DRAFT FEASIBILITY REPORT
FEASIBILITY ANALYSIS OF WATER SUPPLY FOR SMALL PUBLIC WATER SYSTEMS

BRUNI RURAL WSC
PWS ID# 2400003, CCN# 12462

Prepared for:

THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Prepared by:

THE UNIVERSITY OF TEXAS BUREAU OF ECONOMIC GEOLOGY

AND

PARSONS

Preparation of this report was financed by the Texas Commission on Environmental Quality through the Drinking Water State Revolving Fund Small Systems Assistance Program

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AUGUST 2006

EXECUTIVE SUMMARY

INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Infrastructure and Technology Group Inc. (Parsons), was contracted by the Texas Commission on Environmental Quality (TCEQ) to conduct a study to assist with identifying and analyzing alternatives for use by Public Water Systems (PWS) to meet and maintain Texas drinking water standards.

The overall goal of this project was to promote compliance with Texas water quality standards using sound engineering and financial methods and data for PWSs that had recently recorded sample results exceeding maximum contaminant levels (MCL). The primary objectives of this project were to provide feasibility studies for PWSs and the TCEQ Water Supply Division that evaluate water supply compliance options, and to suggest a list of compliance alternatives that may be further investigated by the subject PWS for future implementation.

This feasibility report provides an evaluation of water supply alternatives for the Bruni Rural Water Supply Corporation located in the town of Bruni, Texas (hereinafter referred to as the Bruni PWS). Bruni is on State Highway 359 50 miles east by southeast of Laredo in Webb County. Available records indicate the average arsenic concentration for records from 1997 through 2005 was 90 micrograms per liter (µg/L).

Basic system information for the Bruni Rural WSC PWS is shown in Table ES.1.

Table ES.1
Bruni PWS
Basic System Information

Population served	589
Connections (occupied)	208
Average daily demand	0.087 million gallons per day (mgd)
Peak demand flow rate	240 gallons per minute
Water system peak capacity	0.095 mgd
Total arsenic range	75.9 – 113.4 µg/L

STUDY METHODS

The methods used for this study were based on a pilot study performed in 2004 and 2005 by TCEQ, BEG, and Parsons. Methods for identifying and analyzing compliance options were developed in the pilot study (a decision tree approach).

The process for developing the feasibility study used the following general steps:

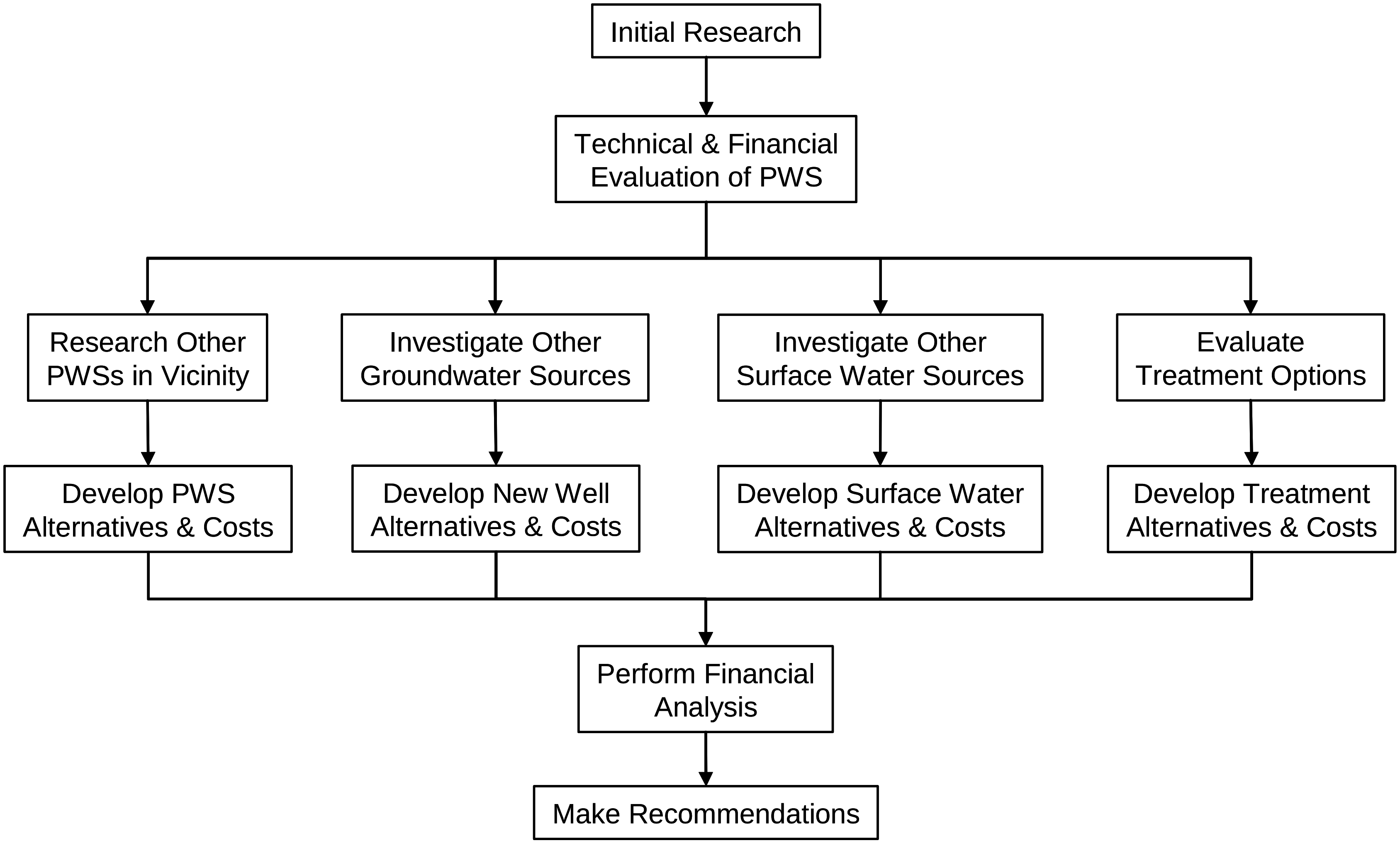
1. Gather data from the TCEQ and Texas Water Development Board databases, from TCEQ files, and from information maintained by the PWS;
2. Conduct financial, managerial, and technical (FMT) evaluations of the PWS;
3. Perform a geologic and hydrogeologic assessment of the study area;
4. Develop treatment and non-treatment compliance alternatives which, in general, consist of the following possible options:
    a. Connecting to neighboring PWSs via new pipeline or by pumping water from a newly installed well or an available surface water supply within the jurisdiction of the neighboring PWS;
    b. Installing new wells within the vicinity of the PWS into other aquifers with confirmed water quality standards meeting the MCLs;
    c. Installing a new intake system within the vicinity of the PWS to obtain water from a surface water supply with confirmed water quality standards meeting the MCLs;
    d. Treating the existing non-compliant water supply by various methods depending on the type of contaminant; and
    e. Delivering potable water by way of a bottled water program or a treated water dispenser as an interim measure only.
5. Assess each potential alternative with respect to economic and non-economic criteria;
6. Prepare a feasibility report and present the results to the PWS.

This basic approach is summarized in Figure ES-1.

HYDROGEOLOGICAL ANALYSIS

The Bruni PWS obtains groundwater from the Jasper subunit of the Gulf Coast Aquifer. Arsenic is commonly found in area wells at concentrations greater than the MCL of 10 micrograms per liter (µg/L). Natural geologic sources may be responsible for the arsenic found in the area groundwater. Historical data show that arsenic concentrations exceed the MCL. Arsenic concentrations can vary significantly over relatively short distances; as a result, there could be good quality groundwater nearby. However, the variability of arsenic concentrations makes it difficult to determine where wells can be located to produce acceptable water.

Figure ES-1
Summary of Project Methods



COMPLIANCE ALTERNATIVES

Bruni PWS provides water to a small community, and is governed by a 5-member board. It is financed by user fees. Overall, the system had an adequate level of FMT capacity. The system had some areas that needed improvement to be able to address future compliance issues; however, the system does have many positive aspects, including knowledgeable and dedicated staff, and good sharing of resources with Webb County Independent School District. Areas of concern for the system included lack of long-term planning, and insufficient water production.

There are relatively few PWSs within 30 miles of Bruni PWS. Many of these nearby systems also have problems with arsenic, but there are a few with good quality water. In general, feasibility alternatives were developed based on obtaining water from the nearest PWSs, either by directly purchasing water, or by expanding the existing well field. There is a minimum of surface water available in the area

A number of centralized treatment alternatives for arsenic removal have been developed and were considered for this report, including reverse osmosis, electrodialysis reversal, iron-based adsorption, and coagulation/filtration. Point-of-use (POU) and point-of-entry treatment alternatives were also considered. Temporary solutions such as providing bottled water or providing a centralized dispenser for treated or trucked-in water, were also considered as alternatives.

If compliant groundwater can be found, developing a new well close to Bruni PWS is likely to be an attractive solution. Having a new well close to Bruni PWS is likely to be one of the lower cost alternatives, and the Bruni PWS already possesses the technical and managerial expertise needed to implement this option. The cost of new well alternatives quickly increases with pipeline length, making proximity of the alternate source a key concern. A new compliant well or obtaining water from a neighboring compliant PWS has the advantage of providing compliant water to all taps in the system.

Central treatment can be cost-competitive with the alternative of new nearby wells, but would require significant institutional changes to manage and operate. Like obtaining an alternate compliant water source, central treatment would provide compliant water to all water taps.

Point-of-use treatment can be cost competitive, but does not supply compliant water to all taps. Additionally, significant efforts would be required for maintenance and monitoring of the POU treatment units.

Providing compliant water through a central dispenser is significantly less expensive than providing bottled water to 100 percent of the population, but a significant effort is required for clients to fill their containers at the central dispenser.

FINANCIAL ANALYSIS

Financial analysis of the Bruni PWS indicated that current water rates are not sufficient to fund operations, and a rate increase of approximately 3% would be necessary to meet operating expenses. The current average water bill of $383 represents approximately 1.5 percent of the median household income (MHI) for the area, and the increased bill would also represent approximately 1.5 percent. Table ES.2 provides a summary of the financial impact of implementing selected compliance alternatives, including the rate increase necessary to meet current operating expenses. The alternatives were selected to highlight results for the lowest cost alternatives from each different type or category.

Some of the compliance alternatives offer potential for shared or regional solutions. A group of PWSs could work together to implement alternatives for developing a new groundwater source or expanding an existing source, obtaining compliant water from a large regional provider, or for central treatment. Sharing the cost for implementation of these alternatives could reduce the cost on a per user basis. Additionally, merging PWSs or management of several PWSs by a single entity offers the potential for reduction in administrative costs.

Table ES.2
Selected Financial Analysis Results

Alternative	Funding Option	Average Annual Water Bill	Percent of MHI
Current	NA	$383	1.5
To meet current expenses	NA	$396	1.5
New well at Cogema Malapai	100% Grant	$625	2.4
	Loan/Bond	$1,319	5.1
Central treatment – coagulation/filtration	100% Grant	$761	2.9
	Loan/Bond	$937	3.6
Point-of-use	100% Grant	$1,189	4.6
	Loan/Bond	$1,241	4.8

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ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
ft^2	square foot
APU	arsenic package unit
BEG	Bureau of Economic Geology
bgs	Below ground surface
Bruni PWS	Bruni Rural Water Supply Corporation
CA	Chemical analysis
CCN	Certificate of Convenience and Necessity
CFR	Code of Federal Regulations
CO	Correspondence
EDR	Electrodialysis reversal
FMT	Financial, managerial, and technical
GAM	Groundwater Availability Model
gpm	Gallons per minute
ISD	Independent School District
IX	Ion exchange
MCL	Maximum contaminant level
MG	Million gallons
mgd	Million gallons per day
MHI	Median household income
MOR	Monthly operating report
NMEFC	New Mexico Environmental Financial Center
NURE	National Uranium Resource Evaluation
O&M	Operation and Maintenance
Parsons	Parsons Infrastructure and Technology, Inc.
POE	Point-of-entry
POU	Point-of-use
PVC	Polyvinyl chloride
PWS	Public water system
RO	Reverse osmosis
SDWA	Safe Drinking Water Act
SWAP	Source Water Assessment Program
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TSS	Total suspended solids
TWDB	Texas Water Development Board
USEPA	United States Environmental Protection Agency

WAM	Water Availability Model
WSC	Water Supply Corporation

SECTION 1
INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Infrastructure and Technology Group Inc. (Parsons), were contracted by the Texas Commission on Environmental Quality (TCEQ) to assist with identifying and analyzing compliance alternatives for use by Public Water Systems (PWS) to meet and maintain Texas drinking water standards.

The overall goal of this project is to promote compliance using sound engineering and financial methods and data for PWSs that have recently had sample results that exceed maximum contaminant levels (MCL). The primary objectives of this project are to provide feasibility studies for PWSs and the TCEQ Water Supply Division that evaluate water supply compliance options, and to suggest a list of compliance alternatives that may be further investigated by the subject PWS with regard to future implementation. The feasibility studies identify a range of potential compliance alternatives, and present basic data that can be used for evaluating feasibility. The compliance alternatives addressed include a description of what would be required for implementation, conceptual cost estimates for implementation, and non-cost factors that could be used to differentiate between alternatives. The cost estimates are intended for comparing compliance alternatives, and to give a preliminary indication of potential impacts on water rates resulting from implementation.

It is anticipated the PWS will review the compliance alternatives in this report to determine if there are promising alternatives, and then select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation. This report contains a decision tree approach that guided the efforts for this study, and also contains steps to guide a PWS through the subsequent evaluation, selection, and implementation of a compliance alternative.

This feasibility report provides an evaluation of water supply compliance options for the Bruni Rural Water Supply Corporation Water System, PWS ID# 2400003, Certificate of Convenience and Necessity (CCN) #12462, located in Webb County (hereinafter referred to as the Bruni PWS). Recent sample results from the Bruni PWS water system exceeded the MCL for arsenic of 10 micrograms per liter (µg/L) that went into effect January 23, 2006 (USEPA 2005; TCEQ 2004).

The location of the Bruni PWS is shown on Figure 1.1. Various water supply and planning jurisdictions are shown on Figure 1.2. These water supply and planning jurisdictions are used in the evaluation of alternate water supplies that may be available in the area.

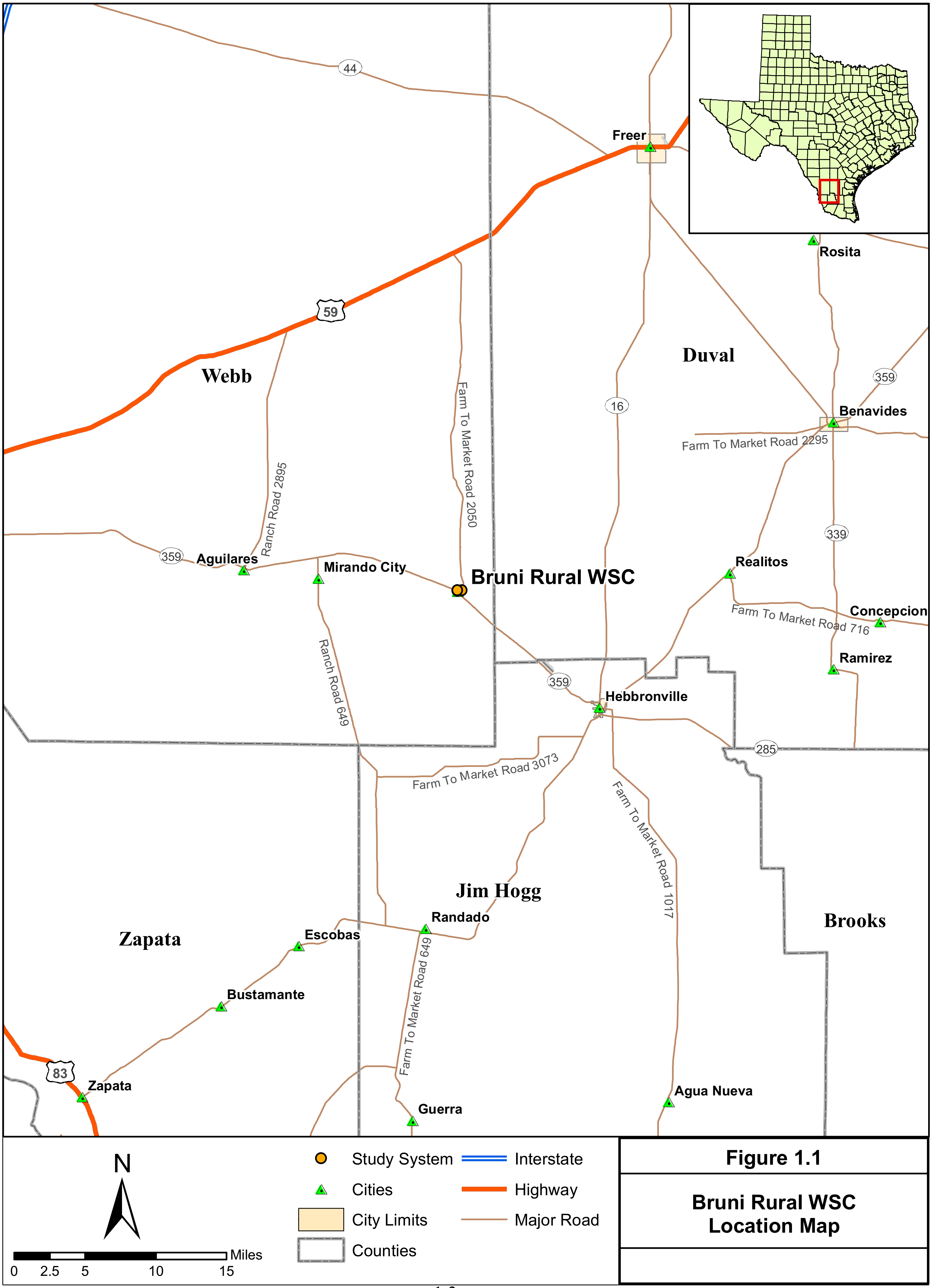

Figure 1.1

Bruni Rural WSC Location Map

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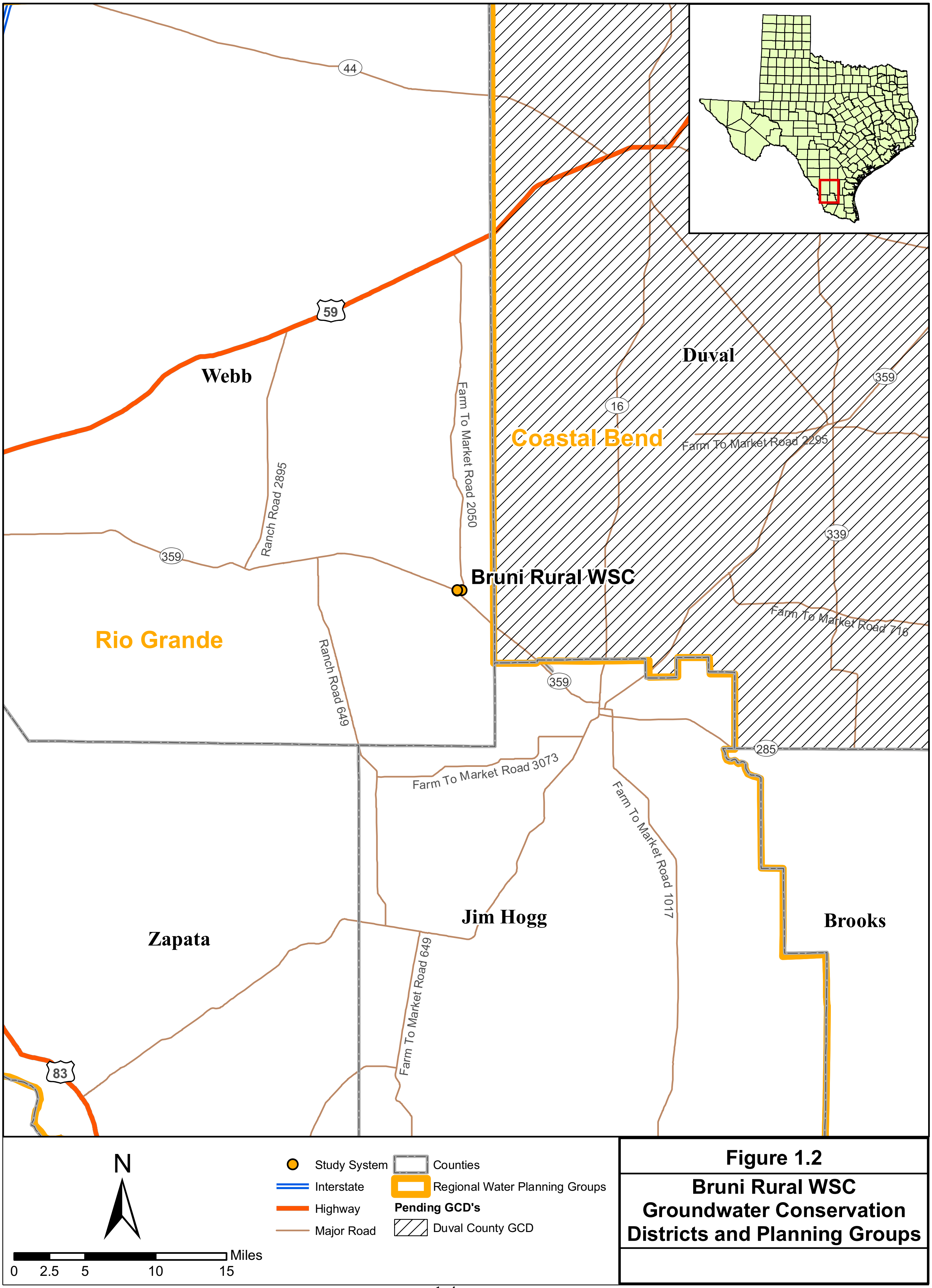


Figure 1.2
Bruni Rural WSC Groundwater Conservation Districts and Planning Groups

1.1 PUBLIC HEALTH AND COMPLIANCE WITH MCLS

The goal of this project is to promote compliance for PWSs that supply drinking water containing contaminants that exceed regulatory MCLs. This project only addresses those contaminants and does not address any other violations that may exist for a PWS. As mentioned above, the Bruni PWS had recent sample results that exceeded the MCL for arsenic. Health concerns related to drinking water above MCLs for this chemical are briefly described below.

According to the U.S. Environmental Protection Agency (USEPA), potential health effects from long-term ingestion of water with levels of arsenic above the MCL (10 µg/L) include non-cancerous effects, such as cardiovascular, pulmonary, immunological, neurological and endocrine effects, and cancerous effects, including skin, bladder, lung, kidney, nasal passage, liver and prostate cancer (USEPA 2005c).

1.2 METHODOLOGY

The method for this project follows that of the pilot study performed in 2004 and 2005 by TCEQ, BEG, and Parsons. The pilot study evaluated water supply alternatives for PWSs that supply drinking water with nitrate concentrations above USEPA and Texas drinking water standards. Three PWSs were evaluated in the pilot study to develop the methodology (*i.e.*, decision tree approach) for analyzing options for provision of compliant drinking water. This project is performed using the decision tree approach developed in the pilot study.

Other tasks of the feasibility study are as follows:

- Identifying available data sources;
- Gathering and compiling data;
- Conducting financial, managerial, and technical (FMT) evaluations of the selected PWSs;
- Performing a geologic and hydrogeologic assessment of the study area;
- Developing treatment and non-treatment compliance alternatives;
- Assessing potential alternatives with respect to economic and non-economic criteria;
- Preparing a feasibility report; and
- Suggesting refinements to the approach for future studies.

The remainder of Section 1 of this report addresses the regulatory background, and provides a summary of arsenic abatement options. Section 2 describes the methodology used to develop and assess compliance alternatives. The groundwater sources of arsenic are addressed in Section 3. Findings for the Bruni PWS, along with development and evaluation of compliance alternatives, can be found in Section 4. Section 5 references the sources used in this report.

1.3 REGULATORY PERSPECTIVE

The Utilities & Districts and Public Drinking Water Sections of the TCEQ Water Supply Division are responsible for implementing requirements of the Federal Safe Drinking Water Act (SDWA), including oversight of PWSs and water utilities. These responsibilities include:

- Monitoring public drinking water quality;
- Processing enforcement referrals for MCL violators;
- Tracking and analyzing compliance options for MCL violators;
- Providing FMT assessment and assistance to PWSs;
- Participating in the Drinking Water State Revolving Fund program to assist PWSs in achieving regulatory compliance; and
- Setting rates for privately-owned water utilities.

This project was conducted to assist in achieving these responsibilities.

1.4 ABATEMENT OPTIONS

When a PWS exceeds a regulatory MCL, the PWS must take action to correct the violation. The MCL exceedances at the Bruni PWS involve arsenic. The following subsections explore alternatives considered as potential options for obtain/providing compliant drinking water.

1.4.1 Existing Public Water Supply Systems

A common approach to achieving compliance is for the PWS to make arrangements with a neighboring PWS for water supply. For this arrangement to work, the PWS from which water is being purchased (supplier PWS) must have water in sufficient quantity and quality, the political will must exist, and it must be economically feasible.

1.4.1.1 Quantity

For purposes of this report, quantity refers to water volume, flowrate, and pressure. Before approaching a potential supplier PWS, the non-compliant PWS should determine its water demand on the basis of average day and maximum day. Peak instantaneous demands can be met through proper sizing of storage facilities. Further, the potential for obtaining the appropriate quantity of water to blend to achieve compliance should be considered. The concept of blending involves combining water with low levels of contaminants with non-compliant water in sufficient quantity so the resulting blended water is compliant. The exact blend ratio would depend on the quality of the water a potential supplier PWS can provide, and would likely vary over time. If high quality water is purchased, produced or otherwise obtained, blending can reduce the amount of high quality water required. Implementation of blending will require a control system to ensure the blended water is compliant.

If the supplier PWS does not have sufficient quantity, the non-compliant community could pay for the facilities necessary to increase the quantity to the extent necessary to supply the needs of the non-compliant PWS. Potential improvements might include, but are not limited to:

- Additional wells;
- Developing a new surface water supply;
- Additional or larger-diameter piping;
- Increasing water treatment plant capacity;
- Additional storage tank volume;
- Reduction of system losses;
- Higher-pressure pumps; or
- Upsized, or additional, disinfection equipment.

In addition to the necessary improvements, a transmission pipeline would need to be constructed to tie the two PWSs together. The pipeline must tie-in at a point in the supplier PWS where all the upstream pipes and appurtenances are of sufficient capacity to handle the new demand. In the non-compliant PWS, the pipeline must tie in at a point where no down stream bottlenecks are present. If blending is the selected method of operation, the tie-in point must be at the proper point of the existing non-compliant PWS to ensure that all water in the system is blended to achieve regulatory compliance.

1.4.1.2 Quality

If a potential supplier PWS obtains its water from the same aquifer (or same portion of the aquifer) as the non-compliant PWS, the quality of water may not be significantly better. However, water quality can vary significantly due to well location, even within the same aquifer. If localized areas with good water quality cannot be identified, the non-compliant PWS would need to find a potential supplier PWS that obtains its water from a different aquifer or from a surface water source. Additionally, a potential supplier PWS may treat non-compliant raw water to an acceptable level.

Surface water sources may offer a potential higher-quality source. Since there are significant treatment requirements, utilization of surface water for drinking water is typically most feasible for larger local or regional authorities or other entities that may provide water to several PWSs. Where PWSs that obtain surface water are neighbors, the non-compliant PWS may need to deal with those systems as well as with the water authorities that supply the surface water.

1.4.2 Potential for New Groundwater Sources

1.4.2.1 Existing Non-Public Supply Wells

Often there are wells not associated with PWSs located in the vicinity of non-compliant PWS. The current use of these wells may be for irrigation, industrial purposes, domestic supply, stock watering, and other purposes. The process for investigating existing wells is as follows:

- Use existing data sources (see below) to identify wells in the areas that have satisfactory quality. For the Bruni PWS, the following standards could be used in a rough screening to identify compliant groundwater in surrounding systems
- Arsenic concentrations less than 0.008 mg/L (below the MCL of 0.01 mg/L);
- Review the recorded well information to eliminate those wells that appear to be unsuitable for the application. Often, the "Remarks" column in the Texas Water Development Board (TWDB) hard-copy database provides helpful information. Wells eliminated from consideration generally include domestic and stock wells, dug wells, test holes, observation wells, seeps and springs, destroyed wells, wells used by other communities, etc;
- Identify wells of sufficient size that have been used for industrial or irrigation purposes. Often the TWDB database will include well yields, which may indicate the likelihood that a particular well is a satisfactory source.

At this point in the process, the local groundwater control district (if one exists) should be contacted to obtain information about pumping restrictions. Also, preliminary cost estimates should be made to establish the feasibility of pursuing further well development options.

If particular wells appear to be acceptable, the owner(s) should be contacted to ascertain their willingness to work with the PWS. Once the owner agrees to participate in the program, questions should be asked about the wells. Many owners have more than one well, and would probably be the best source of information regarding the latest test dates, who tested the water, flow rates, and other well characteristics.

After collecting as much information as possible from cooperative owners, the PWS would then narrow the selection of wells and sample and analyze them for quality. Wells with good quality would then be potential candidates for test pumping. In some cases, a particular well may need to be refurbished before test pumping. Information obtained from test pumping would then be used in combination with information about the general characteristics of the aquifer to determine whether a well at this location would be suitable as a supply source.

It is recommended that new wells be installed instead of using existing wells to ensure that well characteristics are known and the well meets construction standards.

Permit(s) would then be obtained from the groundwater control district or other regulatory authority, and an agreement with the owner (purchase or lease, access easements, *etc*.) would then be negotiated.

1.4.2.2 Develop New Wells

If no existing wells are available for development, the PWS or group of PWSs has an option of developing new wells. Records of existing wells, along with other hydrogeologic information and modern geophysical techniques, should be used to identify potential locations for new wells. In some areas, the TWDB's Groundwater Availability Model (GAM) may be applied to indicate potential sources. Once a general area has been identified, land owners and regulatory agencies should be contacted to determine an exact location for a new well or well field. Pump tests and water quality tests would be required to determine if a new well will produce an adequate quantity of good quality water. Permits from the local groundwater control district or other regulatory authority could also be required for a new well.

1.4.3 Potential for Surface Water Sources

Water rights law dominates the acquisition of water from surface water sources. For a PWS, 100 percent availability of water is required, except where a back-up source is available. For PWSs with an existing water source, although it may be non-compliant because of elevated concentrations of one or more parameters, water rights may not need to be 100 percent available.

1.4.3.1 Existing Surface Water Sources

"Existing surface water sources" refers to municipal water authorities and cities that obtain water from surface water sources. The process of obtaining water from such a source is generally less time consuming and less costly than the process of developing a new source; therefore, it should be a primary course of investigation. An existing source would be limited by its water rights, the safe yield of a reservoir or river, or by its water treatment or water conveyance capability. The source must be able to meet the current demand and honor contracts with communities it currently supplies. In many cases, the contract amounts reflect projected future water demand based on population or industrial growth.

A non-compliant PWS would look for a source with sufficient spare capacity. Where no such capacity exists, the non-compliant PWS could offer to fund the improvements necessary to obtain the capacity. This approach would work only where the safe yield could be increased (perhaps by enlarging a reservoir) or where treatment capacity could be increased. In some instances water rights, where they are available, could possibly be purchased.

In addition to securing the water supply from an existing source, the non-compliant PWS would need to arrange for transmission of the water to the PWS. In some cases, that could require negotiations with, contracts with, and payments to an intermediate PWS (an intermediate PWS is one where the infrastructure is used to transmit water from a "supplier" PWS to a "supplied" PWS, but does not provide any additional treatment to the supplied water). The non-compliant PWS could be faced with having to fund improvements to the intermediate PWS in addition to constructing its own necessary transmission facilities.

1.4.3.2 New Surface Water Sources

Communication with the TCEQ and relevant planning groups from the beginning is essential in the process of obtaining a new surface water source. Preliminary assessment of the potential for acquiring new rights may be based on surface water availability maps located on the TWDB website. Where water rights appear to be available, the following activities need to occur:

- Discussions with TCEQ to indicate the likelihood of obtaining those rights. The TCEQ may use the Water Availability Model (WAM) to assist in the determination.
- Discussions with land owners to indicate potential treatment plant locations.
- Coordination with U.S. Army Corps of Engineers and local river authorities.
- Preliminary engineering design to determine the feasibility, costs, and environmental issues of a new treatment plant.

Should these discussions indicate that a new surface water source is the best option, the community would proceed with more intensive planning (initially obtaining funding), permitting, land acquisition, and detailed designs.

