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

GREENWOOD WATER SYSTEM

PWS ID# 1650078, CCN# 11792

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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EXECUTIVE SUMMARY

INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Technology 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 Greenwood Water System PWS, ID# 1650078, Certificate of Convenience and Necessity (CCN) #11792, located in Midland County. The Greenwood Water System PWS supplies water to the residents of Greenwood, Texas. The water system serves a population of 800 and contains 267 connections. The water source comes from six groundwater wells completed to depths ranging from 100 feet to 190 feet in the Ogallala-North Aquifer. Wells #2, #3, #4, #5, and #6 (G1650078B, G1650078C, G1650078D, G1650078E, and G1650078F) are rated at 50 gallons per minute (gpm), 45 gpm, 200 gpm, 200 gpm, 250 gpm, respectively. Well #1 (G1650078A) is for emergency use only and is not active.

During the period April 2006 to March 2007, arsenic concentrations ranged from 0.0108 milligrams per liter (mg/L) to 0.0241 mg/L, exceeding the 0.01 mg/L maximum contaminant level (MCL) for arsenic. In August 2004, a fluoride concentration of 4.5 mg/L was detected and exceeded the 4 mg/L MCL for fluoride (USEPA 2008a). Between February 1998 and March 2005 fluoride concentrations between 3.4 mg/L and 3.8 mg/L were recorded, exceeding the secondary fluoride MCL of 2 mg/L (TCEQ 2004); therefore, Greenwood Water System PWS faces compliance issues under the water quality standards for arsenic and fluoride.

Basic system information for the Greenwood Water System PWS is shown in Table ES.1.

Table ES.1 Greenwood Water System PWS
Basic System Information

Population served	800
Connections	267
Average daily flow rate	0.145 million gallons per day (mgd)
Peak demand flow rate	400 gallons per minute
Water system peak capacity	0.705 mgd
Typical fluoride range	3.4 mg/L – 4.5 mg/L
Typical arsenic range	0.0108 mg/L – 0.0241 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:

- Gather data from the TCEQ and Texas Water Development Board databases, from TCEQ files, and from information maintained by the PWS;
- Conduct financial, managerial, and technical (FMT) evaluations of the PWS;
- Perform a geologic and hydrogeologic assessment of the study area;
- Develop treatment and non-treatment compliance alternatives which, in general, consist of the following possible options:
- 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;
- Installing new wells within the vicinity of the PWS into other aquifers with confirmed water quality standards meeting the MCLs;
- 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;
- Treating the existing non-compliant water supply by various methods depending on the type of contaminant; and
- Delivering potable water by way of a bottled water program or a treated water dispenser as an interim measure only.

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

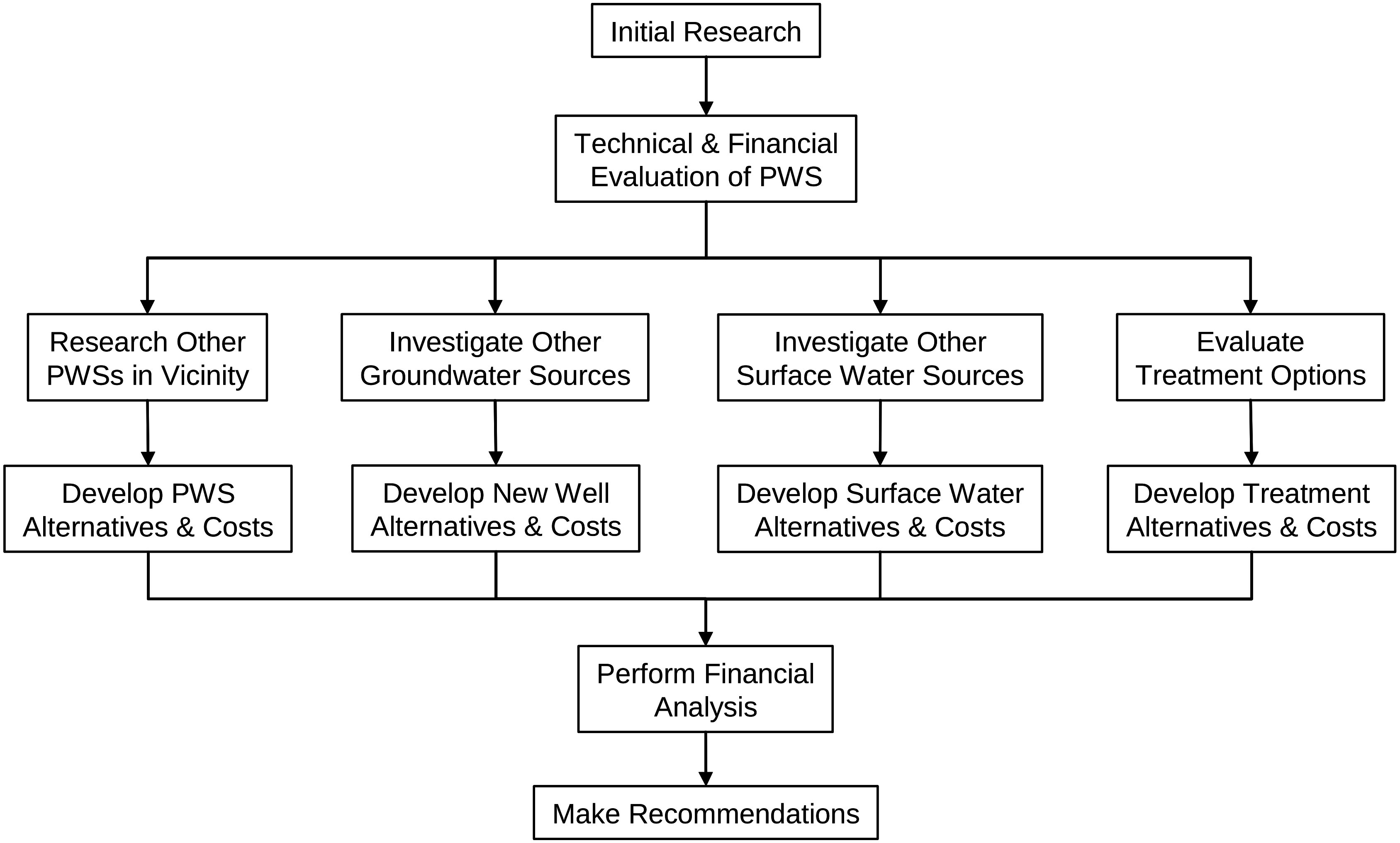
This basic approach is summarized in Figure ES.1.

HYDROGEOLOGICAL ANALYSIS

The Greenwood Water System PWS obtains groundwater from the Ogallala aquifer. Arsenic and fluoride are commonly found in area wells at concentrations greater than the MCL. Of the wells within 6.2 miles of the Greenwood Water System PWS wells tested for arsenic, only one showed arsenic concentrations below the MCL. This well is located about 5-1/2 miles west of the Greenwood Water System PWS wells and is currently in use as a private domestic water supply. It also showed acceptable levels of fluoride, nitrate, and selenium, but was sampled most recently sampled more than 10 years ago and would need to be resampled to measure current solute concentrations before consideration as an alternative supply.

In addition, regional analyses indicate that wells deeper than about 250 feet are much less likely to exceed the MCLs for arsenic and fluoride. Thus, deepening one or both of the wells might result in lower arsenic and fluoride concentrations, provided the aquifer is thick enough. Additionally, it may also be possible to do down-hole testing on non-compliant wells to determine the source of the contaminants. If the contaminants derive primarily from a single part of the formation, that part could be excluded by modifying the existing well, or avoided altogether by completing a new well.

1 **Figure ES.1 Summary of Project Methods**



COMPLIANCE ALTERNATIVES

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 dedicated and knowledgeable owner and operator, and financial sustainability. Areas of concern for the system included lack of compliance with the arsenic standard, lack of written capital improvements plan, and lack of source water and wellhead protection plan.

There are several PWSs within 10 miles of the Greenwood Water System PWS. Few of these nearby systems also have good water quality. In general, feasibility alternatives were developed based on obtaining water from the nearest PWSs with good quality water, 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 the alternatives where treated surface water is obtained from the Cities of Midland and Stanton, which obtain raw surface water from the Colorado River Municipal Water District.

Centralized treatment alternatives for arsenic and fluoride removal have been developed and were considered for this report; for example, reverse osmosis and electrodialysis reversal. Point-of-use (POU) and point-of-entry treatment alternatives were also considered. Temporary solutions such as providing bottled water or providing a centralized dispenser for treated or trucked-in water, were also considered as alternatives.

Developing a new well close to Greenwood Water System PWS is likely to be the best solution if compliant groundwater can be found. Having a new well close to Greenwood Water System PWS 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.

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 Greenwood Water System PWS indicated that current water rates are funding operations, and a rate increase is not necessary to meet operating expenses at this time. The current average water bill represents approximately 1.7 percent of the median household income (MHI). 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	$750	1.7
To meet current expenses	NA	$595	1.6
Purchase Water from City of Midland	100% Grant	$998	2.3
	Loan/Bond	$1,669	3.8
Nearby well within approximately 1 mile	100% Grant	$750	1.7
	Loan/Bond	$840	1.9
Central treatment-RO	100% Grant	$750	1.7
	Loan/Bond	$1,102	2.5
Point-of-use	100% Grant	$1,430	3.3
	Loan/Bond	$1,530	3.5
Public dispenser	100% Grant	$855	2.0
	Loan/Bond	$865	2.0

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ACRONYMS AND ABBREVIATIONS

µg/L	Micrograms per liter
°F	Degrees Fahrenheit
AFY	acre-feet per year
ANSI	American National Standards Institute
BAT	Best available technology
BCA	Bilateral Compliance Agreement
BEG	Bureau of Economic Geology
CA	cellulose acetate
CCN	Certificate of Convenience and Necessity
CD	Community Development
CDBG	Community Development Block Grants
CFR	Code of Federal Regulations
CRMWD	Canadian River Municipal Water District
DWSRF	Drinking Water State Revolving Fund
ED	Electrodialysis
EDR	Electrodialysis reversal
FM	Farm-to-Market
FMT	Financial, managerial, and technical
GAM	Groundwater Availability Model
gpd	gallons per day
gpm	Gallons per minute
IX	Ion exchange
MCL	Maximum contaminant level
MG	million gallons
mg/L	Milligram per liter
mgd	Million gallons per day
MHI	Median household income
NF	nanofiltration
NMEFC	New Mexico Environmental Financial Center
NURE	National Uranium Resource Evaluation
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 Systems

RFP	Revolving Fund Program
RO	Reverse osmosis
RUS	Rural Utilities Service
RWAF	Economically Distressed Areas Program
SDWA	Safe Drinking Water Act
STEP	Small Towns Environment Program
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TFC	thin film composite
TTHM	total trihalomethanes
TWDB	Texas Water Development Board
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WAM	Water Availability Model
WEP	Water and Environment Program

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. The feasibility studies identify a range of potential compliance alternatives, and present basic data that can be used for evaluating feasibility. The compliance alternatives addressed include a description of what would be required for implementation, conceptual cost estimates for implementation, and non-cost factors that could be used to differentiate between alternatives. The cost estimates are intended for comparing compliance alternatives, and to give a preliminary indication of potential impacts on water rates resulting from implementation.

It is anticipated the PWS will review the compliance alternatives in this report to determine if there are promising alternatives, and then select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation. This report contains a decision tree approach that guided the efforts for this 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 Greenwood Water System, PWS ID# 1650078, Certificate of Convenience and Necessity (CCN) #11792, located in Midland County, hereinafter referred to in this document as the "Greenwood PWS." Recent sample results from the Greenwood PWS exceeded the MCL for arsenic of 0.01 milligrams per liter (mg/L), the MCL for fluoride of 4.0 mg/L, and a TCEQ secondary standard for fluoride of 2.0 mg/L (USEPA 2008a; TCEQ 2004). The location of the Greenwood PWS is shown on Figure 1.1. Various water supply and planning jurisdictions are shown on Figure 1.2. These water supply and planning jurisdictions are used in the evaluation of alternate water supplies that may be available in the area.

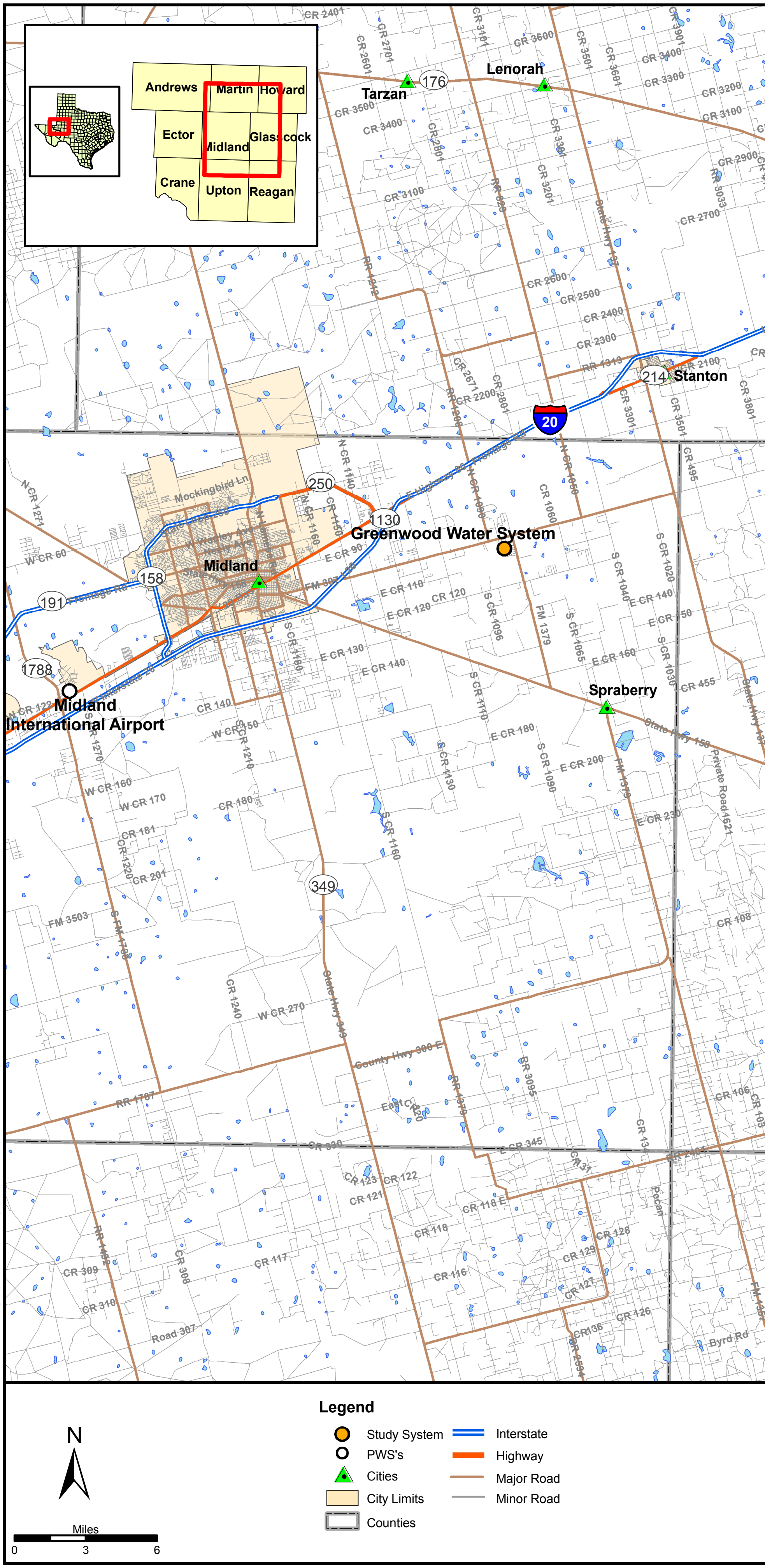

Figure 1.1

GREENWOOD WATER SYSTEM

Location Map

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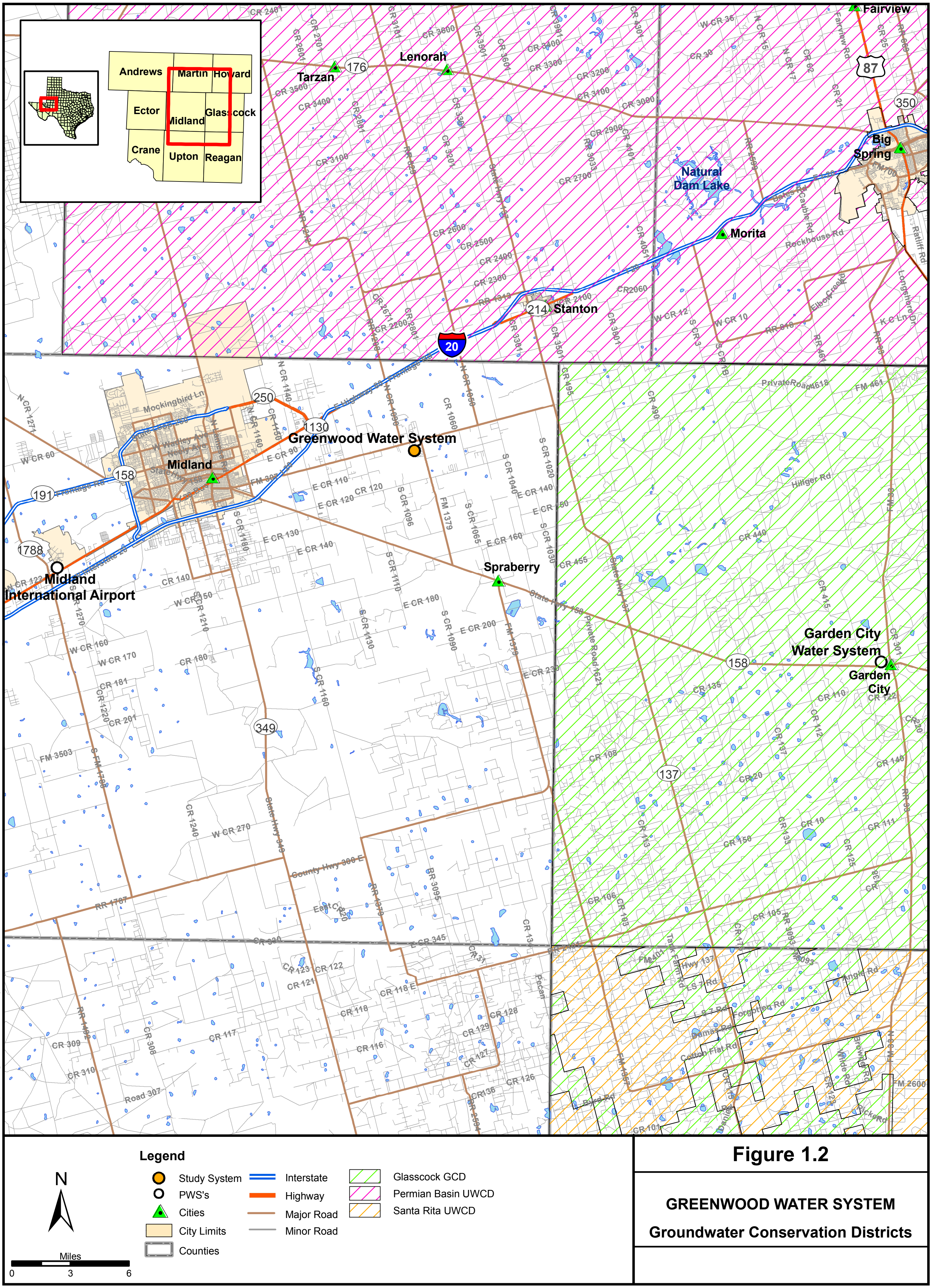

Figure 1.2

GREENWOOD WATER SYSTEM

Groundwater Conservation Districts

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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 Greenwood PWS had recent sample results exceeding the MCLs 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 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 TCEQ has 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 nine years of age (USEPA 2008c; TCEQ 2004).

