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

CITY OF ANDREWS
PWS ID# 0020001, CCN# 10208

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 2009

EXECUTIVE SUMMARY

INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Transportation Group Inc. (Parsons), was contracted by the Texas Commission on Environmental Quality (TCEQ) to conduct a project 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 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 City of Andrews PWS (PWS ID#0020001, Certificate of Convenience and Necessity (CCN) #10208, located in Andrews County. The City of Andrews PWS is located northeast of the intersection of US Highway 385 and State Highway 115. The water system serves a population of 9,652 and has 4,420 connections. Water sources for this water system include 17 wells: six wells in the Florey Well Field and 10 wells and one emergency well at the University Well Field. The Florey Well Field is the primary water source and is located 10 miles northeast of the city. The University Well Field is located 10 miles southeast of the city. The average daily water demand is approximately 2.6 million gallons a day.

Fluoride was detected between 3.8 mg/L and 5.4 mg/L from January 1999 to February 2009, and several results exceed the MCL of 4 mg/L. Concentrations of arsenic were detected at values ranging between 0.0177 mg/L to 0.0495 mg/L from February 1999 to February 2009, exceeding the MCL of 0.010 mg/L that went into effect on January 23, 2006 (USEPA 2009a; TCEQ 2008). Therefore, the City of Andrews PWS faces compliance issues under the water quality standards for arsenic and fluoride.

Basic system information for the City of Andrews PWS is shown in Table ES.1.

Table ES.1 City of Andrews PWS
Basic System Information

Population served	9,652
Connections	4,420
Average daily flow rate	2.595 million gallons a day
Peak demand flow rate	7,208 gallons per minute
Water system peak capacity	12.3 mgd
Typical arsenic range	0.0177 – 0.0495 mg/L
Typical fluoride range	3.8 mg/L to 5.4 mg/L

STUDY METHODS

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

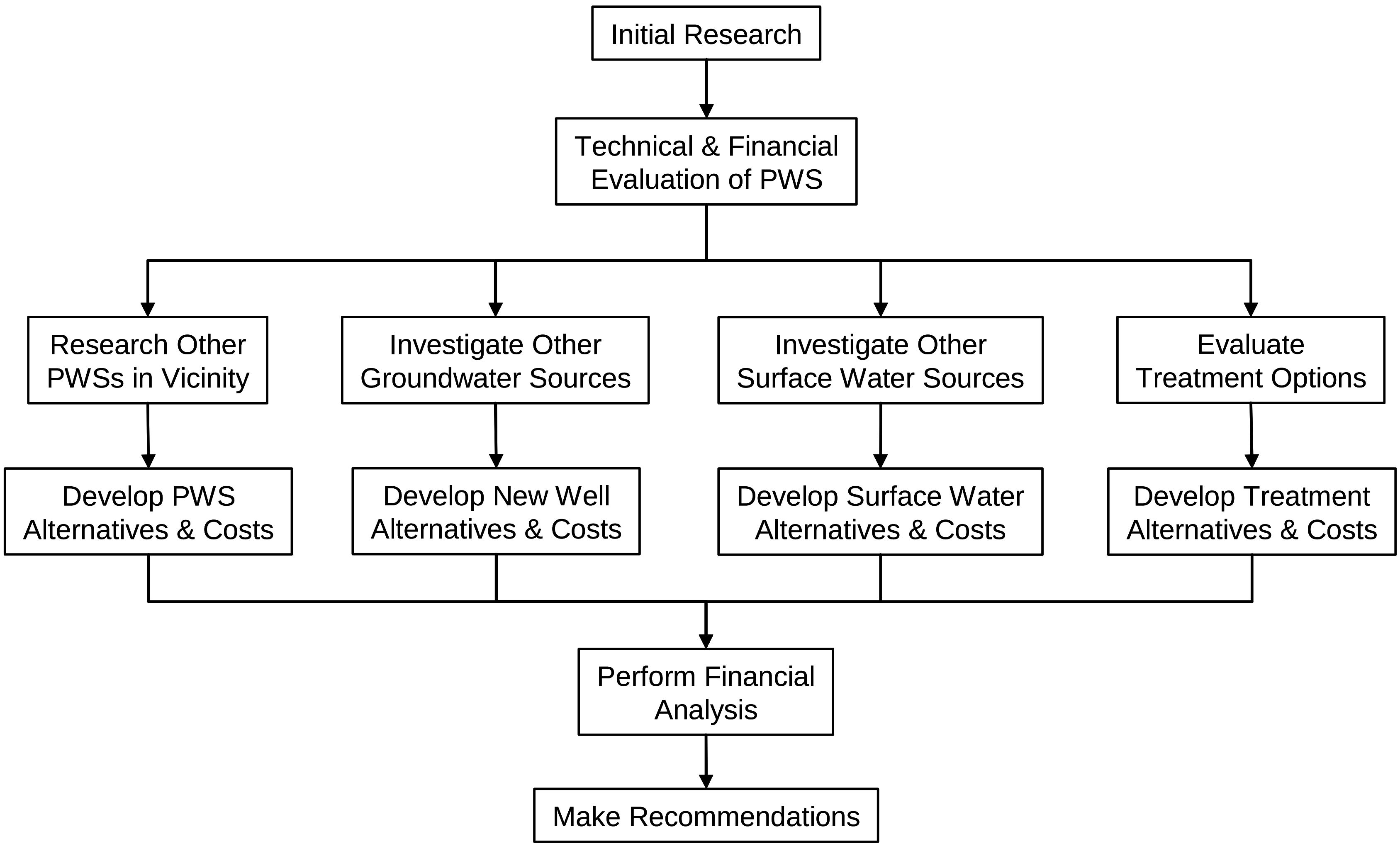
5. Assess each of the potential alternatives with respect to economic and non-economic criteria;
6. Prepare a feasibility report and present the results to the PWS.

This basic approach is summarized in Figure ES.1.

HYDROGEOLOGICAL ANALYSIS

The City of Andrews PWS obtains groundwater from the Ogallala Aquifer. Arsenic and fluoride are commonly found in area wells at concentrations greater than the MCLs, particularly in shallower zones of the Ogallala Aquifer. The City of Andrews has sampled individual wells, and may be able to reduce arsenic and fluoride concentrations by shifting production to wells with lower arsenic and fluoride concentrations. While this may lower contaminant concentrations, it most likely will not be sufficient to reduce concentrations below the MCLs.

Figure ES.1 Summary of Project Methods



COMPLIANCE ALTERNATIVES

The City of Andrews is governed by a City Council and a City Manager. Overall, the system had a good 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 strong capital improvements financing, a meter replacement program, good disinfection practices, a proactive City Manager, and a plan for employee retention. Areas of concern for the system include need for better understanding of the POU regulations, and a reconnection fee that might be too low.

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, and obtaining a new surface water source is considered through an alternative where treated surface water is obtained from the Colorado River Municipal Water District through the City of Odessa or the City of Midland.

Centralized treatment alternatives for combined arsenic and fluoride removal were developed and were considered for this report; for example, reverse osmosis and electro-dialysis reversal. Point-of-use (POU) and point-of-entry (POE) 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.

Developing a new well field close to the City of Andrews would likely be the best solution provided compliant groundwater can be found. Having a new well field close to the City of Andrews is likely to be one of the lower cost alternatives since the 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. Similar to obtaining an alternate compliant water source, central treatment would provide compliant water to all water taps.

POU 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. POU treatment would also be required for 100 percent of the connections where domestic consumption is expected. The PWS would be responsible for replacing all filter cartridges, which increases the cost of this alternative significantly.

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 City of Andrews PWS indicated that current water and wastewater rates are sufficient to cover operation and maintenance at this time. The current average water bill represents approximately 1.38 percent of the median household income (MHI). Separate revenue financial data were available for the water and wastewater systems, while the expenses financial data were combined for the both system. To understand the impact of compliance alternatives for the water system, cost for operation and maintenance were proportioned according to the revenues of each system. Table ES.2 provides a summary of the financial impact of implementing selected compliance alternatives. The alternatives were selected to highlight results for the best 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	$345	1.38
To meet current expenses	NA	$338	1.35
Purchase water from Midland	100% Grant	$771	3.1
	Loan/Bond	$1,211	4.8
Central treatment (RO)	100% Grant	$669	2.7
	Loan/Bond	$951	3.8
Point-of-use	100% Grant	$894	3.6
	Loan/Bond	$940	3.8
Trucked drinking water and Public dispenser	100% Grant	$350	1.4
	Loan/Bond	$353	1.4

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
°F	degrees Fahrenheit
BAT	best available technology
BEG	Bureau of Economic Geology
CA	chemical analysis
CD	community development
CCN	Certificate of Convenience and Necessity
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CO	correspondence
CRMWD	Colorado River Municipal Water District
ED	electrodialysis
EDR	electrodialysis reversal
FMT	financial, managerial, and technical
GAM	groundwater availability model
gpm	gallons per minute
gpd	gallons per day
IX	Ion exchange
MCL	maximum contaminant level
mgd	Million gallons per day
mg/L	milligram per liter
MHI	Median household income
NF	nanofiltration
NMEFC	New Mexico Environmental Financial Center
NPDWR	National Primary Drinking Water Regulations
O&M	Operation and Maintenance
ORCA	Office of Rural Community Affairs
Parsons	Parsons Transportation Group Inc.
POE	Point-of-entry
POU	Point-of-use
PWS	Public water system
RO	Reverse osmosis
RUS	Rural Utilities Service
SDWA	Safe Drinking Water Act
SMCL	secondary maximum contaminant level
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids

TFC	thin film composite
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 Transportation 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. Feasibility studies identify a range of potential compliance alternatives and present basic data that can be used for evaluating feasibility. 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 project, 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 City of Andrews Water System, PWS ID# 0020001, Certificate of Convenience and Necessity (CCN) #10208, located in Andrews County, hereinafter referred to in this document as the "City of Andrews PWS." Analytical results of drinking water from the City of Andrews PWS exceeded the MCL for arsenic of 0.010 milligrams per liter (mg/L) and fluoride of 4 mg/L (USEPA 2009a; TCEQ 2008). The location of the City of Andrews 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.

1.1 PUBLIC HEALTH AND COMPLIANCE WITH MCLs

The goal of this project is to promote compliance for PWSs that supply drinking water exceeding 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 City of

Andrews water system had recent sample results exceeding the MCL for arsenic and fluoride. In general, contaminant(s) in drinking water above the MCL(s) can have both short-term (acute) and long-term or lifetime (chronic) effects. Health concerns related to drinking water above MCLs for these two chemicals are briefly described below.

Potential health effects from long-term ingestion of water with levels of arsenic above the MCL (0.010 mg/L) include non-cancerous effects, such as thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis, and blindness, and cancerous effects, including skin, bladder, lung, kidney, nasal passage, liver and prostate cancer (USEPA 2009b).

Potential health effects from the ingestion of water with levels of fluoride above the MCL (4 mg/L) over many years include bone disease, including pain and tenderness of the bones. Additionally, the U.S. Environmental Protection Agency (USEPA) set a secondary fluoride standard of 2 mg/L to protect against dental fluorosis, which in its moderate or severe forms may result in a brown staining and/or pitting of the permanent teeth in children under 9 years (USEPA 2009c).

1.2 METHOD

The method for this project follows that of a pilot project performed by TCEQ, BEG, and Parsons. The pilot project evaluated water supply alternatives for PWSs that supplied drinking water with contaminant concentrations above USEPA and Texas drinking water standards. Three PWSs were evaluated in the pilot project to develop the method (*i.e.*, decision tree approach) for analyzing options for provision of compliant drinking water. This project is performed using the decision tree approach that was developed for the pilot project, and which was also used for subsequent projects.

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 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.

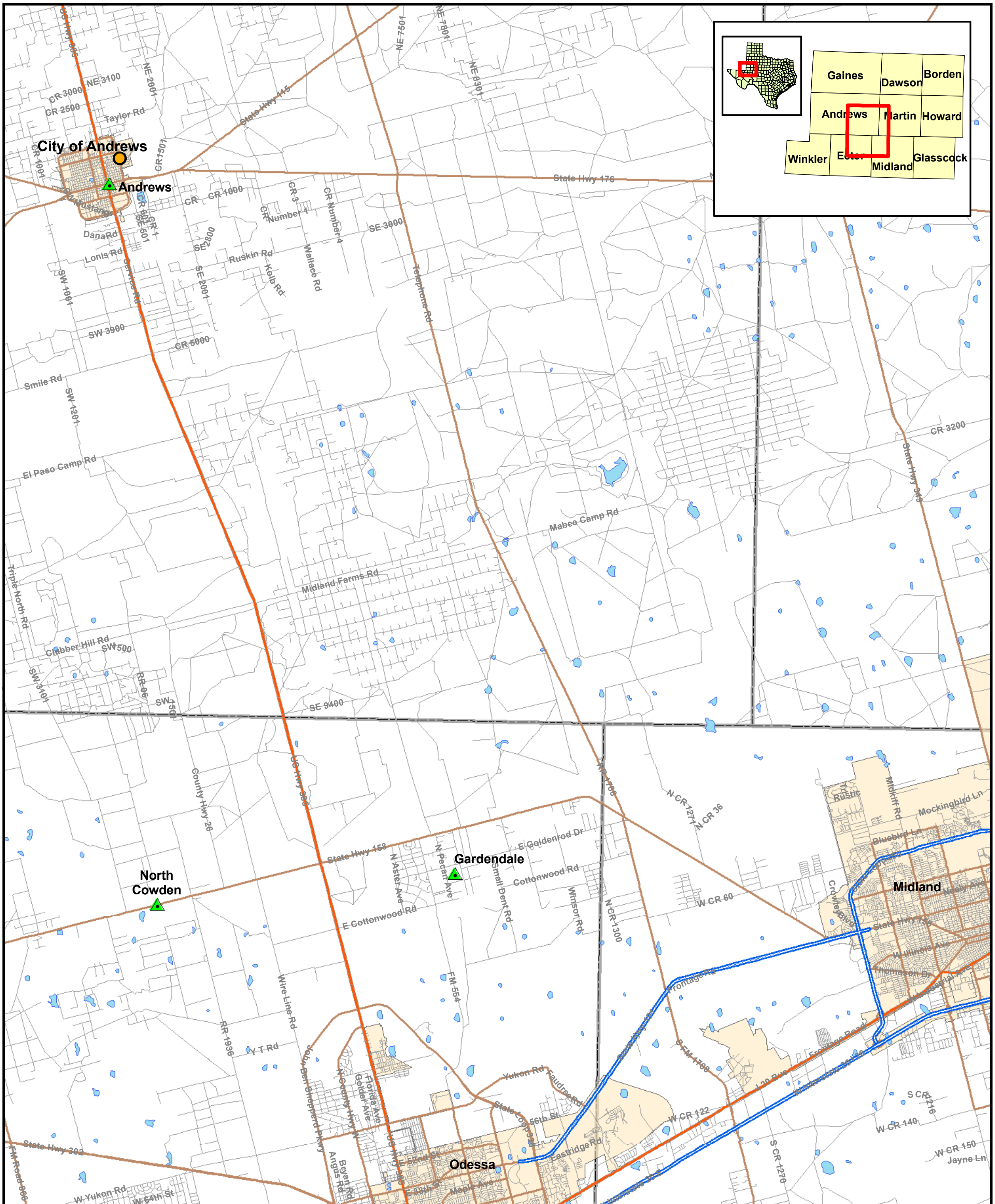

Figure 1.1

CITY OF ANDREWS

Location Map

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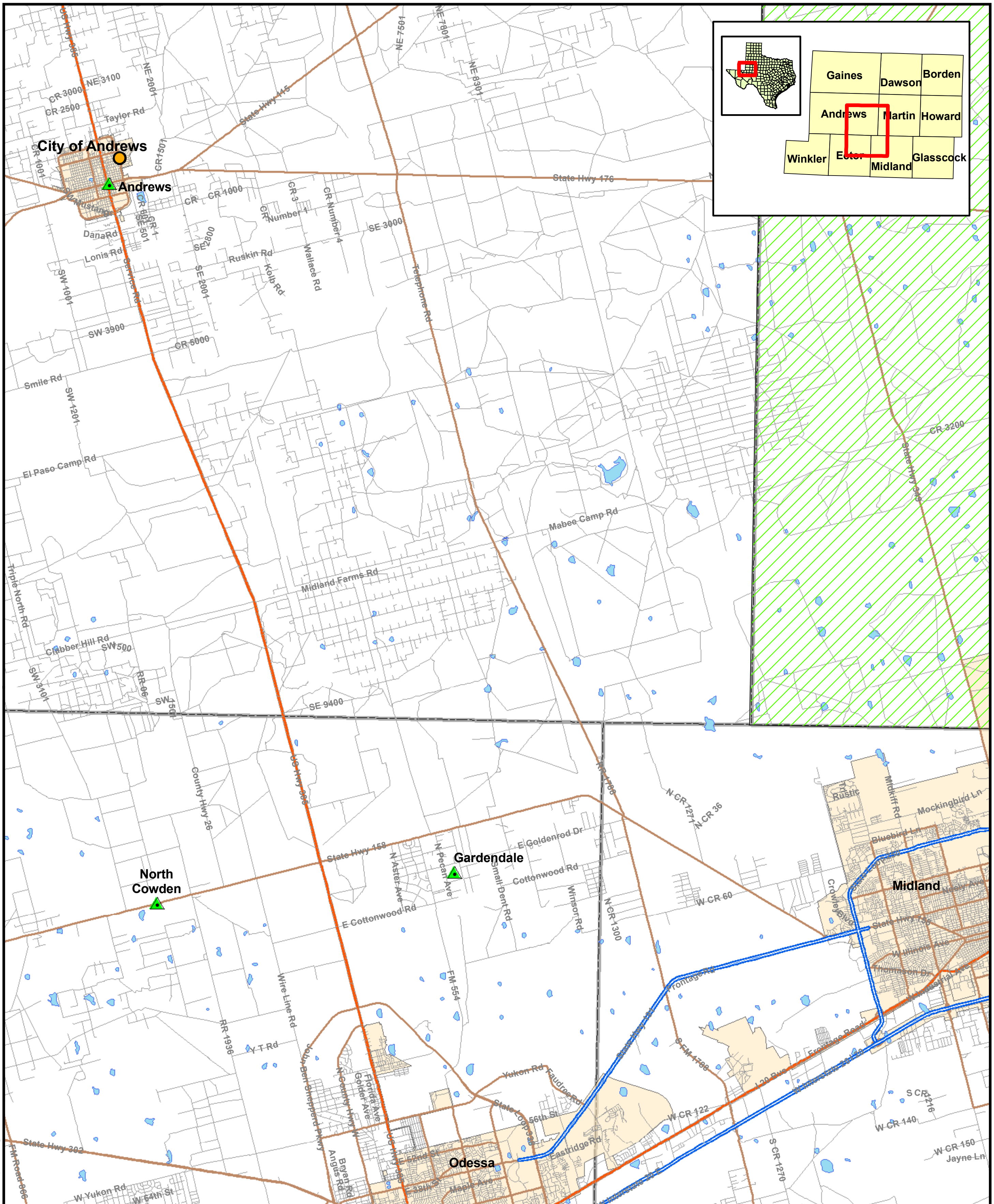

Legend

- Study System
- Cities
- City Limits
- Counties
- Interstate
- Highway
- Major Road
- Minor Road
- Permian Basin UWCD

N

Miles

0 1.5 3

Figure 1.2

CITY OF ANDREWS

Groundwater Conservation Districts

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The remainder of Section 1 of this report addresses the regulatory background, and provides a summary of arsenic and fluoride abatement options. Section 2 describes the method used to develop and assess compliance alternatives. Groundwater sources of arsenic and fluoride are addressed in Section 3. Findings for the City of Andrews PWS, along with compliance alternatives development and evaluation, 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), which include 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 City of Andrews PWS involve arsenic and fluoride. The following subsections explore alternatives considered as potential options for obtaining/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 that 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 selected to ensure all the 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 the 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:

- Existing data sources (see below) will be used to identify wells in the areas that have satisfactory quality. For the City of Andrews PWS, the following standards could be used in a rough screening to identify compliant groundwater in surrounding systems:
  - Nitrate (measured as nitrogen) concentrations less than 8 mg/L (below the MCL of 10 mg/L);
  - Fluoride concentration less than 2.0 mg/L (below the Secondary MCL of 2 mg/L);
  - Arsenic concentration less than 0.008 mg/L (below the MCL of 0.01 mg/L);
  - Uranium concentration less than 0.024 mg/L (below the MCL of 0.030 mg/L ; and
  - Selenium concentration less than 0.04 mg/L (below the MCL of 0.05 mg/L).
- The recorded well information will be reviewed 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.
- Wells of sufficient size are identified. Some may be 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, flowrates, 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 water 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 that location would be suitable as a supply source.
- It is recommended that new wells be installed instead of using existing wells to ensure the 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 is 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" of water 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 for Fluoride and Arsenic

Various treatment technologies were also investigated as compliance alternatives for treatment of fluoride and arsenic to regulatory levels (*i.e.*, MCLs). Numerous options have been identified by the USEPA as best available technologies (BAT) for non-compliant constituents. Identification and descriptions of the various BATs are provided in the following sections.

1.4.4.1 Treatment Technologies for Fluoride

Fluoride is a soluble anion and is not removed by particle filtration. The secondary MCL for fluoride is 2 mg/L, and the primary MCL is 4.0 mg/L. The USEPA BATs for fluoride removal include activated alumina adsorption and reverse osmosis (RO). Other treatment technologies that can potentially remove fluoride from water include lime softening (modified), alum coagulation, electrodialysis (ED or EDR), and anion exchange.

1.4.4.2 Treatment Technologies for Arsenic

In January 2001, the USEPA published a final rule in the Federal Register that established an MCL for arsenic of 0.01 mg/L (USEPA 2009b). The regulation applies to all community water systems and non-transient, non-community water systems, regardless of size.

The new arsenic MCL of 0.01 mg/L became effective January 23, 2006, at which time the running average annual arsenic level would have to be at or below 0.01 mg/L at each entry point to the distribution system, although point-of-use (POU) treatment could be instituted in place of centralized treatment. All surface water systems had to complete initial monitoring for the new arsenic MCL or have a state-approved waiver by December 31, 2006. All groundwater systems are to have completed initial monitoring or have a state-approved waiver by December 31, 2007.

Various treatment technologies were 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 less than 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 Description of Treatment Technologies

RO, EDR, and adsorption are identified by USEPA as BATs for removal where both fluoride and arsenic exceed the compliance limits. In this case, adsorption is not a feasible technology because of the high TDS and alkalinity of the groundwater. Also the effectiveness of an adsorption media suitable for reduction of both fluoride and arsenic is relatively low and requires frequent replacement. RO is also a viable option for point of entry (POE) and POU systems. A description of these technologies follows.

1.4.5.1 Reverse Osmosis

Process**.** RO is a physical process in which contaminants are removed by applying pressure on the feed water to force it through a semi-permeable membrane. RO membranes reject ions based on 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 (CA) or polyamide thin film composite (TFC). The TFC membrane operates at much lower pressure and can achieve higher salt rejection than the CA membranes, but is less chlorine resistant. Each material has specific benefits and limitations depending on the raw water characteristics and pre-treatment. A newer, lower pressure type membrane, similar in operation to RO, is nanofiltration (NF), which has higher rejection for divalent ions than mono-valent ions. NF is sometimes used instead of RO for treating water with high hardness and sulfate concentrations. A typical RO installation includes a high pressure feed pump; 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 pre-treatment. Factors influencing performance are raw water characteristics, pressure, temperature, and regular monitoring and maintenance. Depending on the membrane type and operating pressure, RO is capable of removing 85-95 percent of fluoride, and over 95 percent of nitrate and arsenic. The treatment process is relatively insensitive to pH. Water recovery is 60-80 percent, depending on raw water characteristics. The concentrate volume for disposal can be significant. The conventional RO treatment train for well water uses anti-scalant addition, cartridge filtration, RO membranes, chlorine disinfection, and clearwell storage.

Pre-treatment. RO requires careful review of raw water characteristics, and pre-treatment needs to prevent membranes from fouling, scaling, or other membrane degradation. Removal or sequestering of suspended solids is necessary to prevent colloidal and bio-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 to remove suspended particles; IX softening to remove hardness; antiscalant feed; temperature and pH adjustment to maintain efficiency; acid to prevent scaling and membrane damage; activated carbon or bisulfite to remove chlorine (post-disinfection may be required); and cartridge filters to remove any remaining suspended particles to protect membranes from upsets.

Maintenance. Rejection percentages must be monitored to ensure contaminant removal below MCLs. Regular monitoring of membrane performance is necessary to determine fouling, scaling, or other membrane degradation. Use of monitoring equipment to track membrane performance is recommended. Acidic or caustic solutions are regularly flushed through the system at high volume/low pressure with a cleaning agent to remove fouling and scaling. The system is flushed and returned to service. RO stages are cleaned sequentially. Frequency of membrane replacement is dependent on raw water characteristics, pre-treatment, and maintenance.

Waste Disposal. Pre-treatment waste streams, concentrate flows, and spent filters and membrane elements all require approved disposal methods. Disposal of the significant volume of the concentrate stream is a problem for many utilities.

Advantages (RO)

- Produces the highest water quality.
- Can effectively treat a wide range of dissolved salts and minerals, turbidity, health and aesthetic contaminants, and certain organics. Some highly maintained units are capable of treating biological contaminants.
- Low pressure - less than 100 pounds per square inch, compact, self-contained, single membrane units are available for small installations.

Disadvantages (RO)

- Relatively expensive to install and operate.
- Frequent membrane monitoring and maintenance; pressure, temperature, and pH requirements to meet membrane tolerances. Membranes can be chemically sensitive.
- Additional water usage depending on rejection rate.
- Concentrate disposal required.

A concern with RO for treatment of inorganics is that if the full stream is treated, then most of the alkalinity and hardness would also be removed. In that event, post-treatment may be necessary to avoid corrosion problems. If feasible, a way to avoid this issue is to treat a slip stream of raw water and blend the slip stream back with the raw water rather than treat the full stream. The amount of water rejected is also an issue with RO. Discharge concentrate flow can be between 10 and 50 percent of the influent flow.

1.4.5.2 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 spacers, 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 fluoride, nitrate, arsenic, and total dissolved solids (TDS). Additional stages are required to achieve higher removal efficiency (85-95% for fluoride). 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 pre-treatment steps such as raw water pumps, debris screens, rapid mix with addition of an anti-scalant, slow mix flocculator, sedimentation basin or clarifier, and gravity filters. Microfiltration could be used in place of flocculation, sedimentation, and filtration. Additional treatment or management of the concentrate and the removed solids would be necessary prior to disposal.

Pre-treatment**.** 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. If arsenite [As(III)] occurs, oxidation via pre-chlorination is required since the arsenite specie at pH below 9 has no ionic charge and will not be removed by EDR.

Maintenance. EDR membranes are durable, can tolerate a pH range from 1 to 10, and temperatures to 115 degrees Fahrenheit (^{o}F) 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, pre-treatment 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. Pre-treatment 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.
- Waste of water because of the significant concentrate flows.

- Generates relatively large saline waste stream requiring disposal.
- Pre-oxidation required for arsenite (if present).

EDR can be quite expensive to run because of the energy it uses. However, because it is generally automated and allows for part-time operation, it may be an appropriate technology for small systems. It can be used to simultaneously reduce fluoride, selenium, nitrate, arsenic, and TDS.

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

POE and POU treatment devices or systems rely on many of the same treatment technologies used in central treatment plants. However, while central treatment plants treat all water distributed to consumers to the same level, POU and POE treatment devices are designed to treat only a portion of the total flow. POU devices treat only the water intended for direct consumption, typically at a single tap or limited number of taps, while POE treatment devices are typically installed to treat all water entering a single home, business, school, or facility. POU and POE treatment systems may be an option for PWSs where central treatment is not affordable. Updated USEPA guidance on use of POU and POE treatment devices is provided in "*Point-of-Use or Point-of-Entry Treatment Options for Small Drinking Water Systems,"* EPA 815-R-06-010, April 2006 (USEPA 2006).