1.4.4 Identification of Treatment Technologies

Various treatment technologies were also investigated as compliance alternatives for treatment of arsenic to regulatory levels (*i.e.*, MCL). According to a recent USEPA report for small water systems with <10,000 customers (EPA/600/R-05/001) a number of drinking water treatment technologies are available to reduce arsenic concentrations in source water to below the new MCL of 10 µg/L, including:

- Ion exchange (IX);
- Reverse osmosis (RO);
- Electrodialysis reversal (EDR);
- Adsorption, and
- Coagulation/filtration.

1.4.5 Treatment Technologies Description

Many of the most effective arsenic removal processes available are iron-based treatment technologies such as chemical coagulation/filtration with iron salts, and adsorptive media with iron-based products. These processes are particularly effective at removing arsenic from aqueous systems because iron surfaces have a strong affinity for adsorbing arsenic. Other arsenic removal processes such as activated alumina and enhanced lime softening are more applicable to larger water system because of their operational complexity and cost. A description and discussion of arsenic removal technologies applicable to smaller systems follow.

1.4.5.1 Ion Exchange

Process – In solution, salts separate into positively charged cations and negatively charged anions. Ion exchange is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that certain ions are preferentially adsorbed on the ion exchange resin. Operation begins with a fully charged cation or anion bed, having enough positively or negatively charged ions to carry out the cation or anion exchange. Usually a polymeric resin bed is composed of millions of spherical beads about the size of medium sand grains. As water passes the resin bed, the charged ions are released into the water, being substituted or replaced with the contaminants in the water (ion exchange). When the resin becomes exhausted of positively or negatively charged ions, the bed must be regenerated by passing a strong, sodium chloride, solution over the resin bed, displacing the contaminant ions with sodium ions for cation exchange and chloride ion for anion exchange. Many different types of resins can be used to reduce dissolved contaminant concentrations. The IX treatment train for groundwater typically includes cation or anion resin beds with a regeneration system, chlorine disinfection, and clear well storage. Treatment trains for surface water may also include raw water pumps, debris screens, and filters for pre-treatment. Additional treatment or management of the concentrate and the removed solids will be necessary prior to disposal. For arsenic removal, an anion exchange resin in the chloride form is used to remove arsenate [As(V)]. Because arsenite [As(III)] occurs in water below pH 9 with no ionic charge, As(III) is not consistently removed by the anionic exchange process.

Pretreatment – Pretreatment guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of total suspended solids (TSS), iron, and manganese, which could plug the resin bed, and typically includes media or carbon filtration. In addition, chlorination or oxidation may be required to convert As(III) to As(V) for effective removal.

Maintenance – The IX resin requires regular on-site regeneration, the frequency of which depends on raw water characteristics, the contaminant concentration, and the size and number of IX vessels. Many systems have undersized the IX vessels only to realize higher than necessary operating costs. Preparation of the sodium chloride solution is required. If used, filter replacement and backwashing will be required.

Waste Disposal – Approval from local authorities is usually required for disposal of concentrate from the regeneration cycle (highly concentrated salt solution); occasional solid wastes (in the form of broken resin beads) which are backwashed during regeneration; and if used, spent filters and backwash wastewater.

Advantages (IX)

- Well established process for arsenic removal.
- Fully automated and highly reliable process.
- Suitable for small and large installations.

Disadvantages (IX)

- Requires salt storage; regular regeneration.
- Concentrate disposal.
- Resins are sensitive to the presence of competing ions such as sulfate.

In considering application of IX for inorganics removal, it is important to understand what the effect of competing ions will be, and to what extent the brine can be recycled. Similar to activated alumina, IX exhibits a selectivity sequence, which refers to an order in which ions are preferred. Sulfate competes with both nitrate and arsenic, but more aggressive with arsenic in anion exchange. Source waters with TDS levels above 500 mg/L or 120 mg/L sulfate are not amenable to IX treatment for arsenic removal. Spent regenerant is produced during IX bed regeneration, and this spent regenerant may have high concentrations of sorbed contaminants which can be expensive to treat and/or dispose. Research has been conducted to minimize this effect; recent research on arsenic removal shows that the brine can be reduced as many as 25 times.

1.4.5.2 Reverse Osmosis

Process – RO is a pressure-driven membrane separation process capable of removing dissolved solutes from water by means of particle size and electrical charge. The raw water is typically called feed; the product water is called permeate, and the concentrated reject is called concentrate. Common RO membrane materials include asymmetric cellulose acetate and polyamide thin film composite. Common RO membrane configurations include spiral wound hollow fine fiber but most of RO systems to date are of the spiral wound type. A typical RO installation includes a high pressure feed pump with chemical feed; parallel first and second stage membrane elements in pressure vessels; and valves and piping for feed, permeate, and concentrate streams. Factors influencing membrane selection are cost, recovery, rejection, raw water characteristics, and pretreatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance. RO is capable of achieving over 97 percent removal of As(V) and 92 percent removal of As(III). The treatment process is relatively insensitive to pH. Water recovery is typically 60-80 percent, depending on the raw water characteristics. The concentrate volume for disposal can be significant.

Pretreatment – RO requires careful review of raw water characteristics and pretreatment needs to prevent membranes from fouling, scaling or other membrane degradation. Removal or sequestering of suspended and colloidal solids is necessary to prevent fouling, and removal of sparingly soluble constituents such as calcium, magnesium, silica, sulfate, barium, etc. may be required to prevent scaling. Pretreatment can include media filters, ion exchange softening, acid and antiscalant feed, activated carbon of bisulfite feed to dechlorinate, and cartridge filters to removing any remaining suspended solids to protect membranes from upsets.

Maintenance – Monitoring rejection percentage is required to ensure contaminant removal below MCL. Regular monitoring of membrane performance is necessary to determine fouling, scaling, or other membrane degradation. Acidic or caustic solutions are regularly flushed through the system at high volume/low pressure with a cleaning agent to remove foulants and scalants. Frequency of membrane replacement is dependent on raw water characteristics, pretreatment, and maintenance.

Waste Disposal – Pretreatment waste streams, concentrate flows, spent filters and membrane elements all require approved disposal methods.

Advantages (RO)

- Can remove both As(III) and As(V) effectively; and
- Can remove other undesirable dissolved constituents and excessive TDS, if required.

Disadvantages (RO)

- Relatively expensive to install and operate.
- Concentrate disposal required.
- Need sophisticated monitoring systems.
- Need to handle multiple chemicals.
- Waste of water because of the significant concentrate flows
- High silica concentration limits water recovery rate

RO is an expensive alternative to remove arsenic and is usually not economically competitive with other processes unless nitrate and/or TDS removal is also required. The biggest drawback for using RO to remove arsenic is the waste of water through concentrate disposal which is also difficult or expensive because of the volume involved.

1.4.5.3 Electrodialysis Reversal

Process. EDR is an electrochemical process in which ions migrate through ion-selective semi-permeable membranes as a result of their attraction to two electrically charged electrodes. A typical EDR system includes a membrane stack with a number of cell pairs, each consisting of a cation transfer membrane, a demineralized flow spacer, an anion transfer membrane, and a concentrate flow spacer. Electrode compartments are at opposite ends of the stack. The influent feed water (chemically treated to prevent precipitation) and the concentrated reject flow in parallel across the membranes and through the demineralized and concentrate flow spaces, respectively. The electrodes are continually flushed to reduce fouling or scaling. Careful consideration of flush feed water is required. Typically, the membranes are cation or anion exchange resins cast in sheet form; the spacers are high density polyethylene; and the electrodes are inert metal. EDR stacks are tank-contained and often staged. Membrane selection is based on review of raw water characteristics. A single-stage EDR system usually removes 40-50 percent of arsenic and TDS. Additional stages are required to achieve higher removal efficiency if necessary. EDR uses the technique of regularly reversing the polarity of the electrodes, thereby freeing accumulated ions on the membrane surface. This process requires additional plumbing and electrical controls, but it increases membrane life, may require less added chemicals, and eases cleaning. The conventional EDR treatment train typically includes EDR membranes, chlorine disinfection, and clearwell storage. Treatment of surface water may also require pretreatment steps such as raw water pumps, debris screens, rapid mix with addition of a coagulant, slow mix flocculator, sedimentation basin or clarifier, and gravity filters. Microfiltration (MF) could be used in placement of flocculation, sedimentation and filtration. Additional treatment or management of the concentrate and the removed solids would be necessary prior to disposal.

Pretreatment. There are pretreatment requirements for pH, organics, turbidity, and other raw water characteristics. EDR typically requires chemical feed to prevent scaling, acid addition for pH adjustment, and a cartridge filter for prefiltration.

Maintenance. EDR membranes are durable, can tolerate a pH range from 1 to 10, and temperatures to 115 degrees Fahrenheit (ºF) for cleaning. They can be removed from the unit and scrubbed. Solids can be washed off by turning the power off and letting water circulate through the stack. Electrode washes flush out byproducts of electrode reaction. The byproducts are hydrogen, formed in the cathode space, and oxygen and chlorine gas, formed in the anode space. If the chlorine is not removed, toxic chlorine gas may form. Depending on raw water characteristics, the membranes would require regular maintenance or replacement. EDR requires reversing the polarity. Flushing at high volume/low pressure continuously is required to clean electrodes. If used, pretreatment filter replacement and backwashing would be required. The EDR stack must be disassembled, mechanically cleaned, and reassembled at regular intervals.

Waste Disposal. Highly concentrated reject flows, electrode cleaning flows, and spent membranes require approved disposal methods. Pretreatment processes and spent materials also require approved disposal methods.

Advantages (EDR)

- EDR can operate with minimal fouling or scaling, or chemical addition.
- Low pressure requirements; typically quieter than RO.
- Long membrane life expectancy; EDR extends membrane life and reduces maintenance.
- More flexible than RO in tailoring treated water quality requirements.

Disadvantages (EDR)

- Not suitable for high levels of iron, manganese, and hydrogen sulfide.

- High energy usage at higher TDS water.

EDR can be quite expensive to run because of the energy it uses. However, it is generally automated, which allows for small systems use. It can be used to simultaneously reduce arsenic and TDS.

1.4.5.4 Adsorption

Process – The adsorptive media process is a fixed-bed process by which ions in solution, such as arsenic, are removed by available adsorptive sites on an adsorptive media. When the available adsorptive sites are filled, spent media may be regenerated or simply thrown away and replaced with new media. Granular activated alumina (AA) was the first adsorptive media successfully applied for the removal of arsenic from water supplies. More recently, other adsorptive media (mostly iron-based) have been developed and marketed for arsenic removal. Recent USEPA studies demonstrated that iron-based adsorption media typically have higher arsenic removal capacities compared to alumina-based media. In the USEPA-sponsored Round 1 full-scale demonstration of arsenic removal technologies for small water systems program, the selected arsenic treatment technologies included nine adsorptive media systems, one IX system, one coagulation/filtration system, and one process modification.

The selected adsorptive media systems used four different adsorptive media, including three iron-based media (*e.g.,* ADI's G2, Severn Trent and AdEdge's E33, and US Filter's GFH), and one iron-modified AA media (*e.g.,* Kinetico's AAFS50, a product of Alcan). The G2 media is a dry powder of diatomaceous earth impregnated with a coating of ferric hydroxide, developed by ADI specifically for arsenic adsorption. ADI markets G2 for both As(V) and As(III) removal, but it preferentially removes As(V). G2 media adsorbs arsenic most effectively at pH values within the 5.5 to 7.5 range, and less effectively at a higher pH value.

The Bayoxide® E33 media was developed by Bayer AG for removal of arsenic from drinking water supplies. It is a dry granular iron oxide media designed to remove dissolved arsenic via adsorption onto its ferric oxide surface. Severn Trent markets the media in the U.S. for As(III) and As(V) removal as Sorb-33, and offers several arsenic package units (APU) with flowrates ranging from 150 to 300 gpm. Another company, AdEdge, provides similar systems using the same media (marketed as AD-33) with flowrates ranging from 5 to 150 gpm. E33 adsorbs arsenic and other ions, such as antimony, cadmium, chromate, lead, molybdenum, selenium and vanadium. The adsorption is effective at pH values ranging between 6.0 and 9.0. At greater than 8.0 to 8.5, pH adjustment is recommended to maintain its adsorption capacity. Two competing ions that can reduce the adsorption capacity are silica (at levels greater than 40 mg/L) and phosphate (at levels greater than 1 mg/L).

GFH is a moist granular ferric hydroxide media produced by GEH Wasserchemie GmbH of Germany and marketed by US Filter under an exclusive marketing agreement. GFH is capable of adsorbing both As(V) and As(III). GFH media adsorb arsenic with a pH range of 5.5 to 9.0, but less effectively at the upper end of this range. Competing ions such as silica and phosphate in source water can adsorb onto GFH media, thus reducing the arsenic removal capacity of the media.

The AAFS50 is a dry granular media of 83% alumina and a proprietary iron-based additive to enhance the arsenic adsorption performance. Standard AA was the first adsorptive media successfully applied for the removal of arsenic from water supplies. However, it often requires pH adjustment to 5.5 to achieve optimum arsenic removal. The AAFS50 product is modified with an iron-based additive to improve its performance and increase the pH range within which it can achieve effective removal. Optimum arsenic removal efficiency is achieved with a pH of the feed water less than 7.7. Competing ions such as fluoride, sulfate, silica, and phosphate can adsorb onto AAFS50 media, and potentially reduce its arsenic removal capacity. The adsorption capacity of AAFS50 can be impacted by both high levels of silica (>40 mg/L) and phosphate (>1 mg/L). The vendor recommended that the system be operated in a series configuration to minimize the chance for arsenic breakthrough to impact drinking water quality.

All iron-based or iron-modified adsorptive media are of the throwaway type after exhaustion. The operations of these adsorption systems are quite similar and simple. Some of the technologies such as the E33 and GFH media have been operated successfully on large scale plants in Europe for several years.

Pretreatment – The adsorptive media are primarily used to remove dissolved arsenic and not for suspended solids removal. Pretreatment to remove TSS may be required if raw water turbidity is >0.3 NTU. However, most well waters are low in turbidity and hence, pre-filtration is usually not required. Pre-chlorination may be required to oxidize As(III) to As(V) if the proportion of As(III) is high. No pH adjustment is required unless pH is relatively high.

Maintenance – Maintenance for the adsorption media system is minimal if no pretreatment is required. Backwash is required infrequently (monthly) and replacement and disposal of the exhausted media occurs between one to 3 years, depending on average water consumption, the concentrations of arsenic and competing ions in the raw water, and the media bed volume.

Waste Disposal – If no pretreatment is required there is minimal waste disposal involved with the adsorptive media system. Disposal of backwash wastewater is required especially during startup. Regular backwash is infrequent and disposal of the exhausted media occurs once every one to three years, depending on operating conditions. The exhausted media are usually considered non-hazardous wastes.

Advantages (Adsorption)

- Some adsorbents can remove both As(III) and As(V); and
- Very simple to operate.

Disadvantages (Adsorption)

- Relatively new technology; and

- Need replacement of adsorption media when exhausted.

The adsorption media process is the most simple and requires minimal operator attention, compared to other arsenic removal processes. The process is most applicable to small wellhead systems with low or moderate arsenic concentrations with no treatment process in place (*e.g.,* iron and manganese removal; if treatment facilities for iron and/or manganese removal are already in place, incorporating ferric chloride coagulation in the existing system would be a more cost-effective alternative for arsenic removal). The choice of media will depend on raw water characteristics, life cycle cost, and experience of the vendor. Many of the adsorption media are at the field-trial stage, but others are already being used in full-scale applications throughout Europe and the U.S.. Pilot testing may or may not be necessary prior to implementation depending on the experience of the vendor with similar water characteristics.

1.4.5.5 Coagulation/Filtration and Iron Removal Technologies

Process – Iron removal processes can be used to removal arsenic from drinking water supplies. Iron removal processes involved the oxidation of soluble iron and As(III), adsorption and/or co-precipitation of As(V) onto iron hydroxides, and filtration. The filtration can be accomplished with granular media filter or microfilter. When iron in the raw water is inadequate to accomplish arsenic removal an iron salt such as ferric chloride is added to the water to form ferric hydroxide. The iron removal process is commonly called coagulation/filtration because iron in the form of ferric chloride is a common coagulant. The actual capacity to remove arsenic during iron removal depends on a number of factors, including the amount of arsenic present, arsenic speciation, pH, amount and form of iron present, and existence of competing ions, such as phosphate, silicate, and natural organic matter. The filters used in groundwater treatment are usually pressure filters feeding directly by the well pumps. The filter media can be regular dual media filters or proprietary media such as the engineered ceramic filtration media, Macrolite®, developed by Kinetico. Macrolite® is a low-density, spherical media designed to allow for filtration rates up to 10 gpm/ft^2, which is a higher loading rate than commonly used for conventional filtration media.

Pretreatment – Pre-chlorination to oxidize As(III) to As(V) is usually required for most groundwater sources. The adjustment of pH is required only for relatively high pH value. Coagulation with the feed of ferric chloride is required for this process. Sometimes a 5-minute contact tank is required ahead the filters if the pH is high.

Maintenance – Maintenance is mainly to handle ferric chloride chemical and feed system, and for regular backwash of the filters. No filter replacement is required for this process.

Waste Disposal – The waste from the coagulation/filtration process is mainly the iron hydroxide sludge with adsorbed arsenic in the backwash water. The backwash water can be discharged to a public sewer if it is available. If a sewer is not available, the backwash water can be discharged to a storage and settling tank from where the supernatant is recycled in a controlled rate to the front of the treatment system and the settled sludge can be disposed of periodically to a landfill. The iron hydroxide sludge is usually not classified as hazardous waste.

Advantages (Coagulation/Filtration)

- Very established technology for arsenic removal; and
- Most economical process for arsenic removal.

Disadvantages (Coagulation/Filtration)

- Need to handle chemical;
- Need to dispose of regular backwash wastewater; and
- Need to dispose of sludge.

The coagulation/filtration process is usually the most economical arsenic removal alternative, especially if a public sewer is available for accepting the discharge of the backwash water. However, because of the regular filter backwash requirements, more operation and maintenance attention is required from the utilities. Because of potential interference by competing ions bench-scale or pilot scaling testing may be required to ensure that the arsenic MCL can be met with this process alternative.

1.4.6 Point-of-Entry and Point-of-Use Treatment Systems

Point-of-entry (POE) and point-of-use (POU) treatment systems can be used to provide compliant drinking water. For arsenic removal, these systems typically use small RO treatment units installed "under the sink" in the case of POU, and where water enters a residence or building in the case of POE. POE and POU treatment units would be purchased and owned by the PWS. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets in order to meet regulatory requirements, making purchase and installation more expensive. These solutions are decentralized in nature, and require utility personnel entry into houses or at least onto private property for installation, maintenance, and testing. Due to the small number of treatment units that would be employed and which would be primarily out of the control of the PWS, it is very difficult to ensure 100 percent compliance. Prior to selection of a point-of-entry or point-of-use program for implementation, consultation with TCEQ would be required to address measurement and determination of level of compliance.

The SDWA [§1412(b)(4)(E)(ii)] regulates the design, management and operation of POU and POE treatment units used to achieve compliance with an MCL. These restrictions, relevant to arsenic are:

- POU and POE treatment units must be owned, controlled, and maintained by the water system, although the utility may hire a contractor to ensure proper operation and maintenance (O&M) and compliance with MCLs. The water system must retain unit ownership and oversight of unit installation, maintenance and sampling; the utility is ultimately the responsible party for regulatory compliance. The water system staff need not perform all installation, maintenance, or management functions, as these tasks may be contracted to a third party-but the final responsibility for the quality and quantity of the water supplied to the community resides with the water system, and the utility must monitor all contractors closely. Responsibility for O&M of POU or POE devices installed for SDWA compliance may not be delegated to homeowners.

- POU and POE units must have mechanical warning systems to automatically notify customers of operational problems. Each POU or POE treatment device must be equipped with a warning device (e.g., alarm, light) that would alert users when their unit is no longer adequately treating their water. As an alternative, units may be equipped with an automatic shut-off mechanism to meet this requirement.
- If the American National Standards Institute (ANSI) has issued product standards for a specific type of POU or POE treatment unit, only those units that have been independently certified according to those standards may be used as part of a compliance strategy.

The following observations with regard to using POE and POU devices for SDWA compliance were made by Raucher, *et al.* (2004):

- If POU devices are used as an SDWA compliance strategy, certain consumer behavioral changes will be necessary (e.g., encouraging people to drink water only from certain treated taps) to ensure comprehensive consumer health protection.
- Although not explicitly prohibited in the SDWA, USEPA indicates that POU treatment devices should not be used to treat for radon or for most volatile organic contaminants (VOC) to achieve compliance, because POU devices do not provide 100 percent protection against inhalation or contact exposure to those contaminants at untreated taps (e.g., shower heads).
- Liability – PWSs considering unconventional treatment options (POU, POE, or bottled water) must address liability issues. These could be meeting drinking water standards, property entry and ensuing liabilities, and damage arising from improper installation or improper function of the POU and POE devices.

1.4.7 Water Delivery or Central Drinking Water Dispensers

Current USEPA regulations (40 Code of Federal Regulations [CFR] 141.101) prohibit the use of bottled water to achieve compliance with an MCL, except on a temporary basis. State regulations do not directly address the use of bottled water. Use of bottled water at a non-compliant PWS would be on a temporary basis. Every 3 years, the PWSs that employ interim measures are required to present the TCEQ with estimates of costs for piping compliant water to their systems. As long as the projected costs remain prohibitively high, the bottled water interim measure is extended. Until USEPA amends the noted regulation, the TCEQ is unable to accept water delivery or central drinking water dispensers as compliance solutions.

Central provision of compliant drinking water would consist of having one or more dispensers of compliant water where customers could come to fill containers with drinking water. The centralized water source could be from small to medium-sized treatment units or could be compliant water delivered to the central point by truck.

Water delivery is an interim measure for providing compliant water. As an interim measure for a small impacted population, providing delivered drinking water may be cost effective. If the susceptible population is large, the cost of water delivery would increase significantly.

Water delivery programs require consumer participation to a varying degree. Ideally, consumers would have to do no more than they currently do for a piped-water delivery system. Least desirable are those systems that require maximum effort on the part of the customer (*e.g.,* customer has to travel to get the water, transport the water, and physically handle the bottles). Such a system may appear to be lowest-cost to the utility; however, should a consumer experience ill effects from contaminated water and take legal action, the ultimate cost could increase significantly.

The ideal system would:

- Completely identify the susceptible population. If bottled water is only provided to customers who are part of the susceptible population, the utility should have an active means of identifying the susceptible population. Problems with illiteracy, language fluency, fear of legal authority, desire for privacy, and apathy may be reasons that some members of the susceptible population do not become known to the utility, and do not take part in the water delivery program.
- Maintain customer privacy by eliminating the need for utility personnel to enter the home.
- Have buffer capacity (*e.g.,* two bottles in service, so when one is empty, the other is being used over a time period sufficient to allow the utility to change out the empty bottle).
- Provide for regularly scheduled delivery so the customer would not have to notify the utility when the supply is low.
- Use utility personnel and equipment to handle water containers, without requiring customers to lift or handle bottles with water in them.
- Be sanitary (*e.g.,* where an outside connection is made, contaminants from the environment must be eliminated).
- Be vandal-resistant.
- Avoid heating the water due to exterior temperatures and solar radiation.
- Avoid freezing the water.

SECTION 2
EVALUATION METHODS

2.1 DECISION TREE

The decision tree is a flow chart for conducting feasibility studies for a non-compliant PWS. The decision tree is shown in Figures 2.1 through 2.4. The tree guides the user through a series of phases in the design process. Figure 2.1 shows Tree 1, which outlines the process for defining the existing system parameters, followed by optimizing the existing treatment system operation. If optimizing the existing system does not correct the deficiency, the tree leads to six alternative preliminary branches for investigation. The groundwater branch leads through investigating existing wells to developing a new well field. The treatment alternatives address centralized and on-site treatment. The objective of this phase is to develop conceptual designs and cost estimates for the six types of alternatives. The work done for this report follows through Tree 1 and Tree 2, as well as a preliminary pass through Tree 4.

Tree 3, which begins at the conclusion of the work for this report, starts with a comparison of the conceptual designs, selecting the two or three alternatives that appear to be most promising, and eliminating those alternatives which are obviously infeasible. It is envisaged that a process similar to this would be used by the study PWS to refine the list of viable alternatives. The selected alternatives are then subjected to intensive investigation, and highlighted by an investigation into the socio-political aspects of implementation. Designs are further refined and compared, resulting in selection of a preferred alternative. The steps for assessing the financial, managerial, and economic aspects of the alternatives (one of the steps in Tree 3) are given in Tree 4 in Figure 2.4.

2.2 DATA SOURCES AND DATA COLLECTION

2.2.1 Data Search

2.2.1.1 Water Supply Systems

The TCEQ maintains a set of files on public water systems, utilities, and districts at its headquarters in Austin, Texas. The files are organized under two identifiers: a PWS identification number and a Certificate of Convenience and Necessity (CCN) number. The PWS identification number is used to retrieve four types of files:

- CO – Correspondence,
- CA – Chemical analysis,
- MOR – Monthly operating reports (quality/quantity), and
- FMT – Financial, managerial and technical issues.

Figure 2.1
TREE 1 – EXISTING FACILITY ANALYSIS

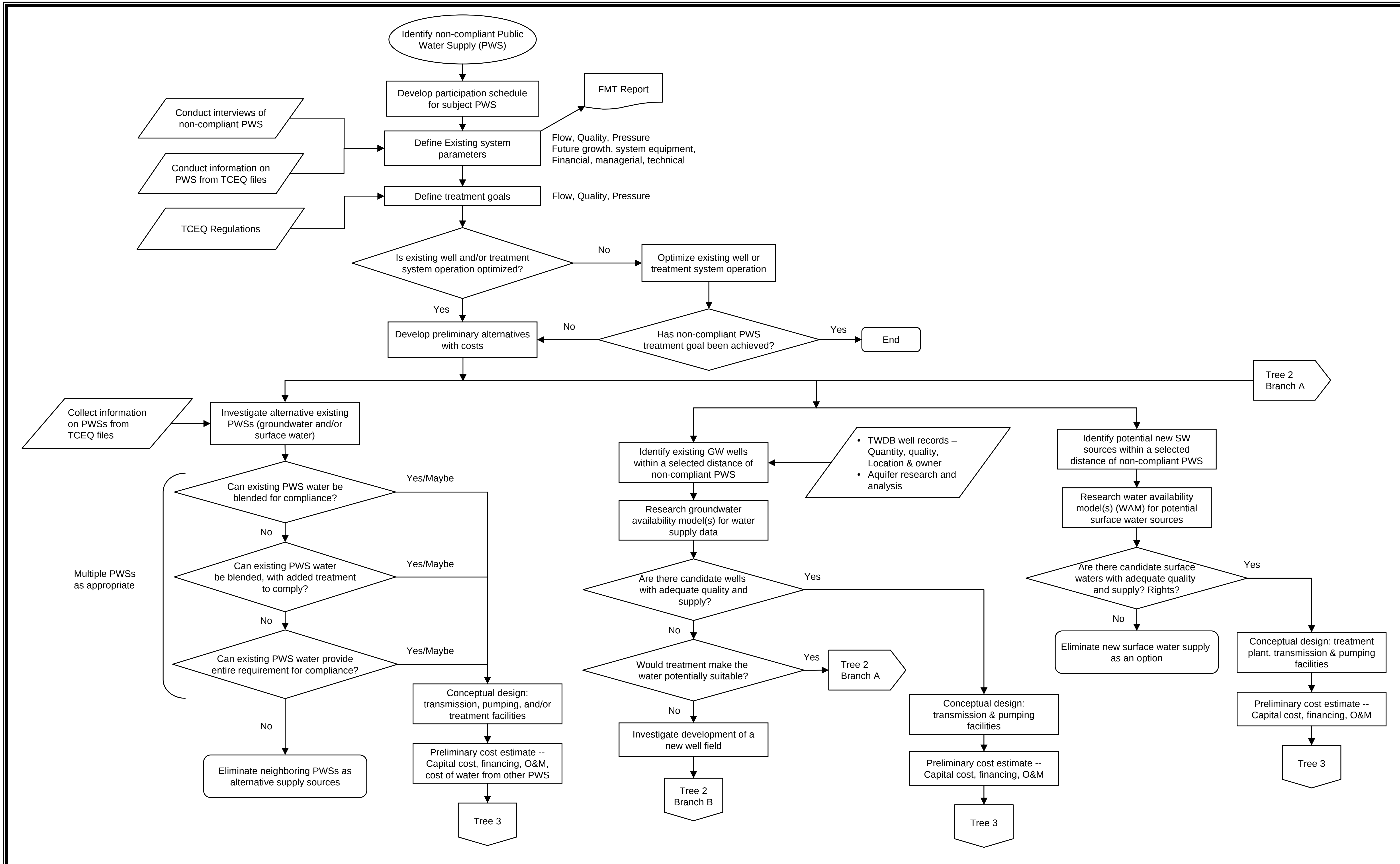
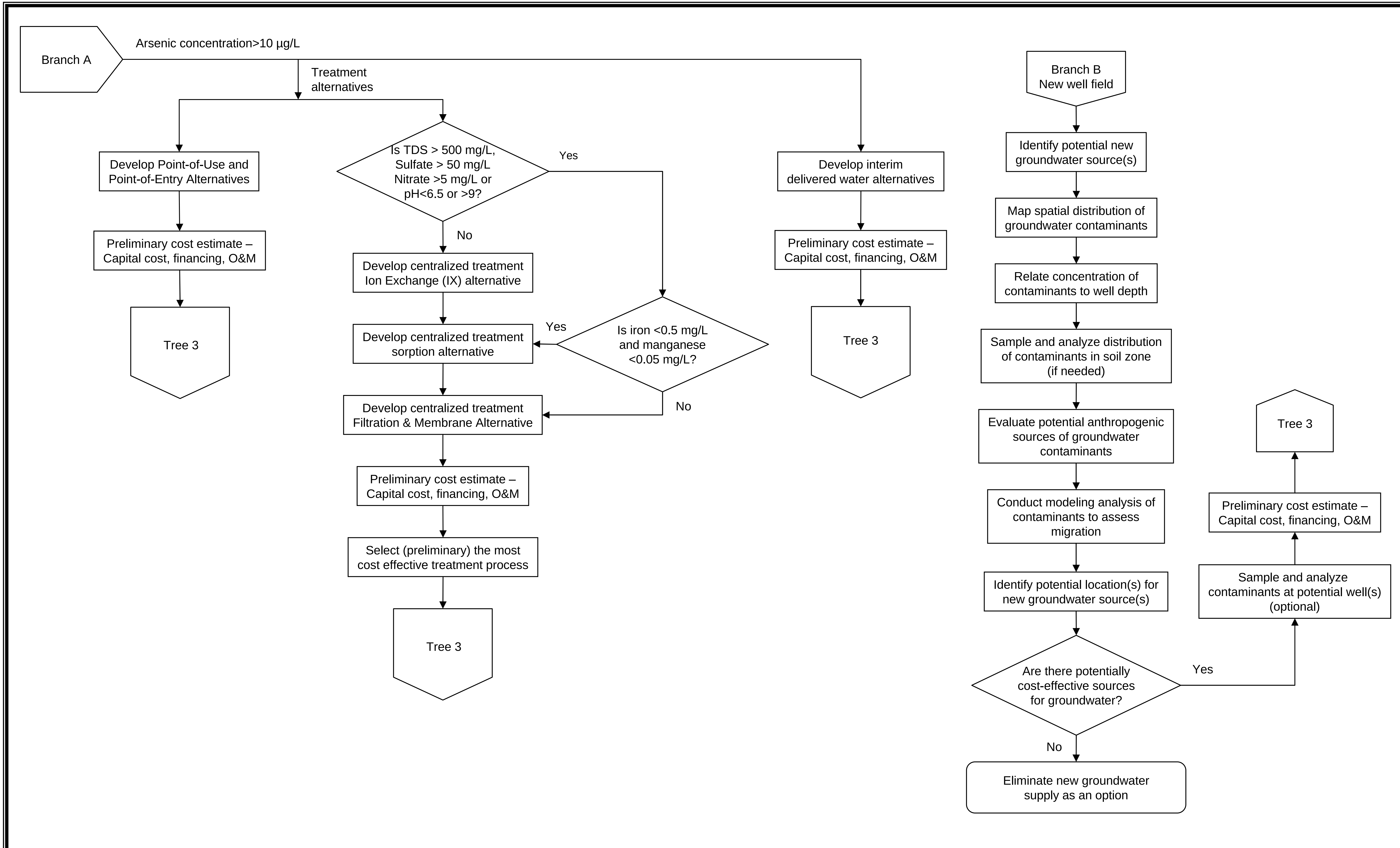


