groundwater ownership is transferred with the land acquired for the well field such that no additional costs for groundwater (other than regulatory permitting, production and reservation costs) are needed;
- Each well is assumed to have 2,500 feet of 8-inch pipe from the well to the storage tank and treatment facilities;


PHASE 2 DESIRED DEVELOPMENT ZONE
PHASE 1 DESIRED DEVELOPMENT ZONE
TREATED WATER LINE
LAKE
BASTROP
M.K.T. RAILROAD
FM 1441
SEP TREATED
WATER LINE
CONNECT TO WATER
DISTRIBUTION SYSTEM*
COUNTY ROAD 43
C.R. 41
STATE HWY 95
STATE HWY 21
*NOTE: NECESSARY IMPROVEMENTS
TO THE DISTRIBUTION ARE NOT
INCLUDED IN THIS STUDY.
LEGEND
CURRENT WATER CCN BOUNDRY
STUDY AREA
CITY LIMITS
EXISTING WELLS - CITY OF BASTROP
EXISTING WELLS - OTHER ENTITIES
LPHCP AREA
CITY OF
BASTROP
FIGURE 5-7
SIMSBORO WELLS
K·FRIESE
+ ASSOCIATES

- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur in a single location for each phase adjacent to the storage tank prior to the well field 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. 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 3 miles of 30-inch pipe from the Phase 2 well field to the Phase 1 well field and approximately 2 miles of 36-inch pipe from the Phase 1 well field to the delivery point;
- All pipeline easements are 40-feet wide;
- A LPGCD groundwater operation production fee of $9.80 per ac-ft for the total permitted amount. The production fee used for each phase is based on the average permitted amount of water for that phase; 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 shown in ***Table 5-4***. The detailed cost estimate is included in ***Appendix F***.

Table 5-4 Annual Unit Costs for Simsboro Groundwater Option

Phase	Project Delivery Costs			
Simsboro Phase 1	$2.79	/1,000 gal	$908.42	/ac-ft
Simsboro Phase 2	$1.72	/1,000 gal	$560.86	/ac-ft

5.4 Third Party Options

At the time of this Study, there were three third party purveyors whom had contacted the City to discuss long-term water supply contracts. These include Jason Allen, the Boy Scouts of America, and XS Ranch.

5.4.1 Jason Allen

The Jason Allen property is located in the ETJ approximately 1.2 miles north east of the Loop 150 Tank Yard on the north side of SH 21. The property is approximately 1.7 acres and is capable of accommodating one well. Mr. Allen is currently in the process of installing a test well and obtaining a production report. He has verbally informed the City that his well is capable of producing 1,800 gpm. The City is awaiting the delivery of production and water quality report to verify these assumptions.

Mr. Allen's property is located within LPHCP area. In order to construct any facilities in the LPHCP area, the City would be required to obtain an incidental take authorization from USFWS. The Bastrop County Habitat Conservation Plan Coordinator as well as USFWS have been contacted to determine if the City of Bastrop could construct infrastructure within the ROW under the County's general plan without obtaining an incidental take authorization from USFWS.

A typical project development schedule for a City water supply project including design, permitting, and construction is estimated 1-2 years for a well field as 3-4 years for a surface water option. Based on this estimate, bringing either the surface water or the groundwater supply online prior to 2015 or 2017 is not feasible. Recognizing the difficulties of the timing, the Jason Allen project offers the City an option to meet the estimated demand deficits prior to the implementation of a long term surface or groundwater supply strategy. The benefit of this particular short term project cannot fully be considered Mr. Allen provide documentation which verifies the well production.

The cost estimate for this supply option is based on the following assumptions:

- A rate of $2.00 per 1,000 gallons was proposed by Mr. Allen. The delivery rate is assumed to be 1,800 gpm as provided by Mr. Allen. The cost estimate will need to be updated upon receipt of a well monitoring report from Mr. Allen;
- The City would be responsible for all design, permitting, and construction of the well and associated facilities;
- A 30–year contract was proposed by Mr. Allen;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- A storage tank is not included based on the assumption that the water could be pumped directly to the Loop 150 tank yard;
- A pump station will not be required to transport water to Tank #3 at the the Loop 150 Tank;
- An area of 0.5-acres is acquired/leased for the well;
- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur prior to the 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. 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 1.2 miles of 12-inch pipe from the property to the Loop 150 Tank Yard delivery point;
- All pipeline easements are 40-feet wide;
- A LPGCD groundwater operation production fee of $9.80 per ac-ft for the total permitted amount. The production fee used for each phase is based on the average permitted amount of water for that phase; and
- Distribution system improvements are not assessed for this Study

The resulting annual unit cost for developing the Jason Allen third party source and delivery to the existing system is shown in ***Table 5-5***. The detailed cost estimate is included in ***Appendix F***.

Table 5-5 Annual Unit Costs for Jason Allen Option

Phase	Project Delivery Costs			
Allen Phase 1	$7.27	/1,000 gal	$2,369.21	/ac-ft

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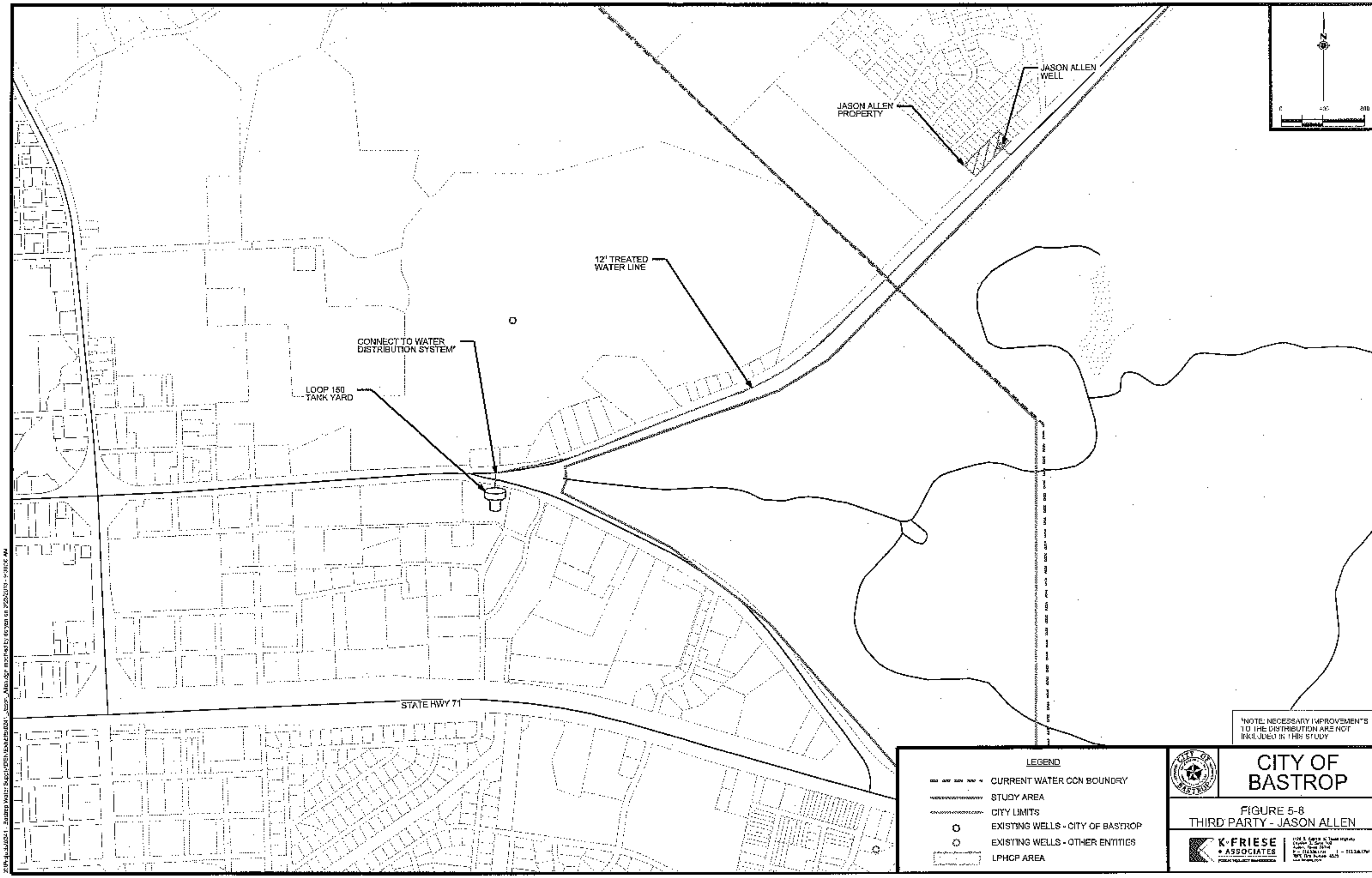


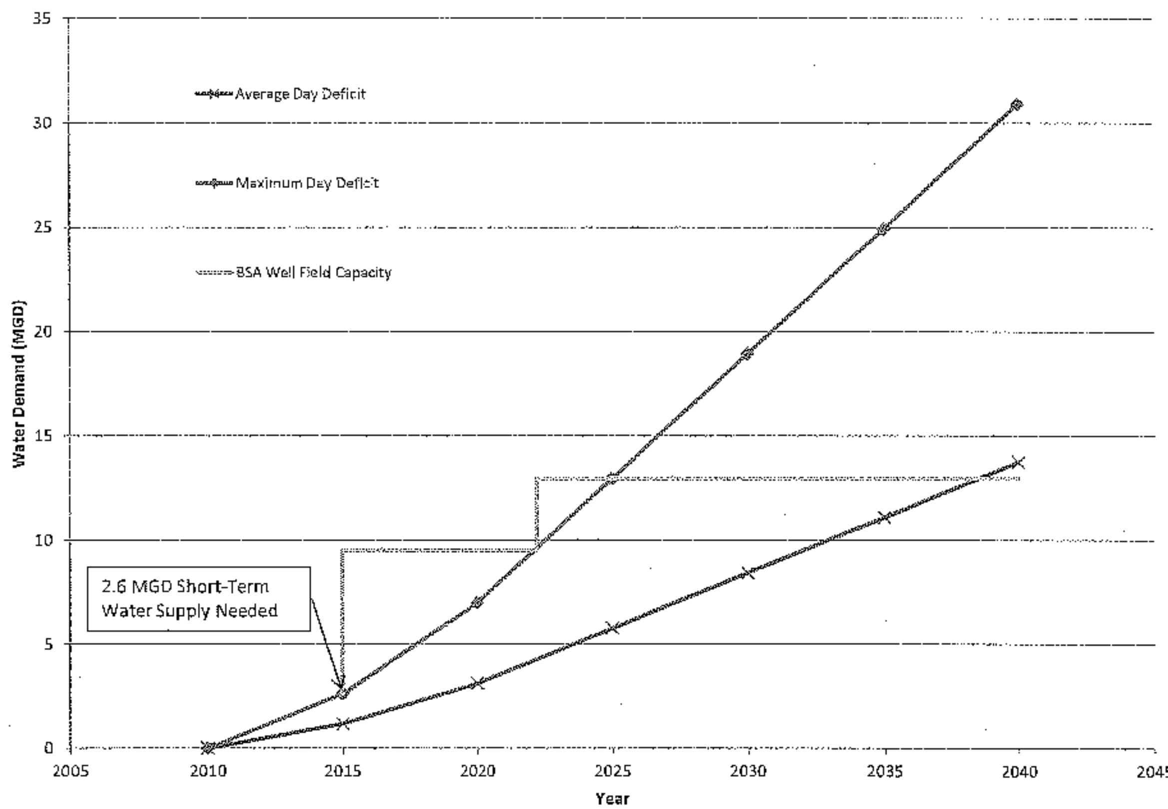
FIGURE 5-8
THIRD PARTY - JASON ALLEN

5.4.2 Boy Scouts of America

The Boy Scouts of America (BSA) operate the Griffith League Ranch (Ranch) which is located approximately 5.5 miles north east of the Loop 150 Tank Yard. BSA previously had a contract with Aqua which is now void due to a default by Aqua. Per the direction of the BSA, the fee structure of that voided contract has been used to provide a cost estimate for the City, however, it should be noted that the BSA have expressed a willingness to negotiate fees and terms with the City. No other legal terms of the BSA-Aqua contract have been reviewed for the Study as the BSA have stated they were not satisfied with the legal terms of the Aqua contract and they desire to develop a new contract. It should be noted that the BSA indicated they were also exploring contract opportunities with the LCRA.

LBG-Guyton Associates preapred a monitoring well report for Aqua which indicated that a large diamter well was capable of producing over 1,000 gpm of good water quality (February 2010). The Ranch is approximately 4,797 acres. Per the LPGCD spacing rules for wells which produce more than 1,000 gpm (5,000 feet) the property could contain approximately six wells. The actual number of wells supported by the Simsboro Aquifer or permitted by LPGCD may vary, however, for the purposes of this Study six wells each producing 1,200 gpm have been assumed. It has been assumed that the six wells will be constructed in two separate phases; the first phase includes four wells while the second phase has two wells. ***Figure 5-9*** shows the capacity of this option with regard to the average and peak day deficits.

Figure 5-9 Boy Scouts of America Well Capacity



The Ranch is located within the LPHCP as shown in ***Figure 5-10***. The BSA Ranch is subject to the Habitat Conservation Plan dated November 5, 2003, the USFWS Incidental Take Permit No. TE 065406-0, and the USFWS Conservation Bank Agreement dated April 21, 2004. These plans provide guidance and requirements for work performed by the BSA, however, research indicates that these permits and agreements would not support work performed by the City. In order to construct any facilities in the LPHCP area, the City would be required to obtain an incidental take authorization from USFWS.

The cost estimate for this supply option is based on the following assumptions:

- An assumed rate of $0.45 per 1,000 gallons. Per the BSA-Aqua voided contract the rate is based on the difference in the LCRA rate for surface water less the LPGCD production rate;
- The annual advance payment fee is an average of the fees for the period based on the fee schedule provided in the BSA-Aqua voided contract.;
- The City would be responsible for all design, permitting, and construction of the wells and associated facilities;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;

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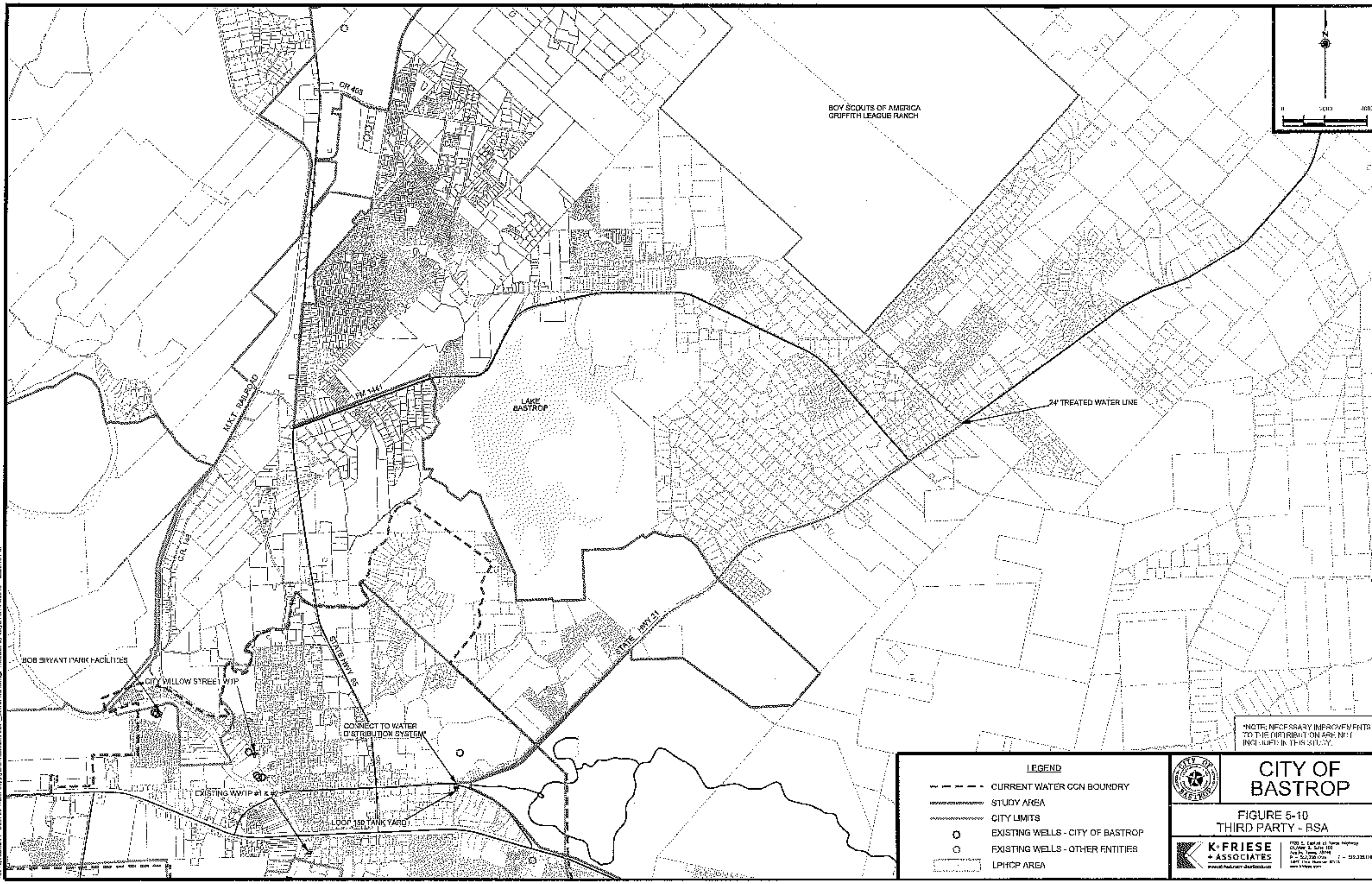


- The Phase 1 well field is comprised of four wells each with a production rate of 1,200 gpm. In addition, there is a 0.7 MG storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- The Phase 2 well field is comprised of two wells each with a production rate of 1,200 gpm and a 0.4 MG storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- A total of 3.0-acres acquired/leased for all of the wells;
- Each well is assumed to have 5,000 feet of 10-inch pipe from the well to the storage tank facilities;
- Treatment for reduction of high metal ions is not assumed for this option based on the water quality reported in the February 2010 monitoring well report;
- Approximately 7 miles of 24-inch pipe from the Ranch to the Loop 150 Tank Yard delivery point;
- All pipeline easements are 40-feet wide;
- A LPGCD groundwater operation production fee of $9.80 per ac-ft for the total permitted amount. The production fee used for each phase is based on the average permitted amount of water for that phase; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the Boy Scouts of America third party source and delivery to the existing system is shown in ***Table 5-6***. The detailed cost estimate is included in ***Appendix F***.

Table 5-6 Annual Unit Costs for Boy Scouts of America Option

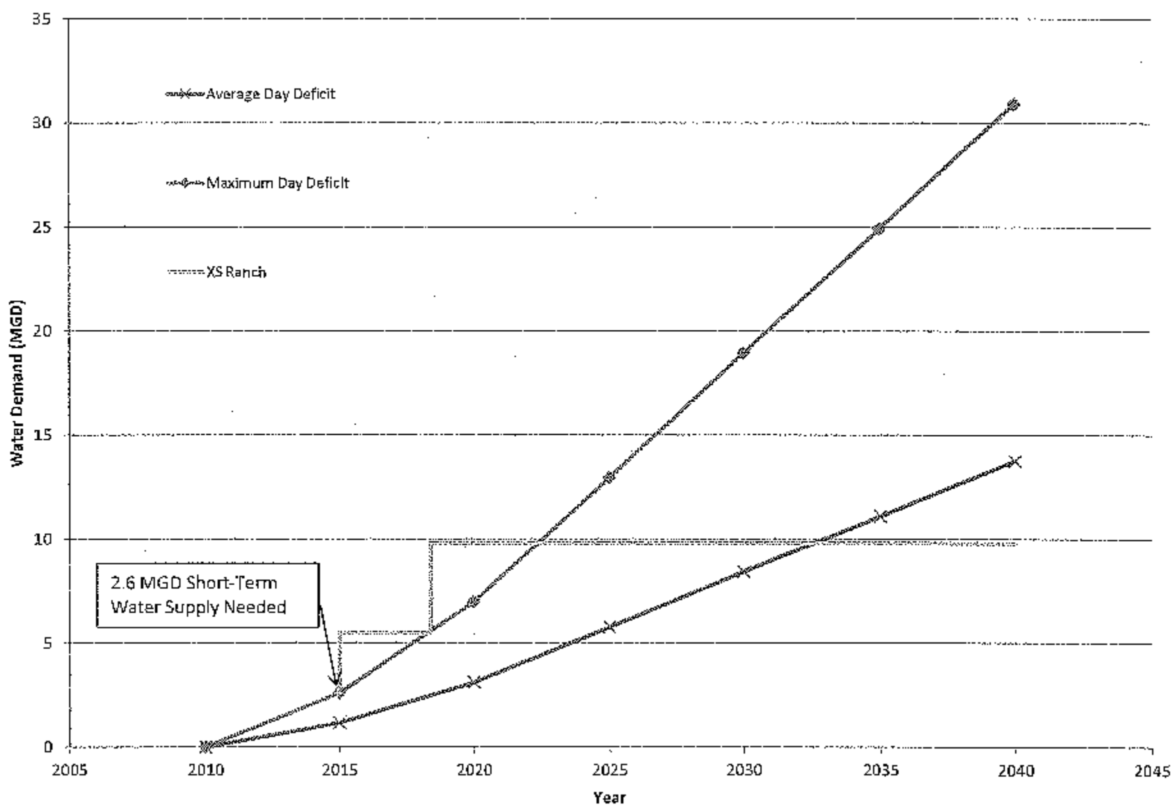
Phase	Project Delivery Costs			
BSA Phase 1	$2.22	/1,000 gal	$722.11	/ac-ft
BSA Phase 2	$1.65	/1,000 gal	$536.62	/ac-ft

5.4.3 XS Ranch

The XS Ranch Municipal Utility District (MUD) development is located approximately 3 miles north of the City on the west side of SH 95. XS Ranch is approximately 10,000 acres; however, they have identified an area that is approximately 800 acres in the south east corner of XS Ranch near SH 95 as the desired development zone for City water facilities. Per the LPGCD spacing rules for wells which produce 1,000 gpm or less (2,500 feet) the property could contain approximately five wells. The production is assumed to be lower than 1,000 gpm because XS Ranch is located west of the desired development zone identified by RWHA for the Simsboro aquifer shown in ***Figure 5-7***. XS Ranch is currently in the process of installing a test well and obtaining a production report. The actual number of wells and production supported by the Simsboro Aquifer at this location or permitted by LPGCD may vary, however, for the purposes of this Study five wells each producing 1,000 gpm have been assumed. The City is awaiting the delivery of production and water quality report to verify the production and treatment assumptions.

It has been assumed that the five wells will be constructed in two separate phases; the first phase includes two wells while the second phase has three wells. ***Figure 5-11*** shows the capacity of this option with regard to the average and peak day deficits.

Figure 5-11 XS Ranch Well Capacity



XS Ranch property is not located within LPHCP area. If the pipeline is located east of SH 95 incidental take authorization from USFWS will not be required. The XS Ranch desired development zone and the proposed pipeline to the SH 95 delivery point are shown in ***Figure 5-12***.

The cost estimate for this supply option is based on the following assumptions:

- At the time of the Study proposed rates, reservation fees or advancement payment fees had not been received from the XS Ranch developers. An assumed rate of $3.00 per 1,000 gallons was used. No other water cost, reservation, or advanced payment fees were assumed;
- The City would be responsible for all design, permitting, and construction of the wells and associated facilities;

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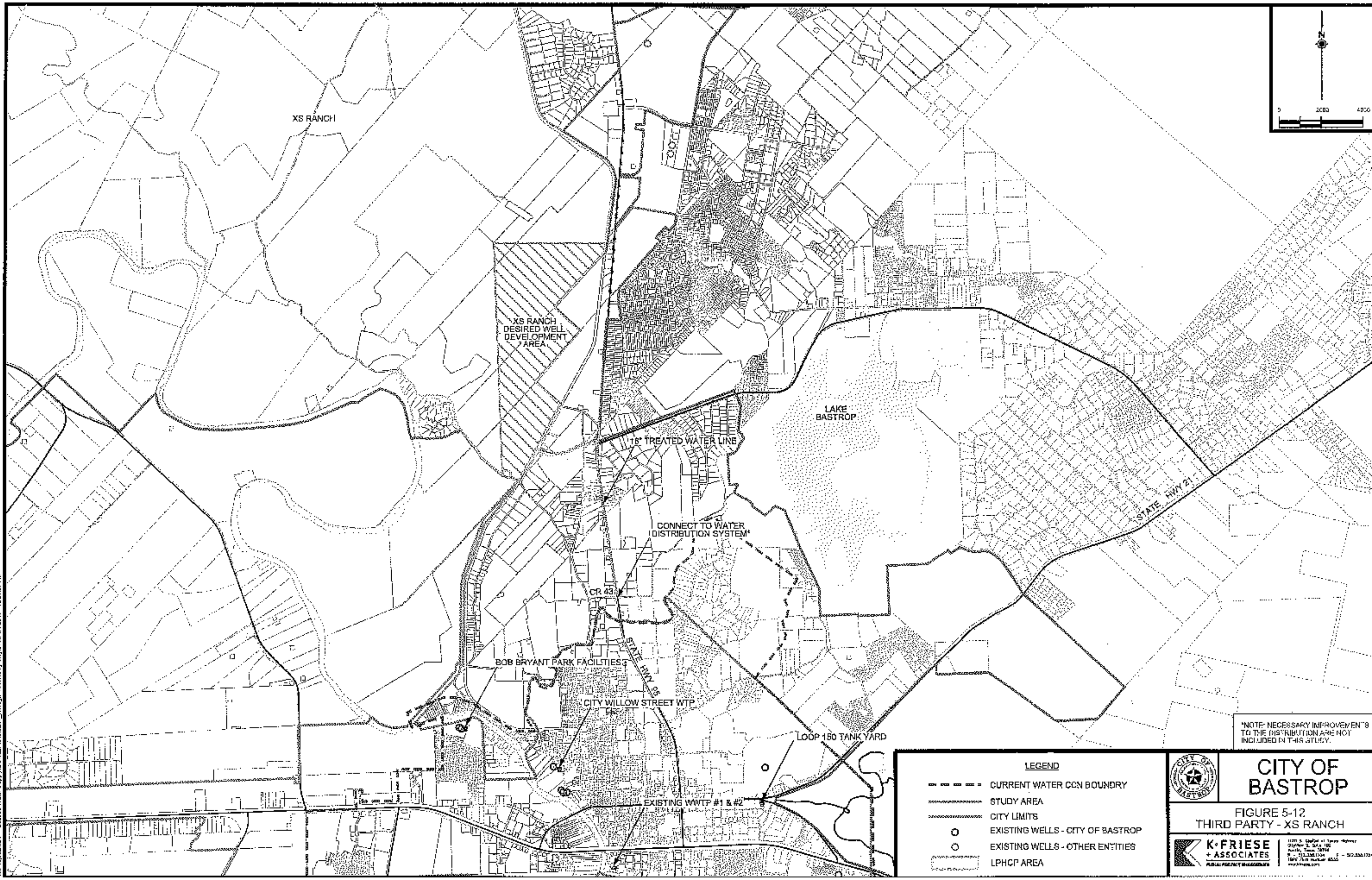


*NOTE: NECESSARY IMPROVEMENTS TO THE DISTRIBUTION ARE NOT INCLUDED IN THIS STUDY.

CITY OF
BASTROP

FIGURE 5-12
THIRD PARTY - XS RANCH

K·FRIESE + ASSOCIATES

- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- The Phase 1 well field is comprised of two wells each with a production rate of 1,000 gpm. In addition, there is a 0.25 MG storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- The Phase 2 well field is comprised of three wells each with a production rate of 1,000 gpm and a .25 MG storage tank which is approximately 10 percent of the peak day delivery volume to balance hourly fluctuations and meet peak hour system demands;
- A total of 2.5-acres was acquired/leased for all of the wells;
- Each well is assumed to have 2,500 feet of 8-inch pipe from the well to the storage tank facilities;
- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur in a single location for each phase adjacent to the storage tank prior to the well field 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. 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 2 miles of 18-inch pipe from the Ranch to the distribution system at SH 95 and CR 43;
- All pipeline easements are 40-feet wide;
- A LPGCD groundwater operation production fee of $9.80 per ac-ft for the total permitted amount. The production fee used for each phase is based on the average permitted amount of water for that phase; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the XS Ranch third party source and delivery to the existing system is shown in ***Table 5-7***. The detailed cost estimate is included in ***Appendix F***.

Table 5-7 Annual Unit Costs for XS Ranch Option

Phase	Project Delivery Costs			
XS Phase 1	$2.40	/1,000 gal	$783.19	/ac-ft
XS Phase 2	$1.29	/1,000 gal	$421.23	/ac-ft

6 Cost Summary

Unit costs for the seven water supply options were developed based on the assumptions described in ***Section 5***. 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 E*** and ***Appendix F***, respectively. The costs estimates are summarized in 2013 dollars in ***Table 6-1***, ***Table 6-2***, ***Table 6-3*** and ***Table 6-4***. The "Capital Costs" include water supply infrastructure costs. "Other Project Costs" include engineering, survey, environmental studies and mitigation costs, legal and land costs. ***Table 6-2*** includes the capital costs per acre-foot of water produced. 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. Project delivery costs equal the annual costs for each phase divided by the annual average supply for that phase.