Point-of-entry and POU treatment systems can be used to provide compliant drinking water. These systems typically use small adsorption or reverse osmosis treatment units installed "under the sink" in the case of POU, and where water enters a house or building in the case of POE. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets to meet regulatory requirements, making purchase and installation more expensive. Point-of-entry and POU treatment units would be purchased and owned by the PWS. 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 large number of treatment units that would be employed and would be largely out of the control of the PWS, it is very difficult to ensure 100 percent compliance. Prior to selection of a POE or POU program for implementation, consultation with TCEQ would be required to address measurement and determination of level of compliance.

The National Primary Drinking Water Regulations (NPDWR), 40 Code of Federal Regulations (CFR) Section 141.100, covers criteria and procedures for PWSs using POE devices and sets limits on the use of these devices. According to the regulations (July 2005 Edition), the PWS must develop and obtain TCEQ approval for a monitoring plan before POE devices are installed for compliance with an MCL. Under the plan, POE devices must provide health protection equivalent to central water treatment meaning the water must meet all NPDWR and would be of acceptable quality similar to water distributed by a well-operated central treatment plant. In addition, monitoring must include physical measurements and observations such as total flow treated and mechanical condition of the treatment equipment. The system would have to track the POE flow for a given time period, such as monthly, and maintain records of device inspection. The monitoring plan should include frequency of monitoring for the contaminant of concern and number of units to be monitored. For instance, the system may propose to monitor every POE device during the first year for the contaminant of concern and then monitor one-third of the units annually, each on a rotating schedule, such that each unit would be monitored every three years. To satisfy the requirement that POE devices must provide health protection, the water system may be required to conduct a pilot study to verify the POE device can provide treatment equivalent to central treatment. Every building connected to the system must have a POE device installed, maintained, and properly monitored. Additionally, TCEQ must be assured that every building is subject to treatment and monitoring, and that the rights and responsibilities of the PWS customer convey with title upon sale of property.

Effective technology for POE devices must be properly applied under the monitoring plan approved by TCEQ and the microbiological safety of the water must be maintained. TCEQ requires adequate certification of performance, field testing, and, if not included in the certification process, a rigorous engineering design review of the POE devices. The design and application of the POE devices must consider the tendency for increase in heterotrophic bacteria concentrations in water treated with activated carbon. It may be necessary to use frequent backwashing, post-contactor disinfection, and Heterotrophic Plate Count monitoring to ensure that the microbiological safety of the water is not compromised.

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 MCL compliance 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 O&M and MCL compliance. The water system must retain unit ownership and oversight of unit installation, maintenance and sampling; the utility ultimately is 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 issued product standards for a specific type of POU or POE treatment unit, only those units that were 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 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 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 three 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).

SECTION 2
EVALUATION METHOD

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 that 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 the selection of a preferred alternative. The steps for assessing the financial 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 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

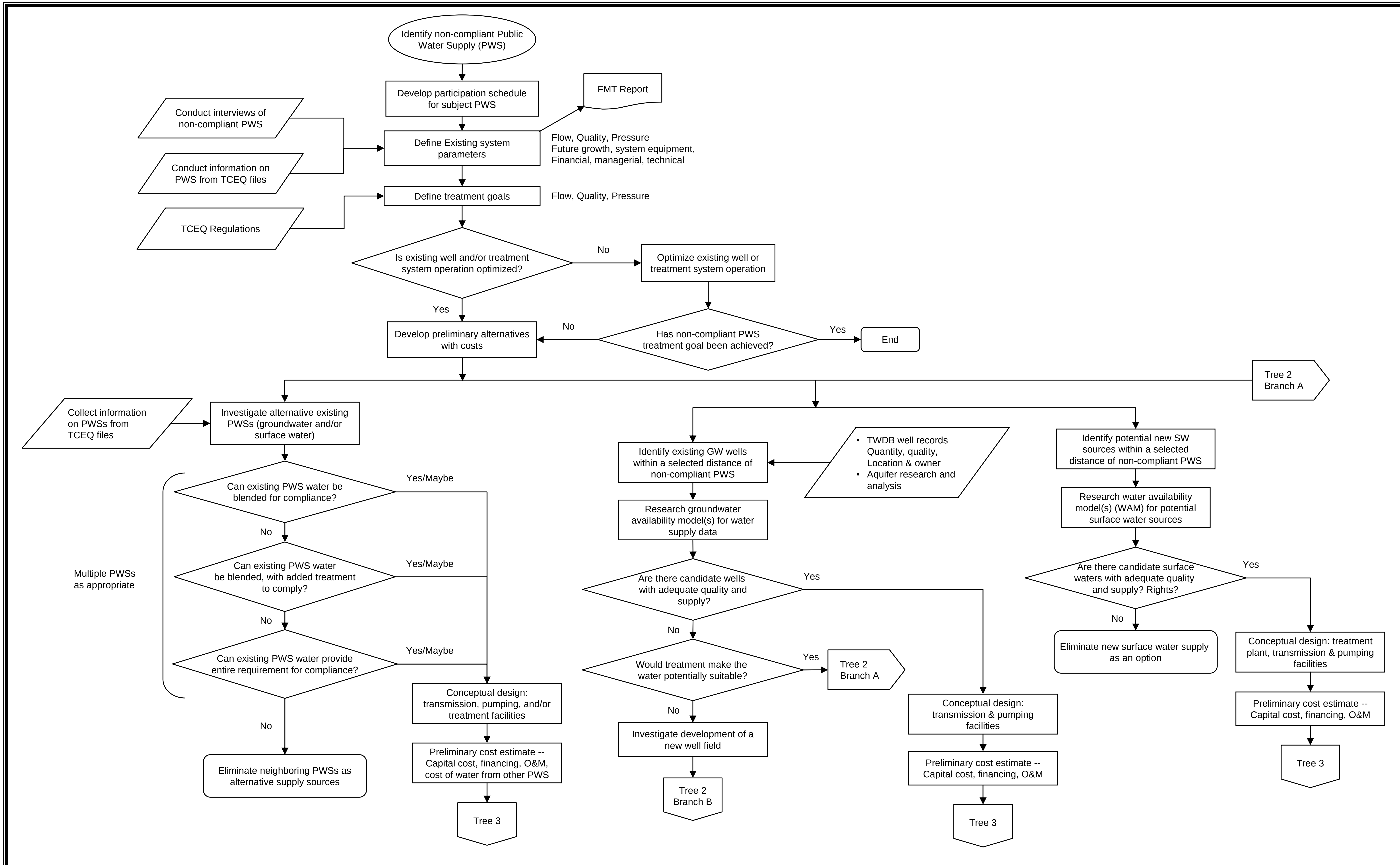


Figure 2.2
TREE 2 – DEVELOP TREATMENT ALTERNATIVES

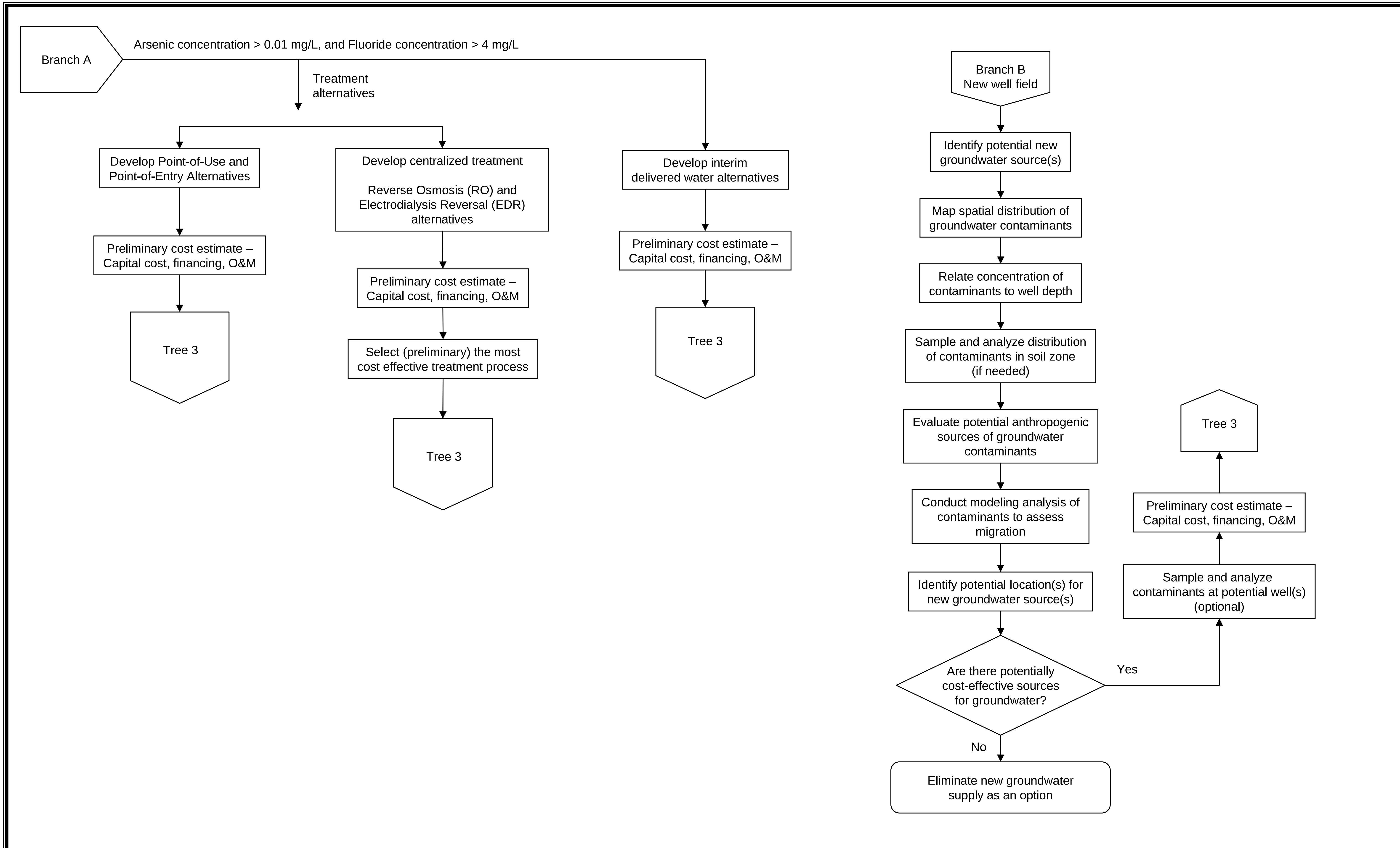


Figure 2.3
Tree 3 – PRELIMINARY ANALYSIS

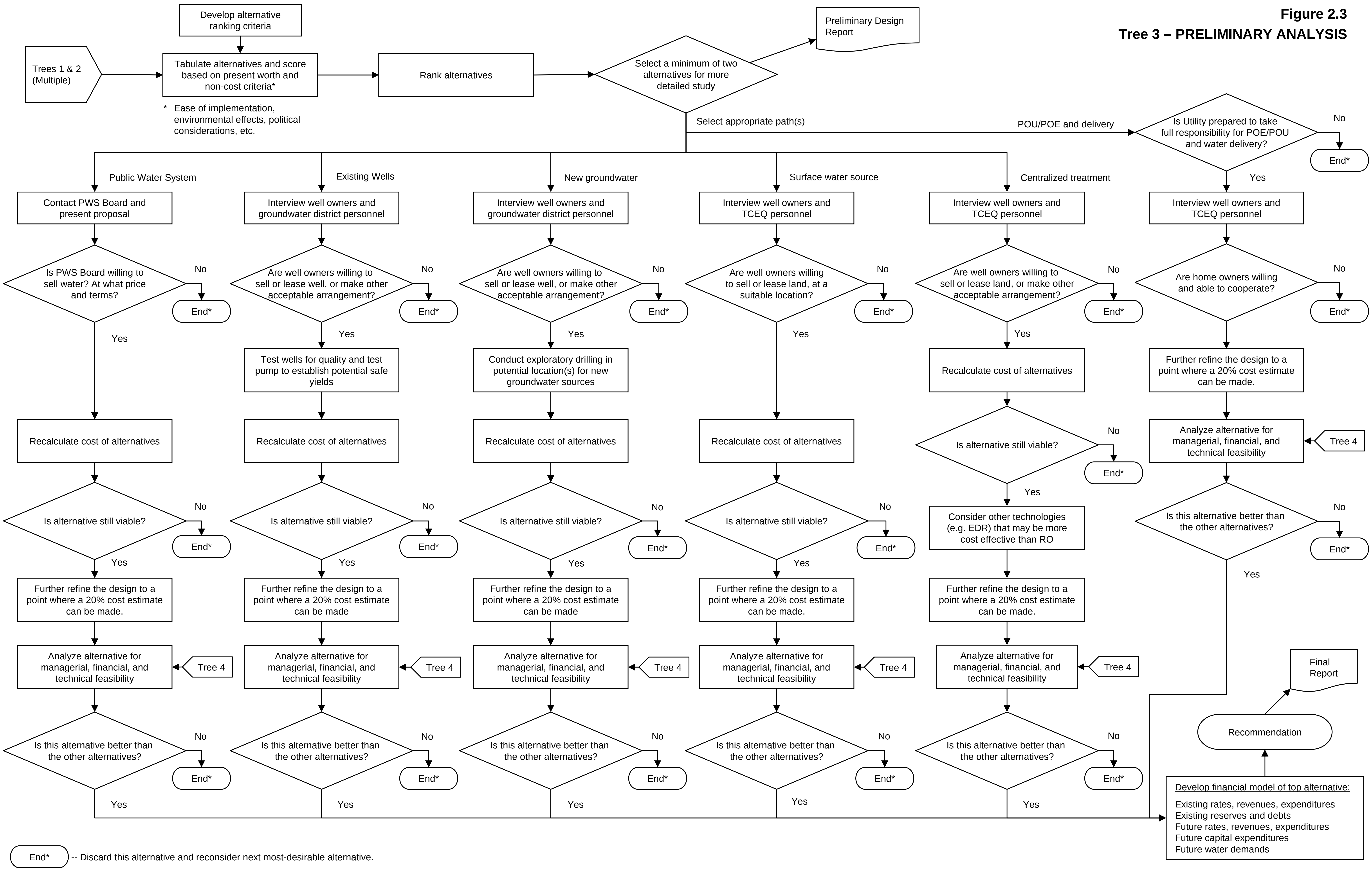
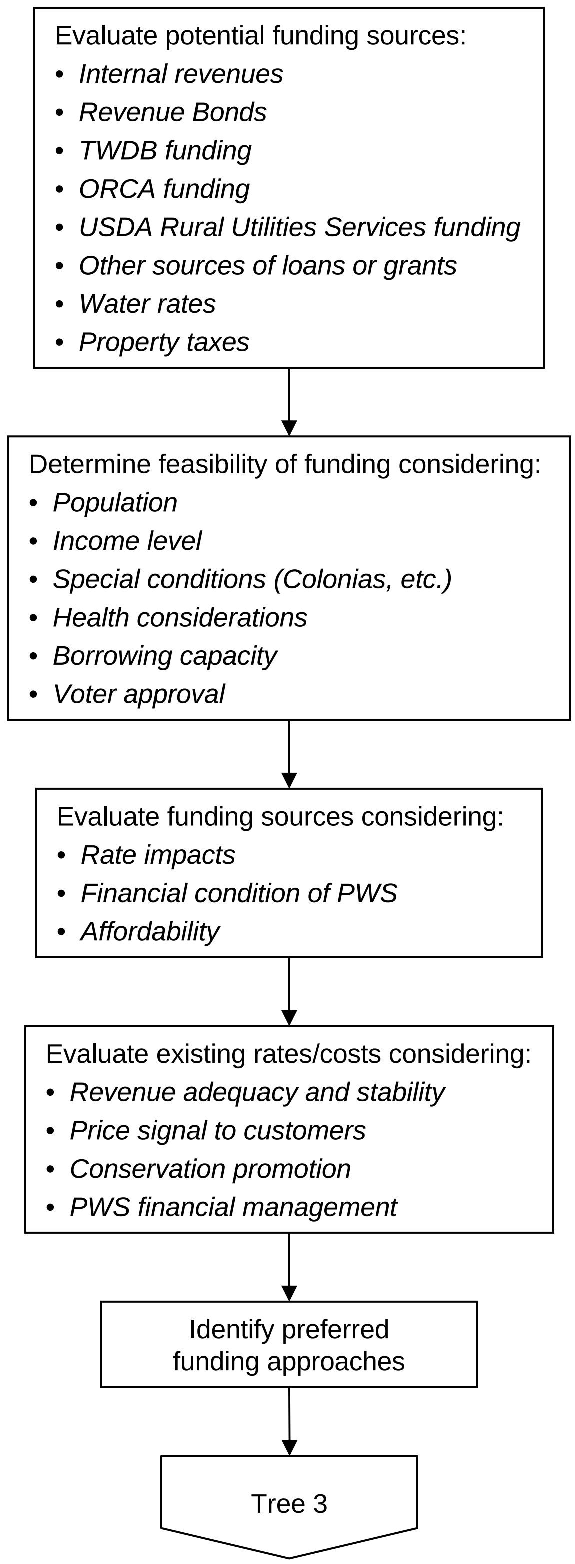


Figure 2.4
TREE 4 – FINANCIAL



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 PWS and surrounding systems.

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

- Texas Commission on Environmental Quality
  www3.tceq.state.tx.us/iwud/.
- 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 Ogallala aquifer was investigated as a potential tool for identifying available and suitable groundwater resources.

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 one 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.

2.2.1.6 Financial Data

An evaluation of existing data will yield an up-to-date assessment of the financial condition of the water system. As part of a site visit, financial data were collected through a site visit. Data sought included:

- Annual Budget
- Audited Financial Statements
  - Balance Sheet
  - Income & 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 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

Capacity assessment is the industry standard term for 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 operations and management of the system.

Financial, managerial, and technical 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 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 with customers and regulatory agencies.

Technical capacity is the physical and operational ability of a water system to achieve and maintain compliance with 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 operation. A system that is able to meet both its immediate and long-term challenges demonstrates that it has sufficient FMT capacity.

Assessment of FMT capacity of the PWS was based on an approach developed by the New Mexico Environmental Finance Center (NMEFC), which is consistent with the 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 is to identify a comprehensive range of possible options that can be evaluated to determine 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 project 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 area, as well as the major reservoirs. TCEQ WAMs were inspected, and the WAM was run, where appropriate.

2.3.4 Treatment

The only common treatment technologies considered potentially applicable for removal of fluoride and arsenic are RO and EDR. RO and EDR can remove fluoride as well as arsenic, selenium, nitrate, TDS and other dissolved constituents. RO treatment is considered for central treatment alternatives, as well as POU and POE alternatives. EDR is considered for central treatment 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 RO treatment and blending treated and untreated water to meet the fluoride MCL would reduce the amount of raw water used. The EDR operation can be tailored to provide a desired fluoride effluent concentration by controlling the electrical energy applied. 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 and the average water consumption rate, respectively. 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 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.

2.4 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. It has been suggested by agencies such as USEPA that federal and state programs consider several criteria to determine "disadvantaged communities" with one based on the typical residential water bill as a percentage of MHI.

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 (liquid assets that could be readily converted to cash) divided by current liabilities (accounts payable, accrued expenses, and other short-term financial obligations) 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 (total amount of long-term debt) divided by net worth (total assets minus total liabilities) shows to what degree assets of the company were 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. 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 median annual household income 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 > 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 are presented in a Table 4.4, which shows the percentage of MHI represented by the annual water bill that results from any rate increases necessary to maintain financial viability over time. In some cases, this may require rate increases even without implementing a compliance alternative (the no action alternative). The table shows any increases such as these separately. The results table shows the total increase in rates necessary, including both the no-action alternative increase and any increase required for the alternative. For example, if the no action alternative requires a 10 percent increase in rates and the results table shows a rate increase of 25 percent, then the impact from the alternative is an increase in water rates of 15 percent. Likewise, the percentage of household income in the table reflects the total impact from all rate increases.

2.4.5.4 Potential Funding Sources

A number of potential funding sources exist for Water Supply Corporations (WSC), which typically provide service to less than 50,000 people. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs. Most are available to "political subdivisions" such as counties, municipalities, school districts, special districts, or authorities of the state with some programs providing access to private individuals. Grant funds are made more available with demonstration of economic stress, typically indicated with MHI below 80 percent that of the state. The funds may be used for planning, design, and construction of water supply construction projects including, but not limited to, line extensions, elevated storage, purchase of well fields, and purchase or lease of rights to produce groundwater. Interim financing of water projects and water quality enhancement projects such as wastewater collection and treatment projects are also eligible. Some funds are used to enable a rural water utility to obtain water or wastewater service supplied by a larger utility or to finance the consolidation or regionalization of neighboring utilities. Three Texas agencies that offer financial assistance for water infrastructure are:

- Texas Water Development Board has several programs that offer loans at interest rates lower than the market offers to finance projects for public drinking water systems that facilitate compliance with primary drinking water regulations. Additional subsidies may be available for disadvantaged communities. Low interest rate loans with short and long-term finance options at tax exempt rates for water or water-related projects give an added benefit by making construction purchases qualify for a sales tax exemption. Generally, the program targets customers with eligible water supply projects for all political subdivisions of the state (at tax exempt rates) and WSCs (at taxable rates) with projects.

- Office of Rural Community Affairs (ORCA) is a Texas state agency with a focus on rural Texas by making state and federal resources accessible to rural communities. Funds from the U.S. Department of Housing and Urban Development Community Development Block Grants (CDBG) are administered by ORCA for small, rural communities with populations less than 50,000 that cannot directly receive federal grants. These communities are known as non-entitlement areas. One of the program objectives is to meet a need having a particular urgency, which represents an immediate threat to the health and safety of residents, principally for low- and moderate-income persons.

- U.S. Department of Agriculture Rural Development Texas (Texas Rural Development) coordinates federal assistance to rural Texas to help rural Americans improve their quality of life. The Rural Utilities Service (RUS) programs provide funding for water and wastewater disposal systems.

The application process, eligibility requirements, and funding structure vary for each of these programs. There are many conditions that must be considered by each agency to determine eligibility and ranking of projects. The principal factors that affect this choice are population, percent of the population under the state MHI, health concerns, compliance with standards, Colonia status, and compatibility with regional and state plans.

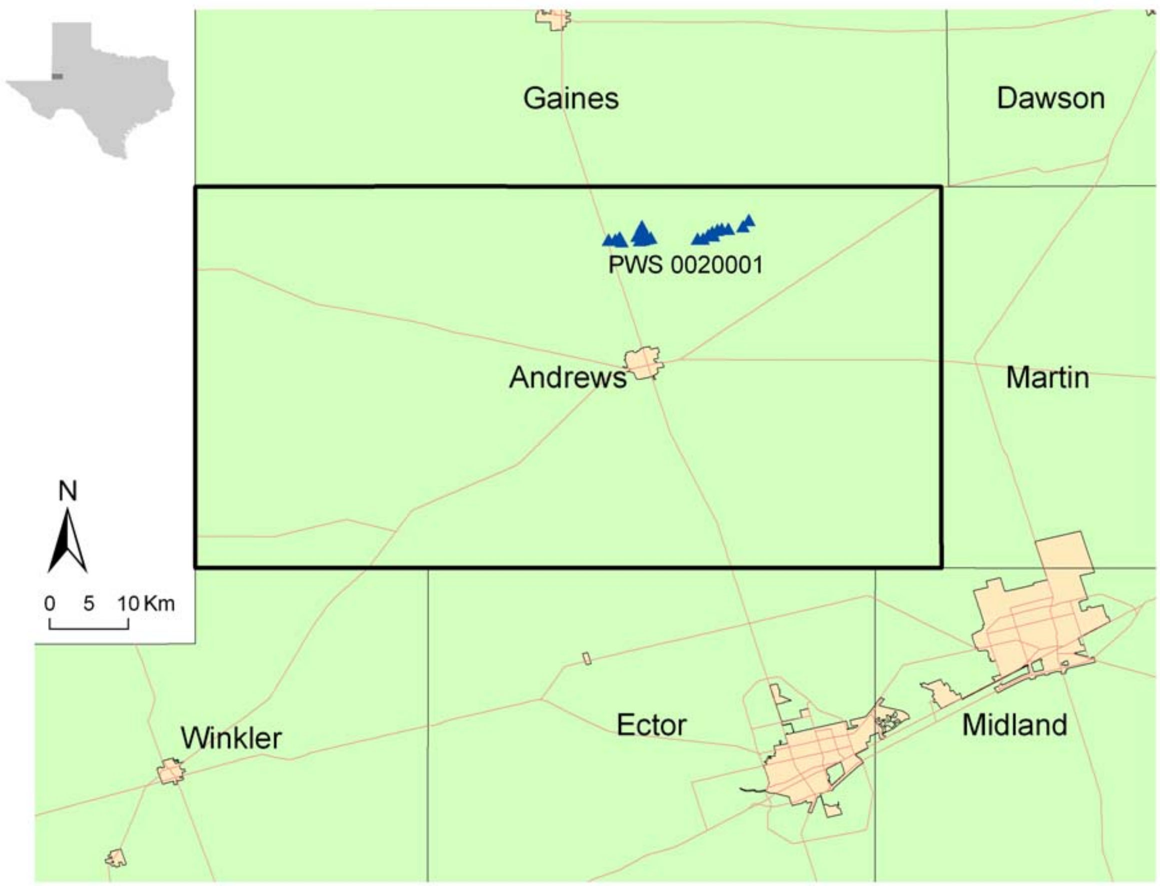
SECTION 3
UNDERSTANDING SOURCES OF CONTAMINANTS

3.1 REGIONAL ANALYSIS

3.1.1 Overview of the Study Area

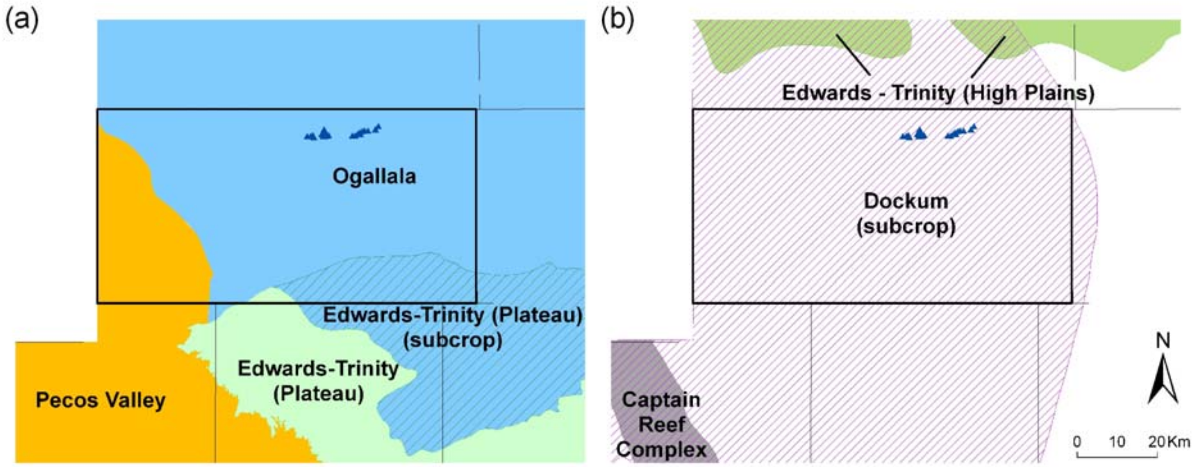
The public water supply (PWS) assessed by this study is located in Andrews county. The regional analysis described below includes data from seven counties in and around the High Plains within Texas: Andrews, Dawson, Ector, Gaines, Martin, Midland, and Winkler Counties (Figure 3.1).