Figure 2.2
TREE 2 – DEVELOP TREATMENT ALTERNATIVES



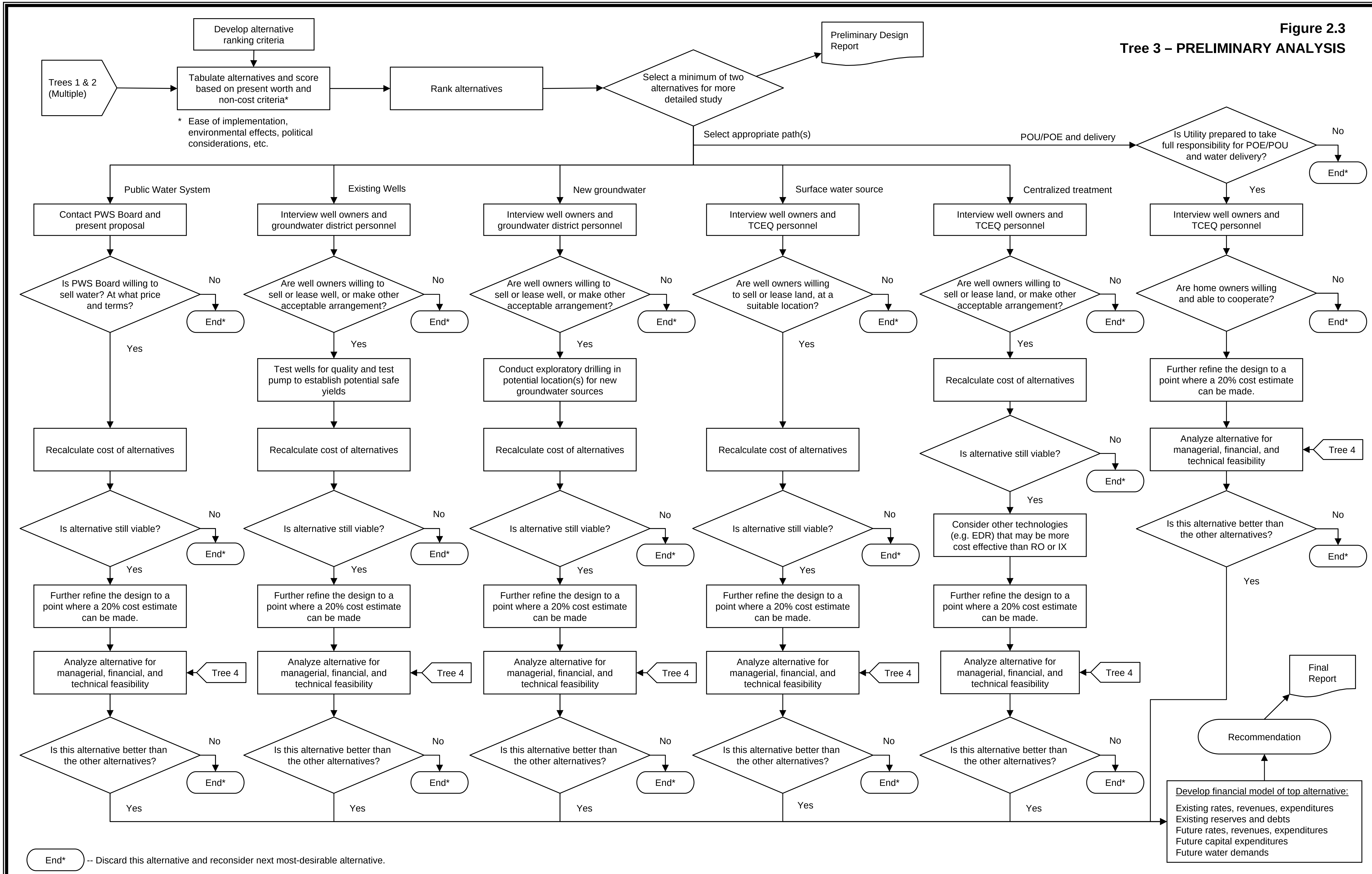
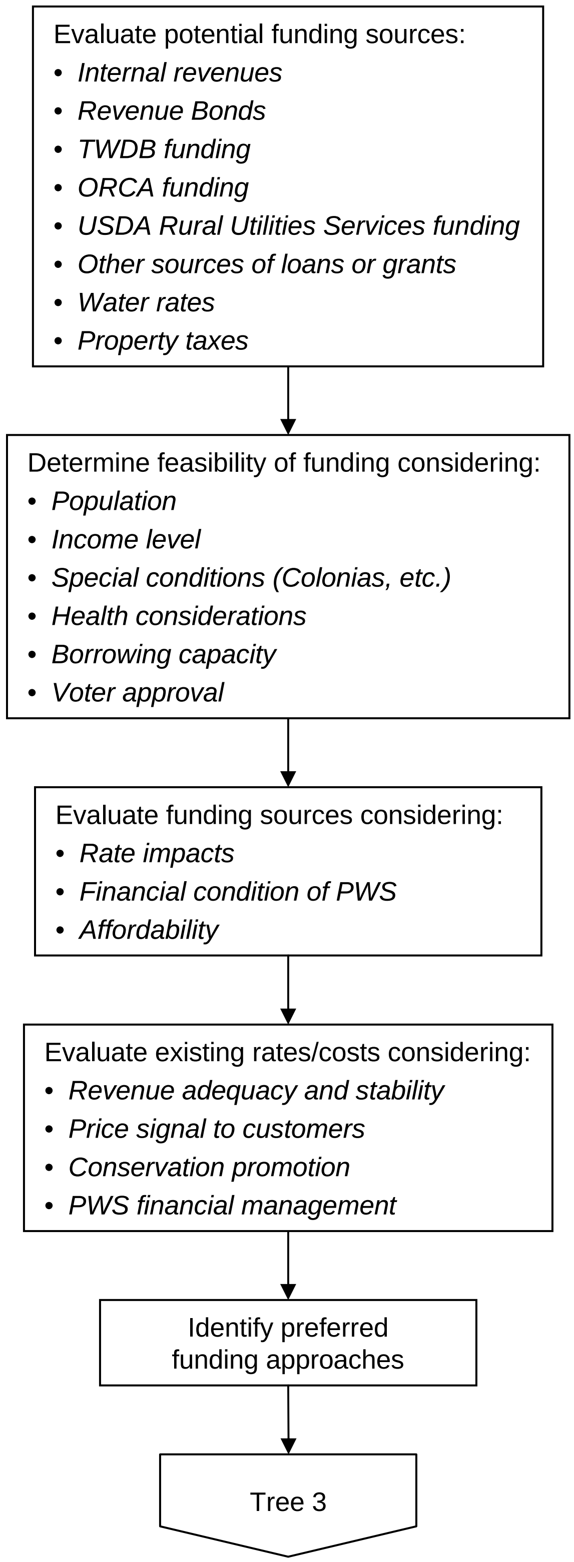


Figure 2.3
Tree 3 – PRELIMINARY ANALYSIS

Figure 2.4
TREE 4 – FINANCIAL



The CCN files generally contain a copy of the system's Certificate of Convenience and Necessity, along with maps and other technical data.

These files were reviewed for the Bruni PWS and surrounding systems.

The following websites were consulted to identify the water supply systems in the study area:

- Texas Commission on Environmental Quality www3.tnrcc.state.tx.us/iwud/pws/index.cfm?. Under "Advanced Search," type in the name(s) of the County(ies) in the area to get a listing of the public water supply systems.
- USEPA Safe Drinking Water Information System www.epa.gov/safewater/data/getdata.html

Groundwater Control Districts were identified on the TWDB web site, which has a series of maps covering various groundwater and surface water subjects. One of those maps shows groundwater control districts in the State of Texas.

2.2.1.2 Existing Wells

The TWDB maintains a groundwater database available at www.twdb.state.tx.us that has two tables with helpful information. The "Well Data Table" provides a physical description of the well, owner, location in terms of latitude and longitude, current use, and for some wells, items such as flowrate, and nature of the surrounding formation. The "Water Quality Table" provides information on the aquifer and the various chemical concentrations in the water.

2.2.1.3 Surface Water Sources

Regional planning documents were consulted for lists of surface water sources.

2.2.1.4 Groundwater Availability Model

GAMs, developed by the TWDB, are planning tools and should be consulted as part of a search for new or supplementary water sources. The GAM for the Gulf Coast Aquifer was investigated as a potential tool for identifying available and suitable groundwater resources.

The Gulf Coast aquifer is the main groundwater source in Webb and surrounding counties; the Bruni system is located in the western edge of the aquifer, where water is obtained from the deepest of four Gulf Coast aquifer units, the Catahoula formation. The Yegua-Jackson aquifer, a minor aquifer as defined by TWDB, is also groundwater source in Webb County; PWS connected to this aquifer are found within 10 miles of the Bruni System. Groundwater use in Webb County is relatively small, approx 1,526 AFY or 3.4% of total county water uses (Mace et al., 2006).

A groundwater availability model (GAM) evaluation was not run for the Bruni system. The TWDB developed a GAM for southern section of the Gulf Coast aquifer, the lower Rio Grande Valley (Chowdhury and Mace, 2003). The model covered the adjacent counties of Starr and Jim Hogg but not Webb County itself given its location at the aquifer's edge. On a regional basis, the lower Rio Grande Valley GAM predicted an approx. 16% increase in Gulf Coast aquifer utilization, from a current value of approx. 24,000 AFY to 28,000 AFY in 2050. The projected demand is expected to result in a cumulative decrease in the regional aquifer storage of approx. 8,900 AFY.

For the Yegua-Jackson aquifer, a relatively large use of water from this source has been reported (Mace et al., 2006). A GAM model for this aquifer is under development by the TWDB, but numerical simulation data are not yet available.

2.2.1.5 Water Availability Model

The WAM is a computer-based simulation predicting the amount of water that would be in a river or stream under a specified set of conditions. WAMs are used to determine whether water would be available for a newly requested water right or amendment. If water is available, these models estimate how often the applicant could count on water under various conditions (*e.g.*, whether water would be available only 1 month out of the year, half the year, or all year, and whether that water would be available in a repeat of the drought of record).

WAMs provide information that assist TCEQ staff in determining whether to recommend the granting or denial of an application.

There is a minimum potential for development of new surface water sources for the Bruni system as indicated by limited water availability within the site vicinity. The Bruni System is located within the Nueces-Rio Grande Coastal Basin where current surface water availability is expected to remain at current levels over the next 50 years according to the Texas Water Development Board's 2002 Water Plan (approximately 18,341 AFY during drought conditions).

The vicinity of the Bruni system has a minimum availability of surface water for new uses as indicated by the TCEQ's availability maps for the Nueces-Rio Grande Coastal Basin. Over a 20-mile radius of the site, unappropriated flows for new uses within the basin are available at most 25 percent of the time. This supply is inadequate as the TCEQ requires 100 percent supply availability for a PWS.

Approximately 15 miles west and 10 miles southwest of Bruni, the potential surface water source transitions from the Nueces-Rio Grande Coastal Basin to the Rio Grande River Basin. The Rio Grande River Basin segment located within a 20-mile radius of Bruni is also very limited in surface water availability; the Texas Water Development Board's 2002 Water Plan anticipates a 25 percent reduction in surface water availability over the entire basin over the next 50 years, from approximately 1,238,743 AFY in 2000 to 932,510 AFY in 2050.

2.2.1.6 Financial Data

Financial data were collected through a site visit. Data sought included:

- Annual Budget
- Audited Financial Statements
  - Balance Sheet
  - Income and Expense Statement
  - Cash Flow Statement
  - Debt Schedule
- Water Rate Structure
- Water Use Data
  - Production
  - Billing
  - Customer Counts

2.2.1.7 Demographic Data

Basic demographic data were collected from the 2000 U.S. Census to establish incomes and eligibility for potential low cost funding for capital improvements. Median household income (MHI) and number of families below poverty level were the primary data points of significance. If available, MHI for the customers of the PWS should be used. In addition, unemployment data were collected from current U.S. Bureau of Labor Statistics. These data were collected for the following levels: national, state, and county.

2.2.2 PWS Interviews

2.2.2.1 PWS Capacity Assessment Process

A capacity assessment is the industry standard term for an evaluation of a water system's FMT capacity to effectively deliver safe drinking water to its customers now and in the future at a reasonable cost, and to achieve, maintain and plan for compliance with applicable regulations. The assessment process involves interviews with staff and management who have a responsibility in the O&M of the system.

FMT capacity are individual yet highly interrelated components of a system's capacity. A system cannot sustain capacity without maintaining adequate capability in all three components.

Financial capacity is a water system's ability to acquire and manage sufficient financial resources to allow the system to achieve and maintain compliance with SDWA regulations.

Financial capacity refers to the financial resources of the water system, including but not limited to revenue sufficiency, credit worthiness, and fiscal controls.

Managerial capacity is the ability of a water system to conduct its affairs so that the system is able to achieve and maintain compliance with SDWA requirements. Managerial capacity refers to the management structure of the water system, including but not limited to ownership accountability, staffing and organization, and effective relationships to customers and regulatory agencies.

Technical capacity is the physical and operational ability of a water system to achieve and maintain compliance with the SDWA regulations. It refers to the physical infrastructure of the water system, including the adequacy of the source water, treatment, storage and distribution infrastructure. It also refers to the ability of system personnel to effectively operate and maintain the system and to otherwise implement essential technical knowledge.

Many aspects of water system operations involve more than one component of capacity. Infrastructure replacement or improvement, for example, requires financial resources, management planning and oversight, and technical knowledge. A deficiency in any one area could disrupt the entire effort. A system that is able to meet both its immediate and long-term challenges demonstrates that it has sufficient FMT capacity.

Assessment of the FMT capacity of the PWS was based on an approach developed by the New Mexico Environmental Finance Center (NMEFC), which is consistent with TCEQ FMT assessment process. This method was developed from work the NMEFC did while assisting USEPA Region 6 in developing and piloting groundwater comprehensive performance evaluations. The NMEFC developed a standard list of questions that could be asked of water system personnel. The list was then tailored slightly to have two sets of questions – one for managerial and financial personnel, and one for operations personnel (the questions are included in Appendix A). Each person with a role in the FMT capacity of the system was asked the applicable standard set of questions individually. The interviewees were not given the questions in advance and were not told the answers others provided. Also, most of the questions are open ended type questions so they were not asked in a fashion to indicate what would be the "right" or "wrong" answer. The interviews lasted between 45 minutes to 75 minutes depending on the individual's role in the system and the length of the individual's answers.

In addition to the interview process, visual observations of the physical components of the system were made. A technical information form was created to capture this information. This form is also contained in Appendix A. This information was considered supplemental to the interviews because it served as a check on information provided in the interviews. For example, if an interviewee stated he or she had an excellent preventative maintenance schedule and the visit to the facility indicated a significant amount of deterioration (more than would be expected for the age of the facility) then the preventative maintenance program could be further investigated or the assessor could decide that the preventative maintenance program was inadequate.

Following interviews and observations of the facility, answers that all personnel provided were compared and contrasted to provide a clearer picture of the true operations at the water system. The intent was to go beyond simply asking the question, "Do you have a budget?" to actually finding out if the budget was developed and being used appropriately. For example, if a water system manager was asked the question, "Do you have a budget?" he or she may say, "yes" and the capacity assessor would be left with the impression that the system is doing well in this area. However, if several different people are asked about the budget in more detail, the assessor may find that although a budget is present, operations personnel do not have input into the budget, the budget is not used by the financial personnel, the budget is not updated regularly, or the budget is not used in setting or evaluating rates. With this approach, the inadequacy of the budget would be discovered and the capacity deficiency in this area would be noted.

Following the comparison of answers, the next step was to determine which items noted as a potential deficiency truly had a negative effect on the system's operations. If a system had what appeared to be a deficiency, but this deficiency was not creating a problem in terms of the operations or management of the system, it was not considered critical and may not have needed to be addressed as a high priority. As an example, the assessment may have revealed an insufficient number of staff members to operate the facility. However, it may also have been revealed that the system was able to work around that problem by receiving assistance from a neighboring system, so no severe problems resulted from the number of staff members. Although staffing may not be ideal, the system does not need to focus on this particular issue. The system needs to focus on items that are truly affecting operations. As an example of this type of deficiency, a system may lack a reserve account which can then lead the system to delay much-needed maintenance or repair on its storage tank. In this case, the system needs to address the reserve account issue so that proper maintenance can be completed.

The intent was to develop a list of capacity deficiencies with the greatest impact on the system's overall capacity. Those were the most critical items to address through follow-up technical assistance or by the system itself.

2.2.2.2 Interview Process

PWS personnel were interviewed by the project team, and each was interviewed separately. Interview forms were completed during each interview.

2.3 ALTERNATIVE DEVELOPMENT AND ANALYSIS

The initial objective for developing alternatives to address compliance issues was to identify a comprehensive range of possible options that can be evaluated to determine which are the most promising for implementation. Once the possible alternatives are identified, they must be defined in sufficient detail so a conceptual cost estimate (capital and O&M costs) can be developed. These conceptual cost estimates are used to compare the affordability of compliance alternatives, and to give a preliminary indication of rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation. The basis for the unit costs used for the compliance alternative cost estimates is summarized in Appendix B. Other non-economic factors for the alternatives, such as reliability and ease of implementation, are also addressed.

2.3.1 Existing PWS

The neighboring PWSs were identified, and the extents of their systems were investigated. PWSs farther than 30 miles from the non-compliant PWSs were not considered because the length of the pipeline required would make the alternative cost prohibitive. The quality of water provided was also investigated. For neighboring PWSs with compliant water, options for water purchase and/or expansion of existing well fields were considered. The neighboring PWSs with non-compliant water were considered as possible partners in sharing the cost for obtaining compliant water either through treatment or developing an alternate source.

The neighboring PWSs were investigated to get an idea of the water sources in use and the quantity of water that might be available for sale. They were contacted to identify key locations in their systems where a connection might be made to obtain water, and to explore on a preliminary basis their willingness to partner or sell water. Then, the major system components that would be required to provide compliant water were identified. The major system components included treatment units, wells, storage tanks, pump stations, and pipelines.

Once the major components were identified, a preliminary design was developed to identify sizing requirements and routings. A capital cost estimate was then developed based on the preliminary design of the required system components. An annual O&M cost was also estimated to reflect the change in O&M expenditures that would be needed if the alternative was implemented.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increase in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.3.2 New Groundwater Source

It was not possible in the scope of this study to determine conclusively whether new wells could be installed to provide compliant drinking water. To evaluate potential new groundwater source alternatives, three test cases were developed based on distance from the PWS intake point. The test cases were based on distances of 10 miles, 5 miles, and 1 mile. It was assumed that a pipeline would be required for all three test cases, and a storage tank and pump station would be required for the 10-mile and 5-mile alternatives. It was also assumed that new wells would be installed, and that their depths would be similar to the depths of the existing wells, or other existing drinking water wells in the area.

A preliminary design was developed to identify sizing requirements for the required system components. A capital cost estimate was then developed based on the preliminary design of the required system components. An annual O&M cost was also estimated to reflect the change (*i.e.*, from current expenditures) in O&M expenditures that would be needed if the alternative was implemented.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increase in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.3.3 New Surface Water Source

New surface water sources were investigated. Availability of adequate quality water was investigated for the main rivers in the study area, as well as the major reservoirs. TCEQ WAMs were inspected, and the WAM was run, where appropriate.

2.3.4 Treatment

Treatment technologies considered potentially applicable to arsenic removal are IX, RO, EDR, adsorption and coagulation/filtration. However, because of the high TDS in the well water (>1,800 mg/L), IX is not economically feasible. RO and EDR can also reduce TDS higher than the state secondary MCL of 1,000 mg/L. Adsorption and coagulation/filtration processes remove arsenic only without significantly affecting TDS. RO treatment is considered for central treatment alternatives, as well as POU and POE alternatives. EDR, adsorption, and coagulation/filtration are considered for central treatment alternatives only. Both RO and EDR treatment produce a liquid waste: a reject stream from RO treatment and a concentrate stream from EDR treatment. As a result, the treated volume of water is less than the volume of raw water that enters the treatment system. The amount of raw water used increases to produce the same amount of treated water if RO or EDR treatment is implemented. Partial treatment and blending treated and untreated water to meet the arsenic MCL would reduce the amount of raw water used. Adsorption and coagulation filtration treatments produce periodic backwash wastewater for disposal. The treatment units were sized based on flow rates, and capital and annual O&M cost estimates were made based on the size of the treatment equipment required. Neighboring non-compliant PWSs were identified to look for opportunities where the costs and benefits of central treatment could be shared between systems.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant increases in the management or technical capability of the PWS, and whether the alternative had the potential for regionalization.

2.4 COST OF SERVICE AND FUNDING ANALYSIS

The primary purpose of the cost of service and funding analysis is to determine the financial impact of implementing compliance alternatives, primarily by examining the required rate increases, and also the fraction of household income that water bills represent. The current financial situation is also reviewed to determine what rate increases are necessary for the PWS to achieve or maintain financial viability.

2.4.1 Financial Feasibility

A key financial metric is the comparison of average annual household water bill for a PWS customer to the MHI for the area. MHI data from the 2000 Census are used, at the most detailed level available for the community. Typically, county level data are used for small rural water utilities due to small population sizes. Annual water bills are determined for existing, base conditions, including consideration of additional rate increases needed under current conditions. Annual water bills are also calculated after adding incremental capital and operating costs for each of the alternatives to determine feasibility under several potential funding sources.

Additionally, the use of standard ratios provides insight into the financial condition of any business. Three ratios are particularly significant for water utilities:

- Current Ratio = current assets divided by current liabilities provides insight into the ability to meet short-term payments. For a healthy utility, the value should be greater than 1.0.
- Debt to Net Worth Ratio = total debt divided by net worth shows to what degree assets of the company have been funded through borrowing. A lower ratio indicates a healthier condition.
- Operating Ratio = total operating revenues divided by total operating expenses show the degree to which revenues cover ongoing expenses. The value is greater than 1.0 if the utility is covering its expenses.

2.4.2 Median Household Income

The 2000 U.S. Census is used as the basis for MHI. In addition to consideration of affordability, the annual MHI may also be an important factor for sources of funds for capital programs needed to resolve water quality issues. Many grant and loan programs are available to lower income rural areas, based on comparisons of local income to statewide incomes. In the 2000 Census, MHI for the State of Texas was $39,927, compared to the U.S. level of $41,994. For service areas with a sparse population base, county data may be the most reliable, and for many rural areas corresponds to census tract data. The census broke down MHIs geographically by block group and ZIP code. The MHIs can vary significantly for the same location, depending on the geographic subdivision chosen. The MHI for each PWS was estimated by selecting the most appropriate value based on block group or ZIP code based on results of the site interview and a comparison with the surrounding area.

2.4.3 Annual Average Water Bill

The annual average household water bill was calculated for existing conditions and for future conditions incorporating the alternative solutions. Average residential consumption is estimated and applied to the existing rate structure to estimate the annual water bill. The estimates are generated from a long-term financial planning model that details annual revenue, expenditure, and cash reserve requirements over a 30-year period.

2.4.4 Financial Plan Development

The financial planning model uses available data to establish base conditions under which the system operates. The model includes, as available:

- Accounts and consumption data
- Water tariff structure
- Beginning available cash balance
- Sources of receipts:
    - Customer billings
    - Membership fees
    - Capital Funding receipts from:
        - Grants
        - Proceeds from borrowing
- Operating expenditures:
    - Water purchases
    - Utilities
    - Administrative costs
    - Salaries
- Capital expenditures
- Debt service:
    - Existing principal and interest payments
    - Future principal and interest necessary to fund viable operations
- Net cash flow
- Restricted or desired cash balances:
    - Working capital reserve (based on 1-4 months of operating expenses)
    - Replacement reserves to provide funding for planned and unplanned repairs and replacements

From the model, changes in water rates are determined for existing conditions and for implementing the compliance alternatives.

2.4.5 Financial Plan Results

Results from the financial planning model are summarized in two areas: percentage of household income and total water rate increase necessary to implement the alternatives and maintain financial viability.

2.4.5.1 Funding Options

Results are summarized in a table that shows the following according to alternative and funding source:

- Percentage of the annual MHI that the average annual residential water bill represents.
- The first year in which a water rate increase would be required.
- The total increase in water rates required, compared to current rates.

Water rates resulting from the incremental capital costs of the alternative solutions are examined under a number of funding options. The first alternative examined is always funding from existing reserves plus future rate increases. Several funding options were analyzed to frame a range of possible outcomes.

- Grant funds for 100 percent of required capital. In this case, the PWS is only responsible for the associated O&M costs.
- Grant funds for 75 percent of required capital, with the balance treated as if revenue bond funded.
- Grant funds for 50 percent of required capital, with the balance treated as if revenue bond funded.
- State revolving fund loan at the most favorable available rates and terms applicable to the communities.
- If local MHI is greater than 75 percent of state MHI, standard terms, currently at 3.8 percent interest for non-rated entities. Additionally:
    - If local MHI = 70-75 percent of state MHI, 1 percent interest rate on loan.
    - If local MHI = 60-70 percent of state MHI, 0 percent interest rate on loan.
    - If local MHI = 50-60 percent of state MHI, 0 percent interest and 15 percent forgiveness of principal.
    - If local MHI less than 50 percent of state MHI, 0 percent interest and 35 percent forgiveness of principal.
- Terms of revenue bonds assumed to be 25-year term at 6.0 percent interest rate.

2.4.5.2 General Assumptions Embodied in Financial Plan Results

The basis used to project future financial performance for the financial plan model includes:

- No account growth (either positive or negative).
- No change in estimate of uncollectible revenues over time.
- Average consumption per account unchanged over time.
- No change in unaccounted for water as percentage of total (more efficient water use would lower total water requirements and costs).
- No inflation included in the analyses (although the model has provisions to add escalation of O&M costs, doing so would mix water rate impacts from inflation with the impacts from the alternatives being examined).
- Minimum working capital fund established for each district, based on specified months of O&M expenditures.
- O&M for alternatives begins 1 year after capital implementation.
- Balance of capital expenditures not funded from primary grant program is funded through debt (bond equivalent).
- Cash balance drives rate increases, unless provision chosen to override where current net cash flow is positive.

2.4.5.3 Interpretation of Financial Plan Results

Results from the financial plan model for each alternative are presented in Table 4.5 in Section 4 of this report. The model used six funding alternatives: paying cash up front (all revenue); 100 percent grant; 75 percent grant; 50 percent grant, State Revolving Fund (SRF); and obtaining a Loan/Bond. Table 4.5 shows the projected average annual water bill, the maximum percent of household income, and the percentage rate increase over current rates.

2.4.5.4 Potential Funding Sources

A number of potential funding sources exist for rural utilities. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs.

Within Texas, the following state agencies offer financial assistance if needed:

- TWDB;
- Office of Rural Community Affairs; and
- Texas Department of Health (Texas Small Towns Environment Program).

Small rural communities can also get assistance from the federal government. The primary agencies providing aid are:

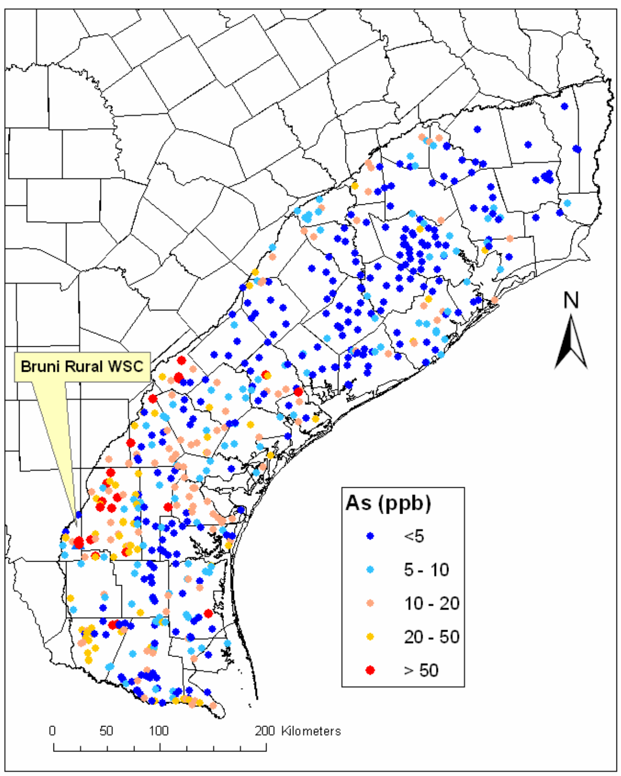
- United States Department of Agriculture, Rural Utilities Service, and
- United States Housing and Urban Development.

SECTION 3
UNDERSTANDING SOURCES OF CONTAMINANTS

3.1 ARSENIC IN THE GULF COAST AQUIFER

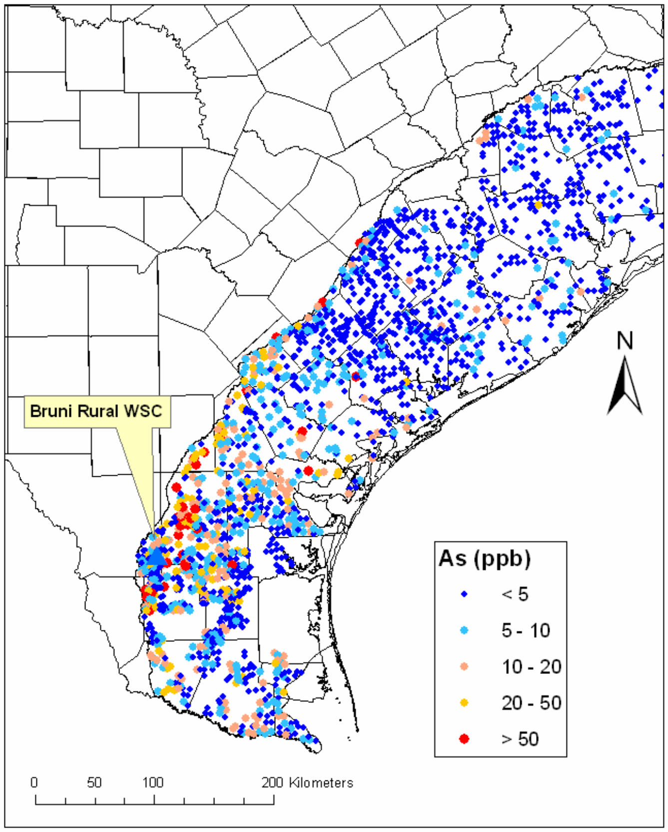
The Gulf Coast aquifer parallels the Texas Gulf Coast and extends from the Texas-Louisiana border to the Rio Grande. Individual aquifers within the larger Gulf Coast aquifer are, from oldest to youngest, the Jasper, Evangeline, and Chicot aquifers. The Gulf Coast aquifer is a leaky artesian system composed of middle to upper Tertiary and younger interbedded and hydrologically connected layers of clay, silt, sand, and gravel (Ashworth and Hopkins 1992). The PWS wells of concern are located in Webb County and are completed in the Jasper aquifer. Figure 3.1 shows detectable arsenic concentrations in the Gulf Coast aquifer. Data were obtained from the TWDB database and from the National Geochemical Database, also known as the National Uranium Resource Evaluation (NURE) database (Figure 3.2) (http://pubs.usgs.gov/of/1997/ofr-97-0492/index.html). Both figures show arsenic concentrations are higher in the southern part of the aquifer, especially south of the Colorado River, and highest in the southwestern area of the aquifer including Duval, McMullen, Webb, Jim Hogg, and Live Oak Counties.

Figure 3.1 Detectable Arsenic Concentrations in Groundwater (TWDB database)



The most recent value is shown for each well (number of samples shown is 583), and the most recent sample dates ranged between 1987 and 2005.

Figure 3.2 Detectable Arsenic Concentrations in Groundwater (NURE Database, Analyses from 1976 through 1980)



In the NURE database there is only one sample per well (number of samples shown is 3,920).

3.2 GEOLOGY OF WEBB COUNTY

Webb County represents a large area (8,743 km^2) with geology similar to the rest of the Gulf Coast. The several Gulf Coast progradation wedges of Tertiary age consist of alternating sandstones and claystones corresponding to variations in sea level and in inland sediment input as well as other factors. Those wedges are approximately parallel to the current shoreline, and the deposition process is still active today (*e.g.,* Mississippi River). Sediment layers are progressively younger from northwest to southeast through Webb County. Formations cropping out in the vicinity of the Dimmit County line have a regional dip of a couple of degrees and can be followed to a depth of approximately 8,000 feet at the Zapata – Jim Hogg County line.