Table 6-1. Project Cost Summary – 2013 Dollars

Water Supply Option	Capital Costs	Other Project Costs	Total Project Costs
Colorado River Surface Water Option	$83,674,000	$55,455,200	$139,129,200
Lake Bastrop Surface Water Option	$86,188,000	$57,257,100	$143,445,100
ASR Wells Option	$67,141,000	$44,487,500	$111,628,500
Simsboro Groundwater Option	$52,639,000	$35,938,200	$88,577,200
Third Party - Jason Allen Groundwater Option	$2,732,000	$1,901,300	$4,633,300
Third Party - Boy Scouts of America (BSA) Groundwater Option	$18,516,000	$13,207,900	$31,723,900
Third Party - XS Ranch Groundwater Option	$9,145,000	$6,377,800	$15,522,800

Table 6-2 Capital Costs and Average Production

Water Supply Option	Avg Production (ac-ft/yr)	Costs (ac-ft)	Costs (1,000 gal)
Colorado River Surface Water Option	12,942	$6,465	$19.84
Lake Bastrop Surface Water Option	12,942	$6,659	$20.44
ASR Wells Option	12,106	$5,546	$17.02
Simsboro Groundwater Option	14,339	$3,671	$11.27
Third Party - Jason Allen Groundwater Option	1,290	$2,117	$6.50
Third Party - Boy Scouts of America (BSA) Groundwater Option	5,162	$3,587	$11.01
Third Party - XS Ranch Groundwater Option	3,585	$2,551	$7.83

Table 6-3 Annual Costs by Phase

	Phase 1		Phase 2		Phase 3	
Water Supply Option	**Year**	**Annual Costs**	**Year**	**Annual Costs**	**Year**	**Annual Costs**
Colorado River Surface Water Option	2018	$12,743,000	2027	$20,886,000	2035	$25,771,000
Lake Bastrop Surface Water Option	2018	$13,096,000	2027	$21,238,000	2035	$26,123,000
ASR Wells Option	2018	$12,530,000	2030	$21,041,000		
Simsboro Groundwater Option	2015	$4,559,000	2025	$8,042,000		
Third Party - Jason Allen Groundwater Option	2015	$3,057,455				
Third Party - Boy Scouts of America (BSA) Groundwater Option	2015	$2,485,000	2022	$2,770,000		
Third Party - XS Ranch Groundwater Option	2015	$1,123,000	2018	$1,510,000		

Table 6-4 Project Delivery Costs by Phase per 1,000 Gallons of Water Produced

	Phase 1		Phase 2		Phase 3	
Water Supply Option	**Year**	**Costs**	**Year**	**Costs**	**Year**	**Costs**
Colorado River Surface Water Option	2018	$7.86	2027	$6.44	2035	$6.11
Lake Bastrop Surface Water Option	2018	$8.07	2027	$6.55	2035	$6.19
ASR Wells Option	2018	$5.58	2030	$5.33		
Simsboro Groundwater Option	2015	$2.79	2025	$1.72		
Third Party - Jason Allen Groundwater Option	2015	$7.27				
Third Party - Boy Scouts of America (BSA) Groundwater Option	2015	$2.22	2022	$1.65		
Third Party - XS Ranch Groundwater Option	2015	$2.40	2018	$1.29		

7 Water Supply Strategy Planning Triggers

The water supply strategy implementation phasing and costs to this point are the results of an analysis based on the Study Area defined by the City at the beginning of the Study. The Study Area was developed over several meetings where the Utility Committee and Staff identified and refined a boundary around the City thought to contain the areas with potential for high density and growth which the City desired to serve. While this Study Area may represent a desired future condition for the City; the evaluation of the area for water supply options raises four considerations for relevancy of the implementation phasing and the required financial resources for said implementation in the City's immediate planning needs:

- Size or magnitude of the service area;
- Population growth rate;
- Duration or implementation phasing; and
- Financial resources

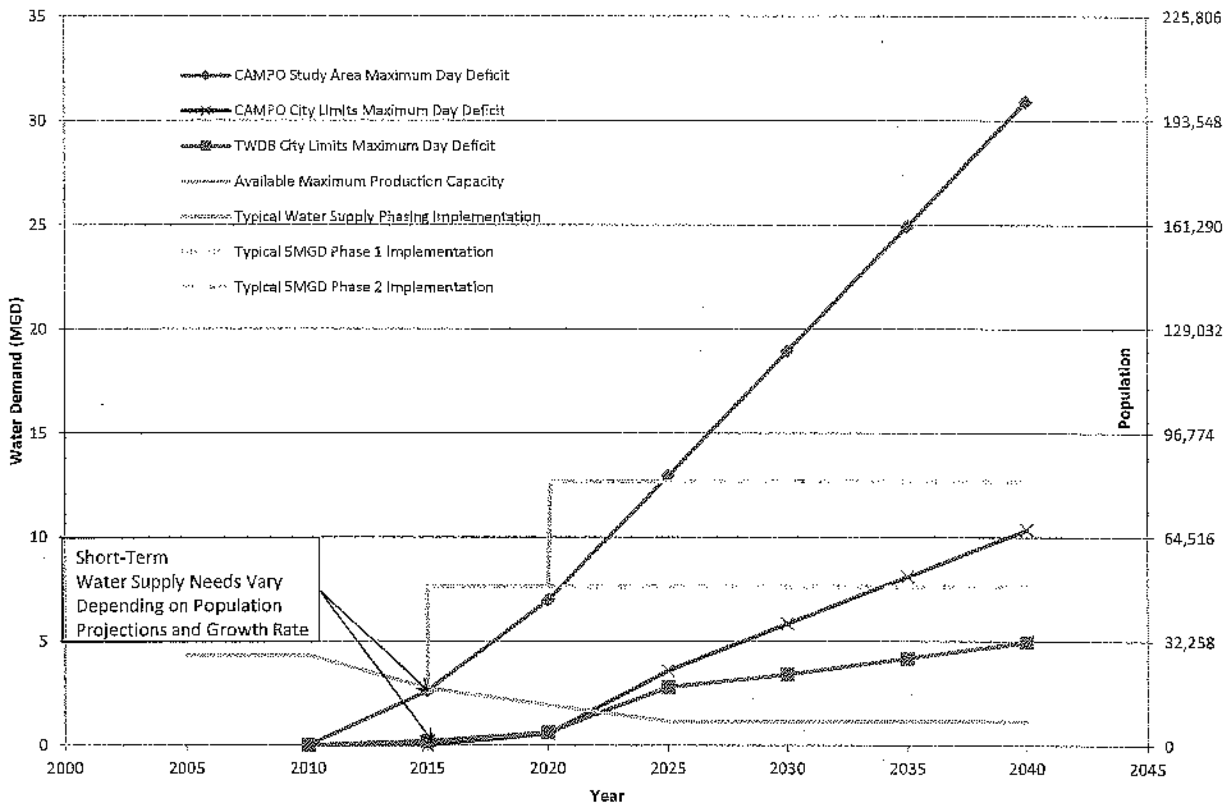
The size of the Study Area is nearly five times the land area of the City limits. The review of population projections discussed in ***Section 2*** revealed that the Study Area did achieve the goal of containing the high growth areas immediately around the City. Capture of the high growth areas is evident by comparing the Regional Study Area population projections with the Study Area population projections. Although the Study Area is approximately 33% smaller than the Regional Study Area the population projections are 4% larger due to the high density areas included in the Study Area.

Growth rates for the City limits and Study Area are discussed in ***Section 2.*** The summary of this data is that the City's historical population growth from 2005 to 2010 is 3.05% which is equal to the TWDB growth rates applied to the City limits from 2010 to 2040. The CAMPO population projections for the City limits area use a growth rate of 4.55% from 2010 to 2040, while they utilize a 6.69% growth rate for the Study Area. During the Regional Study, the Utility Committee and the Staff expressed a concern with limiting the City's planning efforts to the moderate TWDB population projections. Therefore, this Study used the more aggressive CAMPO projections.

These first two factors are the basic drivers of the second two factors: implementation phasing and required financial resources. The size of the Study area and the growth rate for population projections directly affect the timing and size of needed infrastructure and, consequently, the cost of the proposed water supply options. The actual population growth rate of the City will likely vary from the TWDB and the CAMPO projections.

Figure 7-1 depicts a typical water supply phased implementation for comparison against the three different growth scenarios discussed. The chart shows two implementation phases of 5 MGD each. The purpose of the chart is to provide a visual demonstration of how the implementation of a water supply project may satisfy the City's demand for varying durations depending upon the actual growth rate experienced.

Figure 7-1 Typical Water Supply Phasing Implementation for City Limits



7.1 Planning Chart Tools

As a tool for the City in the next stage of capital improvement planning, deficit trigger tables provided in ***Appendix B*** present a range of populations and the corresponding water supply deficit for a range of growth rates.

Starting with the 2010 census population for the City, population projections based on growth rates from 1% to 10%, at half percent increments, are presented in the first chart in ***Appendix B***. The second chart relates the population to annual average demand based on the City's criteria of 155 gpcd and the adjustments for the diminishing existing supplies as described in ***Sections 3 and 4***. Adjustments for Aqua connections were not made as these demand estimates are representative of the City's current service area and not the Study Area which is largely within Aqua's service area.

The charts are highlighted in bands of color. Each band represents a 5 MGD water supply deficit which is roughly equivalent to an average demand of 5600 ac-ft/yr or an approximate growth of 32,000 people. A water supply of 5 MGD represents a small surface water treatment plant or a productive well field. These charts can be used as a planning tool by overlaying the City's actual growth rate and existing population, then identifying the year in which the planning for a surface water treatment plant or a well field must be initiated.

A second page of charts was developed starting with the 2010 CAMPO population projections for the Study Area. This is provided as a planning tool in support of the scope of the Study. Again the first chart shows population projections based on growth rates from 1% to 10%, every half percent. The second chart relates the population to annual average demand based on the City's criteria of 155 gpcd, the adjustments for the diminishing existing supplies and Aqua service connections were made as described in ***Sections 3 and 4***.

These charts are a broad planning tool that can continually be used over time. The remainder of this section will review specific demand, deficit, cost estimates and implementation recommendations based on the TWDB 2016 State Water Plan population projections for the City of Bastrop City limits. The current City limits and the current CCN are considered coincident for this long term water supply planning effort.

7.2 City Limit Population, Demand, and Deficit Projections

Population projections for the City of Bastrop from the TWDB 2016 State Water Plan are shown in ***Table 7-1***. The State Water Plan is a 50-year planning document and therefore includes the available data from 2010-2060, however, the implementation phases generally evaluate the 2010-2040 duration of the Study.

Table 7-1 TWDB 2016 State Water Plan Population Projections for the City of Bastrop

2010	2015	2020	2025	2030	2035	2040	2050	2060
7,218	8,436	9,653	11,371	13,088	15,321	17,553	23,603	31,775

Projections for the average annual demand and maximum day demand were developed based on the City's criteria of 155 gpcd as described in ***Sections 3***.

Table 7-2. City Limit Projected Average Annual Demand (ac-ft/yr)

2010	2015	2020	2025	2030	2035	2040	2050	2060
1,253	1,465	1,676	1,974	2,273	2,660	3,048	4,098	5,517

Table 7-3. Projected Maximum Day Delivery Rate (MGD)

2010	2015	2020	2025	2030	2035	2040	2050	2060
2.5	2.9	3.4	4.0	4.6	5.3	6.1	8.0	11.1

Projections for the average annual deficit and maximum day deficit were developed based on the above demand and accounting for the diminishing existing supplies as described in ***Section 4***.

Adjustments for Aqua connections were not made as these demand estimates are representative of the City's current service area and not the Study Area which is largely within Aqua's service area.

Table 7-4. Projected Average Annual Deficit (ac-ft/yr)

2010	2015	2020	2025	2030	2035	2040	2050	2060
908	-97	-309	-1,400	-1,698	-2,086	-2,474	-3,524	-4,943

Table 7-5. Projected Maximum Day Delivery Rate Deficit (MGD)

2010	2015	2020	2025	2030	2035	2040	2050	2060
1.8	-0.2	-0.6	-2.8	-3.4	-4.2	-5.0	-7.1	-9.9

7.3 City Limit Water Source Options

The purpose of this section of the report is to evaluate the delivery, phasing and implementation costs of the water supply options to meet the 2040 City Limit water supply deficit based on the TWDB 2016 population projections. The following water supply options were evaluated:

- Lower Colorado River surface water – a firm water contract with the LCRA and a water treatment plant located on the west side of the City;
- Aquifer Storage and Recover (ASR) - Lower Colorado River surface water firm water contract with the LCRA and a water treatment plant located on the west side of the City and conjunctive use with aquifer storage recovery with the Simsboro aquifer groundwater;
- Simsboro groundwater – desired development zone in the Simsboro aquifer located north and east of the City;

The water supply option of a firm water contract with the LCRA and a water treatment plant located on Lake Bastrop was not evaluated for this section due to the uncertainties of availability and permitting which were outlined in Section 5.1.2. Should these uncertainties be resolved this option could be furthered explored. However, for the purposes of this report section the evaluation of the surface water treatment plant located on the west side of the City will provide adequate information for the City to compare the surface water options to the others.

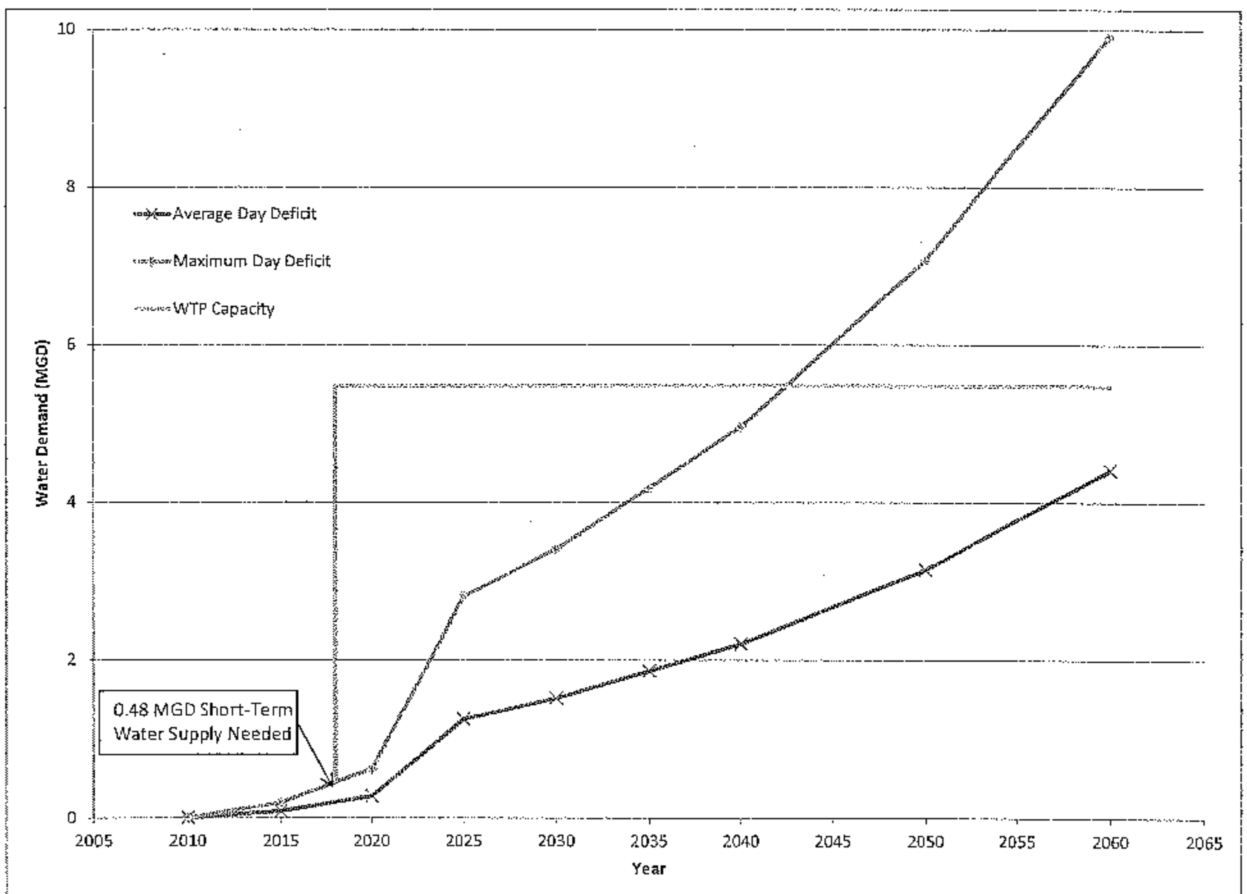
The third party options were also not evaluated within this section. These are not included because the implementation and costs of these options are not impacted by the smaller service area and reduced demands. All of the third party options in Section 5.4 were evaluated for the scenario of maximizing the available water supply development for the option based on the information provided by the various purveyors.

7.3.1 Colorado River Water Treatment Plant Option – City Limits

Vendor package plants are typically available in sizes of 2 MGD or less. Although a vendor-supplied package treatment plant may be utilized while considering size alone, due to the fluctuations in turbidity that will be encountered from the Colorado River source water a traditional treatment plant described in ***Section 5.1*** is recommended.

It typically takes 3-4 years to design, permit, and construct a WTP, therefore it is anticipated that the earliest the plant could produce water is 2018. The City should secure a short-term supply of approximately 0.48 MGD to supply the deficit expected in 2018. The 2040 peak day deficit is 5 MGD; therefore the plant must provide 5 MGD in 2040. It is recommended that this plant be built in a single phase. ***Figure 7-2*** shows the projected deficit and the proposed plant phasing.

Figure 7-2 Surface Water Treatment Plant Capacity – City Limits



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

- All intake and pipeline facilities are sized for the 2040 peak day of 5 MGD;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- A river intake and a diversion structure are included;
- Approximately 0.15 miles of 16-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed in a single 5 MGD phase;
- 11-acres of land are acquired for the water treatment plant and intake facilities;
- Two 0.25 million gallon clearwells 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 0.6 miles of 16-inch pipe from the WTP to the distribution system;
- A disinfection system at the existing wells to convert chloramines;
- 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 is based on the average production for the phase. Note that under a firm water contract, the reservation fee is a contract for the water available in conditions that do not exceed the drought of record; 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 for each phase is shown in ***Table 7-6***. The detailed cost estimate is included in **Appendix G**.

Table 7-6 Annual Unit Costs for Colorado River Water Treatment Plant – City Limits

Phase	Project Delivery Costs			
Colorado River WTP Phase 1	$8.37	/1,000 gal	$2,728.13	/ac-ft

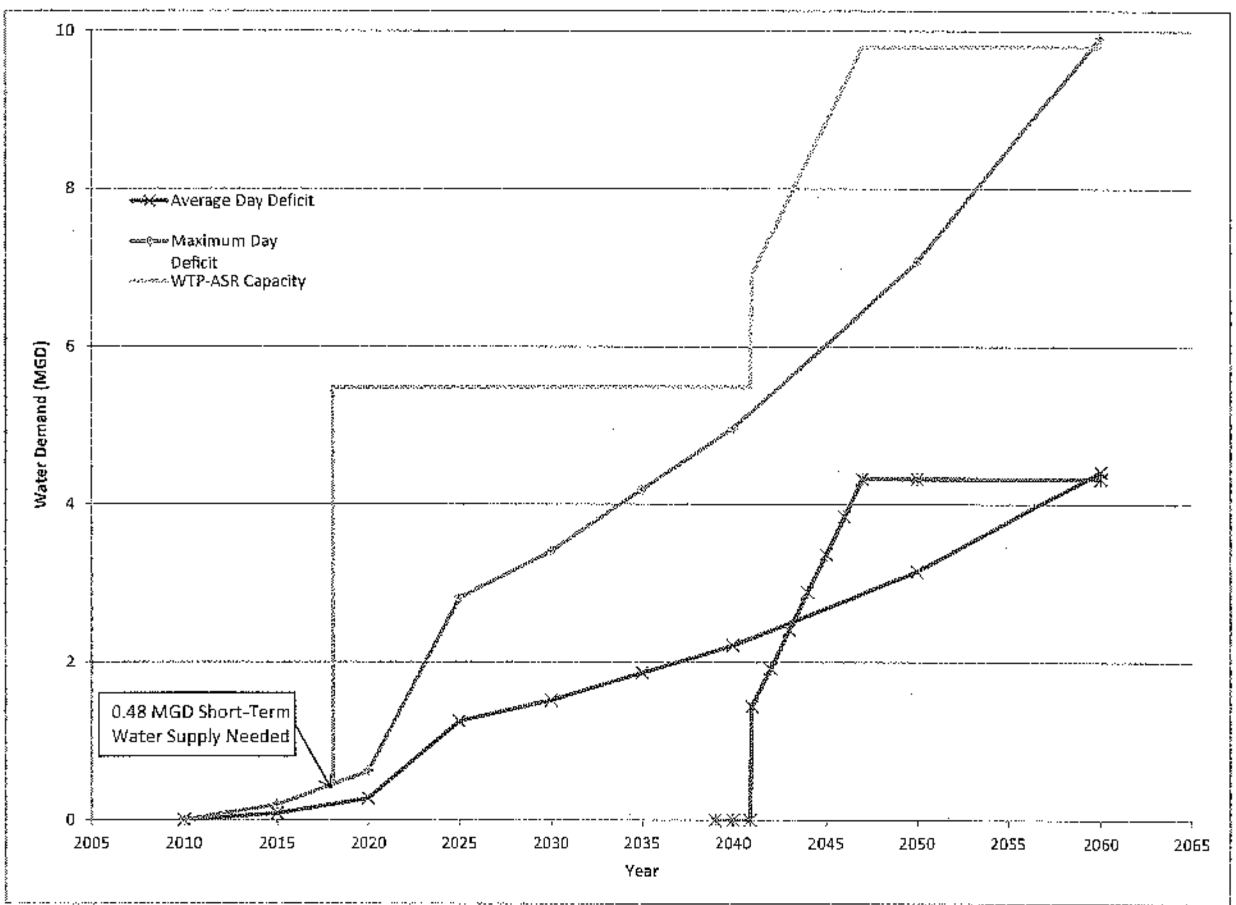
7.3.2 Aquifer Storage and Recovery Option – City Limits

This option describes implementation of the conventional surface water treatment plant described in ***Section 7.3.1*** used in conjunction with an Aquifer Storage and Recovery (ASR) system. Surplus treated water from the WTP will be injected into the Simsboro Aquifer through ASR wells during low demand periods (typically 9 months in length) and withdrawn to meet demand during peak periods (during hot, dry summer months typically 3 months).

The general system feasibility and assumptions described in ***Section 5.2*** are the basis for the development of this option. The capacity of the ASR system is limited by the amount of water able to be injected and withdrawn from the Aquifer which is governed by the hydraulic characteristics of the aquifer. As mentioned previously, excess water is injected over a period of roughly nine months, while water is produced for approximately three months. The option evaluated three wells. Approximately 310 gpm per well can be injected and 1,000 gpm per well is produced. The production limit for multiple wells is limited by a regulatory requirements related to the spacing of the wells less than 2,500 feet. The capacity of the three well option is 3,000 gpm, which corresponds to 4.3 MGD, which is 43% of the 10 MGD supply needed in 2060.

This option assumes 0.48 MGD from the short-term supply, 5 MGD from the WTP discussed in ***Section 7.3.1*** which exceeds the 5 MGD deficit in 2040, and 4.3 MGD from the ASR wells which nearly meets the 2060 deficit of ~10 MGD. ***Figure 7-3*** shows the capacity of the WTP-ASR system as well as the ASR system with regards to the demands. Planning and design of the ASR system would begin approximately 5 years prior to production needs to allow for design, permitting and priming phases. The WTP meets the 2040 demands and therefore the ASR implementation could be delayed until 2035. For the first two years of the physical implementation, 2039 and 2040, no water is extracted from the aquifer, while during the remaining years until 2047 increasingly more water is extracted until reaching the 3,000 gpm limit.

Figure 7-3 ASR System Capacity – City Limits



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

- All intake facilities are sized for the 2040 peak day of 5 MGD;
- Treated water facilities are sized for 5 MGD:
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- A river intake and a diversion structure are included;
- Approximately 0.15 miles of 16-inch pipe for the raw water conveyance system from the intake to a surface water treatment plant;
- Conventional surface water treatment plant is constructed in a single 5 MGD phase;
- 11-acres of land are acquired for the water treatment plant and intake facilities;
- Two 0.25 million gallon clearwells 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 0.6 miles of 20-inch pipe from the WTP to the distribution system;
- A disinfection system at the existing wells to convert chloramines;
- All pipeline easements are 40-feet wide;
- Each of the three ASR wells can produce 1,000 gpm:
- 2-acres of land are acquired for the ASR wells;
- No fees are paid to LPGCD for water that is withdrawn from the ASR wells, since that is treated water that was injected;
- 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 phase is the design production for the phase. Note that under a firm water contract, the reservation fee is a contract for the water available in conditions that do not exceed the drought of record; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the surface water – ASR source and delivery to the existing system for each phase is shown in ***Table 7-7.*** The detailed cost estimate is included in **Appendix G.**

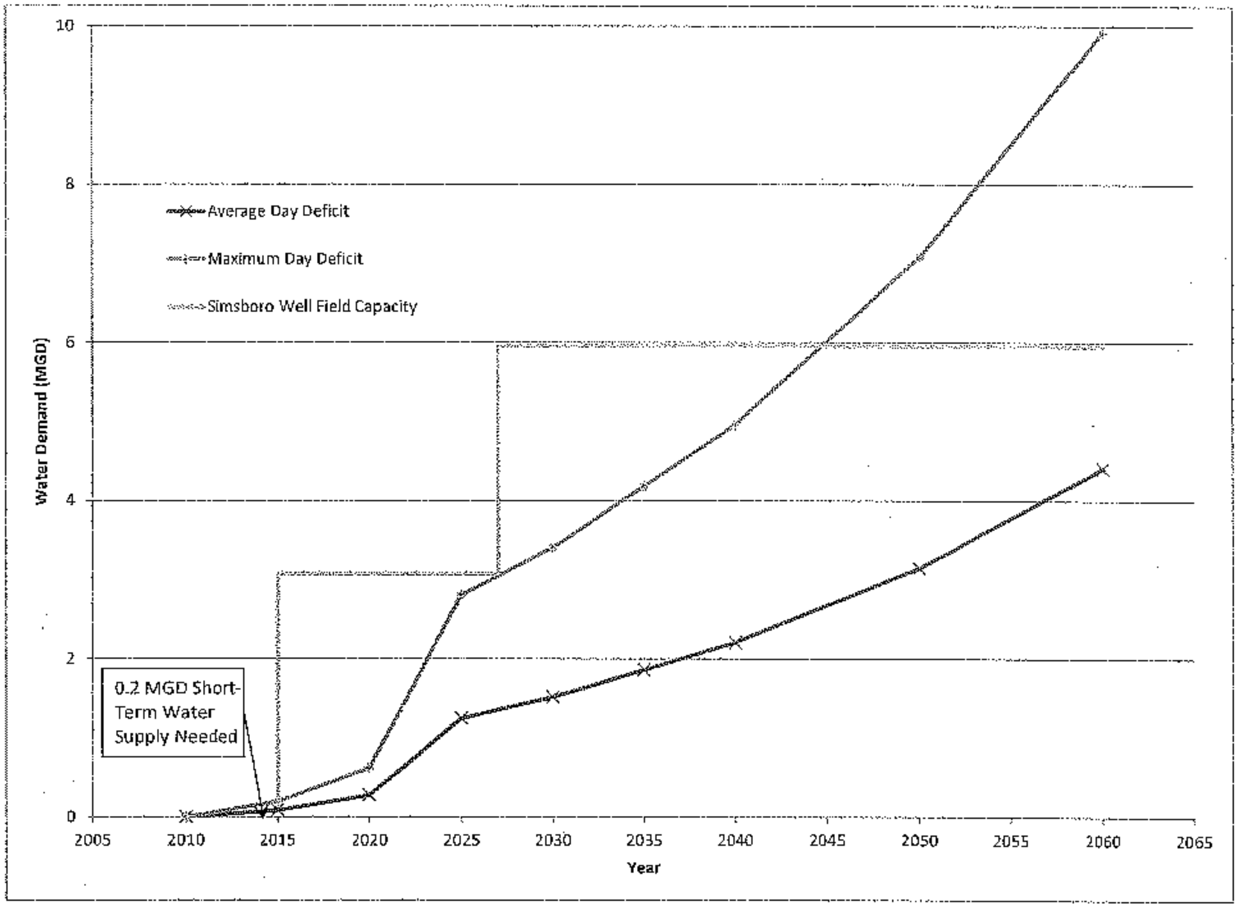
Table 7-7 Annual Unit Costs for ASR System – City Limits

Phase	Project Delivery Costs			
WTP Phase 1	$8.72	/1,000 gal	$2,840.07	/ac-ft
ASR Phase 2	$4.78	/1,000 gal	$1,557.14	/ac-ft

7.3.3 Simsboro Groundwater Option – City Limits

This option includes two phases of wells, where all wells are assumed to produce a maximum of 1,000 gpm. Estimated development time is 1-2 years to permit and construct the wells; therefore requiring a 0.2 MGD short-term supply to meet the demand during the interim period. An initial phase of two wells and a subsequent phase with two wells, for a total of four wells are required to meet projected 2040 demands. Although the annual unit cost estimates are based upon this phasing, in actuality, each well would be constructed as it is needed and triggered by the demand curve. 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 be adapted to actual growth in demand. ***Figure 7-4*** shows the projected capacity of the two phases as compared with the demand curves.

Figure 7-4 Simsboro Well Capacity – City Limits



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

- An average delivery rate of 5.7 MGD and a peak day capacity of 9.9 MGD. All facilities are sized for the peak day rate;
- All transmission pipe diameters are based on the design rate that would maintain velocities below 7 feet per second during peak day flows;
- The Phase 1 well field is comprised of two wells each with a production rate of 1,000 gpm. In addition, there is two 0.25 million gallon storage tank which is approximately 10 percent of the peak day delivery volume (for both phases) to balance hourly fluctuations and meet peak hour system demands;

- The Phase 2 well field is comprised of two wells each with a production rate of 1,000 gpm;
- A total of 2-acres will be acquired for all of the wells and it is assumed that groundwater ownership is transferred with the land acquired for the well field such that no additional costs for groundwater (other than regulatory permitting, production and reservation costs) are needed;
- Each well is assumed to have 2,500 feet of 8-inch pipe from the well to the storage tank and treatment facilities;
- Chlorination and treatment for reduction of high metal ions is required. Treatment will occur in a single location for each phase adjacent to the storage tank prior to the well field 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. 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 2 miles of 16-inch pipe from the well field to the Hwy 95 and CR 243 delivery point;
- All pipeline easements are 40-feet wide;
- A LPGCD groundwater operation production fee of $9.80 per ac-ft for the total permitted amount. The production fee used for each phase is based on the average permitted amount of water for that phase; and
- Distribution system improvements are not assessed for this Study.

The resulting annual unit cost for developing the surface water – ASR source and delivery to the existing system for each phase is shown in ***Table 7-8***. The detailed cost estimate is included in **Appendix G**.

Table 7-8 Annual Unit Costs for Simsboro Groundwater Option – City Limits

Phase	Project Delivery Costs			
Simsboro Phase 1	$2.41	/1,000 gal	$785.28	/ac-ft
Simsboro Phase 2	$1.50	/1,000 gal	$488.53	/ac-ft

8 Water Supply Source Blending

A high level blending analysis performed as part the Regional Study reviewed the typical regional water quality characteristics of the lower Colorado River water, the Simsboro aquifer water and the existing Alluvium water. The planning scope of the Study did not provide the opportunity or benefit of any further blending analysis.

In summary, the Regional Study blending analysis indicated that 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.

9 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, a water supply strategy to meet these demands must be developed. 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, and timing of capital expenditures.

Currently, the City of Bastrop's water source is predominately shallow Alluvium wells. It was a directive of the City Council to pursue source diversification 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 permits for Simsboro wells may be issued by the LPGCD, there is no accompanying guarantee that the permitted water will be available in accordance with the district's management plan. 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. In contrast, the Lower Colorado River Authority (LCRA) firm water contracts are managed under a plan that will provide the contracted surface water during the drought of record. However, if conditions exceed the drought of record, firm water users may be affected.

Costs for all implementation options reviewed in ***Section 5*** are summarized ***Section 6***. 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. Following the identification of a long term water supply strategy the City's next step is to develop a Capital Improvements Program which includes both the water supply facilities as well as the distribution system elements.

Of the supply options considered, the development of a Simsboro well field option is the lowest cost option available for the Study Area. Based on the costs developed above, the third party options yield a supply delivery with the lowest unit cost, but the amount of water those projects can provide do not meet the projected 2040 maximum day deficit. However, the regulatory uncertainty of groundwater introduces risk that may not be acceptable for a long term water supply option. Pending the resulting LPCGD management plan and existing regulatory uncertainties, a conjunctive use or joint development scenario with both Colorado surface water and Simsboro groundwater would diversify the risks associated with drought, contamination, and regulatory availability.

Note that at this juncture, very little detail on well productivity, contracting and cost structure have been provided by the potential third party partners. Prior to moving forward with any of these options additional information should be obtained from these entities. Additionally, some factors reduced the third party unit costs in comparison with the independent Simsboro well field development. Site specific knowledge on well field elevations allows for a more detailed cost analysis. For example the Boy Scouts of America property is located on a hill which has elevations above the City's existing tank yard elevations and therefore does not require a pump to convey water to the City's distribution system. This ability to eliminate a pump from the costing options greatly reduces both the capital and unit costs of the option. Other factors include the size of delivery pipelines. The delivery pipe for the third party options are sized for maximum day delivery of the limited well field estimated to be developed, whereas the pipelines for the independent Simsboro well field option is sized to delivery supply for the 2040 deficit and is not limited by a specific number of wells.

KFA recommends that the City pursue development of Simsboro wells either independently or with a third party in the near term to meet immediate needs but consider reserving surface water rights from LCRA to secure a long term supply in the future. The strategy of developing Simsboro water now will provide the City with more time to observe population growth rates, prepare a City annexation and service area growth plan, and prepare a CIP plan to determine the financial resources required to serve and grow into the Study Area. If the regulation of groundwater becomes more predictable, then the surface water rights may be released. During this time the City can also monitor the events of the LCRA pumping permits and the potential for conjunctive of joint surface and groundwater supply developments. A joint development option would diversify the water supply sources and distribute drought susceptibility, permitting and water rights risks. As the City develops a Simsboro well field careful consideration should be given to the pipeline sizes and alignments so as to maximize the pipeline infrastructure for either a future surface or groundwater supply.