Figure 3.1 Regional Study Area and Location of the PWS Wells Assessed in this Report



Major and minor aquifers within the region are shown in Figure 3.2. Most of the PWS wells are drilled within the tertiary sediments of the Ogallala aquifer. Other aquifers in the region that may locally be hydraulically connected to the Ogallala aquifer include younger alluvial and fluvial deposits of Quaternary age (Blackwater Draw Formation, not shown) and underlying older aquifers, including the Cretaceous-age Edwards-Trinity (Plateau) aquifer, the Edwards-Trinity (High Plains) aquifer of Cretaceous age, the Dockum aquifer of Triassic age, and undifferentiated Permian aquifers (not shown). Other aquifers in the area include the Capitan Reef, and Pecos Valley aquifers.

Figure 3.2 Major (a) and Minor (b) Aquifers



"Subcrop" indicates a portion of an aquifer that underlies other formations.
All other labels indicate a portion of an aquifer that is exposed on the surface.

Data used for this study include information come from two sources:

- Texas Water Development Board groundwater database available at www.twdb.state.tx.us. The database includes information on the location and construction of wells throughout the state as well as historical measurements of water chemistry and levels in the wells.
- Texas Commission on Environmental Quality Public Water Supply database (not publicly available). The database includes information on the location, type, and construction of water sources used by PWS in Texas, along with historical measurements of water levels and chemistry.

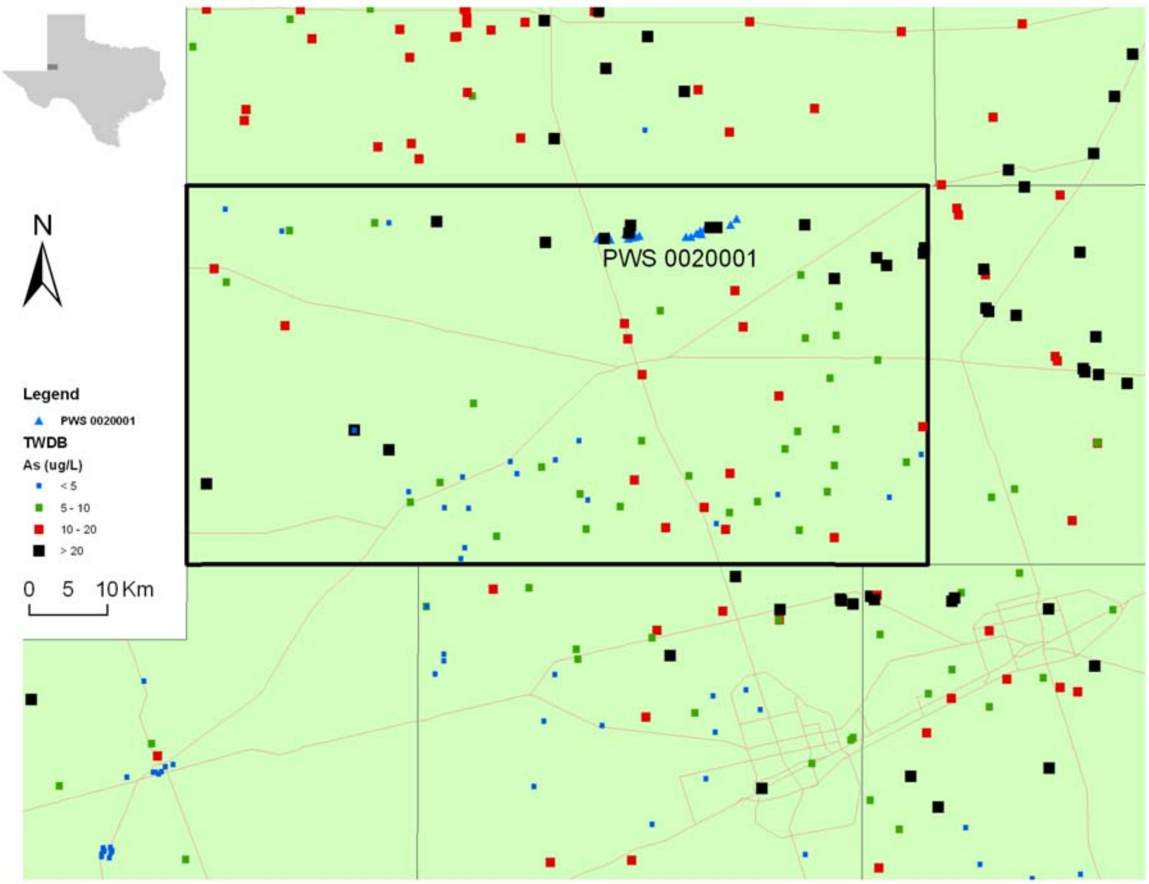
3.1.2 Contaminants of Concern in the Study Area

Common contaminants of concern in the study area include arsenic, fluoride, nitrate, selenium, uranium, and TDS. In each PWS studied here, water sampling shows that one or more of these solutes exceeds USEPA's maximum contaminant level (MCL).

Arsenic

Arsenic concentrations exceed USEPA's MCL (10 µg/L) throughout the study area (Figure 3.3). More than half of the wells in the Ogallala aquifer and one-quarter of wells in the Dockum aquifer contain arsenic levels above the MCL.

Figure 3.3 Spatial Distribution of Arsenic Concentrations in the Study Area



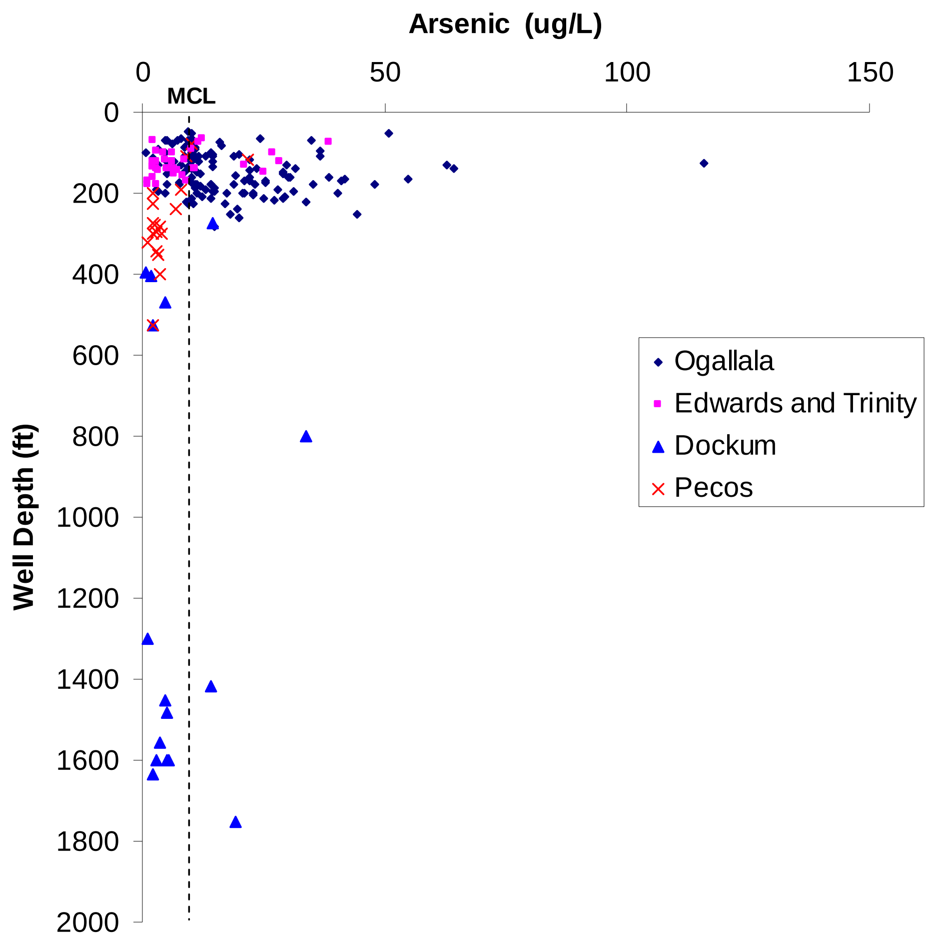
Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.1 gives the percentage of wells with arsenic exceeding the MCL (10 μg/L) in each of the major aquifers in the study area.

Table 3.1 Summary of Wells that Exceed the MCL for Arsenic, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 10 μg/L	Percentage of wells that exceed 10 μg/L
Ogallala	184	102	55%
Dockum	12	3	25%
other	45	19	42%

The majority of arsenic-compliant wells are located 10-20 miles east and south of the City of Andrews. Although it seems there is a clear stratification of arsenic concentrations with depth in the study area (Figure 3.4), with arsenic concentrations decreasing with depth, the distribution is controlled primarily by location. When studying each aquifer separately, this is not apparent. Therefore, tapping deeper water by deepening shallow wells or casing off shallower parts of wells will not necessarily decrease arsenic concentrations.

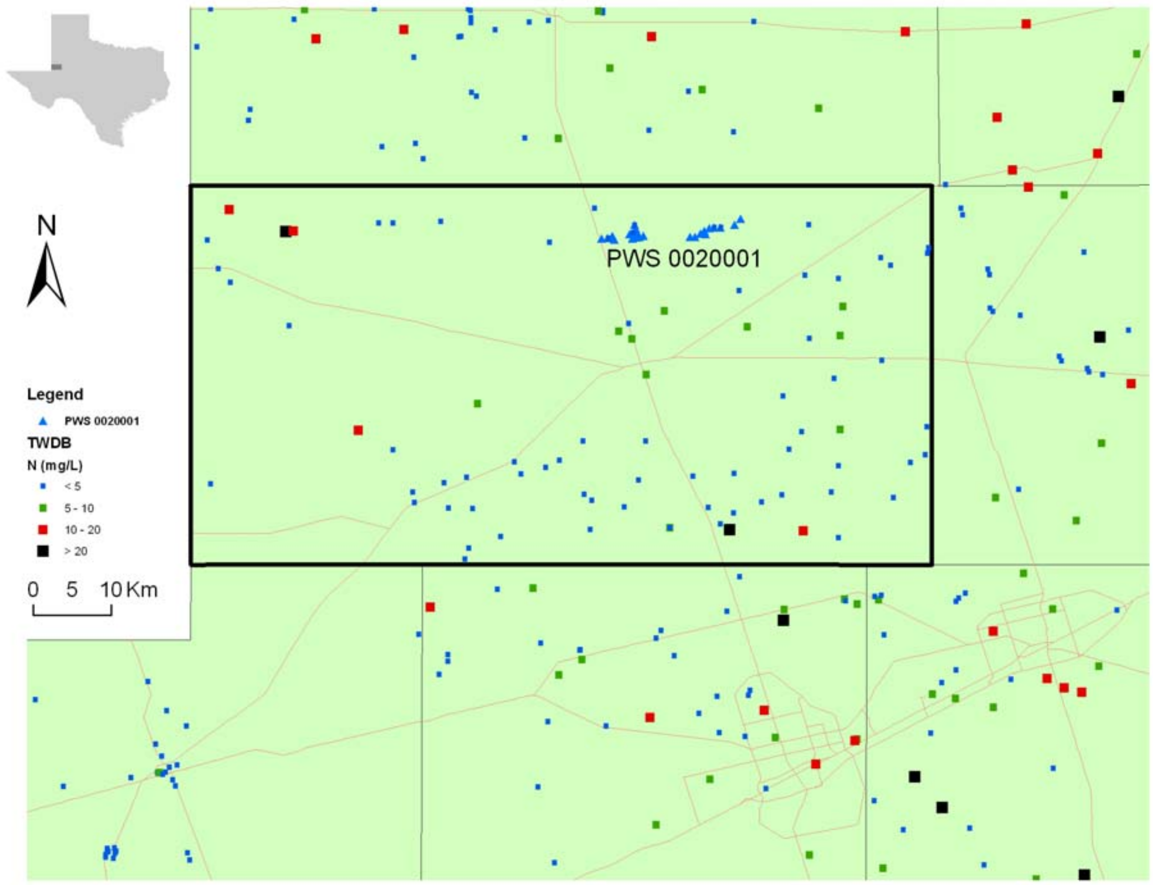
Figure 3.4 Arsenic Concentrations and Well Depths



Nitrate

Nitrate concentrations exceed the MCL (10 mg/L) in 14 percent of the wells in the area of the Ogallala aquifer, and do not exceed the MCL in the Dockum aquifer (Figure 3.5, Table 3.2).

Figure 3.5 Spatial Distribution of Nitrate Concentrations



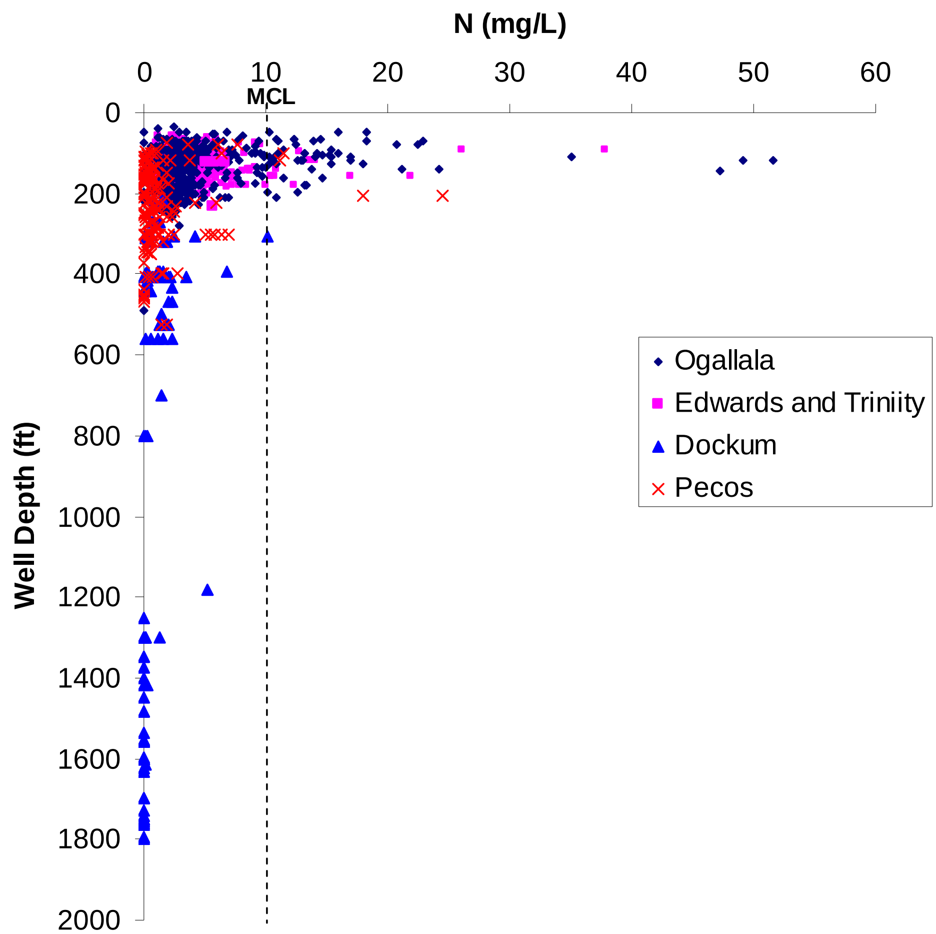
Data presented here are from the TWDB database. The most recent measurement from each well is shown. Table 3.2 shows the percentage of wells with nitrate as N exceeding the MCL (10 mg/L).

Table 3.2 Summary of Wells that Exceed the MCL for Nitrate, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 10 mg/L	Percentage of wells that exceed 10 mg/L
Ogallala	191	27	14%
Dockum	12	0	0%
other	44	7	16%

Within the study area, the concentration of nitrate as N tends to decrease with well depth (Figure 3.6). All wells deeper than 210 feet have acceptable nitrate levels. Therefore, deepening shallow wells or casing the upper portions of problematic wells might decrease nitrate concentrations.

Figure 3.6 Nitrate as N Concentrations and Well Depths



Fluoride

Fluoride concentrations above the MCL (4 mg/L) are found in one-fifth of the Ogallala aquifer and are relatively rare in the Dockum aquifer (8% of wells) (Figure 3.7, Table 3.3).

Data presented here are from the TWDB database. The most recent measurement from each well is shown. Table 3.3 shows the percentage of wells with fluoride exceeding the MCL (4 mg/L).

Figure 3.7 Spatial Distribution of Fluoride Concentrations

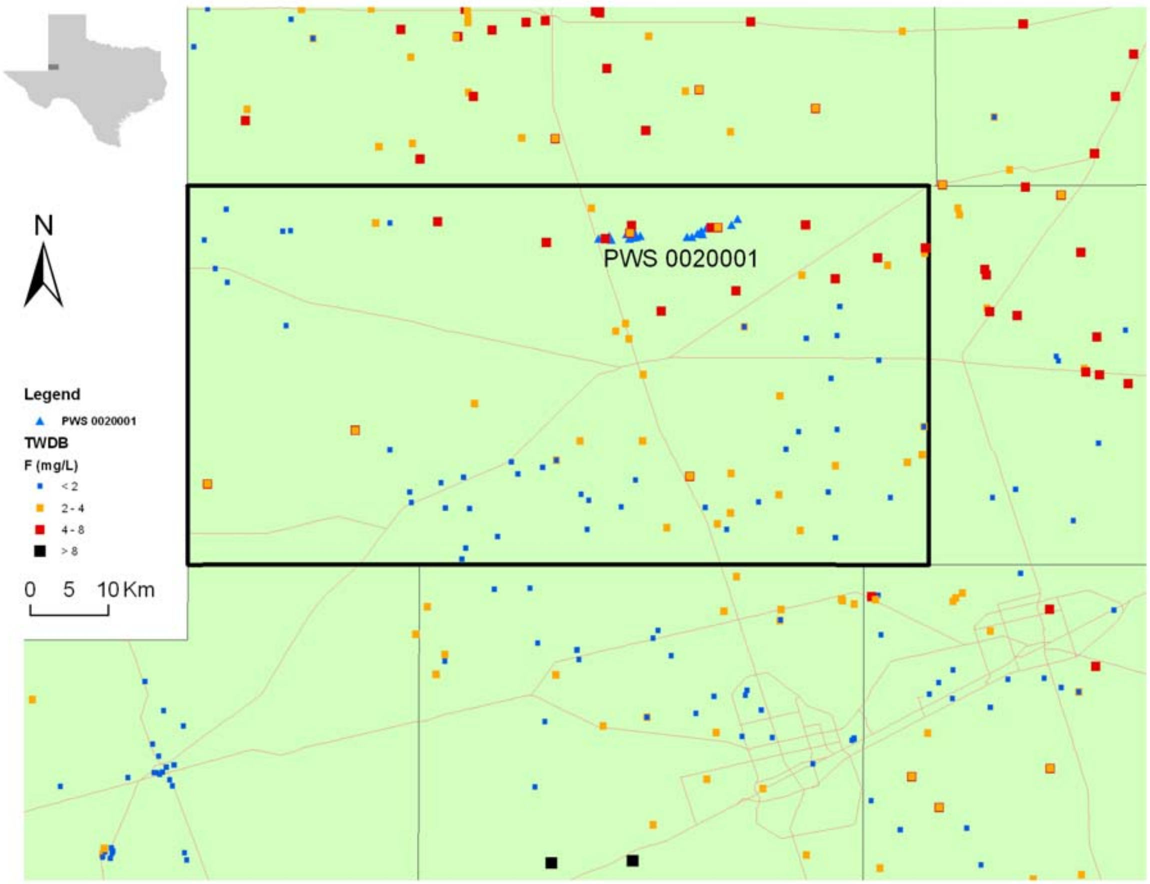
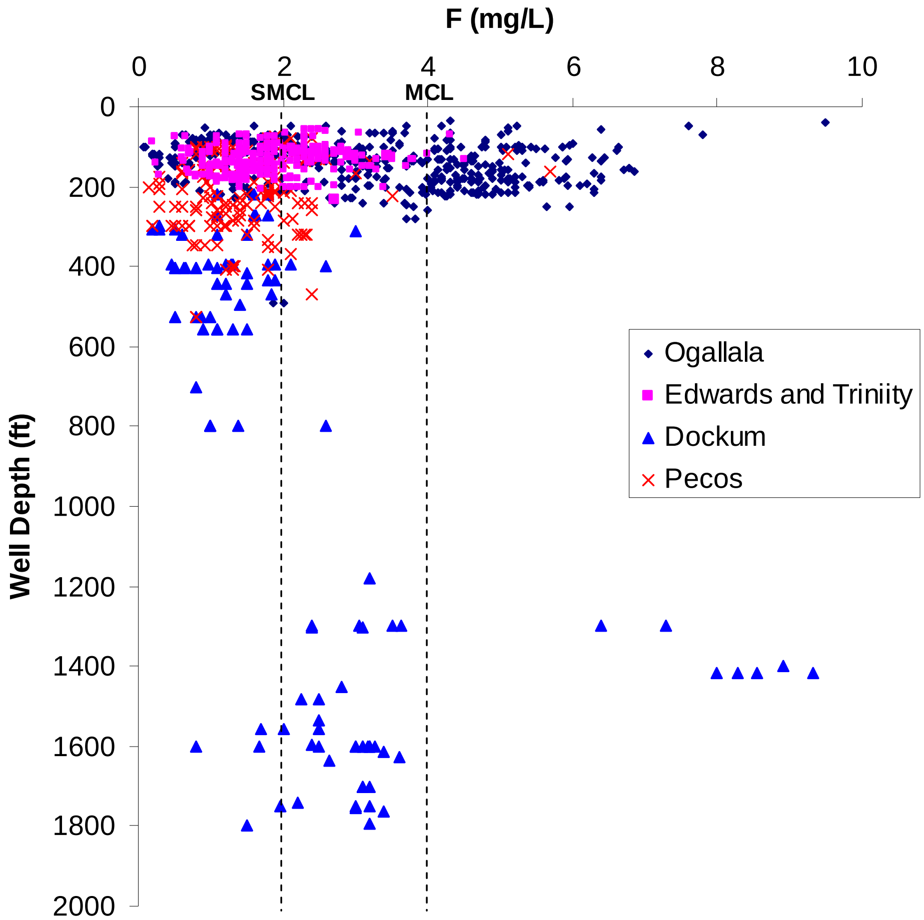


Table 3.3 Summary of Wells that Exceed the MCL for Fluoride, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 4 mg/L	Percentage of wells that exceed 4 mg/L
Ogallala	236	46	19%
Dockum	13	1	8%
other	44	8	18%

The majority of fluoride-compliant wells are located 10-20 miles east and south of the City of Andrews. Although it seems there is a clear stratification of fluoride concentrations with depth in the study area (Figure 3.8), with fluoride concentrations decreasing with depth, the distribution is controlled primarily by location. When studying each aquifer separately, this is not apparent. Therefore, tapping deeper water by deepening shallow wells or casing off shallower parts of wells will not necessarily decrease fluoride concentrations.

Figure 3.8 Fluoride Concentrations and Well Depths



Selenium

Selenium concentrations in the study area are generally below the MCL (50 µg/L). Over 90 percent of the wells tested were compliant. However, some shallow wells with excess selenium occur in the Ogallala aquifers and one well in the Dockum aquifer too has high selenium levels (Figure 3.9, Table 3.4).

Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.4 shows the percentage of wells with selenium concentrations exceeding the selenium MCL (50 µg/L).

Figure 3.9 Spatial Distribution of Selenium Concentrations

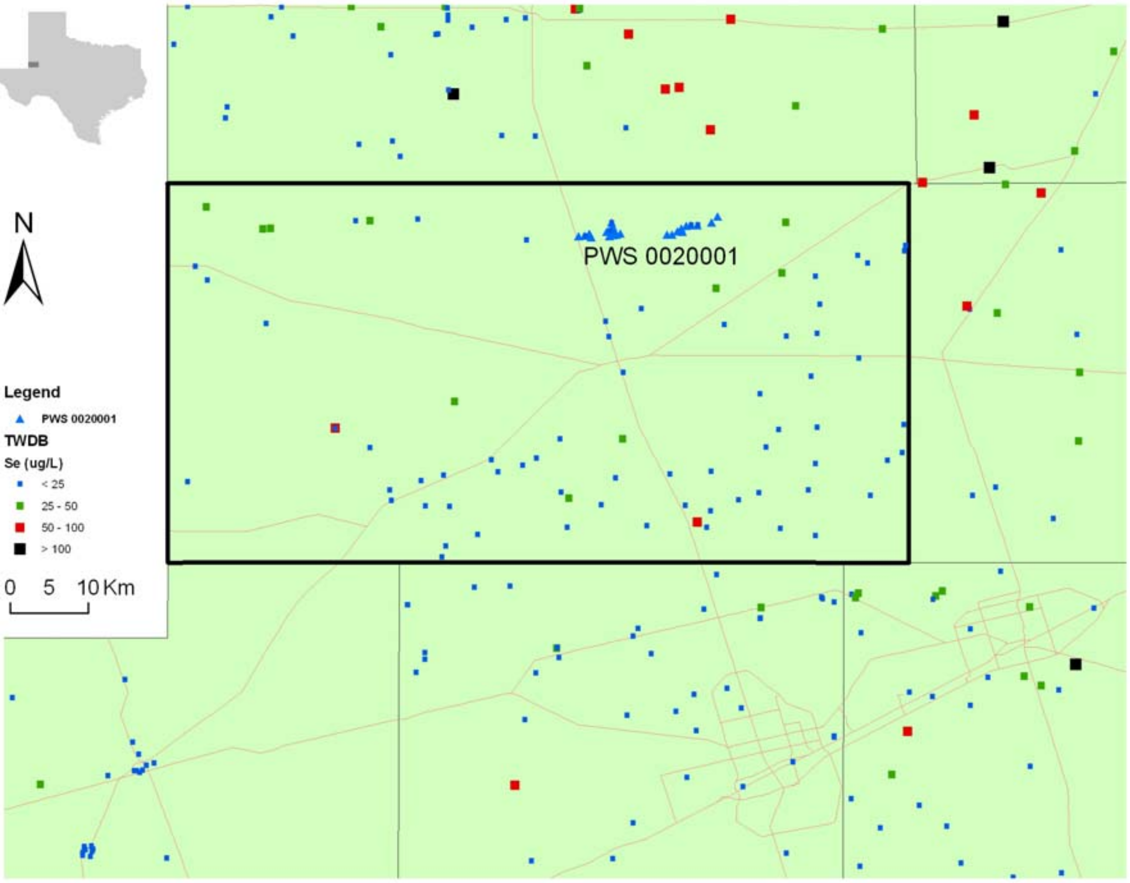
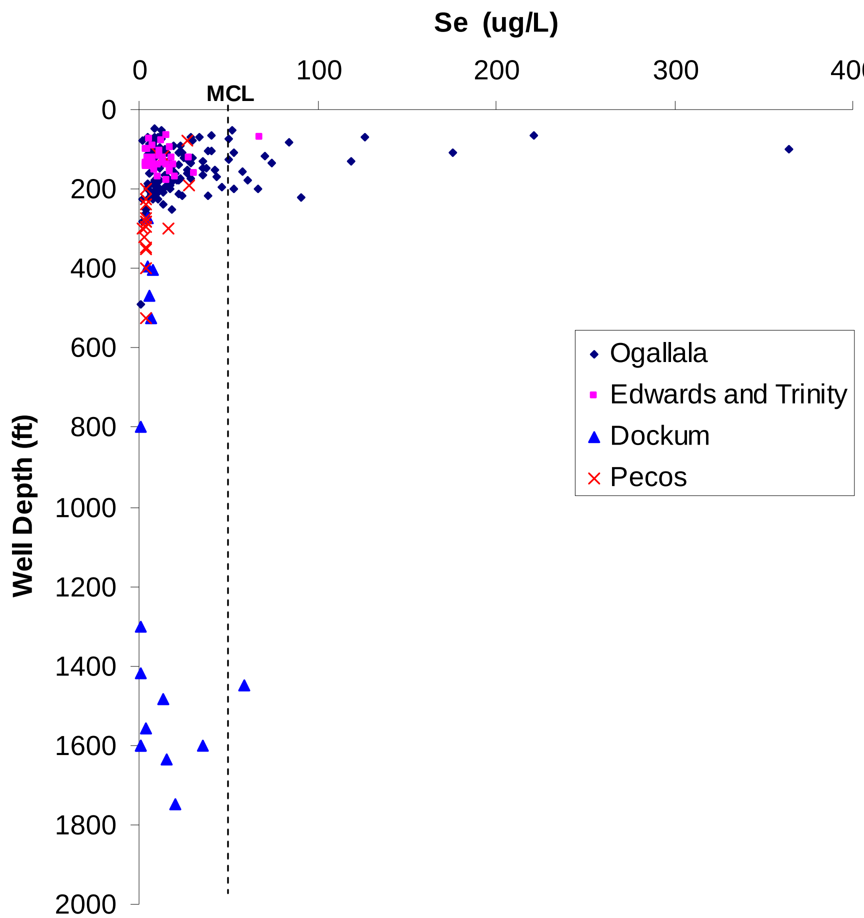


Table 3.4 Summary of Wells that Exceed the MCL for Selenium, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 50 µg/L	Percentage of wells that exceed 50 µg/L
Ogallala	172	15	9%
Dockum	12	1	8%
other	44	2	5%

Most selenium values below 200 feet are compliant with the MCL (Figure 3.10). Thus, deepening a well to more than 200 feet or casing the shallower portion of deeper wells could lead to reduced selenium concentrations.