Similar to other Gulf Coast counties, the oldest formations covering the mostly carbonate Cretaceous platform are predominantly clayey formations of the Midway Group. They crop out in Dimmit County and form the low-permeability base of the Tertiary Gulf Coast aquifer system. The subsequent sediment input cycles have been grouped into the following hydrostratigraphic units, approximately valid from the Mexican border to the Louisiana State line. They are, starting with the oldest: (1) the Carrizo - Wilcox aquifer (Eocene), (2) the Queen City – Sparta aquifer (Eocene), (3) the Yegua – Jackson aquifer (Eocene), and (4) the Gulf Coast aquifers sensu stricto (Miocene to recent) present in the coastal plains. Each of these units is separated by clayey aquitards and could also contain layers of lower permeability. The Carrizo-Wilcox and Gulf Coast aquifers are recognized as major aquifers in the State of Texas (Ashworth and Hopkins 1995). In the Tertiary Gulf Coast system, the general flow system consists of water infiltrating in the outcrop areas of the more permeable formations, some of it discharging into rivers and springs along short flow paths, and some of it flowing downdip into the deeper sections of the aquifers. The fate of that slowly moving water is to slowly percolate up by cross-formational flow and discharge into the ocean. This step is necessary to maintain a mass balance of the regional flow system although, because of sometimes heavy pumping, the natural upward flow has been locally reversed.

The Carrizo-Wilcox aquifer is mainly present in the northern half of Webb County and could provide a significant amount of water, although little pumping currently occurs (*e.g.,* Deeds, *et al.* 2003). The aquifer consists of fluvio-deltaic sediments of the Wilcox Group and of the Carrizo Sand. The Carrizo Sand produces high quality water, especially in the extreme northwest of the county. The Queen City Formation is separated from the Carrizo Sand by a marine clay: the Reclaw formation and from the overlying Sparta Sands by another marine clay: the Weches formation. Queen City and Sparta formations are often grouped together and are of fluvio-deltaic origin. The Queen City – Sparta aquifers do not strictly exist south of the Frio River, but equivalent water-bearing formations have been recognized (Bigford and Laredo formations) (Kelley *et al.* 2004). In Webb County, wells drilled in the formations equivalent to the Queen City – Sparta Formations yield slightly saline water. The Yegua Formation overlies another shaly layer (the Cook Mountain formation) separating it from the Sparta Sand and equivalent formations. The Yegua formation and Jackson Group yield relatively saline water in Webb County, except perhaps in the outcrop and shallow downdip areas (Mace, *et al.*. 2006). The top formation of the Jackson Group, the Frio Clay, and the Catahoula formation, form the regional confining unit between the Yegua – Jackson aquifer and the Gulf Coast aquifers in south Texas. Both are of Oligocene age, and the latter consists mainly of volcanic tuffs and their derived sediments. The Frio Clay is not to be confused with the Frio formation or Frio Sandstones of the deep subsurface that host multiple oil and gas reservoirs. Locally, the permeability of the Catahoula tuffs and sediments is high enough to qualify as an aquifer. A recognized geologic source of arsenic in groundwater is volcanic ash such as the tuffs of the Catahoula formation (Scanlon, *et al.* 2005). Arsenic is often associated with other chemical elements such as fluoride, vanadium, molybdenum, selenium, and uranium. The association is, in general, seen at the subregional level, although not necessarily at the well level because of different geochemical behavior of individual elements.

Only the base of the Gulf Coast aquifers is present in the extreme southeast of Webb County (Bruni area). The sediments are mainly of fluvio-deltaic or shallow marine in origin. In most of south Texas, the base of the Gulf Coast aquifers consists of the Jasper aquifer approximately equivalent to the Oakville Sandstones of Miocene age and of the Evangeline aquifer corresponding to the Goliad Sand of Pliocene age. A complex lower permeability system, called the Burkeville Confining System, which primarily includes the upper part of the Fleming formation, separates the Jasper and Evangeline aquifers. Although the Oakville Sandstones are thick in the middle sections of the Gulf Coast, they pinch out or have been eroded toward the Mexico border. This has generated confusion in the definition of the Jasper aquifer in Webb and surrounding counties. This hydrostratigraphic unit could also include Catahoula sandstones (*e.g.*, Chowdhury and Mace 2003), Oakville sandstones, and permeable formations of the Fleming formation or be altogether lumped into the Evangeline aquifer (*e.g.*, Adidas 1991). The four PWS wells of concern in Webb County are identified by the TWBD as being in the Jasper aquifer; completion depths are between 320-410 feet. The younger Chicot aquifer, uppermost subunit of the Gulf Coast aquifers and composed of Pleistocene sediments, is not present in Webb County.

3.3 GENERAL TRENDS IN ARSENIC CONCENTRATIONS

The geochemistry of arsenic is described in Appendix E. A regional analysis of arsenic trends in the southern part of the Gulf Coast aquifer was conducted to assess spatial trends, as well as correlations with other water quality parameters. Arsenic measurements from the TWDB database, the TCEQ PWS database, and from a subset of the NURE database, were used to assess arsenic trends. The spatial distribution of arsenic concentrations are shown from the TWDB (Figure 3.3) and NURE (Figure 3.4) databases.

Figure 3.3 Spatial Distribution of Arsenic Concentrations (TWDB Database)

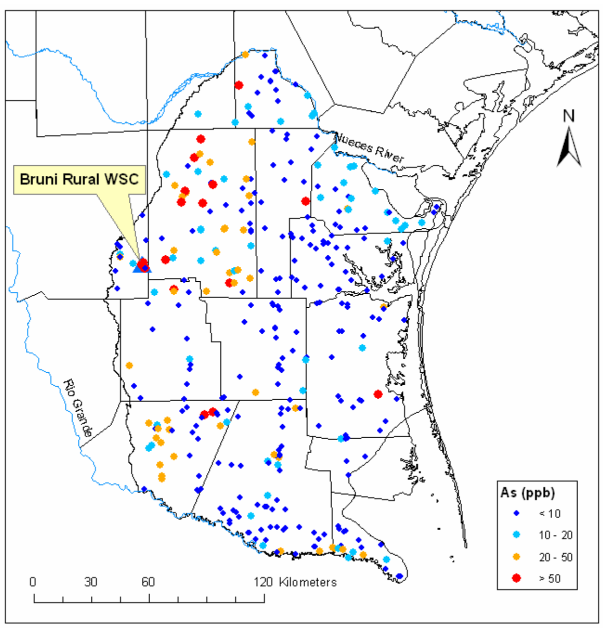
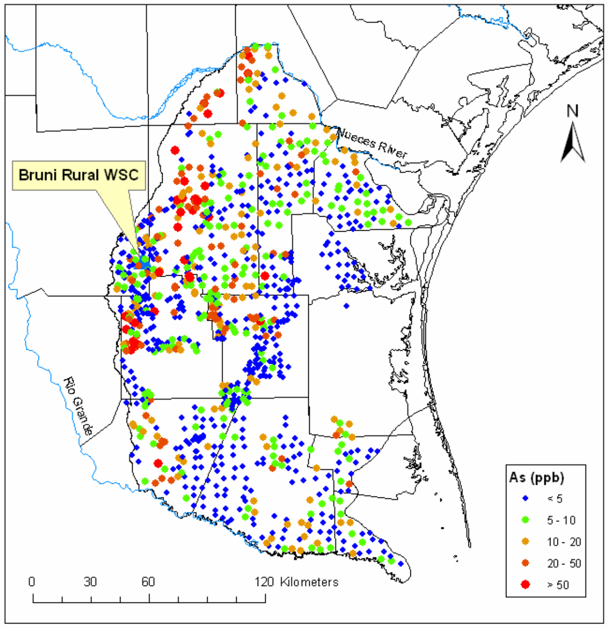


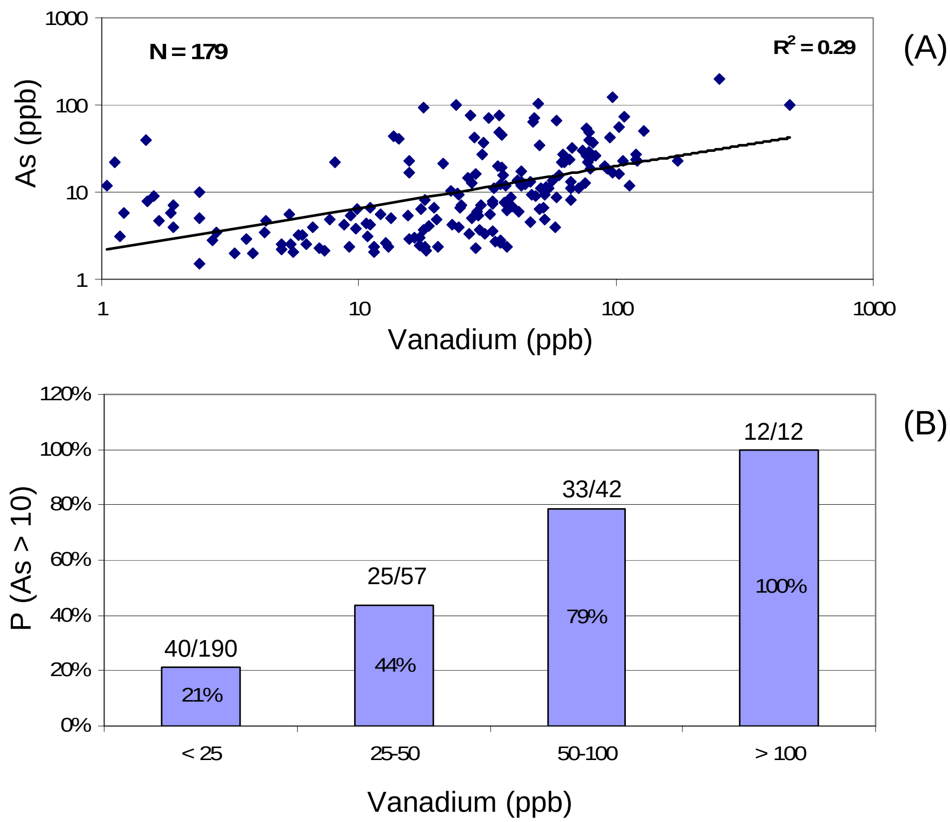
Figure 3.4 Spatial Distribution of Arsenic Concentrations (NURE Database)



The databases were queried within the southern part of the Gulf Coast aquifer, in the area south of the Nueces River. A total of 271 measurements are shown from the TWDB database; the values representing the most recent arsenic measurement taken at each well (only wells categorized within the Gulf Coast aquifer are included). Samples with values less than the detection limit are shown only if the detection limit is 10 ppb or less (total of three samples were omitted because of detection limits higher than 10 ppb). The NURE database contained 991 groundwater (sample type 03) arsenic measurements within the defined boundary. Because the wells have no aquifer identifier, no measurements were excluded.

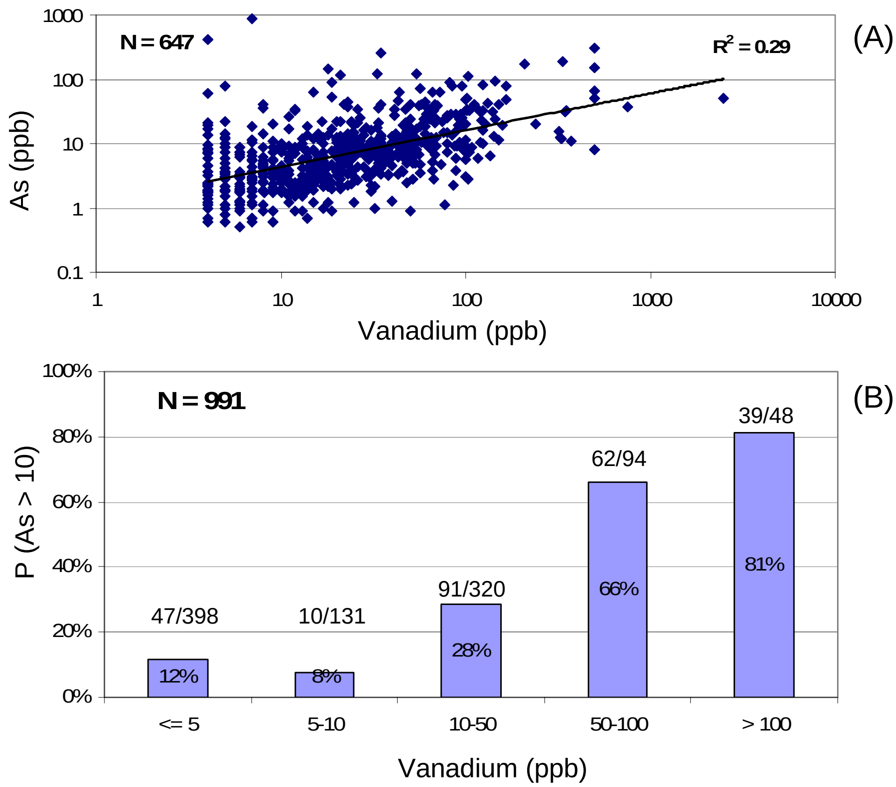
Relationships between arsenic and well depth, pH, dissolved oxygen, sulfate, fluoride, chloride, TDS, phosphorus, iron, selenium, boron, vanadium, uranium, and molybdenum were evaluated using data from the NURE and TWDB databases separately. Correlations between arsenic concentrations and most parameters were weak (r square values < 0.1); the highest correlation was found between arsenic and vanadium (r square $= 0.29$). Correlations with vanadium and probability plots of arsenic exceeding 10 ppb are shown in Figures 3.5 (NURE database) and Figure 3.6 (TWDB database).

Figure 3.5 Relationship Between Arsenic and Vanadium
(Data from the TWDB Database)



The correlation between arsenic and vanadium with data from the TWDB database is shown in Figure 3.5a. N represents the number of samples (samples below detection limit are not included in the upper plot). Percentages of arsenic samples ≥ 10 ppb for different ranges of vanadium concentrations are shown in Figure 3.5b. Numbers on top of the bar columns represent numbers of arsenic measurements ≥ 10 ppb relative to the total number of measurements in each bin. For example, "40/190" in the first vanadium bin (≤25), shows that 40 of 190 analyses had arsenic concentrations ≥ 10 ppb.

Figure 3.6 Relationship Between Arsenic and Vanadium (Data from the NURE Database)



The correlation between arsenic and vanadium with data from the NURE database is shown in Figure 3.6a. N represents the number of samples (samples below detection limit are not included). Percentages of arsenic samples ≥10 ppb for different ranges of vanadium concentrations are shown in Figure 3.5b.

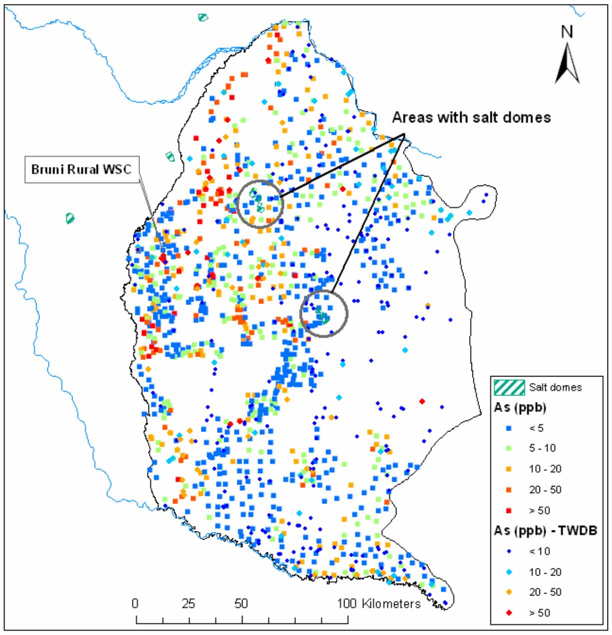
Relationships between arsenic and vanadium suggest natural geologic sources of arsenic in the analyzed area. However, data are insufficient to make this conclusion definitively.

3.4 POTENTIAL POINT SOURCES OF CONTAMINATION

Information regarding the location of Potential Sources of Contamination (PSOC) is collected as part of the TCEQ Source Water Assessment Program (SWAP). According to data in the SWAP database, the nearest potential sources of contamination are located about 1.5 km from the nearest Bruni PWS well, making the potential impact on the water quality in the well small.

Arsenic concentrations were also compared with known locations of salt domes. There are only two areas of known salt domes in the studied area, and these do not correspond with areas of elevated groundwater arsenic concentrations (Figure 3.7), and are not in the proximity to the PWS wells.

Figure 3.7 Salt Dome Locations and Arsenic Concentrations from TWDB and NURE databases



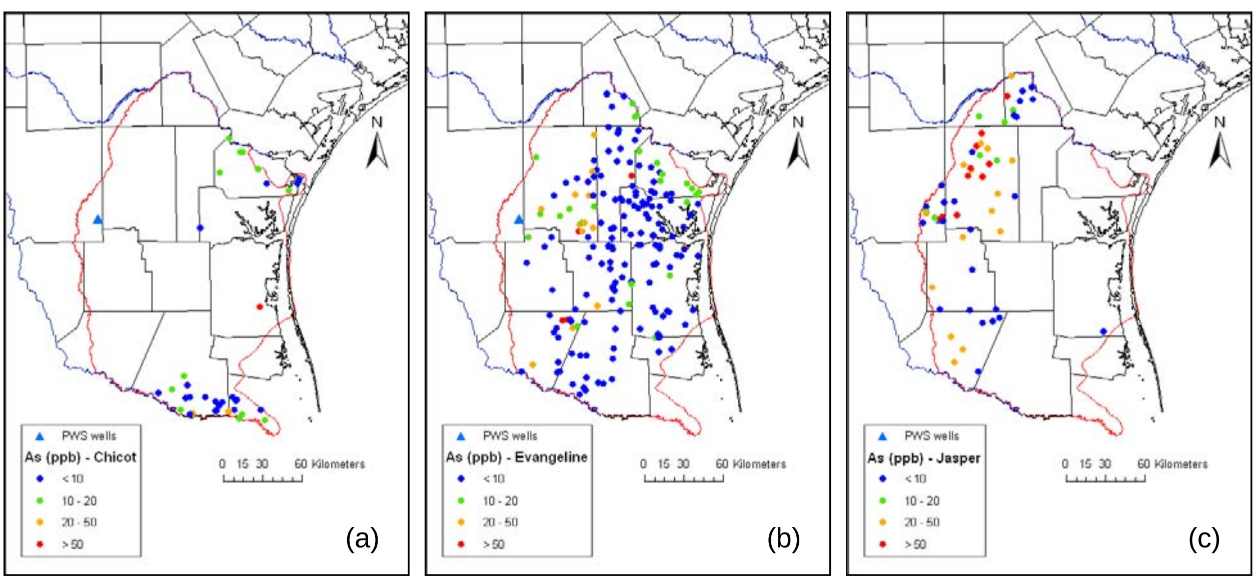
3.5 VARIABILITY OF ARSENIC CONCENTRATIONS AMONG GULF COAST AQUIFERS

Arsenic concentrations in the Jasper, Evangeline, and Chicot aquifers, from the southern part of the Gulf Coast aquifer, are compared (data from the TWDB database) to characterize arsenic concentrations and distribution in each aquifer. Table 3.1 shows the classification of the aquifers designated from the TWDB aquifer codes with arsenic summary statistics. The statistics show that arsenic concentrations are generally higher in the Jasper aquifer than in the Chicot and Evangeline aquifers. Especially notable are the high percentages (63%) of wells with concentrations greater than the 10 ppb arsenic MCL. Wells in the vicinity of the Bruni PWS are mostly in the Jasper aquifer, and many of the wells exhibit high arsenic concentrations (Figure 3.8).

Table 3.1 Summary Statistics for Wells in the Chicot, Evangeline, and Jasper Aquifer Subunits

Aquifer Sub Unit	Arsenic concentrations from the TWDB database (ppb)						
	Count	Minimum	Maximum	Median (including nondetects)	% < 10 ppb	% > 10 ppb	% > 25 ppb
Chicot: Aquifer codes: 110AVLS, 112BMLG, 112BMLS, 112BMNT, 112CHCT, 112CHCTL, 112CHCTU, and 112LISS	39	1.5	82	<10	59%	41%	8%
Evangeline: Aquifer codes: 110AVGL, 121EVGL, 112GOLD, and 121GOLD	191	1.4	99	7	76%	24%	7%
Jasper: Aquifer codes: 122CTHL, 122JSPR, 122LGRT, 122LOKV, 122OKVC, and 122OKVL	71	< 2	202	21	37%	63%	44%

Figure 3.8 Spatial Distribution of Arsenic (Most Recent Sample). (a) Chicot Aquifer, (b) Evangeline Aquifer, and (c) Jasper Aquifer



3.6 BRUNI PWS (PWS 2400003)

There are four wells in the Bruni PWS: G2400003A, G2400003B, G2400003C, and G0200011D. Table 3.2 shows the depth and screen intervals of the wells, and their associated aquifer, and Table 3.3 summarizes arsenic concentrations measured at the PWS. All the PWS wells are related to the same entry point of the water supply, thus making it difficult to separate the source of arsenic in samples taken at the water supply system.

Table 3.2 Well Depth and Screen Depth for Wells in the Bruni PWS

Water source	Depth	Screen depth	Aquifer
G2400003A*	400	NA	Jasper
G2400003B	410	235 - 410	Jasper
G2400003C*	400	NA	Jasper
G2400003D	320	NA	Jasper

NA = Not Available
** Currently used by the Bruni PWS*

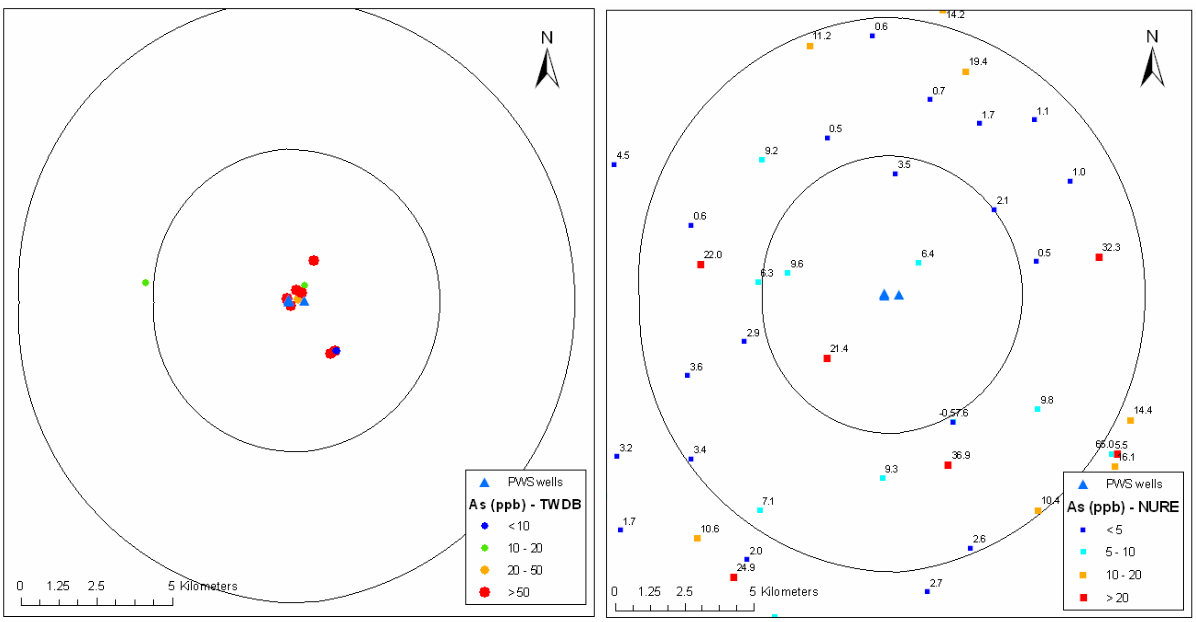
Table 3.3 Arsenic Concentrations in the Bruni PWS (data from the TCEQ and TWDB databases).

Date	Well	As (ppb)	Source
3/25/1986	State well number 8434403 (62400003C)	88	TWDB
12/18/1987	State well number 8434401 (62400003A)	76	TWDB
12/18/1987	State well number 8434402 (62400003B)	197	TWDB
12/18/1987	State well number 8434403 (62400003C)	71	TWDB
4/2/1997	NA	113.4	TCEQ
5/6/1997	State well number 8434401 (62400003A)	120	TWDB
1/12/1998	NA	104	TCEQ
8/21/2000	NA	95.2	TCEQ
1/25/2001	NA	82	TCEQ
4/3/2001	State well number 8434401 (62400003A)	86.8	TWDB
2/25/2002	NA	90.7	TCEQ
2/25/2002	NA	90.7	TCEQ
5/28/2002	NA	83	TCEQ
8/5/2002	NA	92.2	TCEQ
8/5/2002	NA	92.2	TCEQ
10/17/2002	NA	89	TCEQ
10/17/2002	NA	89	TCEQ
3/26/2003	NA	80	TCEQ
6/19/2003	NA	90	TCEQ
8/5/2003	NA	89.5	TCEQ
10/27/2003	NA	75.9	TCEQ
2/18/2004	NA	76.5	TCEQ

Date	Well	As (ppb)	Source
5/20/2004	NA	88.4	TCEQ
8/12/2004	NA	100	TCEQ
10/26/2004	NA	84.8	TCEQ
2/15/2005	NA	100	TCEQ
3/15/2005	State well number 8434401 (62400003A)	94.8	TWDB

There are 27 arsenic measurements from the TCEQ and TWDB databases taken between 1986 and 2005. All entry point samples had arsenic concentration exceeding the MCL of 10 ppb, in addition wells A, B, and C were sampled individually and also had high arsenic concentrations (between 71 and 120 ppb). This suggests that all wells in the PWS yield high arsenic water, and closing specific wells in the PWS will not resolve the arsenic incompliance. Figure 3.9 shows arsenic concentrations measured at wells in the 5- and 10-km buffers of the PWS wells.

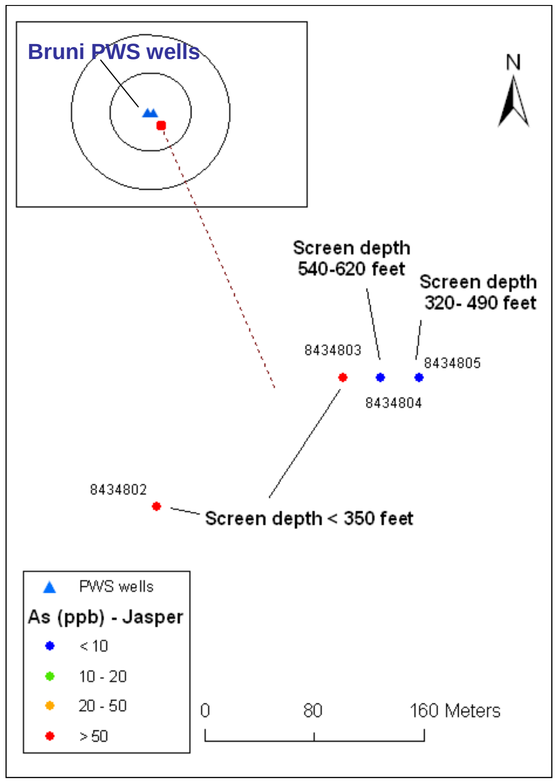
Figure 3.9 Arsenic Concentrations in 5- and 10-km Buffers of Bruni PWS Wells (TWDB and NURE databases)



Arsenic concentrations from the TWDB database represent the most recent measurements from the TWDB database (dates between 1987 and 2005). Samples in the NURE database were taken between 1976 and 1980. Negative values are less than detection limit (0.5 ppb). The samples in the TWDB wells show high arsenic concentrations near the PWS wells, and only two wells within the 5-km buffer had concentrations less then the arsenic MCL (Wells 8434804 and 8434805, see Figure 3.10). All wells in the TWDB database within the buffers are in the Catahoula (code 122CTHL) except well 8434804, which is categorized as being in the Catahoula tuff and Jackson Group (code 122CJCK). The NURE data show a number of wells with low arsenic concentrations, but all wells with arsenic <10 ppb are relatively shallow wells with depth <130 feet, and most wells have depths <50 feet. The NURE data show only 19 of the 31 wells in the 10-km buffer have a recorded depth, thus a comparison of arsenic concentrations with well depth is somewhat inaccurate and limited by the available data.

The two wells with arsenic concentrations <10 ppb (8434804 and 8434805) are deeper wells with deeper screened intervals (Figure 3.10). Adjacent wells within 30 and 200 meters (wells 8434802 and 8434803) have shallower screens and also exhibited higher arsenic concentrations. The most recent arsenic concentration in each well is shown in the map; all wells were sampled in May 1990.

Figure 3.10 Wells with Low Arsenic Concentrations in the 5-km Buffer of Bruni PWS Wells (TWDB database)



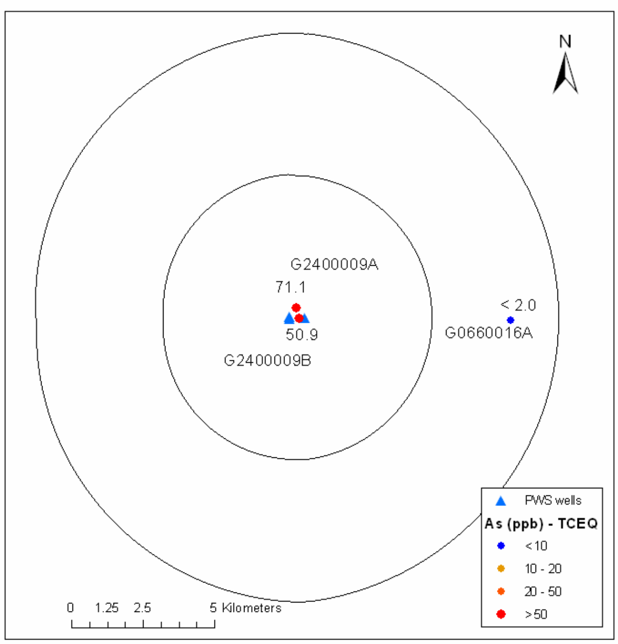
The most recent arsenic concentration, well depth, and screen depth for wells from the TWDB database in the 5- and 10-km buffers are provided in Table 3.4. As mentioned all the wells except well 8434804 are open to the Catahoula Formation at depths between 140 to 350 feet. The two wells with arsenic concentrations below the 10 ppb MCL are screened at depths of 320 to 620 feet.

Table 3.4 Most recent arsenic sample, well depth, and screen depth for wells in the 5- and 10-km buffers (data from TWDB database)

State well number	As (ppb)	Well depth (feet)	Screen top (feet)	Screen bottom (feet)
8433601	12	258	208	258
8434401	94.8	400	NA	
8434402	197	300	NA	
8434403	71	400	NA	
8434404	102	320	230	315
8434405	46.5	345	236	345
8434406	80	340	237	340
8434407	12	210	140	204
8434412	58	280	NA	
8434413	71	285	NA	
8434502	99	326	295	326
8434802	102	320	NA	
8434803	160	440	320	350
8434804	< 10	740	540	620
			320	340
8434805	< 10	500	440	490

In addition to the TWDB and NURE databases, arsenic concentrations from the TCEQ PWS database are shown in Figure 3.11.

Figure 3.11 Arsenic concentrations in the 5- and 10-km buffers of Bruni PWS wells (TCEQ database)



Two types of samples were used in the analysis: raw samples that can be related to a single well and entry-point samples taken from a single entry point, which can be related to a single well. The results include three PWS wells in the 5- and 10-km buffers. Table 3.5 details arsenic concentrations, well depth, and screen depths of the PWS wells in the 5- and 10-km buffers.

Table 3.5 Water source, Most Recent Arsenic Sample Date, Arsenic Concentration, Total Well Depth, and Screen Depth of Wells in the 5- And 10-Km Buffers of Bruni PWS Wells (Data from the TCEQ Database)

Water source	Most recent Arsenic sample date	Arsenic (µg/L)	Well depth (feet)	Screen depth (feet)	Aquifer code
G0660016A	6/11/2001	< 2	900	NA	122CJCK (Catahoula tuff and Jackson group)
G2400009A	2/15/2005	50.9	340	237-340	122CTHL (Catahoula formation)
G2400009B	5/28/2002	71.1	345	236-345	122CTHL(Catahoula formation)

From the three wells identified in the 5- and 10-km buffers, only the deeper well (G0660016A) categorized as being in the Jackson Group, had arsenic concentrations below 10 ppb. The other two wells are screened at depths in the range of 236 to 345 feet within the Catahoula formation, and have arsenic levels greater than the 10 ppb MCL.