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 cardiovascular, pulmonary, immunological, neurological and endocrine effects, and cancerous effects, including skin, bladder, lung, kidney, nasal passage, liver and prostate cancer (USEPA 2008b).

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 U.S. Environmental Protection Agency (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.

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. The groundwater sources of arsenic and fluoride are addressed in Section 3. Findings for the Greenwood 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 Greenwood 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 Greenwood 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 2008b). 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 of both fluoride and arsenic. In this case, adsorption is not a feasible technology because of the high TDS and alkalinity of the groundwater. Also 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

Point-of-entry 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 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 operation and maintenance (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 (ANSI) issued product standards for a specific type of POU or POE treatment unit, only those units that have been independently certified according to those standards may be used as part of a compliance strategy.

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

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

1.4.7 Water Delivery or Central Drinking Water Dispensers

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

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

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

- Water delivery programs require consumer participation to a varying degree. Ideally, consumers would have to do no more than they currently do for a piped-water delivery system. Least desirable are those systems that require maximum effort on the part of the customer (*e.g.,* customer has to travel to get the water, transport the water, and physically handle the bottles).

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

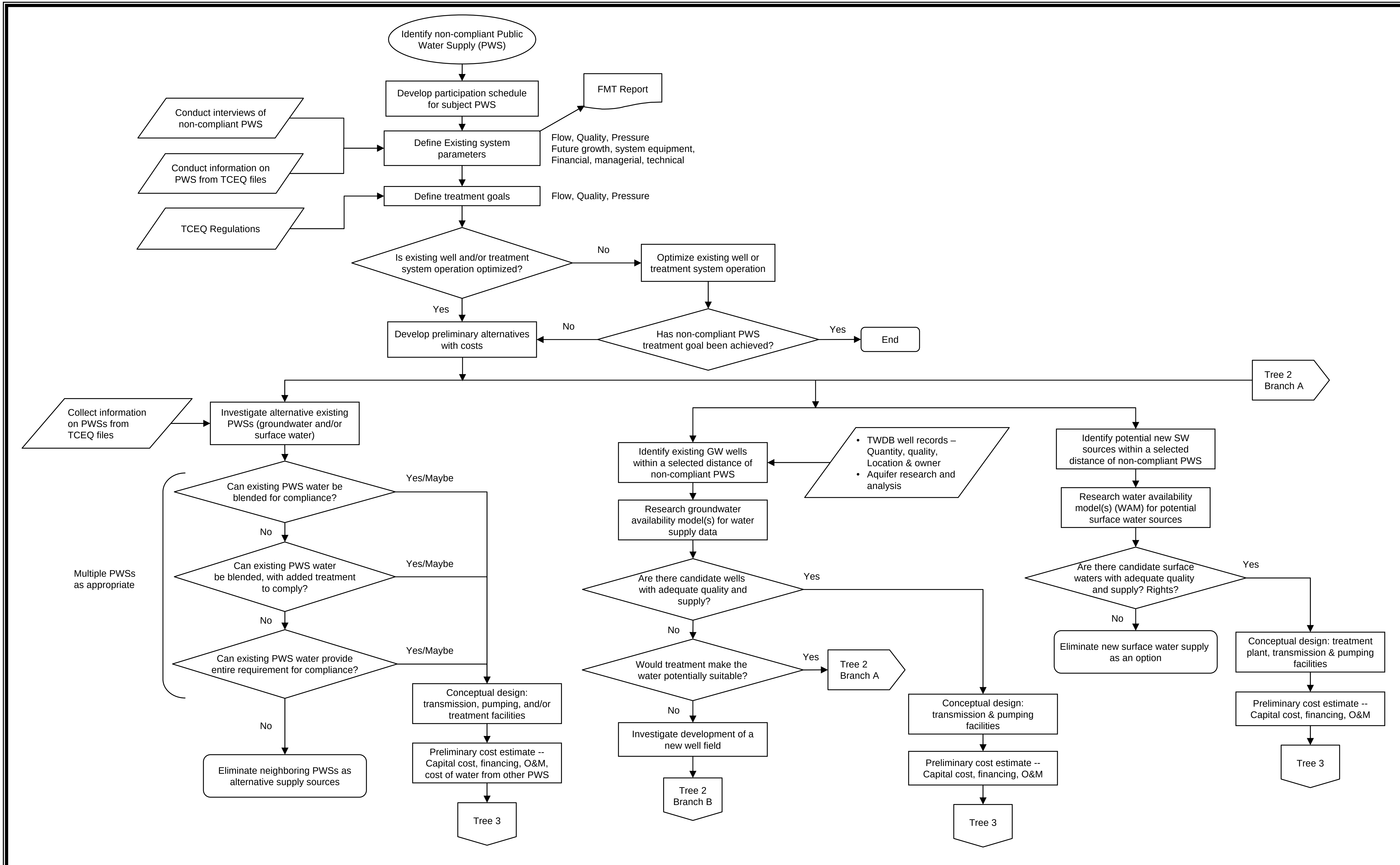
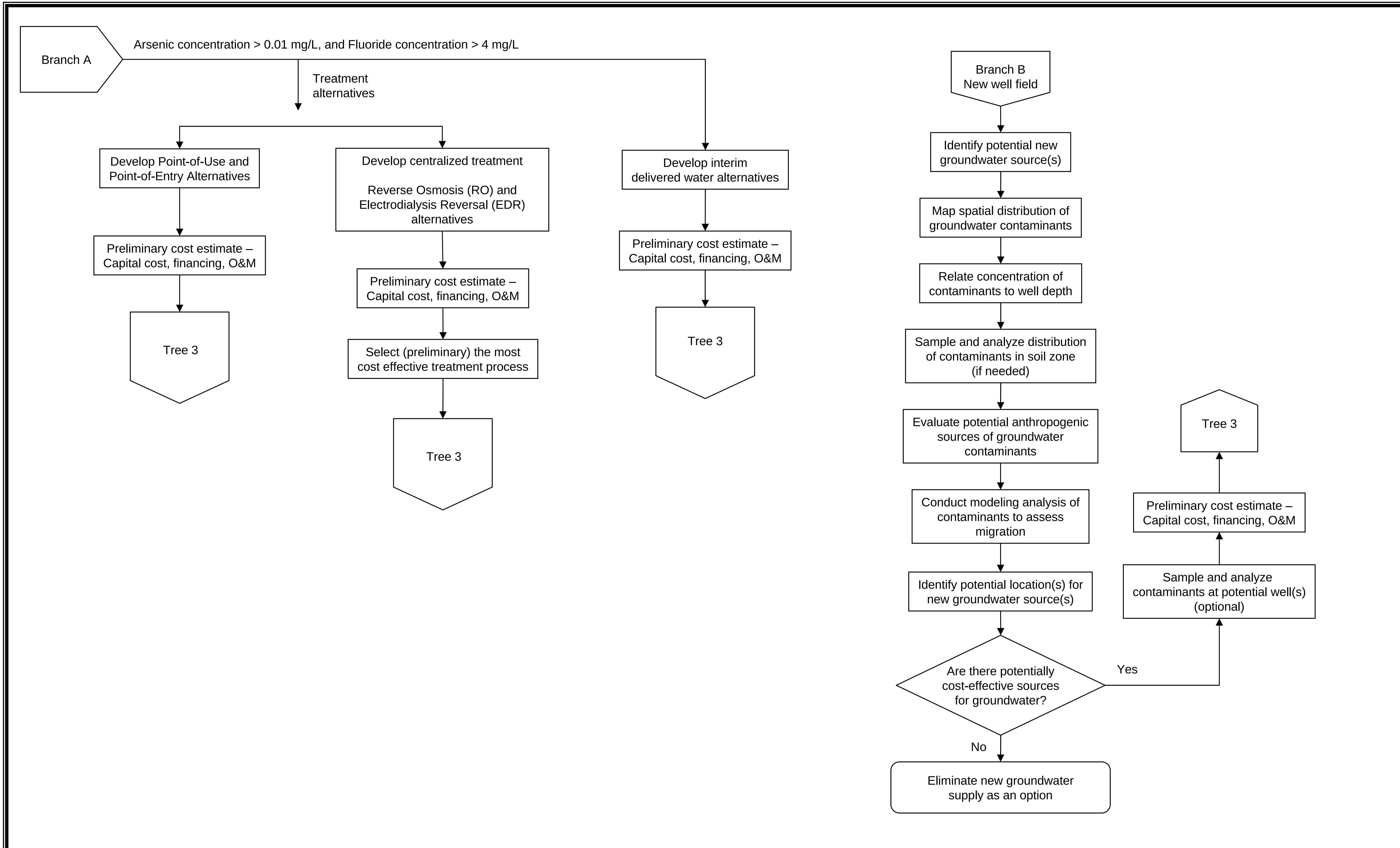


Figure 2.2
TREE 2 – DEVELOP TREATMENT ALTERNATIVES



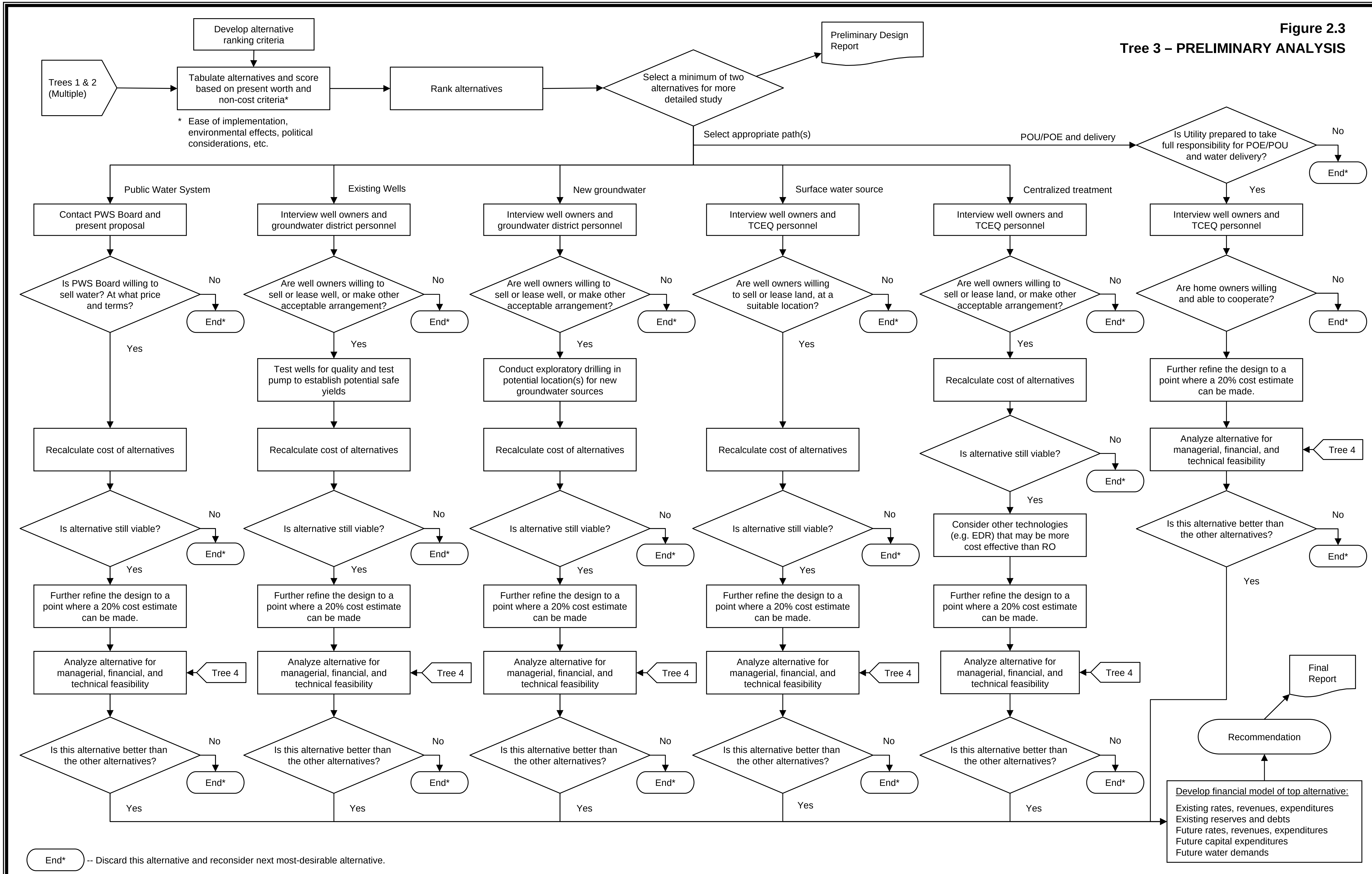
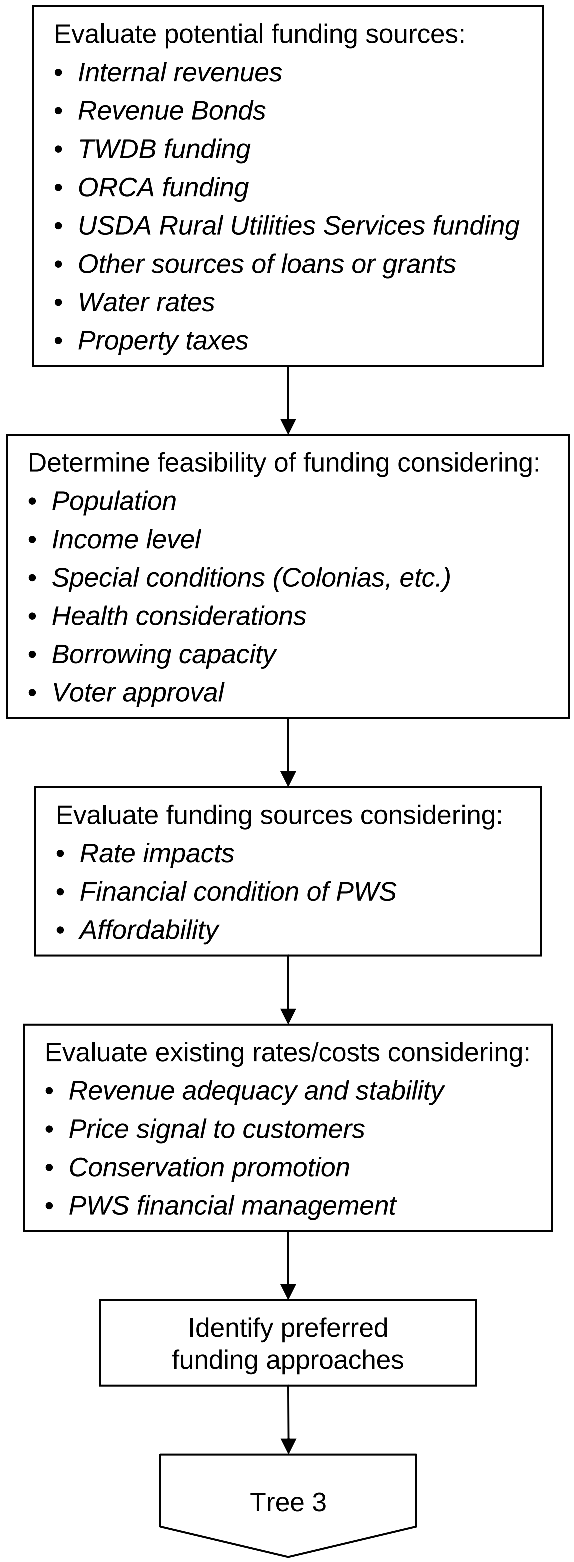


Figure 2.3
Tree 3 – PRELIMINARY ANALYSIS

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. GAMs for the Ogallala Aquifer and Edwards-Trinity Plateau Aquifer were investigated as potential tools 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 in various forms such as electronic files, hard copy documents, and focused interviews. 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 that 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 an 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 (items that could be converted to cash) divided by current liabilities (accounts payable, accrued expenses, and debt) 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 money borrowed) divided by net worth (total assets minus total liabilities) shows to what degree assets of the company have been funded through borrowing. A lower ratio indicates a healthier condition.
- Operating Ratio = total operating revenues divided by total operating expenses show the degree to which revenues cover ongoing expenses. The value is greater than 1.0 if the utility is covering its expenses.

2.4.2 Median Household Income

The 2000 U.S. Census is used as the basis for MHI. In addition to consideration of affordability, the annual MHI may also be an important factor for sources of funds for capital programs needed to resolve water quality issues. Many grant and loan programs are available to lower income rural areas, based on comparisons of local income to statewide incomes. In the 2000 Census, MHI for the State of Texas was $39,927, compared to the U.S. level of $41,994. 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 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, 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 Water Supply Corporations (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.