Figure 3.10 Selenium Concentrations and Well Depths

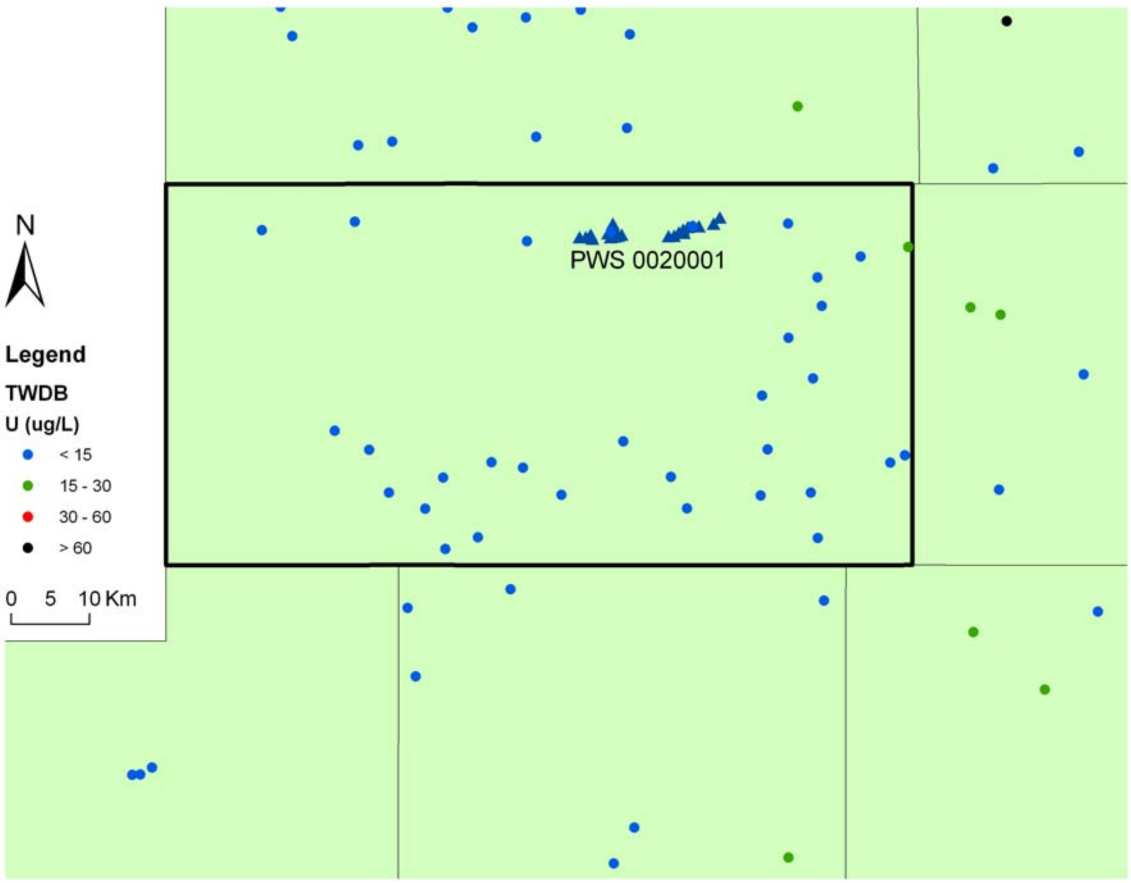


Uranium

The TWDB started testing for uranium recently in this area (2007), so all data presented are from 2007-2008. Out of the entire database for both Ogallala and Dockum aquifers (65 wells tested), only a single violation was found in a shallow well (100 feet deep) (Figures 3-11, 2-12, Table 3.5).

Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.5 shows the percentage of wells with uranium concentrations exceeding the uranium MCL (30 µg/L).

Figure 3.11 Spatial Distribution of Uranium Concentrations

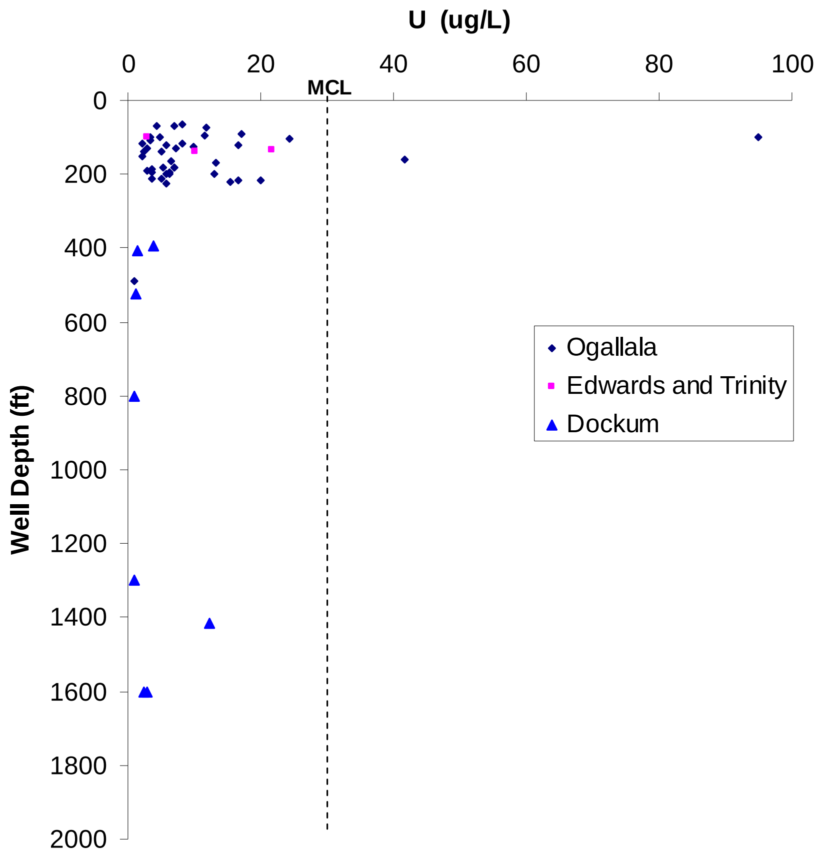


A comparison of uranium concentrations and well depths shows that nearly all wells with high uranium levels are less than about 220 feet deep (Figure 3.12), but these levels are below the MCL (30 µg/L). Therefore, uranium does not constitute a problem in this area.

Table 3.5 Summary of Wells that Exceed the MCL for Uranium, by Aquifer

Aquifer	Wells with measurements	Wells that exceed 30 µg/L	Percentage of wells that exceed 30 µg/L
Ogallala	47	1	2%
Dockum	4	0	0%
other	14	0	0%

Figure 3.12 Uranium Concentrations and Well Depths

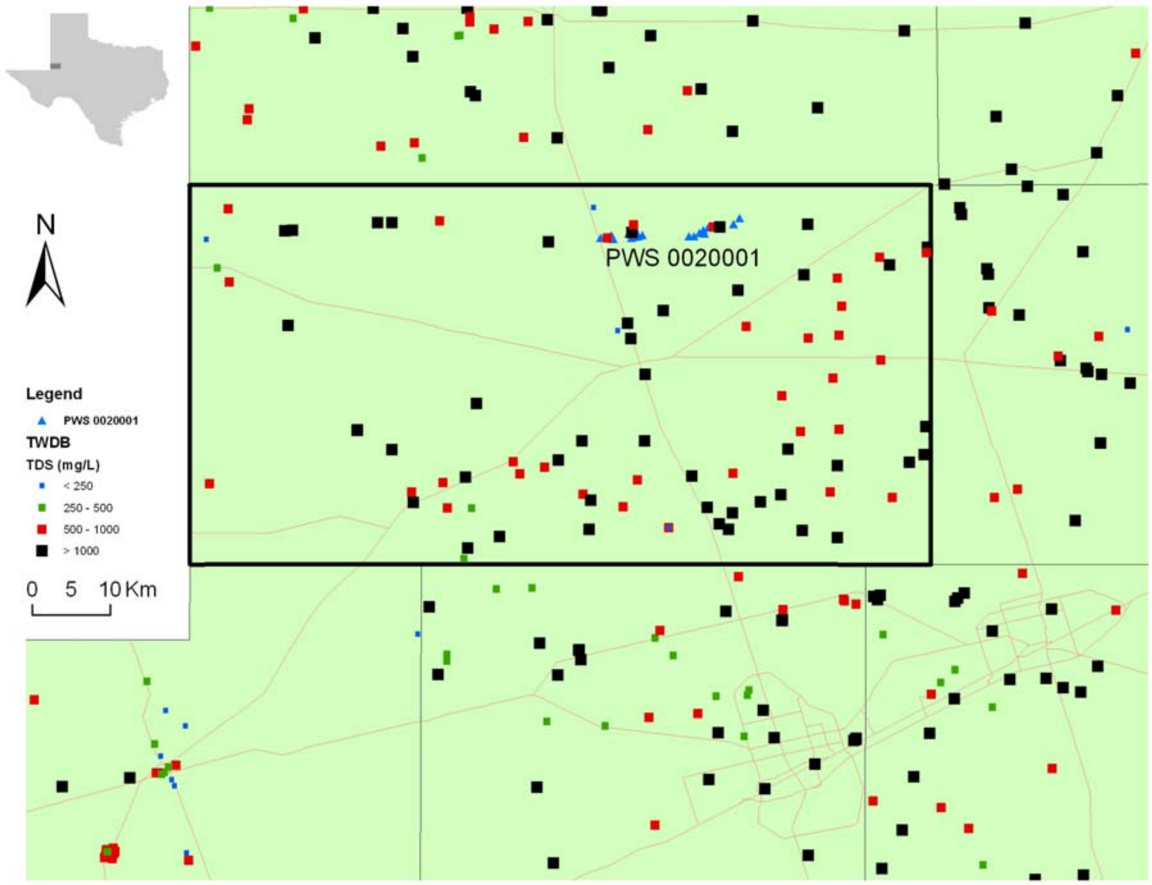


TDS

Total dissolved solid concentrations in the study area exceed 500 mg/L in most of the wells tested (Figure 3.13). Eighty-three percent of Ogallala wells, and 70 percent of Dockum wells exceed 500 mg/L (Table 3.6).

Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.6 shows the percentage of wells with TDS concentrations exceeding 500 mg/L.

1 **Figure 3.13 Spatial Distribution of TDS Concentrations**



2

3 **Table 3.6 Summary of Wells that Exceed 500 mg/L for TDS, by Aquifer**

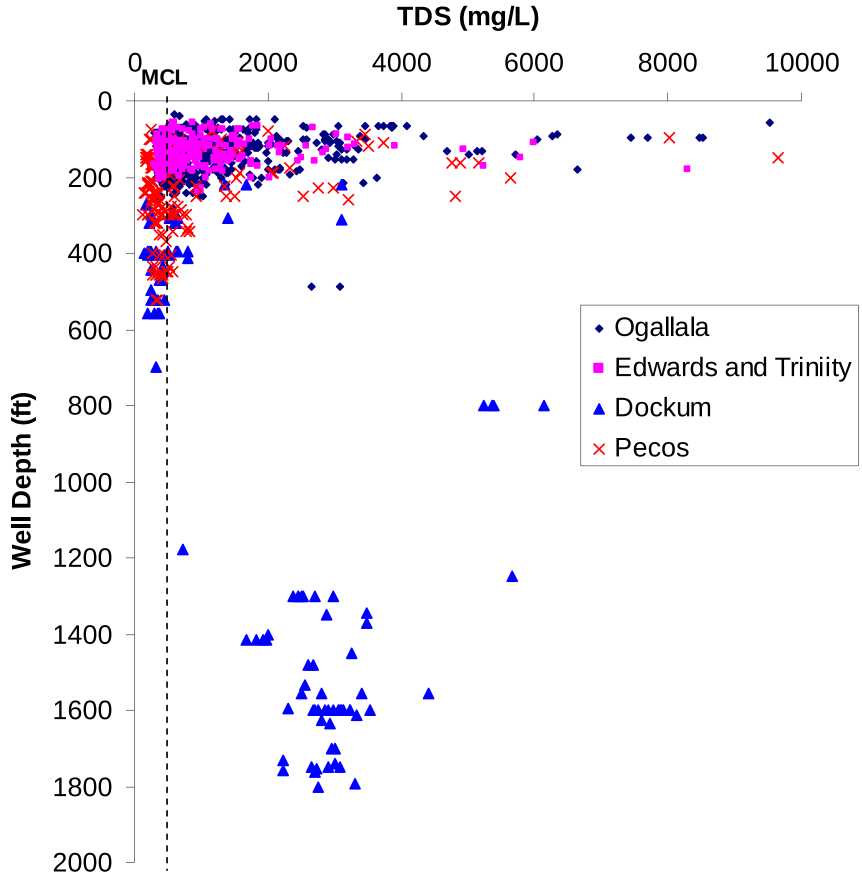
Aquifer	Wells with measurements	Wells that exceed 500 mg/L	Percentage of wells that exceed 500 mg/L
Ogallala	463	382	83%
Dockum	115	81	70%
other	43	24	56%

4 Although there is some stratification of TDS concentrations with depth in the study area
5 (Figure 3.14), with TDS concentrations decreasing with depth, the low values are still generally
6 above 500 mg/L.

7

8

Figure 3.14 TDS Concentrations and Well Depths



3.1.3 Regional Geology

The major aquifer in the study area is the southern part of the Ogallala aquifer, which is equivalent to the Ogallala formation, the predominant geologic unit that makes up the High Plains aquifer. The Ogallala formation is late Tertiary (Miocene–Pliocene, or about 2–12 million years ago) in age (Nativ 1988). It consists of coarse fluvial sandstone and conglomerates that were deposited in the paleovalleys of a mid-Tertiary erosional surface and eolian sand that was deposited in intervening upland areas (Gustavson and Holliday 1985). In the Ogallala-South area, the Ogallala formation is composed of deposition on top of a paleoupland. The formation is thin, resulting in a small saturated thickness and shallow water table. The top of the Ogallala formation is marked in many places by a resistant calcite layer known as the “caprock caliche.”

Within much of the study area, the Ogallala formation is overlain by Quarternary-age (Pleistocene–Holocene) eolian, fluvial, and lacustrine sediments, collectively called the

Blackwater Draw Formation (Holliday 1989). Texture of the formation ranges from sand and gravel along riverbeds to clay-rich sediment in playa floors.

In much of the southern High Plains, the Ogallala formation lies on top of Lower Cretaceous (Comanchean) strata. The top of the Cretaceous sediments is marked by an uneven erosional surface that represents the end of the Laramide orogeny. Cretaceous strata are absent beneath the thick Ogallala paleovalley fill deposits because they were removed by prior erosion. The Cretaceous sediments were deposited in a subsiding shelf environment and consist of the Trinity Group (including the basal sandy, permeable Antlers Formation); the Fredericksburg Group (limey to shaley formations including the Walnut, Comanche Peak, and Edwards Formations, as well as the Kiamichi Formation); and the Washita Group (low-permeability, shaley sediments of Duck Creek Formation) (Nativ 1988). The sequence results in two main aquifer units: the Antlers Sandstone (also termed the Trinity or Paluxy sandstone, about 15 m thick) and the Edwards Limestone (about 30 m thick). These aquifer units constitute the Edwards-Trinity (High Plains) aquifer (Ashworth and Flores 1991). The limestone decreases in thickness to the northwest and transitions into the Kiamichi and Duck Creek formations.

The Ogallala Formation also overlies the Triassic Dockum Group in much of the southern High Plains. The Dockum Group is generally about 150 m thick and is exposed along the margins of the High Plains. The uppermost sediment consists of red mudstone that generally form an aquitard. Underlying units (Trujillo Sandstone [Upper Dockum] and Santa Rosa Sandstone [lower Dockum]) form the Dockum aquifer. Water quality in the Dockum is generally poor (Dutton and Simpkins 1986). Sediment of the Dockum was deposited in a continental fluvio-lacustrine environment that included streams, deltas, lakes, and mud flats (McGowen et al., 1977) and included alternating arid and humid climatic conditions. The Triassic rocks reach up to 600 m thick in the Midland Basin.

3.2 DETAILED ASSESSMENTS FOR THE CITY OF ANDREWS

The City of Andrews PWS has 14 operational wells, two former PWS wells and seven plugged wells as shown in Table 3.7. These wells range in depth from 150 to 216 feet. The wells tap the shallow Ogallala aquifer. Water from this PWS is sampled from a single entry point. Therefore, the chemical analyses shown in Table 3.8 represent a blend of water from these wells.

Table 3.7 PWS 0020001 Wells

Well	Status	Aquifer	Depth (feet)
G0020001A	PLUGGED	Ogallala	190
G0020001B	PLUGGED	Ogallala	200
G0020001C	PLUGGED	Ogallala	150
G0020001D	PLUGGED	Ogallala	150
G0020001E	FORMER PWS WELL	Ogallala	200
G0020001F	FORMER PWS WELL	Ogallala	193
G0020001G	PLUGGED	Ogallala	200
G0020001H	OPERATIONAL	Ogallala	200
G0020001I	PLUGGED	Ogallala	160
G0020001J	OPERATIONAL	Ogallala	206
G0020001K	OPERATIONAL	Ogallala	216
G0020001L	OPERATIONAL	Ogallala	200
G0020001M	OPERATIONAL	Ogallala	170
G0020001N	OPERATIONAL	Ogallala	172
G0020001O	OPERATIONAL	Ogallala	166
G0020001P	OPERATIONAL	Ogallala	180
G0020001Q	OPERATIONAL	Ogallala	200
G0020001R	OPERATIONAL	Ogallala	184
G0020001S	PLUGGED	UNKNOWN	UNKNOWN
G0020001T	OPERATIONAL	Ogallala	195
G0020001U	OPERATIONAL	Ogallala	195
G0020001V	OPERATIONAL	Ogallala	201
G0020001X	OPERATIONAL	Ogallala	203
Data from TCEQ PWS Database			

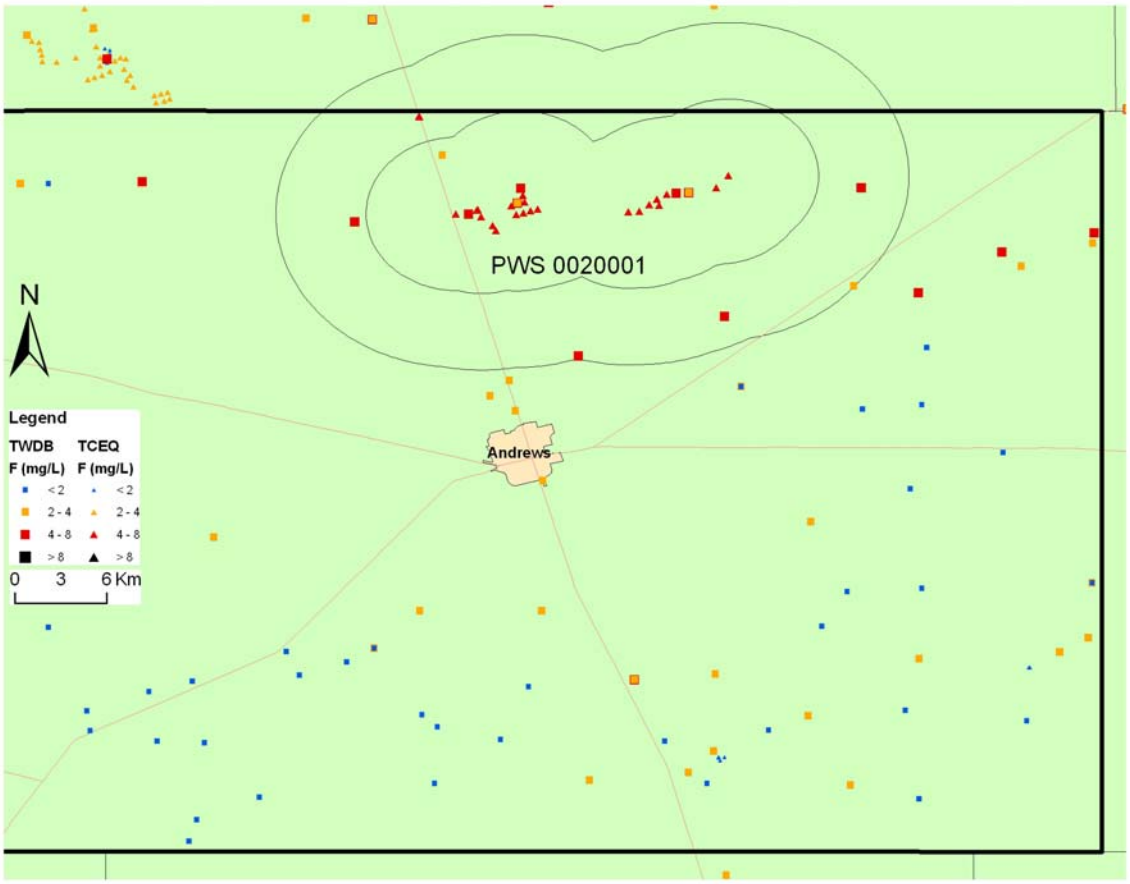
Table 3.8 Fluoride, Arsenic, and TDS concentrations in the Andrews Water System (data from the TCEQ PWS database).

Date	Fluoride	Arsenic	TDS
08-Feb-99	4.7	35.6	-
08-Jan-01	4	-	-
24-Sep-01	4.9	27.6	-
24-Sep-01	3.8	49.5	-
20-Jun-02	4.4	35.2	-
20-Jun-02	5	45.1	-
20-Jun-02	4.7	30.2	-
03-Feb-03	4.4	-	-
11-Sep-03	5.1	-	-
08-Dec-03	4.2	-	-
02-Feb-04	5.4	-	-
26-May-04	4.6	-	-
23-Sep-04	4.52	-	-
18-Nov-04	4.75	-	-
14-Feb-05	4.49	23.4	660
13-Jun-05	4.64	28.2	-
27-Sep-05	4.4	38	-
12-Jan-06	4.62	30.3	-
12-Apr-06	4.82	29.9	-
11-Jul-06	4.65	24.4	-
12-Oct-06	4.85	32.6	-
20-Feb-07	4.31	22.1	-
12-Apr-07	4.62	17.7	-
11-Jul-07	4.6	25.7	-
11-Oct-07	4.58	27.4	-
20-Feb-08	4.47	26	-
08-May-08	4.37	30.5	-
24-Jul-08	4.55	29.2	-
11-Nov-08	4.72	23.6	-
10-Feb-09	4.76	22.6	-

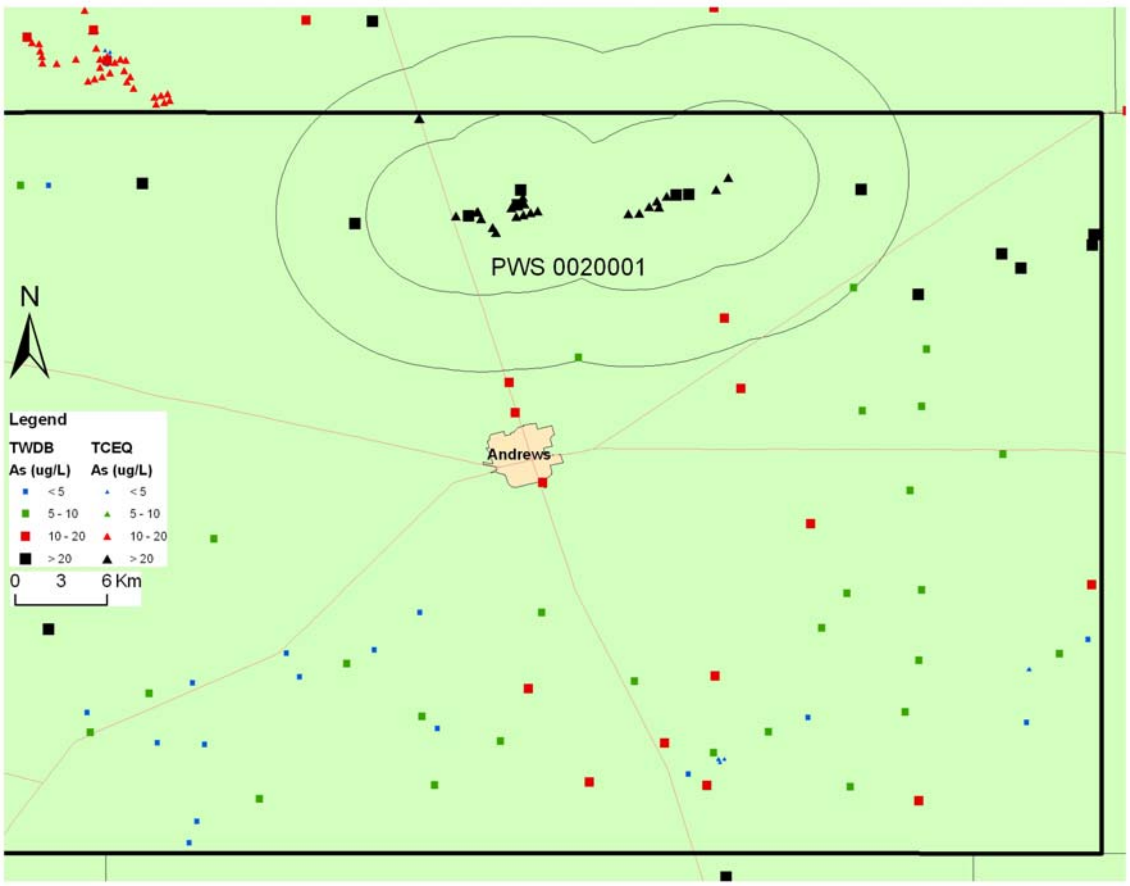
Data from TCEQ PWS Database

Twenty-nine fluoride measurements out of 30 were taken, and all 22 arsenic measurements made between 1999 and 2009 were found to be above the MCLs for fluoride (4 mg/L) and arsenic (10 µg/L). All 30 fluoride measurements exceeded the secondry maximum contaminant level (SMCL) (2 mg/L). The only TDS measurement taken (2005) was found to be above 500 mg/L. The variability in values both for arsenic (17-50 µg/L) and for fluoride (3.8-5.4 mg/L) measurements throughout the past 10 years may imply that a change in the mixtures of well waters at the entry points caused this change. Pumping records might help to indicate what mixture of water resulted in the lower solute concentrations. In addition, sampling each well separately would identify wells with particularly high or low concentrations of these constituents. The spatial distribution of fluoride, arsenic, and TDS concentrations in the vicinity of the PWS wells are shown in Figures 3.15, 3.16, and 3.17, respectively, and are superimposed in Figure 3.18 for all three concentrations.