3.6.1 Summary of Alternative Groundwater Sources for the Bruni PWS

There is evidence that the deeper wells in the vicinity of the Bruni PWS within the Jackson Group (*i.e.,* well G0660016A and well 8434804) have lower arsenic concentrations. In addition to the wells in the 10-km buffer, another PWS, Oilton Rural WSC (PWS ID 2400006) (Oilton WSC), has low arsenic concentrations. The Oilton WSC has six wells and is located about 11 km west of the Bruni PWS wells. Four of the wells are screened within the Jackson Group (124JCKS) with depths of 305 to 360 feet, and two are within the Catahoula formation (122CTHL). Well 8434805, although not designated within the Jackson Group, is screened between 440 to 490 feet, deeper than adjacent wells and with lower arsenic concentrations.

The data suggest that arsenic concentrations at the Bruni PWS wells may be reduced by extending the existing wells to greater depths into the Jackson Group to dilute water from the Catahoula formation, although more detailed studies would be required before adopting this approach.

It is also important to mention a previous study by the TWDB on groundwater quality in and around Bruni (Adidas 1991). This detailed study included a hydrogeologic characterization and assessment of water quality in the area, and detailed recommendations. The report defined six groundwater bearing units underlying Bruni (all six are within the

Catahoula and Goliad formations). Two of the units were found to contain water of higher quality (although concentrations of arsenic in these units might still have exceeded 10 ppb), and were recommended as a source for water supply. One unit (named Unit 3 in the report) is within the Goliad formation at depths of 300 to 410 feet, and the second (named Unit 5 in the report) is within the Catahoula formation at depths of 150 to 170 feet. The report recommended that the PWS isolate Unit 3 (in the Catahoula formation) from Unit 4, which is above Unit 3, by plugging off lower sections of Unit 4. The authors also recommended that the PWS drill an additional well to be completed in the sand units (Unit 5) between 130 and 190 feet, to blend water from Unit 5 with water from Unit 3. When looking at data from the TWDB database in Table 4, there is one well (834407) screened at the recommended depths between 140 and 204 feet. This well also has relatively lower arsenic concentration (12 ppb) although still above the 10 ppb MCL. When evaluating recommendations from the TWDB report, it should be noted that they were written in light of an arsenic MCL of 50 ppb.

SECTION 4
ANALYSIS OF THE BRUNI PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1. Existing System

The Bruni PWS is shown in Figure 4.1. Bruni WSC (BR) provides potable water to the town of Bruni that has a population of 589 and 208 connections.

The water sources for this PWS are two wells, both of which are completed in the Catahoula formation (Code 122CTHL). Wells #1 and #2 are 400 feet deep. The total production of the two wells is 0.230 million gallons per day (mgd). Disinfection with hypochlorite is performed at each wellhead before water enters the standpipe that feeds the distribution system. There is an elevated ground storage tank in the system that has a capacity of 0.060 million gallons (MG).

The treatment employed for disinfection is not appropriate or effective for removal of arsenic, so optimization is not expected to be effective in increasing removal of this contaminant. There is, however, a potential opportunity for system optimization to reduce arsenic concentration. There are lower arsenic concentrations (although not less than 10 µg/L) in water bearing units at depths of 150 through 170 feet and 300 through 410 feet. The existing wells could be rescreened to block groundwater from water-bearing units not within these two ranges. The PWS could also drill an additional well in the sand units between 130 and 190 feet, to blend water with the existing wells. It is not likely that re-screening the existing wells and drilling a new well would produce water with an arsenic concentration below 10 µg/L. Nevertheless, adsorption treatment costs may be substantially lower due to a substantially lower arsenic concentration resulting in longer adsorption media life.

Basic system information is as follows:

- Population served: 588 (estimate)
- Connections: 208
- Average daily flow: 0.087 mgd (April 2006)
- Total production capacity: 0.230 mgd

Basic system raw water quality data is as follows:

- Typical arsenic range: 75.9 through 113.4 µg/L
- Total dissolved solids: 791 mg/L (one sample result)
- Typical pH range: 6.8 to 8.23 s.u.

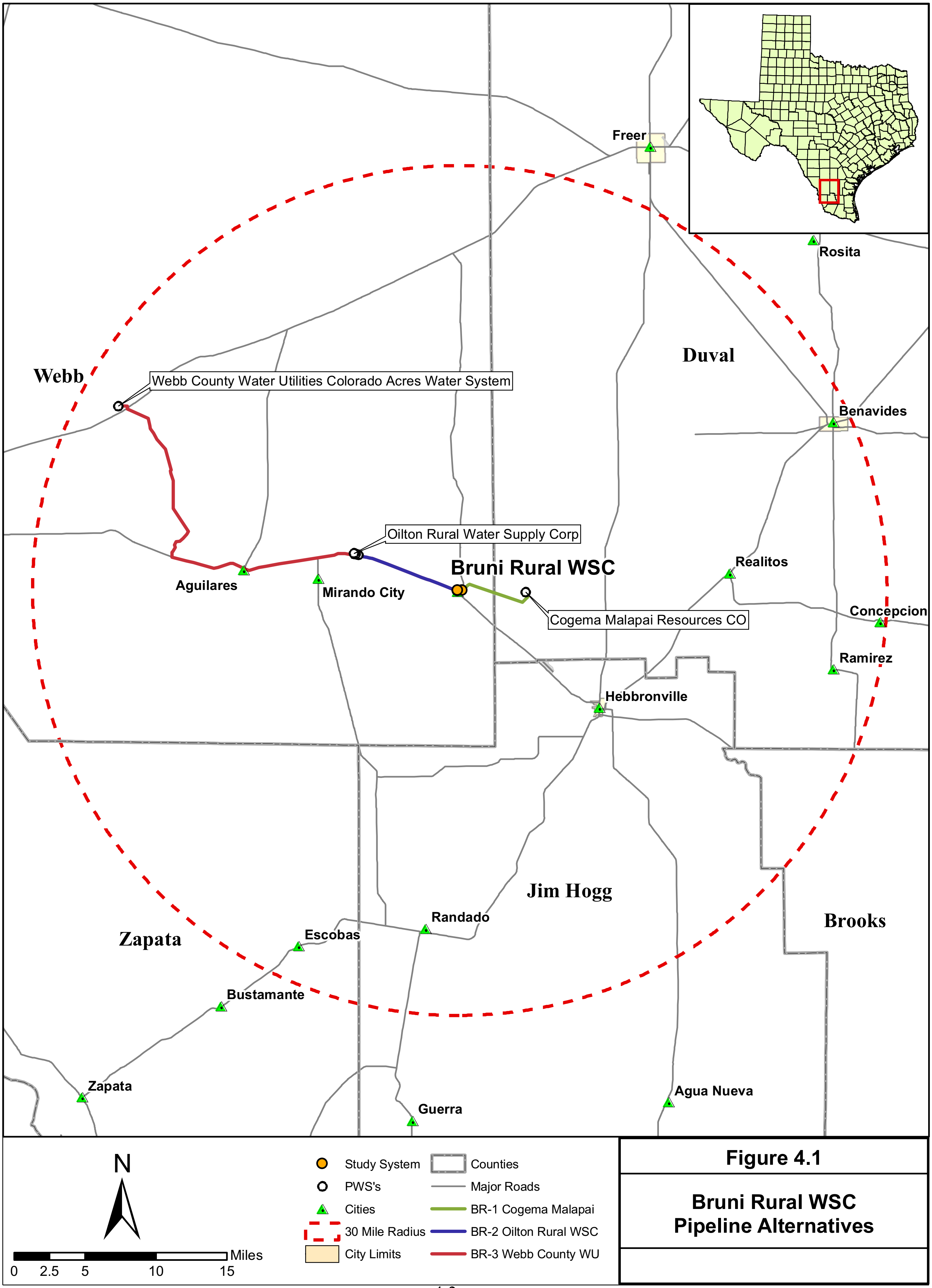


Figure 4.1

Bruni Rural WSC Pipeline Alternatives

- Typical calcium range: 7.14 to 8 mg/L
- Typical magnesium range: 1 to 2.29 mg/L
- Typical sodium range: 272 to 293 mg/L
- Typical chloride range: 180 to 229 mg/L
- Typical bicarbonate (HCO3) range: 283 to 362 mg/L
- Typical fluoride range: 0.699 to 0.80 mg/L
- Typical iron range: 0.01 to 0.05 mg/l

Bruni PWS reports system losses of more than 30 percent. This loss rate is high enough to warrant investigation to reduce losses. A reduction in system losses would reduce the implementation cost for the compliance alternatives.

4.1.2 Capacity Assessment for the Bruni PWS

The project team conducted a capacity assessment of the Bruni PWS. The results of this evaluation are separated into four categories: general assessment of capacity, positive aspects of capacity, capacity deficiencies, and capacity concerns. The general assessment of capacity describes the overall FMT capability of the water system. The positive aspects of capacity describe those factors that the system is doing well. These factors should provide opportunities for the system to build upon to improve capacity deficiencies. The capacity deficiencies noted are those aspects that are creating a particular problem for the system related to long-term sustainability. Primarily, these problems are related to the system's ability to meet current or future compliance, ensure proper revenue to pay the expenses of running the system, and to ensure proper operation of the system. The last category is titled capacity concerns. These are items that in general are not causing significant problems for the system at this time. However, the system may want to address them before those issues have the opportunity to cause problems.

The project team interviewed the following individuals:

- Irene Solano, General Manager
- Dale Conner, Board President

4.1.2.1 General Structure

The Bruni PWS is located approximately 40 miles southeast of Laredo and provides water and sewer service to a small community. It is governed by a 5-member board of directors and is financed through user fees. The staff consists of a general manager and a certified water operator. The operator reports directly to the board.

The PWS has two active wells that combine and are disinfected with chlorine gas prior to entering the storage tank. Both wells have exceeded the 50 µg/L arsenic standard since the system began operation in 1995. The primary well runs 18 hours a day, and is barely able to meet demand.

The general manager and operator also manage and operate the water systems for the Webb County Independent School District (Webb County ISD), which provides water services to three schools. The Webb County ISD owns two wells: one well serves the three schools and the second well serves a football field and an apartment complex. The distribution systems are not connected, so they are considered two separate water systems. Since both wells exceed the arsenic standard, the Webb County ISD would like to get out of the water supply business. The school board has already approved transfer of the two wells and the distribution systems to the Bruni PWS. However, at this time, there are no funds available to connect the School District's two systems to the Bruni PWS.

Bruni and the Webb County ISD applied to participate in the USEPA's Demonstration Project for arsenic treatment. The USEPA selected the Webb County ISD wells for the project, and in December 2005, an AdEdge arsenic treatment system was installed at the well that serves the schools. The demonstration project is only for the period of 1 year, and the Webb County ISD will gain ownership of the arsenic treatment system at the end of the project.

4.1.2.2 General Assessment of Capacity

Based on the team's assessment, this system has an adequate level of capacity. There are several positive managerial, financial and technical aspects of the water system, but there are also some areas that need improvement. The deficiencies noted could prevent the water system from being able to meet compliance now or in the future and may also impact the water system's long-term sustainability.

4.1.2.3 Positive Aspects of Capacity

In assessing a PWS's overall capacity, it is important to look at all aspects – positive and negative. It is important for owners of these PWSs to understand those characteristics that are working well, so that those activities can be continued or strengthened. In addition, these positive aspects can assist the owners in addressing the capacity deficiencies or concerns. The factors that were particularly important for the Bruni PWS are listed below.

- **Knowledgeable and Dedicated Staff –** The general manager has been managing the Bruni PWS for the past 13 years. The certified water operator has been working for Bruni for 10 years, and the board president has been in his position for 4 years. All positions have written job descriptions. Someone on the staff is available 24 hours a day, and they all live in the community so they can respond to residents in a timely manner. The phone numbers for the operator and the water board are easily accessible or residents can stop by their houses. The operator checks the wells and disinfection system every day. In addition, he communicates daily with the general manager.

- **Sharing Resources –** Because they have a good working relationship with the Webb County ISD, the District provides the Bruni PWS office space free of charge. This office is used for administrative purposes, including record keeping and board meetings. This saves the Bruni PWS the expense associated with renting or building an office.

4.1.2.4 Capacity Deficiencies

The following capacity deficiencies, which seriously impact the ability of the water system to comply with current and future regulations and to ensure long-term sustainability, were discovered while conducting the assessment.

- **Lack of Long-Term Planning for Compliance and Sustainability –** The Bruni PWS has been aware of the arsenic compliance problem for more than 10 years and has issued a public notice every quarter as required by TCEQ. Although they have a reserve account, they have not allocated any funds to address the compliance issue. They only recently attempted to resolve the problem by applying for the USEPA Demonstration Project, which was denied. They have not actively investigated any other treatment options. If the Bruni PWS were to acquire the Webb County ISD's arsenic treatment system, they might be able to move it to a location that could treat more than one well, which would solve some of their compliance issues.

  As another example, the Bruni PWS indicated that for safety reasons, they need to move the gas chlorinator to a new location. This would involve building a new structure to meet Occupational Safety and Health Administration safety requirements for gas chlorine, and dismantling the old chlorine building and old tank. They estimate the cost of the project at about $10,000 and are planning to obtain a loan for this project.

  The lack of planning negatively impacts the PWS's ability to develop a budget and associated rate structure that will provide for the system's long term needs. Also, a long-term plan could be used to integrate all of the projects the system needs to undertake.

- **Insufficient Water Production** – TCEQ has informed the Bruni PWS that the capacity of their two wells is insufficient to meet TCEQ regulations. This significantly limits any future growth of the PWS. TCEQ has asked the Bruni PWS to consider drilling another well; however, it does not have the land to do so. It is unable to purchase any land because large ranches surround the community and landowners are unwilling to sell. If the PWS were to undertake major water conservation efforts, it might be able to sufficiently reduce demand to help address this issue.

  Currently, if a well is down, the utility sends notices to its customers to conserve water; however, there is no formal conservation program in place. In addition, the current rate structure does not encourage water conservation. Water rates that promote conservation can yield savings. Conservation reduces the demand on the source, reduces chemical and electrical costs, and minimizes wear and tear on equipment such as pumps. In many cases a system can avoid the need for an additional water source by implementing an effective water conservation program. This program is critical for the Bruni PWI because of its limited source capacity.

4.1.2.5 Potential Capacity Concerns

The following items were concerns regarding capacity but no specific FMT problems can be attributed to these items at this time. The system should address the items listed below to further improve FMT capabilities and to improve the PWS's long-term sustainability.

- **Financial Accounting** – Because sewer services were recently added, water and sewer revenues are not yet tracked separately. The PWS plans to separate these in the near future.

- **Preventative Maintenance –** The project team was unable to interview the water operator. Therefore, it is unclear whether there was a regular schedule for preventative maintenance. The following items should be included in a preventative maintenance program:

    - Flushing
    - Valve exercising
    - Meter replacement
    - Well pump maintenance
    - Chlorine equipment maintenance
    - Storage tank maintenance

    In addition, routine O&M practices should include the following:

    - Checking the free chlorine residual at least once a week at the pumphouse and in distribution.
    - Maintaining a free chlorine residual of at least 0.2 mg/L at all connections.
    - Procedures for disinfection of water lines after new construction or repairs.

    It was indicated that the exterior of the storage tank is inspected annually, but it has not been cleaned. Due to the limited capacity of its sources, the tank would have to be cleaned while in service. This can be expensive for a small system. The Bruni PWS does not have an adequate facility to store spare parts, and is using space provided by the Webb County ISD.

- **Emergency Plan –** The PWS does not have a written emergency plan, nor does it have emergency equipment such as generators. In the event of a power outage, it would have to rely only on water in the storage tank. The PWS should have an emergency or contingency plan that outlines what actions would be taken and by whom. The emergency plan should meet the needs of the facility, the geographical area, and the nature of the likely emergencies. Conditions such as storms, floods, major line breaks, electrical failure, drought, system contamination, or equipment failure should be considered. The emergency plan should be updated annually, and larger facilities should practice implementation of the plan annually.

4.2 ALTERNATIVE WATER SOURCE DEVELOPMENT

4.2.1 Identification of Alternative Existing Public Water Supply Sources

Using data drawn from the TCEQ drinking water and TWDB groundwater well databases, the PWSs surrounding the Bruni PWS were reviewed with regard to their reported drinking water quality and production capacity. PWSs that appeared to have water supplies with water quality issues were ruled out from evaluation as alternative sources, while those without identified water quality issues were investigated further. If it was determined that these PWSs had excess supply capacity and might be willing to sell the excess, or might be a suitable location for a new groundwater well, the system was taken forward for further consideration.

Table 4.1 is a list of the selected PWSs within approximately 30 miles of the Bruni PWS. Thirty miles was selected as the radius for the evaluation owing to the small number of PWSs with compliant water in proximity to the Bruni PWS .

Table 4.1 Selected Public Water Systems within 30 Miles of the Bruni PWS

System Name	Distance from Bruni PWS	Comments/Other Issues
Webb Consolidated Schools Bruni	0 miles	Small system with identified arsenic WQ issues.
Cogema Malapai Resources Co	5 miles	Small system with TDS exceedances. No excess capacity. However, based on WQ data, this PWS may provide a suitable location for a new well. **Evaluate further**.
Oilton Rural Water Supply Corp	8 miles	Small system with marginal TDS WQ. Based on WQ data, this PWS does not have enough capacity to provide water to Bruni PWS. Nevertheless, the groundwater is low in arsenic, so a new well(s) may be a option. **Evaluate further**.
Jim Hogg County WCID 2	13 miles	Intermediate system with WQ issues: arsenic, iron, TDS.
Duval Cnty Cons & Reclam Realitos	19 miles	Small system with WQ issues: arsenic, TDS.
Freer WCID	27 miles	Intermediate system with WQ issues: arsenic, Gross Alpha, TDS.

Table 4.1 Selected Public Water Systems within 30 Miles of the Bruni PWS

System Name	Distance from Bruni PWS	Comments/Other Issues
Webb County Water Utilities Colorado Acres	27 miles	Small system with identified iron WQ issues. Based on WQ data, this PWS may provide a suitable location for water purchase. **Evaluate further.**
Duval Cnty Cons & Reclamation Benav	29 miles	Small system with WQ issues: arsenic, TDS.
Duval Cnty Cons & Reclam Concepcion	30 miles	Small system with WQ issues: arsenic, iron, TDS.

Based on water quality records summarized in Table 4.1, above, three neighboring PWSs were selected for further evaluation. These three water systems were selected based on factors such as water quality, distance from the Bruni PWS, sufficient total production capacity for selling or sharing water, and willingness of the system to sell or share water or drill a new well. These are summarized in Table 4.2.

Table 4.2 Public Water Systems Within the Vicinity of the Bruni PWS Selected for Further Evaluation

System Name	Pop	Conn	Total Production (mgd)	Ave Daily Usage (mgd)	Approx. Dist. from Bruni Rural	Comments/Other Issues
Cogema Malapai Resources Co	20	4	0.020	0.001	5 miles	Small system with TDS exceedances. No excess capacity. However, based on WQ data, this PWS may provide a suitable location for a new well.
Oilton Rural Water Supply Corp	375	184	0.048	0.024	8 miles	Small system with marginal TDS WQ. Based on WQ data, this PWS may provide a suitable location for water purchase.
Webb County Water Utilities Colorado Acres	600	1	0.101	0.016	27 miles	Small system with identified iron WQ issues. Based on WQ data, this PWS may provide a suitable location for water purchase.

4.2.1.1 Cogema Malapai Resources Co.

Cogema Malapai Resources Co. Water System is located in Duval County. It is approximately 5.0 miles east of Bruni PWS. It is operated by Cogema Malapai Resources

Company, and serves a population of 20 with four connections. This PWS is supplied by one water well (G0660016A) completed in the Carrizo Wilcox aquifer and drilled to a depth of 900 feet. The total system production is 0.020 mgd, the average daily consumption is 0.001 mgd, the total storage is 0.005 MG, the booster pump capacity is 0.115 mgd, and the pressure tank capacity is 0.0005 MG. The water is used primarily for industrial and agricultural purposes. The water is hypo-chlorinated for disinfection before distribution.

The well does not have enough capacity to meet the peak demand flow rate of Bruni PWS. However, based on Cogema Malapai Resources water quality data and its proximity to Bruni PWS, Cogema Malapai Resources may provide a suitable location for a new well.

4.2.1.2 Oilton Rural Water Supply Corp

Oilton Rural Water Supply Corp PWS is located in Webb County. It is approximately 8.0 miles west by northwest of Bruni PWS . It is operated by Oilton Rural Water Supply Corp., and serves a population of 375 with 184 metered connections. The PWS is supplied by three local groundwater wells. Well G2400006D was drilled to a depth of 460 feet with a tested/rated flow rate of 16 gpm. The second well, G2400006F, was drilled to a depth of 395 feet with a tested/rated flow rate of 41 gpm. The third well, G2400006G, was drilled to a 400 feet depth with a rated flow rate of 28 gpm. The total system production is 0.048 mgd. The average daily consumption is 0.024 mgd which means that the Oilton WSC is utilizing approximately 50 percent of the total system production. The water is used primarily for residential purposes. The water is chlorinated for disinfection before distribution. The system has total tank storage of 0.100 MG, a total booster pump capacity of 0.288 mgd, and a pressure tank capacity of 0.0025 MG.

This PWS has limited excess capacity available for the Bruni PWS. Oilton WSC already sells water to the Webb County ISD, and has discussed selling water to Miranda City. No water quality issues are reported for the Oilton WSC system in the TCEQ database. Analytical date from June 2000 through August 2004 indicate the arsenic concentration is approximately 3 μg/L. The Oilton WSC has three wells at depths ranging from 395 feet to 460 feet deep, with rated capacities from 16 gpm to 4 gpm.

4.2.1.3 Webb County Water Utilities Colorado Acres

Webb County Water Utilities Colorado Acres is located in Webb County. It is 27.0 miles north of Bruni PWS and serves a population of 600 with one metered connection. The PWS is supplied by one local groundwater well. Well G2400029A was drilled to a depth of 1,235 feet with tested and rated flow rates of 120 gpm. The system has total tank storage of 0.05 MG and a pressure tank capacity of 0.0002 MG. The total system production is 0.101 mgd. The average daily consumption is 0.016 mgd, which indicates that the Webb County Water Utilities Colorado Acres system is utilizing approximately 16 percent of the total system production. The water is used primarily for residential purposes. The water goes through thorough treatment, such as pre hypo-chlorination, pH adjustment, algae control, RO, and post gaseous chlorination.

This water supply system has excess capacity to supplement the Bruni PWS.

4.2.2 Potential for New Groundwater Sources

4.2.2.1 Installing New Compliant Wells

Developing new wells or well fields is recommended, provided good quality groundwater available in sufficient quantity can be identified. Since there are number of water systems in the area have problems with arsenic, it may be possible to share in the cost and effort of identifying compliant groundwater and constructing well fields.

Installation of a new well in the vicinity of the system intake point is likely to be an attractive option provided compliant groundwater can be found, since the PWS is already familiar with operating water wells. As a result, existing nearby wells identified with good water quality should be investigated. Re-sampling and test pumping would be required to verify and determine the quality and quantity of water at those wells.

The use of existing wells should probably be limited to use as indicators of groundwater quality and availability. If a new groundwater source is to be developed, it is recommended that a new well or wells be installed instead of using existing wells. This would ensure well characteristics are known and meet standards for drinking water wells.

Some of the alternatives suggest new wells be drilled in areas where existing wells are compliant with the current arsenic MCL of 10 µg/L. In developing the cost estimates, Parsons assumed that the aquifer in these areas would produce the required amount of water with only one well. Site investigations and geological research, which are beyond the scope of this study, could indicate whether the aquifer at a particular site and depth would provide the amount of water needed or if more than one well would need to be drilled in separate areas. . Two wells are used in cases where the PWS is large enough that two wells are required by TCEQ rules.

4.2.2.2 Results of Groundwater Availability Modeling

The Gulf Coast aquifer is the main groundwater source in Webb and surrounding counties; the Bruni PWS is located in the western edge of the aquifer, where water is obtained from the deepest of four Gulf Coast aquifer units, the Catahoula formation. The Yegua-Jackson aquifer, a minor aquifer as defined by TWDB, is also groundwater source in Webb County; PWSs connected to this aquifer are found within 10 miles of the Bruni PWS. Groundwater use in Webb County is relatively small, approximately 1,526 acre-feet per year (AFY) or 3.4 percent of total county water uses (Mace, *et al.* 2006).

A GAM evaluation was not run for the Bruni PWS. The TWDB developed a GAM for southern section of the Gulf Coast aquifer, the lower Rio Grande Valley (Chowdhury and Mace 2003). The model covered the adjacent counties of Starr and Jim Hogg, but not Webb County itself given its location at the aquifer's edge. On a regional basis, the lower Rio Grande Valley GAM predicted an approximate 16 percent increase in Gulf Coast aquifer utilization, from a current value of approximately 24,000 AFY to 28,000 AFY in 2050. The projected demand is expected to result in a cumulative decrease in the regional aquifer storage of approx. 8,900 AFY.

For the Yegua-Jackson aquifer, a relatively large use of water from this source was reported (Mace, *et al.* 2006). A GAM model for this aquifer is under development by the TWDB, but numerical simulation data are not yet available.

4.2.3 Potential for New Surface Water Sources

There is a minimum potential for development of new surface water sources for the Bruni PWS as indicated by limited water availability within the site vicinity. The Bruni PWS is located within the Nueces-Rio Grande Coastal Basin where current surface water availability is expected to remain at current levels over the next 50 years according to the TWDB's 2002 Water Plan (approximately 18,341 AFY during drought conditions).

The vicinity of the Bruni PWS has a minimum availability of surface water for new uses as indicated by the TCEQ's availability maps for the Nueces-Rio Grande Coastal Basin. Over a 20-mile radius of the site, unappropriated flows for new uses within the basin are available, at most, 25 percent of the time. This supply is inadequate as the TCEQ requires 100 percent supply availability for a PWS.

Approximately 15 miles west and 10 miles southwest of the Bruni PWS, the potential surface water source transitions from the Nueces-Rio Grande Coastal Basin to the Rio Grande River Basin. The Rio Grande River Basin segment located within a 20-mile radius of Bruni is also very limited in surface water availability; the Texas Water Development Board's 2002 Water Plan anticipates a 25 percent reduction in surface water availability over the entire basin over the next 50 years, from approximately 1,238,743 AFY in 2000 to 932,510 AFY in 2050.

4.2.4 New Water Source Options for Detailed Consideration

The initial review of alternative sources of water results in the following options for more-detailed consideration:

1. Cogema Malapai Resources Company Water System. A new groundwater well would be completed in the vicinity of the well for this PWS. A pipeline would be constructed and the water would be piped to Bruni PWS (Alternative BR-1).

2. Oilton Rural Water Supply Corp Water System. A new groundwater well would be completed in the vicinity of the well at Oilton Rural Water Supply Corp Water System. Depending on the rated capacity of the new well, a small amount of additional water may be obtained from the Oilton WSC. A pipeline and pump station would be constructed to transfer the water to Bruni PWS (Alternative BR-2).

3. Webb County Water Utilities Colorado Acres Water System. Obtain treated water through the Webb County Water Utilities Colorado Acres system. A pipeline and

pump station would be constructed to transfer the water to Bruni PWS (Alternative BR-3).

4. Installing a new well within 10, 5, or 1 mile of the Bruni PWS that would produce compliant water in place of the water produced by the existing wells (Alternatives BR-4, BR-5 and BR-6).

4.3 TREATMENT OPTIONS

4.3.1 Centralized Treatment Systems

Centralized treatment of the well field water is identified as a potential alternative for Bruni PWS. RO, EDR, iron-based adsorption, and coagulation/filtration treatments are potential applicable processes. RO, EDR, iron-based adsorption, and coagulation/filtration treatments can reduce TDS and arsenic to produce compliant water. The central RO treatment alternative is Alternative BR-7, the central EDR treatment alternative is Alternative BR-8, the central iron-based adsorption treatment is Alternative BR-9, and the central coagulation/filtration treatment is Alternative BR-10.

4.3.2 Point-of-Use Systems

POU treatment using resin-based adsorption technology, or RO, is valid for total arsenic removal. The POU treatment alternative is BR-11.

4.3.3 Point-of-Entry Systems

POE treatment using resin based adsorption technology, or RO, is valid for total arsenic removal. The POE treatment alternative is BR-12.

4.4 BOTTLED WATER

Providing bottled water is considered an interim measure to be used until a compliance alternative is implemented. Even though the community is small and people know each other; it would be reasonable to require a quarterly communication advising customers of the need to take advantage of the bottled water program. An alternative to providing delivered bottled water is to provide a central, publicly accessible dispenser for treated drinking water. Alternatives addressing bottled water are BR-13, BR-14, and BR-15.

4.5 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives for compliance with the MCL for arsenic have been identified. Each of the potential alternatives is described in the following subsections. It should be noted that the cost information given is the capital cost and change in O&M costs associated with implementing a particular alternative. Appendix C contains cost estimates for the compliance alternatives. These compliance alternatives represent a range of possibilities, and a number of them are likely not feasible. However, all have been presented to provide a complete picture of the range of alternatives considered. It is anticipated that a PWS will be able to use the information contained herein to select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation.

4.5.1 Alternative BR-1: New Well in the Vicinity of Cogema Malapai Resources Company Water System

This alternative involves completing a new well in the vicinity of Cogema Malapai Resources Company, and constructing pipeline to transfer the pumped groundwater to the Bruni PWS. A new storage tank and pump station would need to be built near the new well and also near the standpipe to pump the water into the existing standpipe.

The Cogema Malapai RC's well is 900 feet deep. Two analytical results from 1998 and 2001 indicate the arsenic concentration was not detectable (<0.002 µg/L). Based on the water quality data in the TCEQ database, it is expected that groundwater from this well would be compliant with drinking water MCLs. An agreement would need to be negotiated with Cogema Malapai Resources Company to expand its well field or new land would need to be purchased or leased.

The required pipeline would be constructed of 6-inch pipe and would follow Avenue G and several minor roads to the Bruni PWS. Using this route, the pipeline required would be approximately 5.7 miles in length. The difference in elevation is 83 feet. The pump horsepower required is 15 hp.

The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the Bruni PWS, since the incremental cost would be relatively small, and it would provide operational flexibility.

This alternative has the potential to provide a regional solution, as there are several PWSs in the vicinity that have a need for compliant water. PWSs located near to the proposed pipeline route could share the cost of drilling the new well and pipeline construction.

The estimated capital cost for this alternative includes completing the new well, and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes the maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $1.81 million, and the alternative's estimated annual O&M cost is $25,070.

The reliability of adequate amounts of compliant water under this alternative should be good. From the perspective of the Bruni PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pumps stations is well understood, and Bruni PWS currently operates pumps.

The feasibility of this alternative is dependent on finding a suitable well site.

4.5.2 Alternative BR-2: New Well at Oilton Rural Water Supply Corp Water System

This alternative involves developing one or two wells in the same water bearing zone as the Oilton Rural WSC wells to a depth of 420 feet. The Oilton WSC currently has some excess capacity that could be used to supplement the capacity of the new well(s).

This alternative would require constructing a pipeline from the Oilton Rural WSC area to a new storage tank and feed pump set near the existing standpipe storage tank for the Bruni PWS. A pump station would also be required to overcome pipe friction and the elevation difference between Oilton WSC and the Bruni PWS standpipe water elevation. Oilton WSC is uphill of Bruni PWS by 73 feet. Therefore, the water will generally be flowing downhill through the pipeline. The pipeline would be constructed of 6-inch pipe and would follow several minor roads and Highway 359 to the Bruni PWS. Using this route, the pipeline required would be approximately 7.6 miles long. The required pump horsepower is a minimum of 15 hp. The pipeline would terminate at a new storage tank and feed pump set.

The pump station would include two pumps, including one standby, and would be housed in a building. A tank would also be constructed for the pumps to draw from. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the Bruni PWS, since the incremental cost would be relatively small, and it would provide operational flexibility.

This alternative involves regionalization by definition, since the Bruni PWS would be obtaining drinking water from an existing larger supplier. It is possible the Bruni PWS could turn over provision of drinking water to the Oilton WSC instead of purchasing water. Also, other PWSs near Bruni PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline and pump station. The estimated O&M cost for this alternative includes the maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $2.33 million, and the alternative's estimated annual O&M cost is $25,269.

The reliability of adequate amounts of compliant water under this alternative is good based on compliance history. From the perspective of the Bruni PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood.

The feasibility of this alternative is dependent on an agreement being reached with the Oilton WSC to purchase raw well water.

4.5.3 Alternative BR-3: Purchase Water from the Webb County Water Utilities Colorado Acres Water System

This alternative involves purchasing compliant water from the Webb County Water Utilities Colorado Acres Water System, which will be used to supply Bruni PWS. The Webb County Water Utilities Colorado Acres Water System currently has sufficient excess capacity for this alternative to be feasible.