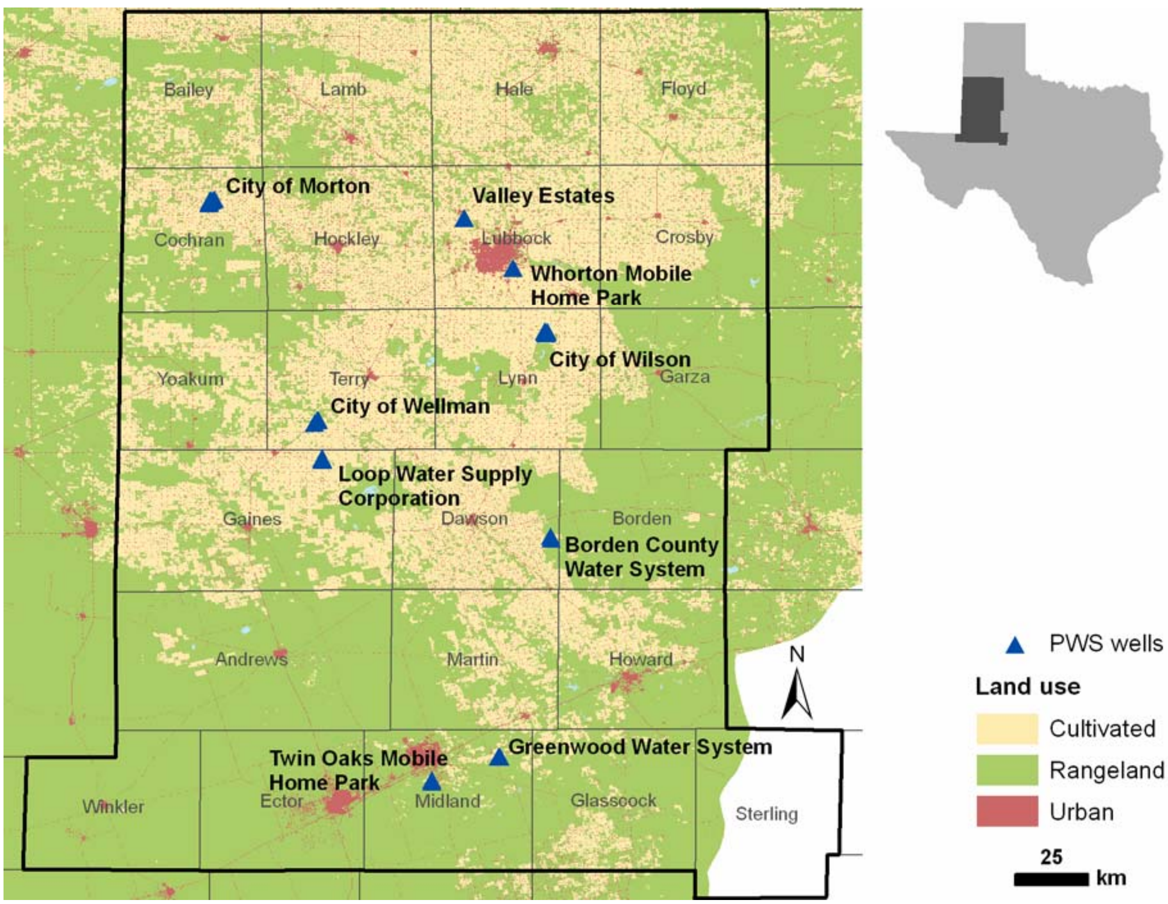
SECTION 3
UNDERSTANDING SOURCES OF CONTAMINANTS

3.1 REGIONAL ANALYSIS

3.1.1 Overview of the Study Area

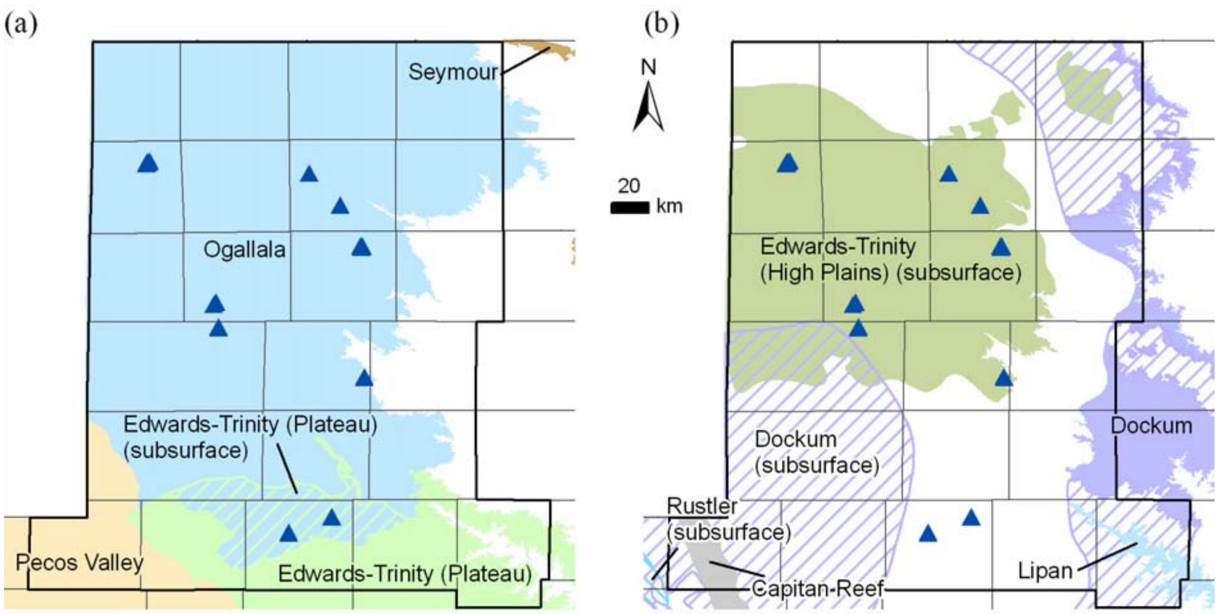
The regional analysis described below includes data from 23 counties in the High Plains within Texas: Andrews, Bailey, Borden, Cochran, Crosby, Dawson, Ector, Floyd, Gaines, Garza, Glasscock, Hale, Hockley, Howard, Lamb, Lubbock, Lynn, Martin, Midland, Sterling, Terry, Winkler, and Yoakum(Figure 3.1).

Figure 3.1 Regional Study Area and Locations of the PWS Wells Assessed



The major and minor aquifers within the region are shown in Figure 3.2. Most of the PWS wells of concern 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, including the Capitan Reef, Lipan, Pecos Valley, Rustler, and Seymour aquifers, are not located near any of the wells in this analysis.

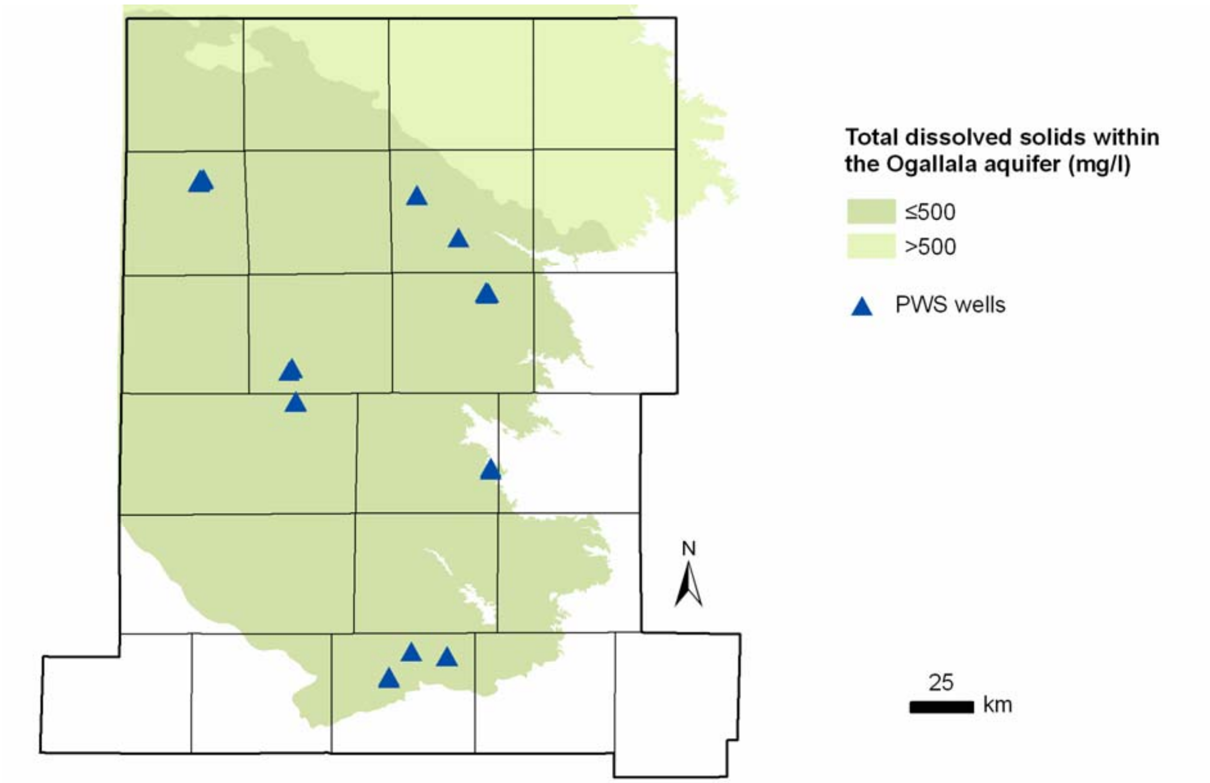
Figure 3.2 Major (a) and Minor (b) Aquifers in the Study Area



"Subsurface" indicates a portion of an aquifer that underlies other formations. All other labels indicate a portion of an aquifer that lies at the land surface.

Water quality in the Ogallala aquifer is distinctively different in the northern portion of the study area. Thus, this study analyzes the Ogallala aquifer in two parts: Ogallala-North (TDS ≤ 500 mg/L) and Ogallala-South (TDS > 500 mg/L) (Figure 3.3).

Figure 3.3 Water Quality Zones in the Study Area



Data used for this study include information from three 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.
- National Uranium Resource Evaluation (NURE) database available at: tin.er.usgs.gov/nure/water. The NURE dataset includes groundwater quality data collected between 1975 and 1980. The database provides well locations and depths with an array of analyzed chemical data. The NURE dataset covers only the eastern part of the study area.

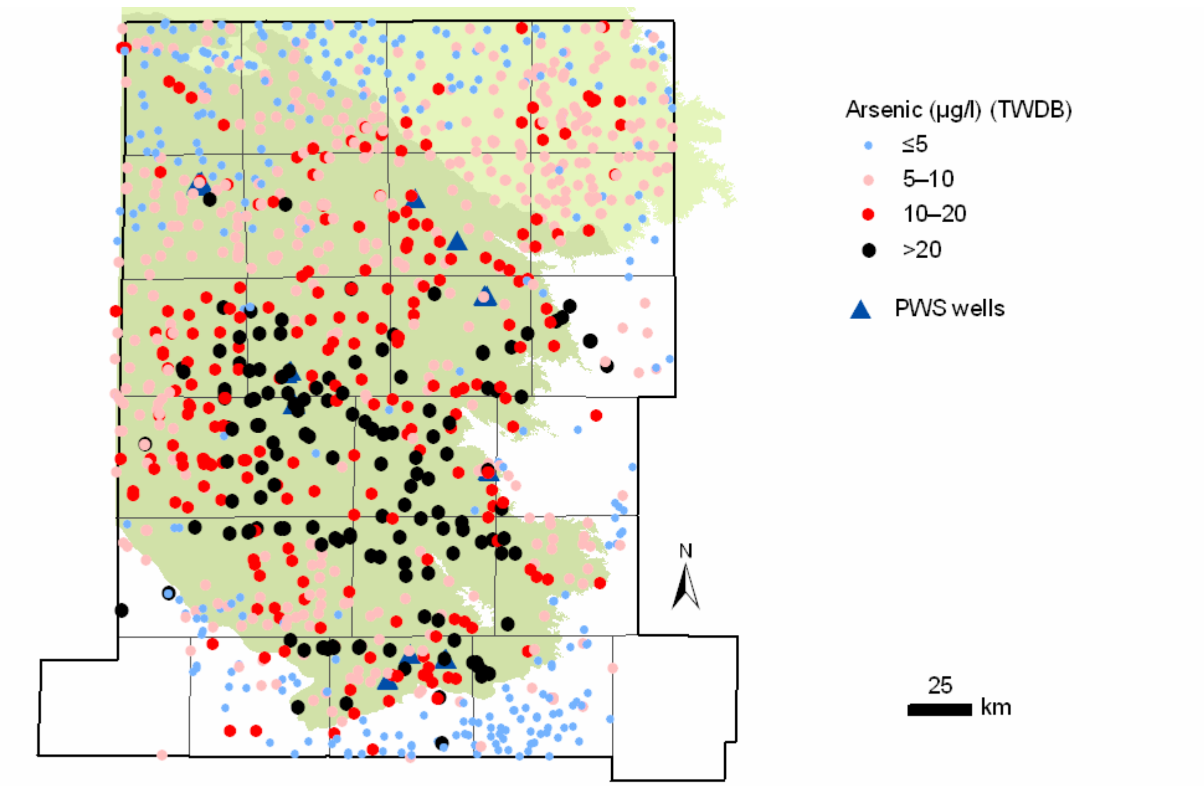
3.1.2 Contaminants of Concern in the Study Area

Contaminants addressed include arsenic, fluoride, nitrate, selenium, and uranium. In PWSs in the area, water sampling shows that one or more of these solutes exceeds the USEPA's MCL.

Arsenic

Arsenic concentrations exceed the USEPA's MCL (10 µg/L) throughout the study area, especially in the Ogallala-South area (Figure 3.4). Half of the wells in the Ogallala-South aquifer and one-fifth of wells in the Edwards-Trinity (High Plains) aquifer contain arsenic levels above the MCL. In contrast, only 10 percent or less of wells in the Ogallala-North, Edwards-Trinity (Plateau), and Dockum aquifers exceed the MCL for arsenic.

Figure 3.4 Spatial Distribution of Arsenic Concentrations



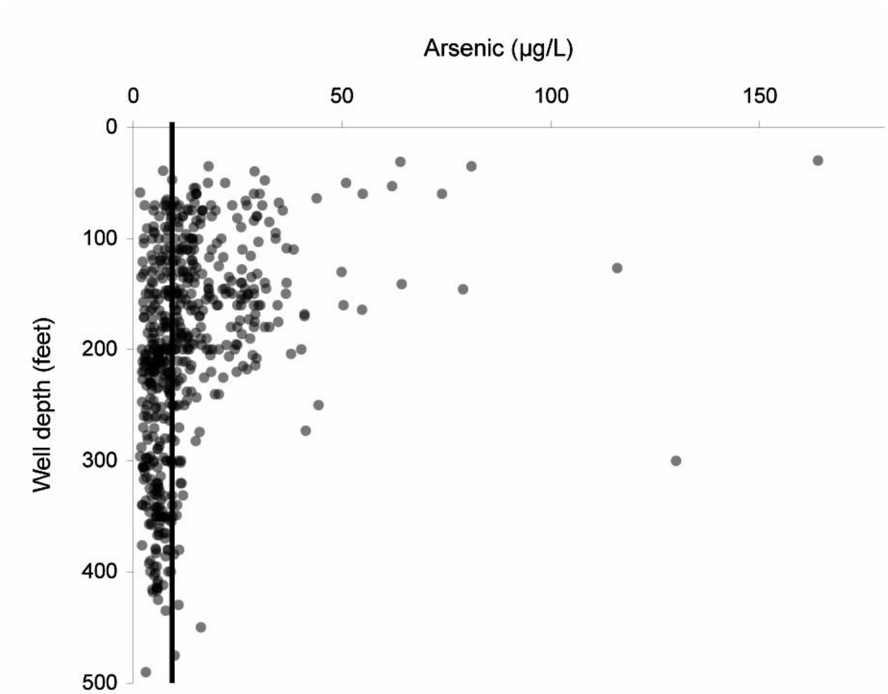
Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.1 gives the percentage of wells with arsenic exceeding the MCL (10 µg/L) in each of the major aquifers in the study area.

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-North	228	15	7%
Ogallala-South	642	323	50%
Edwards-Trinity (Plateau)	127	13	10%
Edwards-Trinity (High Plains)	16	3	19%
Dockum	70	4	6%
Other	5	0	0%

There is a clear stratification of arsenic concentrations with depth in the study area (Figure 3.5), with arsenic concentrations decreasing with depth. This suggests that tapping deeper water by deepening shallow wells or casing off shallower parts of wells might decrease arsenic concentrations.

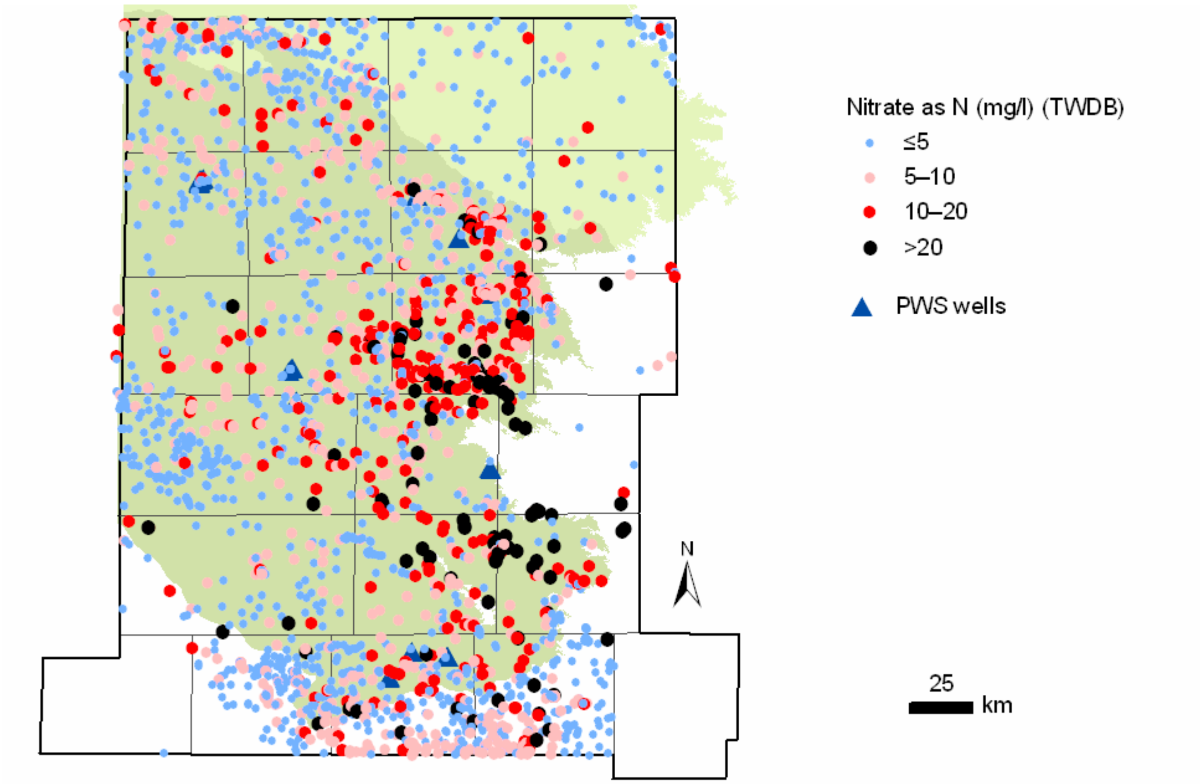
Figure 3.5 Arsenic Concentrations and Well Depths in the Ogallala Aquifer



Nitrate

Nitrate concentrations exceed the MCL (10 mg/L) throughout the study area, especially in the eastern part of the Ogallala-South aquifer (Figure 3.6). In the Ogallala-North, only one percent of wells have nitrate concentrations above the MCL.