Figure 3.15 Fluoride Concentrations within 5- and 10-km Buffers around Andrews County Water System Wells



1 **Figure 3.16 Arsenic Concentrations within 5- and 10-km Buffers around Andrews**
2 **County Water System Wells**



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1 **Figure 3.17 TDS Concentrations within 5- and 10-km Buffers around Andrews County**
2 **Water System Wells**

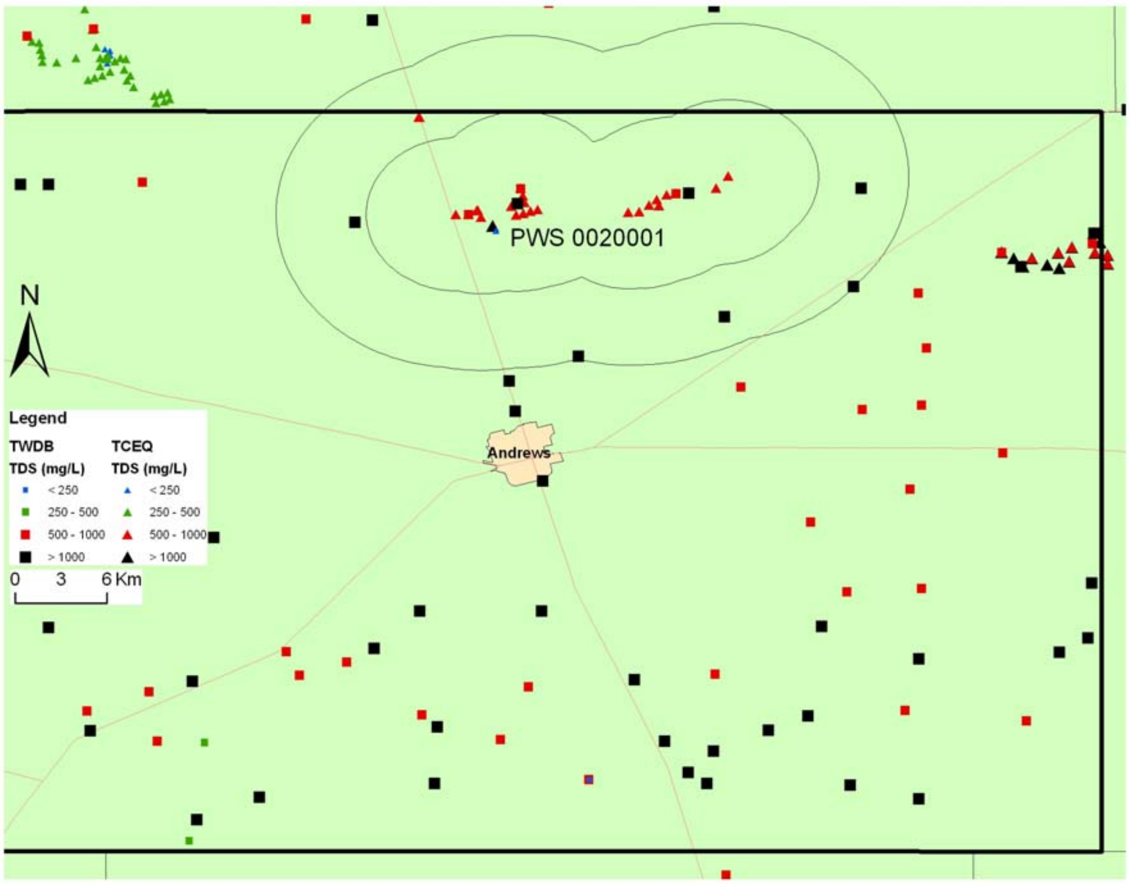

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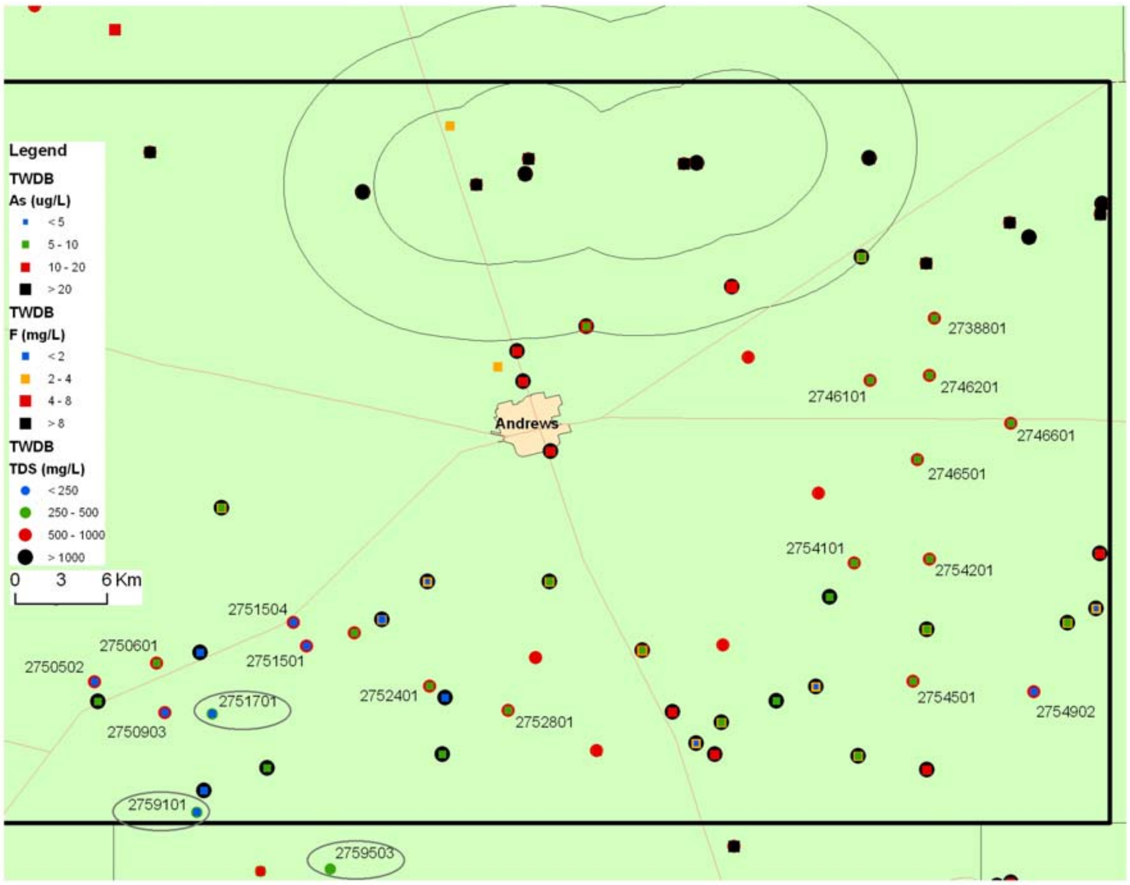
Figure 3.18 Fluoride, Arsenic, and TDS Concentrations Superimposed near Andrews County Water System Wells



Figures 3.14, 3.15, and 3.16 were created using data from the TCEQ and TWDB databases. Two types of samples were included in the analysis. Samples from the TCEQ database (shown as triangles on the map) represent the most recent sample taken at a PWS, which can be raw samples from a single well or entry point samples that may combine water from multiple sources. Samples from the TWDB database are taken from single wells (shown as squares in the map). Where more than one measurement was made from a source, the most recent concentration is shown.

Three TWDB wells within 5 km of the PWS wells show fluoride values below the MCL, but above the SMCL, and a fourth well can be found within 10 km of the PWS wells. Two TWDB wells within 10 km of the PWS wells show arsenic values below the MCL. One PWS (0020012) adjacent to the PWS shows low TDS water (this might be treated water). Areas east and south of Andrews City have wells with compliant fluoride and arsenic water, but mostly have elevated TDS. Wells north of Andrews are non compliant both arsenic and fluoride and also have elevated TDS. When presenting fluoride, arsenic, and TDS superimposed on one map (Figure 3.17), it is apparent that three wells are compliant for both arsenic and fluoride and also have low TDS (Table 3.9). Sixteen more wells compliant for fluoride and arsenic, but with elevated TDS are listed in Table 3.9. It is possible that water quality standards might be met with the existing wells. Testing the wells individually might make it possible to shift production between wells to reduce arsenic and fluoride concentrations.

Table 3.9 Most Recent Concentrations of Select Constituents in Potential Alternative Water Sources

Well	Owner	Depth (ft)	Aquifer	Use	As ppb	F mg/L	TDS mg/L
2738801	Jimmy Sterling Five	-	Ogallala	stock	5.28	1.53	727
2746101	Cotten Ranch	-	Ogallala	stock	6.35	0.79	590
2746201	Fraskin Ranch	65	Ogallala	stock	8.05	1.12	853
2746501	Cotten Ranch	107	Ogallala	stock	9.92	1.68	588
2746601	7 Bird Ranch	-	Ogallala	stock	6.96	1.52	690
2750502	UT Lands	190	Ogallala	stock	2.99	0.65	569
2750601	UT Lands	180	Ogallala	stock	7.75	0.95	687
2750903	UT Lands	100	Ogallala	stock	0.73	0.09	444
2751501	UT Lands	91	Ogallala	stock	3.40	0.50	691
2751504	UT Lands	150	Ogallala	stock	4.95	0.73	-
2751701	UT Lands	119	Ogallala	stock	4.80	0.20	601
2752401	UT Lands	140	Ogallala	stock	5.07	0.70	602
2752801	Casselman Ranch	-	Ogallala	stock	9.80	0.68	608
2754101	Proctor Ranch	-	Ogallala	stock	5.40	1.91	857
2754201	Proctor Ranch	-	Ogallala	stock	6.34	0.45	765
2754501	Cotton Ranch	-	Ogallala	stock	7.49	1.40	798
2754902	Fasken Ranch	-	Ogallala	unused	1.70	0.98	501
2759101	Edwin Magruder	-	Antlers Sand	stock	2.05	0.30	392
2759503	Conoco Phillips	100	Antlers Sand	stock	6.00	1.00	431

3.2.1 Summary of Alternative Groundwater Sources for the Andrews County Water System

Several nearby wells drilled show acceptable levels of arsenic and fluoride. These wells are 15-20 km east and south of the City of Andrews. In most places TDS values exceed 500 mg/L, but using water from the wells described in Table 3.9 and Figure 3.17 may eliminate the need to remove arsenic and fluoride, requiring only treatment for TDS. Blending water from several wells (low arsenic and high TDS with high arsenic and low TDS) may prevent the need for treatment. It is suggested that the existing PWS wells continue to be tested for arsenic and fluoride to be able to minimize contaminant concentrations.

SECTION 4
ANALYSIS OF THE CITY OF ANDREWS PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1 Existing System

The location of the City of Andrews PWS is shown in Figure 4.1. The City of Andrews PWS is located northeast of the intersection of U.S. Highway 385 and State Highway 115. The system serves a total population of 9,652 and has 4,420 connections that are all metered. The water sources for this water system include 17 wells: six wells in the Florey Well Field and 10 wells and one emergency well at the University Well Field. The Florey Well Field is the primary water source and is located ten miles northeast of the city. The University Well Field is located 10 miles southeast of the city.

Water is gas chlorinated prior to storage at Mustang Station. This station consists of two 1.40 million gallon ground storage tanks and four service pumps that discharge into the distribution system. The capacities of the four service pumps are as follows: # 1 – 750 gallons per minute (gpm); #2 - 1,500 gpm, #3 – 3,000 gpm, and #4 – 2,700 gpm. An additional 900 gpm service pump and chlorinator is used only in emergencies and peak demand. Two elevated storage tanks with a total capacity of 1 million gallons float on the system.

Fluoride was detected between 3.8 mg/L and 5.4 mg/L from January 1999 to February 2009, and several results exceed the MCL of 4 mg/L. Concentrations of arsenic were detected at values ranging between 0.0177 mg/L to 0.0495 mg/L from February 1999 to February 2009, exceeding the MCL of 0.010 mg/L that went into effect on January 23, 2006 (USEPA 2009a; TCEQ 2008). Therefore, the City of Andrews PWS faces compliance issues under the water quality standards for arsenic and fluoride.

The treatment employed for disinfection is not appropriate or effective for removal of fluoride or arsenic, so optimization is not expected to be effective for increasing removal of these contaminants. The City of Andrews has sampled individual wells, and has reduced arsenic and fluoride concentrations by shifting production to wells with lower arsenic and fluoride concentrations. While this lowered contaminant concentrations, it has not been sufficient to reduce concentrations below the MCLs.

The city also has a 1,800 GPD reverse osmosis unit that was installed to provide compliant drinking water to residents.

Basic system information is as follows:

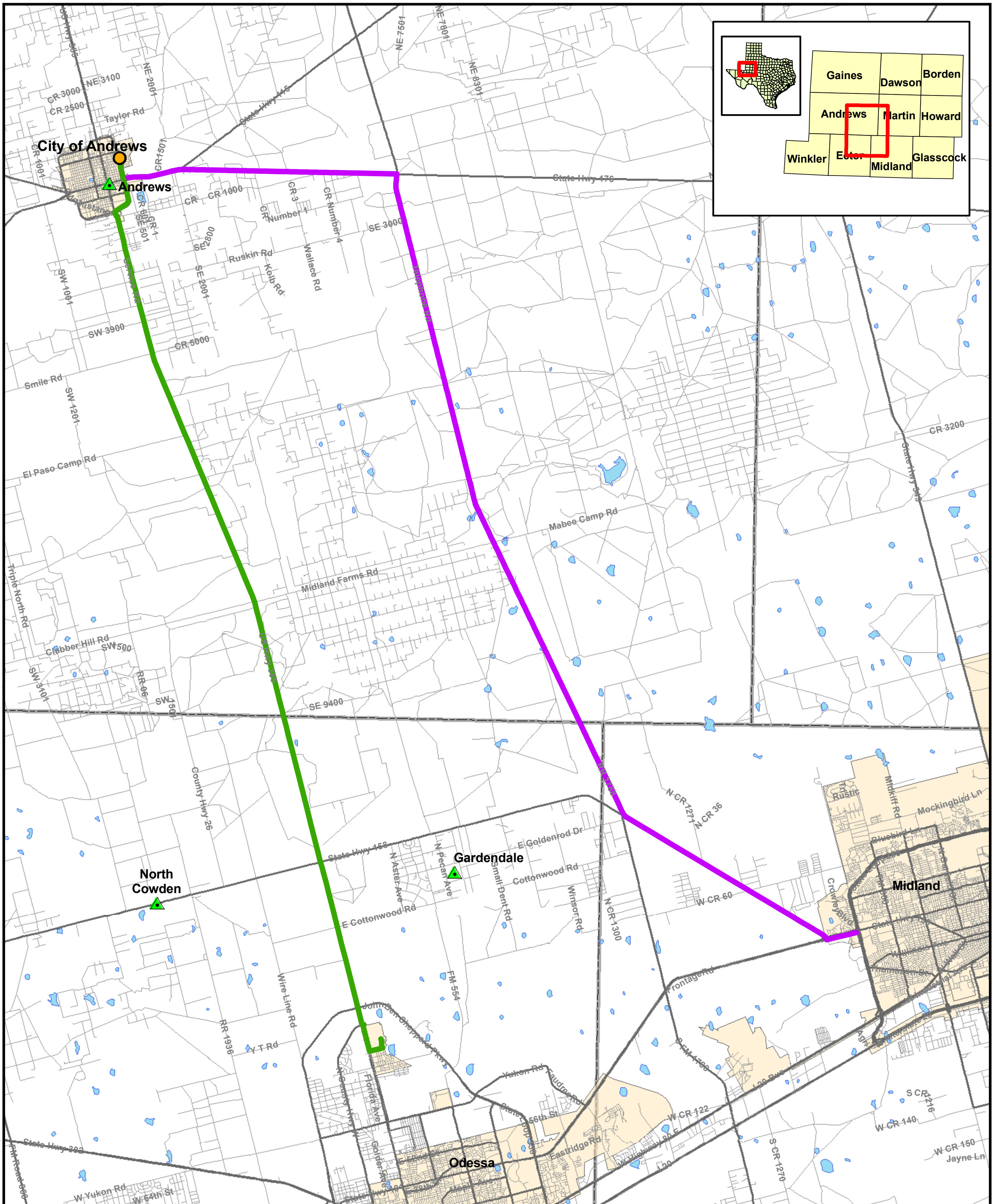
- Population served: 9,652
- Connections: 4,420
- Metered Connections: 4,420

- Average daily flow: 2.595 million gallons per day (mgd)
- Total production capacity: 12.305 mgd

Basic system raw water quality data are as follows:

- Typical arsenic range: 0.00177 – 0.0495 mg/L
- Typical fluoride range: 3.8 – 5.4 mg/L
- Typical alkalinity, bicarbonate (as $CaCO_3$) range: 211 – 279 mg/L
- Typical calcium range: 42.5 – 79.7 mg/L
- Typical chloride range: 138 – 193 mg/L
- Total hardness (as $CaCO_3$) range: 283 – 603 mg/L
- Typical iron range: <0.012 – 0.073 mg/L
- Typical magnesium range: 45.3 – 98.2 mg/L
- Typical manganese: <0.008 mg/L
- Typical nitrate range: 1.17 – 2.6 mg/L
- Typical selenium range: 0.00917 – 0.0299 mg/L
- Typical sodium range: 72.1 – 114 mg/L
- Typical sulfate range: 116 mg/L – 155 mg/L
- Typical total dissolved solids range: 485 – 863 mg/L
- Typical pH range: 7.2 – 7.94

The typical ranges for water quality data listed above are based on a TCEQ database that contains data updated through 2009.



Legend

- Study System
- Cities
- City Limits
- Counties
- Major Road
- Minor Road
- AD-1 City of Odessa - 29.1 Miles
- AD-2 City of Midland - 37.7 Miles

Figure 4.1

CITY OF ANDREWS

Pipeline Alternative

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4.1.2 Capacity Assessment for the City of Andrews PWS

The project team conducted a capacity assessment of the City of Andrews water system on July 1, 2009. 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 impression of the technical, managerial, and financial capability of the water system. The positive aspects of capacity describe the strengths of the system. These factors can provide the building blocks for the system 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 the proper operation of the system. The last category, capacity concerns, includes items that are not causing significant problems for the system at this time. However, the system may want to address them before they become problematic.

The project team interviewed the following people.

- Glenn Hackler, City Manager
- Kitty Bristow, Finance Director
- Danny "Bo" Griffin, Assistant Director Water Production and Plant Management
- Bert Lopez, Assistant Director Water Distribution and Sewer Collection

4.1.2.1 General Structure of the Water System

The City of Andrews is governed by a city council and a city manager. The utility department has nine employees, six of whom are licensed in water and wastewater. All water users are metered, including city parks and buildings. The city has been under a Bilateral Compliance Agreement since 1992 for exceeding the fluoride MCL. Under that agreement, the city has provided bottled water through a central water station that is open to residents twenty-four hours a day. The city is currently looking at options for arsenic treatment. They are also considering developing a new well field to address capacity as well as compliance issues.

4.1.2.2 General Assessment of Capacity

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

4.1.2.3 Positive Assessment of Capacity

In assessing a system's overall capacity, it is crucial to look at all aspects – positive and negative. It is important for systems 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 system in addressing the capacity deficiencies or concerns. The factors that were particularly important for the City of Andrews water system are listed below.

- **Capital Improvements Financing:** The City of Andrews has a "pay as you go" policy, which means it does not incur any debt. This financial policy has been in effect for the last 40 to 50 years. The city has set up a general fund capital trust account for capital improvements. All city projects and improvements are paid for out of this fund. The city has a capital improvement surcharge in the water rate structure and fully funds depreciation. There is an extremely high collection rate for water.

- **Meter Replacement Program:** The utility has installed a radio read meter system and has developed a meter replacement program. Approximately one-third of the meters are replaced every three years, based on a 10-year life cycle.

- **Disinfection Practices:** The staff rebuilds disinfection units every year to prevent breakdown and has one portable unit available for emergencies. These actions can prevent the utility from serving non-compliant water due to bacteriological contamination.

- **Proactive City Manager**: The city manager conducts work sessions with the council and brings in consultants for presentations as needed. The City manager is very proactive in keeping the city council informed and educating them on budget items for the water and wastewater systems as well as water supply.

- **Plan for Employee Retention:** The city manager has been with the city for eight years, the finance director for 25 years, and the water distribution and treatment manager for about 20 years. The city has a strong belief in retaining good employees and has a very low turnover in staffing. All employees have written job descriptions and the city developed a step-plan with incremental salary increases for all employees, including water and wastewater operators. Funds are made available for training, which includes college courses, certifications and licenses.

4.1.2.4 Capacity Deficiencies

The following capacity deficiency was noted in conducting the assessment and seriously impacts the ability of the water system to meet compliance with current and future regulations and to ensure long-term sustainability.

- **Need for Greater Understanding of Safe Drinking Water Act regarding POU Devices for Treatment Compliance**: While the City has conducted research about the cost of complying with the arsenic regulations, including using POU treatment devices as treatment technologies for compliance, greater understanding is needed about the regulations. In the interview, it was indicated that the city believes a 90 percent participation rate with POU will be adequate. However, regulations (40 CFR 1412) require 100 percent participation. The water utility or contractor must own the units and be responsible for maintenance. In addition, compliance sampling shall be required for all units. This means that the water utility must sample the entire POU system for arsenic every three years. There are many logistical issues with attempting to sample from residential customers. In addition, the cost of sampling and maintaining the units could be prohibitive. Several states have determined that point- of-use treatment is not feasible for systems with more than a few hundred connections.

4.1.2.4 Potential Capacity Concerns

The following item was a concern regarding capacity but no specific operational, managerial, or financial problems can be attributed to this item at this time. The system should consider the item listed below to further improve technical, managerial, and financial capabilities and to improve the system's long-term sustainability.

- **Low Reconnection Fee:** The operators shutoff approximately 80-90 connections per month for non-payment. Bills are due on the 15th and customers are disconnected for non-payment on the 30th. Almost all these customers will pay their bill after being disconnected; however, the fee for reconnection is only $10 per month and may not provide enough incentive for customers to pay their bills on time. The fee does not cover the operator's time for disconnection and reconnection. A higher reconnection fee might encourage more customers to pay their bill on time and avoid disconnection.

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 City of Andrews 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. Small systems (<1 mgd) were only considered if they were established residential or non residential systems within 5 miles of the City of Andrews PWS. Large systems or systems capable of producing twice the daily volume produced by the study system were considered if they were within 30 miles of the study system. A distance of 30 miles was considered to be the upper limit of economic feasibility for constructing a new water line. Table 4.1 is a list of the selected PWSs based on these criteria for large and small PWSs within 30 miles of the City of Andrews. If it was determined 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 and identified with "EVALUATE FURTHER" in the comments column of Table 4.1.

Table 4.1 Selected Public Water Systems within 30 Miles of the City of Andrews

PWS ID	PWS Name	Distance from City of Andrews (miles)	Comments/Other Issues
0020009	FLOREY PARK ANDREWS COUNTY PARK	9	Smaller GW system. WQ issues: Arsenic, Fluoride, Sulfate, TDS
0020012	EXXONMOBIL PRODUCTION COMPANY MEANS FIELD OFFICE	9	Smaller GW system. WQ issues: Treated drinking water.
0020011	EXXONMOBIL FULLERTON	13	Smaller GW system. WQ issues: Not possible to confirm WQ.
0020008	TXDOT ANDREWS COUNTY SRA	14	Smaller GW system. WQ issues: Arsenic, Fluoride, Iron
0020004	DCP MIDSTREAM FULLERTON PLANT	20	Smaller GW system. WQ issues: Treated drinking water.
0680151	OCCIDENTAL PERMIAN LTD N COWDEN	21	Smaller GW system. WQ issues: Arsenic, Iron
0830023	TEXLAND GREAT PLAINS WATER SUPPLY COMPANY	21	Smaller GW system. WQ issues: Arsenic, Fluoride
0680195	GARDENDALE COUNTRY WATER INC	22	Smaller GW system. WQ issues: Nitrate
0680012	CITY OF GOLDSMITH	24	Smaller GW system. WQ issues: Arsenic, Iron
0680148	GARDENDALE MOBILE HOME PARK	24	Smaller GW system. WQ issues: Arsenic, Nitrate
0680068	DCP MIDSTREAM GOLDSMITH PLANT	25	Smaller GW system. WQ issues: Treated drinking water
1650096	KENT KWIK CONVENIENCE STORE 315	25	Smaller system. WQ issues: Treated drinking water
1650001	CITY OF MIDLAND	26	Larger GW/SW system. WQ issues: None. *Evaluate further*
0680214	GREATER GARDENDALE WSC	28	Smaller GW system. WQ issues: Iron
0830012	CITY OF SEMINOLE	28	Smaller GW system. WQ issues: Arsenic, Fluoride
0680002	CITY OF ODESSA	30	Larger GW/SW system. WQ issues: None. *Evaluate further*

WQ = water quality
GW = groundwater
SW = surface water

After the PWSs in Table 4.1 with water quality problems were eliminated from further consideration, the remaining PWSs were screened by proximity to the City of Andrews and sufficient total production capacity for selling or sharing water. Based on the initial screening summarized in Table 4.1, two alternatives were selected for further evaluation. These alternatives are summarized in Table 4.2. The first alternative is a connection to the City of Midland distribution system that is within 30 miles of the study system. The second alternative is a connection to the City of Odessa that is also within 30 miles of the City of Andrew PWS. Descriptions of both water systems for the Cities of Midland and Odessa follow Table 4.2.

Table 4.2 Public Water Systems Within the Vicinity of the City of Andrews Selected for Further Evaluation

PWS ID	PWS Name	Pop	Connections	Total Production (mgd)	Avg Daily Usage (mgd)	Approx. Dist. from City of Andrews PWS	Comments/ Other Issues
1650001	CITY OF MIDLAND	103,174	47,401	64.138	20.392	26	Larger GW system. WQ issues: None.
0680002	CITY OF ODESSA	100,719	44,135	87.037	18.764	30	Larger GW/SW system. WQ issues: None.

4.2.1.1 Colorado River Municipal Water District

The Colorado River Municipal Water District (CRMWD) supplies raw water to the Cities of Midland and Odessa and, while it would not supply water directly to the City of Andrews, a brief description is included here because of its role in supplying water to these two cities. The CRMWD was authorized in 1949 by the 51st Legislature of the State of Texas for the purpose of providing water to the District's Member cities of Odessa, Big Spring, and Snyder. The CRMWD also has contracts to provide specified quantities of water to the Cities of Midland, San Angelo, Stanton, Robert Lee, Grandfalls, Pyote, and Abilene (through the West Central Texas Municipal Water District).

The CRMWD owns and operates three major surface water supplies on the Colorado River in west Texas. These are Lake J.B. Thomas, the E.V. Spence Reservoir, and the O.H. Ivie Reservoir. Together, the combined capacity of these reservoirs is 1.272 million acre-feet. Additionally, CRMWD operates five well fields for water supply. Three of those fields were developed by the Member Cities prior to 1949. The fourth field, located in Martin County, began delivering water in 1952. The fifth field, located in Ward County southwest of Monahans, can supply up to 28 mgd. CRMWD primarily uses these well fields to supplement surface water deliveries during the summer months.