Appendix A - Acronyms and Conversions

Acronyms

Ac-ft/yr	acre-feet per year
ASR	Aquifer Storage and Recovery
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
LPHCP	Lost Pines Habitat Conservation Plan
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
USFWS	United States Fish and Wildlife Service
WCID	Water Control and Improvement District
WSC	Water Supply Corporation
WUG	water user group

Conversions

1 acre	=	43,560 square feet
1 acre-foot	=	325,851 gallons
1 cubic foot	=	7.48 gallons
1 gallon	=	3.79 liters
1 acre-foot/year	=	0.62 gallons per minute
1 cubic foot/second	=	448.83 gallons per minute
1 million gallons/day	=	694.40 gallons per minute
1 million gallons/day	=	1,120 acre-foot/year

Appendix B – Growth Rate Triggers

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Census Population and
Water Deficit
Planning Triggers for the
City Limits

Annual Population Growth from CAMPO 2010 Estimate

	2010 Census City Limit Population	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.0%	7,218	7,362	7,510	7,660	7,813	7,969	8,129	8,291	8,457	8,626	8,799	8,975	9,154	9,337	9,524	9,714	9,909	10,107	10,309	10,515	10,726	10,940	11,159	11,382	11,610	11,842	12,079	12,320	12,567	12,818	13,074
2.5%	7,218	7,398	7,583	7,773	7,967	8,167	8,371	8,580	8,794	9,014	9,240	9,471	9,707	9,950	10,199	10,454	10,715	10,983	11,258	11,539	11,828	12,123	12,426	12,737	13,055	13,382	13,716	14,059	14,411	14,771	15,140
3.0%	7,218	7,435	7,658	7,887	8,124	8,368	8,619	8,877	9,144	9,418	9,700	9,991	10,291	10,600	10,918	11,245	11,583	11,930	12,288	12,657	13,037	13,428	13,830	14,245	14,673	15,113	15,566	16,033	16,514	17,010	17,520
3.5%	7,218	7,471	7,732	8,003	8,283	8,573	8,873	9,183	9,505	9,837	10,182	10,538	10,907	11,289	11,684	12,093	12,516	12,954	13,407	13,877	14,362	14,865	15,385	15,924	16,481	17,058	17,655	18,273	18,912	19,574	20,259
4.0%	7,218	7,507	7,807	8,119	8,444	8,782	9,133	9,498	9,878	10,273	10,684	11,112	11,556	12,019	12,499	12,999	13,519	14,060	14,622	15,207	15,816	16,448	17,106	17,790	18,502	19,242	20,012	20,812	21,645	22,510	23,411
4.5%	7,218	7,543	7,882	8,237	8,608	8,995	9,400	9,823	10,265	10,727	11,209	11,714	12,241	12,792	13,367	13,969	14,597	15,254	15,941	16,658	17,408	18,191	19,010	19,865	20,759	21,693	22,669	23,690	24,756	25,870	27,034
5.0%	7,218	7,579	7,958	8,356	8,774	9,212	9,673	10,156	10,664	11,197	11,757	12,345	12,962	13,611	14,291	15,006	15,756	16,544	17,371	18,240	19,152	20,109	21,115	22,170	23,279	24,443	25,665	26,948	28,295	29,710	31,196
5.5%	7,218	7,615	8,034	8,476	8,942	9,434	9,952	10,500	11,077	11,687	12,329	13,008	13,723	14,478	15,274	16,114	17,000	17,935	18,922	19,962	21,060	22,219	23,441	24,730	26,090	27,525	29,039	30,636	32,321	34,099	35,974
6.0%	7,218	7,651	8,110	8,597	9,113	9,659	10,239	10,853	11,504	12,195	12,926	13,702	14,524	15,395	16,319	17,298	18,336	19,436	20,603	21,839	23,149	24,538	26,010	27,571	29,225	30,979	32,837	34,808	36,896	39,110	41,457
6.5%	7,218	7,687	8,187	8,719	9,286	9,889	10,532	11,217	11,946	12,722	13,549	14,430	15,368	16,367	17,431	18,564	19,770	21,055	22,424	23,881	25,434	27,087	28,848	30,723	32,720	34,848	37,111	39,524	42,093	44,829	47,742
7.0%	7,218	7,723	8,264	8,842	9,461	10,124	10,832	11,591	12,402	13,270	14,199	15,193	16,256	17,394	18,612	19,915	21,309	22,800	24,396	26,104	27,931	29,887	31,979	34,217	36,612	39,175	41,917	44,852	47,991	51,351	54,945
7.5%	7,218	7,759	8,341	8,967	9,639	10,362	11,140	11,975	12,873	13,839	14,877	15,992	17,192	18,481	19,867	21,357	22,959	24,681	26,532	28,522	30,661	32,961	35,433	38,090	40,947	44,018	47,319	50,868	54,683	58,784	63,193
8.0%	7,218	7,795	8,419	9,093	9,820	10,606	11,454	12,370	13,360	14,429	15,583	16,830	18,176	19,630	21,201	22,897	24,728	26,707	28,843	31,151	33,643	36,334	39,241	42,380	45,771	49,432	53,387	57,658	62,270	[illegible]	[illegible]
8.5%	7,218	7,832	8,497	9,219	10,003	10,853	11,776	12,777	13,863	15,041	16,320	17,707	19,212	20,845	22,617	24,539	26,625	28,888	31,344	34,008	36,899	40,035	43,438	47,130	51,136	55,483	60,199	[illegible]	[illegible]	[illegible]	[illegible]
9.0%	7,218	7,868	8,576	9,348	10,189	11,106	12,105	13,195	14,382	15,677	17,088	18,626	20,302	22,129	24,121	26,291	28,658	31,237	34,048	37,113	40,453	44,093	48,062	52,387	57,102	62,241	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.5%	7,218	7,904	8,655	9,477	10,377	11,363	12,442	13,624	14,919	16,336	17,888	19,587	21,448	23,486	25,717	28,160	30,835	33,764	36,972	40,484	44,330	48,542	53,153	58,202	63,732	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.0%	7,218	7,940	8,734	9,607	10,568	11,625	12,787	14,066	15,472	17,020	18,722	20,594	22,653	24,918	27,410	30,151	33,167	36,483	40,131	44,145	48,559	53,415	58,757	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Annual Average Deficit (ac-ft/year) Based on % Annual Population Growth

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.0%	908	883	857	831	804	-16	-44	-72	-101	-130	-160	-191	-222	-254	-286	-1,113	-1,146	-1,181	-1,216	-1,252	-1,288	-1,325	-1,363	-1,402	-1,442	-1,482	-1,523	-1,565	-1,608	-1,652	-1,696
2.5%	908	876	844	811	778	-50	-86	-122	-159	-198	-237	-277	-318	-360	-403	-1,241	-1,286	-1,333	-1,381	-1,429	-1,480	-1,531	-1,583	-1,637	-1,693	-1,749	-1,807	-1,867	-1,928	-1,991	-2,055
3.0%	908	870	831	791	750	-85	-129	-174	-220	-268	-317	-367	-419	-473	-528	-1,378	-1,437	-1,497	-1,559	-1,624	-1,689	-1,757	-1,827	-1,899	-1,974	-2,050	-2,129	-2,210	-2,293	-2,379	-2,468
3.5%	908	864	818	771	723	-121	-173	-227	-283	-341	-400	-462	-526	-593	-661	-1,526	-1,599	-1,675	-1,754	-1,835	-1,920	-2,007	-2,097	-2,191	-2,288	-2,388	-2,491	-2,599	-2,710	-2,825	-2,944
4.0%	908	858	805	751	695	-157	-218	-282	-348	-416	-488	-562	-639	-719	-803	-1,683	-1,773	-1,867	-1,965	-2,066	-2,172	-2,282	-2,396	-2,515	-2,638	-2,767	-2,901	-3,040	-3,184	-3,334	-3,491
4.5%	908	851	792	731	666	-194	-265	-338	-415	-495	-579	-666	-758	-854	-953	-1,851	-1,960	-2,075	-2,194	-2,318	-2,448	-2,584	-2,727	-2,875	-3,030	-3,193	-3,362	-3,539	-3,724	-3,918	-4,120
5.0%	908	845	779	710	638	-232	-312	-396	-484	-577	-674	-776	-883	-996	-1,114	-2,031	-2,162	-2,298	-2,442	-2,593	-2,751	-2,917	-3,092	-3,275	-3,468	-3,670	-3,882	-4,105	-4,339	-4,585	-4,843
5.5%	908	839	766	689	608	-270	-361	-456	-556	-662	-773	-891	-1,015	-1,146	-1,285	-2,224	-2,378	-2,540	-2,711	-2,892	-3,083	-3,284	-3,496	-3,720	-3,956	-4,205	-4,468	-4,745	-5,038	-5,347	-5,672
6.0%	908	832	753	668	579	-310	-410	-517	-630	-750	-877	-1,012	-1,154	-1,306	-1,466	-2,429	-2,610	-2,801	-3,003	-3,218	-3,445	-3,686	-3,942	-4,213	-4,500	-4,805	-5,128	-5,470	-5,832	-6,217	-6,624
6.5%	908	826	739	647	549	-350	-461	-580	-707	-841	-985	-1,138	-1,301	-1,474	-1,659	-2,649	-2,859	-3,082	-3,319	-3,572	-3,842	-4,129	-4,435	-4,760	-5,107	-5,476	-5,870	-6,288	-6,735	-7,210	-7,716
7.0%	908	820	726	626	518	-390	-513	-645	-786	-937	-1,098	-1,270	-1,455	-1,653	-1,864	-2,884	-3,126	-3,385	-3,662	-3,958	-4,276	-4,615	-4,978	-5,367	-5,783	-6,228	-6,704	-7,214	-7,759	-8,342	-8,966
7.5%	908	814	713	604	487	-432	-567	-712	-868	-1,035	-1,216	-1,409	-1,618	-1,841	-2,082	-3,134	-3,412	-3,711	-4,033	-4,378	-4,750	-5,149	-5,578	-6,040	-6,536	-7,069	-7,642	-8,258	-8,921	-9,633	-10,398
8.0%	908	807	699	582	456	-474	-621	-780	-952	-1,138	-1,338	-1,555	-1,788	-2,041	-2,314	-3,402	-3,720	-4,063	-4,434	-4,835	-5,267	-5,735	-6,239	-6,785	-7,373	-8,009	-8,696	-9,437	-10,208	-11,103	[illegible]
8.5%	908	801	686	560	424	-517	-677	-851	-1,040	-1,244	-1,466	-1,707	-1,968	-2,252	-2,560	-3,687	-4,049	-4,442	-4,868	-5,331	-5,833	-6,377	-6,968	-7,609	-8,305	-9,060	-9,878	-10,767	[illegible]	[illegible]	[illegible]
9.0%	908	795	672	538	392	-561	-734	-924	-1,130	-1,354	-1,599	-1,866	-2,158	-2,475	-2,821	-3,991	-4,402	-4,850	-5,338	-5,870	-6,450	-7,082	-7,771	-8,522	-9,341	-10,233	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.5%	908	789	658	515	359	-605	-793	-998	-1,223	-1,469	-1,738	-2,033	-2,357	-2,710	-3,098	-4,315	-4,780	-5,288	-5,845	-6,455	-7,123	-7,854	-8,655	-9,532	-10,492	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.0%	908	782	644	493	326	-651	-853	-1,075	-1,319	-1,588	-1,883	-2,208	-2,566	-2,959	-3,392	-4,661	-5,185	-5,761	-6,394	-7,091	-7,857	-8,701	-9,628	-10,648	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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CAMPO Population and Water Deficit Planning Triggers for the Study Area

Annual Population Growth from CAMPO 2010 Estimate

	2010 CAMPO Study Area Population	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.0%	15,162	15,465	15,774	16,090	16,412	16,740	17,075	17,416	17,765	18,120	18,482	18,852	19,229	19,614	20,006	20,406	20,814	21,230	21,655	22,088	22,530	22,980	23,440	23,909	24,387	24,875	25,372	25,880	26,397	26,925	27,464
2.5%	15,162	15,541	15,930	16,328	16,736	17,154	17,583	18,023	18,473	18,935	19,409	19,894	20,391	20,901	21,423	21,959	22,508	23,071	23,647	24,239	24,845	25,466	26,102	26,755	27,424	28,109	28,812	29,532	30,271	31,028	31,803
3.0%	15,162	15,617	16,085	16,568	17,065	17,577	18,104	18,647	19,207	19,783	20,376	20,988	21,617	22,266	22,934	23,622	24,330	25,060	25,812	26,587	27,384	28,206	29,052	29,923	30,821	31,746	32,698	33,679	34,689	35,730	36,802
3.5%	15,162	15,693	16,242	16,810	17,399	18,008	18,638	19,290	19,965	20,664	21,387	22,136	22,911	23,713	24,543	25,402	26,291	27,211	28,163	29,149	30,169	31,225	32,318	33,449	34,620	35,831	37,085	38,383	39,727	41,117	42,556
4.0%	15,162	15,768	16,399	17,055	17,737	18,447	19,185	19,952	20,750	21,580	22,443	23,341	24,275	25,246	26,256	27,306	28,398	29,534	30,715	31,944	33,222	34,551	35,933	37,370	38,865	40,419	42,036	43,717	45,466	47,285	49,176
4.5%	15,162	15,844	16,557	17,302	18,081	18,895	19,745	20,633	21,562	22,532	23,546	24,606	25,713	26,870	28,079	29,343	30,663	32,043	33,485	34,992	36,566	38,212	39,931	41,728	43,606	45,568	47,619	49,762	52,001	54,341	56,786
5.0%	15,162	15,920	16,716	17,552	18,429	19,351	20,318	21,334	22,401	23,521	24,697	25,932	27,229	28,590	30,020	31,521	33,097	34,751	36,489	38,313	40,229	42,241	44,353	46,570	48,899	51,344	53,911	56,606	59,437	62,409	[illegible]
5.5%	15,162	15,996	16,876	17,804	18,783	19,816	20,906	22,056	23,269	24,549	25,899	27,323	28,826	30,411	32,084	33,849	35,710	37,674	39,747	41,933	44,239	46,672	49,239	51,947	54,804	57,818	60,998	64,353	[illegible]	[illegible]	[illegible]
6.0%	15,162	16,072	17,036	18,058	19,142	20,290	21,508	22,798	24,166	25,616	27,153	28,782	30,509	32,339	34,280	36,336	38,517	40,828	43,277	45,874	48,626	51,544	54,637	57,915	61,390	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.5%	15,162	16,147	17,197	18,315	19,505	20,773	22,123	23,561	25,093	26,724	28,461	30,311	32,281	34,380	36,614	38,994	41,529	44,228	47,103	50,165	53,425	56,898	60,596	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.0%	15,162	16,223	17,359	18,574	19,874	21,265	22,754	24,347	26,051	27,875	29,826	31,914	34,148	36,538	39,096	41,832	44,761	47,894	51,246	54,834	58,672	62,779	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.5%	15,162	16,299	17,522	18,836	20,248	21,767	23,399	25,154	27,041	29,069	31,249	33,593	36,112	38,821	41,732	44,862	48,227	51,844	55,732	59,912	64,406	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.0%	15,162	16,375	17,685	19,100	20,628	22,278	24,060	25,985	28,064	30,309	32,733	35,352	38,180	41,235	44,534	48,096	51,944	56,099	60,587	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.5%	15,162	16,451	17,849	19,366	21,012	22,798	24,736	26,839	29,120	31,595	34,281	37,195	40,356	43,787	47,508	51,547	55,928	60,682	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.0%	15,162	16,527	18,014	19,635	21,402	23,329	25,428	27,717	30,211	32,930	35,894	39,124	42,645	46,484	50,667	55,227	60,198	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.5%	15,162	16,602	18,180	19,907	21,798	23,869	26,136	28,619	31,338	34,315	37,575	41,144	45,053	49,333	54,020	59,152	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.0%	15,162	16,678	18,346	20,181	22,199	24,418	26,860	29,546	32,501	35,751	39,326	43,259	47,585	52,343	57,577	63,335	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Annual Average Deficit (ac-ft/year) Based on % Annual Population Growth

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.0%	174	122	68	13	-43	-893	-951	-1,011	-1,071	-1,133	-1,196	-1,260	-1,325	-1,392	-1,460	-2,323	-2,394	-2,466	-2,540	-2,615	-2,692	-2,770	-2,850	-2,931	-3,014	-3,099	-3,185	-3,274	-3,363	-3,455	-3,549
2.5%	174	108	41	-28	-99	-965	-1,040	-1,116	-1,194	-1,274	-1,357	-1,441	-1,527	-1,616	-1,706	-2,593	-2,688	-2,786	-2,886	-2,989	-3,094	-3,202	-3,312	-3,425	-3,542	-3,661	-3,783	-3,908	-4,036	-4,167	-4,302
3.0%	174	95	14	-70	-156	-1,038	-1,130	-1,224	-1,321	-1,422	-1,525	-1,631	-1,740	-1,853	-1,969	-2,881	-3,005	-3,131	-3,262	-3,396	-3,535	-3,677	-3,824	-3,976	-4,137	-4,292	-4,457	-4,628	-4,803	-4,984	-5,170
3.5%	174	82	-13	-112	-214	-1,113	-1,223	-1,336	-1,453	-1,575	-1,700	-1,830	-1,965	-2,104	-2,248	-3,191	-3,345	-3,505	-3,670	-3,841	-4,018	-4,202	-4,391	-4,588	-4,791	-5,001	-5,219	-5,445	-5,678	-5,919	-6,169
4.0%	174	69	-41	-154	-273	-1,190	-1,318	-1,451	-1,589	-1,734	-1,883	-2,039	-2,201	-2,370	-2,545	-3,521	-3,711	-3,908	-4,113	-4,326	-4,548	-4,779	-5,019	-5,269	-5,528	-5,798	-6,079	-6,371	-6,674	-6,990	-7,319
4.5%	174	56	-68	-197	-333	-1,267	-1,415	-1,569	-1,730	-1,899	-2,075	-2,259	-2,451	-2,652	-2,862	-3,875	-4,104	-4,344	-4,594	-4,856	-5,129	-5,415	-5,713	-6,025	-6,351	-6,692	-7,048	-7,420	-7,809	-8,215	-8,640
5.0%	174	43	-96	-241	-393	-1,347	-1,515	-1,691	-1,876	-2,071	-2,275	-2,489	-2,714	-2,951	-3,199	-4,253	-4,527	-4,814	-5,116	-5,432	-5,765	-6,114	-6,481	-6,866	-7,270	-7,695	-8,141	-8,609	-9,100	-9,616	-10,158
5.5%	174	29	-123	-284	-454	-1,427	-1,617	-1,816	-2,027	-2,249	-2,483	-2,731	-2,992	-3,267	-3,557	-4,657	-4,980	-5,321	-5,681	-6,061	-6,461	-6,884	-7,329	-7,800	-8,296	-8,819	-9,371	-9,954	-10,568	[illegible]	[illegible]
6.0%	174	16	-151	-329	-517	-1,510	-1,721	-1,945	-2,183	-2,434	-2,701	-2,984	-3,284	-3,602	-3,939	-5,089	-5,468	-5,869	-6,294	-6,745	-7,223	-7,730	-8,267	-8,836	-9,439	-10,079	-10,757	[illegible]	[illegible]	[illegible]	[illegible]
6.5%	174	3	-179	-373	-580	-1,593	-1,828	-2,078	-2,344	-2,627	-2,928	-3,250	-3,592	-3,956	-4,344	-5,551	-5,991	-6,459	-6,959	-7,490	-8,056	-8,659	-9,302	-9,985	-10,714	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.0%	174	-10	-207	-418	-644	-1,679	-1,937	-2,214	-2,510	-2,827	-3,165	-3,528	-3,916	-4,331	-4,775	-6,043	-6,552	-7,096	-7,678	-8,301	-8,967	-9,681	-10,444	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.5%	174	-23	-235	-464	-709	-1,766	-2,049	-2,354	-2,682	-3,034	-3,412	-3,819	-4,257	-4,727	-5,233	-6,570	-7,154	-7,782	-8,457	-9,183	-9,963	-10,802	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.0%	174	-36	-264	-509	-775	-1,855	-2,164	-2,498	-2,859	-3,249	-3,670	-4,125	-4,616	-5,146	-5,719	-7,131	-7,799	-8,521	-9,300	-10,142	-11,051	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.5%	174	-50	-292	-556	-842	-1,945	-2,282	-2,647	-3,043	-3,473	-3,939	-4,445	-4,994	-5,589	-6,236	-7,730	-8,491	-9,316	-10,212	-11,184	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.0%	174	-63	-321	-602	-909	-2,037	-2,402	-2,799	-3,232	-3,704	-4,219	-4,780	-5,391	-6,058	-6,784	-8,369	-9,232	-10,173	-11,198	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.5%	174	-76	-350	-650	-978	-2,131	-2,525	-2,956	-3,428	-3,945	-4,511	-5,131	-5,809	-6,552	-7,366	-9,051	-10,026	-11,095	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.0%	174	-89	-379	-697	-1,048	-2,226	-2,650	-3,117	-3,630	-4,194	-4,815	-5,498	-6,249	-7,075	-7,984	-9,777	-10,877	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Appendix C - CH2M HILL Bastrop Water Supply Analysis Technical Memorandum

Bastrop Water Supply Analysis

PREPARED FOR: Charlotte Gilpen, Project Manager
K Friese & Associates, Inc.

PREPARED BY: CH2M HILL

DATE: March 21, 2013

PROJECT NUMBER: 459894

K Friese & Associates, Inc. (KFA), with assistance from CH2M HILL, completed the Bastrop Regional Water Supply Facility Plan (Regional Study). The Regional Study identified water sources and evaluated the physical and regulatory availability of the sources. The three sources identified include Colorado River water from the Lower Colorado River Authority (LCRA), Simsboro groundwater from the Carrizo-Wilcox Aquifer regulated by the Lost Pines Groundwater Conservation District (LPGCD) in Bastrop County, and third party partnering with Aqua Water Supply Corporation (Aqua).

Several potential water supply scenarios were subsequently identified by the City of Bastrop Water Committee for further evaluation. Some of these scenarios include the use of surface water, and several of these scenarios involve using aquifer storage and recover (ASR) to manage potable water in a poor quality zone of the Simsboro formation in the City of Bastrop.

The following analysis was completed by CH2M HILL in support of the current study. Work included review of the ASR basis of design provided by others, and development of a conceptual design and cost for a surface water treatment plant.

Review of ASR Design Basis

KFA provided CH2M HILL with a proposed location, depth of formation, and well depth for a one-, two-, or three-well ASR field near Bastrop, TX. CH2M HILL reviewed the proposed information, and determined that the selected well depths were appropriate based on the data provided. CH2M HILL also provided KFA with conceptual drawings of a typical ASR well and well head for use as reference. These are presented in Figure 1 and Figure 2. CH2M HILL did not review the storage capacity of the proposed well field location, or review other possible well field locations.

CH2M HILL had originally intended to provide the conceptual design and well site costs, a schematic diagram of the well site and major components, a list of relevant permitting requirements and costs, and timelines associated for an ASR option. These items will be provided by others, as directed by KFA.

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of
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FIGURE 1
Typical ASR Well Head

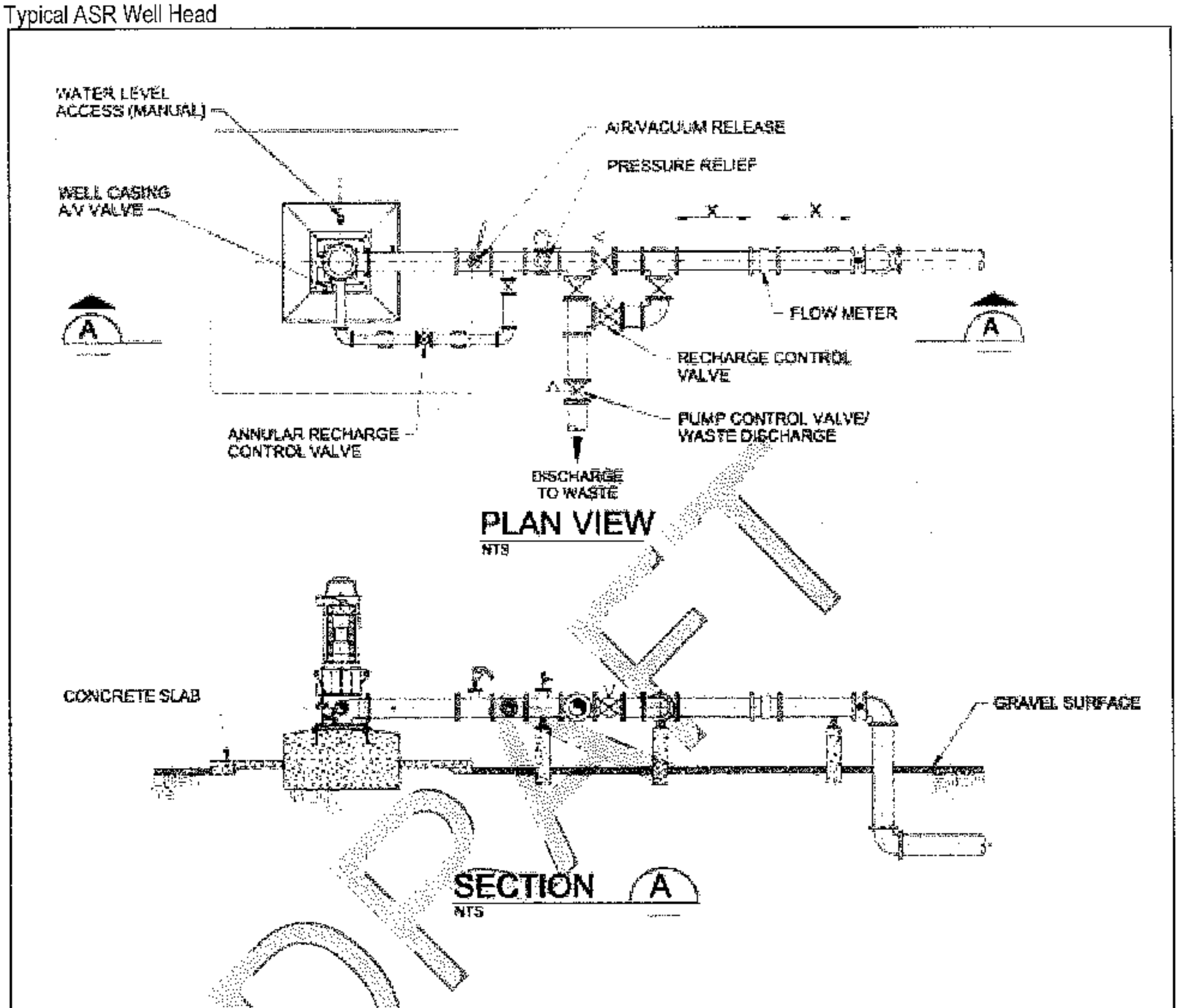
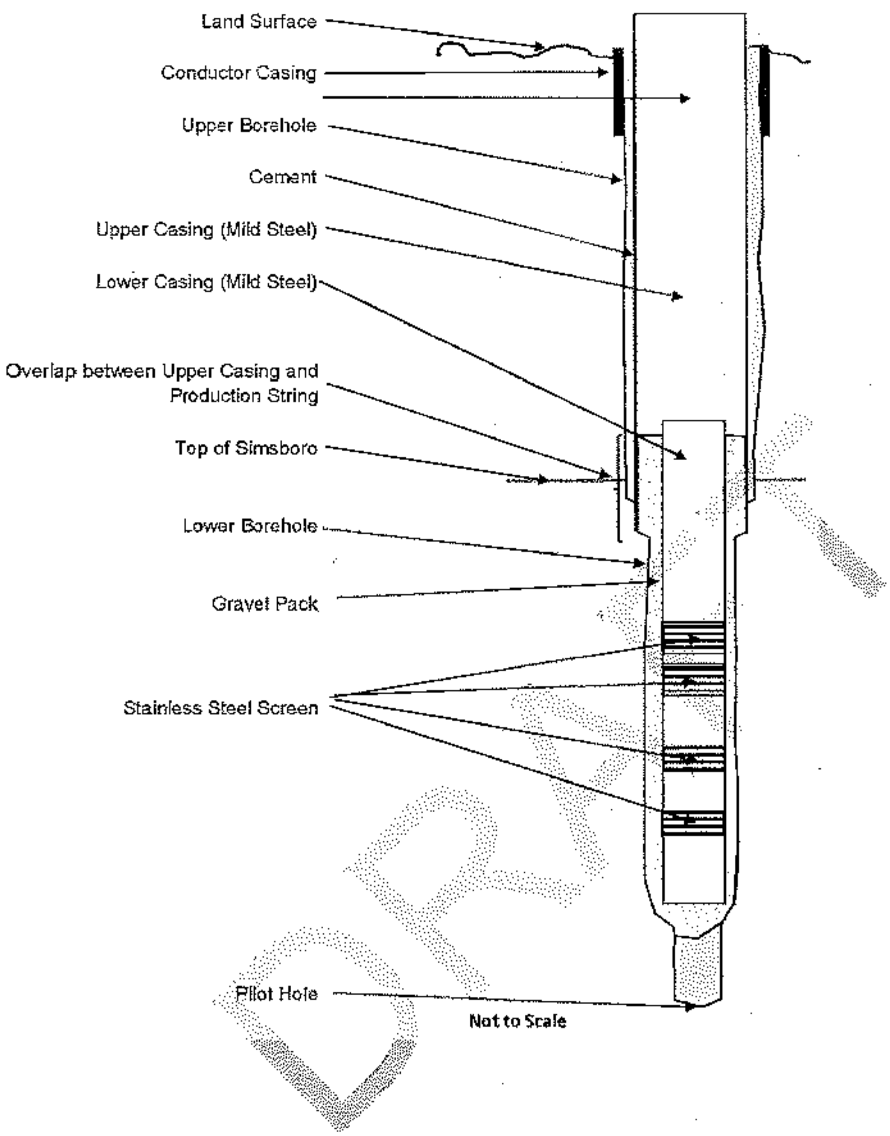


FIGURE 2
Typical ASR Well Below-Ground Components



Surface Water Treatment Plant Evaluation

CH2M HILL developed the following surface water treatment plant conceptual design, construction cost estimate, and yearly O&M cost estimate. The analysis began by revisiting the water quality goals and data developed during the previous study, and verifying that no new information was available. The water quality information became the basis from which the water treatment plant process was selected. Plant capacity and phasing was defined in conjunction with KFA based on demand projections provided by KFA. The assumed WTP location is unchanged from the previous study.

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 conceptual design. 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 **Table 1**.

TABLE 1
Water Quality Goals

Constituent	Goal	TCEQ Standard	USEPA Standard
Turbidity, NTU	< 0.1	< 0.3	< 0.3
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	-	-
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 Table 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 the recommended corrosion properties included in the water quality goals.

Water Quality Evaluation

The raw water quality anticipated in the Colorado River near Bastrop, TX was assumed to be the same as in the previous study; no additional data was obtained. The data were based on publicly available databases, and experience with other water treatment facilities that use the Colorado River as a source water. Assumed water quality data for key parameters is presented in **Table 2**, repeated from the previous water planning study.

TABLE 2
Raw Water Quality, Colorado River Water

Constituent	Goal	TCEQ Standard	Raw Colorado		
			Min	Max	Avg
Turbidity (NTU)	<0.1	<0.3	0.8	55	3.6
TDS (mg/L)	<500	1000	341	365	353
pH	6.5-8.5	6.5-8.5	7.1	9.0	8.1
Total Alkalinity (mg/L)	>100	--	114.0	225.0	165.7
Calcium (mg/L)	-	-	53.5	53.5	53.5
Magnesium (mg/L)	-	-	22.0	22.0	22.0
Iron (mg/L)	0.30	0.30	0.038	0.249	0.099
Manganese (mg/L)	0.05	0.05	0.008	0.024	0.013
Chloride (mg/L)	<250	300	20.8	204.0	58.8
Sulfate (mg/L)	<250	300	15.0	101.0	46.5
Nitrate (mg/L)	10	10	0.3	8.8	1.5
Temperature (C°)			4.3	31.5	21.2

Data Sources: Data obtained from or provided by KFA, and City of Austin.

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 range of turbidity levels is common for river water sources, and the plant will have to be designed to achieve the water quality goals under the full range of water quality conditions.