Figure 3.6 Spatial Distribution of Nitrate Concentrations



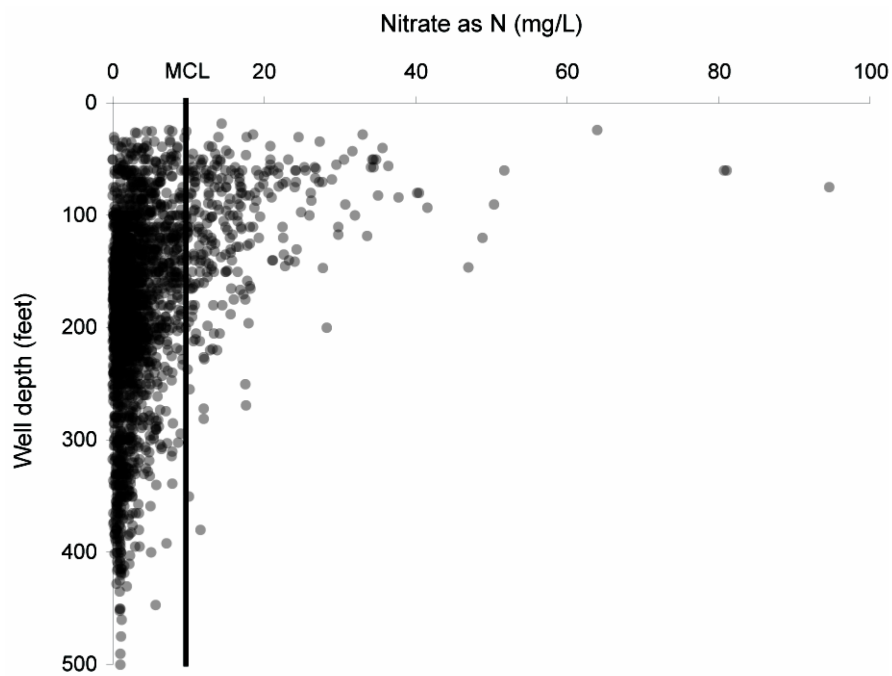
Data presented here are from the TWDB database. The most recent measurement from each well is shown. Table 3.2 shows the percentage of wells with nitrate as N exceeding the MCL (10 mg/L).

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-North	590	6	1%
Ogallala-South	2826	370	13%
Edwards-Trinity (Plateau)	642	39	6%
Edwards-Trinity (High Plains)	76	3	4%
Dockum	149	9	6%
Seymour	1	1	100%
other	40	5	13%

Within the study area, the concentration of nitrate as N tends to decrease with well depth (Figure 3.7). Nearly all wells in the Ogallala aquifer deeper than 250 feet have acceptable nitrate levels. Therefore, deepening shallow wells or casing the upper portions of problematic wells might decrease nitrate concentrations.

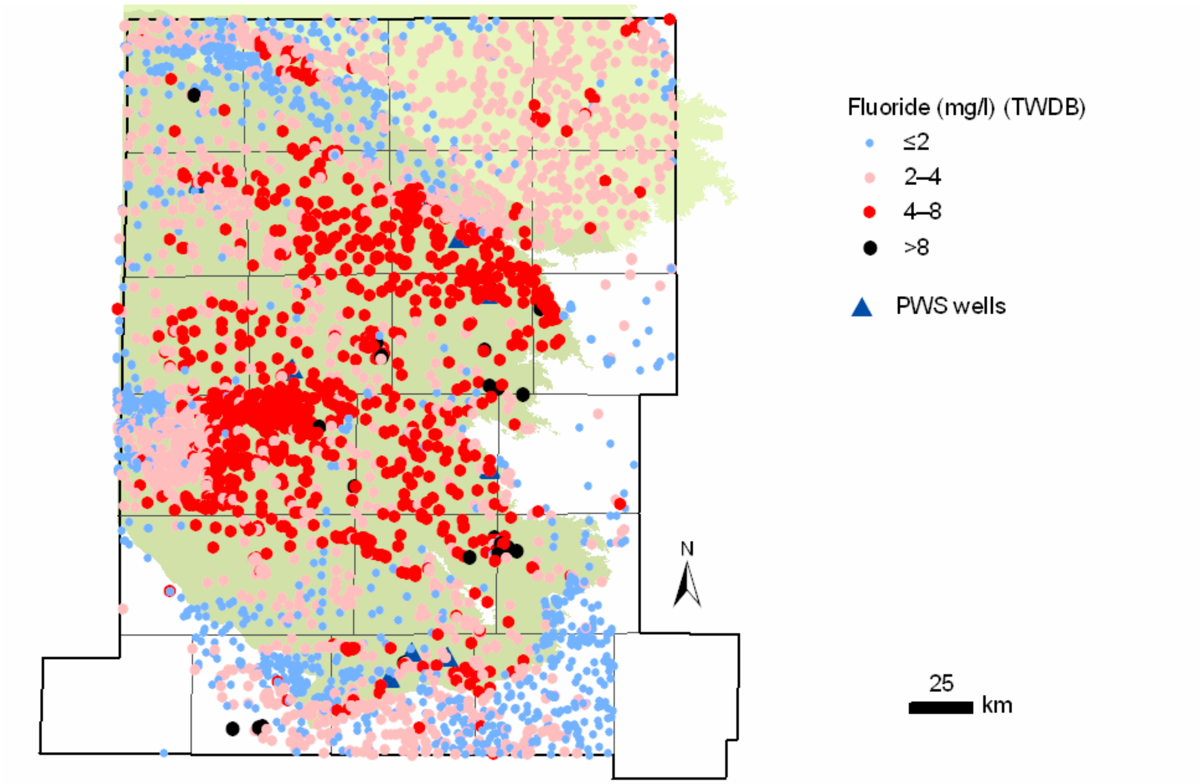
Figure 3.7 Nitrate as N Concentrations and Well Depths in the Ogallala Aquifer within the Study Area



Fluoride

Fluoride concentrations above the MCL (4 mg/L) are widespread in the Ogallala-South area (42% of wells) and relatively rare in the Ogallala-North area (2% of wells) (Figure 3.8, Table 3.3). Fluoride levels are also high in the Edwards-Trinity (High Plains) aquifer, with over half of wells in the aquifer containing fluoride in excess of the MCL.

Figure 3.8 Spatial Distribution of Fluoride Concentrations



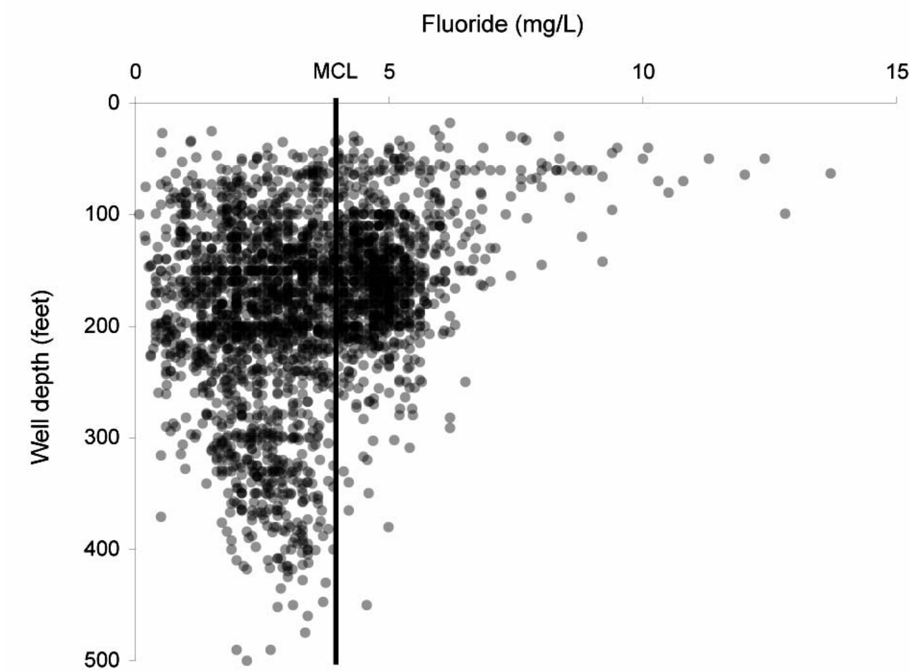
Data presented here are from the TWDB database. The most recent measurement from each well is shown. Table 3.3 shows the percentage of wells with fluoride exceeding the MCL (4 mg/L).

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-North	588	13	2%
Ogallala-South	2622	1098	42%
Edwards-Trinity (Plateau)	626	5	1%
Edwards-Trinity (High Plains)	76	40	53%
Dockum	144	10	7%
other	29	5	17%

Comparing fluoride levels with well depth, it is clear that the highest fluoride concentrations occur in wells shallower than about 100 feet and that concentrations tend to decrease with well depth (Figure 3.9). However, fluoride levels above the MCL are common in wells 100–200 feet deep. Based on this trend, deepening shallow wells or casing the shallower portions of wells could lead to decreased fluoride concentrations in produced groundwater.

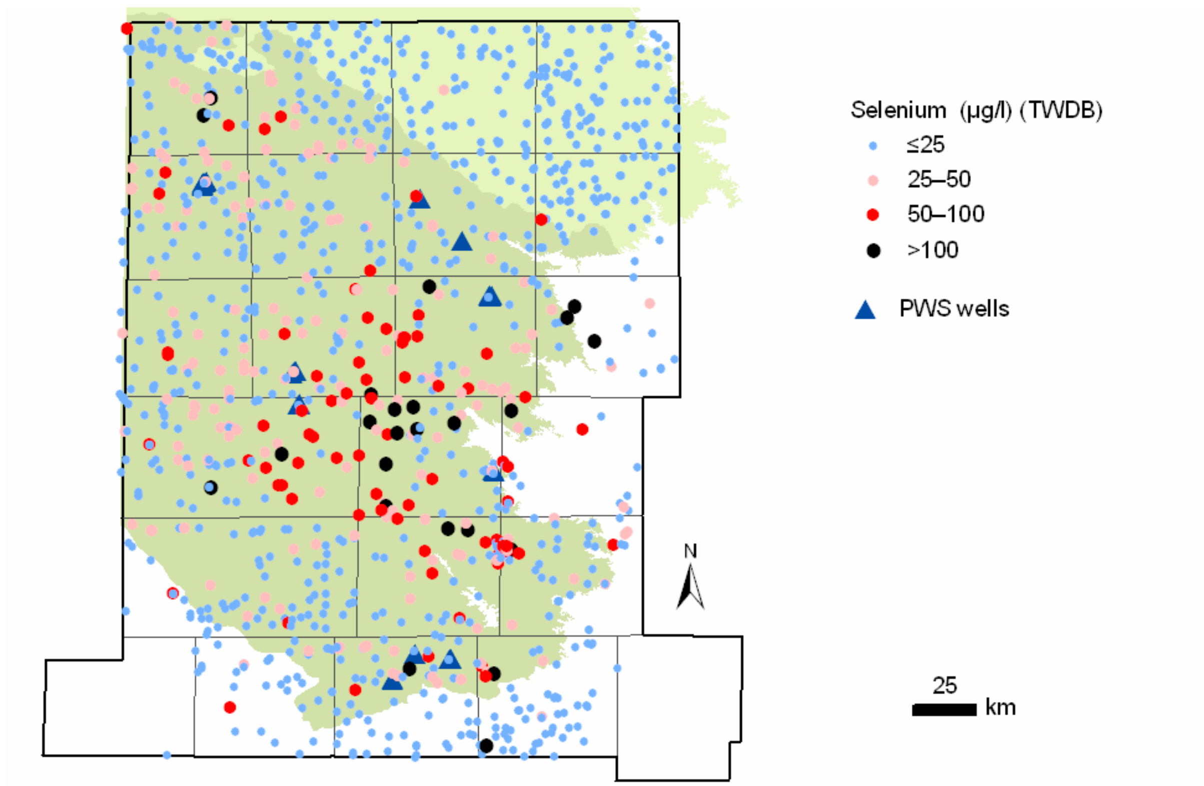
Figure 3.9 Fluoride Concentrations and Well Depths in the Ogallala Aquifer within the Study Area



Selenium

Selenium concentrations in the study area are generally below the MCL (50 µg/L). However, some wells with excess selenium occur in the Dockum and Ogallala-South aquifers, particularly in the eastern part of the study area (Figure 3.10, Table 3.4).

Figure 3.10 Spatial Distribution of Selenium Concentrations



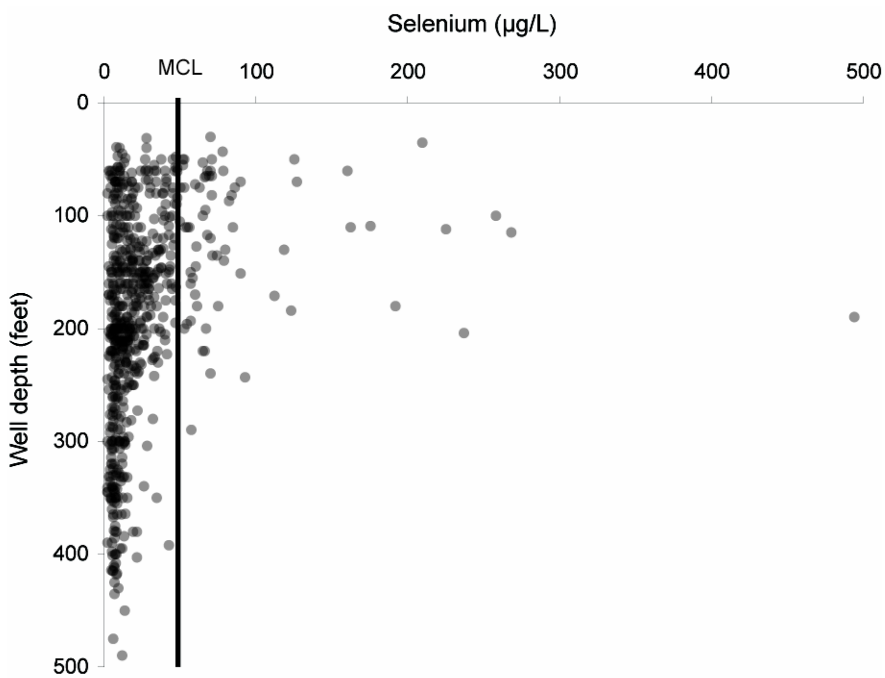
Data presented here are from the TWDB database. The most recent sample for each well is shown. Table 3.4 shows the percentage of wells with selenium concentrations exceeding the selenium MCL (50 µg/L).

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-North	233	0	0%
Ogallala-South	693	84	12%
Edwards-Trinity (Plateau)	104	1	1%
Edwards-Trinity (High Plains)	16	1	6%
Dockum	74	10	14%
Other	5	1	20%

Selenium shows a trend with well depth similar to that of the other constituents discussed (Figure 3.11). Most wells with selenium concentrations above the MCL are shallower than 200 feet. Thus, deepening a well to more than 200 feet or casing the shallower portion of deeper wells could lead to reduced selenium concentrations.