4.2.1.2 City of Midland

The City of Midland is located approximately 32 miles southeast of the City of Andrews. The City of Midland purchases approximately 80 to 85 percent of its water from the CRMWD through two contracts. This purchased water is untreated surface water from several reservoirs, including Lake J.B. Thomas, Lake E.V. Spence, and Lake O.H. Ivie. The City of Midland gets the other 15 to 20 percent of its water from the University Lands well field, which contains lower quality water. Midland is classified as a customer city of the CRMWD, which limits their deliveries to contractual amounts and allows Midland to use alternate water supplies. This is unlike Odessa who has unlimited supplies but can only use CRMWD as their source.

As part of Midland's primary water sources, raw water from the CRMWD is delivered to one of three reservoirs. Two of the three reservoirs are owned by CRMWD and include a 15 million gallon reservoir located at the water treatment plant and the 100 million gallon

Terminal Reservoir located on FM 1788, approximately 2 miles south of Highway 191. The Terminal Reservoir is shared by both Midland and Odessa. The third reservoir, Lake Peggy Sue, is owned by Midland and is located approximately 2 miles west of the City's water treatment plant. In addition to the contracted quantities provided by the CRMWD from Lakes Spence and Thomas, Midland owns 16.54 percent of Lake Ivie, which is located approximately 170 miles southwest of Midland. As long as the lake levels are not below certain limits, a maximum of 15 million gallons from the Lake Ivie system and 16 million gallons from Lakes Spence and Thomas are delivered daily to one of the three reservoirs around Midland or directly to the water treatment plant.

In addition to CRMWD surface water, the city owns or leases water rights in two well fields. The Paul Davis well field, located 30 miles north of Midland, was developed in the late 1950s and is used during peak periods to offset the demand exceeding the 31 mgd provided by the CRMWD reservoirs. The well field can sustain a pumping rate of 18 to 19 mgd, but normally averages 8 mgd. The well field uses 29 wells that pump water to two 2.5 million gallon aboveground storage tanks. These wells are installed between 150 and 200 feet deep in the Ogallala aquifer (Code 121OGLL). Since arsenic, fluoride, perchlorate, and radionuclides were reported in samples from the well field, the City of Midland carefully monitors the blending of surface water with groundwater to avoid exceeding the current limits for these constituents. The second well field is the T-Bar Ranch, located in western Winkler County approximately 70 miles west of Midland. This well field is still being developed and will be brought online as the Paul Davis well field is depleted.

The City of Midland operates one water treatment plant to treat the surface water and provide water to a service population of approximately 100,000. The city has a total of approximately 35,000 connections, all of which are metered. The major users of water in Midland include the college, parks, and schools, which use the water for irrigation. The current monthly rates per connection are a $13.33 base charge for the first 2,000 gallons and a tiered rate structure varying from $3.02 per thousand for 2,000-10,000 gallons up to $3.49 per thousand for usage above 35,000 gallons.

In the Fall of 2003, the Midland City Council decided that water could only be provided to areas annexed by the City of Midland. Consequently, while the City of Midland has sufficient drinking water capacity, residents in a location would have to agree to be annexed to receive water from the City. To be annexed, the residents of the area requesting annexation must submit a petition signed by at least 50 percent of the property owners and residents wanting to be annexed. Once annexation is approved, the City forms a Public Improvement District for the installation of water and sewer lines. Property owners participating in the Public Improvement District are assessed their portion of the cost of such lines based on frontage areas or lot size. In the past, Midland has financed the Public Improvement District. The annexed area would be subject to the same rates as other residences in Midland.

The City of Midland has adequate supplies for existing residents. However, due to decreasing levels in CRMWD lakes and groundwater quality issues, the City has limited capability to provide water for projects in areas outside the City. Since the City is located in an oil producing area, contamination of local groundwater can and does occur. The ability to provide water to these areas is assessed on a case-by-case basis. Positive consideration is only granted if the supplies are available, financial assistance is provided for installation of the system, and the City Council approves.

4.2.1.3 City of Odessa

The connection point for the City of Odessa is located approximately 28 miles south of the City of Andrews. The City of Odessa is one of three original members of CRMWD, and= by contract, may only obtain its water supply through them. Being an original member allows them first access to available water to meet its needs. This access assures it has as much water as needed based on existing supply. The water supplied to the City of Odessa originates in a network of three reservoirs (Lake Ivie, Lake Spence, and Lake Thomas), but this water may be supplemented with CRMWD-supplied groundwater during the high-demand summer months.

Raw water is treated in a treatment facility, and then stored prior to entry to the distribution system. The City of Odessa used approximately 625 MG of well water in 2008.

Average usage by the City of Odessa ranges from 12 to 15 mgd in the winter to 35 to 36 mgd in the summer. The City of Odessa provides water to a population of approximately 108,000 and approximately 36,000 connections. The current customer rate is $3.38 per 1,000 gallons, which may increase by 3 percent in the Fall of 2009.

The City of Odessa does have excess treated water capacity and may be willing to sell water to other PWSs. A community wanting to purchase treated water from the City of Odessa must submit a formal request to the City for review by the five-member city council. A community does not have to be annexed to receive treated water via pipeline, but it would have to fund the cost of the connecting pipeline. Although, no one has approached them, it is likely that City Council would be open to a discussion about providing water. Consideration would have to include who is providing services, operation, and ownership. Past wholesale prices were typically around $3 per thousand gallons. Odessa would consult with the CRMWD if the customers would need a substantial quantity of water.

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 a number of water systems in the area have water quality problems, it should 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 operation of a water well. As a result, existing nearby wells 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 have acceptable water quality. In developing the cost estimates, Parsons assumed 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.

4.2.2.2 Results of Groundwater Availability Modeling

The Ogallala Aquifer and the Dockum Aquifer are the two main groundwater sources in Andrews County. The Ogallala Aquifer is a large, relatively shallow aquifer providing drinking water to most of the Texas panhandle communities, as well as irrigation water. The Dockum aquifer is a deep, low-yield aquifer of relatively poor water quality that is used primarily for oil field water-flooding operations and, to a lesser extent, irrigation (Bradley and Kalaswad 2003).

Eighteen operational wells of the City of Andrews are completed in the Ogallala Aquifer, at depths ranging from 166 to 216 feet. A search of wells registered in TCEQ's Public Water Supply database was conducted to assess groundwater sources utilized within a 10-mile radius of the PWS. The search indicated that all domestic and public wells located within the search area utilize the Ogallala Aquifer as the water source, as well as numerous irrigation wells. Several industrial wells that are in operation within the search area are listed as completed in the underlying Dockum Aquifer.

Groundwater Supply

The Ogallala is the largest aquifer in the United States. The aquifer outcrop underlies eastern New Mexico and much of the Texas High Plains region, extending eastward over most of Andrews County. The Ogallala provides significantly more water for users than any other aquifer in the state. The aquifer saturated thickness ranges up to an approximate depth of 600 feet. Supply wells have an average yield of approximately 500 gal/min, but higher yields, up to 2,000 gal/min, are found in previously eroded drainage channels filled with coarse-grained sediments (TWDB 2007).

Water level declines in excess of 300 feet have occurred in several aquifer areas over the last decades. The 2007 Texas Water Plan anticipated that, over a 50-year planning period, the water supply would have more than a 40 percent depletion, from 5,968,260 AFY projected for

2010, to 3,534,124 AFY by the year 2060. Nearly 95 percent of the groundwater pumped from the Ogallala Aquifer is used for irrigated agriculture.

Groundwater Availability

Regional groundwater withdrawal in the Texas High Plains region is extensive and likely to remain near current levels for several decades. Water needs by individual county reported in the 2007 State Water Plan indicated that in Andrews County, water needs in county, over a 50-year planning period, would actually have an overall reduction as a result of improved conservation in irrigation water use. A projected irrigation use of 14,094 AFY for 2010 would decrease to 12,165 AFY by the year 2060. Over the same planning period, municipal water use is expected to moderately increase from 671 AFY to 773 AFY.

A groundwater availability model (GAM) for the Ogallala aquifer was developed by the TWDB (Blandford et al. 2003). Modeling was performed to develop long-term groundwater projections based on historical water use and aquifer conditions. Predictive simulations using the GAM model indicated that, if estimated future withdrawals are realized, aquifer water levels could decline to a point where significant regions currently practicing irrigated agriculture could be essentially dewatered by 2050 (Blandford et al. 2003). The 2007 State Water Plan, however, indicates that the rate of decline has slowed relative to previous decades, and water levels have risen in a few areas.

The GAM model predicted that the most critical depletions in the southern Ogallala Aquifer would be take place in Cochran, Hockley, Lubbock, Yoakum, Terry, and Gaines Counties where the simulated drawdown in the year 2050 would exceed 100 feet. For Andrews County, the simulated drawdown by the year 2050 would be moderate, typically less than 25 feet (Blandford, et al. 2003). The Ogallala Aquifer GAM was not run for the PWS system. Municipal water use by the system would represent a minor addition to regional withdrawal conditions, making potential changes in aquifer levels beyond the spatial resolution of the regional GAM model.

4.2.3 Potential for New Surface Water Sources

There is a minimum potential for development of new surface water sources for the City of Andrews PWS because of very limited water availability within the site vicinity, at the county level, and over the entire river basin.

The PWS is located in the upper reach of the Colorado Basin, within a relatively arid region of Texas with a low surface water yield. The 2007 update of Texas State Water Plan estimated that the average yield over the entire basin is 1.2 inches per year. Surface water rights are assigned primarily to municipal use and irrigation (66 and 25%, respectively). Over a 50-year planning period, the plan anticipates that availability will steadily decrease as a result of an increasing water demand. A projected 2010 surface water supply value of 1,110,000 AFY for the Colorado Basin is expected to decrease over 10 percent by the year 2060. This decrease takes into account the implementation of various long-term water management strategies proposed in the State Water Plan.

In Andrews County, nearly all water is provided by the Ogallala Aquifer, and primarily used for irrigation. The 2007 State Water Plan indicated that municipal water use is only a small fraction of county water needs. Over a 50-year planning period, the plan anticipates a moderate increase in municipal water use, from 671 AFY in 2010 to 773 AFY in the year 2060. Overall water demand, however, would decrease as a result of improved conservation measures reducing irrigation water use from 14,094 AFY projected for 2010 to 12,165 AFY by the year 2060.

The TWDB developed a surface water availability model for the Colorado Basin as a tool to determine, at a regional level, the maximum amount of water available during the drought of record over a simulation period. The model determines the percent of months of flow per year, regardless of whether the supply is physically or legally available. In the PWS vicinity, simulation data indicated that there is a minimum availability of surface water for new uses. Surface water availability maps developed by TCEQ for the Colorado Basin indicate that in the site vicinity, and in all of Andrews County, unappropriated flows for new applications are typically available 25 to 50 percent of the time. This potential availability is inadequate for development of new municipal water supplies as TCEQ requires a 100 percent year-round availability to consider new surface water source permit applications.

4.2.4 Options for Detailed Consideration

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

1. City of Midland. Treated water would be purchased from the City of Midland to be used by City of Andrews PWS. A pipeline would be constructed to convey water from the City of Midland to City of Andrews PWS (Alternative CA-1).

2. City of Odessa. Treated water would be purchased from the City of Odessa to be used by City of Andrews PWS. A pipeline would be constructed to convey water from the City of Odessa to City of Andrews PWS (Alternative CA-2).

3. New Wells at 10, 5, and 1 mile. Installing a new well within 10, 5, or 1 mile of the City of Andrews PWS may produce compliant water in place of the water produced by the existing active wells. A pipeline would be constructed to transfer the water to the City of Andrews PWS (Alternatives CA-3, CA-4, and CA-5).

4.3 TREATMENT OPTIONS

4.3.1 Centralized Treatment Systems

Centralized treatment of the well water is identified as a potential option. Both RO and EDR could be potentially applicable. The central RO treatment alternative is Alternative CA-6, and the central EDR treatment alternative is Alternative CA-7.

4.3.2 Point-of-Use Systems

POU treatment using RO technology is valid for fluoride and arsenic removal. The POU treatment alternative is CA-8.

4.3.3 Point-of-Entry Systems

POE treatment using RO technology is valid for fluoride and arsenic removal. The POE treatment alternative is CA-9.

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 CA-10, CA-11, and CA-12.

4.5 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives for compliance with the MCL for fluoride and arsenic were identified. Each potential alternative 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 the 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 are 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 CA-1: Purchase Treated Water from City of Odessa

This alternative involves purchasing compliant water from the City of Odessa, which would be used to supply City of Andrews. The City of Odessa currently has sufficient excess capacity for this alternative to be feasible. For purposes of this report, to allow direct and straightforward comparison with other alternatives, this alternative assumes that water would be purchased from the City. Also, it is assumed that City of Andrews would obtain all its water from the City of Odessa.

This alternative would require constructing a pipeline from a City of Odessa water main to the existing storage tank for the City of Andrews system. Five pump stations and 5,000 gallon feed tanks would be required to overcome pipe friction and elevation differences between the City of Odessa and the City of Andrews. The required pipeline would be 18 inches in diameter and would originate from the City of Odessa water elevated tank on Rainbow Drive where it would follow west onto E 91st Street. It would also flow north on US Hwy 385 and US Hwy.

385 Service Roads for approximately 26.5 miles. At the Andrews city limits the pipeline would follow east onto SE Mustang Drive/NE Mustang Drive where it would terminates at the intersection of NE Mustang Road and Moxley Drive. Using this route, the length of pipe required would be approximately 29 miles.

Each 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 City of Andrews, since the incremental cost would be relatively small, and would provide operational flexibility.

By definition, this alternative involves regionalization since the City of Andrews would be obtaining drinking water from an existing larger supplier. Also, other PWSs near City of Andrews 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 stations. The estimated O&M cost for this alternative includes the purchase price for the treated water minus the cost the City of Andrews currently pays to operate its well field, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump stations. The estimated capital cost for this alternative is $19.0 million, with an estimated annual O&M cost of $5.26 million. If the purchased water was used for blending rather than for the full water supply, the annual O&M cost for this alternative could be reduced because of reduced pumping costs and reduced water purchase costs. However, additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

The reliability of adequate amounts of compliant water under this alternative should be good. City of Odessa provides treated surface water on a large scale, facilitating adequate O&M resources. From the perspective of the City of Andrews, 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 City of Odessa to purchase treated drinking water.

4.5.2 Alternative CA-2: Purchase Treated Water from City of Midland

This alternative involves purchasing potable water from the City of Midland that will be used to supply the City of Andrews PWS. The City of Midland currently has sufficient excess capacity for this alternative to be feasible. It is assumed that the City of Andrews would obtain all its water from the City of Midland.

This alternative would require constructing a pipeline from a City of Midland water main to the existing storage tank for the City of Andrew PWS. Six pump stations and 5,000 gallon feed tanks would be required to overcome pipe friction and elevation differences between the

City of Midland and the City of Andrews. The required pipeline would be 18 inches in diameter and would originate from Midland passing through the intersection of State Hwy 191 and State Loop 250 and would follow west along State Hwy. 191. After following north onto State Hwy 158 and north onto Ranch Road 1788 (Telephone Road) for approximately 21 miles, the pipeline would flow onto State Hwy 176 before reaching north onto NE Mustang Drive where it would terminate at the intersection of Mustang Drive and Moxley Drive. Using this route, the length of pipe required would be approximately 38 miles.

The pump stations would each include two pumps, including one standby, and would be housed in a building. A 5,000 gallon feed 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 City of Andrews, since the incremental cost would be relatively small, and would provide operational flexibility.

By definition this alternative involves regionalization, since City of Andrews would be obtaining drinking water from an existing larger supplier. Also, other PWSs near City of Andrews 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 stations. 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 City of Andrew's wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump stations. The estimated capital cost for this alternative is $24.9 million, with an estimated annual O&M cost of $1.91 million. If the purchased water was used for blending rather than for the full water supply, the annual O&M cost for this alternative could be reduced because of reduced pumping costs and reduced water purchase costs. However, additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

The reliability of adequate amounts of compliant water under this alternative should be good. The City of Midland provides treated surface water on a large scale, facilitating adequate O&M resources. From the perspective of the City of Andrews PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pumps are well understood. If the decision were made to perform blending then the operational complexity would increase.

The feasibility of this alternative is dependent on an agreement being reached with the City of Midland to purchase treated drinking water.

4.5.3 Alternative CA-3: New Well at 10 miles

This alternative consists of installing five new wells within 10 miles of the City of Andrews 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 compliant well could be installed. An existing or new well would have to have a greater capacity than the existing wells.

This alternative would require constructing five new 320-foot wells, two new pump stations with 5,000 gallon feed tanks and a pipeline from the new well/feed tank to the existing intake point for the City of Andrews PWS. The estimated O&M cost for this alternative includes O&M for the pipeline and pump stations. The estimated capital cost for this alternative is $7.17 million, and the estimated annual O&M cost for this alternative is $219,200.

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 City of Andrews PWS, this alternative would be similar to operate as the existing system. City of Andrews 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 City of Andrews, so landowner cooperation would likely be required.

4.5.4 Alternative CA-4: New Well at 5 miles

This alternative consists of installing five new wells within 5 miles of the City of Andrews 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 existing wells or the location where new compliant wells could be installed. Existing or new wells would have to have greater capacity than the existing wells.

This alternative would require constructing five new 320-foot wells, a new pump station with a 5,000 gallon feed tank near the new well and a pipeline from the new well/feed tank to the existing intake point for the City of Andrews PWS. The pump stations and feed tanks would be necessary to overcome pipe friction and changes in elevation. For this alternative, the pipeline is assumed to be 18-inches in diameter, approximately 5 miles long, and would discharge to the existing storage tank at the City of Andrews PWS. Each pump station would include two transfer 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 $3.83 million and the estimated annual O&M cost for this alternative is $57,400.

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 City of Andrews PWS, this alternative would be similar to operate as the existing system. City of Andrews 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 City of Andrews, so landowner cooperation would likely be required.

4.5.5 Alternative CA-6: New Well at 1 mile

This alternative consists of installing five new wells within 1 mile of City of Andrews 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 existing compliant wells or the location where new compliant wells could be installed. Existing or new wells would have to have a greater capacity than the existing wells

This alternative would require constructing five new 320-foot wells, an 18-inch diameter, 1-mile pipeline from the new wells to the existing intake point at the City of Andrews system. Since the new well is relatively close, a pump station/feed tank near the well would not be necessary.

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, constructing the pipeline, and constructing the feed tank and booster pumps. The estimated O&M cost for this alternative includes O&M for the pipeline. The estimated capital cost for this alternative is $1.1 million, and the estimated annual O&M savings for this alternative is $106,300.

The reliability of adequate amounts of compliant water under this alternative should be good, since water wells and pipelines are commonly employed. From the perspective of the City of Andrews PWS, this alternative would be similar to operate as the existing system. City of Andrews 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 City of Andrews, so landowner cooperation may be required.

4.5.6 Alternative CA-6: Central RO Treatment

This system would continue to pump water from the existing wells, and would treat the water through RO treatment systems prior to distribution. In this case, two separate RO units would be required, one for each group of wells – Florey and University. For this option, 85 percent of the raw water would be treated in a slip stream to obtain compliant water. It is estimated the total RO reject generation would be approximately 600,000 gallons per day (gpd) when the systems are operated at the average daily consumption (2.2 mgd).

This alternative consists of constructing the RO treatment plants at the existing pumping stations at each well field. Each RO plant includes 4,800 square foot buildings with paved driveways; skids with the pre-constructed RO plants; two sets of two transfer pumps, and a 34,000-gallon tank at the University Field for storing the treated water. An existing tank at Florey Field would be reused for permeate water. The raw water from the wells would be pre-oxidized to convert AS(III) to AS(V) species upstream of the RO units. Treated water would be pumped to the Mustang (Central) Pump Station, and chlorinated, stored, and distributed as is currently done. Both well-field facilities would be fenced.

Reject water would be disposed of primarily through evaporation in a 73-acre evaporation pond at University Field and a 150-acre evaporation pond at the Florey Field. The evaporation pond sizes were based on a net evaporation of 40 inches per year. Costs for periodic removal and disposal of 10 percent of the generated brine are included in the cost estimate. It was assumed that the brine could be disposed of through deep well injection, with a 40 mile round trip distance.

The estimated capital cost for this alternative is $15.9 million, and the estimated annual O&M cost is $1.5 million.

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.

4.5.7 Alternative CA-7: Central EDR Treatment

The system would continue to pump water from the existing wells, and would treat the water through two EDR systems prior to distribution. In this case, as with RO, two separate EDR units would be required, one at each well field. For this option the EDR treatment units were considered to treat a slip stream of 84 percent of the full flow. EDR was also assumed to have an 82 percent recovery rate versus the 75 percent rate assumed for RO. It is estimated the EDR reject generation would be approximately 390,000 gpd when the system is operated at the average daily consumption (2.2 mgd).

This alternative consists of constructing the EDR treatment plants near the existing ground storage tanks. Each EDR plant includes a 3,200 square foot building with a paved driveway; a skid with the pre-constructed EDR system; two sets of transfer pumps; and a 34,000-gallon tank at the University Field for storing the treated water. An existing tank at Florey Field would be reused for permeate water. The raw water from the wells would be pre-oxidized to convert AS(III) to AS(V) species upstream of the RO units. Treated water would be pumped to the Mustang (Central) Pump Station, and chlorinated, stored, and distributed as is currently done. Both well-field facilities would be fenced.

Reject water would be disposed of primarily through evaporation in a 50-acre evaporation pond at University Field and a 100-acre evaporation pond at the Florey Field. The evaporation pond sizes were based on a net evaporation of 40 inches per year. Costs for periodic removal and disposal of 10 percent of the generated brine are included in the cost estimate. It was assumed that the brine could be disposed of through deep well injection, with a 40 mile round trip distance.

The estimated capital cost for this alternative is $15.2 million and the estimated annual O&M cost is $2.3 million.

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.

4.5.8 Alternative CA-8: Point-of-Use Treatment

This alternative consists of the continued operation of the City of Andrews well fields, plus treatment of water to be used for drinking or food preparation at the point of use to remove fluoride and 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. City of Andrews staff would be responsible for purchase and maintenance of the treatment units, including 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 City of Andrews 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 for access without house entry, but that would complicate the installation and increase costs.

Treatment processes would involve RO. Treatment processes produce a reject waste stream. The reject waste streams result in a slight increase in the overall volume of water used. POU systems have the advantage that only a minimum volume of water is treated (only that 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 can be discharged to the house septic or sewer system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the POU treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and membranes, as well as periodic sampling and record keeping as required by the Texas Administrative Code (Title 30, Part I, Chapter 290, Subchapter F, Rule 290.106). The estimated capital cost for this alternative is $2.63 million, and the estimated annual O&M cost for this alternative is $2.46 million. For the cost estimate, it is assumed that one POU treatment unit will be required for each of the 4,420 connections in the City of Andrews. It should be noted that POU treatment units would need to be more complex than units typically found in commercial retail outlets to meet regulatory requirements, making purchase and installation more expensive. Additionally, capital cost would increase if POU treatment units are placed at other taps within a home, such as refrigerator water dispensers, ice makers, and bathroom sinks. In school settings, all taps where children and faculty receive water may need POU treatment units or clearly mark those taps suitable for human consumption. Additional considerations may be necessary for preschools or other establishments where individuals cannot read.

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 (including monitoring of the devices to ensure adequate performance) required for the POU systems will be significant, and the current personnel are inexperienced in this type of work. From the perspective of the City of Andrews PWS, 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.

4.5.9 Alternative CA-9: Point-of-Entry Treatment

This alternative consists of the continued operation of the City of Andrews well fields, plus treatment of water as it enters residences to remove fluoride and 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. Every building connected to the system must have a POE device installed, maintained, and adequately monitored. TCEQ must be assured the system has 100 percent participation of all property and or building owners. A way to achieve 100 percent participation is through a public announcement and education program.

Example public programs are provided in the document "*Point-of-Use or Point-of-Entry" Treatment Options for Small Drinking Water Systems*" published by USEPA. The property owner's responsibilities for the POE device must also be contained in the title to the property and "run with the land" so subsequent property owners understand their responsibilities (USEPA 2006).

City of Andrews would be responsible for purchase, operation, and maintenance of the treatment units, including 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.

POE treatment for fluoride and arsenic would involve RO. Treatment processes produce a reject stream that requires disposal. The reject water stream results in a slight increase in 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 backwash reject waste stream can be discharged to the house septic or sewer system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the POE treatment systems. The estimated O&M cost for this alternative includes the purchase and replacement of filters and membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $69.2 million, and the estimated annual O&M cost for this alternative is $9.79 million. For the cost estimate, it is assumed that one POE treatment unit will be required for each of the 4,420 existing connections to the City of Andrews 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 City of Andrews, 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.

4.5.10 Alternative CA-10: Public Dispenser for Treated Drinking Water

This alternative consists of the continued operation of the City of Andrews PWS and current public dispenser plus additional dispensers of treated water for drinking and cooking at other publicly accessible locations. Implementing this alternative would require purchasing and installing twenty treatment units 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 compliance alternative is implemented.

City of Andrews 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 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 $367,100, and the estimated annual O&M cost for this alternative is $713,200.

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. City of Andrews has not provided this type of service in the past. From City of Andrews' perspective this alternative would be characterized as relatively easy to operate, since these types of treatment units are highly automated, and there are twenty units.

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

4.5.11 Alternative CA-11: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the City of Andrews wells, but compliant drinking water will be delivered to customers in containers. This alternative involves setting up and operating a bottled water delivery program to serve all customers in the system. It is expected that City of Andrews 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 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 City of Andrews 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 $27,600, and the estimated annual O&M cost for this alternative is $4.43 million. 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 City of Andrews.

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

4.5.12 Alternative CA-12: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the City of Andrews wells, plus dispensing compliant water for drinking and cooking at a publicly accessible location. The compliant water would be purchased from the cities of Midland and Odessa 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 compliance alternative is implemented.

City of Andrews would purchase a truck 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 $205,800, and the estimated annual O&M cost for this alternative is $52,600.

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 city of Andrews, 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.

4.5.13 Summary of Alternatives

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

Table 4.3 Summary of Compliance Alternatives for City of Andrews PWS

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
CA-1	Purchase water from the City of Odessa	- Five pump stations/feed tanks - 29-mile pipeline	$ 18,950,000	$ 5,257,500	$ 6,910,000	Good	N	Agreement must be successfully negotiated with the City of Odessa,. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
CA -2	Purchase water from the City of Midland	- Six pump stations/feed tanks - 38-mile pipeline	$ 24,891,500	$ 1,912,500	$ 4,082,500	Good	N	Agreement must be successfully negotiated with City of Midland. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
CA -3	Install new compliant wells within 10 miles	- New well - Pump stations/feed tanks - 10-mile pipeline	$ 7,166,000	$ 219,500	$ 844,000	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
CA -4	Install new compliant wells within 5 miles	- New well - Pump station/feed tank - 5-mile pipeline	$ 3,830,000	$ 57,400	$ 391,300	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
CA -5	Install new compliant wells within 1 mile	- New well - 1-mile pipeline	$ 1,097,500	$ (106,300)	$ (10,600)	Good	N	May be difficult to find well with good water quality.
CA -6	Continue operation of Andrews wells with central RO treatment	- Central RO treatment plant	$ 15,940,000	$ 1,464,000	$ 2,854,000	Good	T	No nearby system to possibly share treatment plant cost.
CA -7	Continue operation of Andrews wells with EDR treatment	- Central EDR treatment plant	$ 15,233,500	$ 2,303,500	$ 3,631,500	Good	T	No nearby system to possibly share treatment plant cost.
CA -8	Continue operation of Andrews wells, and POU treatment	- POU treatment units.	$ 2,625,500	$ 2,457,500	$ 2,686,500	Fair	T, M	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing.
CA -9	Continue operation of Andrews wells, and POE treatment	- POE treatment units.	$ 69,247,000	$ 9,790,500	$ 15,827,500	Fair (*better than POU*)	T, M	All home taps compliant and less resident cooperation required.
CA -10	Continue operation of Andrews wells, but furnish public dispenser for treated drinking water	- Water treatment and dispenser unit	$ 367,100	$ 713,200	$ 745,200	Fair/interim measure	T	Does not provide compliant water to all taps, and requires a lot of effort by customers.
CA -11	Continue operation of Andrews wells, but furnish bottled drinking water for all customers	- Set up bottled water system	$ 27,600	$ 4,430,500	$ 4,433,000	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.