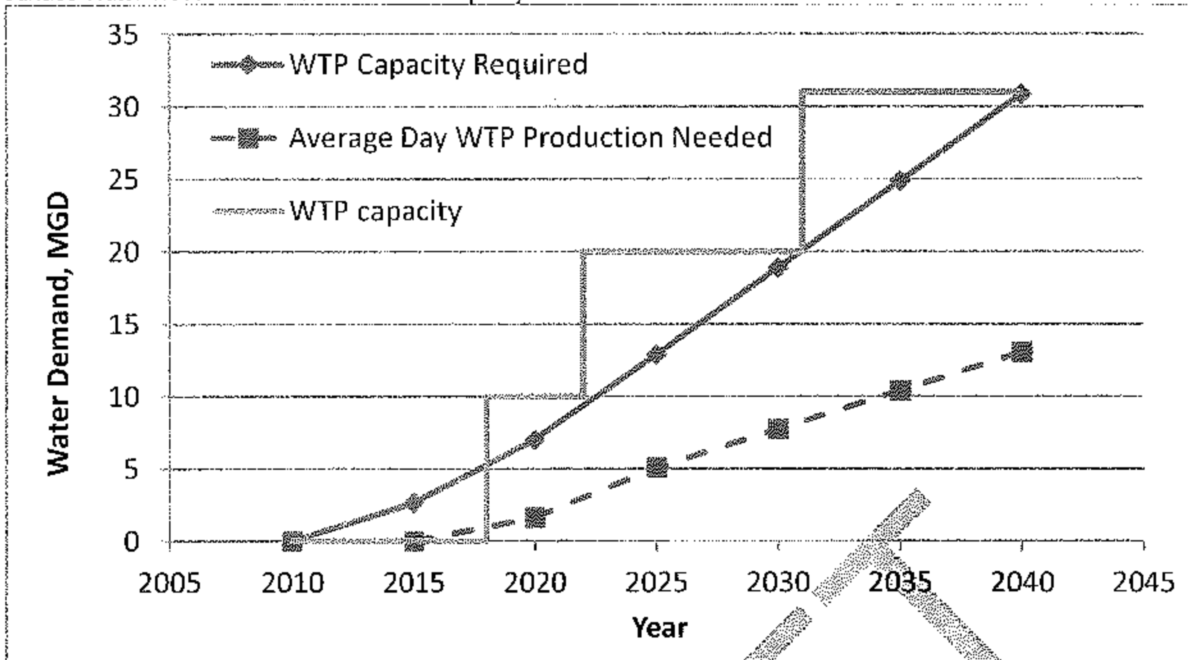
Treatment Plant Capacity

To define the plant capacity, KFA developed demand projections to identify the quantity of water that the plant would need to produce throughout the planning period. These projections assumed that the use of groundwater wells would gradually diminish until Bastrop shifted almost fully to surface water. The resulting average and peak-day water production requirements for the surface water plant are presented in **Figure 3**, along with the recommended surface water treatment plant capacity each year.

It is recommended that a 10 MGD water treatment plant, expandable to 31 MGD, be constructed as soon as possible. Calculations show that the City of Bastrop's peak-day water demand will soon exceed its well capacity. This deficit will grow until additional water production capacity can be developed. Prior to completion of the plant the City may be required to restrict water usage during periods of peak summer demand. It is anticipated that a surface water treatment plant can begin production of water as soon as approximately 2017 or 2018 unless the facility is designed and constructed in an expedited manner.

The ultimate 31 MGD capacity is not needed at this time. To phase construction in reasonable increments that track with anticipated water demand, it is recommended that the plant be constructed in three phases, each approximately 10 MGD, for a total capacity of 31 MGD. This will provide adequate capacity to meet Bastrop's peak daily demand through approximately 2040. The timing of each phase will depend on growth within Bastrop. Based on the expected demands and expected groundwater capacity, the Phase 2 expansion to 20 MGD would likely have to be completed by approximately 2022, and the Phase 3 expansion to 31 MGD would have to be completed by 2031.

FIGURE 3
Surface Water Treatment Plant Demand and Capacity



Treatment Plant Design

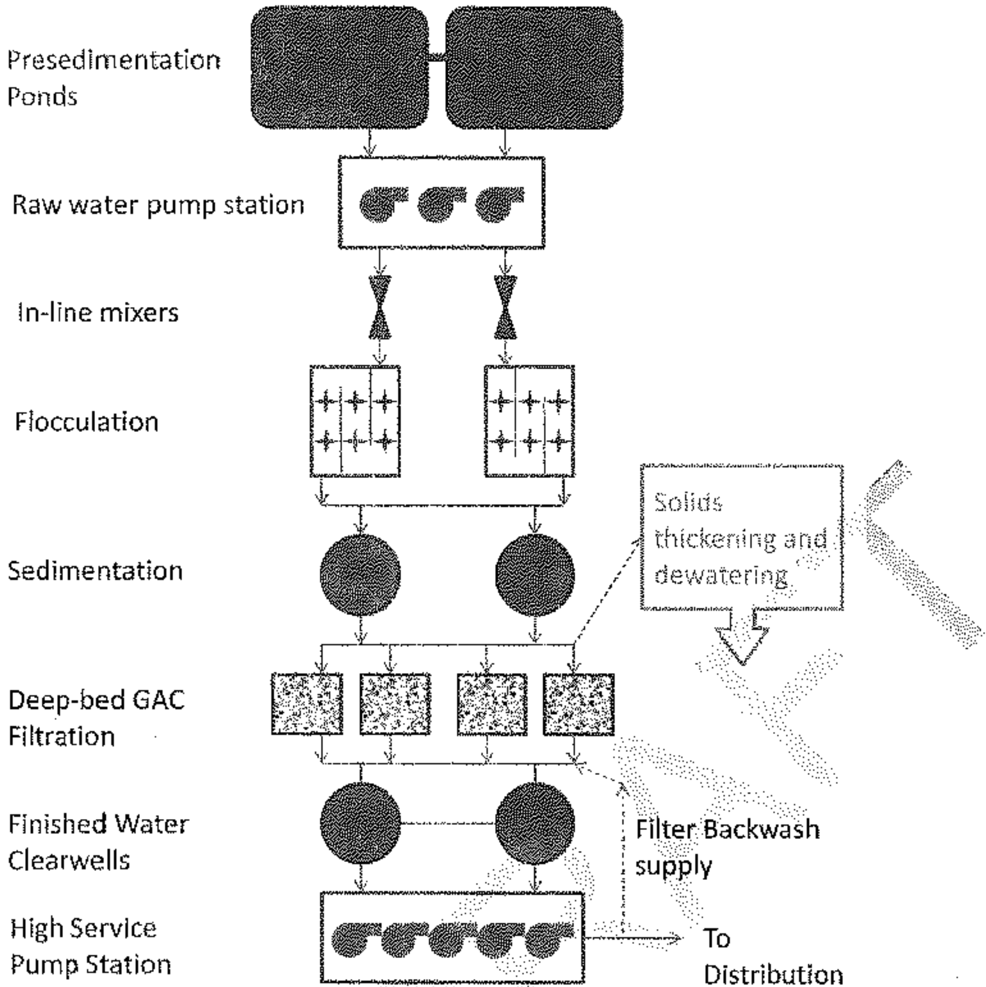
The recommended surface water treatment plant design for the City of Bastrop is described below. This plant would be robust enough to meet the water quality goals and to accommodate the large anticipated fluctuations in raw water quality for the Colorado River as shown in Table 2. **Figure 4** illustrates the conceptual treatment plant process, and **Table 3** presents the key assumptions for each unit process.

Water would be transferred from the Colorado River to an on-site pre-sedimentation pond at the new Bastrop Surface Water Treatment Plant. The pond would have two chambers, with a combined storage volume equivalent to one-day of peak demand, or 10 MG total. The pond would serve two primary functions: 1) To allow for a more consistent quality of water entering the plant for treatment, and 2) to provide storage at the plant in case the raw water intake, pump station, or pipeline from the Colorado River require maintenance.

From the raw water pond, water would be pumped by a raw water pump station containing three vertical turbine pumps to the main treatment plant processes. Three pumps would be included to match the average and peak plant flow rates, plus a third pump is provided as a backup. An Alum-based coagulant would be added via two parallel chemical injection/mixing vaults. Two parallel units would be provided to allow for maintenance of each. Flows would then transfer to two parallel flocculation trains. It is assumed that the flocculators would follow a serpentine flow pattern, with vertical mixers and two stages of mixing intensity. Two parallel circular-shaped sedimentation basins would settle large particles from the water, followed by filtration.

It is recommended that deep bed granular activated carbon (GAC) filters be provided for the WTP. Four filters would be provided with a combined air scour/water backwash system. This would allow each filter to be backwashed approximately once per day while still providing adequate capacity and redundancy. Although slightly more expensive than traditional sand filters, the deep bed GAC filters offer specific advantages that are relevant to the City of Bastrop: 1) Improved removal of organic compounds, which can include complex organic molecules used in personal care products, or medicines in the raw water. 2) These types of filters can be operated in a way that allows some biological activity to occur in the filter, providing additional biological treatment of these same complex organics.

FIGURE 4
Bastrop WTP Conceptual Treatment Process Schematic



Two circular prestressed concrete clearwells would provide contact time for disinfection, and storage for the distribution system to meet peak hourly demands. The combined clearwell capacity would be approximately 10 percent of the plant capacity, with each tank holding 5 percent. This would allow one tank to be out of service for maintenance, and would meet the TCEQ requirement of having at least 5% of plant daily capacity in storage.

The water would be disinfected with liquid sodium hypochlorite bleach prior to entering the clearwell, and the clearwells would then provide adequate contact time to meet TCEQ requirements. A liquid bleach system has been recommended due to the health and safety benefits over gaseous chlorine. The risks associated with a liquid bleach spill are much less than a chlorine gas leak, and these lower risks apply to both the WTP staff and the community surrounding the plant.

Based on the experience of other water systems that use of the Colorado River as a water source, the potential for disinfection byproduct formation in the distribution system is high if the disinfectant is allowed to remain as free chlorine. Therefore, the conceptual WTP design would include a liquid ammonium sulfate injection system that would convert the residual chlorine from a free chlorine form to a chloramine form. Chloramines in the distribution system would greatly reduce the risk of disinfection byproduct formation, and would likely be required to meet regulatory requirements. In addition, when the WTP comes online, Bastrop would also have to convert the groundwater well disinfection systems to chloramines by installing a similar liquid ammonium sulfate system at the well heads for compatibility purposes.

Finished water would be pumped from the clearwells to the existing distribution system through a new water distribution pipeline. The high service pump station would contain five 4-MGD pumps, which would allow plant operators to incrementally increase the output of the plant as needed. The combined pump capacity would exceed that of the plant's treatment process, but this is typical in order to meet peak-houly demands and to provide reliable fire flow.

Sludge that settles in the sedimentation basins or is backwashed off of the filters would be thickened by two parallel gravity thickeners, and dewatered in a centrifuge facility designed with truck access for loading and hauling of the material. Lastly, the design includes a backup diesel-powered generator to run essential plant functions during short power outages.

TABLE 3
Water Treatment Plant Unit Process Design Assumptions

Unit Process	Design Assumptions	Estimated Space Required
Raw Water Pre-sedimentation Pond		
	2 bays	588'x286'
	5.0 MG per bay	3.9 acres
Raw Water Pump Station		
	3 vertical turbine pumps	27'x22'
	5 MGD each	0.1 acres
	Variable speed	
Inline Rapid Mix		
	2 parallel trains	40' x 20'
	In pipe mixing	0.1 acres
	Concrete vault	
Flocculation		
	2 stages	40' x 55' per train
	2 trains	0.1 acres
	Vertical paddle mixers in serpentine channel	
	45 minute detention time	
Circular Clarifiers		
	2 circular clarifiers	2 @ 91' Diameter
	800 gpd/sf loading rate	0.3 acres
Deep Bed GAC Filtration		
	4 filters	6330 square feet
	5 gpm/sf loading rate	0.2 acres
	72-inch deep bed GAC	
	Combined air scour/backwash	
Filter Backwash Pump Station		
	2 vertical turbine pumps	20'x24'
	20 gpm/sf of filter area max flow	0.1 acres
	Constant speed	

TABLE 3
Water Treatment Plant Unit Process Design Assumptions

Unit Process	Design Assumptions	Estimated Space Required
Concrete Clearwells		
	2 clearwells, 0.5 MG each	2@ 70' DIA each
	Circular	0.2 acres
	Prestressed Concrete Tanks	
	Assumed baffle factor: 0.5	
High Service Pumps		
	5 vertical turbine pumps	53'x126'+1820 sf+150 sf
	4 MGD per pump	0.2 acres
	Constant speed	
Gravity Thickener: BW_Settler		
	2 gravity thickeners	2@ 34' DIA + 28'x33' sludge pump area + 20'x7' electrical room
	300 gpm/sf loading rate (hydraulic)	0.1 acres
	10 lbs/day/sf loading rate (solids)	
	Thickens to 2% solids	
Dewatering Centrifuges		
	2 centrifuges	73'x74' building
	Polymer storage and feed system	0.2 acres
	Truck loadout facility	
	Operates 5 days/week, 8 hrs	
Emergency Generator		
	1500 kW	50'x15'
	Sound attenuating, weather proof	0.1 acres
Liquid Chemical: Alum		
	30 mg/L average dose	1624 sf
	40 mg/L maximum dose	0.1 acres
	2 injection points	
	FRP Bulk tank storage	
	Day Tank	
	Located in building	
Liquid Chemical: Liquid Sodium Hypochlorite		
	8 mg/L average dose	1512 sf
	6 mg/L maximum dose	0.1 acres

TABLE 3

Water Treatment Plant Unit Process Design Assumptions

Unit Process	Design Assumptions	Estimated Space Required
	2 injection points	
	FRP Bulk tank storage	
	Day Tank	
	Located in building	
Liquid Chemical: Liquid Ammonium Sulfate		
	2 mg/L average dose	1485 sf
	1.5 mg/L maximum dose	0.1 acres
	2 injection points	
	FRP Bulk tank storage	
	Day Tank	
	Located in building	
Subtotal Acreage		5.9 acres
Yard piping, access roads, misc.	20%	1.2 acres
Total Acreage per 10 MGD train		7.1 acres

Expandability, Phasing, and Vendor-supplied systems

For a 10 MGD plant, expandable to 31 MGD, it is not recommended that a vendor-supplied package system be provided. Vendor package facilities are typically available in increments of 2 MGD or less, making such a system infeasible. In addition, vendor-supplied systems would not eliminate the need for all of the required unit operations. Typically vendor systems provide mixing, flocculation, sedimentation, and filtration only.

For the Bastrop WTP, it is recommended that the preliminary design include both the initial 10 MGD capacity plus the two subsequent expansions to reach a total of 31 MGD. This would allow the designer to accommodate the two future stages on the plant site, and more appropriately locate unit processes that will be common to all three treatment trains. These include the raw water pond, raw water pump station, solids handling, and high service pump station. These unit processes would likely be designed to serve the ultimate plant capacity, with provisions to expand or install higher capacity mechanical equipment in the future. This pro-active approach would ultimately result in capital cost savings to City, and improved operational efficiency.

Cost Estimate

The estimated cost to construct the described 10 MGD surface water plant is summarized in Table 4. This cost is based on the initial construction of the first 10 MGD phase only. However, as a planning level estimate, the total in Table 4 would also be representative of the cost required to construct each of the two subsequent approximately 10-MGD plant expansions.

TABLE 4

Estimated Construction Cost, Bastrop Surface Water Treatment Plant, 10 MGD

Item	Cost
Raw Water Pre-sedimentation Pond	$ 1,380,000
Raw Water Pump Station	$ 1,180,000

TABLE 4

Estimated Construction Cost, Bastrop Surface Water Treatment Plant, 10 MGD

Item		Cost
Inline Rapid Mix		$ 430,000
Flocculation		$ 1,300,000
Circular Clarifiers		$ 1,620,000
Deep Bed GAC Filtration		$ 3,480,000
Filter Backwash Pump Station		$ 920,000
Concrete Clearwell		$ 1,570,000
High Service Pumps		$ 2,720,000
Gravity Thickener: BW_Settler		$ 830,000
Dewatering Centrifuges		$ 3,420,000
Emergency Generator		$ 780,000
Liquid Chemical: Alum		$ 480,000
Liquid Chemical: Hypo		$ 380,000
Liquid Chemical: Liquid Ammonium Sulfate		$ 370,000
Subtotal Construction/Installation Cost		*$ 20,860,000*
Additional Project Costs		
Demolition	0%	$ -
Overall Sitework	5%	$ 1,050,000
Plant Computer System	2%	$ 420,000
Yard Electrical	5%	$ 1,050,000
Yard Piping	8%	$ 1,670,000
Subtotal		*$ 25,050,000*
Other Markups		
Overhead	10%	$ 27,560,000
Profit	5%	$ 28,940,000
Mob/Bonds/Insurance	5%	$ 30,390,000
Contingency	30%	$ 39,510,000
Escalation to Construction Midpoint	9.4%	$ 43,230,000
Location Adjustment Factor (Houston)	86.5%	$ 37,400,000
Non-Construction Costs		
Permitting	2%	$ 748,000

TABLE 4

Estimated Construction Cost, Bastrop Surface Water Treatment Plant, 10 MGD

Item		Cost
Engineering	8%	$ 2,992,000
Services During Construction	5%	$ 1,870,000
Commissioning & Startup	5%	$ 1,870,000
Land / ROW	0%	$ -
Legal / Admin	2%	$ 748,000
Subtotal Non-Construction		$ 8,228,000
Total Estimated Construction Cost		$ 45,600,000

It should be noted that these costs do not included any of the following items:

- Piping from the high service pump station to the distribution system , or accommodations to introduce the treated surface water into the existing distribution system
- Raw water Intake Costs
  - Intake structure
  - Associated off-channel storage or control structures
  - Pump station to transfer raw water from Colorado River to plant; surge suppression
  - Screening at Colorado River
  - Pipeline(s) from river to WTP
  - Two chlorine (or other oxidant) chemical injection points for control of biological growth in the raw water system, with facilities for chemical storage, feed, and delivery access
  - Electrical service or backup power
- Land/ROW cost
- Conversion of groundwater well disinfection systems to chloramines

Estimated yearly operation and maintenance costs for the plant were calculated to support the overall cost estimate. The following key assumptions were made in developing the O&M cost:

- The facility operates at an annual average flow rate of 5 MGD.
- Electrical Cost assumed to be $0.100 per kWh
- Facility electrical demand assumed to be 2 watts per square foot
- Plant operates 24/7, 365 days per year
- Includes maintenance, equipment repair, and an allowance for equipment replacement
- Includes chemical costs for sodium hypochlorite, liquid ammonium sulfate, alum, and dewatering polymer.
- Assumes landfill disposal of dewatered sludge at 35% solids, within 50 miles round trip.
- Includes allowance for yearly lab costs, office equipment.
- Includes 20% contingency on O&M costs
- Includes labor at an average rate of $30/hour

Based on these assumptions, the resulting average yearly O&M cost would be approximately $5.3 million per year. This equates to a unit O&M cost of $2.906 per 1000 gallons treated at an average annual rate of 5 MGD.

Appendix D - R.W. Harden City of Bastrop Groundwater Development Strategies Technical Memorandum

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CITY OF BASTROP GROUNDWATER DEVELOPMENT STRATEGIES

Prepared By:
R. W. Harden & Associates, Inc.

March, 20th 2013

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CITY OF BASTROP GROUNDWATER DEVELOPMENT STRATEGIES

Introduction

This work represents an expansion and refinement of the "Bastrop Regional Water Facilities Planning Study" (Initial Study) completed in May 2011. As part of an assessment of the water supply options available to the residents of the City of Bastrop ("Bastrop" or "City"), R.W. Harden & Associates, Inc. (RWH&A) has performed an evaluation of two water development strategies in the Bastrop region, including an exploration of hydrogeologic conditions, costs, and regulations.

For this study, RWH&A compiled available hydrologic information from various published and unpublished reports, databases, and maps. Information sources included the Texas Water Development Board (TWDB), the University Of Texas Bureau Of Economic Geology (BEG), the United States Geological Survey (USGS), the Lower Colorado River Authority (LCRA), the Railroad Commission of Texas (RCT), previous studies conducted for the City of Bastrop, and RWH&A files. Estimates of the probable costs associated with each potential groundwater development strategy were produced using information received from contractors and information previously acquired by RWH&A. 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) and the Texas Commission of Environmental Quality (TCEQ).

This study focuses on two groundwater development options, with tasks as described below:

1) ***Aquifer Storage and Recovery (ASR) Evaluation*** – ASR is the process of injecting surplus water in an aquifer during periods of low demand, and later producing the stored water as needed during higher-demand times. For this evaluation, it is assumed that excess treated Colorado River water will be available for storage in the Simsboro aquifer.

    - Using available Simsboro aquifer information and computer modeling, the affects of operation of an ASR system on water quality and quantity were assessed. Three potential ASR development scenarios were modeled, which incorporated from one to three wells.

    - Using information distributed by the LPGCD and TCEQ, the State regulations and requirements pertaining to ASR system construction and injection/withdrawal cycles were assessed.

    - Preliminary estimates of the probable costs associated with the development of an ASR system were compiled.

2) ***Simsboro Groundwater Development Options*** – During the Initial Study conducted for the City, a Simsboro groundwater development option was explored. In this study, the Simsboro development option is revisited with updated demand and aquifer information.

- Using aquifer data compiled from various sources, a well field design was generated that satisfies the updated average and peak demand projections generated during this study. Analytical and finite-difference modeling was employed to estimate the long-term well bore pumping levels and regional impacts due to the proposed well field.

- The regulatory climate surrounding groundwater production in the Bastrop area has been in a state of flux for several years. Recently, the LPGCD lifted its moratorium on permitting; however, there continues to be significant uncertainty with regard to obtaining long-term production permits for the Simsboro groundwater option evaluated as part of this study. Using information distributed by the LPGCD and other sources, an assessment was made of the potential permitting process that may be applicable to the proposed groundwater development.

- Using the modeling results and other information compiled during previous tasks, opinions of the probable costs associated with the updated development option were generated.

Aquifer Storage and Recovery Evaluation

Aquifer Storage and Recovery (ASR) is the simple concept of using an aquifer to store surplus fresh water during intervals when supply exceeds demand. This stored water can then be recovered to supplement supplies during periods of greater demand. ASR typically utilizes wells to inject and recover fresh water. There are several conditions that must exist for ASR to be a viable water supply management solution, including:

- The available annual supply exceeds the average daily needs,
- an aquifer with suitable hydrologic conditions for injection and withdrawal must exist in the region,
- the quality of the excess water stored in an ASR system must be chemically compatible with the existing aquifer water quality, and must be suited to the ultimate use of the water, and
- the costs associated with implementation of an ASR system must be offset or surpassed by the benefits of the resulting augmentation in supply.

The City is considering constructing a surface water treatment plant to supply growing demands over the next 30 years. In general, municipal water systems must be designed with enough capacity to meet daily peak demand rates during summer months, which can exceed two times the average daily demands throughout the remainder of the year. Consequently, where no other supplies are available to augment peaking supplies, a potential treatment plant must be designed with a significant amount of surplus capacity to satisfy peak daily rates. Utilizing stored, fresh ASR water to augment the capacity of the City's water system during high-demand periods allows for implementation of smaller-capacity, more-efficient, and less-costly treatment facilities.

The available information suggests that the Simsboro aquifer is a good candidate for an ASR system within the City. As part of the Wilcox Group, the Simsboro is a regional, sand-rich formation that is generally productive throughout much of Central Texas. As shown in Figure 1, the Simsboro crops out in a northeast to southwest trending band to the northwest of the City. Geophysical logs recorded in petroleum test holes and other previously published data indicate that the Simsboro is about 200 to 300 feet thick in the Bastrop area, and can often support wells capable of maintaining production rates in excess of 1,000 gallons per minute (gpm). However, within the City, Simsboro water is relatively mineralized and is undesirable as a raw drinking water source.

During an ASR injection cycle, fresh water will slowly displace native, mineralized groundwater around the well bore, creating a zone of good quality water that will expand through time. Once a sufficiently large volume of fresh water has been injected, the well will yield fresh groundwater at high rates of production during subsequent ASR withdrawal cycles. In other words, implementation of an ASR system will allow the City to take advantage of the Simsboro's good productivity (hydrologically limited to an estimated maximum of about 1,500 gpm per site) in areas were the aquifer is not utilized because of poor water quality.

To assess the viability of the ASR water development option, RHW&A compiled and reviewed available information pertaining to the hydrologic conditions of the Simsboro aquifer near the assumed surface water treatment plant site (see Figure 2). Using this information, native groundwater quality and potential well injection/withdrawal rates were estimated. LPGCD and TCEQ regulations were reviewed to determine rules in place which may limit the design and operation of an ASR system, and to establish the steps required to obtain regulatory approval to construct and operate the system. Analytical and finite-difference flow models were created to estimate local groundwater pressure oscillations, freshwater migration, water quality changes, and the regional aquifer response during annual ASR injection/withdrawal cycles. Using the results of this modeling, well field designs and estimates of probable cost were generated.

ASR Injection and Withdrawal

The injection/withdrawal cycles typically employed as part of an ASR system result in water level and water quality oscillations, the magnitude and timing of which are largely governed by the volumes injected and withdrawn. Various other factors including site-specific hydrogeologic characteristics, regional aquifer structure, neighboring pumpage, and native/injected water quality will also significantly affect water level and quality fluctuations observed in an ASR system.

For this study, injection capacity is assumed to be constrained by the ability of the aquifer to absorb water while limiting groundwater pressure to below ground level. Maintaining water levels below ground surface allows for injection of water into the aquifer using gravity alone. Groundwater modeling using estimates of the hydrogeologic properties of the Simsboro in the proposed treatment plant location, a maximum injection rate of about 470 gpm was estimated for the single well scenario described below. Injection at greater rates is possible, but requires the use of injection pumps, which adds to electrical and infrastructure costs. To minimize water level fluctuations at the well bore and maintain economical well spacing, the ASR systems explored for this study utilize from one to three wells depending on the desired capacity of the system.

Available Injection Supply

In most municipal systems, water usage typically peaks during summer months when irrigation needs are greatest. This usage pattern generally holds true for the City; an average demand of about 1.5 million gallons per day (MGD) was reported during the summer months, while the average demand during the period between September and May was about 1.1 MGD. For this evaluation, the hypothetical surface water treatment plant used to supply the ASR system is assumed to have ample surplus capacity available during off-peak months for injection.

As discussed above, the Simsboro generally contains fresh water in Central Texas but only mineralized, methane-rich groundwater has been obtained by test and production wells within the limits of the City thus far. In the first few years of operation, the system will be primed by injecting substantially more water than is extracted, which will displace mineralized water creating a fresh water zone in the aquifer surrounding the ASR wells.

When an adequate buffer is created, fresh water with an acceptable water quality may be produced.

Water Quality

The quality differs between injected and native aquifer waters; consequently, the duration and rate of injection/withdrawal volumes will affect produced water quality. Movement of dissolved minerals occurs through mechanisms called *advection* and *dispersion*. Advection is the transport of solutes through bulk movement of water, while dispersion is the dilution of solutes in the water by mechanical and chemical mixing between two waters. These two processes will affect how injected fresh water migrates within an aquifer and mixes with native groundwater.

The hypothetical treatment plant that will supply water to the ASR system will obtain raw water from the Colorado River. The total dissolved solid (TDS) concentration of the river water is likely to be in the range of 250 mg/L, which is assumed for this study to be the concentration of injection water. Data obtained during previous hydrogeologic investigations conducted by the City indicate that the Simsboro water quality in the City area varies by location and depth (Table 1). According to these data, the TDS concentrations range from 331 to 2,200 mg/L. Using a conservative approach, the high end of this range was used as the input for native aquifer water quality (2,200 mg/L TDS concentration) in the solute transport model.

As discussed above, injection of treated surface water into the aquifer during the initial phases of ASR operation will displace native water, creating a fresh water zone around the well bore. Some mixing of fresh and native groundwater will occur at the perimeter of the zone; however, because groundwater flow is confined to the relatively small pore spaces between the individual aquifer sand grains, the extent of mixing is relatively limited. Solute transport modeling conducted for this study suggests that increased mineralization due to interaction with native groundwater will raise the TDS concentration of approximately five percent of the injected water to levels in excess of the 1,000 mg/L TCEQ limit for public supplies. In other words, it is estimated that about five percent of the fresh water stored by the ASR system will be "lost" through mixing with native Simsboro groundwater.

Table 1: Water Quality in the City of Bastrop Area.

Well Name	Date Collected	Aquifer	Total Dissolved Solid concentration (mg/L)
TH1/MW1	03/04/08	Upper/Middle Simsboro	1,630
TH1/MW1	03/31/08	Upper Simsboro	1,090
TH1/MW1	03/31/08	Upper Simsboro	777
TH1/MW1	04/11/08	Upper Simsboro	1,020
TH2	04/02/08	Middle Simsboro	2,200
58-62-113	02/19/87	Simsboro	261
58-62-114	02/19/87	Simsboro	665
58-62-115	05/10/06	Simsboro	698
58-62-116	11/22/85	Middle Simsboro	912
58-62-409	05/10/06	Simsboro	874
58-62-118	09/01/98	Middle Simsboro	429
58624__	10/06/05	Middle Simsboro	660
58-54-801	08/25/80	Simsboro	417
58-62-107	08/02/66	Simsboro (?)	650
58-62-110	08/02/66	Simsboro (?)	723
58-62-111	09/06/72	Simsboro (?)	331

ASR Modeling

An analytical model developed by RWH&A was used to estimate well bore water level oscillations resulting from ASR injection/withdrawal cycles. MODFLOW, a finite-difference model (USGS, 1996), and the MT3DMS (Zheng and Wang, 1999) solute transport model were used to simulate potential water quality changes and groundwater migration rates. Three model scenarios were generated for this study, which increase in production by scenario, to showcase system potential. Table 2 lists the injection/withdrawal capacity for each scenario.

Well Field Design

Three potential ASR systems incorporating up to three wells were evaluated. As shown in Figure 2, the ASR well(s) are assumed to be located near the site of a hypothetical surface water treatment plant on the west side of the City. The well discharge rates are constrained by the productivity of the Simsboro at the site and/or by LPGCD well spacing regulations. With an estimated average transmissivity of 30,000 gallons per day per foot (gal/day/ft), the Simsboro beneath the site is anticipated to be able to sustain a maximum well yield of about 1,500 gpm. Consequently, the Scenario 1 (single well) discharge rate was assumed to be 1,500 gpm.

The LPGCD rules state that wells which produce in excess of 1,000 gpm must be spaced at least 5,000 feet from other wells completed in the same aquifer, which, for this study, is assumed not to be cost-effective from an infrastructure standpoint when more than one ASR well is contemplated. Where multiple ASR wells were considered (Scenario 2 and Scenario 3), the maximum well discharge rate was limited to 1,000 gpm in order to employ a 2,500-foot well-to-well spacing. See the section below entitled "Lost Pines

Groundwater Conservation District (LPGCD)" for a more detailed discussion of LPGCD groundwater regulation.

Modeled ASR Cycles

The initial periods of the model simulations consisted of an ASR "priming" phase when injection volumes are greater than withdrawal volumes. As discussed above, injecting more than is extracted in the first few years allows fresh water to displace native, mineralized groundwater around the well bore. In this way, production of fresh water is maintained throughout later ASR withdrawal cycles. For this study, ASR withdrawals are assumed to increase over a period of 8 years, reaching full capacity in year 9 and continuing forward.

Table 2 shows the modeled injection/withdrawal rates and schedules associated with the three scenarios evaluated for this study.

During the first two years of each model run no withdrawals were applied while nine months of injection per year was simulated to adequately displace poor quality water in preparation for the first withdraw period. Beginning on the third year of each simulation, injection continued to be modeled for nine months annually, but increasing withdrawals were applied for the remaining three months of each year. The duration of the modeled annual injection/withdrawal cycle was selected to provide a reasonable representation of ASR operation in the future. The actual amount of withdrawal during a given year will depend on several factors, including daily peak demand, duration of the peak, and the amount of available above-ground storage. The amount by which peak demand outweighs the maximum capacity of the treatment plant will govern how much total water is needed. In practice, the amount of water injected will depend on the amount by which the treatment plant capacity exceeds daily demands during low-use periods of the year.

Table 2: Modeled Injection/Withdrawal Rates

	Scenario #1 - 1 Well		Scenario #2 - 2 Wells		Scenario #3 - 3 Wells	
Year	**Well field Injection (gpm)**	**Well field Production (gpm)**	**Well field Injection (gpm)**	**Well field Production (gpm)**	**Well field Injection (gpm)**	**Well field Production (gpm)**
1	470	0	620	0	930	0
2	470	0	620	0	930	0
3	470	500	620	666	930	999
4	470	667	620	888	930	1332
5	470	833	620	1112	930	1668
6	470	1000	620	1334	930	2001
7	470	1167	620	1556	930	2334
8	470	1333	620	1778	930	2667
9 - 30	470	1500	620	2000	930	3000

Model Results

Two types of groundwater models were employed for this study: 1) an analytical model based on the Theis method (Theis, 1935) was used to simulate changes in well bore water levels through time, while a finite-difference modeling approach (Zheng and Wang, 1999; McDonald and Harbaugh, 1983) was used to estimate the extent of groundwater migration and mixing in the aquifer. Model inputs correspond to site-specific aquifer characteristics as determined from the results of aquifer tests and reported regional characteristics.