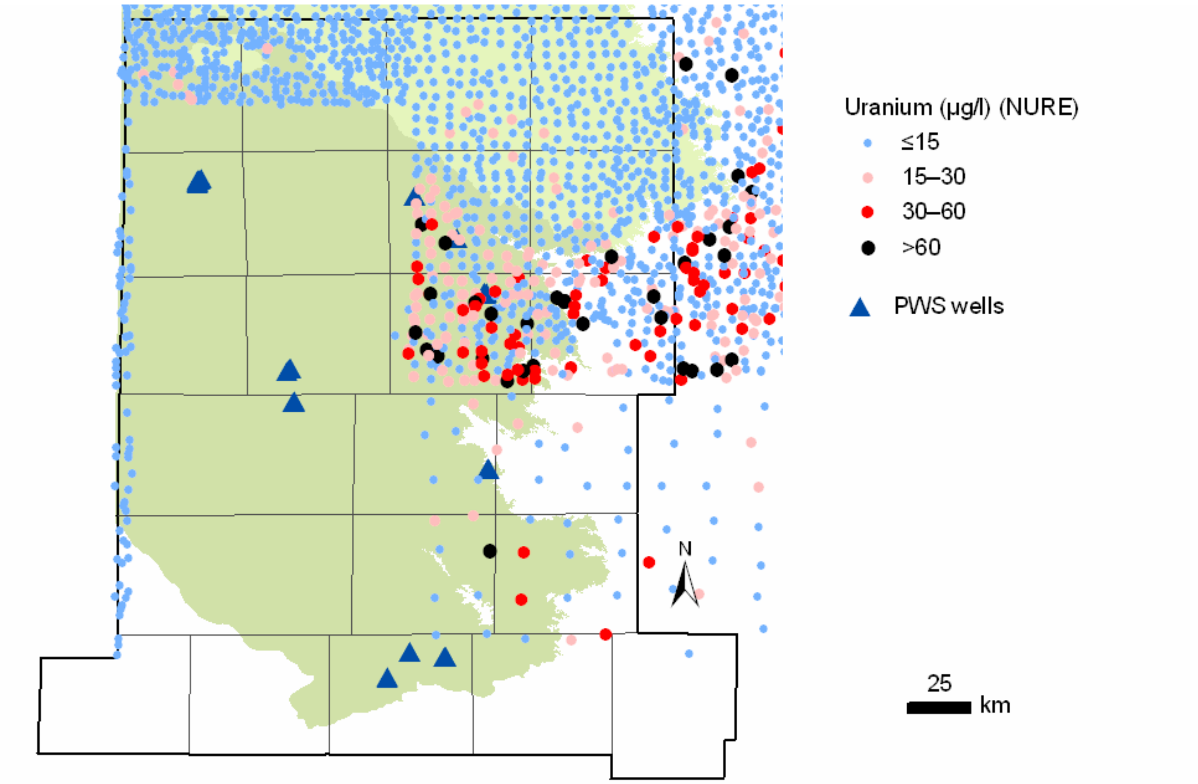
Figure 3.11 Selenium Concentrations and Well Depths in the Ogallala Aquifer within the Study Area



Uranium

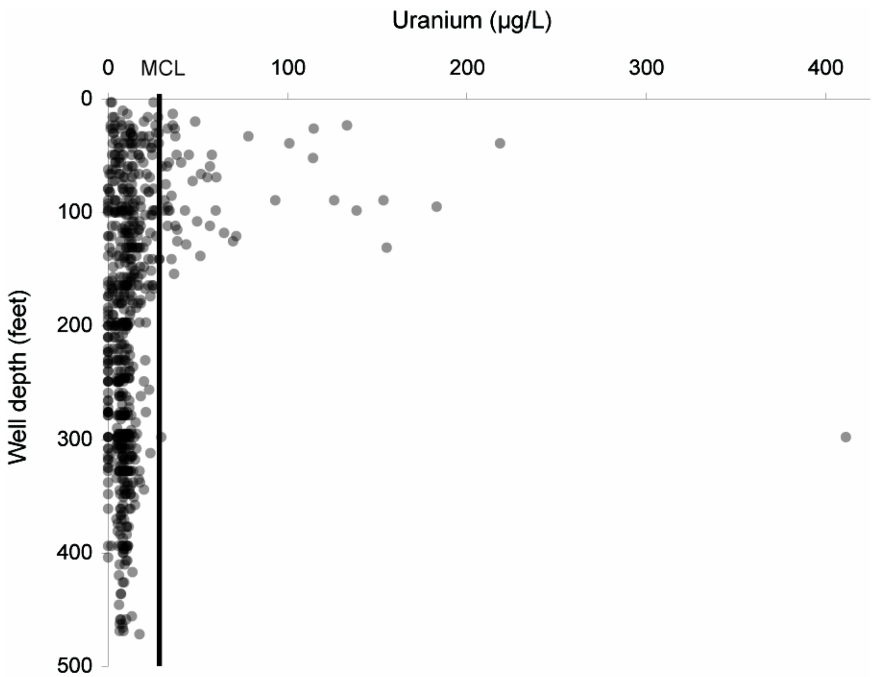
The TWDB rarely tests wells for uranium content in water samples, but the NURE database provides a large dataset of uranium levels in the area. This database only includes wells from part of the study area, as shown in Figure 3.12. Even with this limited distribution of measurements, it is clear that uranium concentrations are much higher in the Ogallala-South aquifer than the Ogallala-North aquifer. However, the NURE database does not include information about which aquifer the sampled wells are from, so a quantitative comparison of uranium levels by aquifer is not available.

Figure 3.12 Spatial Distribution of Uranium Concentrations in the Study Area



A comparison of uranium concentrations and well depths shows that nearly all wells with uranium levels above the MCL are less than about 150 feet deep (Figure 3.13). Therefore, deepening or casing wells to access water from greater depths might reduce uranium levels.

Figure 3.13 Uranium Concentrations and Well Depths in the Study Area



3.1.3 Regional Geology

The major aquifer in the study area is 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) (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 deposited in intervening upland areas (Gustavson and Holliday 1985). In the Ogallala-North area, the Ogallala Formation consists largely of sediments within a paleovalley. In this region, the saturated thickness of the aquifer is greater and the water table is deeper. In contrast, the formation is composed of deposition on top of a paleoupland in the Ogallala-South area. Here the formation is thinner, resulting in a smaller saturated thickness and shallower 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). The texture of the formation ranges from sands and gravels along riverbeds to clay-rich sediments 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 49 feet thick) and the Edwards Limestone (about 98 feet 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 492 feet thick and is exposed along the margins of the High Plains. The uppermost sediments consist of red mudstones 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). The sediments of the Dockum were 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 1,956 feet thick in the Midland Basin.

3.2 DETAILED ASSESSMENT FOR GREENWOOD PWS

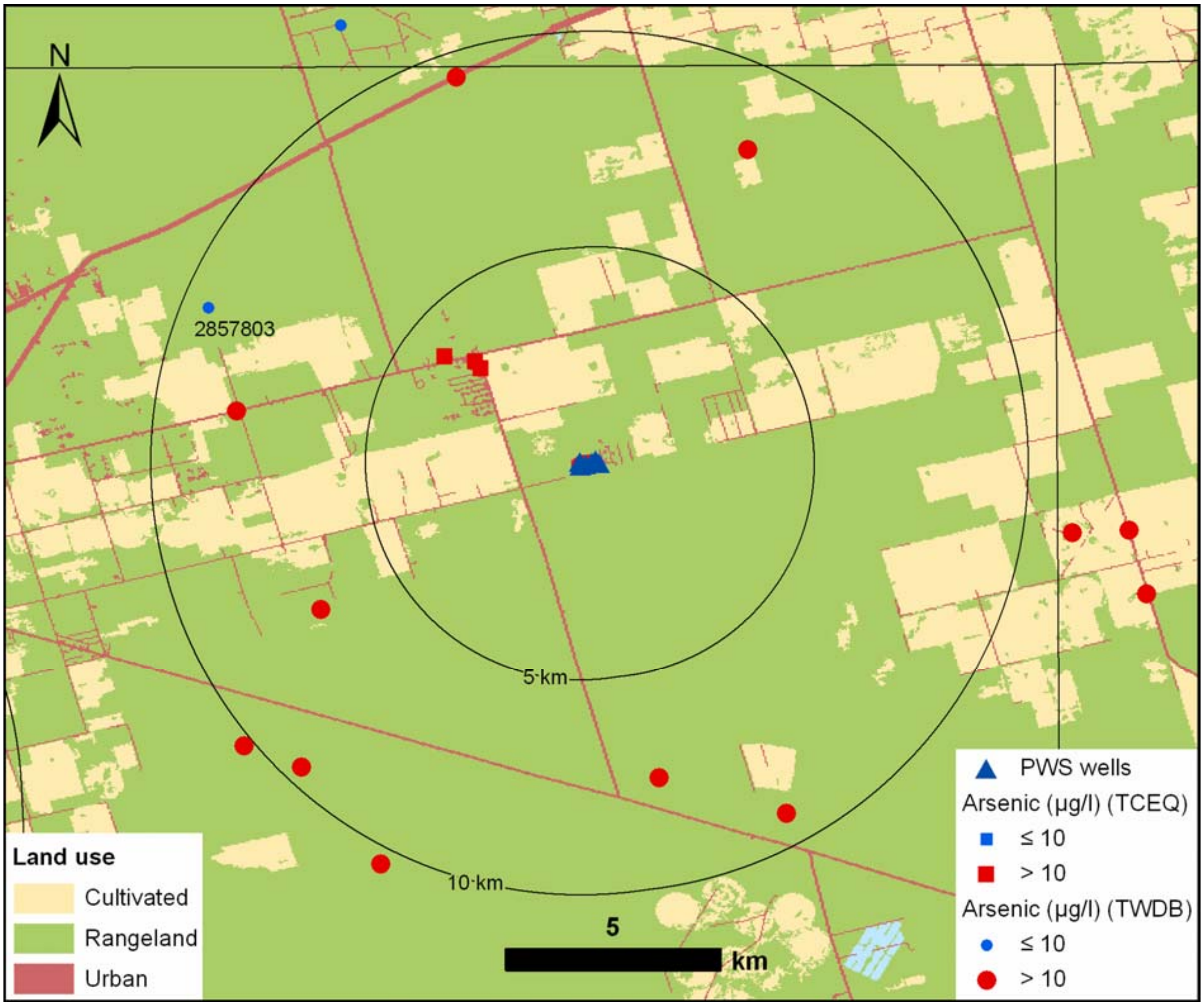
The Greenwood PWS has six wells, G1650078A–F, with depths ranging from 100 to 180 feet. All are listed as being within the Ogallala aquifer. These wells share a single sampling entry point from ground storage, meaning that available water chemistry data cannot be ascribed to an individual well. Arsenic concentrations measured from this groundwater sampling point are listed in Table 3.5.

Table 3.5 Arsenic Concentrations from the Greenwood PWS

Date	Arsenic (µg/L)	Source sampled
2/26/98	25.4	G1650078A–F
2/14/00	28.8	G1650078A–F
7/24/03	28.5	G1650078A–F
3/1/05	22.5	G1650078A–F
5/16/05	26.1	G1650078A–F
12/28/05	18.7	G1650078A–F
1/17/06	20.4	G1650078A–F
4/20/06	22.8	G1650078A–F
7/19/06	21.9	G1650078A–F
12/27/06	27.4	G1650078A–F
2/6/07	24.3	G1650078A–F
4/26/07	16.5	G1650078A–F

Data from the TCEQ PWS Database

Figure 3.14 Arsenic Concentrations within 5- and 10-km Buffers around Greenwood PWS Wells



Data are from the TCEQ and TWDB databases. Two types of samples were included in the analysis. Samples from the TCEQ database (shown as squares 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 circles in the map). Where more than one measurement has been made in a well, the most recent concentration is shown.

One well within 6.2 miles of the Greenwood PWS wells, 2857803, has shown an arsenic concentration below the MCL. It also contains acceptable levels of fluoride, nitrate, and selenium, but has not been tested for uranium (Table 3.6). This well is located about 5-1/2 miles from the PWS wells and is currently in use for domestic supply. It has not been tested since 1998, so it would need to be sampled again to verify that the water quality is currently acceptable before being selected as an alternative water supply.

Table 3.6 Most recent Concentrations of Select Constituents in Potential Alternative Water Sources

Well	Owner	Depth (ft)	Aquifer	Use	Date	Arsenic (µg/L)	Fluoride (mg/L)	Nitrate as N (mg/L)	Selenium (µg/L)
2857803	Tony Hamm	75	Ogallala	domestic	10/13/1998	8	0.64	3.901	20.4

3.2.1 Summary of Alternative Groundwater Sources for the Greenwood PWS

Of the wells within 6.2 miles of the Greenwood PWS wells tested for arsenic, only one showed arsenic concentrations below the MCL. This well is located about 5-1/2 miles west of the PWS wells and is currently in use as a domestic water supply. It also showed acceptable levels of fluoride, nitrate, and selenium, but would need to be resampled to measure current solute concentrations before being chosen as an alternative supply.

In addition, regional analyses indicate that wells deeper than about 250 feet are much less likely to exceed the MCLs for arsenic and other constituents of concern. Because the current PWS wells are all shallower than 200 feet, it is possible that deepening one or more of the wells would help to lower arsenic levels.

SECTION 4
ANALYSIS OF THE GREENWOOD PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1 Existing System

The location of the Greenwood PWS is shown in Figure 4.1. The Greenwood PWS is located in Midland County approximately 8 miles east of the City of Midland at 2810 Farm to Market Road 1379. The water system serves a population of 800 and has 267 connections. The water source comes from six groundwater wells completed to depths ranging from 100 feet to 190 feet in the Ogallala aquifer (121OGLL). Wells #2, #3, #4, #5, and #6 (G1650078B, G1650078C, G1650078D, G1650078E, and G1650078F) are rated at 50 gallons per minute (gpm), 45 gpm, 200 gpm, 200 gpm, 250 gpm, respectively. Well #1 (G1650078A) is for emergency use only and is not active. The wells have a total production 0.745 mgd.

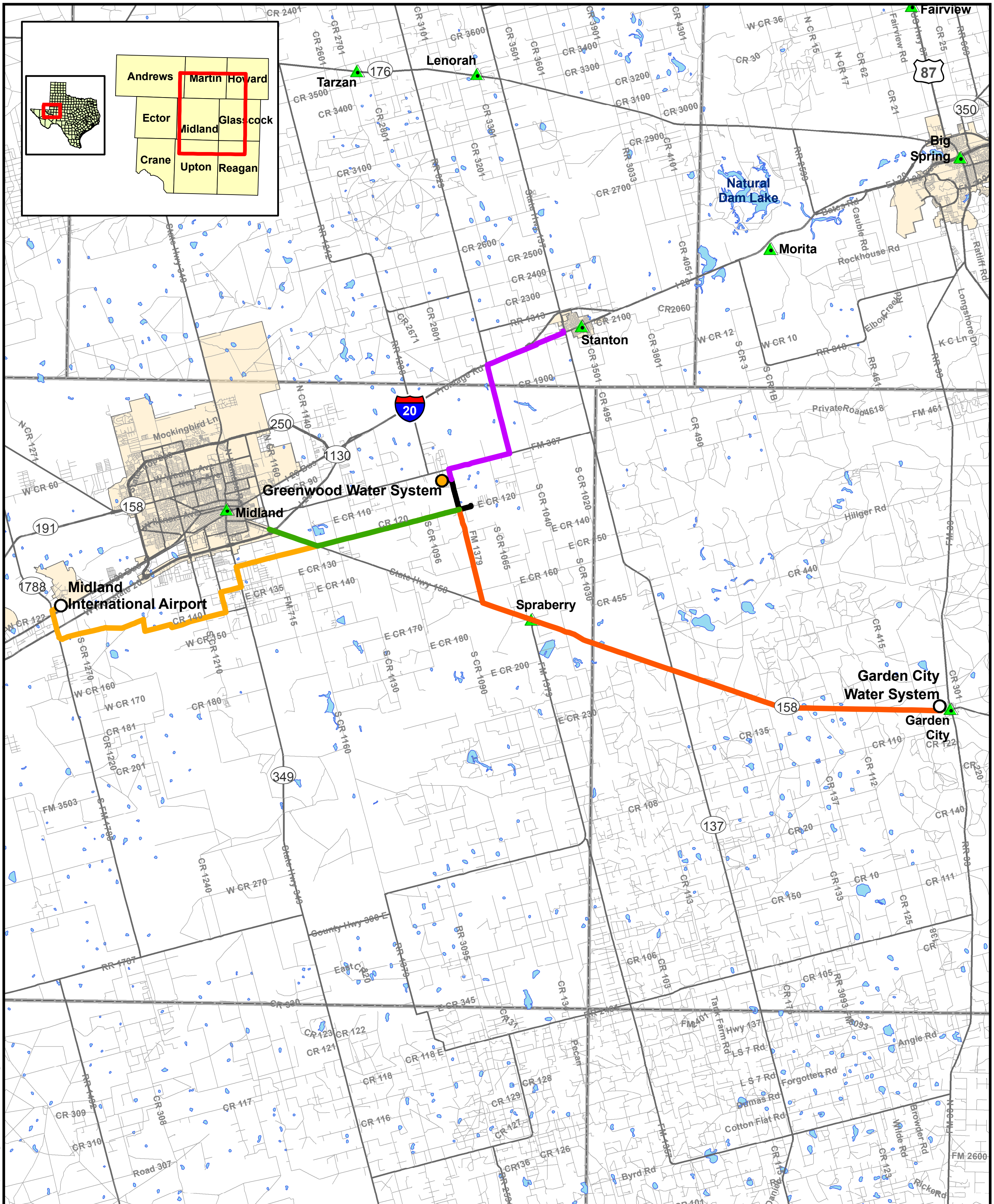
The wells pump to a ground storage tank (0.115 million gallon capacity). The water is chlorinated ahead of the ground storage tank. Four service pumps feed the distribution system, and the pressure tanks float on the distribution system.

The treatment employed for disinfection is not appropriate or effective for removal of arsenic and fluoride, so optimization is not expected to be effective for increasing removal of these contaminants. However, there is a potential opportunity for system optimization to reduce arsenic and fluoride concentrations. The system has more than one well, and since arsenic and fluoride concentrations can vary significantly between wells, arsenic and fluoride concentrations should be determined for each well. If one or more wells happens to produce water with acceptable arsenic and fluoride levels, as much production as possible should be shifted to that well. It may also be possible to identify contaminant-producing strata through comparison of well logs or through sampling of water produced by various strata intercepted by the well screen.

During the period April 2006 to March 2007, arsenic concentrations ranged from 0.0108 mg/L to 0.0241 mg/L, exceeding the 0.01 mg/L MCL for arsenic. In August 2004, a fluoride concentration of 4.5 mg/L was detected and exceeded the 4 mg/L MCL for fluoride (USEPA 2008a). Between February 1998 and March 2005 fluoride concentrations between 3.4 mg/L and 3.8 mg/L were recorded, exceeding the secondary fluoride MCL of 2 mg/L (TCEQ 2004); therefore, Greenwood PWS faces compliance issues under the water quality standards for arsenic and fluoride.

Basic system information is as follows:

- Population served: 800
- Connections: 267
- Average daily flow: 0.145 mgd



Legend

- Study System
- PWS's
- Cities
- City Limits
- Counties
- Major Road
- Minor Road
- CRMWA Pipeline
- Lubbock Pipeline
- Grass Valley Pipeline
- GW-1 City of Midland - 9.5 Miles
- GW-2 City of Stanton - 12.1 Miles
- GW-3 Midland International Airport - 25 Miles
- GW-4 Garden City Water System - 27.9 Miles
- Existing Pipeline

N

Miles
0 3 6

Figure 4.1

GREENWOOD WATER SYSTEM

Pipeline Alternative

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- Total production capacity: 0.705 mgd

Basic system raw water quality data are as follows:

- Typical arsenic range: 0.0108 to 0.0241 mg/L
- Typical fluoride range: 3.40 to 4.5 mg/L
- Typical calcium range: 87 to 108 mg/L
- Typical chloride range: 182 to 203 mg/L
- Typical iron: <0.081 mg/L
- Typical magnesium range: 34 to 51 mg/L
- Typical manganese : <0.008 mg/L
- Typical nitrate range: 3.76 to 4.82 mg/L
- Typical selenium range: 0.0173 to 0.0222 mg/L
- Typical sodium range: 92 to 116 mg/L
- Typical sulfate range: 180 to 188 mg/L
- Total hardness as CaCO3 range: 411 to 450 mg/L
- Typical pH range: 7.3 to 7.5
- Total alkalinity as CaCO3 range: 181 to 186
- Typical bicarbonate range: 221 to 227 mg/L
- Typical total dissolved solids range: 735 to 903 mg/L

The typical ranges for water quality data listed above are based on a TCEQ database that contains data updated through the beginning of 2005.