This alternative would require constructing a pipeline from the Webb County Water Utilities Colorado Acres Water System water main to a new storage tank and feed pump set near the existing standpipe storage tank for Bruni PWS. Two pump stations would also be required to overcome pipe friction and the elevation differences between Webb County Water Utilities Colorado Acres and the Bruni PWS elevation. The required pipeline would be constructed of 6-inch pipe and would follow many minor roads and Highway 359 to the Bruni PWS. Using this route, the pipeline required would be approximately 34.7 miles in length. The pipeline would terminate at the existing standpipe storage tank owned by the Bruni PWS. The required pump horsepower is 40 hp.

The pump station would include two pumps, including one standby, and would be housed in a building. A tank would also be constructed for the pumps to draw from. It is assumed the pumps and piping would be installed with capacity to meet all water demand for Bruni PWS, since the incremental cost would be relatively small, and it would provide operational flexibility.

This alternative involves regionalization by definition, since Bruni PWS would be obtaining drinking water from an existing larger supplier. It is possible Bruni PWS could turn over provision of drinking water to the Webb County Water Utilities Colorado Acres instead of purchasing water. Also, other PWSs near Bruni PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline and pump station. The estimated O&M cost for this alternative includes the purchase price for the treated water minus the cost related to current operation of the Bruni PWS wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $9.31 million, and the alternative’s estimated annual O&M cost is $121,168.

The reliability of adequate amounts of compliant water under this alternative is good based on compliance history. From the perspective of the Bruni PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood. If the decision was made to perform blending then the operational complexity would increase.

The feasibility of this alternative is dependent on an agreement being reached with the Webb County Water Utilities Colorado Acres Water System to purchase treated drinking water.

4.5.4 Alternative BR-4: New Well at 10 miles

This alternative consists of installing one new well within 10 miles of the Bruni PWS that would produce compliant water in place of the water produced by the existing wells. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require constructing one new 600-foot well, a new pump station with storage tank near the new well, a pipeline from the new well/tank to the Bruni PWS, and a storage tank and feed pump set. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 10 miles long, and would be a 6-inch line that discharges to a new storage tank and feed pump set at the Bruni PWS. The pump station would include two pumps, including one standby, and would be housed in a building.

Depending on well location and capacity, this alternative could present some options for a more regional solution. It may be possible to share water and costs with another nearby system.

The estimated capital cost for this alternative includes installing the wells, and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $2.78 million, and the estimated annual O&M cost for this alternative is $26,335.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From the perspective of the Bruni PWS, this alternative would be similar to operating the existing system. Bruni PWS personnel have experience with O&M of wells, pipelines and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is likely that an alternate groundwater source would not be found on land owned by Bruni PWS, so landowner cooperation would likely be required.

4.5.5 Alternative BR-5: New Well at 5 miles

This alternative consists of installing one new well within 5 miles of the Bruni PWS that would produce compliant water in place of the water produced by the existing wells. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require constructing one new 600-foot well, a new pump station with storage tank near the new well, a pipeline from the new well/tank to the Bruni PWS, and a storage tank and feed pump set. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 5 miles long, and would be a 6-inch line that discharges to a new storage tank and feed pump set at the Bruni PWS. The pump station would include two pumps, including one standby, and would be housed in a building.

Depending on well location and capacity, this alternative could present some options for a more regional solution. It may be possible to share water and costs with another nearby system.

The estimated capital cost for this alternative includes installing the well and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $1.64 million, and the estimated annual O&M cost for this alternative is $24,742.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From the perspective of the Bruni PWS, this alternative would be similar to operate as the existing system. Bruni PWS personnel have experience with O&M of wells, pipelines and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is likely an alternate groundwater source would not be found on land owned by Bruni PWS, so landowner cooperation would likely be required.

4.5.6 Alternative BR-6: New Well at 1 mile

This alternative consists of installing one new well within 1 mile of the Bruni PWS that would produce compliant water in place of the water produced by the existing wells. At this level of study, it is not possible to positively identify an existing well or the location where a new well could be installed.

This alternative would require constructing one new 600-foot well, a pipeline from the new well/tank to the BR system, and a storage tank and feed pump set. For this alternative, the pipeline is assumed to be approximately 1 mile long, and would be a 6-inch line that discharges to a new storage tank and feed pump set at the Bruni PWS. The pump station would include two pumps, including one standby, and would be housed in a building.

It is doubtful this alternative could present options for a regional solution, since there are no other PWSs in the immediate vicinity of the Bruni PWS.

The estimated capital cost for this alternative includes installing the well and constructing the pipeline and pump station. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $388,650, and the estimated annual O&M cost is $8,083. Cost would increase significantly if more than 1 new well is required.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From the perspective of the Bruni PWS, this alternative would be similar to operating the existing system. Bruni PWS personnel have experience with O&M of wells, pipelines, and pump stations.

The feasibility of this alternative is dependent on the ability to find an adequate existing well or success in installing a well that produces an adequate supply of compliant water. It is possible an alternate groundwater source would not be found on land owned by the Bruni PWS, so landowner cooperation may be required.

4.5.7 Alternative BR-7: Central RO Treatment

This system would continue to pump water from the Bruni PWS wells, and would treat the water through an RO system prior to distribution. For this option, a fraction of the raw water would be treated and the blended with the untreated stream to obtain overall compliant water. The RO process concentrates impurities in the reject stream which would require disposal. It is estimated the RO reject generation would be approximately 15,260 gpd when the system is operated at full flow. The RO reject may be disposed into the central wastewater collection system.

This alternative consists of constructing the RO treatment plant near the existing Bruni PWSservice pumps. The plant is composed of a 500 square foot building with a paved driveway; a skid with the pre-constructed RO plant; and two transfer pumps. The treated water would be chlorinated and pump to the existing standpipe.

The estimated capital cost for this alternative is $532,900, and the estimated annual O&M cost is $73,499.

The reliability of adequate amount of compliant water under this alternative is good, since RO treatment is a common and well-understood treatment technology. However, O&M efforts required for the central RO treatment plant may be significant, and O&M personnel would require training with RO. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.8 Alternative BR-8: Central EDR Treatment

The system would continue to pump water from the Bruni PWS wells, and would treat the water through an EDR system prior to distribution. For this option the EDR would treat the full flow without bypass as the EDR operation can be tailored for desired removal efficiency. It is estimated the EDR reject generation would be approximately 12,110 gpd when the system is operated at full flow.

This alternative consists of constructing the EDR treatment plant near the existing Bruni PWS service pumps. The plant is composed of a 500 ft^2 building with a paved driveway; a skid with the pre-constructed EDR system; and two transfer pumps. The treated water would be chlorinated and stored in the new treated water tank prior to being pumped into the standpipe. The reject water would be discharged to the central wastewater collection system.

The estimated capital cost for this alternative is $692,375 and the estimated annual O&M cost is $67,795.

The reliability of adequate amounts of compliant water under this alternative is good, since EDR treatment is a common and well-understood treatment technology. However, O&M efforts required for the central EDR treatment plant may be significant, and O&M personnel would require training with EDR. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.9 Alternative BR-9: Central iron-Based Adsorption Treatment

The system would treat groundwater from the existing wells using an iron-based adsorption system prior to distribution. This alternative consists of constructing the adsorption treatment plant within the fenced in area of Wells #1 and #2. The plant comprises a $500ft^{2-}$ building with a paved driveway, the pre-constructed adsorption system on a skid (*e.g.,* one AdEdge APU-100 package units), and two 10,000-gallon backwash wastewater equalization tanks. The water would be pre-chlorinated to oxidize AS(III) to AS(V) and post chlorinated for disinfection prior to pumping to the existing standpipe. Backwash would be required monthly with raw well water supplied directly by the well pump. The backwash would be equalized in the 10,000-gallon tanks, allowed to settle, and the settled material would be discharged to the wastewater collection system. The adsorption media are expected to last up to 2 years before replacement and disposal. The life of the media could be increased by lowering the raw water arsenic concentration. Chapter 3 included a possible recommended action for rescreening the existing two wells and drilling a new well 170 deep to obtain higher quality water, but the arsenic concentration would likely remain above the MCL of 10 µg/L. Moreover, reducing the arsenic concentration may have the effect of lowering the adsorption media waste.

The estimated capital cost for this alternative is $521,275, and the estimated annual O&M cost is $52,866 which includes the annual media replacement cost of $27,000. Reliability of supply of adequate amounts of compliant water under this alternative is good as the adsorption technology has been demonstrated effective in full-scale and pilot-scale facilities. The technology is simple and requires minimal O&M effort.

Costs may be reduced if the Bruni PWS takes over the ownership and operation of the local school's AdEdge iron absorption system that has an estimated treatment capacity of 60 gpm. It is likely that the full capacity of the school's iron absorption system is not being utilized. This excess treatment capacity could be made available to Bruni PWS customers, which would reduce the amount of additional treatment capacity that would need to be purchased.

4.5.10 Alternative BR-10: Central Coagulation/Filtration Treatment

The system would treat groundwater from the wells using a coagulation/filtration system prior to distribution. This alternative consists of constructing the coagulation/filtration plant at the existing well's site. The new treatment plant requires a 500 ft^2 building with a paved driveway, the pre-constructed coagulation/filtration system on a skid (*e.g.*, two Macrolite filters from Kinetico), a ferric chloride feed and storage system, and two 6,000-gallon backwash wastewater equalization tanks. The water would be pre-chlorinated to oxidize As(III) to As(V) and post-chlorinated for disinfection prior to flowing to the distribution system. Ferric chloride solution would be fed to the well water after pre-chlorination and before entering the filters. The filters would be backwashed every one to two days by well water directly from the well pump. The backwash wastewater would be equalized in the 6,000-gallon tanks and discharged to the central wastewater collection system. The Macrolite media do not need replacement.

The estimated capital cost for this alternative is $456,750, and the estimated annual O&M cost is $52,891. This alternative requires more O&M labor cost and sludge disposal than the adsorption alternative. Reliability of supply of adequate amounts of compliant water under this alternative is good as the coagulation/filtration process is a well-established technology for arsenic removal. The technology is simple but requires significant effort for chemical handling and backwash monitoring. The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.11 Alternative BR-11: Point-of-Use Treatment

This alternative consists of the continued operation of the Bruni PWS wells, plus treatment of water to be used for drinking or food preparation at the point of use to remove arsenic. The purchase, installation, and maintenance of POU treatment systems to be installed "under the sink" would be necessary for this alternative. Blending is not an option in this case.

This alternative would require installing the POU treatment units in residences and other buildings that provide drinking or cooking water. Bruni PWS staff would be responsible for purchase and maintenance of the treatment units, including media or membrane and filter replacement, periodic sampling, and necessary repairs. In houses, the most convenient point for installation of the treatment units is typically under the kitchen sink, with a separate tap installed for dispensing treated water. Installation of the treatment units in kitchens will require the entry of Bruni PWS or contract personnel into the houses of customers. As a result, cooperation of customers would be important for success implementing this alternative. The treatment units could be installed so they could be accessed without house entry, but that would complicate the installation and increase costs.

For the cost estimate, it is assumed the POU total arsenic treatment would involve RO. RO treatment processes typically produce a reject water stream that requires disposal. The reject stream results in an increase in the overall volume of water used. POU systems have the advantage of using only a minimum volume of treated water for human consumption. This minimizes the size of the treatment units, the increase in water required, and the waste for disposal. For this alternative, it is assumed the increase in water consumption is insignificant in terms of supply cost, and that the reject waste stream could be discharged to the house septic or sewer system.

This alternative does not present options for a shared solution.

The estimated capital cost for this alternative includes the cost to purchase and install the POU treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and media or membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $137,300, and the estimated annual O&M cost for this alternative is $140,000. For the cost estimate, it is assumed that one POU treatment unit will be required for each of the 208 connections served by the Bruni PWS. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets in order to meet regulatory requirements, making purchase and installation more expensive.

The reliability of adequate amounts of compliant water under this alternative is fair, since it relies on the active cooperation of the customers for system installation, use, and maintenance, and only provides compliant water to single tap within a house. Additionally, the O&M efforts required for the POU systems will be significant, and the current personnel are inexperienced in this type of work. From the Bruni PWS perspective, this alternative would be characterized as more difficult to operate owing to the in-home requirements and the large number of individual units.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.12 Alternative BR-12: Point-of-Entry Treatment

This alternative consists of the continued operation of the Bruni PWS wells, plus treatment of water as it enters residences to remove arsenic. The purchase, installation, and maintenance of the treatment systems at the point of entry to a household would be necessary for this alternative. Blending is not an option in this case.

This alternative would require the installation of the POE treatment units at houses and other buildings that provide drinking or cooking water. Bruni PWS would be responsible for purchasing and maintaining the treatment units, including media or membrane and filter replacement, periodic sampling, and necessary repairs. It may also be desirable to modify piping so water for non-consumptive uses can be withdrawn upstream of the treatment unit. The POE treatment units would be installed outside the residences, so entry would not be necessary for O&M. Some cooperation from customers would be necessary for installation and maintenance of the treatment systems.

For the cost estimate, it is assumed the POE's arsenic treatment system would be RO. RO treatment processes typically produce a reject water stream that requires disposal. The waste streams result in an increased overall volume of water used. POE systems treat a greater volume of water than POU systems. For this alternative, it is assumed the increase in water consumption is insignificant in terms of supply cost, and that the reject waste stream could be discharged to the house septic or sewer system.

This alternative does not present options for a shared solution.

The estimated capital cost for this alternative includes cost to purchase and install the POE treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and media or membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $2.40 million, and the estimated annual O&M cost for this alternative is $301,200. For the cost estimate, it is assumed that one POU treatment unit will be required for each of the 208 connections served by the Bruni PWS system.

The reliability of adequate amounts of compliant water under this alternative are fair, but better than POU systems since it relies less on the active cooperation of the customers for system installation, use, and maintenance, and compliant water is supplied to all taps within a house. Additionally, the O&M efforts required for the POE systems will be significant, and the current personnel are inexperienced in this type of work. From the perspective of the Bruni PWS, this alternative would be characterized as more difficult to operate owing to the on-property requirements and the large number of individual units.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.13 Alternative BR-13: Public Dispenser for Treated Drinking Water

This alternative consists of the continued operation of the Bruni PWS wells, plus dispensing treated water for drinking and cooking at a publicly accessible location. Implementing this alternative would require purchasing and installing a treatment unit where customers would be able to come and fill their own containers. This alternative also includes notifying customers of the importance of obtaining drinking water from the dispenser. In this way, only a relatively small volume of water requires treatment, but customers would be required to pick up and deliver their own water. Blending is not an option in this case. It should be noted that this alternative would be considered an interim measure until a permanent compliance alternative is implemented.

Bruni PWS personnel would be responsible for maintenance of the treatment unit, including media or membrane replacement, periodic sampling, and necessary repairs. The spent media or membranes will require disposal. This alternative relies on a great deal of cooperation and action from the customers in order to be effective.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the treatment system to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes purchasing and replacing filters and media or membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $11,600, and the estimated annual O&M cost for this alternative is $18,400.

The reliability of adequate amounts of compliant water under this alternative is fair, because of the large amount of effort required from the customers and the associated inconvenience. Bruni PWS has not provided this type of service in the past. From the perspective of the Bruni PWS, this alternative would be characterized as relatively easy to operate, since these types of treatment units are highly automated, and there is only one unit.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.14 Alternative BR-14: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the Bruni PWS wells, but compliant drinking water would be delivered to customers in containers. This alternative involves setting up and operating a bottled water delivery program to serve all of the customers in the system. It is expected that Bruni PWS would find it most convenient and economical to contract a bottled water service. The bottle delivery program would have to be flexible enough to allow the delivery of smaller containers should customers be incapable of lifting and manipulating 5-gallon bottles. Blending is not an option in this case. It should be noted that this alternative would be considered an interim measure until a permanent compliance alternative is implemented.

This alternative does not involve capital cost for construction, but would require some initial costs for system setup, and then ongoing costs to have the bottled water furnished. It is assumed for this alternative that bottled water is provided to 100 percent of the Bruni PWS customers.

This alternative does not present options for a regional solution.

The estimated initial capital cost is for setting up the program. The estimated O&M cost for this alternative includes program administration and purchase of the bottled water. The estimated capital cost for this alternative is $27,800, and the estimated annual O&M cost for this alternative is $370,650. For the cost estimate, it is assumed that each person requires one gallon of bottled water per day.

The reliability of adequate amounts of compliant water under this alternative is fair, since it relies on the active cooperation of customers to order and utilize the water. Management and administration of the bottled water delivery program will require attention from Bruni PWS.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.15 Alternative BR-15: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the Bruni PWS wells, plus dispensing compliant water for drinking and cooking at a publicly accessible location. The compliant water could be purchased from Oilton WSC, about 8 miles from Bruni PWS, and delivered by truck to a tank at a central location where customers would be able to fill their own containers. This alternative also includes notifying customers of the importance of obtaining drinking water from the dispenser. In this way, only a relatively small volume of water requires treatment, but customers are required to pick up and deliver their own water. Blending is not an option in this case. It should be noted that this alternative would be considered an interim measure until a permanent compliance alternative is implemented.

Bruni PWS would purchase a truck that would be suitable for hauling potable water, and install a storage tank. It is assumed the storage tank would be filled once a week, and that the chlorine residual would be tested for each truckload. The truck would have to meet requirements for potable water, and each load would be treated with bleach. This alternative relies on a great deal of cooperation and action from the customers for it to be effective.

This alternative presents limited options for a regional solution if two or more systems share the purchase and operation of the water truck.

The estimated capital cost for this alternative includes purchasing a water truck and construction of the storage tank to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes O&M for the truck, maintenance for the tank, water quality testing, record keeping, and water purchase, The estimated capital cost for this alternative is $103,000, and the estimated annual O&M cost for this alternative is $17,550.

The reliability of adequate amounts of compliant water under this alternative is fair because of the large amount of effort required from the customers and the associated inconvenience. Current personnel have not provided this type of service in the past. From the perspective of the Bruni PWS, this alternative would be characterized as relatively easy to operate, but the water hauling and storage would have to be done with care to ensure sanitary conditions.

The feasibility of this alternative is not dependent on the cooperation, willingness, or capability of other water supply entities.

4.5.16 Summary of Alternatives

Table 4.3 provides a summary of the key features of each alternative for Bruni PWS.

1 **Table 4.3 Summary of Compliance Alternatives for Bruni PWS**

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
BR-1	New well at Cogema Malapai Resources Company Water System	- New well - Pump station - 5.7-mile pipeline	$1,807,841	$25,070	$182,686	Good	N	Agreement must be successfully negotiated with Cogema Malapai Resources Company Water System, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
BR-2	New well at Oilton Rural Water Supply Corp Water System	- Storage Tank - Pump station - 7.6-mile pipeline	$2,334,522	$25,269	$228,803	Good	N	Agreement must be successfully negotiated with Oilton Rural Water Supply Corp Water System, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
BR-3	Purchase treated water from Webb County Water Utilities Colorado Acres	- Storage Tank - Pump station - 34.7-mile pipeline	$9,311,104	$121,168	$932,953	Good	N	Agreement must be successfully negotiated with Webb County Water Utilities Colorado Acres. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
BR-4	Install new compliant well within 10 miles	- New well - Storage tank - Pump station - 10-mile pipeline	$2,784,249	$26,335	$269,078	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
BR-5	Install new compliant well within 5 miles	- New well - Storage tank - Pump station - 5-mile pipeline	$1,636,073	$24,742	$167,383	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
BR-6	Install new compliant well within 1 mile	- New well - Storage tank - Pump station - 1-mile pipeline	$388,650	$8,083	$41,967	Good	N	May be difficult to find well with good water quality.
BR-7	Continue operation of Bruni PWS well field with central RO treatment	- Central RO treatment plant	$532,875	$73,499	$119,957	Good	T	Costs could possibly be shared with nearby small systems.
BR-8	Continue operation of Bruni PWS well field with central EDR treatment	- Central EDR treatment plant	$692,375	$67,795	$128,159	Good	T	Costs could possibly be shared with nearby small systems.
BR-9	Continue operation of Bruni PWS well field with central IBAT treatment	- Central IBAT treatment plant	$521,275	$52,866	$98,313	Good	T	Costs could possibly be shared with nearby small systems.
BR-10	Continue operation of Bruni PWS well field with C/F treatment	- Central C/F treatment plant	$456,750	$52,891	$92,713	Good	T	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing.

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
BR-11	Continue operation of Bruni Rural WSC well field, and POU treatment	- POU treatment units.	$137,280	$139,984	$151,953	Fair	T, M	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing.
BR-12	Continue operation of Bruni PWS well field, and POE treatment	- POE treatment units.	$2,402,400	$301,184	$510,636	Fair (*better than POU*)	T, M	All home taps compliant and less resident cooperation required.
BR-13	Continue operation of Bruni PWS well field, but furnish public dispenser for treated drinking water	- Water treatment and dispenser unit	$11,600	$18,402	$19,413	Fair/interim measure	T	Does not provide compliant water to all taps, and requires a lot of effort by customers.
BR-14	Continue operation of Bruni PWS well field, but furnish bottled drinking water for all customers	- Set up bottled water system	$27,770	$370,637	$373,058	Fair/interim measure	M	Does not provide compliant water to all taps, and requires customers to order and use. Management of program may be significant.
BR-15	Continue operation of Bruni PWS well field, but furnish public dispenser for trucked drinking water.	- Construct storage tank and dispenser - Purchase potable water truck	$102,986	$17,528	$26,506	Fair/interim measure	M	Does not provide compliant water to all taps, and requires a lot of effort by customers.

Notes: *N – No significant increase required in technical or management capability*
T – Implementation of alternative will require increase in technical capability
M – Implementation of alternative will require increase in management capability
1 – See cost breakdown in Appendix C
2 – 20-year return period and 6 percent interest

4.6 COST OF SERVICE AND FUNDING ANALYSIS

To evaluate the financial impact of implementing the compliance alternatives, a 30-year financial planning model was developed. This model can be found in Appendix D. The financial model is based on estimated cash flows, with and without implementation of the compliance alternatives. Data for such models are typically derived from established budgets, audited financial reports, published water tariffs, and consumption data. Information that was available to complete the financial analysis included 2004 revenues and expenses and current water rates for the Bruni PWS. Bruni PWS customers use on average 417 gallons per day (gpd) per connection, which includes system losses. Customer use without the system losses is 273 gpd per connection.

This analysis will need to be performed in a more detailed fashion and applied to alternatives that are deemed attractive and worthy of more detailed evaluation. A more detailed analysis should include additional factors such as:

- Cost escalation;
- Price elasticity effects where increased rates may result in lower water consumption; and
- Costs for other system upgrades and rehabilitation needed to maintain compliant operation.

4.6.1 Financial Plan Development

Water/wastewater sales were $58,517. The water/wastewater base rate is $39.10 per month, which consists of a $15 wastewater charge, a State Fee of $0.10, and a water charge of $24. Based on these figures, 61.4 percent, or $35,929, is generated from the sale of potable water.

The basic monthly water charge of $24 includes 3,000 gallons of water. The Bruni PWS employs a tiered water usage rate structure of $1.50 per 1,000 gallons, up to 10,000 gallons; $1.75 per 1,000 gallons, up to 40,000 gallons, and $2.50 per 1,000 gallons thereafter. These values were entered into the financial model.

Total Expenses for the Bruni PWS were $92,368. Operating Expenses were $82,462; the difference between the two being a $9,906 interest expense.

4.6.2 Current Financial Condition

4.6.2.1 Cash Flow Needs

Using the base rate and water usage rates as noted above, the current average annual water bill for Bruni PWS customers is estimated at $288, or about 1.0 percent of the Webb County MHI of $28,100, and approximately 1.1 percent of the MHI ($25,893) of the ZIP code area for Bruni service area. .

Bruni's 2004 Annual Financial Report reveals that excluding revenues from grants received, the facility's operating expenses are greater than revenues. The long-term financial plan indicates that the Bruni PWS has insufficient revenue to operate. Bruni utility rates are not high enough to maintain operations. Bruni will need to raise rates in the future to pay for operating expenses and any capital improvements for the various alternatives that may be implemented to address compliance issues.

4.6.2.2 Ratio Analysis

Current Ratio= 4.46

The Current Ratio is a measure of liquidity. A Current Ratio of 4.46 is unusually high and indicates that Bruni Rural Water Supply Corporation would be able to meet all its current obligations, with total assets of $1,696,096 exceeding total liabilities of $380,213.

Debt to Net Worth Ratio=0.29

A Debt to Net Worth ratio is another measure of financial liquidity. Bruni has a Net Worth of $1,315,883 and Total Liabilities amounting to $380,213 resulting in a Debt to Net Worth ratio of 0.29. The Ratio of 0.29 is very low and indicates that Bruni is financially stable, and therefore a good credit risk for borrowing. The debt is funded through operating revenues which include water sales and grants.

Operating Ratio = 0.71

In 2004 Bruni RWSC had operating revenues of $952,969 and operating expenses of $82,462 resulting in an Operating Ratio equal to 11.56. However, it should be noted that the operating revenues were heavily distorted by grant revenues totaling $894,969. Because receiving annual grants is an unpredictable source of revenue, a more realistic Operating Ratio is obtained by excluding the grant revenues from the total revenues, and using only those revenues generated by the sale of potable water. Doing so results in operating revenues of $58,517 and operating expenses of $82,462, resulting in an Operating Ratio of 0.71. Accordingly, for fiscal year 2004 actual water service operating revenues were insufficient to cover the operating expenses

4.6.3 Financial Plan Results

Each of the compliance alternatives for the Bruni PWS was evaluated using the financial model to determine the overall increase in water rates that would be necessary to pay for the improvements. Each alternative was examined under the various funding options described in Subsection 2.4.

For SRF funding options, customer MHI compared to the state average determines the availability of subsidized loans. According the 2000 U.S. Census data, the MHI for customers of Bruni PWS was $23,630, which is 59 percent of the statewide income average of $39,927.

Consequently, the Bruni RWSC would qualify for an interest rate of 0 percent and a 15 percent forgiveness of the principle

The financial model results are summarized in Table 4.4. Table 4.4 presents rate impacts assuming that any deficiencies in reserve accounts are funded immediately in the year following the occurrence of the deficiency, which would cause the first few years' water rates to be higher than they would be if the reserve account was built-up over a longer period of time. Figure 4.2 provides a bar chart that in terms of the yearly billing to an average customer (12,500 gallons/month consumption), shows the following:

- Current annual average bill,
- Projected annual average bill including rate increase, if needed, to match existing expenditures, and
- Projected annual bill including rate increases needed to fund implementation of a compliance alternative (this does not include funding for reserve accounts).

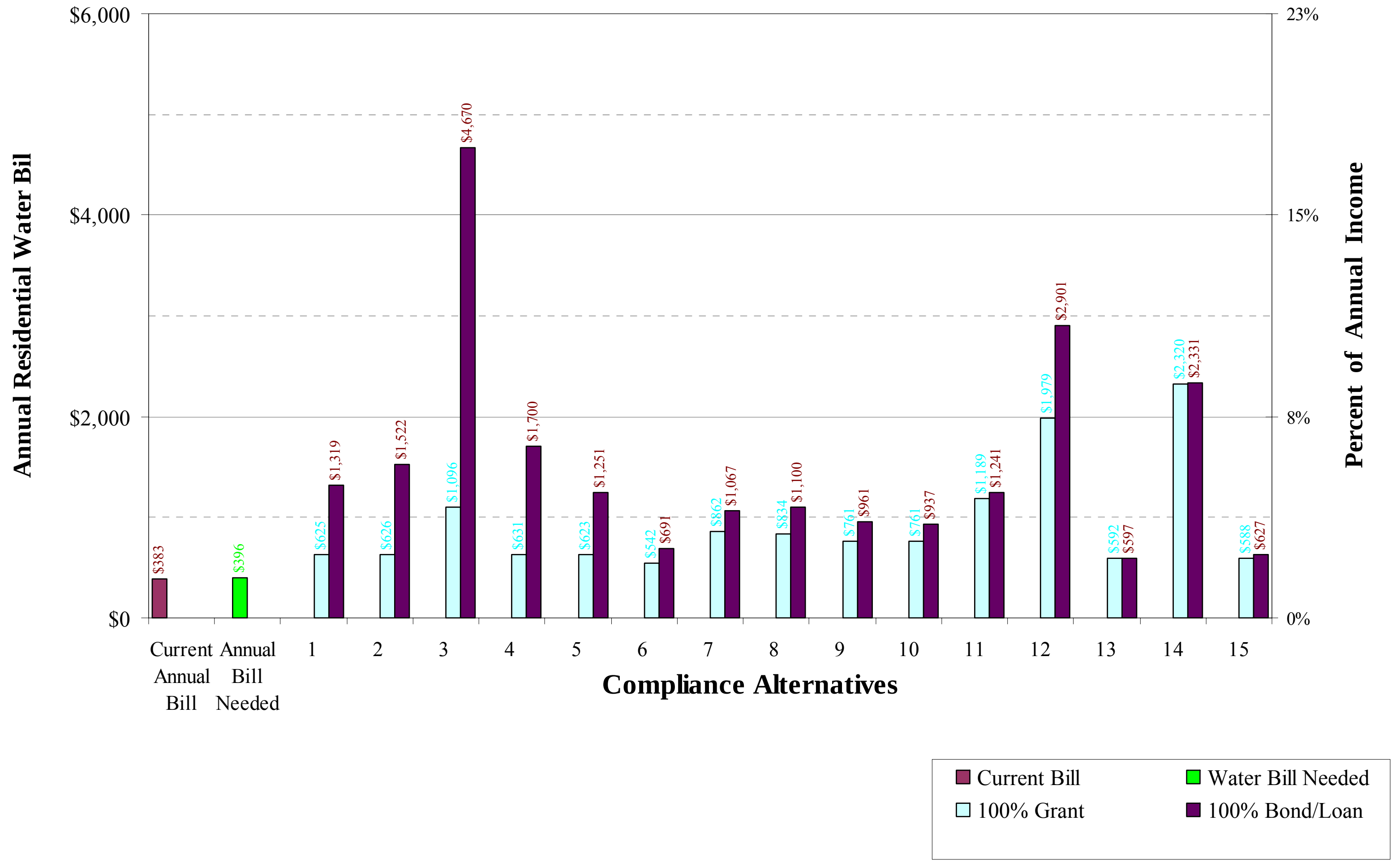
The two bars shown for each compliance alternative represent the rate changes necessary for revenues to match total expenditures assuming 100 percent grant funding and 100 percent loan/bond funding. Most funding options will fall between 100 percent grant and 100 percent loan/bond funding, with the exception of 100 percent revenue financing. Establishing or increasing reserve accounts would require an increase in rates. If existing reserves are insufficient to fund a compliance alternative, rates would need to be raised before implementing the compliance alternative. This would allow for accumulation of sufficient reserves to avoid larger but temporary rate increases during the years the compliance alternative was being implemented.