Figures 3, 4, and 5 show the cumulative water volumes associated with operation of ASR systems corresponding to the three model scenarios. As shown, the total volume of water in storage increases during the first seven years of operation because annual injection volumes are greater than withdrawal volumes. Following that initial period of storage buildup, the total water in storage declines slowly through the remainder of the simulation period because simulated annual withdrawal volumes are assumed to slightly exceed annual injection volumes.

Figure 6 shows the ASR well bore water level drawdowns through time. As expected for a confined aquifer such as the Simsboro, the annual injection-withdrawal cycles produced significant oscillations in artesian pressure levels within the well bores. Negative water level drawdowns (water level above initial, static water level) are predicted for the first two years in each scenario, which corresponds to the initial "priming" period discussed above. Figure 6 also shows that, although water levels fluctuate during each year, once the maximum withdraw rate is reached on the ninth year the pumping water levels stabilize, changing little in later stages of operation. This is because annual injection and withdrawal volumes are nearly in balance during later periods. As a result, the net change in aquifer pressure levels within a given year will be near zero.

Figure 7 shows well bore TDS concentrations of water withdrawn from the ASR system through time. As shown, TDS concentrations are estimated to rise slowly and stabilize at about year 15, with only minor increases in later periods. TDS concentrations remain below the 1,000 mg/L level required by the TCEQ for public supplies throughout the 30-year study period.

The regional effects of the ASR system on the aquifer are expected to be minor. Fresh water movement away from the ASR well(s) is also expected to be limited. In the model, changes in TDS concentration can be used as an indicator of the extent of interaction between native, mineralized groundwater and injected, fresh water. Figures 8 through 10 show the maximum extent of the region predicted to undergo more than a 1.0 mg/L change in TDS concentration during each scenario. As shown, the area affected by injection water mixing is estimated to extend about 2,800 feet from each ASR well after 30 years of operation.

Regulation of ASR

Construction and operation of an ASR system in the City requires approval from two regulatory agencies in Texas: 1) permits to construct and operate groundwater wells must be obtained from the LPGCD and 2) the TCEQ must issue a permit to inject water into an underground reservoir and must approve the ASR well for public supply use. The focus of this portion of the evaluation was to determine the specific steps necessary to obtain authorization for an ASR system. In addition, RWH&A reviewed the current rules and regulatory objectives promulgated by the TCEQ and LPGCD in order to identify potential restrictions on system design or operation.

The steps needed to acquire TCEQ approval for an ASR system are discussed in the following paragraphs. The LPGCD does not currently promulgate rules or policies specifically relating to ASR systems; therefore, the process of obtaining LPGCD operation permits for ASR wells is assumed not to differ from that needed to obtain typical well operation permits. A discussion of the LPGCD permitting process is included in the later section entitled "Lost Pines Groundwater Conservation District (LPGCD)".

Texas Commission on Environmental Quality (TCEQ)

A rule set was obtained from the TCEQ, which regulates the construction practices and material selection for public supply and ASR well systems. The following summarizes the pertinent portions of the TCEQ rules with regard to the ASR permitting process.

Well Construction and Operating Approval Process

Users are required to obtain approval for construction and operation of an ASR system. ASR wells are classified by the TCEQ as Class V injection wells, and initial approval is required prior to construction and testing. Construction requirements for ASR system are similar to standard municipal public supply production wells.

Once testing is completed, a report must be submitted to the TCEQ summarizing the information compiled during drilling and testing of the well. Various types of information are required to be included in the application report such as: 1) drillers logs, 2) geophysical logs, 3) as-built well drawings, 4) pumping test results, 5) water quality analyses of injected and produced water, and 6) documentation of the availability of water rights. Approvals for operation of an ASR system are reviewed on a case-by-case basis, and are generally contingent on verification that the ASR system will not cause degradation of the target aquifer or adjoining aquifer zones. Because the approval process is not standardized, multiple conversations with TCEQ staff and subsequent alterations to submitted materials may be necessary. A 60-day waiting period is typical between submittal of final documents and authorization of approval by the TCEQ for construction and operation of a well system.

ASR Well Costs

Estimates of probable well costs for the three potential ASR scenarios are outlined in Table 3. Total costs for the well fields are itemized in Table 4. Capital costs included underground infrastructure (Table 3), underground infrastructure costs included standard well materials, well pumps, a recharge/discharge manifold necessary for a dual purpose injection/production well, and a valve to control injection flow. Power costs were calculated using a $0.10 per kilowatt-hour rate and the annual operation and maintenance cost were calculated by assuming a pumping equipment replacement in all wells every 10 years. Power costs represent an annual cost averaged from the 30 year well field life, including the non-producing to low-producing ramp-up years. These costs are of a preliminary nature and will need to be reassessed if the project moves into the next phase.

Table 3: Probable ASR Well Field Costs

	Depth (ft)	Construction Cost	Average Electrical Cost Per Year
Scenario 1: 1 Well			
Well 1	661	$608,489	16,397
Total		**$608,489**	**$16,397**
Scenario 2: 2 Wells			
Well 1	661	$573,490	8,950
Well 2	700	$599,528	8,950
Total		**$1,173,018**	**$17,899**
Scenario 3: 3 Wells			
Well 1	661	$580,855	10,036
Well 2	700	$604,884	10,036
Well 3	626	$555,959	10,036
Total		**$1,741,698**	**$30,109**

Table 4: Itemized ASR Well Field Costs

	Scenario 1: 1 Well	Scenario 2: 2 Wells	Scenario 3: 3 Wells
Well Field Materials and Construction Cost	$608,489	$1,173,018	$1,741,698
Engineering Cost	$82,210	$134,420	$186,630
TCEQ Permitting	$3,000	$6,000	$9,000
GCD Permitting	$3,500	$7,000	$10,500
Project Cost	**$697,199**	**$1,320,438**	**$1,947,828**
Operation and Maintenance	$8,217	$9,434	$16,007
Average Power Cost	$16,397	$17,899	$30,109
Total Annual Cost	**$24,615**	**$27,333**	**$46,117**

Groundwater Development Option

Two potential groundwater development options were included in the Initial Study conducted in 2011. As part of this study, projected City water demands have been updated, which affects the scale of a potential groundwater development project. The following discussion redefines and resizes the potential development from the Simsboro aquifer using this updated information.

Bastrop will require additional water supplies incrementing to an average annual demand of 31,028 acre feet per year by 2040 to meet the needs of an increasing population over the next thirty years. Use of groundwater represents a potential strategy to fulfill future demands, and the Simsboro aquifer represents one of the most conveniently located and productive groundwater sources near the City. Initially, a potential well field design was generated that is consistent with the estimated hydrogeologic conditions in the area and with the LPGCD regulations. Groundwater modeling was performed using the well field layout to estimate the well bore pumping levels and regional impacts resulting from long-term production. From these data, costs associated with construction and operation of a Simsboro well field and pipeline were compiled.

Well Field Design

The well field layout for the Simsboro aquifer was 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.

For this study, a potential well field layout was generated that lies to the north of the City. The well field area was chosen because of the relatively favorable water quality and generally high productivity of the Simsboro aquifer. To facilitate costing of this development option, individual well yields were assumed to be constant over the 30-year study period. Well locations were chosen such that long-term well field productivity is maintained without excessive well-to-well interference effects, while conforming to LPGCD well spacing regulations.

Aquifer transmissivity and "available drawdown" were the primary factors used to determine potential well yields. 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 aquifer sediments. For this study, it was assumed that desaturation of the Simsboro near a well bore is undesirable. The well yield calculations presented herein assume the available drawdown at a particular well is the vertical distance between the static (non-pumping) water level and the top of the aquifer at the site.

In general, 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. The depth of the Simsboro increases toward the southeast, while aquifer pressure remains comparatively consistent in the region. Consequently, available drawdown increases to the southeast, allowing for larger-capacity wells in more downdip zones.

Figure 11 shows the available drawdown of the aquifer and the location and layout of the well field. Wells were placed in a location within reasonable proximity to the City of Bastrop delivery point while maximizing available drawdown. As discussed above, the LPGCD rules place some constraints on the location for the well field. To avoid prohibitive pipeline costs, offsets for each well were limited to 2,500 feet, which corresponds to pumping rates of 1,000 gpm or less. Adjustments to the specific location of each well were necessary to maintain proper offsets from existing LPGCD wells.

Well Field Production

The City's water demands will increase over the next 30 years in response to population growth coupled with reduced use of existing wells that produce groundwater from the Colorado River Alluvium. It was assumed that the groundwater option presented herein will be capable of supplying sufficient groundwater to satisfy the projected average annual demands, as well as the projected daily peak delivery rates.

Two phases were modeled to better match projected trends in demand through time: 1) an initial phase utilizing seven wells to meet supply deficits until 2025 and 2) a subsequent phase with twenty wells (thirteen wells constructed in addition to the seven wells constructed in phase one) that provides supplies through 2040. The average pumping rates chosen are based on the assumed deficits listed in Table 5. The maximum pumping rates correspond to the maximum daily delivery rates needed to satisfy system demands during short-term peaks in usage. Although the total annual production from the well field will be limited to the average deficits listed in Table 5, the system is designed to be capable of producing the maximum daily deficit in times of peak demand. All of the wells during both phases are assumed to produce a maximum of 1,000 gpm, while the average pumping rates for the wells increases from 192 gpm in Phase 1 to 344 gpm during Phase 2. For simplicity, it was assumed for this study that each well produces an equal percentage of the overall respective deficit during each phase.

Table 5: Model Well Field Production and Deficit for the City of Bastrop

Year	Average Annual Deficit (acre-feet/year)	Peak Daily Deficit (MGD)	Number of Wells	Average Pumping Rate Per Well (gpm)	Maximum Pumping Rate Per Well (gpm)
2010-2025	2,174	9.8	7	192	1000
2025-2040	11,125	27.7	20	344	1000

Groundwater Modeling and Predicted Declines

A groundwater model is a computer program that simulates groundwater flow through an aquifer system. Models consist of a framework of mathematical equations that are used to calculate flow based on various input parameters. The area covered by the modeled aquifer is subdivided into model cells, which allows for the application of flow equations to smaller, mathematically manageable areas. For this study, groundwater modeling was conducted using the Central Simsboro-Wilcox-Queen City-Sparta Groundwater Availability Model (GAM) distributed by the TWDB. The GAM is a regional-scale model that is used by various regulatory agencies in Texas for planning purposes.

Water Table vs. Artesian Pressure Drawdown

Typical model outputs include decline in aquifer water levels, which is commonly known as "drawdown". However, it is important to note the physical distinction between water table drawdown and artesian pressure drawdown because the significance of the predicted drawdowns is dependent upon the hydrogeological setting in which the declines take place.

The Simsboro aquifer exhibits characteristics of both a water table aquifer and an artesian aquifer depending on location. The Simsboro aquifer consists of sand-rich beds that are recharged by downward percolation of precipitation in areas where aquifer sediments outcrop at ground level. In outcrop areas, the term "water table" is commonly used to denote the boundary between overlying unsaturated sediments and underlying saturated aquifer materials. After the recharge water reaches the water table, it slowly migrates through the aquifer beds, which dip toward the southeast at about 100 to 200 feet per mile. In these deeper, downdip zones, the flow is confined within the sand-rich aquifer beds by clay-rich, relatively impermeable beds that lie above and below the Simsboro aquifer. As a result, the groundwater is under "artesian" pressure in these deeper aquifer zones.

The aquifer response to pumpage in outcrop (water table) areas is fundamentally different from the aquifer response in deeper (artesian) portions of the aquifer. When a well is pumped in an outcrop area, well bore water levels are lowered and these declines are transmitted outward from the well, forming a "cone of depression" in the water table. In other words, pumpage in water table areas drains water from the pore spaces between the aquifer sediments, reducing the saturated thickness of the aquifer near the well.

Wells completed in deep aquifer zones to the southeast of the aquifer outcrop areas, such as the wells proposed herein, behave very differently. The primary physical difference is that artesian pressure drives the water above the top of the aquifer in wells that are completed in downdip areas. As a result, drawdown from a well completed in a downdip zone is transmitted outward from the well in the form of a reduction in artesian pressure, not a reduction in saturated thickness. Aquifer materials remain fully saturated near the well bore during pumping as long as artesian pressure levels remain above the top of the aquifer.

Regional Aquifer Water Level Trends

All wells producing from the Simsboro contribute to the drawdown in the aquifer. Long-term changes in aquifer water levels resulting from other users in Central Texas affect groundwater availability and well yields in the Bastrop region. In general, Wilcox Group (of which the Simsboro is a member) 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 to a maximum of about 250 feet in Simsboro wells located in Brazos County (largely due to production by the cities of Bryan and College Station).

Estimates of the impacts resulting from other groundwater users in the region were incorporated into the evaluation of this groundwater development option. These impacts were estimated using data acquired from State water planning entities in Central Texas. Specifically, model pumpage inputs generated by Groundwater Management Area No. 12 (which includes Bastrop County) during recent joint planning efforts were obtained. These pumpage inputs were then applied to the well field evaluation modeling performed for this study in order to more accurately simulate the total drawdown in the proposed well field. For reference, the amount of drawdown from regional pumpage that is predicted to occur during the 30-year study period ranges from about 35 feet in southern areas to 80 feet in northern portions of the well field.

Modeled Aquifer Response

Figures 12 and 13 depict drawdowns in the Simsboro aquifer due to only the proposed pumpage in years 2025 and 2040. As shown, drawdown is about 24 feet within the well field in year 2025, and about 98 feet in year 2040. Because the Simsboro aquifer is artesian in this area and static water levels rise about 300-350 feet above the top of the formation, the predicted drawdown in 2025 accounts for about 8% of the available artesian pressure, and drawdown in 2040 accounts for approximately 28% of the available artesian pressure at the site.

Water Quality

For general reference, Table 6 shows the estimated Simsboro water quality at the proposed well field sites. The values were interpolated from regional data obtained from the TWDB. As shown in Table 6, all constituents are within TCEQ primary and/or secondary state drinking water standards for public supplies, established in Texas Administrative Code (30 TAC, Chapter 290, Subchapter F).

Table 6: Estimated General Water Quality for Proposed Well Field

Constituent	TCEQ Standard	Simsboro Well Field
TDS (mg/L)	1000	394
pH	6.5-8.5	7.9
Total Alkalinity (mg/L)	--	221.5
Temperature (C°)	--	29.5
Calcium (mg/L)	--	41.23
Magnesium (mg/L)	--	5.59
Sodium (mg/L)	--	100.27
Chloride (mg/L)	300	36.46
Sulfate (mg/L)	300	69.84
Bicarbonate (mg/L)	--	264.13
Nitrate (mg/L)	10	0.06

Well Costs

Estimates of potential well costs and depths are outlined in Table 7. Total costs for the well fields are itemized in Table 8 and were estimated using RWH&A files. Construction costs include underground and well head infrastructure only. Power costs were calculated using a $0.10 per kilowatt-hour rate and the annual operation and maintenance cost were calculated by assuming a pumping equipment replacement in all wells every ten years. These costs are of a preliminary nature and will need to be reassessed in the future as the project moves into the next phase.

Table 7: Probable Simsboro Well Field Costs

	Depth	Construction Cost	Electrical Cost Per Year (2010-2025)	Electrical Cost Per Year (2025-2040)
Well 1	792	$582,236	$6,051	$27,277
Well 2	898	$674,944	$6,051	$27,277
Well 3	805	$597,017	$6,051	$27,277
Well 4	825	$618,553	$6,051	$27,277
Well 5	846	$638,782	$6,051	$27,277
Well 6	973	$750,698	$6,051	$27,277
Well 7	857	$652,978	$6,051	$27,277
Well 8	803	$604,833		$27,277
Well 9	858	$657,302		$27,277
Well 10	778	$580,699		$27,277
Well 11	1036	$799,456		$27,277
Well 12	946	$725,447		$27,277
Well 13	1187	$931,305		$27,277
Well 14	1106	$860,982		$27,277
Well 15	1229	$966,183		$27,277
Well 16	898	$703,687		$27,277
Well 17	957	$758,673		$27,277
Well 18	1144	$907,447		$27,277
Well 19	1013	$807,494		$27,277
Well 20	872	$700,083		$27,277
Total		**$14,518,799**	**$42,359**	**$545,546**

Table 8: Itemized Simsboro Well Field Costs

Capital Costs	
Well Field Materials and Construction Cost	$14,518,799
Engineering Cost	$934,200
TCEQ Permitting	$60,000
GCD Permitting	$70,000
Project Cost	**$15,582,999**
Annual Costs for Years 2010-2025	
Operation and Maintenance	$51,270
Power Cost	$42,359
Annual Cost	**$93,629**
Annual Costs for Years 2025-2050	
Operation and Maintenance	$195,179
Power Cost	$545,546
Annual Cost	**$740,726**

Lost Pines Groundwater Conservation District (LPGCD)

RWH&A obtained a current rule set and management plan from the LPGCD, which regulates well construction and groundwater use in Bastrop and Lee Counties. The rules, which became effective January 13, 2013, provide no specific guidelines or rules for injection wells or ASR systems in general. Following meetings and conversations with the LPGCD, it has been concluded that no assumptions regarding variances from current rules can be made until a defined project is presented to the LPGCD board for review. Consequently, it was assumed for this evaluation that no special exceptions from current rules would be granted for wells comprising an ASR system. In other words, it is assumed that all district rules applicable to the design and operation of typical groundwater wells will also apply to potential ASR wells. The following summarizes the pertinent portions of the LPGCD rules with regard to groundwater production.

- ***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 Desired Future Conditions (DFCs) is included:

  "Rule 9.1 Production Limits. To accomplish the purposes of Texas Water Code chapter 36, and to achieve the stated purposes and goals of the District, including managing the sustainability of the aquifers and preventing significant, sustained water-level declines within the aquifers, the district shall manage total groundwater production on a long-term

> *basis to achieve the applicable Desired Future Condition. The District may establish production limits on all permits for this purpose following the procedures in Rule 14.1 and 14.2. All Operating Permits are issued subject to any future production limits adopted by the District under this Rule."*

Rule 14.1 and 14.2 (referenced above) discuss the rule creation procedures to be followed by the LPGCD. The rules also discuss general protocol by which the LPGCD may decrease the allowable 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.

- ***Well Spacing*** – Wells in the Simsboro aquifer capable of producing up to and including 500 gallons per minute (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.

LPGCD Permitting Process

It will be necessary to obtain permits from the LPGCD to produce groundwater from either the proposed ASR well(s) or the Simsboro production wells. Compilation of district permit applications for larger-scale projects (such as those explored herein) is typically a complex, 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. Once submitted, the application is reviewed by the LPGCD with regard to completeness and technical accuracy. Administratively complete applications are publically posted and may be formally contested by affected stakeholders in the region and by the LPGCD itself through action of the LPGCD General Manager. Contested applications require the compilation of extensive evidence (expert witness depositions, testimony, etc.) that is presented to an appointed hearings examiner who provides guidance to the District board prior to decision-making with regard to the application. In general, an applicant must provide technical and/or legal support during the permitting process. The amount of effort required to provide professional support during the permitting process can vary significantly. In general, the greater the amount of potential opposition to an application, the greater the costs associated with obtaining LPGCD permits.

The total amount of time needed to obtain LPGCD operation permits is dependent on various factors, some of which are difficult to predict. Currently, there is a backlog of other permit applications to be heard by the LPGCD that may affect permitting timelines in the coming months. However, assuming that normal administrative schedules are achieved by the LPGCD in the near future and that the applications are not contested, it is estimated that District approval may be obtained within six months of submittal of the appropriate documents. It is expected that the TCEQ application discussed in earlier sections can be submitted concurrently with LPGCD applications.

Historically, groundwater conservation districts like the LPGCD autonomously controlled water regulation within their political boundaries. In 2005, a legislative modification of Chapter 36 of the Texas Water Code known as House Bill 1763 attempted to impose some regional continuity on the current management system through the creation of Groundwater Management Areas (GMAs). 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. As part of the effort to encourage a regional perspective from groundwater districts, House Bill 1763 altered Chapter 36 such that that each GMA is required to adopt "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 practice, most districts assume that the MAGs represent production caps for each aquifer in a GMA.

Permitted groundwater production in the LPGCD currently surpasses and will continue to exceed the MAG within the district for at least the next 50 years. In addition, the LPGCD recently ended a permitting moratorium that had been in place since 2010. Currently, there is a backlog of permit applications requesting production for more than 100,000 acre-feet per year, which the LPGCD began reviewing in 2013. As a result, the potential for obtaining permits for development of additional groundwater resources within Bastrop County remains uncertain at this time.

Study Limitations and Uncertainty

This study provides preliminary ASR and groundwater development scenarios for the City of Bastrop. It should be noted that the hydrogeologic interpretations and well field modeling employed herein are based on available information. As discussed above, the water quality found during previous subsurface explorations within the City is not typical of Simsboro water quality in the region. Specifically, elevated dissolved mineral and gas (primarily methane and carbon dioxide) concentrations were found in Simsboro groundwater during drilling and testing of wells in the Bastrop area. The cause of the atypical groundwater quality has not been definitively determined, but may be the result of hydraulic isolation of the portion of the Simsboro underlying the City from the regional body of the aquifer by faulting or other structural boundaries. If this is the case, the aquifer response to ASR injection/withdrawal cycles and/or large-scale production from the Simsboro may differ from the modeling results presented herein. Specific aquifer testing at proposed development areas will present more definitive data, allowing for more accurate estimates of well layouts, yields, regional impacts, and costs.

References

McDonald, M.G., and Harbaugh, A.W., 1983. *A modular three-dimensional finite-difference ground-water flow model*. Open-File Report 83-875. U.S. Geological Survey.

Theis, Charles V., 1935. *The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage.* Transactions, American Geophysical Union 16: 519–524.

Zheng, C. and P.P. Wang, 1999, *MT3DMS: A modular three-dimensional multispecies model for simulation of advection, dispersion and chemical reactions of contaminants in groundwater systems; Documentation and User's Guide*, Contract Report SERDP-99-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

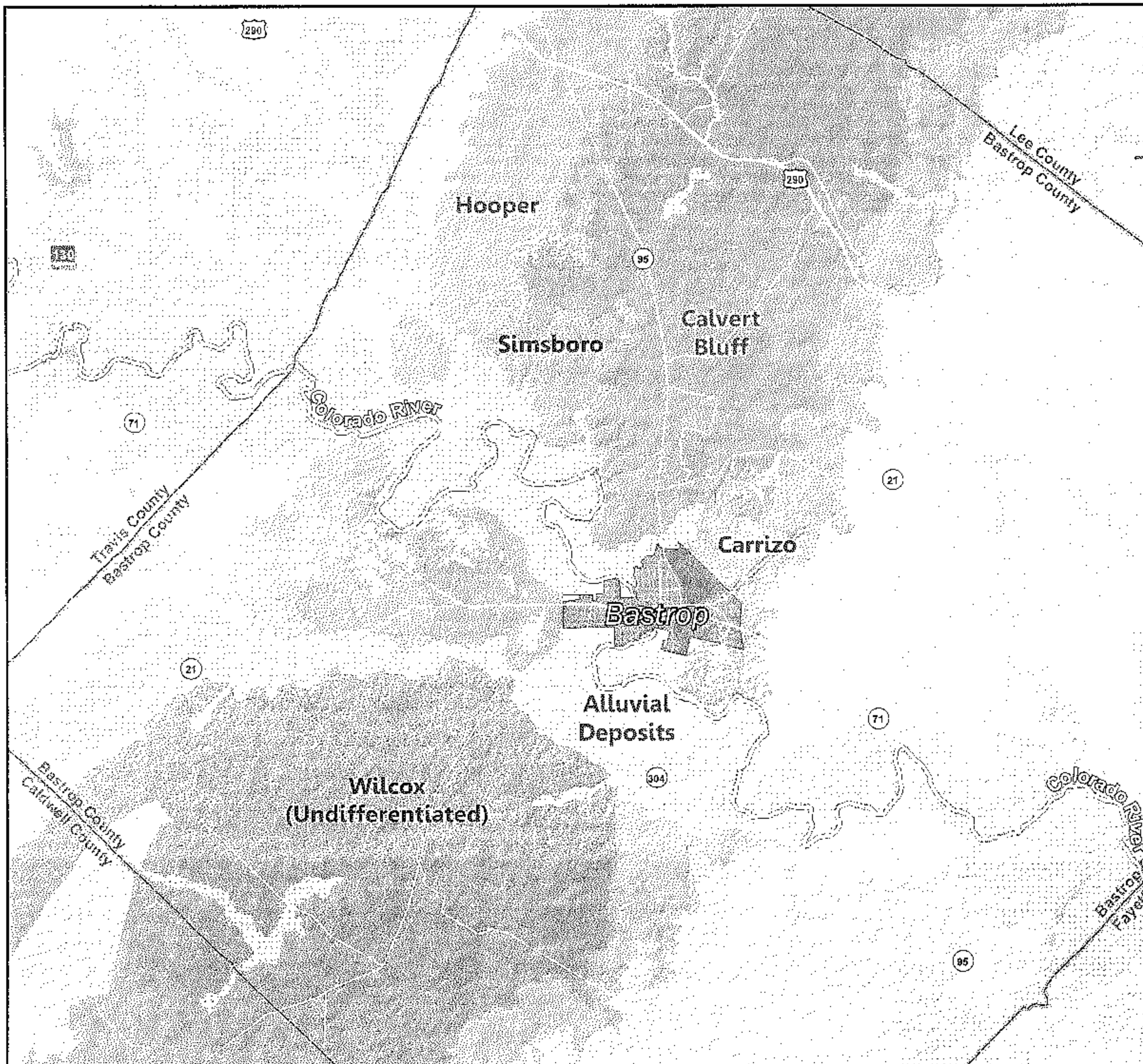

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Figure 1

Regional Outcrops

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Print Date: 1/3/2013

File: D:\598\Graphics\Figure 1 - Outcrops Map.mxd

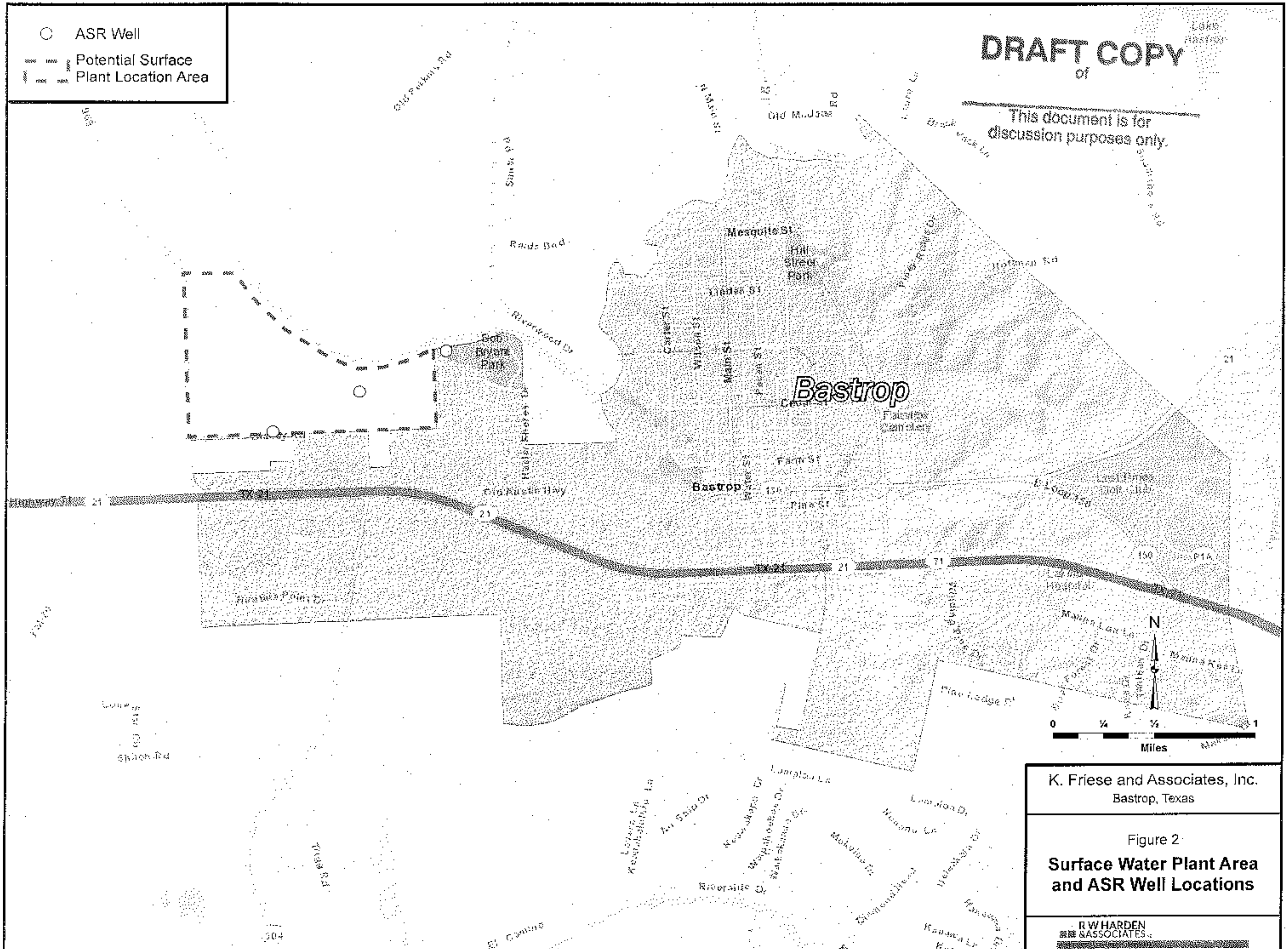

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Figure 2

Surface Water Plant Area and ASR Well Locations

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Figure 3: ASR Scenario No. 1 - 1 Well