4.1.2 Capacity Assessment for the Greenwood PWS

The project team conducted a capacity assessment of the Greenwood PWS on July 17, 2008. 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 financial, managerial, and technical 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 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 ensure proper operation of the system. The last category, capacity concerns, includes items not causing significant problems for the system at this time. However, the system may want to address them before they become problematic.

Because of the challenges facing very small water systems, it is increasingly important for them to develop the internal capacity to comply with all state and federal requirements for public drinking water systems. For example, it is especially important for very small water systems to develop long-term plans, set aside money in reserve accounts, and track system expenses and revenues because they cannot rely on increased growth and economies of scale to offset their costs. In addition, it is crucial for the owner, manager, and operator of a very small water system to understand the regulations and participate in appropriate training. Providing safe drinking water is the responsibility of every public water system, including those very small water systems that face increased challenges with compliance.

The project team interviewed Paul Wilhite, owner and Curtis Fosberg, part-time operator.

4.1.2.1 General Structure of the Water System

The Greenwood subdivision was created in 1982, and the water system was constructed to enhance land sales. The current owner is one of the original partners in the subdivision and has lived in Greenwood since initial creation of the subdivision. The owner as well as his wife, Caroll Wilhite, is a licensed operator. Curtis Fosberg is the system's part-time operator. The water system serves approximately 800 residents with 267 service connections. The current minimum charge for water service is $42.45 per month, which does not include any water usage. Additional charges are $3.50 per 1,000 gallons up to 20,000 gallons. The system has a $25 reconnect fee.

The system is not in compliance with the drinking water standards for arsenic and has signed a Bilateral Compliance Agreement (BCA) with TCEQ for arsenic. In addition, the system exceeds the secondary standard for fluoride.

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, financial, managerial, and technical aspects of the water system, but there are also some areas that need improvement. The deficiencies noted could prevent the water system from being able to meet compliance now or in the future and may also impact the water system's long-term sustainability.

4.1.2.3 Positive Aspects of Capacity

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

- **Dedicated and Knowledgeable Owner and Operator–** Both Mr. Wilhite and Mr. Fosberg have been with the water system since 1982 and are extremely knowledgeable about the issues. Both are certified operators (Level C Groundwater) as well as certified Customer Service Investigators. The owner's wife, Caroll Wilhite, is also a certified operator in addition to her responsibilities for the billing and financial accounting for the system. All live in the subdivision and are personally committed to providing residents with safe drinking water. In addition Mr. Wilhite has used his own money to keep the water system running, including $12,000 in 2003.

- **Financial Sustainability** – In 1982, the water rates were extremely low and were not based on the actual costs of providing water. The owner filled out the application for a rate case in 2003 and 2006. Both applications were approved. He has since filed another rate case in January 2008. Because he has been able to increase rates, he has been able to cover costs of the water system and be proactive in meeting the water system improvement needs.

4.1.2.4 Capacity Deficiencies

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

- **Lack of Compliance with Arsenic Standard –** While the owner of the water systems has done some research on the treatment alternatives and the costs of those alternatives, the water system is not in compliance with the arsenic standard. They have signed a BCA with TCEQ.

4.1.2.5 Potential Capacity Concerns

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

- **Lack of Written Capital Improvements Plan** – Although the owner has an idea of future projects that are needed, such as replacing main lines and replacing water meters, there is no written plan for future improvements. This lack of a plan makes it difficult to know the true financial impact of future projects as well as installation of treatment to meet compliance.
- **Lack of a Source Water and Wellhead Protection Plan** - Although participation in the source water protection program through TCEQ is voluntary, it is recommended the water system participate in the program to better protect its water source. In addition, the water system should develop a wellhead protection plan. Although not required, wellhead protection plans provide a valuable resource to the water system in the maintenance and protection of the water wells the system relies on for safe drinking water. As a first step, the system should contact TCEQ to inquire about participating in the source water protection plan.

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 Greenwood PWS were reviewed with regard to their reported drinking water quality and production capacity. PWSs that have had water quality issues were ruled out from evaluation as alternative sources, while those without identified water quality issues were investigated further. Small systems were only considered if they were within 15 miles of the Greenwood PWS. Large systems or systems capable of producing greater than four times 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 Greenwood PWS. 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 Greenwood PWS

PWS ID	PWS Name	Distance from Greenwood PWS (miles)	Comments/Other Issues
1650006	GREENWOOD VENTURES INC	1.86	Small GW system. WQ issues: arsenic, uranium, and Nitrate
1650035	GREENWOOD ISD	2.01	Larger Small GW system. WQ issues: arsenic, nitrate, and selenium
1650112	RANGER STATION CAFE	2.18	Small GW system. WQ issues: arsenic, fluoride, nitrate, and selenium
1650024	PECAN GROVE MOBILE HOME PARK	7.54	Larger SW System. WQ issues: Marginal arsenic and nitrate
1650007	VALLEY VIEW MOBILE HOME PARK	7.58	Small GW system. WQ issues: arsenic, uranium, and nitrate
1650048	GREENWOOD TERRACE M H SUBDIV	7.87	Larger GW system. WQ issues: arsenic and nitrate
1650022	SHERWOOD MOBILE HOME ESTATES	7.93	Larger GW system. WQ issues: arsenic and sulfate
1590011	TEXAS WATER STATION	9.69	Small GW system. Use treatment to overcome WQ issues
1650113	WATER RUNNERS INC	9.89	Small GW system. Use treatment to overcome WQ issues
1650086	KENT KWIK CONVENIENCE STORE 312	10.22	Small GW system. WQ issue: Nitrate
1650026	DEFS-SPRAYBERRY PLT	11.41	Larger GW system. Use treatment to overcome WQ issues
1650077	SOUTH MIDLAND COUNTY WATER SYSTEM	12.21	Larger GW system. arsenic, and nitrate
1650084	WARREN ROAD DEVELOPMENT	12.31	Larger GW system. arsenic, and nitrate
1650043	JOHNS MOBILE HOME PARK	12.66	Small GW system. arsenic, and nitrate

PWS ID	PWS Name	Distance from Greenwood PWS (miles)	Comments/Other Issues
1650057	TWIN OAKS MOBILE HOME PARK	13.04	Small GW system. arsenic, and nitrate
1650111	COUNTRY VILLAGE MOBILE HOME ESTATE	14.97	Larger GW system. arsenic, and nitrate
1650001	MIDLAND CITY OF	15	Larger SW/GW system. No WQ issue. **Evaluate Further**
1650047	WESTGATE MOBILE HOME PARK	15.34	Larger GW system. WQ issues: marginal arsenic and high TDS
1590003	CIRCLE SIX RANCH BAPTIST CAMP INC	15.41	Larger GW system. WQ issue: arsenic
1650003	AIRLINE MOBILE HOME PARK LTD	17.64	Larger system. WQ issues: Gross Alpha
1650066	SPRING MEADOW MOBILE HOME PARK	18.14	Larger GW system. WQ issues: arsenic
1590002	MARTIN COUNTY FRESH WATER DISTRICT	18.7	Larger GW system. WQ issue: nitrate
1650070	PECAN ACRES HOMEOWNERS ASSN	19.61	Larger GW system. WQ issues: arsenic
1650002	MIDLAND INTERNATIONAL AIRPORT	20.38	Larger System: No WQ issues. **Evaluate Further**
1590007	GRADY ISD	21.31	Small GW system. WQ issues: arsenic, and nitrate
1590001	STANTON CITY OF	21.5	Larger SW/GW System: WQ issues: arsenic, and nitrate. Uses compliant surface water. **Evaluate Further**:
1650029	MIDESSA OILPATCH RV PARK	21.99	Larger GW system. WQ issue: Nitrate
1650114	BLUE NILE WATER CO	23.35	Small GW system. WQ issues: Nitrate
1650096	KENT KWIK CONV STORE 315	23.85	Small GW system. No WQ issues
0870011	GARDEN CITY WTR SYS GLASSCOCK CNTY	24.2	Larger GW system. No WQ issues. **Evaluate Further**
0680072	ODESSA COUNTRY CLUB	25.51	Larger GW system. WQ issues: nitrate
0870003	GLASSCOCK COUNTY CO OP GIN	28.49	Small GW system. WQ issues: nitrate
0680174	DOUBLE H MOBILE HOME PARK	29.01	Small GW system. No WQ issues
0680202	CENTRIFLO PUMP & MACHINE CO	29.05	Small GW system. WQ issue: nitrate
0680195	GARDENDALE COUNTRY WATER INC	29.72	Small GW system. No WQ issues

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 Greenwood PWS and sufficient total production capacity for selling or sharing water. Based on the initial screening summarized in Table 4.1, four alternatives were selected for further evaluation. These alternatives are summarized in Table 4.2. The alternatives are a connection to the City of Midland, the Garden City Water Treatment System in Glasscock County, and the Midland

International Airport, and the City of Stanton systems. Descriptions of the potential water provider systems follow Table 4.2.

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

PWS ID	PWS Name	Pop.	Connec-tions	Total Production (mgd)	Avg Daily Usage (mgd)	Approx. Dist. from Greenwood	Comments/Other Issues
1650001	CITY OF MIDLAND	100,387	38,677	98.58	21.2	15	Larger GW/SW system. No WQ issues.
1650002	MIDLAND INTERNATIONAL AIRPORT	1,000	166	1.529	0.281	20	Larger System: No WQ issues.
1590001	CITY OF STANTON	2,556	998	1.678	0.379	10	Larger SW/GW System: WQ issues: arsenic, and nitrate. Uses compliant surface water. **Evaluate Further**:
870011	GARDEN CITY	300	119	0.373	0.052	24	Larger GW system. No WQ issues.

WQ = water quality
GW = groundwater

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 Greenwood PWS, 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 million gallons per day (mgd). CRMWD primarily uses these well fields to supplement surface water deliveries during the summer months.

4.2.1.2 City of Midland

The center of the City of Midland is located approximately 15 miles west of the Greenwood PWS. The City of Midland purchases approximately 75 to 80 percent of its water from the CRMWD through a 1966 contract agreement. This purchased water comprises mainly untreated surface water from several reservoirs, including Lake J.B. Thomas, Lake E.V. Spence, and Lake O.H. Ivie, although the CRMWD may also supplement the supply with groundwater during the high demand summer months. The City of Midland gets the other 20 to 25 percent of its water from various City-owned well fields, which contain lower quality water. Midland is classified as a customer city of CRMWD and is allowed to use alternate water supplies, unlike Odessa whose water can only be provided by CRMWD.

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 Farm-to-Market Road (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 surface water provided by the CRMWD, Midland owns 16.54 percent of Lake Ivie, which is located approximately 170 miles southwest of Midland. Each day, 15 million gallons from Lake Ivie and 16 million gallons from CRMWD reservoirs are delivered via pipeline from Ballinger to San Angelo, and then to one of the three reservoirs around Midland.

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 10 MGD annually. 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 MCLs for these four constituents. The second well field is the T-Bar Ranch, which is 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 two water treatment plants 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, about 32,000 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 $12 base charge for the first 2,000 gallons and $2.75 for each additional 1,000 gallons.

In the fall of 2003, the Midland City Council decided that water can only be provided to areas annexed by the City of Midland. Consequently, while the City of Midland does have sufficient excess drinking water capacity, any location to receive water from the city would have to agree to be annexed. To be annexed, a commission representing the town to be annexed must submit a petition signed by at least 50 percent of the community residents wanting to be annexed. The commission representing the community then appoints a Public Improvement District to build a water line from a Midland supply line to the community. In the past, Midland has financed the Public Improvement District through the sale of bonds. The community would be subject to the same rates as other residences in Midland.

The City of Midland appreciates the issues faced by poor communities south of the Interstate Highway 20, as many were left abandoned by the original owner as water quality became bad. However, the City of Midland does not have infrastructure in the area to provide service to this area, and crossing under Interstate Highway 20 with a pipeline would be expensive. If funds can be made available to assist the City of Midland to expand its infrastructure to this area, the city would be interested in providing services to the communities in need. However, these communities would need to be annexed or at least be limited to small communities on small tracts of land such as mobile home parks. The City of Midland does have excess water and, with financial assistance for projects in poor areas outside the city, Midland may be an alternative water source for small communities.

4.2.1.3 Midland International Airport

Midland International Airport is located approximately 20 miles west from Greenwood PWS. The Midland International Airport is supplied by 10 groundwater wells that are completed in the Antler Sands aquifer (Code 218ALRS), range in depth from 85 to 130 feet, and are rated from 61 to 203 gpm. These wells are maintained and operated by the City of Midland Utility Department. Water from the wells is chlorinated and piped to an elevated 500,000-gallon storage tank before entering the airport's distribution system. The system is capable of producing up to 1.5 MGD, and average daily consumption is approximately 0.5 MGD.

Currently the operators of the PWS do not consider there to be sufficient excess capacity to provide water to offsite facilities or areas. However, based on available water quality data, the location may be a suitable point for a new groundwater well.

4.2.1.4 City of Stanton

The City of Stanton is located approximately 9.5 miles northwest of the Greenwood PWS. Stanton is under contract with the CRMWD to receive up to 90 million gallons (MG) of raw water per year via pipeline to Stanton's water treatment facility. Over the past few years, the water source has been either Lake Ivie or Lake Thomas, both located southeast of Stanton. In 2004, Stanton received a total of 113 MG of water or 0.31 mgd from CRMWD. In addition to receiving surface water from CRMWD, Stanton also has an emergency source consisting of a six-well ground water collection system. When water is needed, it is pumped to a central storage area consisting of two 150,000-gallon storage tanks. Each well is completed to approximately 180 feet in the Ogallala aquifer, and each well is capable of producing an average sustained rate of 65 gpm. The wells were tested individually, and sample results indicate elevated levels of nitrate above the MCL and also arsenic just below the current MCL. In 2004, no water was pumped from the six-well system.

The utility department in Stanton is currently providing water to several rural communities beyond city limits and is willing to provide water to other communities. However, the current water treatment plant serving Stanton was built in 1965 and needs to be replaced or upgraded prior to allocating any excess water supplies to additional users. Trucking of treated water to a nearby community can be approved by the Stanton utility manager. If a community requests treated water be piped to its area, then the plan must be approved by the five-member city council.

Current rates for city residential areas are as follows:

- Raw water – Minimum use of 3,000 gallons/month for a cost of $4.55 and $1.50/every 1,000 gallons over the initial 3,000 gallons.
- Treated water – Minimum use of 3,000 gallons/month for a cost of $21.00 and $3.50/every 1,000 gallons over 3,000 gallons.
- The current rate for outlying communities using City of Stanton water is:
- Treated water - $42.00 for the first 3,000 gallons and then $7.00 for every 1,000 gallons over 3,000 gallons.

The population of Stanton is around 2,700 with approximately 1,000 connections. There is no anticipated growth for Stanton.

4.2.1.5 Garden City Water System Glassrock County

Garden City Water System Glasscock County (Garden City) is located approximately 24 miles southeast of Greenwood PWS. Garden City serves a population of 300 through 119 connections. Garden City's customers use 0.052 MGD on an average day. The water system has a total water production capacity of 0.373 MGD.

This system has 0.165 MGD available to supply water to another system. Based on the available water quality data, the location may also be a suitable point for a new groundwater well if other systems require more than the 0.165 MGD available.

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

In northern Midland County, where the PWS is located, two aquifers are potential groundwater sources for public supplies: the Ogallala aquifer, and the subsurface section of the Edwards-Trinity Plateau aquifer. The Ogallala provides drinking water to most of the communities in the Texas panhandle, as well as irrigation water. The Edwards-Trinity Plateau is also a major aquifer extending across the southwestern part of the state. More than two-thirds of pumped groundwater is used for irrigation.

Six wells operated by the Greenwood PWS are completed in the southern Ogallala Aquifer, at depths ranging from 100 to 180 feet. A search of registered wells was conducted using TCEQ's Public Water Supply database to assess groundwater sources utilized within a 10-mile radius of the PWS. The search indicated that domestic and public supply wells located within a 10 miles from the Greenwood PWS also withdraw groundwater from the Ogallala; this aquifer is also extensively used in the PWS vicinity as a source of irrigation water. Within the same database search area, there are numerous active wells that obtain groundwater from the Edwards-Trinity Plateau Aquifer for stock watering and, to a lesser extent, domestic and industrial use.

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 the entire Midland County. The Ogallala provides significantly more water for users than any other aquifer in the state, and is used primarily for irrigation. 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. Over a 50-year planning period, the 2007 Texas Water Plan anticipates a water supply depletion of more than 40 percent, from 5,968,260 acre-feet per year (AFY) projected for the year 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.

Throughout northern Midland County, where the PWS is located, the subsurface section of the Edwards-Trinity Plateau Aquifer underlays the Ogallala aquifer. Wells in this region are supplied by both the Antlers Sands formation of the Trinity Group, and the Edwards and Comanche Peak formations of Fredericksburg Group.

Groundwater Availability

Regional groundwater withdrawal in the Texas High Plains region is extensive and likely to remain near current levels over the next decades. The 2007 State Water Plan indicates that in Midland County, without implementation of additional water management strategies, the increasing water demand will exceed projected water supply estimates. For the 50-year planning period ending in 2060, the additional water need will be 38,599 AFY by the year 2060. Over fifty percent of this deficit, 22,606 AFY, results from a rapidly increasing demand for municipal supplies. Irrigation water needs are expected to remain near current levels over the 50-year planning period.

A GAM for the Ogallala aquifer was developed by the TWDB (Blandford et al., 2003). Modeling was performed to simulate historical conditions and to develop long-term groundwater projections. Predictive simulations using the GAM model indicated that, if estimated future withdrawals are realized, aquifer water levels could decline to a point at which 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 the most critical conditions for Cochran, Hockley, Lubbock, Yoakum, Terry, and Gaines Counties where the simulated drawdown could exceed 100 feet. For northern Midland County, the simulated drawdown by the year 2050 would be more moderate, within the 0 to 25 feet range (Blandford et al., 2003). The Ogallala Aquifer GAM was not run for the PWS. 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.