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
CA -12	Continue operation of Andrews wells, but furnish public dispenser for trucked drinking water	- Construct storage tank and dispenser - Purchase potable water truck	$ 205,800	$ 52,600	$ 70,600	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. The City of Andrews PWS serves a total population of 9,652 and has 4,420 connections. Information that was used to complete the financial analysis was based on annual maintenance fees for revenues and expenses.

This analysis will need to be performed in a more detailed fashion and applied to alternatives 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,
- Costs for other system upgrades and rehabilitation needed to maintain compliant operation.

4.6.1 Financial Plan Development

Expenses for the City of Andrews PWS were derived from the "Comprehensive Annual Financial Report of the City of Andrews, Texas" for the fiscal year ending September 30, 2008. The financial documents obtained included numbers that combined water and wastewater operations. For the financial model, water system expenses were proportioned at the same ratio as the system revenues. A total of 947 million gallons of water were sold in FY2008, with water service annual revenues of $1,525,606. Direct water service expenses were estimated to $1,493,404. These values as well as other financial data were entered into the financial model.

4.6.2 Current Financial Condition

4.6.2.1 Cash Flow Needs

Using the annual revenue as noted above, the current average annual water bill for the City of Andrews PWS customers is estimated at $345 or about 1.38 percent of the City of Andrews Block Group median household income of $25,057, as given in the 2000 Census.

The long-term financial plan indicates that City of Andrews rates are currently high enough to maintain operations for the next several years. The City of Andrews may need to raise rates in the future to service the debt associated with any capital improvements for the various alternatives that may be implemented to address compliance issues.

4.6.2.2 Ratio Analysis

Current Ratio = 18.1

The Current Ratio is a measure of liquidity. It is defined as the ratio of current assets to current liabilities. Current liabilities are defined as all debt due within 1 year. A Current Ratio of 18.1 indicates that the City of Andrews PWS would be able to meet all its current obligations, with total current assets of $20,781,116 exceeding the current liabilities of $1,148,234.

Debt to Net Worth Ratio = 0.02

A Debt to Net Worth ratio is another measure of financial liquidity and stability. The City of Andrews PWS has a net worth of $36,861,901, and a total debt of $902,585, resulting in a debt to net worth ratio of 0.02. Ratios less than 1.25 are indicative of financial stability, with lower ratios indicating greater financial stability and better credit risks for future borrowings. Based on the present ratio, the City of Andrews PWS is two orders of magnitude below the suggested threshold for financially stability indicating strong financial stability.

Operating Ratio = 1.34

The Operating Ratio is a financial term defined as a company's revenues divided by the operating expenses. For this calculation water service related revenues and expenses, including interest income, connections fees, debt service, and other sources (uses) for sustained operations. An operating ratio of 1.0 means that a utility is collecting just enough money to meet expenses. In general, an operating ratio of 1.25 or higher is desirable. An operating ratio of 1.34 indicates that the City of Andrews PWS does not need to raise further water rates for its customers, based on financial estimates and the no action alternative.

4.6.3 Financial Plan Results

Each of the compliance alternatives for the City of Andrews 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 Section 2.4.

Results of the financial impact analysis are provided in Table 4.4 and Figure 4.2. Table 4.4 and Figure 4.2 present rate impacts assuming that revenues match expenses, without funding reserve accounts, and that operations and implementation of compliance alternatives are funded with revenue and are not paid for from reserve accounts. Figure 4.2 provides a bar chart that, in terms of the yearly billing to an average customer (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.

4.6.4 Evaluation of Potential Funding Options

There are a variety of funding programs available to entities as described in Section 2.4. The City of Andrews PWS is most likely to obtain funding from programs administered by the TWDB, ORCA, and Rural Development. This report contains information that would be used for an application for funding. Information such as financial analyses, water supply assessment, and records demonstrating health concerns, failing infrastructure, and financial need, may be required by these agencies. This section describes the candidate funding agencies and their appropriate programs as well as information and steps needed to begin the application process.

This report should serve to document the existing water quality issues, infrastructure need and costs, and water system information needed to begin the application process. Although this report is at the conceptual level, it demonstrates that significant funding will be needed to meet Safe Drinking Water Standards. The information provided in this report may serve as the needed documentation to justify a project that may only be possible with significant financial assistance.

4.6.4.1 TWDB Funding Options

TWDB programs include the Drinking Water State Revolving Fund (DWSRF), Rural Water Assistance Fund, State Loan Program (Development Fund II), and Economically Distressed Areas Program (EDAP). Additional information on these programs can be found online at the TWDB website under the Assistance tab, Financial Assistance section, under the Public Works Infrastructure Construction subsection.

Drinking Water State Revolving Fund

The DWSRF offers net long-term interest lending rates below the rate the borrower would receive on the open market for a period no longer than 20 years. A cost-recovery loan origination charge is imposed to cover the administrative costs of operating the DWSRF, but an additional interest rate subsidy is offered to offset the charge. The terms of the loan typically require a revenue or tax pledge. The DWSRF program can provide funds from State sources or Federal capitalization grants. State loans provide a net long-term interest rate of 0.7 percentage points below the rate the borrower would receive on the open market at the time of loan closing and Federal Capitalization Grants provide a lower net long-term interest rate of 1.2 percentage points. "Disadvantaged communities" may obtain loans at even greater subsidies and up to a 30-year loan term.

The loan application process has several steps: pre-application, application and commitment, loan closing, funding and construction monitoring, and any other special requirements. In the pre-application phase, prospective loan applicants are asked to submit a brief DWSRF Information Form to the TWDB that describes the applicant's existing water facilities, additional facility needs and the nature of projects being considered for meeting those needs, project cost estimates, and "disadvantaged community" status. The TCEQ assigns a priority rating that includes an applicant's readiness to proceed. TWDB staff notifies prospective applicants of their priority rating and encourage them to schedule a pre-planning conference for guidance in preparing the engineering, planning, environmental, financial, and water conservation portions of the DWSRF application.

Rural Water Assistance Fund

Small rural water utilities can finance water projects with attractive interest rate loans with short and long-term finance options at tax exempt rates. Funding through this program gives an added benefit to nonprofit WSCs because construction purchases can qualify for a sales tax exemption. Rural Political Subdivisions are eligible (nonprofit WSCs; water districts or municipalities serving a population of up to 10,000; and counties in which no urban area has a population exceeding 50,000). A nonprofit WSC is eligible to apply these funds for design and construction of water projects. Projects can include line extensions, elevated storage, the purchase of well fields, the purchase or lease of rights to produce groundwater, and interim financing of construction projects. The fund may also be used to enable a rural water utility to obtain water service supplied by a larger utility or to finance the consolidation or regionalization of a neighboring utility.

A maximum financing life is 50 years for projects. The average financing period is 20 to 23 years. System revenues and/or tax pledges are typically required. The lending rate is set in accordance with the TWDB rules in 31 TAC 384.5 and the scale varies according to the length of the loan and several factors. The TWDB seeks to provide reasonable rates for its customers with minimal risk to the state. The TWDB posts rates for comparison for applicants, and in August 2009 the TWDB showed its rates for a 22-year, taxable loan at 7.07 percent, where the market was at 8.47 percent. Funds in this program are not restricted.

The TWDB's Office of Project Finance and Construction Assistance staff can discuss the terms of the loan and assist applicants during preparation of the application, and this is encouraged. The application materials must include an engineering feasibility report, environmental information, rates and customer base, operating budgets, financial statements, and project information. The TWDB considers the needs of the area; benefits of the project; the relationship of the project to the overall state water needs; relationship of the project to the State Water Plan; and availability of all sources of revenue to the rural utility for the ultimate repayment of the water supply project cost. The board considers applications monthly.

State Loan Program (Development Fund II)

The State Loan Program is a diverse lending program directly from state funding sources. As it does not receive federal subsidies, it is more streamlined. The loans can incorporate more than one project under the umbrella of one loan. Water supply corporations are eligible, but will have taxable rates. Projects can include purchase of water rights, treatment plants, storage and pumping facilities, transmission lines, well development, and acquisitions.

The loan requires that the applicant pledge revenue or taxes, as well as some collateral for The City of Andrews PWS. The maximum financing life is 50 years. The average financing period is 20 to 23 years. The interest rate is set in accordance with the TWDB rules in 31 TAC 363.33(a). The TWDB seeks to provide reasonable rates with minimal risk to the state. The TWDB post rates for comparison for applicants and in August 2009, the TWDB showed their rates for a 22-year, taxable loan at 7.07 percent where the market was at 8.47 percent.

The TWDB staff can discuss the terms of the loan and assist applicants during preparation of the application, and a preapplication conference is encouraged. The application materials must include an engineering feasibility report, environmental information, rates and customer base, operating budgets, financial statements, and project information. The board considers applications monthly.

Economically Distressed Areas Program

The EDAP Program was designed to assist areas along the U.S./Mexico border in areas that were economically distressed. In 2008, this program was extended to apply to the entire state so long as requirements are met. This program provides financial assistance through the provision of grants and loans to communities where present facilities are inadequate to meet minimal residential needs. Eligible communities are those that have median household income less than 75 percent of the state household income. The applicant must be capable of maintaining and operating the completed system, and hold or be in the process of obtaining a Certificate of Convenience and Necessity. The county where the project is located must adopt model rules for the regulation of subdivisions prior to application for financial assistance. If the applicant is a city, the city must also adopt Model Subdivision Rules of TWDB (31 Texas Administrative Code Chapter 364). The program funds planning, design, construction, and acquisition. Up to 75 percent funding is available for facility plans with certain hardship cases 100 percent funding may be available. Projects must complete the planning, acquisition, and design phase before applying for second phase construction funds. The TWDB works with the applicant to find ways to leverage other state and federal financial resources. For grant fund above 50 percent, the Texas Department of State Health Services must determine if there is a health and safety nuisance.

The loan requires that the applicant pledge revenue or taxes, as well as some collateral for the City of Andrews PWS. The maximum financing life is 50 years. The average financing period is 20 to 23 years. The lending rate scale varies according to several factors but is set by the TWDB in accordance with the TWDB rules in 31 TAC 363.33(a). The TWDB seeks to provide reasonable rates with minimal loss to the state. The TWDB posts rates for comparison for applicants and in August 2009 the TWDB showed its rates for a 22-year, tax exempt loan at

5.05 percent where the market was at 6.05 percent. Most projects have a financial package with the majority of the project financed with grants. Many have received 100 percent grants.

The first step in the application process is to meet with TWDB staff to discuss the terms of the loan and assist applicants during preparation of the application. Major components of the application materials must include an engineering feasibility report, environmental information, rates and customer base, operating budgets, financial statements, community information, project information, and other legal information.

4.6.4.2 ORCA Funding Options

Created in 2001, ORCA seeks to strengthen rural communities and assist them with community and economic development and healthcare by providing a variety of rural programs, services, and activities. Of their many programs and funds, the most appropriate programs related to drinking water are the Community Development (CD) Fund and the Texas Small Towns Environment Program. These programs offer attractive funding packages to help make improvements to potable water systems to mitigate potential health concerns. These programs are available to counties and cities, which have to submit an ORCA application on behalf of the WSC. All program requirements would have to be met by the benefiting community receiving services by the WSC.

Community Development Fund

The CD Fund is a competitive grant program for water system improvements as well as other utility services (wastewater, drainage improvements, and housing activities). Funds are distributed between 24 state planning regions where funds are allocated to address each region's utility priorities. Funds can be used for various types of public works projects, including water system improvements. Communities with a population of less than 50,000 that are not eligible for direct CDBG funding from the U.S. Department of Housing and Urban Development are eligible. Funds are awarded on a competitive basis decided twice a year in each region by local elected officials, appointed by the Governor using a defined scoring system (past performance with CDBG is a factor). Awards are no less then $75,000 and cannot exceed $800,000. More information can be found at the Office of Community Affairs website under Community Development Fund.

Texas Small Towns Environment Program

Under special occasions some communities are invited to participate in grant programs when self-help is a feasible method for completing a water project, the community is committed to self-help, and the community has the capacity to complete the project. The purpose is to significantly reduce the cost of the project by using the communities' own human, material, and financial capital. Communities with a population of less than 50,000 that are not eligible for direct CDBG funding from the U.S. Department of Housing and Urban Development are eligible. Projects typically are repair, rehabilitation, improvements, service connections, and yard services. Reasonable associated administration and engineering cost can be funded. A letter of interest is first submitted, community meetings are held, and after CDBG staff determine eligibility with a written invitation to apply, an application may be submitted. Awards are only given twice per year on a priority basis so long as the project can be fully funded ($350,000 maximum award). Ranking criteria are project impact, local effort, past performance, percent of savings, and benefit to low to medium-income persons.

4.6.4.3 Rural Development

The RUS agency of Rural Development established Water and Waste Disposal Program for public entities administered by the staff of the Water and Environment Program to assist communities with water and wastewater systems. The purpose is to fund technical assistance and projects to help communities bring safe drinking water and sanitary, environmentally sound, waste disposal facilities to rural Americans in greatest need.

The Water and Waste Disposal Program provides loans, grants, and loan guarantees for drinking water, sanitary sewer, solid waste, and storm drainage facilities in rural areas and cities and towns with a population of 10,000 people and rural areas with no population limits. Recipients must be public entities such as municipalities, counties, special purpose districts, Indian tribes, and non-profit corporations. RUS has set aside direct loans and grants for several areas (e.g., empowerment zones). Projects include all forms of infrastructure improvement, acquisition of land and water rights, and design fees. Funds are provided on a first come, first serve basis; however, staff do evaluate need and assign priorities as funds are limited. Grant/loan mixes vary on a case by case basis and some communities may have to wait though several funding cycles until funds become available.

Entities must demonstrate that they cannot obtain reasonable loans at market rates, but have the capacity to repay loans, pledge security, and operate the facilities. Grants can be up to 75 percent of the project costs, and loan guarantees can be up to 90 percent of eligible loss. Loans are not to exceed a 40-year repayment period, require tax or revenue pledges, and are offered at three rates:

- Poverty Rate - The lowest rate is the poverty interest rate of 4.5 percent. Loans must be used to upgrade or construct new facilities to meet health standards, and the MHI in the service area must be below the poverty line for a family of four or below 80 percent of the statewide MHI for non-metropolitan communities.

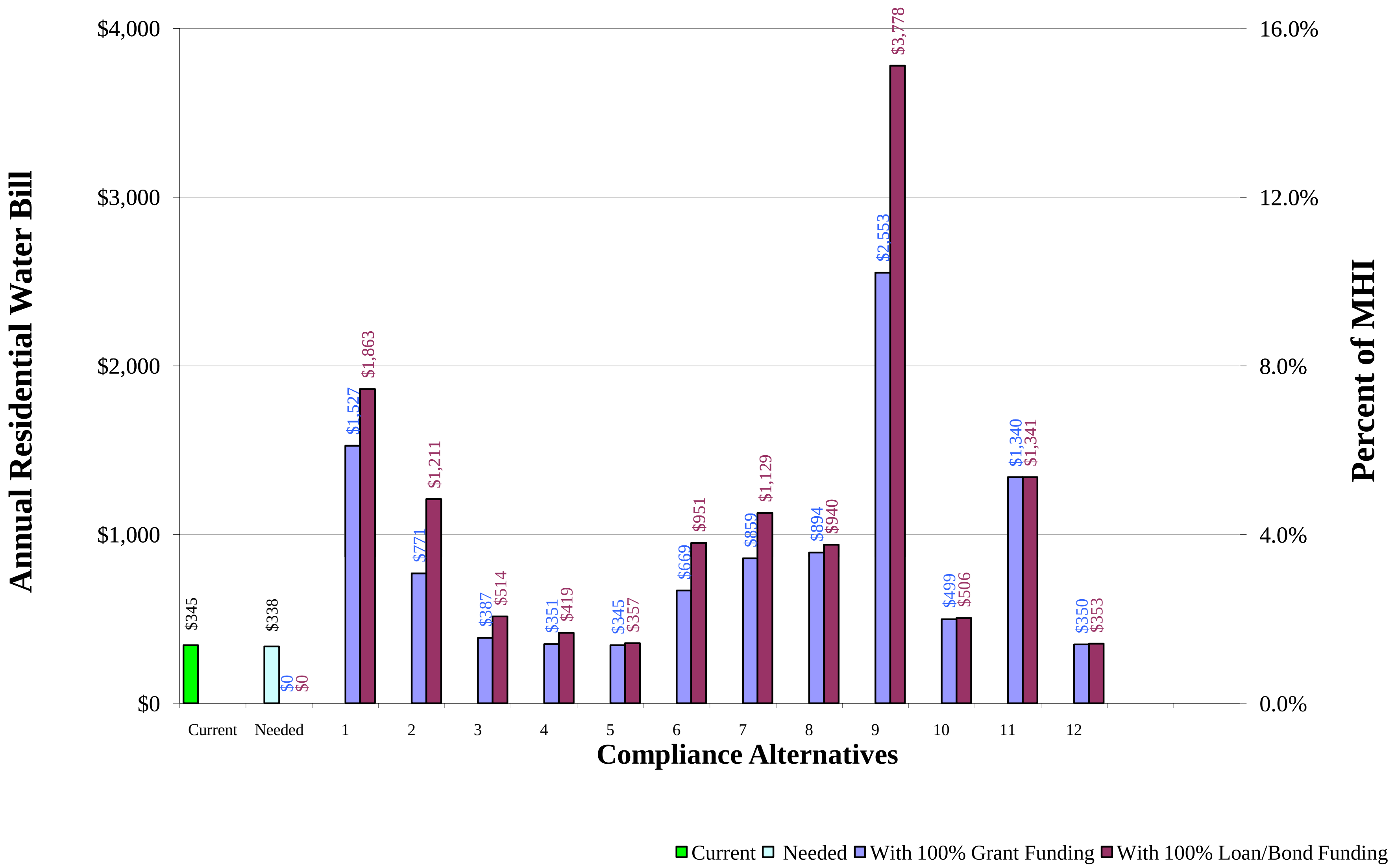
- Market Rate – Where the MHI in the service exceeds the state MHI, the rate is based on the average of the “Bond Buyer” 11-Bond Index over a four week period.

- Intermediate Rate – the average of the Poverty Rate and the Market Rate, but not to exceed seven percent.

Table 4.4 Financial Impact on Households for City of Andrews PWS

#		Funding Source #	0	1	2	3	4	5
	ALTERNATIVES		All Revenue	100% Grant	75% Grant	50% Grant	State Revolving Fund	Loan/Bond
CA-1	Purchase Water from City of Odessa	Maximum % of MHI	18.5%	6.1%	6.4%	6.8%	7.0%	7.4%
		Percentage Rate Increase Compared to Current	1240%	343%	367%	391%	405%	440%
		Average Annual Water Bill	$4,625	$1,527	$1,611	$1,695	$1,742	$1,863
CA-2	Purchase Water from City of Midland	Maximum % of MHI	23.8%	3.1%	3.5%	4.0%	4.2%	4.8%
		Percentage Rate Increase Compared to Current	1629%	123%	155%	187%	205%	251%
		Average Annual Water Bill	$5,969	$771	$881	$991	$1,052	$1,211
CA-3	New Well at 10 Miles	Maximum % of MHI	7.8%	1.5%	1.7%	1.8%	1.9%	2.1%
		Percentage Rate Increase Compared to Current	468%	12%	21%	31%	36%	49%
		Average Annual Water Bill	$1,959	$387	$419	$451	$469	$514
CA-4	New Well at 5 Miles	Maximum % of MHI	4.8%	1.4%	1.5%	1.5%	1.6%	1.7%
		Percentage Rate Increase Compared to Current	249%	2%	7%	11%	14%	21%
		Average Annual Water Bill	$1,204	$351	$368	$385	$394	$419
CA-5	New Well at 1 Mile	Maximum % of MHI	2.3%	1.4%	1.4%	1.4%	1.4%	1.4%
		Percentage Rate Increase Compared to Current	70%	0%	0%	1%	1%	4%
		Average Annual Water Bill	$586	$345	$345	$348	$350	$357
CA-6	Central Treatment - RO	Maximum % of MHI	15.7%	2.7%	3.0%	3.2%	3.4%	3.8%
		Percentage Rate Increase Compared to Current	1043%	94%	114%	135%	146%	176%
		Average Annual Water Bill	$3,944	$669	$740	$810	$849	$951
CA-7	Central Treatment - EDR	Maximum % of MHI	15.1%	3.4%	3.7%	4.0%	4.1%	4.5%
		Percentage Rate Increase Compared to Current	996%	149%	168%	188%	199%	227%
		Average Annual Water Bill	$3,784	$859	$926	$994	$1,031	$1,129
CA-8	POU Treatment Units	Maximum % of MHI	3.7%	3.6%	3.6%	3.7%	3.7%	3.8%
		Percentage Rate Increase Compared to Current	170%	159%	162%	166%	168%	172%
		Average Annual Water Bill	$932	$894	$905	$917	$924	$940
CA-9	POE Treatment Units	Maximum % of MHI	63.9%	10.2%	11.4%	12.6%	13.3%	15.1%
		Percentage Rate Increase Compared to Current	4537%	640%	728%	817%	867%	995%
		Average Annual Water Bill	$16,005	$2,553	$2,859	$3,166	$3,336	$3,778
CA-10	Public Dispenser for Treated Drinking Water	Maximum % of MHI	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

#		Funding Source #	0	1	2	3	4	5
	ALTERNATIVES		All Revenue	100% Grant	75% Grant	50% Grant	State Revolving Fund	Loan/Bond
		Percentage Rate Increase Compared to Current	45%	45%	45%	46%	46%	47%
		Average Annual Water Bill	$499	$499	$501	$502	$503	$506
CA-11	Supply Bottled Water to 100% of Population	Maximum % of MHI	5.3%	5.3%	5.3%	5.3%	5.4%	5.4%
		Percentage Rate Increase Compared to Current	288%	288%	288%	288%	288%	288%
		Average Annual Water Bill	$1,340	$1,340	$1,340	$1,341	$1,341	$1,341
CA-12	Central Trucked Drinking Water	Maximum % of MHI	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%
		Percentage Rate Increase Compared to Current	11%	1%	2%	2%	2%	2%
		Average Annual Water Bill	$384	$350	$351	$352	$352	$353


Annual Residential Water Bill
Percent of MHI
$4,000
$3,000
$2,000
$1,000
$0
16.0%
12.0%
8.0%
4.0%
0.0%
$345
$338
$0
$0
$1,527
$1,863
$771
$1,211
$387
$514
$351
$419
$345
$357
$669
$951
$859
$1,129
$894
$940
$2,553
$3,778
$499
$506
$1,340
$1,341
$350
$353
Current
Needed
1
2
3
4
5
6
7
8
9
10
11
12
Compliance Alternatives
Current
Needed
With 100% Grant Funding
With 100% Loan/Bond Funding

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 2008 RS Means Site Work & Landscape Cost Data. The number of borings and encasements and open cuts and encasements is 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 that gate valves and flush valves would be installed, on average, every 5,000 feet along the pipeline. Pipeline cost estimates are based on the use of C-900 PVC 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 include two pumps, station piping and valves, station electrical and instrumentation, minor site improvement, installation of a concrete pad, fence and building, and tools. The number of pump stations is based on calculations of pressure losses in the proposed pipeline for each alternative. Back-flow prevention is required in cases where pressure losses are negligible, and pump stations are not needed. Construction cost of a storage tank is based on consultations with vendors and 2007 RS Means Site Work & Landscape Cost Data.

Labor costs are estimated based on 2008 RS Means Site Work & Landscape Cost Data specific to the Lubbock County region.

Electrical power cost is estimated to be $0.083 per kWH, as supplied by TXU

. 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 2009 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 2009 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 2009 dollars based on the ENR construction cost index.

The purchase price for point-of-use (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 point-of-entry (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 a 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 each week, and that chlorine residual would be determined for each truck load.