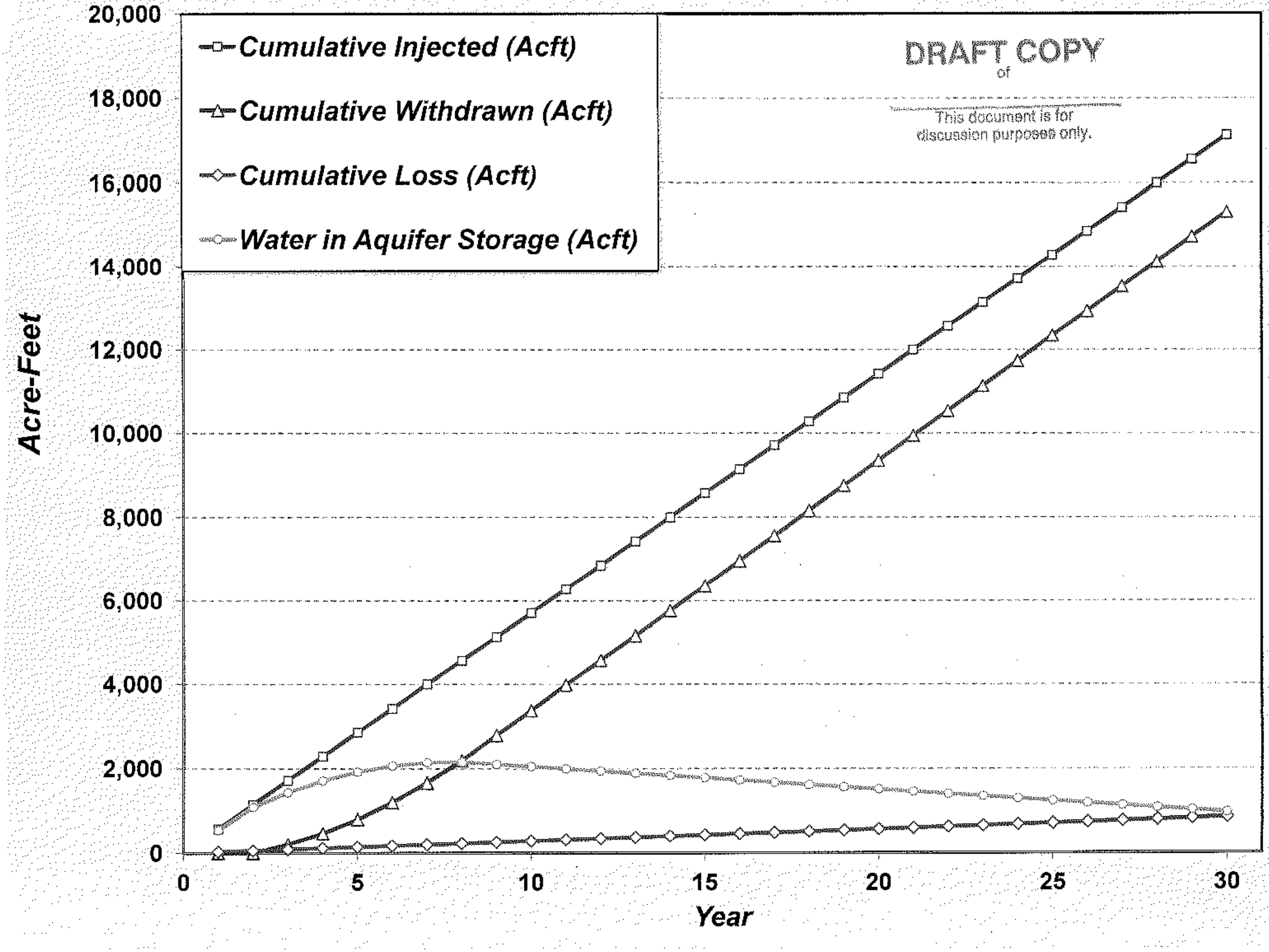


Figure 4. ASR Scenario No. 2 – 2 Wells

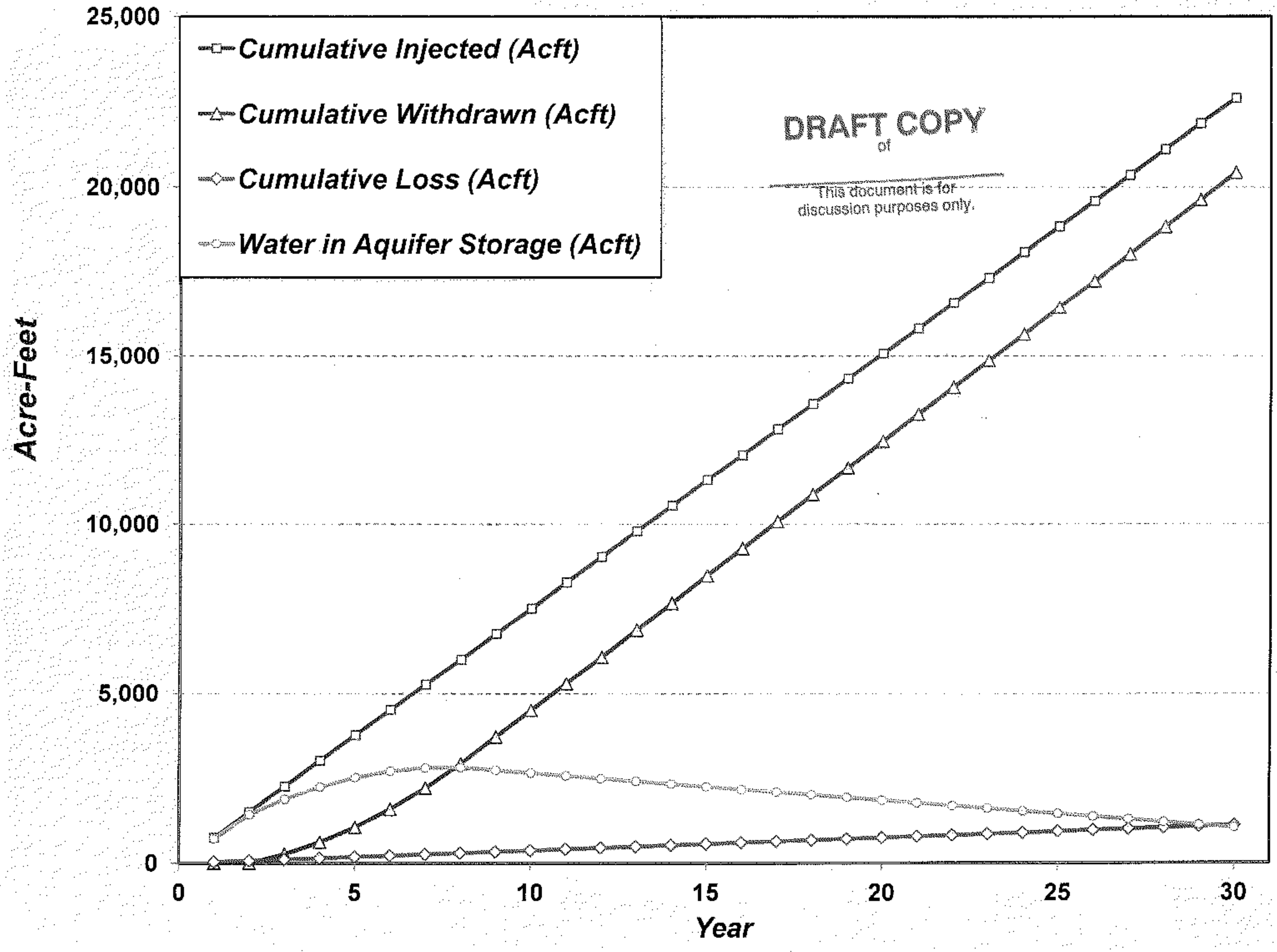


Figure 5: ASR Scenario No. 3 - 3 Wells

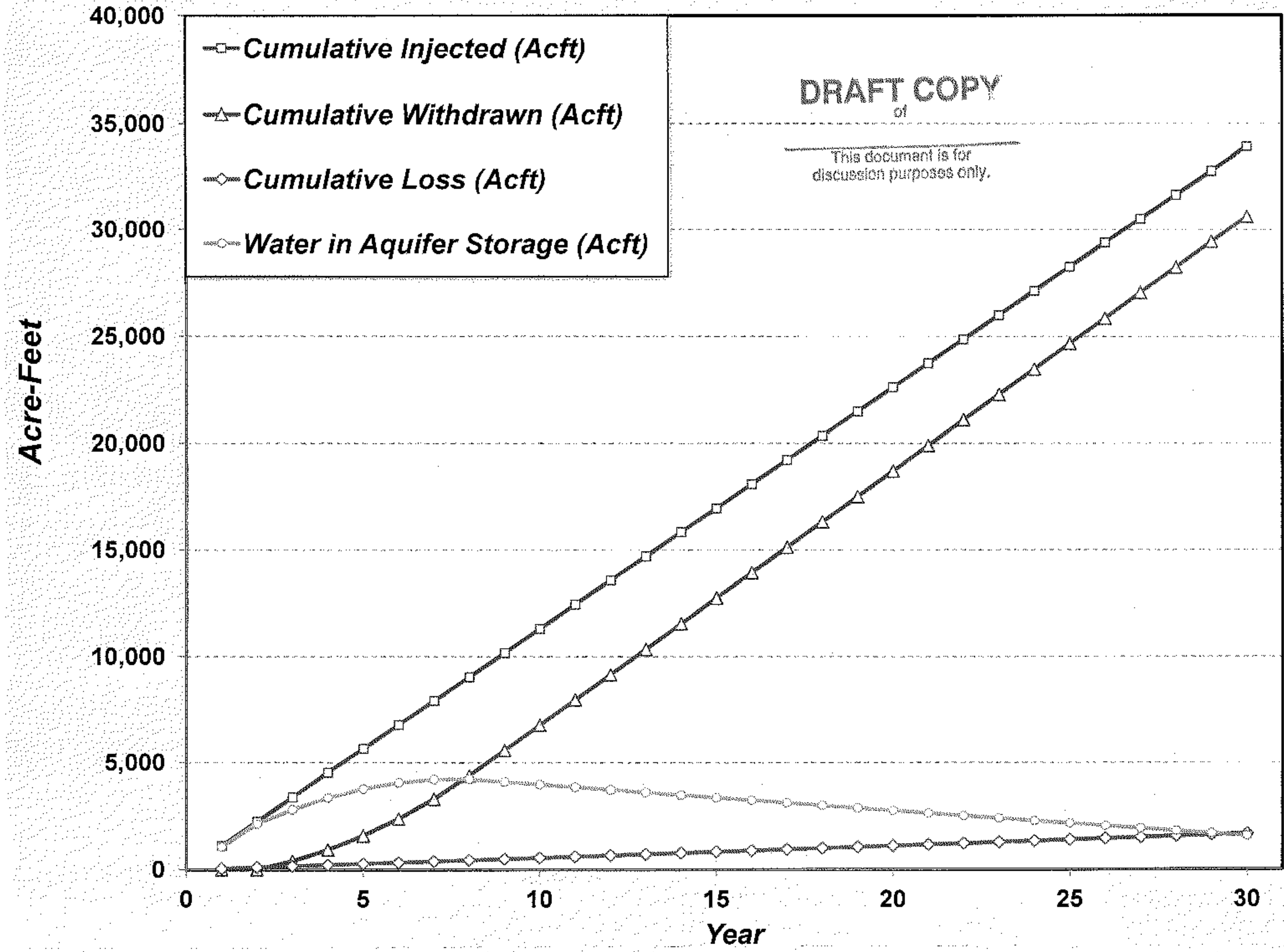


Figure 3: ASR Well Bore Water Levels

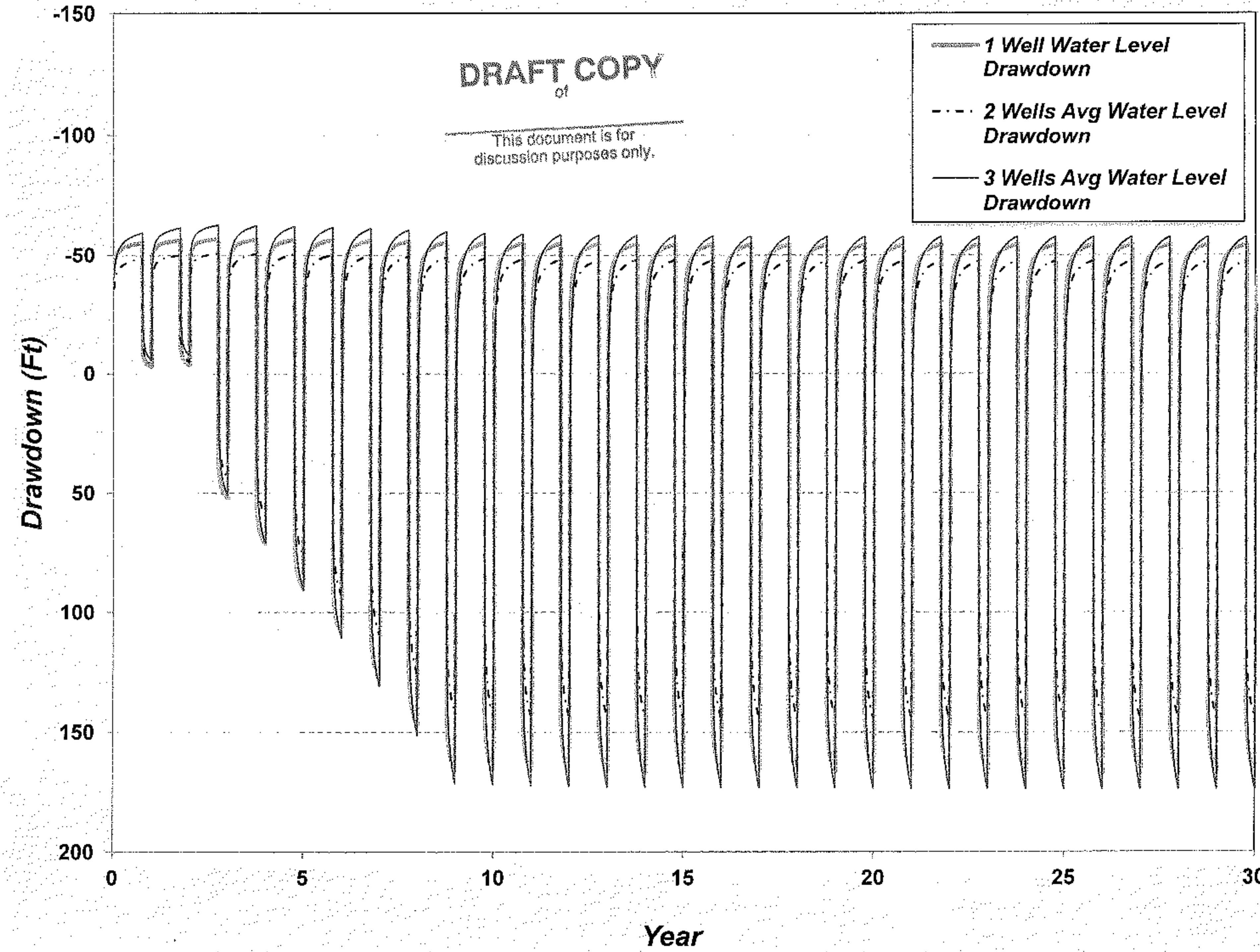
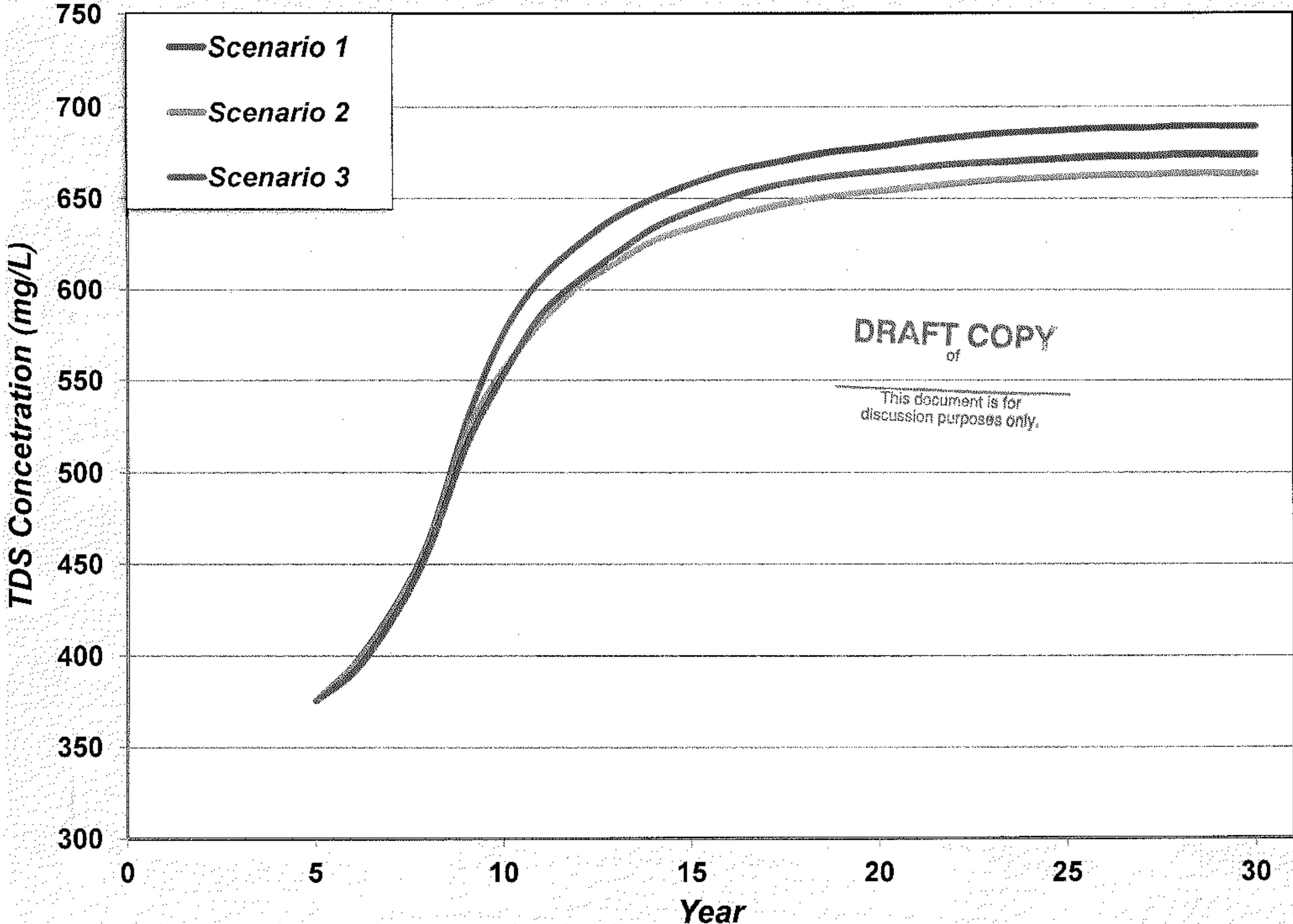


Figure 7: Well bore TDS at End of Withdrawal Period



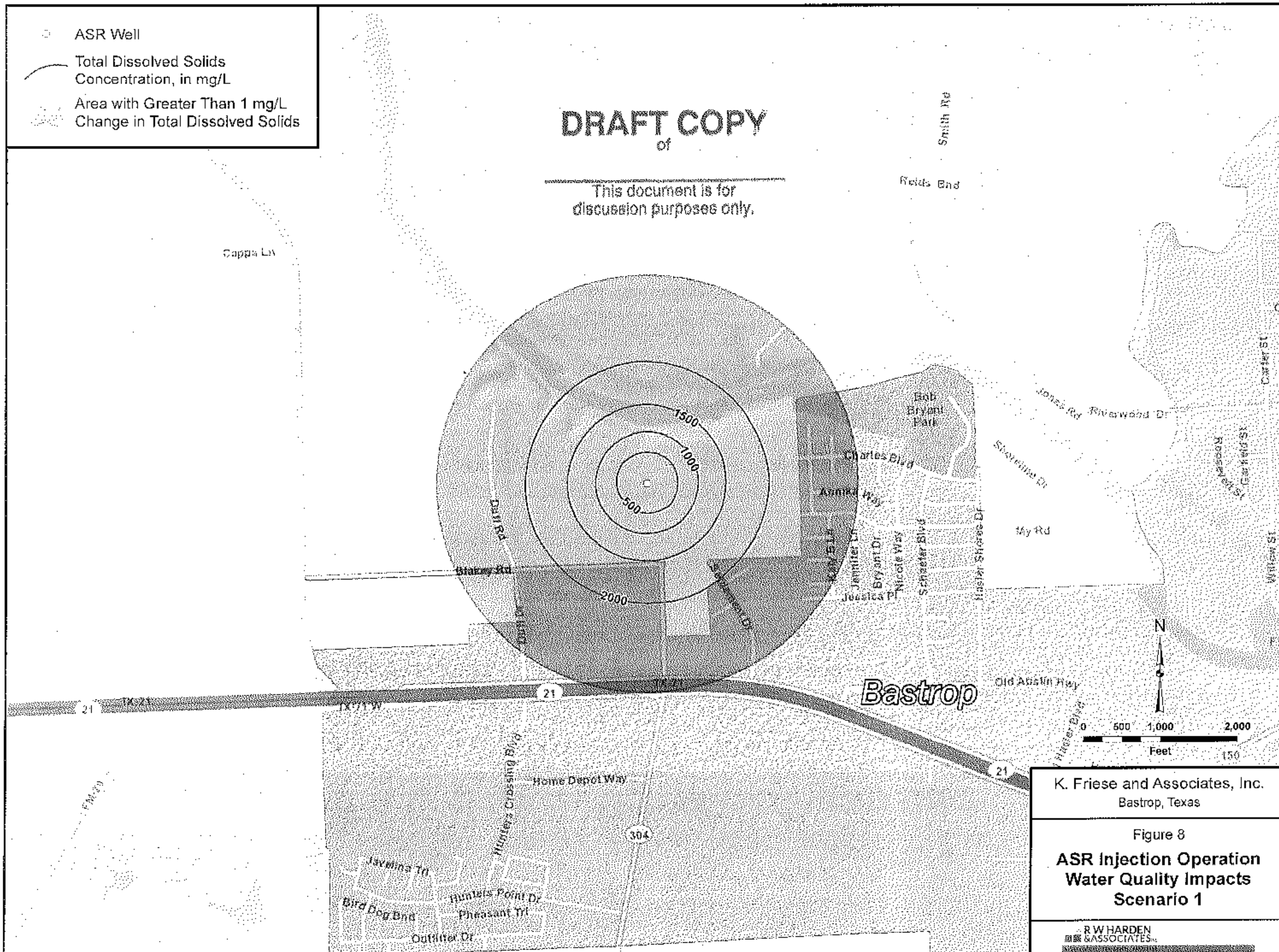


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Figure 8

ASR Injection Operation Water Quality Impacts Scenario 1

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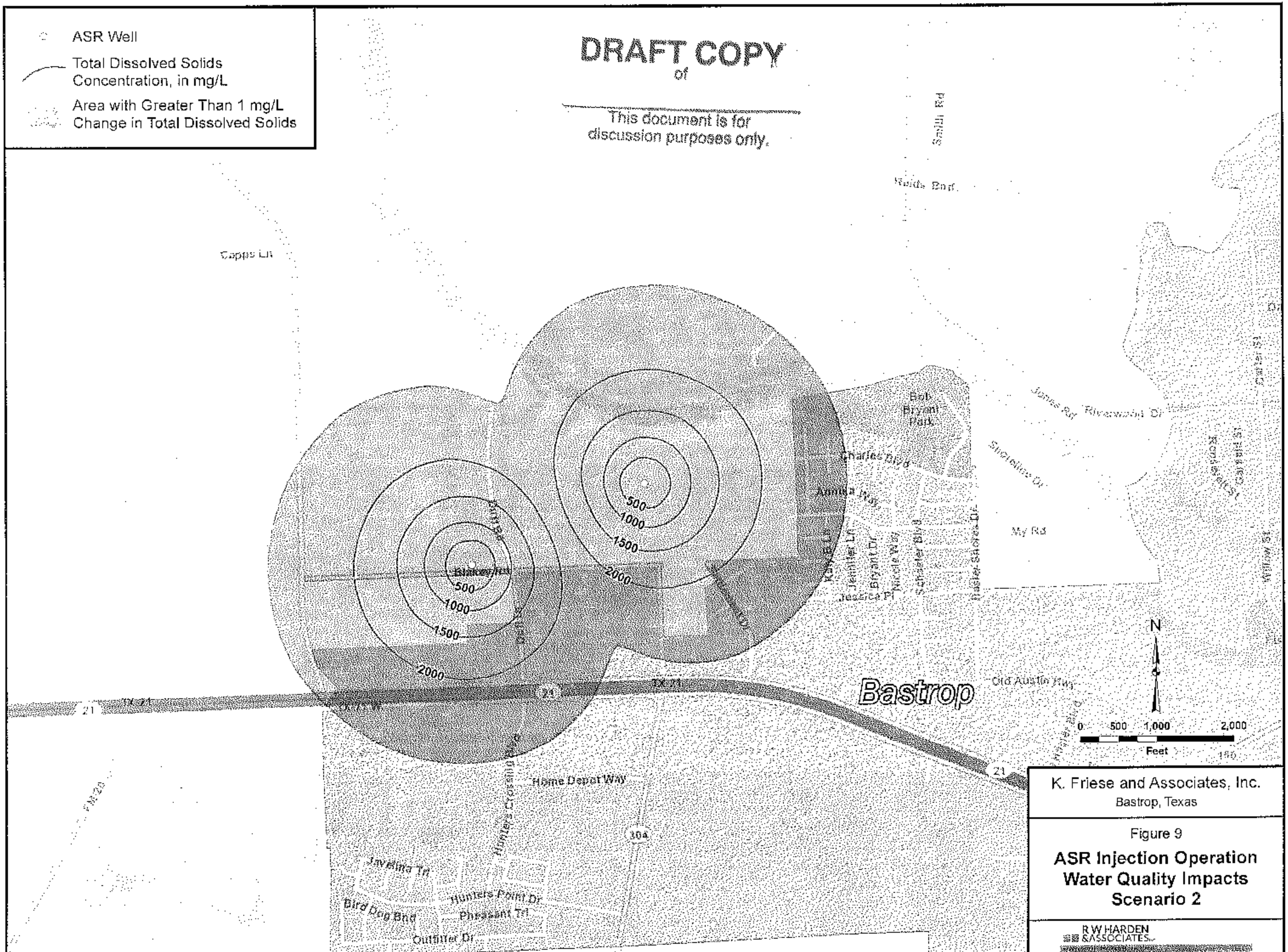

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Figure 9
ASR Injection Operation Water Quality Impacts Scenario 2

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Print Date: 1/29/2013

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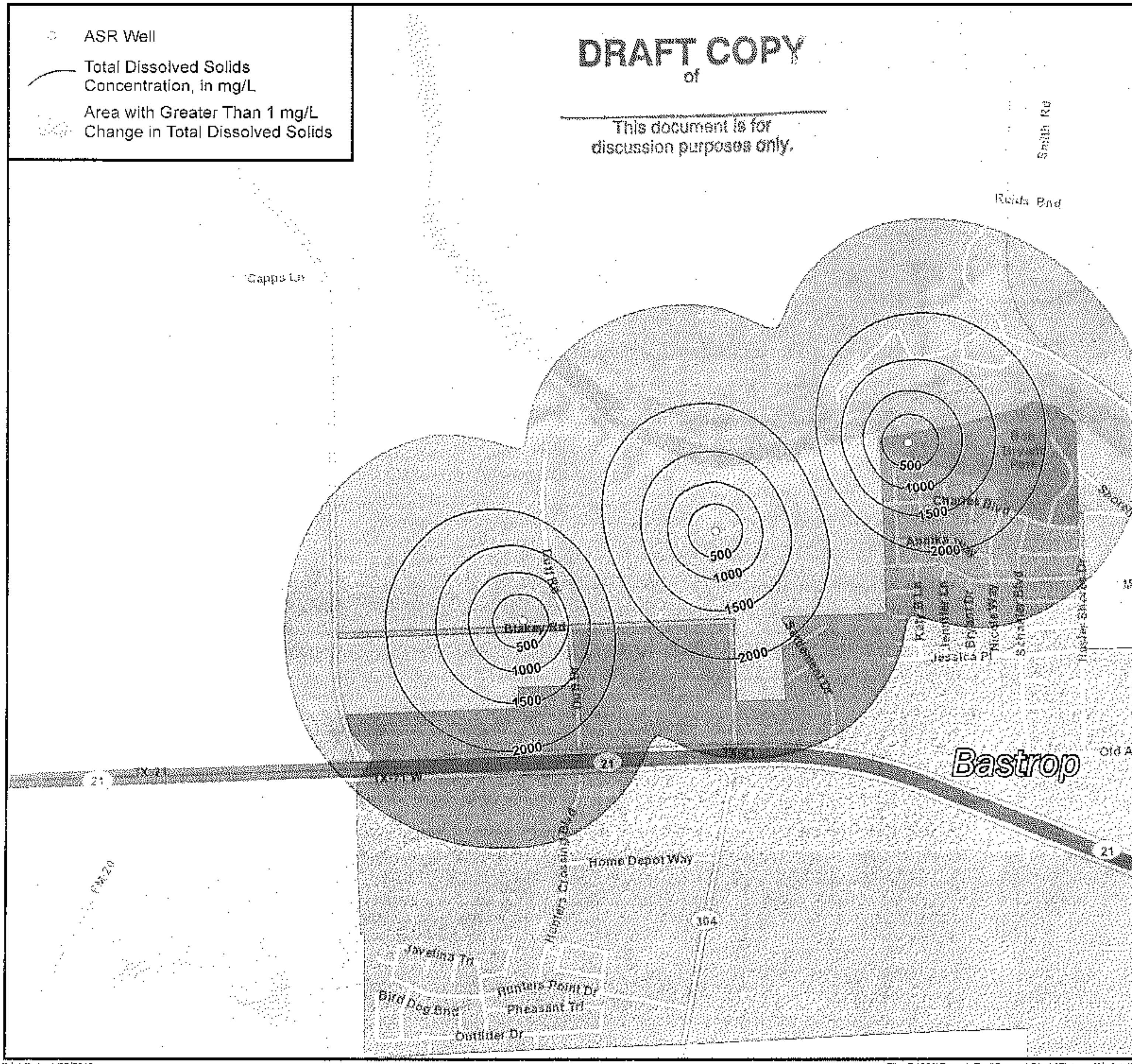

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Figure 10
ASR Injection Operation Water Quality Impacts Scenario 3

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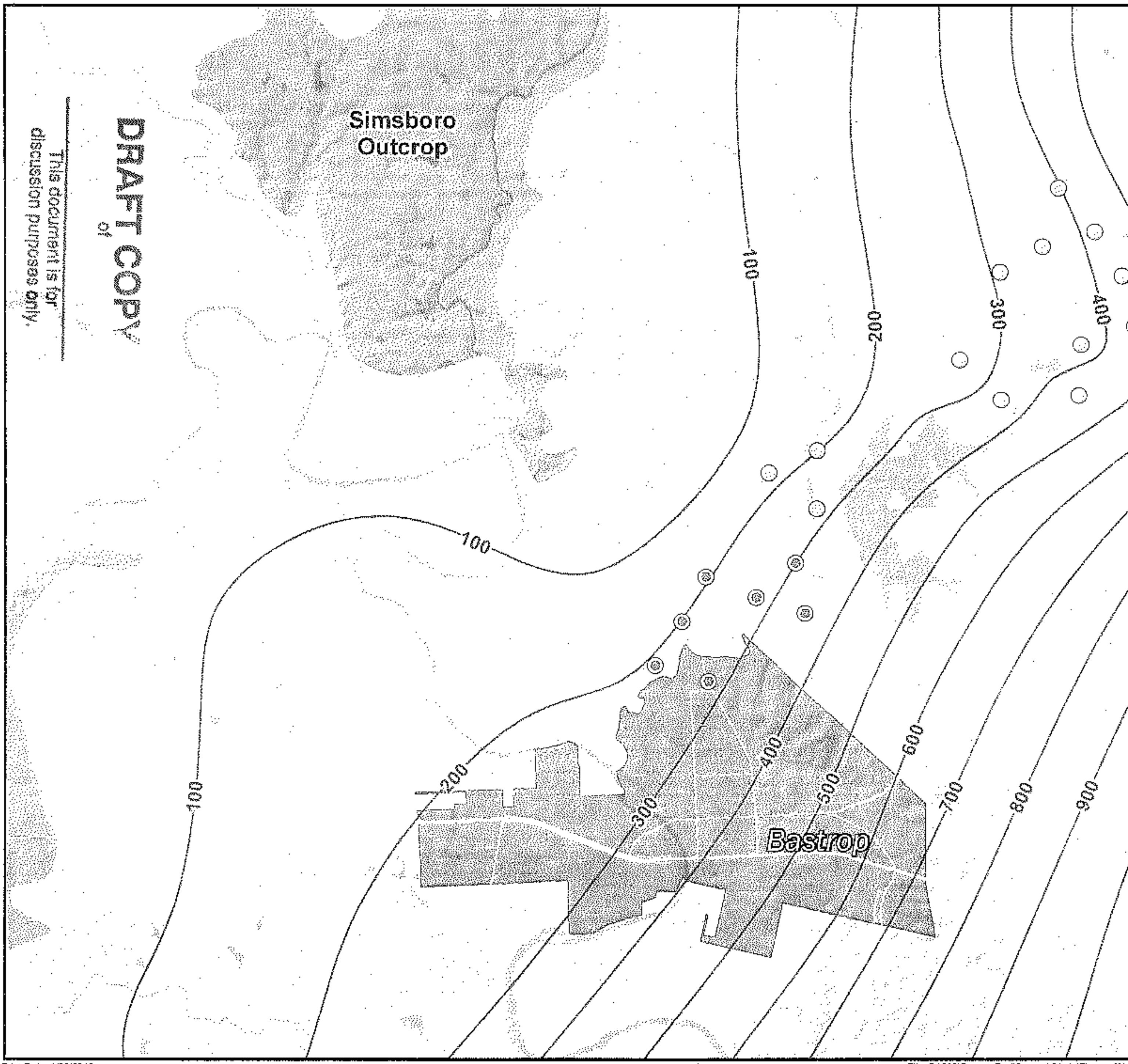

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Figure 11
Proposed Well Field and Available Drawdown

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Print Date: 1/29/2013

File: D:\598\Report_Text\Second Study\Figures Workup\Figure 11 - Proposed Well Field and Available Drawdown.mxd