Wells completed in the Edwards-Trinity Plateau Aquifer in this region are supplied by both the Antlers Sands formation of the Trinity Group, and the Edwards and Comanche Peak formations of Fredericksburg Group. A GAM for the Edwards-Trinity Plateau Aquifer was prepared by Anaya and Jones (2004) for the TWDB. GAM data for the aquifer indicate that total withdrawal in Midland County had a steady decline in recent years, from a peak annual use of 21,127 acre-feet in 1995 to 13,484 acre-feet in 2000. This reduced water withdrawal from the Edwards-Trinity Plateau aquifer is expected to remain nearly constant over a 50-year simulation period ending in the year 2050 (Anaya and Jones 2004).

4.2.3 Potential for New Surface Water Sources

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

The PWS is located in the upper reach of the Colorado Basin, within a relatively arid region of Texas that has a low surface water yield. The State Water Plan, updated in 2007 by the TWDB, estimates 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 Midland County, where the PWS is located, irrigation accounts for 74 percent of the current water use, with the remainder allocated for municipal use. The 2007 State Water Plan indicates that, without implementation of additional water management strategies, the increasing water demand in the county will exceed projected water supply estimates. For the 50-year planning period ending in 2060, the additional water need will be 38,599 AFY by the year 2060. Over fifty percent of this deficit, 22,606 AFY, would a rapidly increasing demand for municipal supplies. Irrigation water needs are expected to remain near current levels over the 50-year planning period.

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 the simulation period, regardless of whether the supply is physically or legally available. For the PWS vicinity, simulation data indicate that there is a minimum availability of surface water for new uses. Surface water availability maps were developed by TCEQ for the Colorado Basin, illustrating percent of months of flow per year. Availability maps indicate that within a 20-mile radius of the PWS, and over all of Midland County, unappropriated flows for new applications are typically available 25 to 50 percent of the time. This availability is inadequate for development of new municipal water supplies as a 100 percent year-round availability is required by TCEQ for 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. CRMWD Water would be purchased from the City of Midland to be used by the Greenwood PWS. A pipeline would be constructed to convey water from the City of Midland to the Greenwood PWS (Alternative GW-1).

2. City of Stanton. Obtain treated CRMWD water through the City of Stanton PWS. A pipeline and pump station would be constructed to transfer the water to the Greenwood PWS (Alternative GW-2).

3. Midland International Airport Water System. New wells would be installed in the vicinity of the wells at Midland International Airport. A pipeline and pump station would be constructed to transfer the water to the Greenwood PWS (Alternative GW-3).

4. Garden City Water System. New wells would be installed in the vicinity of the wells for the Garden City Water System. A pipeline and pump station would be constructed to transfer the water to the Greenwood PWS (Alternative GW-4).

5. New Wells at 10, 5, and 1 mile. Installing new wells within 10, 5, or 1 mile of the 114^{th} Street Mobile Home Park PWS may produce compliant water in place of the water produced by the existing active well. A pipeline and pump station would be constructed to transfer the water to the 114^{th} Street Mobile Home Park PWS (Alternatives GW-5, GW-6, and GW-7).

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 GW-8, and the central EDR treatment alternative is Alternative GW-9.

4.3.2 Point-of-Use Systems

POU treatment using RO technology is valid for arsenic and fluoride removal. The POU treatment alternative is GW-10.

4.3.3 Point-of-Entry Systems

POE treatment using RO technology is valid for arsenic and fluoride removal. The POE treatment alternative is GW-11.

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 GW-12, GW-13, and GW-14.

4.5 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives for compliance with the MCL for arsenic and fluoride have been identified. Each of the potential alternatives is described in the following subsections. It should be noted that the cost information given is the capital cost and change in O&M costs associated with implementing 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 have been presented to provide a complete picture of the range of alternatives considered. It is anticipated that a PWS will be able to use the information contained herein to select the most attractive alternative(s) for more detailed evaluation and possible subsequent implementation.

4.5.1 Alternative GW-1: Purchase Treated Water from the City of Midland

This alternative involves purchasing treated water from the City of Midland, which will be used to supply the Greenwood PWS. The City of Midland currently has sufficient excess capacity for this alternative to be feasible, although current City policy only allows drinking water to be provided to areas annexed by the City. It is assumed that Greenwood 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 Greenwood PWS. A pump station and 5,000 gallon feed tank would be required at a point adjacent to the City main line. A second pump station and feed tank would also be required along the pipeline. The pump stations are needed to overcome pipe friction and the elevation differences between Midland and the Greenwood PWS. The required pipeline would be constructed of 6-inch pipe and would follow State Highway 158 southeast, then east along County Road (CR) 120, then connect to an existing Greenwood PWS supply main that runs north along FM 1379 to the Greenwood PWS. Using this route, the pipeline required would be approximately 11.5 miles of new pipeline.

Each pump stations would include two pumps, including one standby, and would be housed in a building. The 5,000 gallon transfer tanks would also be installed for the pumps to draw from.

By definition this alternative involves regionalization, since Greenwood PWS would be obtaining drinking water from an existing larger supplier. Also, other PWSs near the Greenwood PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline, pump stations, pump houses, and feed tanks. 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 Greenwood PWS wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $2.29 million, with an estimated annual O&M cost of $107,300.

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 Greenwood PWS's perspective, 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 Midland to purchase treated drinking water. There are several small PWSs relatively close to the Greenwood WS with water quality problems and would be good candidates for sharing the cost for obtaining water from the City of Midland. The cost to the Greenwood WS for this alternative could be reduced if the other PWSs would be willing to share the costs. The analysis for a shared solution is presented in Appendix E. This analysis shows that the Fay Ben MHP could expect to save between $385,000 and $1.058 million if they were to implement a shared solution like this, which would be a savings between 19 to 52 percent.

4.5.2 Alternative GW-2: Purchase Treated Water from the City of Stanton

This alternative involves purchasing treated surface water from the City of Stanton, which would be used to supply Greenwood PWS. The City of Stanton currently has sufficient excess capacity for this alternative to be feasible and has indicated it would be amenable to negotiating an agreement to supply water to PWSs in the area. Records as late as 2004 indicate that the City of Stanton treated potable water has excessive concentrations of total trihalomethanes (TTHM). TTHMs are a disinfection by-product that can be reduced with operational and chemical use changes. The City of Stanford has also been cited for not reporting MCL exceedances to the public. These two issues would need to be resolved before this alternative is viable.

This alternative would require constructing a pipeline from the City of Stanton water main to the existing storage tank for the Greenwood PWS. A pump station and 5,000-gallon feed tank would be required at a point adjacent to the City main line. A second pump station and feed tank would also be required along the pipeline. The pump stations are needed to overcome pipe friction and the elevation differences between the City of Stanton and the Greenwood PWS. The required pipeline would be constructed of 6-inch pipe and would follow Interstate Highway 20 west, then south on Ranch Road 829, then west on FM 307, then south on FM 1379 to the Greenwood PWS. Using this route, the pipeline required would be approximately 12.6 miles long. It is assumed the Greenwood PWS would obtain all of its water from the City of Stanton.

Each pump stations would include two pumps, including one standby, and would be housed in a building. The 5,000 gallon transfer tanks would also be installed for the pumps to draw from.

This alternative involves regionalization by definition, since Greenwood PWS would be obtaining drinking water from an existing larger supplier. It is possible the Greenwood PWS could turn over provision of drinking water to the City of Stanton instead of purchasing water.

Also, other PWSs near the Greenwood PWS are in need of compliant drinking water and could share in implementation of this alternative.

The estimated capital cost for this alternative includes constructing the pipeline, pump station, and storage tank with feed pumps. 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 Greenwood PWS wells, plus maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $2.41 million, and the alternative's estimated annual O&M cost is $143,100.

The reliability of adequate amounts of compliant water under this alternative is fair based on compliance history. From the perspective of the Greenwood PWS, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations are well understood. If the decision were made to perform blending then 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. There are several small PWSs relatively close to the Greenwood PWS that have water quality problems that would be good candidates for sharing the cost for obtaining water from the City of Midland. The cost to the Greenwood supply system for this alternative could be reduced if the other PWSs would be willing to share the costs. The analysis for a shared solution is presented in Appendix E. This analysis shows that the Greenwood PWS could expect to save between $0.35 million and $1.06 million on the capital cost for this alternative, which is a saving of between 19 and 52 percent.

4.5.3 Alternative GW-3: New Wells in the Vicinity of Midland International Airport

This alternative involves completing two new wells in the vicinity of the Midland International Airport, and constructing a pipeline to transfer the groundwater to the Greenwood PWS. Based on the water quality data in the TCEQ database, it is expected that groundwater from this well would be compliant with drinking water MCLs. An agreement would need to be negotiated with Midland International Airport to expand its well field.

This alternative would require completing two new 100-foot wells at the Midland International Airport, and constructing a pipeline from the wells to the existing intake point for the Greenwood PWS. Four pump stations and 5,000 gallon feed tanks would also be required to overcome pipe friction and the elevation differences between the Midland International Airport and the Greenwood PWS. The required pipeline would be constructed of 6-inch pipe and would follow CR 1788 south, then east along CR 140, then north along State Highway 349, then east along CR 120 where it will connect to an existing Greenwood supply main that runs north along FM 1379 to the Greenwood PWS. Using this route, the pipeline required would be approximately 27.0 miles of new pipeline. The pipeline would terminate at the existing storage tanks owned by the Greenwood PWS.

Each pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the Greenwood PWS would obtain all of its water from the new wells.

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

The estimated capital cost for this alternative includes completing the new wells, constructing the pipeline, feed tanks, pump houses, and pump stations. The estimated O&M cost for this alternative includes the maintenance cost for the pipeline, and power and O&M labor and materials for the pump station. The estimated capital cost for this alternative is $5.34 million, with an estimated annual O&M cost of $171,800.

The reliability of adequate amounts of compliant water under this alternative should be good. From the Greenwood's perspective, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood, and Greenwood personnel currently operate pipelines and a pump station. If the decision was made to perform blending then the operational complexity would increase.

The feasibility of this alternative would be dependent on Midland International Airport being able to reach an agreement with Greenwood PWS to install new groundwater wells.

4.5.4 Alternative GW-4: New Wells in the Vicinity of Garden City Water System

This alternative involves completing two new wells in the vicinity of Garden City and constructing a pipeline to transfer the groundwater to the Greenwood PWS. Based on the water quality data in the TCEQ database, it is expected that groundwater from this well would be compliant with drinking water MCLs. Although, the concentration of iron may require additional treatment. An agreement would need to be negotiated with Garden City to expand its well field.

This alternative would require completing two new 320-foot wells at Garden City, and constructing a pipeline from the wells to the existing intake point for the Greenwood PWS. Four pump stations and 5,000 gallon feed tanks would also be required to overcome pipe friction and the elevation differences between Garden City and the Greenwood PWS. The required pipeline would be constructed of 6-inch pipe and would follow westward on State Highway 158 over several minor roads where it will connect to an existing Greenwood supply main that runs north along FM 1379 to the Greenwood PWS. Using this route, the pipeline required would be approximately 29.9 miles long. The pipeline would terminate at the existing storage tank owned by the Greenwood PWS.

Each pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the Greenwood PWS would obtain all its water from the new wells.

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

The estimated capital cost for this alternative includes completing the new wells, constructing the pipeline, pump station and houses, and feed tanks. The estimated O&M cost for this alternative includes the maintenance cost for the pipeline, and power and O&M labor and materials for the pump stations. The estimated capital cost for this alternative is $5.87 million, with an estimated annual O&M cost of $190,400.

The reliability of adequate amounts of compliant water under this alternative should be good. From the Greenwood PWS's perspective, this alternative would be characterized as easy to operate and repair, since O&M and repair of pipelines and pump stations is well understood, and Greenwood PWS personnel currently operate pipelines and a pump station. If the decision was made to perform blending then the operational complexity would increase.

The feasibility of this alternative would be dependent on Garden City being able to reach an agreement with Greenwood PWS to install new groundwater wells.

4.5.5 Alternative GW-5: New Wells at 10 miles

This alternative consists of installing two new wells within 10 miles of the Greenwood 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 new wells could be installed.

This alternative would require constructing two new 180-foot wells, a new pump station with a 5,000-gallon feed tank near the new wells, an additional pump station and feed tank along the pipeline, and a pipeline from the new well/feed tank to the existing storage tank for the Greenwood PWS system. The pump stations and feed tanks would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 10 miles long, and would be a 6-inches in diameter.

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, the pump stations, and the transfer tanks. 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 $2.14 million, and the estimated annual O&M cost for this alternative is $81,700.

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 Greenwood PWS, this alternative would be similar to operate as the existing system. Greenwood PWS personnel have experience with O&M of wells, pipelines, and pump stations.

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

4.5.6 Alternative GW-6: New Wells at 5 miles

This alternative consists of installing two new wells within 5 miles of the Greenwood 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 new wells could be installed.

This alternative would require constructing two new 180-foot wells, a new pump station with a 5,000 gallon feed tank near the new wells, and a pipeline from the new well/feed tank. The pump station and feed tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be 6-inches in diameter, approximately 5 miles long, and would discharge to the existing storage tank at the Greenwood PWS. The pump station near the well 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, the pump station, the transfer tank, service pumps and pump houses. The estimated O&M cost for this alternative includes O&M for the pipeline and pump station. The estimated capital cost for this alternative is $1.15 million, and the estimated annual O&M cost savings for this alternative is $41,400.

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 Greenwood PWS, this alternative would be similar to operate as the existing system. Greenwood PWS personnel have experience with O&M of wells, pipelines and pump stations.

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

4.5.7 Alternative GW-7: New Wells at 1 mile

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

This alternative would require constructing two new 180-foot wells and a pipeline from the new wells to the existing intake point for the Greenwood PWS system. Since the new wells are relatively close, a pump station would not be necessary. For this alternative, the pipeline is assumed to be 6 inches in diameter, approximately 1 mile long, and would discharge to the existing storage tank at the Greenwood PWS.

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. The estimated O&M cost for this alternative includes O&M for the pipeline. The estimated capital cost for this alternative is $309,100, and the estimated annual O&M cost for this alternative is $1,400.

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 Greenwood PWS, this alternative would be similar to operate as the existing system. Greenwood PWS personnel have experience with O&M of wells, pipelines and pump stations.

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

4.5.8 Alternative GW-8: Central RO Treatment

This system would continue to pump water from the existing wells, and would treat the water through an RO system prior to distribution. For this option, 100 percent of the raw water would be treated to obtain compliant water. The RO process concentrates impurities in the reject stream that would require disposal. It is estimated the RO reject generation would be approximately 50,000 gallons per day (gpd) when the system is operated at the average daily consumption (0.145 mgd).

This alternative consists of constructing the RO treatment plant near the ground storage tank. The plant is composed of a 1050 square foot building with a paved driveway; a skid with the pre-constructed RO plant; two transfer pumps, a 20,000-gallon tank for storing the treated water, and a 1,500,000-gallon pond for storing reject water. The treated water would be chlorinated and stored in the new treated water tank prior to being pumped into the distribution system. The entire facility is fenced.

The estimated capital cost for this alternative is $1.71-million, and the estimated annual O&M cost is $331,400.

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.

4.5.9 Alternative GW-9: Central EDR Treatment

The system would continue to pump water from the existing wells, and would treat the water through an EDR system prior to distribution. For this option the EDR would treat the full flow without bypass as the EDR operation can be tailored for desired removal efficiency. It is estimated the EDR reject generation would be approximately 32,000 gpd when the system is operated at the average daily consumption (0.145 mgd).

This alternative consists of constructing the EDR treatment plant near the existing ground storage tank. The plant is composed of a 750 square foot building with a paved driveway; a skid with the pre-constructed EDR system; two transfer pumps; a 20,000-gallon tank for storing the treated water, and a 960,000-gallon pond for storing concentrated water. The treated water would be chlorinated and stored in the new treated water tank prior to being pumped into the distribution system. The entire facility is fenced.

The estimated capital cost for this alternative is $1.75-million and the estimated annual O&M cost is $286,700.

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.

4.5.10 Alternative GW-10: Point-of-Use Treatment

This alternative consists of the continued operation of the Greenwood PWS well field, 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. Greenwood PWS 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 Greenwood PWS or contract personnel into the houses of customers. As a result, cooperation of customers would be important for success implementing this alternative. The treatment units could be installed 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 $339,200, and the estimated annual O&M cost for this alternative is $222,900. For the cost estimate, it is assumed that one POU treatment unit will be required for each of the 267 connections in the Greenwood PWS. It should be noted that the POU treatment units would need to be more complex than units typically found in commercial retail outlets in order to meet regulatory requirements, making purchase and installation more expensive. 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 Greenwood 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.

4.5.11 Alternative GW-11: Point-of-Entry Treatment

This alternative consists of the continued operation of the Greenwood PWS well field, 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).

Greenwood PWS 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 $4.06 million, and the estimated annual O&M cost for this alternative is $572,700. For the cost estimate, it is assumed that one POE treatment unit will be required for each of the 267 existing connections to the Greenwood PWS.

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

Greenwood PWS, this alternative would be characterized as more difficult to operate owing to the on-property requirements and the large number of individual units.

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

4.5.12 Alternative GW-12: Public Dispenser for Treated Drinking Water

This alternative consists of the continued operation of the Greenwood PWS wells, plus dispensing treated water for drinking and cooking at a publicly accessible location. Implementing this alternative would require purchasing and installing two 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.

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

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes purchasing and installing the treatment system to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes purchasing and replacing filters and media or membranes, as well as periodic sampling and record keeping. The estimated capital cost for this alternative is $35,700, and the estimated annual O&M cost for this alternative is $69,200.

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

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

4.5.13 Alternative GW-13: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the Greenwood PWS 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 Greenwood PWS would find it most convenient and economical to contract a bottled water service. The bottle delivery program would have to be flexible enough to allow the delivery of smaller containers should customers be incapable of lifting and manipulating 5-gallon bottles. Blending is not an option in this case. It should be noted that this alternative would be considered an interim measure until a 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 Greenwood PWS customers.

This alternative does not present options for a regional solution.