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.12. 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 ***City of Andrews***
Alternative Name ***Purchase Water from Odessa***
Alternative Number ***Alt-1***

Distance from Alternative to PWS (along pipe)	29.1	miles
Total PWS annual water usage	947.175	MG
Treated water purchase cost	$ 4.93	per 1,000 gals
Pump Stations needed w/ 1 feed tank each	5	
On site storage tanks / pump sets needed	0	

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	41	n/a	n/a	n/a
HDPE water line, SDR 21, 18"	153,856	LF	$ 72	$ 11,037,112
Bore and encasement, 18"	600	LF	$ 535	$ 321,000
Open cut and encasement, 18"	2,050	LF	$ 150	$ 307,500
Gate valve and box, 18"	31	EA	$ 10,200	$ 313,877
Air valve	42	EA	$ 2,110	$ 88,620
Flush valve	31	EA	$ 1,055	$ 32,464
Metal detectable tape	153,856	LF	$ 2	$ 307,712
Subtotal				**$ 12,408,284**
Pump Station(s) Installation				
Pump	10	EA	$ 8,230	$ 82,300
Pump Station Piping, 18"	5	EA	$ 8,359	$ 41,797
Gate valve, 18"	20	EA	$ 10,200	$ 204,007
Check valve, 18"	10	EA	$ 9,945	$ 99,453
Electrical/Instrumentation	5	EA	$ 10,550	$ 52,750
Site work	5	EA	$ 2,635	$ 13,175
Building pad	5	EA	$ 5,275	$ 26,375
Pump Building	5	EA	$ 10,550	$ 52,750
Fence	5	EA	$ 6,330	$ 31,650
Tools	5	EA	$ 1,055	$ 5,275
5,000 gal feed tank	5	EA	$ 10,250	$ 51,250
100,000 gal ground storage tank	-	EA	$ 102,900	$ -
Backflow Preventor	-	EA	$ 34,756	$ -
Subtotal				**$ 660,782**
Subtotal of Component Costs				**$ 13,069,066**
Contingency	20%			$ 2,613,813
Design & Constr Management	25%			$ 3,267,267
TOTAL CAPITAL COSTS				**$ 18,950,146**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	29.1	mile	$ 285	$ 8,305
Subtotal				**$ 8,305**
Water Purchase Cost				
From PWS	947,175	1,000 gal	$ 4.93	$ 4,669,573
Subtotal				**$ 4,669,573**
Pump Station(s) O&M				
Building Power	59,000	kWH	$ 0.083	$ 4,897
Pump Power	9,416,557	kWH	$ 0.083	$ 781,574
Materials	5	EA	$ 1,585	$ 7,925
Labor	1,825	Hrs	$ 62.00	$ 113,150
Tank O&M	-	EA	$ 1,055	$ -
Backflow Test/Cert	-	EA	$ 110	$ -
Subtotal				**$ 907,546**
O&M Credit for Existing Well Closure				
Pump power	1,186,449	kWH	$ 0.083	$ (98,475)
Well O&M matl	18	EA	$ 1,585	$ (28,530)
Well O&M labor	3,240	Hrs	$ 62.00	$ (200,880)
Subtotal				**$ (327,885)**
TOTAL ANNUAL O&M COSTS				**$ 5,257,538**

Table C.2

PWS Name *City of Andrews*
Alternative Name *Purchase Water from Midland*
Alternative Number *Alt-2*

Distance from Alternative to PWS (along pipe)	37.7	miles
Total PWS annual water usage	947.175	MG
Treated water purchase cost	$ 1.09	per 1,000 gals
Pump Stations needed w/ 1 feed tank each	6	
On site storage tanks / pump sets needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	9	n/a	n/a	n/a
Number of Crossings, open cut	30	n/a	n/a	n/a
HDPE water line, SDR 21, 18"	198,898	LF	$ 72	$ 14,268,274
Bore and encasement, 18"	1,800	LF	$ 535	$ 963,000
Open cut and encasement, 18"	1,500	LF	$ 150	$ 225,000
Gate valve and box, 18"	40	EA	$ 10,200	$ 405,765
Air valve	34	EA	$ 2,110	$ 71,740
Flush valve	40	EA	$ 1,055	$ 41,967
Metal detectable tape	198,898	LF	$ 2	$ 397,796
Subtotal				**$ 16,373,543**
Pump Station(s) Installation				
Pump	12	EA	$ 8,230	$ 98,760
Pump Station Piping, 18"	6	EA	$ 8,359	$ 50,156
Gate valve, 18"	24	EA	$ 10,200	$ 244,808
Check valve, 18"	12	EA	$ 9,945	$ 119,344
Electrical/Instrumentation	6	EA	$ 10,550	$ 63,300
Site work	6	EA	$ 2,635	$ 15,810
Building pad	6	EA	$ 5,275	$ 31,650
Pump Building	6	EA	$ 10,550	$ 63,300
Fence	6	EA	$ 6,330	$ 37,980
Tools	6	EA	$ 1,055	$ 6,330
5,000 gal feed tank	6	EA	$ 10,250	$ 61,500
100,000 gal ground storage tank	-	EA	$ 102,900	$ -
Backflow Preventor	-	EA	$ 34,756	$ -
Subtotal				**$ 792,939**
Subtotal of Component Costs				**$ 17,166,481**
Contingency	20%			$ 3,433,296
Design & Constr Management	25%			$ 4,291,620
TOTAL CAPITAL COSTS				**$ 24,891,398**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	37.7	mile	$ 285	$ 10,736
Subtotal				**$ 10,736**
Water Purchase Cost				
From PWS	947,175	1,000 gal	$ 1.09	$ 1,032,421
Subtotal				**$ 1,032,421**
Pump Station(s) O&M				
Building Power	70,800	kWH	$ 0.083	$ 5,876
Pump Power	12,525,660	kWH	$ 0.083	$ 1,039,630
Materials	6	EA	$ 1,585	$ 9,510
Labor	2,190	Hrs	$ 62.00	$ 135,780
Tank O&M	6	EA	$ 1,055	$ 6,330
Backflow Test/Cert	0	EA	$ 110	$ -
Subtotal				**$ 1,197,126**
O&M Credit for Existing Well Closure				
Pump power	1,186,449	kWH	$ 0.083	$ (98,475)
Well O&M matl	18	EA	$ 1,585	$ (28,530)
Well O&M labor	3,240	Hrs	$ 62	$ (200,880)
Subtotal				**$ (327,885)**
TOTAL ANNUAL O&M COSTS				**$ 1,912,398**

Table C.3

PWS Name	***City of Andrews***
Alternative Name	***New Well at 10 Miles***
Alternative Number	***Alt-3***

Distance from PWS to new well location	10.0	miles
Estimated well depth	320	feet
Number of wells required	5	
Well installation cost (location specific)	$155	per foot
Pump Stations needed w/ 1 feed tank each	2	
On site storage tanks / pump sets needed	0	

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
HDPE water line, SDR 21, 18"	52,800	LF	$ 72	$ 3,787,694
Bore and encasement, 18"	400	LF	$ 535	$ 214,000
Open cut and encasement, 18"	550	LF	$ 150	$ 82,500
Gate valve and box, 18"	11	EA	$ 10,200	$ 107,716
Air valve	11	EA	$ 2,110	$ 23,210
Flush valve	11	EA	$ 1,055	$ 11,141
Metal detectable tape	52,800	LF	$ 2	$ 105,600
Subtotal				**$ 4,331,861**
Pump Station(s) Installation				
Pump	4	EA	$ 8,230	$ 32,920
Pump Station Piping, 18"	2	EA	$ 8,359	$ 16,719
Gate valve, 18"	8	EA	$ 10,200	$ 81,603
Check valve, 18"	4	EA	$ 9,945	$ 39,781
Electrical/Instrumentation	2	EA	$ 10,550	$ 21,100
Site work	2	EA	$ 2,635	$ 5,270
Building pad	2	EA	$ 5,275	$ 10,550
Pump Building	2	EA	$ 10,550	$ 21,100
Fence	2	EA	$ 6,330	$ 12,660
Tools	2	EA	$ 1,055	$ 2,110
5,000 gal feed tank	2	EA	$ 10,250	$ 20,500
100,000 gal ground storage tank	-	EA	$ 102,900	$ -
Subtotal				**$ 264,313**
Well Installation				
Well installation	1,600	LF	$ 155	$ 248,000
Water quality testing	10	EA	$ 1,320	$ 13,200
Well pump	5	EA	$ 4,824	$ 24,120
Well electrical/instrumentation	5	EA	$ 5,800	$ 29,000
Well cover and base	5	EA	$ 3,165	$ 15,825
Piping	5	EA	$ 3,165	$ 15,825
Subtotal				**$ 345,970**
Subtotal of Component Costs				**$ 4,942,143**
Contingency	20%			$ 988,429
Design & Constr Management	25%			$ 1,235,536
TOTAL CAPITAL COSTS				**$ 7,166,108**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.0	mile	$ 285	$ 2,850
Subtotal				**$ 2,850**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.083	$ 1,959
Pump Power	3,284,297	kWH	$ 0.083	$ 272,597
Materials	2	EA	$ 1,585	$ 3,170
Labor	730	Hrs	$ 62.00	$ 45,260
Tank O&M	-	EA	$ 1,055	$ -
Subtotal				**$ 322,985**
Well O&M				
Pump power	1,898,318	kWH	$ 0.083	$ 157,560
Well O&M matl	5	EA	$ 1,585	$ 7,925
Well O&M labor	900	Hrs	$ 62	$ 55,800
Subtotal				**$ 221,285**
O&M Credit for Existing Well Closure				
Pump power	1,186,449	kWH	$ 0.083	$ (98,475)
Well O&M matl	18	EA	$ 1,585	$ (28,530)
Well O&M labor	3,240	Hrs	$ 62	$ (200,880)
Subtotal				**$ (327,885)**
TOTAL ANNUAL O&M COSTS				**$ 219,236**

Table C.4

PWS Name ***City of Andrews***
Alternative Name ***New Well at 5 Miles***
Alternative Number ***Alt-4***

Distance from PWS to new well location	5.0	miles
Estimated well depth	320	feet
Number of wells required	5	
Well installation cost (location specific)	$155	per foot
Pump Stations needed w/ 1 feed tank each	1	
On site storage tanks / pump sets needed	0	

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	5	n/a	n/a	n/a
HDPE water line, SDR 21, 18"	26,400	LF	$ 72	$ 1,893,847
Bore and encasement, 18"	200	LF	$ 535	$ 107,000
Open cut and encasement, 18"	250	LF	$ 150	$ 37,500
Gate valve and box, 18"	5	EA	$ 10,200	$ 53,858
Air valve	6	EA	$ 2,110	$ 12,660
Flush valve	5	EA	$ 1,055	$ 5,570
Metal detectable tape	26,400	LF	$ 2	$ 52,800
Subtotal				**$ 2,163,235**
Pump Station(s) Installation				
Pump	2	EA	$ 8,230	$ 16,460
Pump Station Piping, 18"	1	EA	$ 8,359	$ 8,359
Gate valve, 18"	4	EA	$ 10,200	$ 40,801
Check valve, 18"	2	EA	$ 9,945	$ 19,891
Electrical/Instrumentation	1	EA	$ 10,550	$ 10,550
Site work	1	EA	$ 2,635	$ 2,635
Building pad	1	EA	$ 5,275	$ 5,275
Pump Building	1	EA	$ 10,550	$ 10,550
Fence	1	EA	$ 6,330	$ 6,330
Tools	1	EA	$ 1,055	$ 1,055
5,000 gal feed tank	1	EA	$ 10,250	$ 10,250
100,000 gal ground storage tank	-	EA	$ 102,900	$ -
Subtotal				**$ 132,156**
Well Installation				
Well installation	1,600	LF	$ 155	$ 248,000
Water quality testing	10	EA	$ 1,320	$ 13,200
Well pump	5	EA	$ 4,824	$ 24,120
Well electrical/instrumentation	5	EA	$ 5,800	$ 29,000
Well cover and base	5	EA	$ 3,165	$ 15,825
Piping	5	EA	$ 3,165	$ 15,825
Subtotal				**$ 345,970**
Subtotal of Component Costs				**$ 2,641,361**
Contingency	20%			$ 528,272
Design & Constr Management	25%			$ 660,340
TOTAL CAPITAL COSTS				**$ 3,829,974**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.0	mile	$ 285	$ 1,425
Subtotal				**$ 1,425**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.083	$ 979
Pump Power	1,642,149	kWH	$ 0.083	$ 136,298
Materials	1	EA	$ 1,585	$ 1,585
Labor	365	Hrs	$ 62.00	$ 22,630
Tank O&M	1	EA	$ 1,055	$ 1,055
Subtotal				**$ 162,548**
Well O&M				
Pump power	1,898,318	kWH	$ 0.083	$ 157,560
Well O&M matl	5	EA	$ 1,585	$ 7,925
Well O&M labor	900	Hrs	$ 62	$ 55,800
Subtotal				**$ 221,285**
O&M Credit for Existing Well Closure				
Pump power	1,186,449	kWH	$ 0.083	$ (98,475)
Well O&M matl	18	EA	$ 1,585	$ (28,530)
Well O&M labor	3,240	Hrs	$ 62	$ (200,880)
Subtotal				**$ (327,885)**
TOTAL ANNUAL O&M COSTS				**$ 57,373**

Table C.5

PWS Name *City of Andrews*
Alternative Name *New Well at 1 Mile*
Alternative Number *Alt-5*

Distance from PWS to new well location	1.0	miles
Estimated well depth	320	feet
Number of wells required	5	
Well installation cost (location specific)	$155	per foot
Pump Stations needed w/ 1 feed tank each	0	
On site storage tanks / pump sets needed	0	

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
HDPE water line, SDR 21, 18"	5,280	LF	$ 72	$ 378,769
Bore and encasement, 18"	-	LF	$ 535	$ -
Open cut and encasement, 18"	50	LF	$ 150	$ 7,500
Gate valve and box, 18"	1	EA	$ 10,200	$ 10,772
Air valve	1	EA	$ 2,110	$ 2,110
Flush valve	1	EA	$ 1,055	$ 1,114
Metal detectable tape	5,280	LF	$ 2	$ 10,560
Subtotal				**$ 410,825**
Pump Station(s) Installation				
Pump	-	EA	$ 8,230	$ -
Pump Station Piping, 18"	-	EA	$ 8,359	$ -
Gate valve, 18"	-	EA	$ 10,200	$ -
Check valve, 18"	-	EA	$ 9,945	$ -
Electrical/Instrumentation	-	EA	$ 10,550	$ -
Site work	-	EA	$ 2,635	$ -
Building pad	-	EA	$ 5,275	$ -
Pump Building	-	EA	$ 10,550	$ -
Fence	-	EA	$ 6,330	$ -
Tools	-	EA	$ 1,055	$ -
5,000 gal feed tank	-	EA	$ 10,250	$ -
100,000 gal ground storage tank	-	EA	$ 102,900	$ -
Subtotal				**$ -**
Well Installation				
Well installation	1,600	LF	$ 155	$ 248,000
Water quality testing	10	EA	$ 1,320	$ 13,200
Well pump	5	EA	$ 4,824	$ 24,120
Well electrical/instrumentation	5	EA	$ 5,800	$ 29,000
Well cover and base	5	EA	$ 3,165	$ 15,825
Piping	5	EA	$ 3,165	$ 15,825
Subtotal				**$ 345,970**
Subtotal of Component Costs				**$ 756,795**
Contingency	20%			$ 151,359
Design & Constr Management	25%			$ 189,199
TOTAL CAPITAL COSTS				**$ 1,097,352**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	1.0	mile	$ 285	$ 285
Subtotal				**$ 285**
Pump Station(s) O&M				
Building Power	-	kWH	$ 0.083	$ -
Pump Power	-	kWH	$ 0.083	$ -
Materials	-	EA	$ 1,585	$ -
Labor	-	Hrs	$ 62.00	$ -
Tank O&M	-	EA	$ 1,055	$ -
Subtotal				**$ -**
Well O&M				
Pump power	1,898,318	kWH	$ 0.083	$ 157,560
Well O&M matl	5	EA	$ 1,585	$ 7,925
Well O&M labor	900	Hrs	$ 62	$ 55,800
Subtotal				**$ 221,285**
O&M Credit for Existing Well Closure				
Pump power	1,186,449	kWH	$ 0.083	$ (98,475)
Well O&M matl	18	EA	$ 1,585	$ (28,530)
Well O&M labor	3,240	Hrs	$ 62	$ (200,880)
Subtotal				**$ (327,885)**
TOTAL ANNUAL O&M COSTS				**$ (106,315)**

Table C.6.1

PWS Name ***City of Andrews***
Alternative Name ***Central Treatment - RO***
Alternative Number ***Alt-6***

Capital Costs

Cost Item	University	Florey	Total Cost
Reverse Osmosis Unit Purchase/Installation			
Site preparation	$ 15,600	$ 15,600	$ 31,200
Slab	$ 180,000	$ 180,000	$ 360,000
Building	$ 288,000	$ 288,000	$ 576,000
Building electrical	$ 38,400	$ 38,400	$ 76,800
Building plumbing	$ 38,400	$ 38,400	$ 76,800
Heating and ventilation	$ 33,600	$ 33,600	$ 67,200
Fence	$ 20,700	$ 20,700	$ 41,400
Paving	$ 11,600	$ 11,600	$ 23,200
Electrical	$ 100,000	$ 100,000	$ 200,000
Piping	$ 50,000	$ 50,000	$ 100,000
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	$ 2,276,000	$2,276,000	$ 4,552,000
Transfer pumps	$ 15,000	$ 15,000	$ 30,000
Permeate tank	$ 67,560	$ -	$ 67,560
Chlorination point	$ 15,000	$ 18,550	$ 33,550
Reject pond:			
Excavation	$132,600	$ 246,600	$ 379,200
Compacted fill	$184,000	$ 282,000	$ 466,000
Lining	$1,128,600	$2,015,400	$ 3,144,000
Vegetation	$19,800	$ 28,500	$ 48,300
Access road	$267,000	$ 384,000	$ 651,000
Subtotal of Design/Construction Costs			**$ 10,924,210**
Contingency	20%		$ 2,184,842
Design & Constr Management	25%		$ 2,731,053
Reject water haulage truck			$ 100,000
TOTAL CAPITAL COSTS			**$ 15,940,105**

Annual Operations and Maintenance Costs

Cost Item	University	Florey	Total Cost
Reverse Osmosis Unit O&M			
Building Power	$ 3,652	$ 3,652	$ 7,304
Equipment power	$ 63,412	$130,559	$ 193,971
Labor	$ 80,000	$ 80,000	$ 160,000
Materials and Chemicals	$ 221,925	$457,275	$ 679,200
Analyses	$ 4,800	$ 4,800	$ 9,600
Subtotal			**$ 1,050,075**
Backwash Disposal			
Disposal truck mileage	$ 95,400	$196,500	$ 291,900
Backwash disposal fee	$ 40,000	$ 82,000	$ 122,000
Subtotal			**$ 413,900**
TOTAL ANNUAL O&M COSTS			**$ 1,463,975**

Table C.7.1

PWS Name	***City of Andrews***
Alternative Name	***Central Treatment - EDR***
Alternative Number	***Alt-7***

Capital Costs

Cost Item	University	Florey	Total Cost
EDR Unit Purchase/Installation			
Site preparation	$ 12,800	$ 12,856	$ 25,656
Slab	$ 200,000	$ 200,000	$ 400,000
Building	$ 240,000	$ 240,000	$ 480,000
Building electrical	$ 32,000	$ 32,000	$ 64,000
Building plumbing	$ 32,000	$ 32,000	$ 64,000
Heating and ventilation	$ 28,000	$ 28,000	$ 56,000
Fence	$ 19,500	$ 18,900	$ 38,400
Paving	$ 9,000	$ 9,000	$ 18,000
Electrical	$ 100,000	$ 100,000	$ 200,000
Piping	$ 50,000	$ 50,000	$ 100,000
Transfer pumps	$ 15,000	$ 15,000	$ 30,000
Permeate tank	$ 101,340	$ -	$ 101,340
Chlorination system	$ 15,000	$ 18,550	$ 33,550
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	$ 2,731,200	$ 2,731,200	$ 5,462,400
Reject pond:			
Excavation	$ 113,100	$ 215,700	$ 328,800
Compacted fill	$ 151,600	$ 225,200	$ 376,800
Lining	$ 711,665	$ 1,375,800	$ 2,087,465
Vegetation	$ 16,200	$ 23,100	$ 39,300
Access road	$ 219,000	$ 312,000	$ 531,000
Subtotal of Design/Construction Costs			**$ 10,436,711**
Contingency	20%		$ 2,087,342
Design & Constr Management	25%		$ 2,609,178
Reject water haulage truck			$ 100,000
TOTAL CAPITAL COSTS			**$ 15,233,230**

Annual Operations and Maintenance Costs

Cost Item	University	Florey	Total Cost
EDR Unit O&M			
Building Power	$ 3,030	$ 3,030	$ 6,059
Equipment power	$ 113,461	$ 233,811	$ 347,272
Labor	$ 72,000	$ 72,000	$ 144,000
Materials	$ 142,032	$ 292,656	$ 434,688
Chemicals	$ 118,360	$ 243,880	$ 362,240
Analyses	$ 4,800	$ 4,800	$ 9,600
Subtotal			**$ 1,303,859**
Backwash Disposal			
Disposal truck mileage	$ 63,000	$ 130,200	$ 193,200
Backwash disposal fee	$ 264,000	$ 542,500	$ 806,500
Subtotal			**$ 999,700**
TOTAL ANNUAL O&M COSTS			**$ 2,303,559**

Table C.8

PWS Name ***City of Andrews***
Alternative Name ***Point-of-Use Treatment***
Alternative Number ***Alt-8***

Number of Connections for POU Unit Installation 4,420 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POU-Treatment - Purchase/Installation				
POU treatment unit purchase	4,420	EA	$ 200	$ 884,000
POU treatment unit installation	4,420	EA	$ 160	$ 707,200
Subtotal				**$ 1,591,200**
Subtotal of Component Costs				**$ 1,591,200**
Contingency	20%			$ 318,240
Design & Constr Management	25%			$ 397,800
Procurement & Administration	20%			$ 318,240
TOTAL CAPITAL COSTS				**$ 2,625,480**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POU materials, per unit	4,420	EA	$ 66	$ 291,720
Contaminant analysis, 1/3 units/yr	1,473	EA	$ 210	$ 309,400
Program labor, 10 hrs/unit	44,200	hrs	$ 42	$ 1,856,400
Subtotal				**$ 2,457,520**
TOTAL ANNUAL O&M COSTS				**$ 2,457,520**

Table C.9

PWS Name *City of Andrews*
Alternative Name *Point-of-Entry Treatment*
Alternative Number *Alt-9*

Number of Connections for POE Unit Installation 4,420 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POE-Treatment - Purchase/Installati				
POE treatment unit purchase	4,420	EA	$ 5,275	$ 23,315,500
Pad and shed, per unit	4,420	EA	$ 2,110	$ 9,326,200
Piping connection, per unit	4,420	EA	$ 1,055	$ 4,663,100
Electrical hook-up, per unit	4,420	EA	$ 1,055	$ 4,663,100
Subtotal				**$ 41,967,900**
Subtotal of Component Costs				**$ 41,967,900**
Contingency	20%			$ 8,393,580
Design & Constr Management	25%			$ 10,491,975
Procurement & Administration	20%			$ 8,393,580
TOTAL CAPITAL COSTS				**$ 69,247,035**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POE materials, per unit	4,420	EA	$ 1,585	$ 7,005,700
Contaminant analysis, 1/yr per unit	4,420	EA	$ 210	$ 928,200
Program labor, 10 hrs/unit	44,200	hrs	$ 42	$ 1,856,400
Subtotal				**$ 9,790,300**
TOTAL ANNUAL O&M COSTS				**$ 9,790,300**

Table C.10

PWS Name ***City of Andrews***
Alternative Name ***Public Dispenser for Treated Drinking Water***
Alternative Number ***Alt-10***

Number of Treatment Units Recommended 20

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Public Dispenser Unit Installation				
POE-Treatment unit(s)	20	EA	$ 7,385	$ 147,700
Unit installation costs	20	EA	$ 5,275	$ 105,500
Subtotal				**$ 253,200**
Subtotal of Component Costs				**$ 253,200**
Contingency	20%			$ 50,640
Design & Constr Management	25%			$ 63,300
TOTAL CAPITAL COSTS				**367,140**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Treatment unit O&M, 1 per unit	20	EA	$ 2,110	$ 42,200
Contaminant analysis, 1/wk per ui	1,040	EA	$ 210	$ 218,400
Sampling/reporting, 1 hr/day	7,300	HRS	$ 62	$ 452,600
Subtotal				**$ 713,200**
TOTAL ANNUAL O&M COSTS				**$ 713,200**

Table C.11

PWS Name ***City of Andrews***
Alternative Name ***Supply Bottled Water to 100% of Population***
Alternative Number ***Alt-11***

Service Population	9,652	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	3,522,980	gallons

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Implementation				
Initial program set-up	500	hours	$ 46	$ 23,000
Subtotal				**$ 23,000**
Subtotal of Component Costs				**$ 23,000**
Contingency	20%			$ 4,600
TOTAL CAPITAL COSTS				**$ 27,600**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water purchase costs	3,522,980	gals	$ 1.25	$ 4,403,725
Program admin, 9 hrs/wk	468	hours	$ 46	$ 21,528
Program materials	1	EA	$ 5,275	$ 5,275
Subtotal				**$ 4,430,528**
TOTAL ANNUAL O&M COSTS				**$ 4,430,528**

Table C.12

PWS Name ***City of Andrews***
Alternative Name ***Central Trucked Drinking Water***
Alternative Number ***Alt-12***

Service Population	9,652	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	3,522,980	gallons
Travel distance to compliant water source	33	miles

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Storage Tank Installation				
50,000 gal ground storage tank	1	EA	$ 61,750	$ 61,750
Site improvements	1	EA	$ 3,165	$ 3,165
Potable water truck	1	EA	$ 77,000	$ 77,000
Subtotal				**$ 141,915**
Subtotal of Component Costs				**$ 141,915**
Contingency	20%			$ 28,383
Design & Constr Management	25%			$ 35,479
TOTAL CAPITAL COSTS				**$ 205,777**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water delivery labor, 4 hrs/wk	208	hrs	$ 62	$ 12,896
Truck operation, 1 round trip/wk	3,463	miles	$ 3.00	$ 10,390
Water purchase	3,523	1,000 gals	$ 3.40	$ 11,978
Water testing, 1 test/wk	52	EA	$ 210	$ 10,920
Sampling/reporting, 2 hrs/wk	104	hrs	$ 62	$ 6,448
Subtotal				**$ 52,632**
TOTAL ANNUAL O&M COSTS				**$ 52,632**

APPENDIX D
EXAMPLE FINANCIAL MODEL

City of Andrews

Number of Alternatives	12	Selected from Results Sheet
Input Fields are Indicated by:		

General Inputs		
Implementation Year	2010	
Months of Working Capital	0	
Depreciation	$ -	
Percent of Depreciation for Replacement Fund	0%	
Allow Negative Cash Balance (yes or no)	No	
Median Household Income	$ 25,057	City of Andrews
Median HH Income -- Texas	$ 39,927	
Grant Funded Percentage	0%	Selected from Results
Capital Funded from Revenues	$ -	

	Base Year Growth/Escalation	2008
Accounts & Consumption		
Metered Residential Accounts		
Number of Accounts	0.0%	4420
Number of Bills Per Year		12
Annual Billed Consumption		947,175,000
Consumption per Account Per Pay Period	0.0%	17,858
Consumption Allowance in Rates		2,000
Total Allowance		106,080,000
Net Consumption Billed		841,095,000
Percentage Collected		100.0%
Unmetered Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Percentage Collected		100.0%
Metered Non-Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Non-Residential Consumption		-
Consumption per Account	0.0%	-
Consumption Allowance in Rates		-
Total Allowance		-
Net Consumption Billed		-
Percentage Collected		0.0%
Unmetered Non-Residential Accounts		
Number of Accounts	0.0%	0
Number of Bills Per Year		12
Percentage Collected		100.0%
Water Purchase & Production		
Water Purchased (gallons)	0.0%	-
Average Cost Per Unit Purchased	0.0%	$ -
Bulk Water Purchases	0.0%	$ -
Water Production	0.0%	947,175,000
Unaccounted for Water		-
Percentage Unaccounted for Water		0.0%

Appendix D
General Inputs

City of Andrews

Number of Alternatives 12 Selected from Results Sheet

Input Fields are Indicated by:

Residential Rate Structure	Allowance within Tier	
	-	
Estimated Average Water Rate ($/1000gallons)		$ 1.61
Non-Residential Rate Structure		
	-	
Estimated Average Water Rate ($/1000gallons)		$ -
INITIAL YEAR EXPENDITURES	Inflation	Initial Year
Operating Expenditures:		
Salaries & Benefits	0.0%	-
Contract Labor	0.0%	-
Water Purchases	0.0%	-
Chemicals, Treatment	0.0%	-
Utilities	0.0%	-
Repairs, Maintenance, Supplies	0.0%	-
Repairs	0.0%	-
Maintenance	0.0%	-
Supplies	0.0%	-
Administrative Expenses	0.0%	
Accounting and Legal Fees	0.0%	-
Insurance	0.0%	-
Automotive and Travel	0.0%	-
Professional and Directors Fees	0.0%	-
Bad Debts	0.0%	-
Garbage Pick-up	0.0%	-
Miscellaneous	0.0%	-
Other 3	0.0%	1,493,404
Other 4	0.0%	-
Incremental O&M for Alternative	0.0%	-
Total Operating Expenses		1,493,404
Non-Operating Income/Expenditures		
Interest Income	0.0%	-
Other Income	0.0%	-
Other Expense	0.0%	-
Transfers In (Out)	0.0%	-
Net Non-Operating		-

Esisting Debt Service		
Bonds Payable, Less Current Maturities		$ -
Bonds Payable, Current		$ -
Interest Expense		$ -

Debt Service for City of Andrews
Alternative Number = 12
Funding Source = Loan/Bond

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Existing Debt Service	$ -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal Payments		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest Payment	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term	25																															
Revenue Bonds		-	-	205,777	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	205,777	202,026	198,050	193,836	189,369	184,634	179,615	174,295	168,655	162,677	156,340	149,624	142,504	134,957	126,957	118,477	109,488	99,961	89,861	79,155	67,807	55,779	43,028	29,513	15,186	0	0	0	0
Principal		-	-	3,751	3,976	4,214	4,467	4,735	5,019	5,320	5,640	5,978	6,337	6,717	7,120	7,547	8,000	8,480	8,989	9,528	10,100	10,706	11,348	12,029	12,751	13,516	14,326	15,186	-	-	-	-
Interest	6.00%	-	-	12,347	12,122	11,883	11,630	11,362	11,078	10,777	10,458	10,119	9,761	9,380	8,977	8,550	8,097	7,617	7,109	6,569	5,998	5,392	4,749	4,068	3,347	2,582	1,771	0	0	0	0	0
Total Debt Service		-	-	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	16,097	15,186	0	0	0	0
New Balance		-	-	202,026	198,050	193,836	189,369	184,634	179,615	174,295	168,655	162,677	156,340	149,624	142,504	134,957	126,957	118,477	109,488	99,961	89,861	79,155	67,807	55,779	43,028	29,513	15,186	0	0	0	0	0
Term	20																															
State Revolving Fund		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	0.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term	10																															
Bank/Interfund Loan				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%	-	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	8.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Term	25																															
RUS Loan			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Forgiveness	0.00%		-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Principal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	5.00%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New Balance		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-