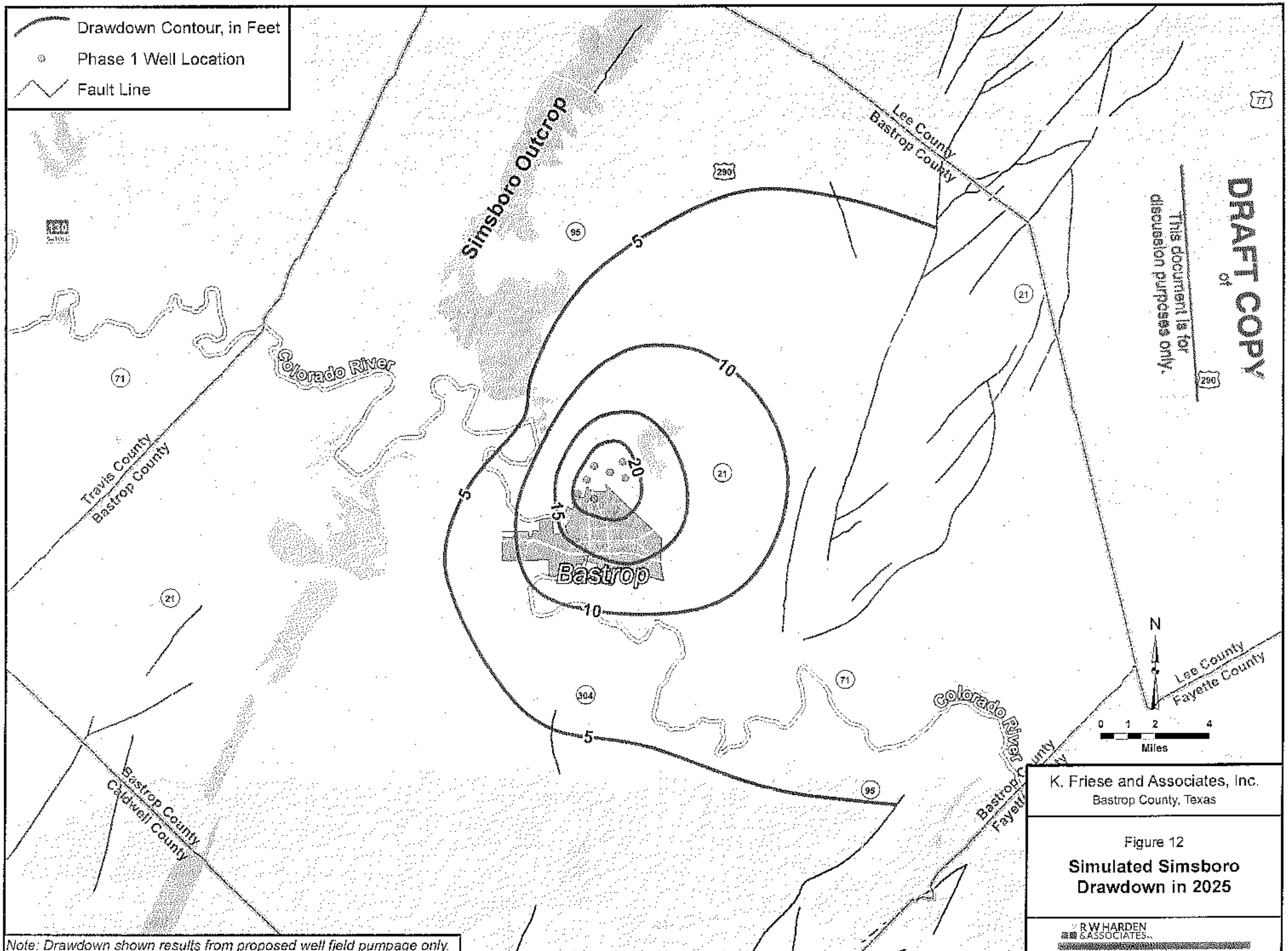

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Figure 12
Simulated Simsboro Drawdown in 2025

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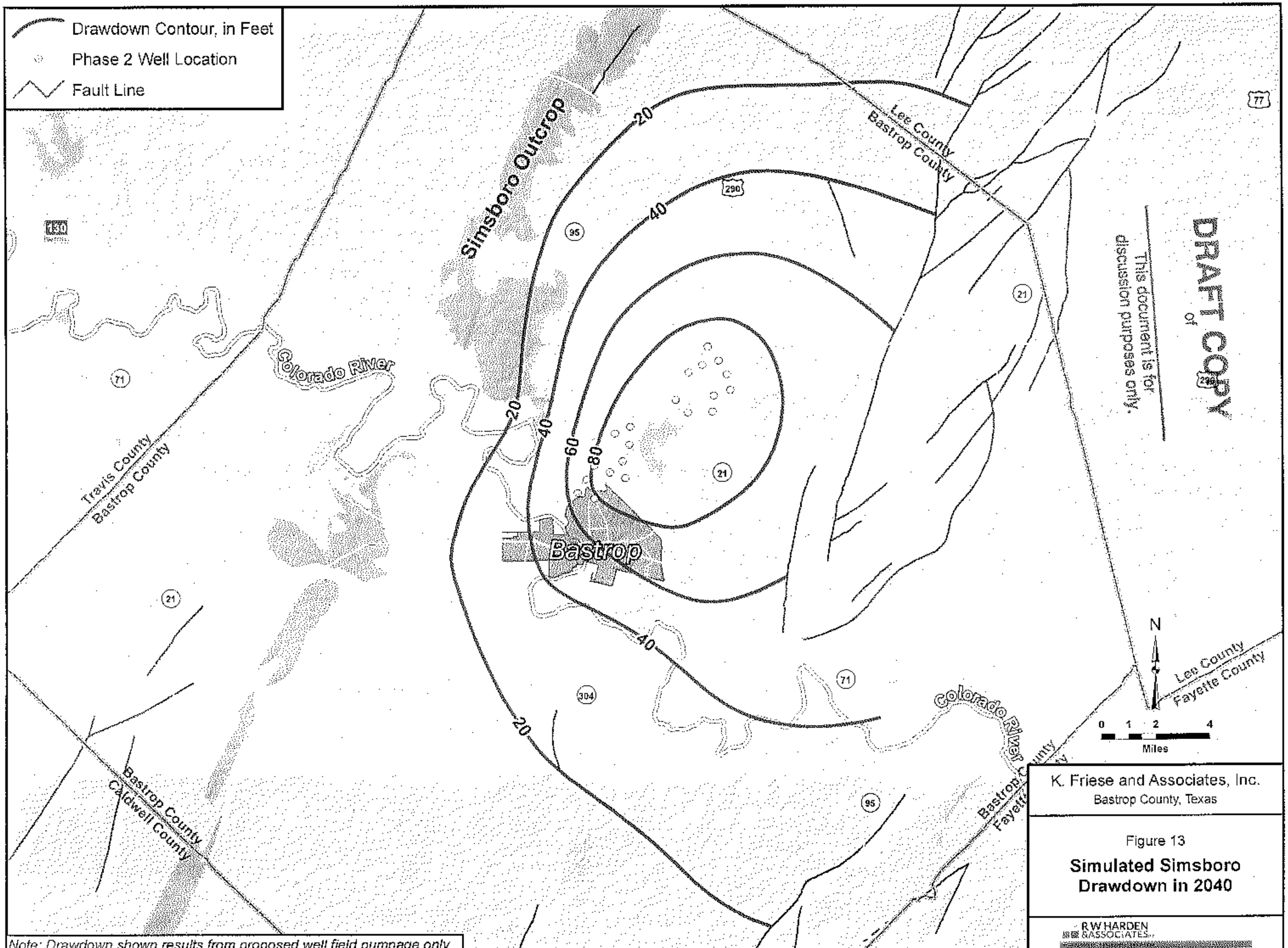
Print Date: 1/29/2013

File: D:\598\Report_Text\Second Study\Figures Workup\Figure 12 - Simulated Simsboro Drawdown in 2025.mxd



Note: Drawdown shown results from proposed well field pumpage only.

Print Date: 1/29/2013

File: D:\698\Report_Text\Second Study\Figures Workup\Figure 13 - Simulated Simsboro Drawdown In 2040.mxd

Appendix E - Cost Estimate Assumptions

Bastrop Water Supply Cost Assumptions

Initial year of analysis period		2010
Ending year of analysis period		2040
Analysis duration		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 200!		8557.00
Engineering News Record Construction Cost Index March 2013		9455.98
Adjustment Ratio		1.11
Engineering		15 %
Legal Costs		5 %
Contingency		30 %
Easement Costs	$	9,627 /ac
Environmental and Mitigation -Pipelines		$5.23 /LF
Pipeline Easement Width		40 ft
Unit cost of energy	$	0.10 / kwh
Electrical hookup	$	150.00 /hp
Pump Efficiency		85%
Motor Efficiency		92%

Notes on Unit Costs:

1 Cost source is the South Central Texas Regional Water Plan (SCTRWPG 2010). The SCTRWPG 2010 presents costs in September 2008 dollars.

2 Costs adjusted to March 2013 dollars using Engineering News Record Construction Cost Index.

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Appendix F - Detailed Cost Estimates

Colorado River Surface Water Option

Description: Conventional Water Treatment Plant built west of Bob Bryant Park

Water Volume

	Peak Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	0	11,202	11,202	22,404	22,404	29,126
Delivery (1,000 gal/year)	0	0	3,650,000	3,650,000	7,300,000	7,300,000	9,490,000
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply (MGD)	0.0	5.0	5.0	5.0	5.0	5.0	5.0
Proposed Surface Water (MGD)	0	0	10	10	20	20	26
Total Supply (MGD)	4	8	18	16	26	26	32
Delivery from WTP (gpm)	**0.0**	**0.0**	**6,944.4**	**6,944.4**	**13,888.9**	**13,888.9**	**18,055.6**
Delivery from WTP (cfs)	0	0	15	15	31	31	40
Avg Delivery WTP (ac-ft/yr)	0	0	4,978	4,978	9,956	9,956	12,942

Capital Costs

Raw Water Facilities	Quantity	Unit	Unit Cost	Total Cost
Intake	1	LS	$ 1,143,735 /EA	$ 1,144,000
Raw Water Pump Station to Water Treatment Plant				
Pump Station	190	hp	$ 2,287,470 EA	$ 2,287,000
Electrical Hookup	190	hp	$ 150 hp	$ 50,000
Raw Water Pipeline to Water Treatment Plant	834	LF	$ 197 LF	$ 164,000
Total Raw Water Facilities				$ 3,645,000

Water Treatment Plant	Quantity	Unit	Unit Cost	Total Cost
Water Treatment Plant Ph. 1 - 10 MGD	1	LS	$ 30,390,000	$ 30,390,000
Water Treatment Plant Ph. 2 - 10 MGD	1	LS	$ 30,390,000	$ 30,390,000
Water Treatment Plant Ph. 3 - 5 MGD	1	LS	$ 18,234,000	$ 18,234,000
Total Water Treatment Plant Facilities				$ 79,014,000

Treated Water Pipeline Facilities	Quantity	Unit	Unit Cost	Total Cost
Inside diameter of pipe	36	in	- -	-
Length of RURAL pipe		feet	$ 197 /LF	$ -
Length of Urban pipe	2,951	feet	$ 302 /LF	$ 890,000
Length of Tunneling	-	feet	$ 25 /inch diameter/ft	$ -
Total Pipe	2,951	feet		
Total Pipeline Facilities				$ 890,000

Disinfection Modifications	Quantity	Unit	Unit Cost	Total Cost
Modify existing wells to use chloramines	1	LS	125000	$ 125,000

Total Capital	**$ 83,674,000**

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Colorado River Surface Water Option
Description: Conventional Water Treatment Plant built west of Bob Bryant Park

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 83,674,000	$ 12,551,000
Legal Costs	5	%	$ 83,674,000	$ 4,184,000
Contingency	30	%	$ 83,674,000	$ 25,102,000
Total Engineering Costs				$ 41,837,000
Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Raw Water Pipeline	0.77	ac	$ 9,627 /ac	$ 7,000
Easement Acquisition Cost - Treated Water Pipeline	3	ac	$ 9,627 /ac	$ 26,000
Land Acquisition Cost - Water Treatment Plant	25	ac	$ 9,627 /ac	$ 241,000
Land Acquisition Cost - Intake & Pump Station	5	ac	$ 9,627 /ac	$ 48,000
Surveying and Legal	10	% of land costs	$ 322,000	$ 32,200
Total Land and Easement Costs				$ 354,200
Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	3,785	LF	$ 5.23 /LF	$ 20,000
Total Environmental Costs				$ 70,000
Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	83,674,000.0	$ 14,867,000
Return on Investment	1.5	YR	41,837,000.0	$ (1,673,000)
Total Interest Accrued Less Earned During Construction				$ 13,194,000
Total Other Project Costs				**$ 55,455,200**

Colorado River Surface Water Option

Description: Conventional Water Treatment Plant built west of Bob Bryant Park

Annual Project Costs

Ph. 1 (use 2020 as Avg Yr)	Average 4,978	Peak	11,202			
	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 90,505,200		$ 6,575,000
Operation and Maintenance - Pipeline	1	%	$ 1,054,000		$ 11,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	1,621,903.36	1000 gal treated	$ 2.906	/1000 gal treated	$ 4,713,000
Pumping Energy Costs - Raw Water PS	1,349,611.30	kWh	$ 0.10	/kWh	$ 135,000
Water Costs (LCRA Firm Water Rates)	4,978	ac-ft	$ 151.00	ac-ft	$ 752,000
Water Costs (LCRA Reservation Water Rates)	6,224	ac-ft	$ 75.50	ac-ft	$ 470,000
Total Annual Costs for Phase 1					**$ 12,743,000**

Annual Project Costs

Ph. 2 (use 2030 as Avg Yr)	Average 9,956	Peak	22,404		
	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 120,895,200		$ 8,783,000
Operation and Maintenance - Pipeline	1	%	$ 1,054,000		$ 11,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	3,243,806.72	1000 gal treated	$ 2.906	/1000 gal treated	$ 9,427,000
Pumping Energy Costs - Raw Water PS	1,349,611.30	kWh	$ 0.10	/kWh	$ 135,000
Water Costs (LCRA Firm Water Rates)	9,956	ac-ft	$ 151.00	ac-ft	$ 1,503,000
Water Costs (LCRA Reservation Water Rates)	12,449	ac-ft	$ 75.50	ac-ft	$ 940,000
Total Annual Costs for Phase 2					**$ 20,886,000**

Annual Project Costs

Ph. 3 (use 2040 as Avg Yr)	Average 12,942	Peak	29,126		
	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 139,129,200		$ 10,108,000
Operation and Maintenance - Pipeline	1	%	$ 1,054,000		$ 11,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	4,216,948.74	1000 gal treated	$ 2.906	/1000 gal treated	$ 12,254,000
Pumping Energy Costs - Raw Water PS	1,349,611.30	kWh	$ 0.10	/kWh	$ 135,000
Water Costs (LCRA Firm Water Rates)	12,942	ac-ft	$ 151.00	ac-ft	$ 1,954,000
Water Costs (LCRA Reservation Water Rates)	16,184	ac-ft	$ 75.50	ac-ft	$ 1,222,000
Total Annual Costs for Phase 3					**$ 25,771,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
Colorado River WTP Phase 1	$7.86	/1,000 gal	$2,559.98	/ac-ft	$ 12,743,000	1,621,903	4,978
Colorado River WTP Phase 2	$6.44	/1,000 gal	$2,097.92	/ac-ft	$ 20,886,000	3,243,807	9,956
Colorado River WTP Phase 3	$6.11	/1,000 gal	$1,991.23	/ac-ft	$ 25,771,000	4,216,949	12,942

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Lake Bastrop Surface Water Option

Description: Conventional Water Treatment Plant built on the south shore of Lake Bastrop

Water Volume

	Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	0	11,202	11,202	22,404	22,404	29,126
Delivery (1,000 gal/year)	0	0	3,650,000	3,650,000	7,300,000	7,300,000	9,490,000
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply (MGD)	0.0	5.0	5.0	5.0	5.0	5.0	5.0
Proposed Surface Water (MGD)	0	0	10	10	20	20	26
Total Supply (MGD)	4	8	18	16	26	26	32
Delivery from WTP (gpm)	**0.0**	**0.0**	**6,944.4**	**6,944.4**	**13,888.9**	**13,888.9**	**18,055.6**
Delivery from WTP (cfs)	0	0	15	15	31	31	40
Avg Delivery WTP (ac-ft/yr)	0	0	4,978	4,978	9,956	9,956	12,942

Capital Costs

Raw Water Facilities	Quantity	Unit		Unit Cost		Total Cost
Intake	1	LS	$	1,143,735	/EA	$ 1,144,000
Raw Water Pump Station to Water Treatment Plant						
Pump Station	210	hp	$	2,287,470	EA	$ 2,287,000
Electrical Hookup	210	hp	$	150	hp	$ 50,000
Raw Water Pipeline to Water Treatment Plant	241	LF	$	197	LF	$ 47,000
Total Raw Water Facilities						$ 3,528,000
Water Treatment Plant	Quantity	Unit		Unit Cost		Total Cost
Water Treatment Plant Ph. 1 - 10 MGD	1	LS	$	30,390,000		$ 30,390,000
Water Treatment Plant Ph. 2 - 10 MGD	1	LS	$	30,390,000		$ 30,390,000
Water Treatment Plant Ph. 3 - 5 MGD	1	LS	$	18,234,000		$ 18,234,000
Total Water Treatment Plant Facilities						$ 79,014,000
Treated Water Pipeline Facilities	Quantity	Unit		Unit Cost		Total Cost
Inside diameter of pipe	36	in		-	-	-
Length of RURAL pipe	6,854	feet	$	197	/LF	$ 1,348,000
Length of Urban pipe	6,448	feet	$	302	/LF	$ 1,945,000
Length of Tunneling	249	feet	$	25	/inch diameter/ft	$ 228,000
Total Pipe	13,551	feet				
Total Pipeline Facilities						$ 3,521,000
Disinfection Modifications	Quantity	Unit		Unit Cost		Total Cost
Modify existing wells to use chloramines	1	LS		125000		$ 125,000
Total Capital						**$ 86,188,000**

Lake Bastrop Surface Water Option

Description: Conventional Water Treatment Plant built on the south shore of Lake Bastrop

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 86,188,000	$ 12,928,000
Legal Costs	5	%	$ 86,188,000	$ 4,309,000
Contingency	30	%	$ 86,188,000	$ 25,856,000
Total Engineering Costs				$ 43,093,000

Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Raw Water Pipeline	0.22	ac	$ 9,627 /ac	$ 2,000
Easement Acquisition Cost - Treated Water Pipeline	12	ac	$ 9,627 /ac	$ 120,000
Land Acquisition Cost - Water Treatment Plant	25	ac	$ 9,627 /ac	$ 241,000
Land Acquisition Cost - Intake & Pump Station	5	ac	$ 9,627 /ac	$ 48,000
Surveying and Legal	10	% of land costs	$ 411,000	$ 41,100
Total Land and Easement Costs				$ 452,100

Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	13,792	LF	$ 5.23 /LF	$ 72,000
Total Environmental Costs				$ 122,000

Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	86,188,000.0	$ 15,314,000
Return on Investment	1.5	YR	43,094,000.0	$ (1,724,000)
Total Interest Accrued Less Earned During Construction				$ 13,590,000
Total Other Project Costs				**$ 57,257,100**

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Lake Bastrop Surface Water Option

Description: Conventional Water Treatment Plant built on the south shore of Lake Bastrop

Annual Project Costs

Phase 1 (use 2020 as Avg Yr) Average 4,978 Peak 11,202

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 94,821,100		$ 6,889,000
Operation and Maintenance - Pipeline	1	%	$ 3,568,000		$ 36,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	1,621,903.36	1000 gal treated	$ 2.906	/1000 gal treated	$ 4,713,000
Pumping Energy Costs - Raw Water PS	1,491,675.65	kWh	$ 0.10	/kWh	$ 149,000
Water Costs (LCRA Firm Water Rates)	4,978	ac-ft	$ 151.00	ac-ft	$ 752,000
Water Costs (LCRA Reservation Water Rates)	6,224	ac-ft	$ 75.50	ac-ft	$ 470,000
Total Annual Costs for Phase 1					**$ 13,096,000**

Annual Project Costs

Phase 2 (use 2030 as Avg Yr) Average 9,956 Peak 22,404

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 125,211,100		$ 9,096,000
Operation and Maintenance - Pipeline	1	%	$ 3,568,000		$ 36,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	3,243,806.72	1000 gal treated	$ 2.906	/1000 gal treated	$ 9,427,000
Pumping Energy Costs - Raw Water PS	1,491,675.65	kWh	$ 0.10	/kWh	$ 149,000
Water Costs (LCRA Firm Water Rates)	9,956	ac-ft	$ 151.00	ac-ft	$ 1,503,000
Water Costs (LCRA Reservation Water Rates)	12,449	ac-ft	$ 75.50	ac-ft	$ 940,000
Total Annual Costs for Phase 2					**$ 21,238,000**

Annual Project Costs

Phase 3 (use 2040 as Avg Yr) Average 12,942 Peak 29,126

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 143,445,100		$ 10,421,000
Operation and Maintenance - Pipeline	1	%	$ 3,568,000		$ 36,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	4,216,948.74	1000 gal treated	$ 2.906	/1000 gal treated	$ 12,254,000
Pumping Energy Costs - Raw Water PS	1,491,675.65	kWh	$ 0.10	/kWh	$ 149,000
Water Costs (LCRA Firm Water Rates)	12,942	ac-ft	$ 151.00	ac-ft	$ 1,954,000
Water Costs (LCRA Reservation Water Rates)	16,184	ac-ft	$ 75.50	ac-ft	$ 1,222,000
Total Annual Costs for Phase 3					**$ 26,123,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
Lake Bastrop WTP Phase 1	$8.07	/1,000 gal	$2,630.89	/ac-ft	$ 13,096,000	1,621,903	4,978
Lake Bastrop WTP Phase 2	$6.55	/1,000 gal	$2,133.28	/ac-ft	$ 21,238,000	3,243,807	9,956
Lake Bastrop WTP Phase 3	$6.19	/1,000 gal	$2,018.43	/ac-ft	$ 26,123,000	4,216,949	12,942

ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (2 phases of 10 MGD each) west of Bob Br

Water Volume

	Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	0	12,815	15,504	27,244	27,244	27,244
Delivery (1,000 gal/year)	0	0	4,175,600	5,051,600	8,876,800	8,876,800	8,876,800
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply (MGD)		5.0	5.0	5.0	5.0	5.0	5.0
Proposed ASR (MGD)	0	0	1	4	4	4	4
Proposed WTP (MGD)			10	10	20	20	20
Total Supply (MGD)	4	8	19	20	30	30	30
Delivery from WTP-ASR (gpm)	**0.0**	**0.0**	**7,944.4**	**9,611.1**	**16,888.9**	**16,888.9**	**16,888.9**
Delivery from WTP-ASR (cfs)	0	0	18	21	38	38	38
Avg Delivery ASR (ac-ft/yr)	0	0	5,695	6,889	12,106	12,106	12,106

Capital Costs

	Quantity	Unit	Unit Cost	Total Cost
Raw Water Facilities				
Intake		1 LS	$ 1,143,735 /EA	$ 1,144,000
Raw Water Pump Station to Water Treatment Plant				
Pump Station		270 hp	$ 2,287,470 EA	$ 2,287,000
Electrical Hookup		270 hp	$ 150 hp	$ 50,000
Raw Water Pipeline to Water Treatment Plant		834 LF	$ 148 LF	$ 123,000
Total Raw Water Facilities				$ 3,604,000
Water Treatment Plant	Quantity	Unit	Unit Cost	Total Cost
Water Treatment Plant Ph. 1 - 10 MGD		1 LS	$ 30,390,000	$ 30,390,000
Water Treatment Plant Ph. 2 - 10 MGD		1 LS	$ 30,390,000	$ 30,390,000
Total Water Treatment Plant Facilities				$ 60,780,000
Treated Water Pipeline Facilities	Quantity	Unit	Unit Cost	Total Cost
Inside diameter of pipe		36 in	- -	-
Length of RURAL pipe		feet	$ 197 /LF	$ -
Length of Urban pipe		2,951 feet	$ 302 /LF	$ 890,000
Length of Tunneling		- feet	$ 25 /inch diameter/ft	$ -
Total Pipe		2,951 feet		
Total Pipeline Facilities				$ 890,000
Well Facilities	Quantity	Unit	Unit Cost	Total Cost
Well Field Materials - 3 wells		1 LS	$ 1,741,698	$ 1,742,000
Disinfection Modifications	Quantity	Unit	Unit Cost	Total Cost
Modify existing wells to use chloramines		1 LS	125000	$ 125,000
Total Capital				**$ 67,141,000**

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ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (2 phases of 10 MGD each) west of Bob Br

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 67,141,000	$ 10,071,000
Legal Costs	5	%	$ 67,141,000	$ 3,357,000
Contingency	30	%	$ 67,141,000	$ 20,142,000
Total Engineering Costs				$ 33,570,000

Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Raw Water Pipeline	0.77	ac	$ 9,627 /ac	$ 7,000
Easement Acquisition Cost - Treated Water Pipeline	3	ac	$ 9,627 /ac	$ 26,000
Land Acquisition Cost - Water Treatment Plant	15	ac	$ 9,627 /ac	$ 144,000
Land Acquisition Cost - Intake & Pump Station	5	ac	$ 9,627 /ac	$ 48,000
Land Acquisition Cost - ASR Wells	2	ac	$ 9,627 /ac	$ 14,000
Surveying and Legal	10	% of land costs	$ 225,000	$ 22,500
Total Land and Easement Costs				$ 261,500

Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	3,785	LF	$ 5.23 /LF	$ 20,000
Total Environmental Costs				$ 70,000

Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	67,141,000.0	$ 11,929,000
Return on Investment	1.5	YR	33,570,500.0	$ (1,343,000)
Total Interest Accrued Less Earned During Construction				$ 10,586,000

Total Other Project Costs				**$ 44,487,500**

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ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (2 phases of 10 MGD each) west of Bob Br

Annual Project Costs

Ph. 1 (use 2025 as Avg Yr) Average 6,889 Peak 15,504	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 81,238,500		$ 5,902,000
Operation and Maintenance - Pipeline	1	%	$ 1,013,000		$ 10,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	1,622,222.22	1000 gal treated	$ 2.906	/1000 gal treated	$ 4,714,000
Operation and Maintenance - Wells	1	annually	$ 9,434		$ 9,000
Pumping Energy Costs - Raw Water PS	1,917,868.70	kWh	$ 0.10	/kWh	$ 192,000
Power Costs for Wells	1	annually	$ 17,899		$ 18,000
Water Costs (LCRA Firm Water Rates)	4,979	ac-ft	$ 151.00	ac-ft	$ 752,000
Water Costs (LCRA Reservation Water Rates)	11,202	ac-ft	$ 75.50	ac-ft	$ 846,000
Total Annual Costs for Phase 1					**$ 12,530,000**

Annual Project Costs

Ph. 2 (use 2040 as Avg Yr) Average 12,106 Peak 27,244	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 111,628,500		$ 8,110,000
Operation and Maintenance - Pipeline	1	%	$ 123,000		$ 1,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	3,244,444.44	1000 gal treated	$ 2.906	/1000 gal treated	$ 9,428,000
Operation and Maintenance - Wells	1	annually	$ 9,434		$ 9,000
Pumping Energy Costs - Raw Water PS	1,917,868.70	kWh	$ 0.10	/kWh	$ 192,000
Power Costs for Wells	1	annually	$ 17,899		$ 18,000
Water Costs (LCRA Firm Water Rates)	9,958	ac-ft	$ 151.00	ac-ft	$ 1,504,000
Water Costs (LCRA Reservation Water Rates)	22,404	ac-ft	$ 75.50	ac-ft	$ 1,692,000
Total Annual Costs for Phase 2					**$ 21,041,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
ASR Phase 1	$5.58	/1,000 gal	$1,818.78	/ac-ft	$ 12,530,000	2,244,714	6,889
ASR Phase 2	$5.33	/1,000 gal	$1,738.07	/ac-ft	$ 21,041,000	3,944,469	12,106

Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 7 wells, Phase 2 of 13 wells) northeast of Bastrop

Water Volume

	Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	11,292	11,292	32,262	32,262	32,262	32,262
Delivery (1,000 gal/year)	0	3,679,200	3,679,200	10,512,000	10,512,000	10,512,000	10,512,000
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Proposed Phase 1 Wells (gpm)		7,000	7,000	7,000	7,000	7,000	7,000
Proposed Phase 2 Wells (gpm)				13,000	13,000	13,000	13,000
Total Supply (MGD)	**4.3**	**12.8**	**12.8**	**30.0**	**30.0**	**30.0**	**30.0**
Delivery Simsboro Wells (gpm)	0	7,000	7,000	20,000	20,000	20,000	20,000
Delivery Simsboro Wells (cfs)	0	16	16	45	45	45	45
Avg Del Simsboro (ac-ft/yr)	0	5,019	5,019	14,339	14,339	14,339	14,339

Capital Costs

Phase 1 Facilities	Pipe Size (in)	Quantity	Unit		Unit Cost			Total Cost
Well Field Facilities - 7 wells		1	LS	$	4,515,208		$	4,515,000
Well Field Piping	8	17500	feet	$	63		$	1,102,000
Electrical Hookup Wells		2000	hp	$	150	/hp	$	300,000
Treatment Facilities		7	well	$	640,612	/well	$	4,484,000
Water Storage Tank		1	MG	$	858,747	/EA	$	859,000
Pump Station		1200	hp	$	4,740,698	/EA	$	4,741,000
Electrical Hookup Pump Station		1200	hp	$	150	/hp	$	180,000
Treated Water pipe	36	7,500	feet	$	302	/LF	$	2,263,000
Length of Tunneling	36	-	feet	$	25	/inch diameter/ft	$	-
Total Phase 1 Facilities							$	18,444,000

Phase 2 Facilities	Pipe Size (in)	Quantity	Unit		Unit Cost			Total Cost
Well Field Facilities - 13 wells		1	LS	$	10,003,591		$	10,004,000
Well Field Piping	8	32500	feet	$	63		$	2,047,000
Electrical Hookup Wells		3700	hp	$	150	/hp	$	555,000
Treatment Facilities		13	well	$	640,612	/well	$	8,328,000
Water Storage Tank		2	MG	$	1,450,986	/EA	$	1,451,000
Pump Station		2400	hp	$	6,895,561	/EA	$	6,896,000
Electrical Hookup Pump Station		2400	hp	$	150	/hp	$	360,000
Treated Water pipe	30	20,300	feet	$	224	/LF	$	4,554,000
Length of Tunneling	30	-	feet	$	25	/inch diameter/ft	$	-
Total Phase 2 Facilities							$	34,195,000
	Total Pipe	77,800	feet					
Total Capital							**$**	**52,639,000**

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Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 7 wells, Phase 2 of 13 wells) northeast of Bastrop

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 52,639,000	$ 7,896,000
Legal Costs	5	%	$ 52,639,000	$ 2,632,000
Contingency	30	%	$ 52,639,000	$ 15,792,000
Total Engineering Costs				$ 26,320,000
Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Treated Water Pipeline	71	ac	$ 9,627 /ac	$ 688,000
Land Acquisition Cost - Well Field Phase 1	4	ac	$ 9,627 /ac	$ 34,000
Land Acquisition Cost - Well Field Phase 2	7	ac	$ 9,627 /ac	$ 67,000
Surveying and Legal	10	% of land costs	$ 722,000	$ 72,200
Total Land and Easement Costs				$ 861,200
Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	77,800	LF	$ 5.23 /LF	$ 407,000
Total Environmental Costs				$ 457,000
Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	52,639,000.0	$ 9,353,000
Return on Investment	1.5	YR	26,319,500.0	$ (1,053,000)
Total Interest Accrued Less Earned During Construction				$ 8,300,000
Total Other Project Costs				**$ 35,938,200**

Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 7 wells, Phase 2 of 13 wells) northeast of Bastrop

Annual Project Costs

Ph. 1 Project Delivery 11,292

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 54,382,200		$ 3,951,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 9,966,000		$ 100,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 12,177,000		$ 304,000
Operation and Maintenance - Wells	1	annually	$ 51,270		$ 51,000
Power Cost for Wells	1	annually	$ 42,359		$ 42,000
Water Costs (LPGCD Production Fee)	11,292	ac-ft	$ 9.80	ac-ft	$ 111,000
Total Annual Costs for Phase 1					**$ 4,559,000**

Annual Project Costs

Ph. 2 Project Delivery 32,262

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 88,577,200		$ 6,435,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 9,966,000		$ 100,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 12,177,000		$ 304,000
Operation and Maintenance - Wells	1	annually	$ 195,180		$ 195,000
Power Cost for Wells	1	annually	$ 692,072		$ 692,000
Water Costs (LPGCD Production Fee)	32,262	ac-ft	$ 9.80	ac-ft	$ 316,000
Total Annual Costs for Phase 2					**$ 8,042,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
Simsboro Phase 1	$2.79	/1,000 gal	$908.42	/ac-ft	$ 4,559,000	1,635,200	5,019
Simsboro Phase 2	$1.72	/1,000 gal	$560.86	/ac-ft	$ 8,042,000	4,672,000	14,339

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Third Party - Jason Allen Groundwater Option

Description: A single Simsboro well located on Mr. Allen's property approximaltey 1.2 miles north east of the Loop 150 Tank Yard.