Table 4.4 Financial Impact on Households

Alternative	Description		All Revenue	100% Grant	75% Grant	50% Grant	SRF	Bond
1	New Well at Cogema Malapai	Max % of HH Income	35%	3%	4%	5%	6%	8%
		Max % Rate Increase Compared to Current	2290%	79%	170%	260%	310%	441%
		Average Water Bill Required by Alternative	$ 8,598	$ 658	$ 974	$ 1,293	$ 1,470	$ 1,931
2	New Well at Oilton Rural WSC	Max % of HH Income	45%	3%	4%	6%	7%	10%
		Max % Rate Increase Compared to Current	2964%	79%	196%	313%	378%	547%
		Average Water Bill Required by Alternative	$ 11,015	$ 659	$ 1,068	$ 1,480	$ 1,709	$ 2,303
3	Purchase Water from Webb County	Max % of HH Income	178%	5%	12%	19%	22%	32%
		Max % Rate Increase Compared to Current	11889%	223%	689%	1154%	1414%	2086%
		Average Water Bill Required by Alternative	$ 43,033	$ 1,154	$ 2,794	$ 4,437	$ 5,351	$ 7,722
4	New Well at 10 Miles	Max % of HH Income	54%	3%	5%	7%	8%	11%
		Max % Rate Increase Compared to Current	3539%	81%	220%	360%	437%	638%
		Average Water Bill Required by Alternative	$ 13,079	$ 664	$ 1,153	$ 1,644	$ 1,917	$ 2,626
5	New Well at 5 Miles	Max % of HH Income	32%	3%	4%	5%	6%	7%
		Max % Rate Increase Compared to Current	2070%	79%	161%	242%	288%	406%
		Average Water Bill Required by Alternative	$ 7,810	$ 656	$ 942	$ 1,230	$ 1,391	$ 1,808
6	New Well at 1 Mile	Max % of HH Income	9%	2%	3%	3%	3%	3%
		Max % Rate Increase Compared to Current	474%	54%	73%	93%	104%	132%
		Average Water Bill Required by Alternative	$ 2,085	$ 570	$ 637	$ 705	$ 742	$ 841
7	Central Treatment - RO	Max % of HH Income	11%	4%	4%	5%	5%	5%
		Max % Rate Increase Compared to Current	659%	151%	178%	205%	220%	258%
		Average Water Bill Required by Alternative	$ 2,747	$ 908	$ 1,000	$ 1,093	$ 1,146	$ 1,281
8	Central Treatment - EDR	Max % of HH Income	14%	4%	4%	5%	5%	6%
		Max % Rate Increase Compared to Current	863%	143%	178%	212%	232%	282%
		Average Water Bill Required by Alternative	$ 3,479	$ 879	$ 999	$ 1,120	$ 1,188	$ 1,364
9	Central Treatment - Adsorption	Max % of HH Income	11%	3%	4%	4%	4%	5%
		Max % Rate Increase Compared to Current	644%	121%	147%	173%	187%	225%
		Average Water Bill Required by Alternative	$ 2,694	$ 801	$ 892	$ 982	$ 1,034	$ 1,166
10	Central Treatment - Coag-Filt	Max % of HH Income	10%	3%	4%	4%	4%	5%
		Max % Rate Increase Compared to Current	561%	121%	144%	166%	179%	212%
		Average Water Bill Required by Alternative	$ 2,397	$ 802	$ 881	$ 960	$ 1,005	$ 1,121
11	Point-of-Use Treatment	Max % of HH Income	8%	5%	5%	5%	5%	6%
		Max % Rate Increase Compared to Current	426%	251%	258%	264%	268%	278%
		Average Water Bill Required by Alternative	$ 1,879	$ 1,252	$ 1,276	$ 1,299	$ 1,313	$ 1,347
12	Point-of-Entry Treatment	Max % of HH Income	47%	9%	11%	12%	13%	16%
		Max % Rate Increase Compared to Current	3051%	491%	611%	732%	799%	972%
		Average Water Bill Required by Alternative	$ 11,327	$ 2,085	$ 2,506	$ 2,930	$ 3,166	$ 3,777
13	Public Dispenser for Treated Drinking Water	Max % of HH Income	3%	3%	3%	3%	3%	3%
		Max % Rate Increase Compared to Current	84%	69%	70%	70%	71%	72%
		Average Water Bill Required by Alternative	$ 675	$ 623	$ 625	$ 627	$ 628	$ 631
14	Supply Bottled Water to 100% of Population	Max % of HH Income	11%	10%	10%	10%	10%	10%
		Max % Rate Increase Compared to Current	630%	595%	596%	598%	598%	601%
		Average Water Bill Required by Alternative	$ 2,569	$ 2,444	$ 2,449	$ 2,454	$ 2,456	$ 2,463
15	Central Trucked Drinking Water	Max % of HH Income	3%	2%	3%	3%	3%	3%
		Max % Rate Increase Compared to Current	109%	68%	73%	78%	81%	89%
		Average Water Bill Required by Alternative	$ 774	$ 619	$ 637	$ 654	$ 664	$ 690

1

Figure 4-2 Alternative Cost Summary



SECTION 5
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APPENDIX A
PWS INTERVIEW FORM

CAPACITY DEVELOPMENT ASSESSMENT FORM

*Prepared By*____________________________________ *Date*____________________________

Section 1. Public Water System Information

1. PWS ID # [ ] 2. Water System Name [ ]

3. County [ ]

4. Owner [ ] Address [ ]

   Tele. [ ] E-mail [ ]

   Fax [ ] Message [ ]

5. Admin [ ] Address [ ]

   Tele. [ ] E-mail [ ]

   Fax [ ] Message [ ]

6. Operator [ ] Address [ ]

   Tele. [ ] E-mail [ ]

   Fax [ ] Message [ ]

7. Population Served [ ] 8. No. of Service Connections [ ]

9. Ownership Type [ ] 10. Metered (Yes or No) [ ]

11. Source Type [ ]

12. Total PWS Annual Water Used [ ]

13. Number of Water Quality Violations (Prior 36 months)

    Total Coliform [ ] Chemical/Radiological [ ]

    Monitoring (CCR, Public Notification, etc.) [ ] Treatment Technique, D/DBP [ ]

A. Basic Information

1. Name of Water System:

2. Name of Person Interviewed:

3. Position:

4. Number of years at job:

5. Number of years experience with drinking water systems:

6. Percent of time (day or week) on drinking water system activities, with current position (how much time is dedicated exclusively to the water system, not wastewater, solid waste or other activities):

7. Certified Water Operator (Yes or No):

   If Yes,
   7a. Certification Level (water):

   7b. How long have you been certified?

8. Describe your water system related duties on a typical day.

B. Organization and Structure

1. Describe the organizational structure of the Utility. Please provide an organizational chart. (Looking to find out the governance structure (who reports to whom), whether or not there is a utility board, if the water system answers to public works or city council, etc.)

2. If not already covered in Question 1, to whom do you report?

3. Do all of the positions have a written job description?

    3a. If yes, is it available to employees?

    3b. May we see a copy?

C. Personnel

1. What is the current staffing level (include all personnel who spend more than 10% of their time working on the water system)?

2. Are there any vacant positions? How long have the positions been vacant?

3. In your opinion, is the current staffing level adequate? If not adequate, what are the issues or staffing needs (how many and what positions)?

4. What is the rate of employee turnover for management and operators? What are the major issues involved in the turnover (e.g., operator pay, working conditions, hours)?

5. Is the system staffed 24 hours a day? How is this handled (on-site or on-call)? Is there an alarm system to call an operator if an emergency occurs after hours?

D. Communication

1. Does the utility have a mission statement? If yes, what is it?

2. Does the utility have water quality goals? What are they?

3. How are your work priorities set?

4. How are work tasks delegated to staff?

5. Does the utility have regular staff meetings? How often? Who attends?

6. Are there separate management meetings? If so, describe.

7. Do management personnel ever visit the treatment facility? If yes, how often?

8. Is there effective communication between utility management and state regulators (e.g., NMED)?

9. Describe communication between utility and customers.

E. Planning and Funding

1. Describe the rate structure for the utility.

2. Is there a written rate structure, such as a rate ordinance? May we see it?

    2a. What is the average rate for 6,000 gallons of water?

3. How often are the rates reviewed?

4. What process is used to set or revise the rates?

5. In general, how often are the new rates set?

6. Is there an operating budget for the water utility? Is it separate from other activities, such as wastewater, other utilities, or general city funds?

7. Who develops the budget, how is it developed and how often is a new budget created or the old budget updated?

8. How is the budget approved or adopted?

9. In the last 5 years, how many budget shortfalls have there been (i.e., didn't collect enough money to cover expenses)? What caused the shortfall (e.g., unpaid bills, an emergency repair, weather conditions)?

    9a. How are budget shortfalls handled?

10. In the last 5 years how many years have there been budget surpluses (i.e., collected revenues exceeded expenses?

    10a. How are budget surpluses handled (i.e., what is done with the money)?

11. Does the utility have a line-item in the budget for emergencies or some kind of emergency reserve account?

12. How do you plan and pay for short-term system needs?

13. How do you plan and pay for long- term system needs?

14. How are major water system capital improvements funded? Does the utility have a written capital improvements plan?

15. How is the facility planning for future growth (either new hook-ups or expansion into new areas)?

16. Does the utility have and maintain an annual financial report? Is it presented to policy makers?

17. Has an independent financial audit been conducted of the utility finances? If so, how often? When was the last one?

18. Will the system consider any type of regionalization with any other PWS, such as system interconnection, purchasing water, sharing operator, emergency water connection, sharing bookkeeper/billing or other?

F. Policies, Procedures, and Programs

1. Are there written operational procedures? Do the employees use them?

2. Who in the utility department has spending authorization? What is the process for obtaining needed equipment or supplies, including who approves expenditures?

3. Does the utility have a source water protection program? What are the major components of the program?

4. Are managers and operators familiar with current SDWA regulations?

5. How do the managers and operators hear about new or proposed regulations, such as arsenic, DBP, Groundwater Rule? Are there any new regulations that will be of particular concern to the utility?

6. What are the typical customer complaints that the utility receives?

7. Approximately how many complaints are there per month?

8. How are customer complaints handled? Are they recorded?

9. (If not specifically addressed in Question 7) If the complaint is of a water quality nature, how are these types of complaints handled?

10. Does the utility maintain an updated list of critical customers?

11. Is there a cross-connection control plan for the utility? Is it written? Who enforces the plan's requirements?

12. Does the utility have a written water conservation plan?

13. Has there been a water audit of the system? If yes, what were the results?

14. (If not specifically answered in 11 above) What is the estimated percentage for loss to leakage for the system?

15. Are you, or is the utility itself, a member of any trade organizations, such as AWWA or Rural Water Association? Are you an active member (i.e., attend regular meetings or participate in a leadership role)? Do you find this membership helpful? If yes, in what ways does it help you?

G. Operations and Maintenance

1. How is decision-making authority split between operations and management for the following items:

    a. Process Control

    b. Purchases of supplies or small equipment

    c. Compliance sampling/reporting

    d. Staff scheduling

2. Describe your utility's preventative maintenance program.

3. Do the operators have the ability to make changes or modify the preventative maintenance program?

4. How does management prioritize the repair or replacement of utility assets? Do the operators play a role in this prioritization process?

5. Does the utility keep an inventory of spare parts?

6. Where does staff have to go to buy supplies/minor equipment? How often?

    6a. How do you handle supplies that are critical, but not in close proximity (for example if chlorine is not available in the immediate area or if the components for a critical pump are not in the area)

7. Describe the system's disinfection process. Have you had any problems in the last few years with the disinfection system?

7a. Who has the ability to adjust the disinfection process?

8. How often is the disinfectant residual checked and where is it checked?

8a. Is there an official policy on checking residuals or is it up to the operators?

9. Does the utility have an O & M manual? Does the staff use it?

10. Are the operators trained on safety issues? How are they trained and how often?

11. Describe how on-going training is handled for operators and other staff. How do you hear about appropriate trainings? Who suggests the trainings – the managers or the operators? How often do operators, managers, or other staff go to training? Who are the typical trainers used and where are the trainings usually held?

12. In your opinion is the level of your on-going training adequate?

13. In your opinion is the level of on-going training for other staff members, particularly the operators, adequate?

14. Does the facility have mapping of the water utility components? Is it used on any routine basis by the operators or management? If so, how is it used? If not, what is the process used for locating utility components?

15. In the last sanitary survey, were any deficiencies noted? If yes, were they corrected?

16. How often are storage tanks inspected? Who does the inspection?

    16a. Have you experienced any problems with the storage tanks?

H. SDWA Compliance

1. Has the system had any violations (monitoring or MCL) in the past 3 years? If so, describe.

2. How were the violations handled?

3. Does the system properly publish public notifications when notified of a violation?

4. Is the system currently in violation of any SDWA or state regulatory requirements, including failure to pay fees, fines, or other administrative type requirements?

5. Does the utility prepare and distribute a Consumer Confidence Report (CCR)? Is it done every year? What type of response does the utility get to the CCR from customers?

I. Emergency Planning

1. Does the system have a written emergency plan to handle emergencies such as water outages, weather issues, loss of power, loss of major equipment, etc?

2. When was the last time the plan was updated?

3. Do all employees know where the plan is? Do they follow it?

4. Describe the last emergency the facility faced and how it was handled.

Attachment A

A. Technical Capacity Assessment Questions

1. Based on available information of water rights on record and water pumped has the system exceeded its water rights in the past year? YES ☐ NO ☐

   In any of the past 5 years? YES ☐ NO ☐ How many times? _____

2. Does the system have the proper level of certified operator? *(Use questions a – c to answer.)*
   YES ☐ NO ☐

   a. What is the Classification Level of the system by NMED? _____

   b. Does the system have one or more certified operator(s)? [20 NMAC 7.4.20]

   YES ☐ NO ☐

   c. If YES, provide the number of operators at each New Mexico Certification Level. [20 NMAC 7.4.12]

   _____NM Small System _____Class 2

   _____NM Small System Advanced _____Class 3

   _____Class 1 _____Class 4

3. Did the system correct any sanitary deficiency noted on the most recent sanitary survey within 6 months of receiving that information? [20 NMAC 7.20.504]

   YES ☐ NO ☐ No Deficiencies ☐

   What was the type of deficiency? *(Check all that are applicable.)*

   Source ☐ Storage ☐

   Treatment ☐ Distribution ☐

   Other _____

   From the system's perspective, were there any other deficiencies that were not noted on the sanitary survey? Please describe.

4. Will the system's current treatment process meet known future regulations?

   Radionuclides YES ☐ NO ☐ Doesn't Apply ☐

   Arsenic YES ☐ NO ☐ Doesn't Apply ☐

   Stage 1 Disinfectants and Disinfection By-Product (DBP)

   YES ☐ NO ☐ Doesn't Apply ☐

   Surface Water Treatment Rule YES ☐ NO ☐ Doesn't Apply ☐

5. Does the system have a current site plan/map? [20 NMAC 7.10.302 A.1.]

   YES ☐ NO ☐

6. Has the system had a water supply outage in the prior 24 months?

YES ☐ NO ☐

What were the causes of the outage(s)? *(Include number of outages for each cause.)*

Drought _____ Limited Supply _____

System Failure _____ Other _____

7. Has the system ever had a water audit or a leak evaluation?

YES ☐ NO ☐ Don't Know ☐

If YES, please complete the following table.

Type of Investigation	Date Done	Water Loss (%)	What approach or technology was used to complete the investigation?	Was any follow-up done? If so, describe

8. Have all drinking water projects received NMED review and approval? [20 NMAC 7.10.201]

YES ☐ NO ☐

If NO, what types of projects have not received NMED review and approval.

Source ☐ Storage ☐

Treatment ☐ Distribution ☐

Other ☐ _____

9. What are the typical customer complaints that the utility receives?

10. Approximately how many complaints are there per month? _____

11. How are customer complaints handled? Are they recorded?

12. What is the age and composition of the distribution system? ***(Collect this information from the Sanitary Survey)***

Pipe Material	Approximate Age	Percentage of the system	Comments
			Sanitary Survey Distribution System Records Attached

13. Are there any dead end lines in the system?

YES ☐ NO ☐

14. Does the system have a flushing program?

YES ☐ NO ☐

If YES, please describe.

15. Are there any pressure problems within the system?

YES ☐ NO ☐

If YES, please describe.

16. Does the system disinfect the finished water?

YES ☐ NO ☐

If yes, which disinfectant product is used? ______

Interviewer Comments on Technical Capacity:

B. Managerial Capacity Assessment Questions

17. Has the system completed a 5-year Infrastructure Capital Improvement Plan (ICIP) plan?

YES ☐ NO ☐

If YES, has the plan been submitted to Local Government Division?

YES ☐ NO ☐

18. Does the system have written operating procedures?

YES ☐ NO ☐

19. Does the system have written job descriptions for all staff?

YES ☐ NO ☐

20. Does the system have:

A preventative maintenance plan?
YES ☐ NO ☐
A source water protection plan?
YES ☐ NO ☐ N/A ☐
An emergency plan?
YES ☐ NO ☐
A cross-connection control program?
YES ☐ NO ☐
An emergency source?
YES ☐ NO ☐
System security measures?
YES ☐ NO ☐

21. Does the system report and maintain records in accordance with the drinking water regulations concerning:

Water quality violations
YES ☐ NO ☐

Public notification
YES ☐ NO ☐

Sampling exemptions
YES ☐ NO ☐

22. Please describe how the above records are maintained:

23. Describe the management structure for the water system, including board and operations staff. Please include examples of duties, if possible.

24. Please describe type and quantity of training or continuing education for staff identified above.

25. Describe last major project undertaken by the water system, including the following: project in detail, positive aspects, negative aspects, the way in which the project was funded, any necessary rate increases, the public response to the project, whether the project is complete or not, and any other pertinent information.

26. Does the system have any debt? YES ☐ NO ☐

If yes, is the system current with all debt payments?
YES ☐ NO ☐

If no, describe the applicable funding agency and the default.

27. Is the system currently contemplating or actively seeking funding for any project?
YES ☐ NO ☐

If yes, from which agency and how much?

Describe the project?

Is the system receiving assistance from any agency or organization in its efforts?

28. Will the system consider any type of regionalization with other PWS? *(Check YES if the system has already regionalized.)*

YES ☐ NO ☐

If YES, what type of regionalization has been implemented/considered/discussed? *(Check all that apply.)*

System interconnection ☐
Sharing operator ☐
Sharing bookkeeper ☐
Purchasing water ☐
Emergency water connection ☐
Other: _____

29. Does the system have any of the following? *(Check all that apply.)*

Water Conservation Policy/Ordinance ☐ Current Drought Plan ☐
Water Use Restrictions ☐ Water Supply Emergency Plan ☐

Interviewer Comments on Managerial Capacity:

C. Financial Capacity Assessment

30. Does the system have a budget?

YES ☐ NO ☐

If YES, what type of budget?

Operating Budget ☐

Capital Budget ☐

31. Have the system revenues covered expenses and debt service for the past 5 years?

YES ☐ NO ☐

If NO, how many years has the system had a shortfall? _____

32. Does the system have a written/adopted rate structure?

YES ☐ NO ☐

33. What was the date of the last rate increase? _____

34. Are rates reviewed annually?

YES ☐ NO ☐

IF YES, what was the date of the last review? _____

35. Did the rate review show that the rates covered the following expenses? *(Check all that apply.)*

Operation & Maintenance ☐

Infrastructure Repair & replacement ☐

Staffing ☐

Emergency/Reserve fund ☐

Debt payment ☐

36. Is the rate collection above 90% of the customers?

YES ☐ NO ☐

37. Is there a cut-off policy for customers who are in arrears with their bill or for illegal connections?

YES ☐ NO ☐

If yes, is this policy implemented?

38. What is the residential water rate for 6,000 gallons of usage in one month. _____

39. In the past 12 months, how many customers have had accounts frozen or dropped for non-payment? _____

[Convert to % of active connections

Less than 1% ☐ 1% - 3% ☐ 4% - 5% ☐ 6% - 10% ☐

11% - 20% ☐ 21% - 50% ☐ Greater than 50% ☐]

40. The following questions refer to the process of obtaining needed equipment and supplies.

a. Can the water system operator buy or obtain supplies or equipment when they are needed?

YES ☐ NO ☐

b. Is the process simple or burdensome to the employees?

c. Can supplies or equipment be obtained quickly during an emergency?

YES ☐ NO ☐

d. Has the water system operator ever experienced a situation in which he/she couldn't purchase the needed supplies?

YES ☐ NO ☐

e. Does the system maintain some type of spare parts inventory?

YES ☐ NO ☐

If yes, please describe.

41. Has the system ever had a financial audit?

YES ☐ NO ☐

If YES, what is the date of the most recent audit? ______

42. Has the system ever had its electricity or phone turned off due to non-payment? Please describe.

Interviewer Comments on Financial Assessment:

43. What do you think the system capabilities are now and what are the issues you feel your system will be facing in the future? In addition, are there any specific needs, such as types of training that you would like to see addressed by NMED or its contractors?

APPENDIX B
COST BASIS

This section presents the basis for unit costs used to develop the conceptual cost estimates for the compliance alternatives. Cost estimates are conceptual in nature (+50%/-30%), and are intended to make comparisons between compliance options and to provide a preliminary indication of possible rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation. Capital cost includes an allowance for engineering and construction management. It is assumed that adequate electrical power is available near the site. The cost estimates specifically do not include costs for the following:

- Obtaining land or easements.
- Surveying.
- Mobilization/demobilization for construction.
- Insurance and bonds

In general, unit costs are based on recent construction bids for similar work in the area; when possible, consultations with vendors or other suppliers; published construction and O&M cost data; and USEPA cost guidance. Unit costs used for the cost estimates are summarized in Table B.1.

Unit costs for pipeline components are based on recent bids for Texas Department of Highways projects. The amounts of boring and encasement and open cut and encasement were estimated by counting the road, highway, railroad, stream, and river crossings for a conceptual routing of the pipeline. The number of air release valves is estimated by examining the land surface profile along the conceptual pipeline route. It is assumed gate valves and flush valves would be installed on average every 5,000 feet along the pipeline. Pipeline cost estimates are based on use of C-900 polyvinyl chloride pipe. Other pipe materials could be considered for more detailed development of attractive alternatives.

Pump station unit costs are based on experience with similar installations. The cost estimate for the pump stations includes two pumps, station piping and valves, station electrical and instrumentation, minor site improvement, installation of a concrete pad and building, and tools. Construction cost of a storage tank is based on similar recent installations in the area.

Electrical power cost is estimated to be $0.128 per kiloWatt hours (kWH), as supplied by the City of Midland. The annual cost for power to a pump station is calculated based on the pumping head and volume, and includes 11,800 kWH for pump building heating, cooling, and lighting, as recommended in USEPA publication, *Standardized Costs for Water Supply Distribution Systems* (1992).

In addition to the cost of electricity, pump stations have other maintenance costs. These costs cover: materials for minor repairs to keep the pumps operating; purchase of a maintenance vehicle, fuel costs, and vehicle maintenance costs; utilities; office supplies, small tools and equipment; and miscellaneous materials such as safety, clothing, chemicals, and paint. The non-power O&M costs are estimated based on the USEPA publication, *Standardized Costs for Water Supply Distribution Systems* (1992), which provides cost curves for O&M components. Costs from the 1992 report are adjusted to 2006 dollars based on the (ENR) construction cost index.

Pipeline maintenance costs include routine cleaning and flushing, as well as minor repairs to lines. The unit rate for pipeline maintenance is calculated based on the USEPA technical report, *Innovative and Alternate Technology Assessment Manual MCD 53* (1978). Costs from the 1978 report are adjusted to 2006 dollars based on the ENR construction cost index.

Storage tank maintenance costs include cleaning and renewal of interior lining and exterior coating. Unit costs for storage tank O&M are based on USEPA publication *Standardized Costs for Water Supply Distribution Systems* (1992). Costs from the 1992 report are adjusted to 2006 dollars based on the ENR construction cost index.

The purchase price for POU water treatment units is based on vendor price lists for treatment units, plus installation. O&M costs for POU treatment units are also based on vendor price lists. It is assumed that a yearly water sample would be analyzed for the contaminant of concern.

The purchase price for POE water treatment units is based on vendor price lists for treatment units, plus an allowance for installation, including a concrete pad and shed, piping modifications, and electrical connection. O&M costs for POE treatment units are also based on vendor price lists. It is assumed that a yearly water sample would be analyzed for the contaminant of concern.

Central treatment plant costs, for both adsorption and coagulation/filtration, include pricing for buildings, utilities, and site work. Costs are based on pricing given in the various R.S. Means Construction Cost Data References, as well as prices obtained from similar work on other projects. Pricing for treatment equipment was obtained from vendors.

Well installation costs are based on quotations from drillers for installation of similar depth wells in the area. Well installation costs include drilling, a well pump, electrical and instrumentation installation, well finishing, piping, and water quality testing. O&M costs for water wells include power, materials, and labor. It is assumed that new wells located more than 1 mile from the intake point of an existing system would require at least one storage tank and pump station.

Purchase price for the treatment unit dispenser is based on vendor price lists, plus an allowance for installation at a centralized public location. The O&M costs are also based on vendor price lists. It is assumed that weekly water samples would be analyzed for the contaminant of concern.

Costs for bottled water delivery alternatives are based on consultation with vendors that deliver residential bottled water. The cost estimate includes an initial allowance for set-up of the program, and a yearly allowance for program administration.

The cost estimate for a public dispenser for trucked water includes the purchase price for a water truck and construction of a storage tank. Annual costs include labor for purchasing the water, picking up and delivering the water, truck maintenance, and water sampling and testing. It is assumed the water truck would be required to make one trip per dispenser each week, and that chlorine residual would be determined for each truck load.

Table B.1
Summary of General Data
Bruni Rural WSC
PWS #2400003
General PWS Information

Service Population	589	**Number of Connections**	208
Total PWS Daily Water Usage	0.087 (mgd)	**Source**	TCEQ website

Unit Cost Data
South Texas

General Items	**Unit**	**Unit Cost**
Treated water purchase cost	*See alternative*	
Water purchase cost (trucked)	$/1,000 gals	$ 2.00
Contingency	20%	n/a
Engineering & Constr. Management	25%	n/a
Procurement/admin (POU/POE)	20%	n/a
Pipeline Unit Costs	**Unit**	**Unit Cost**
PVC water line, Class 200, 06"	LF	$ 32
Bore and encasement, 10"	LF	$ 60
Open cut and encasement, 10"	LF	$ 35
Gate valve and box, 06"	EA	$ 450
Air valve	EA	$ 1,000
Flush valve	EA	$ 750
Metal detectable tape	LF	$ 0.15
Bore and encasement, length	Feet	200
Open cut and encasement, length	Feet	50
Pump Station Unit Costs	**Unit**	**Unit Cost**
Pump	EA	$ 7,500
Pump Station Piping, 06"	EA	$ 4,000
Gate valve, 06"	EA	$ 530
Check valve, 06"	EA	$ 725
Electrical/Instrumentation	EA	$ 10,000
Site work	EA	$ 2,000
Building pad	EA	$ 4,000
Pump Building	EA	$ 10,000
Fence	EA	$ 5,870
Tools	EA	$ 1,000
Well Installation Unit Costs	**Unit**	**Unit Cost**
Well installation	*See alternative*	
Water quality testing	EA	$ 1,500
Well pump	EA	$ 7,500
Well electrical/instrumentation	EA	$ 5,000
Well cover and base	EA	$ 3,000
Piping	EA	$ 2,500
Two 20,000 gal storage tanks	EA	$ 54,000
Electrical Power	$/kWH	$ 0.031
Building Power	kWH	11,800
Labor	$/hr	$ 35
Materials	EA	$ 1,200
Transmission main O&M	$/mile	$ 200
Tank O&M	EA	$ 1,000
POU/POE Unit Costs		
POU treatment unit purchase	EA	$ 250
POU treatment unit installation	EA	$ 150
POE treatment unit purchase	EA	$ 3,000
POE - pad and shed, per unit	EA	$ 2,000
POE - piping connection, per unit	EA	$ 1,000
POE - electrical hook-up, per unit	EA	$ 1,000
POU treatment O&M, per unit	$/year	$ 225
POE treatment O&M, per unit	$/year	$ 1,000
Contaminant analysis	$/year	$ 100
POU/POE labor support	$/hr	$ 35
Dispenser/Bottled Water Unit Costs		
Treatment unit purchase	EA	$ 3,000
Treatment unit installation	EA	$ 5,000
Treatment unit O&M	EA	$ 500
Administrative labor	hr	$ 46
Bottled water cost (inc. delivery)	gallon	$ 1.60
Water use, per capita per day	gpcd	1.0
Bottled water program materials	EA	$ 5,000
Storage Tank - 5,000 gals	EA	$ 7,025
Site improvements	EA	$ 4,000
Potable water truck	EA	$ 60,000
Water analysis, per sample	EA	$ 100
Potable water truck O&M costs	$/mile	$ 1.00

Central Treatment Unit Costs	**Unit**	**Unit Cost**
General		
Site preparation	acre	$ 4,000
Slab	CY	$ 1,000
Building	SF	$ 60
Building electrical	SF	$ 8.00
Building plumbing	SF	$ 8.00
Heating and ventilation	SF	$ 7.00
Fence	LF	$ 15
Paving	SF	$ 2.00
Reject pond, excavation	CYD	$ 3
Reject pond, compacted fill	CYD	$ 7
Reject pond, lining	SF	$ 0.50
Reject pond, vegetation	SY	$ 1
Reject pond, access road	LF	$ 30
Reject water haulage truck	EA	$ 100,000
Chlorination point	EA	$ 2,000
Building power	kwh/yr	$ 0.031
Equipment power	kwh/yr	$ 0.031
Labor, O&M	hr	$ 40
Analyses	test	$ 200
Reverse Osmosis		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
RO package plant	UNIT	$ 150,000
Transfer pumps (5 hp)	EA	$ 5,000
Permeate tank	gal	$ 3
RO materials	year	$ 3,000
RO chemicals	year	$ 1,500
Backwash disposal mileage cost	miles	$ 1.00
Backwash disposal fee	1,000 gal/yr	$ 5.00
EDR		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
Product storage tank	gal	$ 3.00
EDR package plant	UNIT	$ 260,000
EDR materials	year	$ 3,000
EDR chemicals	year	$ 1,500
Backwash disposal mileage cost	miles	$ 1.00
Backwash disposal fee	1,000 gal/yr	$ 5.00
Adsorption		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
Adsorption package plant	UNIT	$ 100,000
Backwash tank	GAL	$ 2.00
Sewer connection fee	EA	$ 15,000
Spent media disposal	CY	$ 20
Adsorption materials	year	$ 27,000
Backwash discharge to sewer	MG/year	$ 5,000
Coagulation/filtration		
Electrical	JOB	$ 45,000
Piping	JOB	$ 15,000
Coagulation package plant	UNIT	$ 80,000
Backwash tank	GAL	$ 2.00
Coagulant tank	GAL	$ 3.00
Sewer connection fee	EA	$ 15,000
Coagulation/Filtration Materials	year	$ 2,000
Chemicals, Coagulation	year	$ 2,000
Backwash discharge to sewer	MG/year	$ 5,000

APPENDIX C
COMPLIANCE ALTERNATIVE CONCEPTUAL COST ESTIMATES

This appendix presents the conceptual cost estimates developed for the compliance alternatives. The conceptual cost estimates are given in Tables C.1 through C.15. The cost estimates are conceptual in nature (+50%/-30%), and are intended for making comparisons between compliance options and to provide a preliminary indication of possible water rate impacts. Consequently, these costs are pre-planning level and should not be viewed as final estimated costs for alternative implementation.