Water Volume

	Total Supply						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	2,904	2,904	2,904	2,904	2,904	2,904
Delivery (1,000 gal/year)	0	946,080	946,080	946,080	946,080	946,080	946,080
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Proposed Phase 1 Well (gpm)		1,800	1,800	1,800	1,800	1,800	1,800
Total Supply (MGD)	**4.3**	**5.3**	**5.3**	**3.7**	**3.7**	**3.7**	**3.7**
Delivery Simsboro Wells (gpm)	0	1,800	1,800	1,800	1,800	1,800	1,800
Delivery Simsboro Wells (cfs)	0	4	4	4	4	4	4
Avg Del Simsboro (ac-ft/yr)	0	1,290	1,290	1,290	1,290	1,290	1,290

Capital Costs

Phase 1 Facilities

	Pipe Size (in)	Quantity	Unit	Unit Cost		Total Cost
Well Facilities - 1 well		1	EA	$ 725,940		$ 726,000
Well Field Piping	8	250	feet	$ 63		$ 16,000
Electrical Hookup Wells		550	hp	$ 150	/hp	$ 83,000
Treatment Facilities		1	well	$ 1,153,102	/well	$ 1,153,000
Pump Station		41.84	hp	$ 2,287,470	/EA	$ -
Electrical Hookup Pump Station		42	hp	$ 150	/hp	$ 50,000
Treated Water pipe	12	6,200	feet	$ 106	/LF	$ 658,000
Length of Tunneling	12	150	feet	$ 25	/inch diameter/ft	$ 46,000
Total Phase 1 Facilities						$ 2,732,000
	Total Pipe	6,600	feet			
Total Capital						**$ 2,732,000**

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Third Party - Jason Allen Groundwater Option

Description: A single Simsboro well located on Mr. Allen's property approximaltey 1.2 miles north east of the Loop 150 Tank Yard.

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 2,732,000	$ 410,000
Legal Costs	5	%	$ 2,732,000	$ 137,000
Contingency	30	%	$ 2,732,000	$ 820,000
Total Engineering Costs				$ 1,367,000

Land and Easements

	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Treated Water Pipeline	6	ac	$ 9,627 /ac	$ 58,000
Land Acquisition Cost - Well	1	ac	$ 9,627 /ac	$ 5,000
Surveying and Legal	10	% of land costs	$ 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	6,600	LF	$ 5.23 /LF	$ 35,000
Total Environmental Costs				$ 35,000

Interest During Construction

	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	2,732,000.0	$ 485,000
Return on Investment	1.5	YR	1,366,000.0	$ (55,000)
Total Interest Accrued Less Earned During Construction				$ 430,000

Total Other Project Costs	**$ 1,901,300**

Third Party - Jason Allen Groundwater Option

Description: A single Simsboro well located on Mr. Allen's property approximaltey 1.2 miles north east of the Loop 150 Tank Yard.

Annual Project Costs

Pipeline Facilities

	Quantity	Unit		Unit Cost			Total Cost
Debt Service	30	YR	$	4,633,300		$	337,000
Operation and Maintenance - Pipeline & System Facilities	1	%	$	2,732,000		$	27,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$	-		$	-
Operation and Maintenance - Treatment Facilities	7	well	$	110,363	/EA	$	773,000
Water Costs (LPGCD Production Fee)	2,904	ac-ft	$	9.80	ac-ft	$	28,455
Water Costs (Jason Allen Contract Rate)	946,080	1,000 gal/year	$	2.00	#REF!	$	1,892,000
Total Annual Costs						**$**	**3,057,455**

Third Party - Boy Scouts of America (BSA) Groundwater Option

Description: A group of Simsboro wells located within the Griffith League Boy Scout Ranch.

Water Volume

	Total Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	7,743	11,614	11,614	11,614	11,614	11,614
Delivery (1,000 gal/year)	0	2,522,880	3,784,320	3,784,320	3,784,320	3,784,320	3,784,320
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Proposed Phase 1 Well (gpm)	0	4,800	4,800	4,800	4,800	4,800	4,800
Proposed Phase 2 Well (gpm)	0	0	2,400	2,400	2,400	2,400	2,400
Total Supply (MGD)	**4.3**	**9.7**	**13.1**	**11.5**	**11.5**	**11.5**	**11.5**
Delivery Simsboro Wells (gpm)	0	4,800	7,200	7,200	7,200	7,200	7,200
Delivery Simsboro Wells (cfs)	0	11	16	16	16	16	16
Avg Del Simsboro (ac-ft/yr)	0	3,441	5,162	5,162	5,162	5,162	5,162

Capital Costs

Phase 1 Facilities

	Pipe Size (in)	Quantity	Unit	Unit Cost		Total Cost
Well Facilities		4	EA	$ 1,098,892		$ 4,396,000
Well Field Piping	10	20000	feet	$ 63		$ 1,260,000
Electrical Hookup Wells		2000	hp	$ 150	/hp	$ 300,000
Water Storage Tank		0.7	MG	$ 503,404	/EA	$ 503,000
Pump Station		98	hp	$ 2,287,470	/EA	$ 2,287,000
Electrical Hookup Pump Station		98	hp	$ 150	/hp	$ 50,000
Treated Water pipe	24	36,577	feet	$ 179	/LF	$ 6,548,000
Length of Tunneling	24	150	feet	$ 25	/inch diameter/ft	$ 91,000
Total Phase 1 Facilities						$ 15,435,000

Phase 2 Facilities

	Pipe Size (in)	Quantity	Unit	Unit Cost		Total Cost
Well Field Facilities		2	LS	$ 1,098,892		$ 2,198,000
Well Field Piping	8	10000	feet	$ 63		$ 630,000
Electrical Hookup Wells		700	hp	$ 150	/hp	$ 105,000
Water Storage Tank		0.4	MG	$ 148,060	/EA	$ 148,000
Pump Station		-	hp	$ -	/EA	$ -
Electrical Hookup Pump Station		-	hp	$ 150	/hp	$ -
Treated Water pipe		-	feet	$ -	/LF	$ -
Length of Tunneling		-	feet	$ 25	/inch diameter/ft	$ -
Total Phase 2 Facilities						$ 3,081,000
	Total Pipe	66,727	feet			
Total Capital						**$ 18,516,000**

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Third Party - Boy Scouts of America (BSA) Groundwater Option

Description: A group of Simsboro wells located within the Griffith League Boy Scout Ranch.

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 18,516,000	$ 2,777,000
Legal Costs	5	%	$ 18,516,000	$ 926,000
Contingency	30	%	$ 18,516,000	$ 5,555,000
Total Engineering Costs				$ 9,258,000

Land and Easements

	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Treated Water Pipeline	61	ac	$ 9,627 /ac	$ 590,000
Land Acquisition Cost - Well	3	ac	$ 9,627 /ac	$ 29,000
Surveying and Legal	10	% of land costs	$ 619,000	$ 61,900
Total Land and Easement Costs				$ 680,900

Environmental Studies and Mitigation

	Quantity	Unit	Unit Cost	Total Cost
Environmental and Mitigation - Pipelines	66,727	LF	$ 5.23 /LF	$ 349,000
Total Environmental Costs				$ 349,000

Interest During Construction

	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	18,516,000.0	$ 3,290,000
Return on Investment	1.5	YR	9,258,000.0	$ (370,000)
Total Interest Accrued Less Earned During Construction				$ 2,920,000
Total Other Project Costs				**$ 13,207,900**

Third Party - Boy Scouts of America (BSA) Groundwater Option

Description: A group of Simsboro wells located within the Griffith League Boy Scout Ranch.

Annual Project Costs

Ph. 1 Project Delivery 7,743

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 28,642,900		$ 2,081,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 7,899,000		$ 79,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000		$ 58,000
Operation and Maintenance - Wells	4	EA	$ 13,500		$ 54,000
Power Cost for Wells	4	EA	$ 34,306		$ 137,000
Water Costs (LPGCD Production Fee)	7,743	ac-ft	$ 9.80	ac-ft	$ 76,000
Water Costs (Assumed BSA Contract Rate)	7,743	ac-ft	$ 141.20	ac-ft	$ 1,093,306
Water Costs (Assumed BSA Annual Payment)	1	annually	$ 145,000	EA	$ 145,000
Total Annual Costs for Phase 1					**$ 2,485,000**

Annual Project Costs

Ph. 2 Project Delivery 11,614

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 31,723,900		$ 2,305,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 630,000		$ 6,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000		$ 58,000
Operation and Maintenance - Wells	6	EA	$ 13,500		$ 81,000
Power Cost for Wells	6	EA	$ 34,306		$ 206,000
Water Costs (LPGCD Production Fee)	11,614	ac-ft	$ 9.80	ac-ft	$ 114,000
Water Costs (Assumed BSA Contract Rate)	11,614	ac-ft	$ 141.20	ac-ft	$ 1,639,959
Water Costs (Assumed BSA Annual Payment)	1	annually	$ 600,000	EA	$ 600,000
Total Annual Costs for Phase 2					**$ 2,770,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
BSA Phase 1	$2.22	/1,000 gal	$722.11	/ac-ft	$ 2,485,000	1,121,280	3,441
BSA Phase 2	$1.65	/1,000 gal	$536.62	/ac-ft	$ 2,770,000	1,681,920	5,162

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Third Party - XS Ranch Groundwater Option

Description: A group of Simsboro wells located within the XS Ranch desired development area.

Water Volume

	Total Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	3,226	8,066	8,066	8,066	8,066	8,066
Delivery (1,000 gal/year)	0	1,051,200	2,628,000	2,628,000	2,628,000	2,628,000	2,628,000
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Proposed Phase 1 Wells (gpm)	0	2,000	2,000	2,000	2,000	2,000	2,000
Proposed Phase 2 Wells (gpm)	0	0	3,000	3,000	3,000	3,000	3,000
Total Supply (MGD)	**4.3**	**5.6**	**9.9**	**8.4**	**8.4**	**8.4**	**8.4**
Delivery Simsboro Wells (gpm)	0	2,000	5,000	5,000	5,000	5,000	5,000
Delivery Simsboro Wells (cfs)	0	4	11	11	11	11	11
Avg Del Simsboro (ac-ft/yr)	0	1,434	3,585	3,585	3,585	3,585	3,585

Capital Costs

Phase 1 Facilities

	Pipe Size (in)	Quantity	Unit		Unit Cost		Total Cost	
Well Facilities		2	EA	$	725,940		$	1,452,000
Well Field Piping	8	5000	feet	$	63		$	315,000
Electrical Hookup Wells		2000	hp	$	150	/hp	$	300,000
Water Storage Tank		0.25	MG	$	148,060	/EA	$	148,000
Pump Station		74	hp	$	2,287,470	/EA	$	2,287,000
Electrical Hookup Pump Station		74	hp	$	150	/hp	$	50,000
Treated Water pipe	18	10,800	feet	$	148	/LF	$	1,599,000
Length of Tunneling	18	200	feet	$	25	/inch diameter/ft	$	91,000
Total Phase 1 Facilities							$	6,242,000

Phase 2 Facilities

	Pipe Size (in)	Quantity	Unit		Unit Cost		Total Cost	
Well Field Facilities		3	LS	$	725,940		$	2,178,000
Well Field Piping	8	7500	feet	$	63		$	472,000
Electrical Hookup Wells		700	hp	$	150	/hp	$	105,000
Water Storage Tank		0.25	MG	$	148,060	/EA	$	148,000
Pump Station		-	hp	$	-	/EA	$	-
Electrical Hookup Pump Station		-	hp	$	150	/hp	$	-
Treated Water pipe		-	feet	$	-	/LF	$	-
Length of Tunneling		-	feet	$	25	/inch diameter/ft	$	-
Total Phase 2 Facilities							$	2,903,000
	Total Pipe	23,500	feet					
Total Capital							**$**	**9,145,000**

Third Party - XS Ranch Groundwater Option

Description: A group of Simsboro wells located within the XS Ranch desired development area.

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 9,145,000	$ 1,372,000
Legal Costs	5	%	$ 9,145,000	$ 457,000
Contingency	30	%	$ 9,145,000	$ 2,744,000
Total Engineering Costs				$ 4,573,000

Land and Easements

	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Treated Water Pipeline	22	ac	$ 9,627 /ac	$ 208,000
Land Acquisition Cost - Well	1	ac	$ 9,627 /ac	$ 10,000
Surveying and Legal	10	% of land costs	$ 218,000	$ 21,800
Total Land and Easement Costs				$ 239,800

Environmental Studies and Mitigation

	Quantity	Unit	Unit Cost	Total Cost
Environmental and Mitigation - Pipelines	23,500	LF	$ 5.23 /LF	$ 123,000
Total Environmental Costs				$ 123,000

Interest During Construction

	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	9,145,000.0	$ 1,625,000
Return on Investment	1.5	YR	4,572,500.0	$ (183,000)
Total Interest Accrued Less Earned During Construction				$ 1,442,000

Total Other Project Costs $ **6,377,800**

Third Party - XS Ranch Groundwater Option

Description: A group of Simsboro wells located within the XS Ranch desired development area.

Annual Project Costs

Ph. 1 Project Delivery 3,226

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 12,619,800		$ 917,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 2,005,000		$ 20,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000		$ 58,000
Operation and Maintenance - Wells	2	EA	$ 13,500		$ 27,000
Power Cost for Wells	2	EA	$ 34,306		$ 69,000
Water Costs (LPGCD Production Fee)	3,226	ac-ft	$ 9.80	ac-ft	$ 32,000
Water Costs (Assumed Contract Rate)	3,226	ac-ft	$ 977.49	ac-ft	$ 3,153,600
Total Annual Costs for Phase 1					**$ 1,123,000**

Annual Project Costs

Ph. 2 Project Delivery 8,066

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 15,522,800		$ 1,128,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 472,000		$ 5,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000		$ 58,000
Operation and Maintenance - Wells	5	EA	$ 13,500		$ 68,000
Power Cost for Wells	5	EA	$ 34,306		$ 172,000
Water Costs (LPGCD Production Fee)	8,066	ac-ft	$ 9.80	ac-ft	$ 79,000
Water Costs (Assumed BSA Contract Rate)	8,066	ac-ft	$ 977.49	ac-ft	$ 7,884,000
Total Annual Costs for Phase 2					**$ 1,510,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply (1000 gal/year)	Annual Average Supply (acre-ft/year)
XS Phase 1	$2.40	/1,000 gal	$783.19	/ac-ft	$ 1,123,000	467,200	1,434
XS Phase 2	$1.29	/1,000 gal	$421.23	/ac-ft	$ 1,510,000	1,168,000	3,585

Appendix G - Detailed Cost Estimates – City Limits

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Colorado River Surface Water Option

Description: Conventional Water Treatment Plant (Single 5 MGD Phase)

Water Volume

	Peak Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	0	5,601	5,601	5,601	5,601	5,601
Delivery (1,000 gal/year)	0	0	1,825,000	1,825,000	1,825,000	1,825,000	1,825,000
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply (MGD)	0.0	0.5	0.5	0.5	0.5	0.5	0.5
Proposed Surface Water (MGD)	0	0	5	5	5	5	5
Total Supply (MGD)	4	3	8	7	7	7	7
Delivery from WTP (gpm)	**0.0**	**0.0**	**3,472.2**	**3,472.2**	**3,472.2**	**3,472.2**	**3,472.2**
Delivery from WTP (cfs)	0	0	8	8	8	8	8
Avg Delivery WTP (ac-ft/yr)	0	0	2,489	2,489	2,489	2,489	2,489

Capital Costs

Raw Water Facilities	Quantity	Unit	Unit Cost	Total Cost
Intake	1	LS	$ 1,143,735 /EA	$ 1,144,000
Raw Water Pump Station to Water Treatment Plant				
Pump Station	60	hp	$ 2,287,470 EA	$ 2,287,000
Electrical Hookup	60	hp	$ 150 hp	$ 50,000
Raw Water Pipeline to Water Treatment Plant	834	LF	$ 88 LF	$ 74,000
Total Raw Water Facilities				$ 3,555,000
Water Treatment Plant	Quantity	Unit	Unit Cost	Total Cost
Water Treatment Plant Ph. 1 - 5 MGD	1	LS	$ 24,090,000	$ 24,090,000
Total Water Treatment Plant Facilities				$ 24,090,000
Treated Water Pipeline Facilities	Quantity	Unit	Unit Cost	Total Cost
Inside diameter of pipe	16	in	- -	-
Length of RURAL pipe		feet	$ 88 /LF	$ -
Length of Urban pipe	2,951	feet	$ 136 /LF	$ 401,000
Length of Tunneling	-	feet	$ 25 /inch diameter/ft	$ -
Total Pipe	2,951	feet		
Total Pipeline Facilities				$ 401,000
Disinfection Modifications	Quantity	Unit	Unit Cost	Total Cost
Modify existing wells to use chloramines	1	LS	125000	$ 125,000
Total Capital				**$ 28,171,000**

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Colorado River Surface Water Option

Description: Conventional Water Treatment Plant (Single 5 MGD Phase)

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 28,171,000	$ 4,226,000
Legal Costs	5	%	$ 28,171,000	$ 1,409,000
Contingency	30	%	$ 28,171,000	$ 8,451,000
Total Engineering Costs				$ 14,086,000

Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Raw Water Pipeline	0.77	ac	$ 9,627 /ac	$ 7,000
Easement Acquisition Cost - Treated Water Pipeline	3	ac	$ 9,627 /ac	$ 26,000
Land Acquisition Cost - Water Treatment Plant	6	ac	$ 9,627 /ac	$ 58,000
Land Acquisition Cost - Intake & Pump Station	5	ac	$ 9,627 /ac	$ 48,000
Surveying and Legal	10	% of land costs	$ 139,000	$ 13,900
Total Land and Easement Costs				$ 152,900

Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	3,785	LF	$ 5.23 /LF	$ 20,000
Total Environmental Costs				$ 70,000

Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	28,171,000.0	$ 5,005,000
Return on Investment	1.5	YR	14,085,500.0	$ (563,000)
Total Interest Accrued Less Earned During Construction				$ 4,442,000

Total Other Project Costs	**$ 18,750,900**

Colorado River Surface Water Option

Description: Conventional Water Treatment Plant (Single 5 MGD Phase)

Annual Project Costs

Average 2,489 Peak 5,601

	Quantity	Unit		Unit Cost			Total Cost
Debt Service	30	YR	$	46,921,900		$	3,409,000
Operation and Maintenance - Pipeline	1	%	$	475,000		$	5,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$	3,481,000		$	87,000
Operation and Maintenance - Water Treatment Plant Ph. 1	810,951.68	1000 gal treated	$	3.249	/1000 gal treated	$	2,635,000
Pumping Energy Costs - Raw Water PS	426,193.04	kWh	$	0.10	/kWh	$	43,000
Water Costs (LCRA Firm Water Rates)	2,489	ac-ft	$	151.00	ac-ft	$	376,000
Water Costs (LCRA Reservation Water Rates)	3,112	ac-ft	$	75.50	ac-ft	$	235,000
Total Annual Costs for Phase 1						**$**	**6,790,000**

Phase	Project Delivery Costs				Annual Costs		Annual Average Supply	
							(1000 gal/year)	(acre-ft/year)
Colorado River WTP Phase 1	$8.37	/1,000 gal	$2,728.13	/ac-ft	$	6,790,000	810,952	2,489

ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (single 5 MGD phase)

Water Volume

	Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	0	7,214	9,903	10,440	10,440	10,440
Delivery (1,000 gal/year)	0	0	2,350,600	3,226,600	3,401,800	3,401,800	3,401,800
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply (MGD)		0.5	0.5	0.5	0.5	0.5	0.5
Proposed ASR (MGD)	0	0	1	4	4	4	4
Proposed WTP (MGD)			5	5	5	5	5
Total Supply (MGD)	4	3	10	10	11	11	11
Delivery from WTP-ASR (gpm)	**0.0**	**0.0**	**4,472.2**	**6,138.9**	**6,472.2**	**6,472.2**	**6,472.2**
Delivery from WTP-ASR (cfs)	0	0	10	14	14	14	14
Avg Delivery ASR (ac-ft/yr)	0	0	3,206	4,400	4,639	4,639	4,639

Capital Costs

		Quantity	Unit		Unit Cost	Total Cost
Raw Water Facilities						
Intake		1	LS	$	1,143,735 /EA	$ 1,144,000
Raw Water Pump Station to Water Treatment Plant						
Pump Station		60	hp	$	2,287,470 EA	$ 2,287,000
Electrical Hookup		60	hp	$	150 hp	$ 50,000
Raw Water Pipeline to Water Treatment Plant		834	LF	$	88 LF	$ 74,000
Total Raw Water Facilities						$ 3,555,000

		Quantity	Unit		Unit Cost	Total Cost
Water Treatment Plant						
Water Treatment Plant Ph. 1 - 5 MGD		1	LS	$	24,090,000	$ 24,090,000
Total Water Treatment Plant Facilities						$ 24,090,000

		Quantity	Unit		Unit Cost	Total Cost
Treated Water Pipeline Facilities						
Inside diameter of pipe		20	in		- -	-
Length of RURAL pipe			feet	$	104 /LF	$ -
Length of Urban pipe		2,951	feet	$	159 /LF	$ 470,000
Length of Tunneling		-	feet	$	25 /inch diameter/ft	$ -
	Total Pipe	2,951	feet			
Total Pipeline Facilities						$ 470,000

		Quantity	Unit		Unit Cost	Total Cost
Well Facilities						
Well Field Materials - 3 wells		1	LS	$	1,741,698	$ 1,742,000

		Quantity	Unit		Unit Cost	Total Cost
Disinfection Modifications						
Modify existing wells to use chloramines		1	LS		125000	$ 125,000

Total Capital	**$ 29,982,000**

ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (single 5 MGD phase)

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 29,982,000	$ 4,497,000
Legal Costs	5	%	$ 29,982,000	$ 1,499,000
Contingency	30	%	$ 29,982,000	$ 8,995,000
Total Engineering Costs				$ 14,991,000

Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Raw Water Pipeline	0.77	ac	$ 9,627 /ac	$ 7,000
Easement Acquisition Cost - Treated Water Pipeline	3	ac	$ 9,627 /ac	$ 26,000
Land Acquisition Cost - Water Treatment Plant	6	ac	$ 9,627 /ac	$ 58,000
Land Acquisition Cost - Intake & Pump Station	5	ac	$ 9,627 /ac	$ 48,000
Land Acquisition Cost - ASR Wells	2	ac	$ 9,627 /ac	$ 14,000
Surveying and Legal	10	% of land costs	$ 139,000	$ 13,900
Total Land and Easement Costs				$ 166,900

Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	3,785	LF	$ 5.23 /LF	$ 20,000
Total Environmental Costs				$ 70,000

Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	29,982,000.0	$ 5,327,000
Return on Investment	1.5	YR	14,991,000.0	$ (600,000)
Total Interest Accrued Less Earned During Construction				$ 4,727,000
Total Other Project Costs				**$ 19,954,900**

ASR Wells Option

Description: Aquifer Storage and Recover using water from conventional water treatment plant (single 5 MGD phase)

Annual Project Costs

Phase 1 Average 2,489 Peak 5,601

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 48,194,900		$ 3,501,000
Operation and Maintenance - Pipeline	1	%	$ 544,000		$ 5,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant	811,111.11	1000 gal treated	$ 3.249	/1000 gal treated	$ 2,635,000
Operation and Maintenance - Wells	0	annually	$ 9,434		$ -
Pumping Energy Costs - Raw Water PS	426,193.04	kWh	$ 0.10	/kWh	$ 43,000
Power Costs for Wells	0	annually	$ 17,899		$ -
Water Costs (LCRA Firm Water Rates)	2,489	ac-ft	$ 151.00	ac-ft	$ 376,000
Water Costs (LCRA Reservation Water Rates)	5,601	ac-ft	$ 75.50	ac-ft	$ 423,000
Total Annual Costs for Phase 1					**$ 7,070,000**

Annual Project Costs

Phase 2 Average 4,639 Peak 10,440

	Quantity	Unit	Unit Cost		Total Cost
Debt Service	30	YR	$ 49,936,900		$ 3,628,000
Operation and Maintenance - Pipeline	1	%	$ 544,000		$ 5,000
Operation and Maintenance - Pump Station Facilities & Intake	2.5	%	$ 3,481,000		$ 87,000
Operation and Maintenance - Water Treatment Plant	811,111.11	1000 gal treated	$ 3.249	/1000 gal treated	$ 2,635,000
Operation and Maintenance - Wells	1	annually	$ 9,434		$ 9,000
Pumping Energy Costs - Raw Water PS	426,193.04	kWh	$ 0.10	/kWh	$ 43,000
Power Costs for Wells	1	annually	$ 17,899		$ 18,000
Water Costs (LCRA Firm Water Rates)	2,489	ac-ft	$ 151.00	ac-ft	$ 376,000
Water Costs (LCRA Reservation Water Rates)	5,601	ac-ft	$ 75.50	ac-ft	$ 423,000
Total Annual Costs for Phase 1					**$ 7,224,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
WTP Phase 1	$8.72	/1,000 gal	$2,840.07	/ac-ft	$ 7,070,000	811,111	2,489

Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 2 wells, Phase 2 of 2 wells) northeast of Bastrop

Water Volume

	Projected Delivery						
Year	***2010***	***2015***	***2020***	***2025***	***2030***	***2035***	***2040***
Delivery (ac-ft/year)	0	3,226	3,226	3,226	6,452	6,452	6,452
Delivery (1,000 gal/year)	0	1,051,200	1,051,200	1,051,200	2,102,400	2,102,400	2,102,400
Existing Wells Supply (MGD)	4.3	2.7	2.7	1.2	1.2	1.2	1.2
Short Term Supply		0.2	0.2	0.2	0.2	0.2	0.2
Proposed Phase 1 Wells (gpm)		2,000	2,000	2,000	2,000	2,000	2,000
Proposed Phase 2 Wells (gpm)					2,000	2,000	2,000
Total Supply (MGD)	**4.3**	**5.8**	**5.8**	**4.2**	**7.1**	**7.1**	**7.1**
Delivery Simsboro Wells (gpm)	0	2,000	2,000	2,000	4,000	4,000	4,000
Delivery Simsboro Wells (cfs)	0	4	4	4	9	9	9
Avg Del Simsboro (ac-ft/yr)	0	1,434	1,434	1,434	2,868	2,868	2,868

Capital Costs

Phase 1 Facilities	Pipe Size (in)	Quantity	Unit		Unit Cost		Total Cost
Well Field Facilities - 2 wells		1	LS	$	1,257,180	$	1,257,000
Well Field Piping	8	5000	feet	$	63	$	315,000
Electrical Hookup Wells		600	hp	$	150 /hp	$	90,000
Treatment Facilities		2	well	$	640,612 /well	$	1,281,000
Water Storage Tank		0.5	MG	$	503,404 /EA	$	503,000
Pump Station		120	hp	$	2,287,470 /EA	$	2,287,000
Electrical Hookup Pump Station		120	hp	$	150 /hp	$	50,000
Treated Water pipe	16	7,500	feet	$	136 /LF	$	1,019,000
Length of Tunneling	16	-	feet	$	25 /inch diameter/ft	$	-
Total Phase 1 Facilities						$	6,802,000

Phase 2 Facilities	Pipe Size (in)	Quantity	Unit		Unit Cost		Total Cost
Well Field Facilities - 2 wells		1	LS	$	1,215,570	$	1,216,000
Well Field Piping	8	5000	feet	$	63	$	315,000
Electrical Hookup Wells		600	hp	$	150 /hp	$	90,000
Treatment Facilities		2	well	$	640,612 /well	$	1,281,000
Total Phase 2 Facilities						$	2,902,000
	Total Pipe	17,500	feet				
Total Capital						**$**	**9,704,000**

Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 2 wells, Phase 2 of 2 wells) northeast of Bastrop

Other Project Costs

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

	Quantity	Unit	Unit Cost	Total Cost
Engineering	15	%	$ 9,704,000	$ 1,456,000
Legal Costs	5	%	$ 9,704,000	$ 485,000
Contingency	30	%	$ 9,704,000	$ 2,911,000
Total Engineering Costs				$ 4,852,000

Land and Easements	Quantity	Unit	Unit Cost	Total Cost
Easement Acquisition Cost - Treated Water Pipeline	16	ac	$ 9,627 /ac	$ 155,000
Land Acquisition Cost - Well Field Phase 1	1	ac	$ 9,627 /ac	$ 10,000
Land Acquisition Cost - Well Field Phase 2	1	ac	$ 9,627 /ac	$ 10,000
Surveying and Legal	10	% of land costs	$ 165,000	$ 16,500
Total Land and Easement Costs				$ 191,500

Environmental Studies and Mitigation	Quantity	Unit	Unit Cost	Total Cost
404 Permitting - Engineering	1	LS	$ 50,000 /EA	$ 50,000
Environmental and Mitigation - Pipelines	17,500	LF	$ 5.23 /LF	$ 92,000
Total Environmental Costs				$ 142,000

Interest During Construction	Quantity	Unit	Unit Cost	Total Cost
Interest Payment on Loan	3	YR	9,704,000.0	$ 1,724,000
Return on Investment	1.5	YR	4,852,000.0	$ (194,000)
Total Interest Accrued Less Earned During Construction				$ 1,530,000
Total Other Project Costs				**$ 6,715,500**

Simsboro Groundwater Option

Description: Two Simsboro well fields constructed in Phases (Phase 1 of 2 wells, Phase 2 of 2 wells) northeast of Bastrop

Annual Project Costs

Phase 1 Project Delivery 3,226

	Quantity	Unit	Unit Cost	Total Cost
Debt Service	30	YR	$ 13,517,500	$ 982,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 1,649,000	$ 16,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000	$ 58,000
Operation and Maintenance - Wells	1	annually	$ 12,880	$ 13,000
Power Cost for Wells	1	annually	$ 25,100	$ 25,000
Water Costs (LPGCD Production Fee)	3,226	ac-ft	$ 9.80 ac-ft	$ 32,000
Total Annual Costs for Phase 1				**$ 1,126,000**

Annual Project Costs

Phase 2 Project Delivery 6,452

	Quantity	Unit	Unit Cost	Total Cost
Debt Service	30	YR	$ 16,419,500	$ 1,193,000
Operation and Maintenance - Pipeline & Facilities	1	%	$ 1,649,000	$ 16,000
Operation and Maintenance - Pump Station Facilities	2.5	%	$ 2,337,000	$ 58,000
Operation and Maintenance - Wells	1	annually	$ 13,530	$ 14,000
Power Cost for Wells	1	annually	$ 56,899	$ 57,000
Water Costs (LPGCD Production Fee)	6,452	ac-ft	$ 9.80 ac-ft	$ 63,000
Total Annual Costs for Phase 2				**$ 1,401,000**

Phase	Project Delivery Costs				Annual Costs	Annual Average Supply	
						(1000 gal/year)	(acre-ft/year)
Simsboro Phase 1	$2.41	/1,000 gal	$785.28	/ac-ft	$ 1,126,000	467,200	1,434
Simsboro Phase 2	$1.50	/1,000 gal	$488.53	/ac-ft	$ 1,401,000	934,400	2,868

Appendix H - Works Cited

Aqua Water Supply Corporation. (1993). *October 1993 Agreement between the City of Bastrop, Texas and Aqua Water Supply Corporation.*

Capital Area Metropolitian Planning Organization (CAMPO). (April 2010). *Demographic Allocation Tool White Paper.*

Engineering News Record (ENR). (n.d.). Retrieved March 2013, from http://enr.construction.com/economics/.

K Friese & Associates, Inc. (KFA). (October 2008). *DRAFT City of Bastrop Water and Wastewater Master Plan.*

K Friese & Associates, Inc. (KFA). (October 2011). *Bastrop Regional Water Facilities Planning Study*

LBG-Guyton Associates (LBG). (February 2010). *Aqua Water Supply Corporation Monitoring Wells.*

South Central Texas Regional Water Planning Group (SCTRWPG, 2010). *2011 South Central Texas Regional Water Plan, Volume II Technical Evaluations of Water Management Strategies.*

Texas Commission on Environmental Quality (TCEQ) . (2004). *Rules and Regulations for Public Water Systems: 30 TAC, Chapter 290, Subchapter D, RG-195.*

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