Table C.1

PWS Name ***Bruni Rural WSC***
Alternative Name ***New Well at Cogema Malapai***
Alternative Number ***BR-1***

Distance from PWS to new well location	5.66	miles
Estimated well depth	900	feet
Number of wells required	1	
Well installation cost (location specific)	$18	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	3	n/a	n/a	n/a
PVC water line, Class 200, 06"	29,869	LF	$ 32.00	$ 955,808
Bore and encasement, 10"	200	LF	$ 60.00	$ 12,000
Open cut and encasement, 10"	150	LF	$ 35.00	$ 5,250
Gate valve and box, 06"	6	EA	$ 450.00	$ 2,688
Air valve	6	EA	$ 1,000.00	$ 6,000
Flush valve	6	EA	$ 750.00	$ 4,480
Metal detectable tape	29,869	LF	$ 0.15	$ 4,480
Subtotal				**$ 990,707**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 06"	2	EA	$ 4,000	$ 8,000
Gate valve, 06"	8	EA	$ 530	$ 4,240
Check valve, 06"	4	EA	$ 725	$ 2,900
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Two 20,000 gal storage tanks	2	EA	$ 54,000	$ 108,000
Subtotal				**$ 218,880**
Well Installation				
Well installation	900	LF	$ 18	$ 16,200
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 37,200**
Subtotal of Component Costs				**$ 1,246,787**
Contingency	20%			$ 249,357
Design & Constr Management	25%			$ 311,697
TOTAL CAPITAL COSTS				**$ 1,807,841**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.7	mile	$ 200	$ 1,131
Subtotal				**$ 1,131**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.031	$ 732
Pump Power	21,616	kWH	$ 0.031	$ 670
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 35	$ 25,404
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 31,206**
Well O&M				
Pump power	11,481	kWH	$ 0.031	$ 356
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 35	$ 6,264
Subtotal				**$ 7,820**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**
TOTAL ANNUAL O&M COSTS				**$ 25,070**

Table C.2

PWS Name	***Bruni Rural WSC***
Alternative Name	***New Well at Oilton Rural WSC***
Alternative Number	***BR-2***

Distance from PWS to new well location	7.60	miles
Estimated well depth	420	feet
Number of wells required	1	
Well installation cost (location specific)	$18	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	3	n/a	n/a	n/a
Number of Crossings, open cut	11	n/a	n/a	n/a
PVC water line, Class 200, 06"	40,115	LF	$ 32.00	$ 1,283,680
Bore and encasement, 10"	600	LF	$ 60.00	$ 36,000
Open cut and encasement, 10"	550	LF	$ 35.00	$ 19,250
Gate valve and box, 06"	8	EA	$ 450.00	$ 3,610
Air valve	8	EA	$ 1,000.00	$ 8,000
Flush valve	8	EA	$ 750.00	$ 6,017
Metal detectable tape	40,115	LF	$ 0.15	$ 6,017
Subtotal				**$ 1,362,575**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 06"	2	EA	$ 4,000	$ 8,000
Gate valve, 06"	8	EA	$ 530	$ 4,240
Check valve, 06"	4	EA	$ 725	$ 2,900
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Two 20,000 gal storage tanks	2	EA	$ 54,000	$ 108,000
Subtotal				**$ 218,880**
Well Installation				
Well installation	420	LF	$ 18	$ 7,560
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 28,560**
Subtotal of Component Costs				**$ 1,610,015**
Contingency	20%			$ 322,003
Design & Constr Management	25%			$ 402,504
TOTAL CAPITAL COSTS				**$ 2,334,522**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	7.6	mile	$ 200	$ 1,520
Subtotal				**$ 1,520**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.031	$ 732
Pump Power	21,616	kWH	$ 0.031	$ 670
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 35	$ 25,404
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 31,206**
Well O&M				
Pump power	5,375	kWH	$ 0.031	$ 167
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 35	$ 6,264
Subtotal				**$ 7,631**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**
TOTAL ANNUAL O&M COSTS				**$ 25,269**

Table C.3

PWS Name *Bruni Rural WSC*
Alternative Name *Purchase Water from Webb County*
Alternative Number *BR-3*

Distance from Alternative to PWS (along pipe)	34.7	miles
Total PWS annual water usage	31.755	MG
Treated water purchase cost	$ 2.50	per 1,000 gals
Number of Pump Stations Needed	2	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	39	n/a	n/a	n/a
PVC water line, Class 200, 06"	183,448	LF	$ 32.00	$ 5,870,336
Bore and encasement, 10"	800	LF	$ 60.00	$ 48,000
Open cut and encasement, 10"	1,950	LF	$ 35.00	$ 68,250
Gate valve and box, 06"	37	EA	$ 450.00	$ 16,510
Air valve	35	EA	$ 1,000.00	$ 35,000
Flush valve	37	EA	$ 750.00	$ 27,517
Metal detectable tape	183,448	LF	$ 0.15	$ 27,517
Subtotal				**$ 6,093,131**
Pump Station(s) Installation				
Pump	6	EA	$ 7,500	$ 45,000
Pump Station Piping, 06"	3	EA	$ 4,000	$ 12,000
Gate valve, 06"	12	EA	$ 530	$ 6,360
Check valve, 06"	6	EA	$ 725	$ 4,350
Electrical/Instrumentation	3	EA	$ 10,000	$ 30,000
Site work	3	EA	$ 2,000	$ 6,000
Building pad	3	EA	$ 4,000	$ 12,000
Pump Building	3	EA	$ 10,000	$ 30,000
Fence	3	EA	$ 5,870	$ 17,610
Tools	3	EA	$ 1,000	$ 3,000
Two 20,000 gal storage tanks	3	EA	$ 54,000	$ 162,000
Subtotal				**$ 328,320**
Subtotal of Component Costs				**$ 6,421,451**
Contingency	20%			$ 1,284,290
Design & Constr Management	25%			$ 1,605,363
TOTAL CAPITAL COSTS				**$ 9,311,104**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	34.7	mile	$ 200	$ 6,949
Subtotal				**$ 6,949**
Water Purchase Cost				
From PWS	31,755	1,000 gal	$ 2.50	$ 79,388
Subtotal				**$ 79,388**
Pump Station(s) O&M				
Building Power	35,400	kWH	$ 0.031	$ 1,097
Pump Power	132,759	kWH	$ 0.031	$ 4,116
Materials	3	EA	$ 1,200	$ 3,600
Labor	1,095	Hrs	$ 35	$ 38,106
Tank O&M	3	EA	$ 1,000	$ 3,000
Subtotal				**$ 49,919**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**
TOTAL ANNUAL O&M COSTS				**$ 121,168**

Table C.4

PWS Name *Bruni Rural WSC*
Alternative Name *New Well at 10 Miles*
Alternative Number *BR-4*

Distance from PWS to new well location	10.0	miles
Estimated well depth	600	feet
Number of wells required	1	
Well installation cost (location specific)	$18	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	2	n/a	n/a	n/a
Number of Crossings, open cut	11	n/a	n/a	n/a
PVC water line, Class 200, 06"	52,800	LF	$ 32.00	$ 1,689,600
Bore and encasement, 10"	400	LF	$ 60.00	$ 24,000
Open cut and encasement, 10"	550	LF	$ 35.00	$ 19,250
Gate valve and box, 06"	11	EA	$ 450.00	$ 4,752
Air valve	10	EA	$ 1,000.00	$ 10,000
Flush valve	11	EA	$ 750.00	$ 7,920
Metal detectable tape	52,800	LF	$ 0.15	$ 7,920
Subtotal				**$ 1,763,442**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 06"	2	EA	$ 4,000	$ 8,000
Gate valve, 06"	8	EA	$ 530	$ 4,240
Check valve, 06"	4	EA	$ 725	$ 2,900
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Two 20,000 gal storage tanks	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 124,930**
Well Installation				
Well installation	600	LF	$ 18	$ 10,800
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 31,800**
Subtotal of Component Costs				**$ 1,920,172**
Contingency	20%			$ 384,034
Design & Constr Management	25%			$ 480,043

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.0	mile	$ 200	$ 2,000
Subtotal				**$ 2,000**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.031	$ 732
Pump Power	38,195	kWH	$ 0.031	$ 1,184
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 35	$ 25,404
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 31,720**
Well O&M				
Pump power	7,665	kWH	$ 0.031	$ 238
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 35	$ 6,264
Subtotal				**$ 7,702**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**

Table C.5

PWS Name *Bruni Rural WSC*
Alternative Name *New Well at 5 Miles*
Alternative Number *BR-5*

Distance from PWS to new well location	5.0	miles
Estimated well depth	600	feet
Number of wells required	1	
Well installation cost (location specific)	$18	per foot
Number of pump stations needed	1	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	1	n/a	n/a	n/a
Number of Crossings, open cut	6	n/a	n/a	n/a
PVC water line, Class 200, 06"	26,400	LF	$ 32.00	$ 844,800
Bore and encasement, 10"	1,800	LF	$ 60.00	$ 108,000
Open cut and encasement, 10"	100	LF	$ 35.00	$ 3,500
Gate valve and box, 06"	5	EA	$ 450.00	$ 2,376
Air valve	5	EA	$ 1,000.00	$ 5,000
Flush valve	5	EA	$ 750.00	$ 3,960
Metal detectable tape	26,400	LF	$ 0.15	$ 3,960
Subtotal				**$ 971,596**
Pump Station(s) Installation				
Pump	4	EA	$ 7,500	$ 30,000
Pump Station Piping, 06"	2	EA	$ 4,000	$ 8,000
Gate valve, 06"	8	EA	$ 530	$ 4,240
Check valve, 06"	4	EA	$ 725	$ 2,900
Electrical/Instrumentation	2	EA	$ 10,000	$ 20,000
Site work	2	EA	$ 2,000	$ 4,000
Building pad	2	EA	$ 4,000	$ 8,000
Pump Building	2	EA	$ 10,000	$ 20,000
Fence	2	EA	$ 5,870	$ 11,740
Tools	2	EA	$ 1,000	$ 2,000
Two 20,000 gal storage tanks	2	EA	$ 7,025	$ 14,050
Subtotal				**$ 124,930**
Well Installation				
Well installation	600	LF	$ 18	$ 10,800
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 31,800**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.0	mile	$ 200	$ 1,000
Subtotal				**$ 1,000**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.031	$ 732
Pump Power	19,098	kWH	$ 0.031	$ 592
Materials	2	EA	$ 1,200	$ 2,400
Labor	730	Hrs	$ 35	$ 25,404
Tank O&M	2	EA	$ 1,000	$ 2,000
Subtotal				**$ 31,128**
Well O&M				
Pump power	7,665	kWH	$ 0.031	$ 238
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 35	$ 6,264
Subtotal				**$ 7,702**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**

Table C.6

PWS Name *Bruni Rural WSC*
Alternative Name *New Well at 1 Mile*
Alternative Number *BR-6*

Distance from PWS to new well location	1.0	miles
Estimated well depth	600	feet
Number of wells required	1	
Well installation cost (location specific)	$18	per foot
Number of pump stations needed	0	
Number of feed tanks/pump sets needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 06"	5,280	LF	$ 32.00	$ 168,960
Bore and encasement, 10"	-	LF	$ 60.00	$ -
Open cut and encasement, 10"	50	LF	$ 35.00	$ 1,750
Gate valve and box, 06"	1	EA	$ 450.00	$ 475
Air valve	1.00	EA	$ 1,000.00	$ 1,000
Flush valve	1	EA	$ 750.00	$ 792
Metal detectable tape	5,280	LF	$ 0.15	$ 792
Subtotal				**$ 173,769**
Pump Station(s) Installation				
Pump	2	EA	$ 7,500	$ 15,000
Pump Station Piping, 06"	1	EA	$ 4,000	$ 4,000
Gate valve, 06"	4	EA	$ 530	$ 2,120
Check valve, 06"	2	EA	$ 725	$ 1,450
Electrical/Instrumentation	1	EA	$ 10,000	$ 10,000
Site work	1	EA	$ 2,000	$ 2,000
Building pad	1	EA	$ 4,000	$ 4,000
Pump Building	1	EA	$ 10,000	$ 10,000
Fence	1	EA	$ 5,870	$ 5,870
Tools	1	EA	$ 1,000	$ 1,000
Two 20,000 gal storage tanks	1	EA	$ 7,025	$ 7,025
Subtotal				**$ 62,465**
Well Installation				
Well installation	600	LF	$ 18	$ 10,800
Water quality testing	2	EA	$ 1,500	$ 3,000
Well pump	1	EA	$ 7,500	$ 7,500
Well electrical/instrumentation	1	EA	$ 5,000	$ 5,000
Well cover and base	1	EA	$ 3,000	$ 3,000
Piping	1	EA	$ 2,500	$ 2,500
Subtotal				**$ 31,800**
Subtotal of Component Costs				**$ 268,034**
Contingency	20%			$ 53,607
Design & Constr Management	25%			$ 67,009
TOTAL CAPITAL COSTS				**$ 388,650**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	1.0	mile	$ 200	$ 200
Subtotal				**$ 200**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.031	$ 366
Pump Power	-	kWH	$ 0.031	$ -
Materials	1	EA	$ 1,200	$ 1,200
Labor	365	Hrs	$ 35	$ 12,702
Tank O&M	1	EA	$ 1,000	$ 1,000
Subtotal				**$ 15,268**
Well O&M				
Pump power	7,665	kWH	$ 0.031	$ 238
Well O&M matl	1	EA	$ 1,200	$ 1,200
Well O&M labor	180	Hrs	$ 35	$ 6,264
Subtotal				**$ 7,702**
O&M Credit for Existing Well Closure				
Pump power	5,121	kWH	$ 0.031	$ (159)
Well O&M matl	2	EA	$ 1,200	$ (2,400)
Well O&M labor	360	Hrs	$ 35	$ (12,528)
Subtotal				**$ (15,087)**
TOTAL ANNUAL O&M COSTS				**$ 8,083**

Table C.7

PWS Name *Bruni Rural WSC*
Alternative Name *Central Treatment - RO*
Alternative Number *BR-7*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	500	SF	$ 60	$ 30,000
Building electrical	500	SF	$ 8	$ 4,000
Building plumbing	500	SF	$ 8	$ 4,000
Heating and ventilation	500	SF	$ 7	$ 3,500
Fence	-	LF	$ 15	$ -
Paving	2,000	SF	$ 2	$ 4,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
Reverse osmosis package including:				
High pressure pumps - 15hp				
Cartridge filters and vessels				
RO membranes and vessels				
Control system				
Chemical feed systems				
Freight cost				
Vendor start-up services	1	UNIT	$ 150,000	$ 150,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Permeate tank	20,000	gal	$ 3	$ 60,000
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Reject pond:				
Excavation	-	CYD	$ 3.00	$ -
Compacted fill	-	CYD	$ 7.00	$ -
Lining	-	SF	$ 0.50	$ -
Vegetation	-	SY	$ 1.00	$ -
Access road	-	LF	$ 30.00	$ -
Subtotal of Design/Construction Costs				**$ 367,500**
Contingency	20%			$ 73,500
Design & Constr Management	25%			$ 91,875
Reject water haulage truck	-	EA	$ 100,000	$ -
TOTAL CAPITAL COSTS				**$ 532,875**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit O&M				
Building Power	7,500	kwh/yr	$ 0.031	$ 233
Equipment power	36,000	kwh/yr	$ 0.031	$ 1,116
Labor	1,000	hrs/yr	$ 35	$ 35,000
Materials	1	year	$ 3,000	$ 3,000
Chemicals	1	year	$ 1,500	$ 1,500
Analyses	24	test	$ 200	$ 4,800
Subtotal				**$ 45,649**
Backwash Disposal				
Disposal truck mileage	-	miles	$ 1.00	$ -
Reject sewer discharge fee	5,570	kgal/yr	$ 5.00	$ 27,850
Subtotal				**$ 27,850**
TOTAL ANNUAL O&M COSTS				**$ 73,499**

Table C.8

PWS Name *Bruni Rural WSC*
Alternative Name *Central Treatment - EDR*
Alternative Number *BR-8*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
EDR Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	500	SF	$ 60	$ 30,000
Building electrical	500	SF	$ 8	$ 4,000
Building plumbing	500	SF	$ 8	$ 4,000
Heating and ventilation	500	SF	$ 7	$ 3,500
Fence	-	LF	$ 15	$ -
Paving	2,000	SF	$ 2	$ 4,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
Product storage tank	20,000	gal	$ 3.00	$ 60,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
EDR package including:				
Feed and concentrate pumps				
Cartridge filters and vessels				
EDR membrane stacks				
Electrical module				
Chemical feed systems				
Freight cost				
Vendor start-up services	1	UNIT	$ 260,000	$ 260,000
Reject pond:				
Excavation	-	CYD	$ 3.00	$ -
Compacted fill	-	CYD	$ 7.00	$ -
Lining	-	SF	$ 0.50	$ -
Vegetation	-	SY	$ 1.00	$ -
Access road	-	LF	$ 30.00	$ -
Subtotal of Design/Construction Costs				**$ 477,500**
Contingency	20%			$ 95,500
Design & Constr Management	25%			$ 119,375
Reject water haulage truck	-	EA	$ 100,000	$ -
TOTAL CAPITAL COSTS				**$ 692,375**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
EDR Unit O&M				
Building Power	9,000	kwh/yr	$ 0.031	$ 279
Equipment power	36,000	kwh/yr	$ 0.031	$ 1,116
Labor	1,000	hrs/yr	$ 35	$ 35,000
Materials	1	year	$ 3,000	$ 3,000
Chemicals	1	year	$ 1,500	$ 1,500
Analyses	24	test	$ 200	$ 4,800
Subtotal				**$ 45,695**
Backwash Disposal				
Disposal truck mileage	-	miles	$ 1.00	$ -
Reject sewer disposal fee	4,420	kgal/yr	$ 5.00	$ 22,100
Subtotal				**$ 22,100**
TOTAL ANNUAL O&M COSTS				**$ 67,795**

Table C.9

PWS Name *Bruni Rural WSC*
Alternative Name *Central Treatment - Adsorption*
Alternative Number *BR-9*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Adsorption Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	500	SF	$ 60	$ 30,000
Building electrical	500	SF	$ 8	$ 4,000
Building plumbing	500	SF	$ 8	$ 4,000
Heating and ventilation	500	SF	$ 7	$ 3,500
Fence	-	LF	$ 15	$ -
Paving	2,000	SF	$ 2	$ 4,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
Adsorption package including:				
4 Adsorption vessels				
E33 Iron oxide media				
Controls & instruments	1	UNIT	$ 100,000	$ 100,000
Backwash Tank	20,000	GAL	$ 2	$ 40,000
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Storage tank	20,000	gal	$ 3	$ 60,000
Chlorination Point	1	EA	$ 2,000	$ 2,000
Subtotal of Component Costs				**$ 359,500**
Contingency	20%			$ 71,900
Design & Constr Management	25%			$ 89,875
TOTAL CAPITAL COSTS				**$ 521,275**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Adsorption Unit O&M				
Building Power	9,000	kwh/yr	$ 0.031	$ 279
Equipment power	1,500	kwh/yr	$ 0.031	$ 47
Labor	500	hrs/yr	$ 35	$ 17,500
Materials	1	year	$ 27,000	$ 27,000
Analyses	24	test	$ 200	$ 4,800
Backwash discharge to sewer	0.60	MG/yr	$ 5,000	$ 3,000
Spent Media Disposal	12	CY	$ 20	$ 240
Subtotal				**$ 52,866**
TOTAL ANNUAL O&M COSTS				**$ 52,866**

Table C.10

PWS Name — ***Bruni Rural WSC***
Alternative Name — ***Central Treatment - Coag-Filt***
Alternative Number — ***BR-10***

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Coagulation/Filtration Unit Purchase/Installation				
Site preparation	0.50	acre	$ 4,000	$ 2,000
Slab	15	CY	$ 1,000	$ 15,000
Building	500	SF	$ 60	$ 30,000
Building electrical	500	SF	$ 8	$ 4,000
Building plumbing	500	SF	$ 8	$ 4,000
Heating and ventilation	500	SF	$ 7	$ 3,500
Fence	-	LF	$ 15	$ -
Paving	2,000	SF	$ 2	$ 4,000
Electrical	1	JOB	$ 45,000	$ 45,000
Piping	1	JOB	$ 15,000	$ 15,000
Coagulant/filter package including:				
Chemical feed system				
Pressure ceramic filters				
Controls & Instruments	1	UNIT	$ 80,000	$ 80,000
Backwash Tank	12,000	GAL	$ 2	$ 24,000
Coagulant Tank	500	GAL	$ 3	$ 1,500
Sewer Connection Fee	1	EA	$ 15,000	$ 15,000
Transfer pumps	2	EA	$ 5,000	$ 10,000
Storage tank	20,000	gal	$ 3	$ 60,000
Chlorination Point	1	EA	$ 2,000	$ 2,000
Subtotal of Component Costs				**$ 315,000**
Contingency	20%			$ 63,000
Design & Constr Management	25%			$ 78,750
TOTAL CAPITAL COSTS				**$ 456,750**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Coagulation/Filtration Unit O&M				
Building Power	9,000	kwh/yr	$ 0.031	$ 279
Equipment power	2,000	kwh/yr	$ 0.031	$ 62
Labor	1,000	hrs/yr	$ 35	$ 35,000
Materials	1	year	$ 2,000	$ 2,000
Chemicals	1	year	$ 2,000	$ 2,000
Analyses	24	test	$ 200	$ 4,800
Backwash discharge to sewer	1.8	MG/yr	$ 5,000	$ 8,750
Subtotal				**$ 52,891**
TOTAL ANNUAL O&M COSTS				**$ 52,891**

Table C.11

PWS Name ***Bruni Rural WSC***
Alternative Name ***Point-of-Use Treatment***
Alternative Number ***BR-11***

Number of Connections for POU Unit Installation 208

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POU-Treatment - Purchase/Installation				
POU treatment unit purchase	208	EA	$ 250	$ 52,000
POU treatment unit installation	208	EA	$ 150	$ 31,200
Subtotal				**$ 83,200**
Subtotal of Component Costs				**$ 83,200**
Contingency	20%			$ 16,640
Design & Constr Management	25%			$ 20,800
Procurement & Administration	20%			$ 16,640
TOTAL CAPITAL COSTS				**$ 137,280**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POU materials, per unit	208	EA	$ 225	$ 46,800
Contaminant analysis, 1/yr per unit	208	EA	$ 100	$ 20,800
Program labor, 10 hrs/unit	2,080	hrs	$ 35	$ 72,384
Subtotal				**$ 139,984**
TOTAL ANNUAL O&M COSTS				**$ 139,984**

Table C.12

PWS Name ***Bruni Rural WSC***
Alternative Name ***Point-of-Entry Treatment***
Alternative Number ***BR-12***

Number of Connections for POE Unit Installation 208

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POE-Treatment - Purchase/Installation				
POE treatment unit purchase	208	EA	$ 3,000	$ 624,000
Pad and shed, per unit	208	EA	$ 2,000	$ 416,000
Piping connection, per unit	208	EA	$ 1,000	$ 208,000
Electrical hook-up, per unit	208	EA	$ 1,000	$ 208,000
Subtotal				**$ 1,456,000**
Subtotal of Component Costs				**$ 1,456,000**
Contingency	20%			$ 291,200
Design & Constr Management	25%			$ 364,000
Procurement & Administration	20%			$ 291,200
TOTAL CAPITAL COSTS				**$ 2,402,400**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POE materials, per unit	208	EA	$ 1,000	$ 208,000
Contaminant analysis, 1/yr per unit	208	EA	$ 100	$ 20,800
Program labor, 10 hrs/unit	2,080	hrs	$ 35	$ 72,384
Subtotal				**$ 301,184**
TOTAL ANNUAL O&M COSTS				**$ 301,184**

Table C.13

PWS Name ***Bruni Rural WSC***
Alternative Name ***Public Dispenser for Treated Drinking Water***
Alternative Number ***BR-13***

Number of Treatment Units Recommended 1

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Public Dispenser Unit Installation				
POE-Treatment unit(s)	1	EA	$ 3,000	$ 3,000
Unit installation costs	1	EA	$ 5,000	$ 5,000
Subtotal				**$ 8,000**
Subtotal of Component Costs				**$ 8,000**
Contingency	20%			$ 1,600
Design & Constr Management	25%			$ 2,000
TOTAL CAPITAL COSTS				**11,600**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Treatment unit O&M, 1 per unit	1	EA	$ 500	$ 500
Contaminant analysis, 1/wk per ui	52	EA	$ 100	$ 5,200
Sampling/reporting, 1 hr/day	365	HRS	$ 35	$ 12,702
Subtotal				**$ 18,402**
TOTAL ANNUAL O&M COSTS				**$ 18,402**

Table C.14

PWS Name ***Bruni Rural WSC***
Alternative Name ***Supply Bottled Water to Population***
Alternative Number ***BR-14***

Service Population	589	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	214,985	gallons

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Implementation				
Initial program set-up	500	hours	$ 46	$ 23,142
Subtotal				**$ 23,142**
Subtotal of Component Costs				**$ 23,142**
Contingency	20%			$ 4,628
TOTAL CAPITAL COSTS				**$ 27,770**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water purchase costs	214,985	gals	$ 1.60	$ 343,976
Program admin, 9 hrs/wk	468	hours	$ 46	$ 21,661
Program materials	1	EA	$ 5,000	$ 5,000
Subtotal				**$ 370,637**
TOTAL ANNUAL O&M COSTS				**$ 370,637**

Table C.15

PWS Name ***Bruni Rural WSC***
Alternative Name ***Central Trucked Drinking Water***
Alternative Number ***BR-15***

Service Population	589	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	214,985	gallons
Travel distance to compliant water source (roundtrip)	20	miles

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Storage Tank Installation				
Storage Tank - 5,000 gals	1	EA	$ 7,025	$ 7,025
Site improvements	1	EA	$ 4,000	$ 4,000
Potable water truck	1	EA	$ 60,000	$ 60,000
Subtotal				**$ 71,025**
Subtotal of Component Costs				**$ 71,025**
Contingency	20%			$ 14,205
Design & Constr Management	25%			$ 17,756
TOTAL CAPITAL COSTS				**$ 102,986**

Annual Operations and Maintenance Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Program Operation				
Water delivery labor, 4 hrs/wk	208	hrs	$ 35	$ 7,238
Truck operation, 1 round trip/wk	1040	miles	$ 1.00	$ 1,040
Water purchase	215	1,000 gals	$ 2.00	$ 430
Water testing, 1 test/wk	52	EA	$ 100	$ 5,200
Sampling/reporting, 2 hrs/wk	104	hrs	$ 35	$ 3,619
Subtotal				**$ 17,528**
TOTAL ANNUAL O&M COSTS				**$ 17,528**

APPENDIX D
EXAMPLE FINANCIAL MODEL

Water System	Bruni
Funding Alternative	Bond
Alternative Description	Purchase Water from Webb County

Sum of Amount		Year																					
Group	Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Capital Expenditures	Capital Expenditures-Funded from Bonds							$ -	$ -	$ -	$ 9,311,104	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded from Grants							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded from Revenue/Reserves							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Capital Expenditures-Funded from SRF Loans							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Capital Expenditures Sum								$ -	$ -	$ -	$ 9,311,104	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service	Existing Debt Service	$ 7,804	$ 7,804	$ 7,804	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619	$ 8,619
	Revenue Bonds										$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377	$ 728,377
	State Revolving Funds										$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Debt Service Sum		$ 7,804	$ 7,804	$ 7,804	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 19,847	$ 748,224	$ 748,224	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996	$ 736,996
Operating Expenditures	Administrative Expenses									$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022	$ 4,022
	Contract Labor									$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380	$ 26,380
	Other Operating Expenditures 1									$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046	$ 3,046
	Other Operating Expenditures 2									$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017	$ 1,017
	Professional and Directors Fees									$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469	$ 1,469
	Repairs									$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610	$ 4,610
	Salaries & Benefits									$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
	Supplies									$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384	$ 2,384
	Utilities									$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235	$ 8,235
	O&M Associated with Alternative											$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168	$ 121,168
	Other Operating Expenditures 3									$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299	$ 25,299
Operating Expenditures Sum										$ 82,462	$ 82,462	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630	$ 203,630
Residential Operating Revenues	Residential Base Monthly Rate							$ 58,706	$ 202,724	$ 58,706	$ 58,706	$ 592,304	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469	$ 1,283,469
	Residential Tier 1 Monthly Rate							$ -	$ -	$ 19,460	$ 19,460	$ 196,339	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450	$ 425,450
	Residential Tier2 Monthly Rate							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Tier3 Monthly Rate							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Tier4 Monthly Rate							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Residential Unmetered Monthly Rate							$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Residential Operating Revenues Sum								$ 58,706	$ 202,724	$ 78,166	$ 78,166	$ 788,643	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919

Location_Name	Bruni
Alt_Desc	Purchase Water from Webb County

		Current_Year																					
Funding_Alt	Data	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Bond	Sum of Beginning_Cash_Bal	$ 118,972	$ 68,436	$ (710,477)	$ (920,276)	$ (198,571)	$ 523,134	$ 1,244,839	$ 1,966,544	$ 2,688,248	$ 3,409,953	$ 4,131,658	$ 4,853,363	$ 5,575,068	$ 6,296,773	$ 7,018,478	$ 7,740,182	$ 8,461,887	$ 9,183,592	$ 9,905,297	$ 10,627,002	$ 11,348,707	$ 12,070,411
	Sum of Total_Expenditures	$ 102,309	$ 10,141,790	$ 951,854	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626	$ 940,626
	Sum of Total_Receipts	$ 78,166	$ 9,389,270	$ 788,643	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919	$ 1,708,919
	Sum of Net_Cash_Flow	$ (24,143)	$ (752,520)	$ (163,211)	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293	$ 768,293
	Sum of Ending_Cash_Bal	$ 94,829	$ (684,084)	$ (873,688)	$ (151,983)	$ 569,722	$ 1,291,427	$ 2,013,131	$ 2,734,836	$ 3,456,541	$ 4,178,246	$ 4,899,951	$ 5,621,656	$ 6,343,361	$ 7,065,065	$ 7,786,770	$ 8,508,475	$ 9,230,180	$ 9,951,885	$ 10,673,590	$ 11,395,294	$ 12,116,999	$ 12,838,704
	Sum of Working_Cap	$ 13,744	$ 13,744	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938	$ 33,938
	Sum of Repl_Resv	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650	$ 12,650
	Sum of Total_Reqd_Resv	$ 26,393	$ 26,393	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588	$ 46,588
	Sum of Net_Avail_Bal	$ 68,436	$ (710,477)	$ (920,276)	$ (198,571)	$ 523,134	$ 1,244,839	$ 1,966,544	$ 2,688,248	$ 3,409,953	$ 4,131,658	$ 4,853,363	$ 5,575,068	$ 6,296,773	$ 7,018,478	$ 7,740,182	$ 8,461,887	$ 9,183,592	$ 9,905,297	$ 10,627,002	$ 11,348,707	$ 12,070,411	$ 12,792,116
	Sum of Add_Resv_Needed	$ -	$ (710,477)	$ (920,276)	$ (198,571)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Sum of Rate_Inc_Needed	0%	909%	117%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0
	Sum of Percent_Rate_Increase	0%	0%	909%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%	2086%

APPENDIX E
GENERAL ARSENIC GEOCHEMISTRY

On January 22, 2001 USEPA adopted a new standard for arsenic in drinking water at 10 ppb, replacing the old standard of 50 ppb. The rule became effective on February 22, 2002. The date by which systems must comply with the new 10 µg/L standard was January 23, 2006. The geochemistry of arsenic is complex because of the possible coexistence of two or even three redox states (-III, III, V) and because of the strong interaction of most arsenic compounds with soil particles, particularly iron oxides. Because groundwater is generally oxidizing in the High Plains, Edwards Trinity (Plateau), and Cenozoic Pecos Alluvium aquifers, it is expected to be in the arsenate form (V). Correlations between arsenic and vanadium and fluoride suggest a geologic rather than an anthropogenic source of arsenic. The large number of potential geologic sources include: volcanic ashes in the Ogallala and underlying units, shales in the Cretaceous, and saline lakes in the Southern High Plains that were evaluated in a separate study and described in Scanlon, *et al.* (2005). Arsenic mobility is generally not controlled by solubility of arsenic-bearing minerals because these minerals are highly soluble. Under oxidizing conditions, arsenic mobility increases with increasing pH (Smedley and Kinniburg 2002). Phosphate can also increase arsenic mobility because phosphate preferentially sorbs onto clays and iron oxides relative to arsenic.

Appendix References

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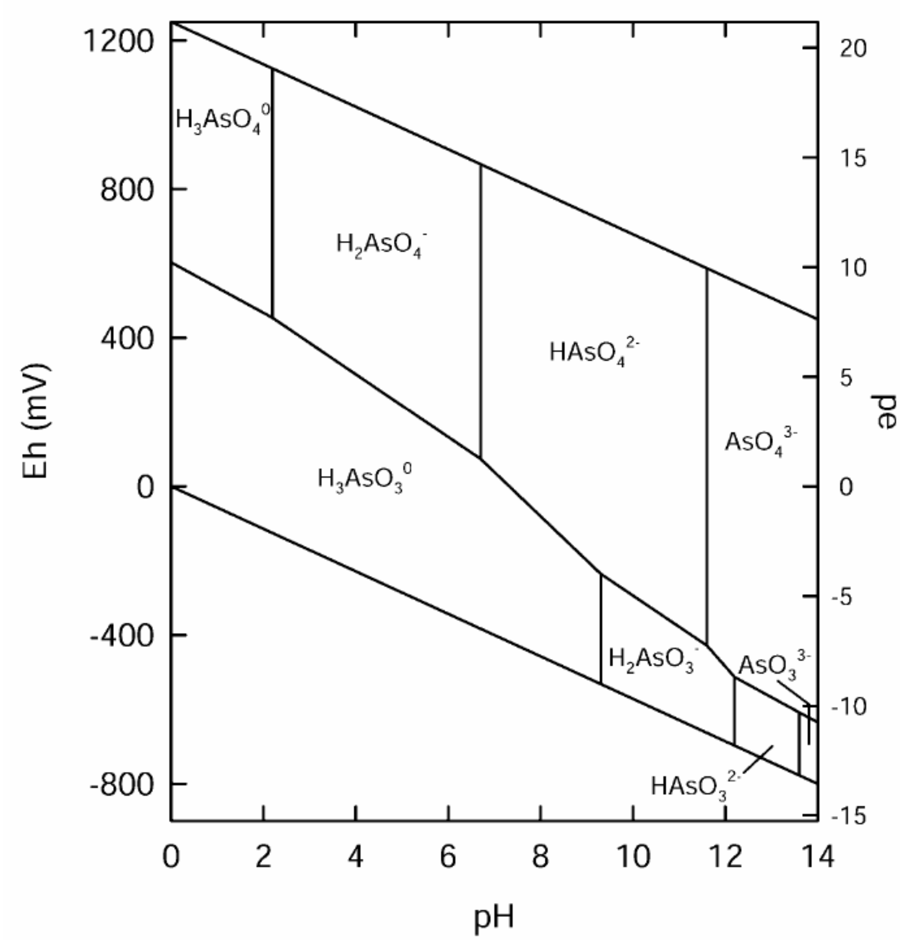

Figure E-1. Eh-pH Diagram for Arsenic Aqueous Species in the As-O_2-H_2O System at 25°C and 1 bar (from Smedley and Kinniburgh 2002)

Appendix References

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