The estimated initial capital cost is for setting up the program. The estimated O&M cost for this alternative includes program administration and purchase of the bottled water. The estimated capital cost for this alternative is $27,000, and the estimated annual O&M cost for this alternative is $318,200. 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 Greenwood PWS.

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

4.5.14 Alternative GW-14: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the Greenwood PWS wells, plus dispensing compliant water for drinking and cooking at a publicly accessible location. The compliant water would be purchased from the City of Midland, 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.

Greenwood PWS 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 $135,000, and the estimated annual O&M cost for this alternative is $32,800.

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

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

4.5.15 Summary of Alternatives

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

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 Greenwood PWS has 267 connections serving a population of 800. Information that was available for 2007 to complete the financial analysis included annual financial report, water usage records, and current water rates for Greenwood PWS.

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.

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

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
GW-1	Purchase Water from City of Midland	- Two new pump stations / feed tanks - 9.5-mile pipeline	$2,292,700	$107,300	$307,200	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.
GW-2	Purchase treated water from the City of Stanton	- Two new pump stations / feed tanks - 11.5-mile pipeline	$2,411,200	$143,100	$353,300	Good	N	Agreement must be successfully negotiated with City of Stanton. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
GW-3	New Well at Midland International Airport	- Two new wells - Four pump stations / feed tanks -27-mile pipeline	$5,336,100	$171,800	$637,100	Good	N	Agreement must be successfully negotiated with Midland International Airport, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
GW-4	New Well at Garden City Wtr Sys Glasscock County	- Two new wells - Four pump stations / feed tanks -29.9-mile pipeline	$5,873,300	$190,400	$702,500	Good	N	Agreement must be successfully negotiated with Garden City WS Glassrock County, or land must be purchased. Blending may be possible. Costs could possibly be shared with small systems along pipeline route.
GW-5	Install new compliant well at 10 Miles	- 2 new wells - 2 pump stations / feed tanks -10-mile pipeline	$2,143,000	$81,700	$268,500	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
GW-6	Install new compliant well at 5 Miles	- Two new wells - 1 pump station / feed tank -5-mile pipeline	$1,146,600	$41,400	$141,400	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
GW-7	Install new compliant well at 1 Miles	- Two new wells -1-mile pipeline	$309,100	$1,400	$28,300	Good	N	May be difficult to find well with good water quality. Costs could possibly be shared with small systems along pipeline route.
GW-8	Continue operation of Greenwood PWS well field with central RO treatment	- Central RO treatment plant	$1,709,700	$331,400	$480,500	Good	T	An additional well may be required.
GW-9	Continue operation of Greenwood PWS well field with central EDR Treatment	- Central EDR treatment plant	$1,753,900	$286,700	$439,700	Good	T	An additional well may be required
GW-10	Continue operation of Greenwood PWS well field, and POU treatment	- POU treatment units.	$339,200	$222,900	$252,500	Fair	T, M	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing. An additional well may be required.

Alt No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost	Total Annualized Cost	Reliability	System Impact	Remarks
GW-11	Continue operation of Greenwood PWS well field, and POE treatment	- POE treatment units.	$4,064,100	$572,700	$927,000	Fair (*better than POU*)	T, M	All home taps compliant and less resident cooperation required. An additional well may be required.
GW-12	Continue operation of Greenwood PWS well field, but furnish public dispenser for treated drinking water	- Water treatment and dispenser unit	$35,700	$69,200	$72,300	Fair/interim measure	T	Does not provide compliant water to all taps, and requires a lot of effort by customers.
GW-13	Continue operation of Greenwood PWS well field, but furnish bottled drinking water for all customers	- Set up bottled water system	$27,000	$318,200	$320,500	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.
GW-14	Continue operation of Greenwood PWS well field, but furnish public dispenser for trucked drinking water.	- Construct storage tank and dispenser - Purchase potable water truck	$135,000	$32,800	$44,600	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

4.6.1 Financial Plan Development

Financial records and statements for Greenwood Water System were used to determine the revenues and expenses for the PWS. According to the Greenwood Water System's financial statements for FY2007 and water records, a total of 52.93 million gallons of water were sold in fiscal year 2007, generating an annual income of $200,391. The system had expenses of $158,992 in 2007. These values were entered into the financial model. Expenses for the Greenwood PWS were derived from the 2007 Greenwood Water System. Profit and Loss Sheet for January to December 2007 and assets and liabilities were derived from balance sheets as of December 31, 2007.

4.6.2 Current Financial Condition

4.6.2.1 Cash Flow Needs

Based on the 2007 revenue, the current average annual water bill for Greenwood PWS customers is estimated at $750 or about 1.7 percent of the Greenwood PWS MHI of $43,388, as given in the 2000 Census Tract Level. It should be noted that MHI at the Census Zip Code is below the state MHI.

A review of the operating revenues and expenses for the Greenwood PWS suggest that the water rates are currently high enough to sustain operations. However, Greenwood PWS 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 = 2.4

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 2.4 indicates that the Greenwood PWS would be able to meet all its current obligations, with total current assets of $87,576 exceeding the current liabilities of $36,053.

Debt to Net Worth Ratio = 0.057

A Debt to Net Worth ratio is another measure of financial liquidity and stability. The Greenwood PWS has a net worth of $183,338, and a total debt of $10,406, resulting in a debt to net worth ratio of 0.057. 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 Greenwood PWS is financially stable.

Operating Ratio = 1.26

The Operating Ratio is a financial term defined as a company's revenues divided by the operating expenses. 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 1.26 indicates that the Greenwood PWS does not need to raise its future water rates for its Greenwood PWS customers, based on financial estimates and the no action alternative.

4.6.3 Financial Plan Results

Each of the compliance alternatives for the Greenwood 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, 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.

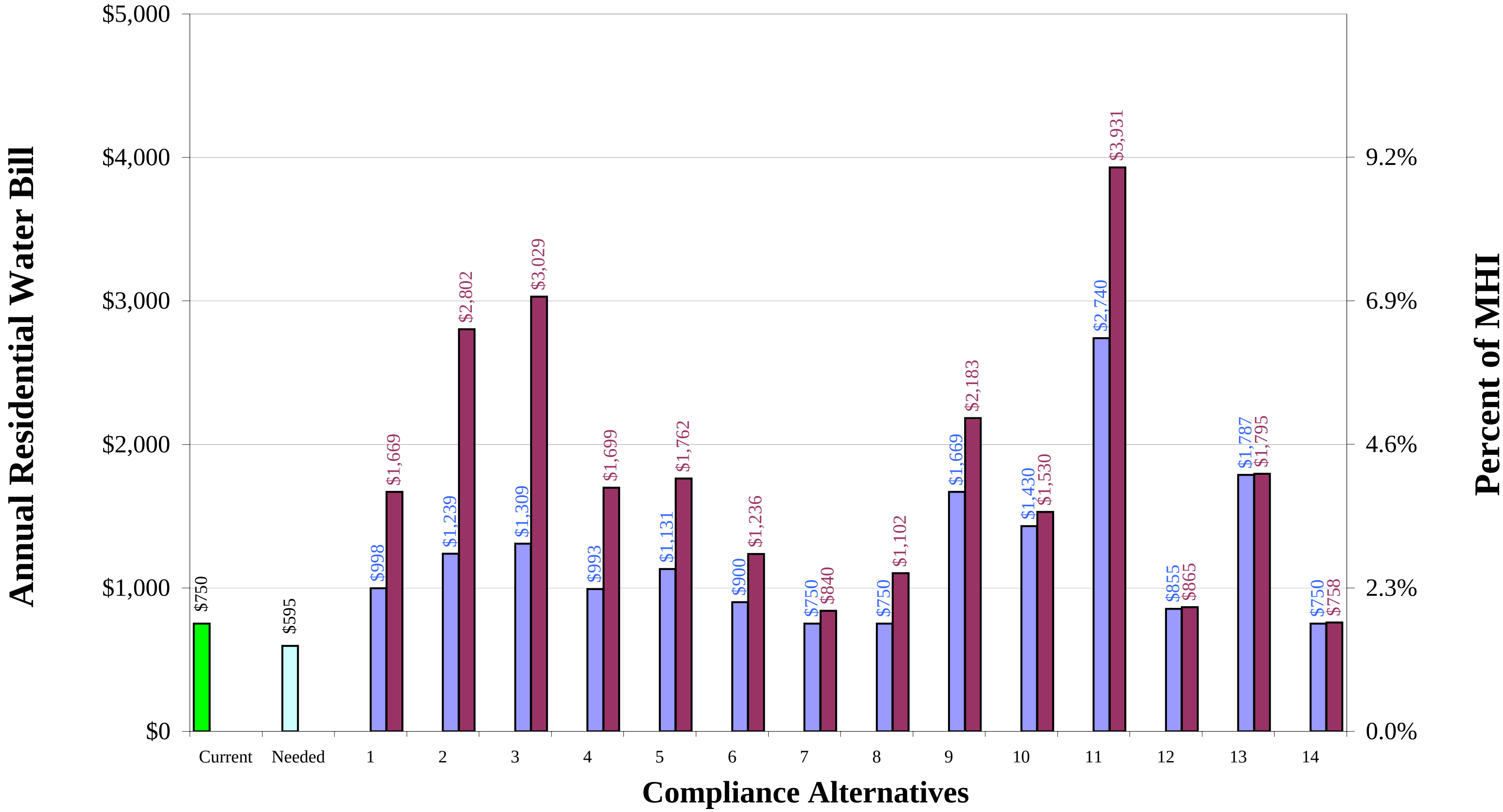
4.6.4 Evaluation of Potential Funding Options

There are a variety of funding programs available to entities as described in Section 2.4. Greenwood 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.

Greenwood
Table 4.4 Financial Impact on Households

Alternative	Description		All Revenue	100% Grant	75% Grant	50% Grant	SRF	Bond
1	Purchase Water from City of Midland	Maximum % of MHI	21.2%	2.3%	2.7%	3.1%	3.6%	3.8%
		Percentage Rate Increase Compared to Current	1124%	33%	55%	78%	109%	122%
		Average Annual Water Bill	$9,182	$998	$1,165	$1,333	$1,569	$1,669
2	New Well at Midland International Airport	Maximum % of MHI	47.4%	2.9%	3.8%	4.7%	5.9%	6.5%
		Percentage Rate Increase Compared to Current	2643%	65%	117%	169%	242%	273%
		Average Annual Water Bill	$20,581	$1,239	$1,630	$2,021	$2,570	$2,802
3	New Well at Garden City Wtr Sys Glasscock	Maximum % of MHI	52.1%	3.0%	4.0%	5.0%	6.4%	7.0%
		Percentage Rate Increase Compared to Current	2911%	74%	132%	189%	270%	304%
		Average Annual Water Bill	$22,593	$1,309	$1,739	$2,169	$2,774	$3,029
4	Purchase Water from City of Stanton	Maximum % of MHI	22.2%	2.3%	2.7%	3.1%	3.7%	3.9%
		Percentage Rate Increase Compared to Current	1183%	32%	56%	79%	112%	126%
		Average Annual Water Bill	$9,626	$993	$1,169	$1,346	$1,594	$1,699
5	New Well at 10 Miles	Maximum % of MHI	20.0%	2.6%	3.0%	3.3%	3.8%	4.1%
		Percentage Rate Increase Compared to Current	1054%	51%	72%	93%	122%	135%
		Average Annual Water Bill	$8,657	$1,131	$1,289	$1,447	$1,668	$1,762
6	New Well at 5 Miles	Maximum % of MHI	11.3%	2.1%	2.3%	2.5%	2.7%	2.8%
		Percentage Rate Increase Compared to Current	552%	20%	31%	42%	58%	65%
		Average Annual Water Bill	$4,890	$900	$984	$1,068	$1,186	$1,236
7	New Well at 1 Mile	Maximum % of MHI	4.0%	1.7%	1.8%	1.8%	1.9%	1.9%
		Percentage Rate Increase Compared to Current	134%	0%	3%	6%	10%	12%
		Average Annual Water Bill	$1,753	$750	$772	$795	$827	$840
8	Central Treatment - RO	Maximum % of MHI	16.1%	1.7%	1.7%	2.0%	2.4%	2.5%
		Percentage Rate Increase Compared to Current	833%	0%	0%	13%	37%	47%
		Average Annual Water Bill	$6,999	$750	$750	$851	$1,027	$1,102
9	Central Treatment - EDR	Maximum % of MHI	16.5%	3.8%	4.1%	4.4%	4.9%	5.0%
		Percentage Rate Increase Compared to Current	855%	122%	140%	157%	181%	191%
		Average Annual Water Bill	$7,164	$1,669	$1,798	$1,926	$2,107	$2,183
10	Point-of-Use Treatment	Maximum % of MHI	4.3%	3.3%	3.4%	3.4%	3.5%	3.5%
		Percentage Rate Increase Compared to Current	149%	91%	94%	97%	102%	104%
		Average Annual Water Bill	$1,866	$1,430	$1,455	$1,480	$1,515	$1,530
11	Point-of-Entry Treatment	Maximum % of MHI	36.5%	6.3%	7.0%	7.7%	8.7%	9.1%
		Percentage Rate Increase Compared to Current	2008%	265%	305%	345%	400%	424%
		Average Annual Water Bill	$15,817	$2,740	$3,038	$3,336	$3,754	$3,931
12	Public Dispenser for Treated Drinking Water	Maximum % of MHI	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
		Percentage Rate Increase Compared to Current	14%	14%	14%	15%	15%	15%
		Average Annual Water Bill	$855	$855	$857	$860	$864	$865
13	Supply Bottled Water to 100% of Population	Maximum % of MHI	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
		Percentage Rate Increase Compared to Current	138%	138%	138%	139%	139%	139%
		Average Annual Water Bill	$1,787	$1,787	$1,789	$1,791	$1,794	$1,795
14	Central Trucked Drinking Water	Maximum % of MHI	2.5%	1.7%	1.7%	1.7%	1.7%	1.7%
		Percentage Rate Increase Compared to Current	47%	0%	0%	0%	0%	1%
		Average Annual Water Bill	$1,101	$750	$750	$750	$752	$758

Figure 4.2
Alternative Cost Summary: Greenwood



Current Average Monthly Bill = $62.54
Mediuan Household Income = $43388
Average Monthly Residential Usage = 16518 gallons

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 (RWAF), and State Loan Program (Development Fund II. 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 of 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. Depending on how the origination charge is handled, interest rates can be as low as 0.95 percent below market rates with the possibility of additional federal subsidies for total interest rates 1.95 percent below market rates. Disadvantaged communities may obtain loans at interest rates between 0 percent and 1 percent.

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 notify 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 water supply corporations as construction purchases and qualify for a sales tax exemption. Rural Political Subdivisions are eligible (nonprofit water supply corporations; 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 water supply corporation 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 scale varies according to several factors, but is set by the TWDB based on cost of funds to the board, risk factors of managing the board loan portfolio, and market rate scales. The TWDB seeks to make reasonable loans with minimal risk to the state. The TWDB posts rates for comparison for applicants, and in August 2008 the TWDB showed its rates for a 22-year, taxable loan at 5.5 percent, where the market was at 7.84 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 Greenwood 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 based on cost of funds to the board, risk factors of managing the board loan portfolio, and market rate scales. The TWDB seeks to make reasonable loans with minimal risk to the state. The TWDB post rates for comparison for applicants and in August 2008, the TWDB showed their rates for a 22-year, taxable loan at 5.5 percent where the market was at 7.84 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 TWDB considers the needs of the area; benefits of the project; the relationship of the project to the overall state water needs and the State Water Plan; and the availability of all sources of revenue to the rural utility for the ultimate repayment of the loan. The board considers applications monthly.

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 Texas Small Towns Environment Program (STEP). 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 PWS. All program requirement would have to be met by the benefiting community receiving services by the PWS. Additional information can be found online at the ORCA website under the Community Development tab, Grant Funds Section, and clicking on the name of the program or grant.

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 by regional review committees 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. 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, and after CDBG staff-determine eligibility, 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 a Revolving Fund Program (RFP) administered by the staff of the Water and Environment Program (WEP) 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. WEP 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 or less. Recipients must be public entities such as municipalities, counties, special purpose districts, Indian tribes, and corporations not operated for profit. Projects include all forms of infrastructure improvement, acquisition of land and water rights, and design fees. Rural Development attempts to provide some level of assistance to all communities that apply. 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.

Water and Wastewater Disposal Program

The major components of the RFP are loan, loan guarantees, and grant funding for water and waste disposal systems. 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 he 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.

SECTION 5
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USEPA 2008c. United States Environmental Protection Agency Drinking Water Contaminants for Fluoride. Last updated on Tuesday, November 28th, 2006. Website accessed on June 5, 2008, http://www.epa.gov/safewater/hfacts.html

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 2008 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 $0.165 per kWH, as supplied by Caprock Energy Co. 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 2008 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 2008 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 2008 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 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 2008 RS Means Site Work & Landscape Cost Data. 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.

Table B.1
Summary of General Data
Greenwood Water System
1650078
General PWS Information

Service Population	800	**Number of Connections**	267
Total PWS Daily Water Usage	0.145 (mgd)	**Source**	Site visit list

Unit Cost Data

General Items	**Unit**	**Unit Cost**
Treated water purchase cost	*See alternative*	
Water purchase cost (trucked)	$/1,000 gals	$ 1.09
Contingency	20%	n/a
Engineering & Constr. Management	25%	n/a
Procurement/admin (POU/POE)	20%	n/a
Pipeline Unit Costs	**Unit**	**Unit Cost**
PVC water line, Class 200, 06"	LF	$ 18
Bore and encasement, 10"	LF	$ 240
Open cut and encasement, 10"	LF	$ 130
Gate valve and box, 06"	EA	$ 805
Air valve	EA	$ 2,050
Flush valve	EA	$ 1,025
Metal detectable tape	LF	$ 2.00
Bore and encasement, length	Feet	200
Open cut and encasement, length	Feet	50
Pump Station Unit Costs	**Unit**	**Unit Cost**
Pump	EA	$ 8,000
Pump Station Piping, 06"	EA	$ 835
Gate valve, 06"	EA	$ 805
Check valve, 06"	EA	$ 1,135
Electrical/Instrumentation	EA	$ 10,250
Site work	EA	$ 2,560
Building pad	EA	$ 5,125
Pump Building	EA	$ 10,250
Fence	EA	$ 6,150
Tools	EA	$ 1,025
5,000 gal feed tank	EA	$ 10,000
Backflow preventer, 6"	EA	$ 3,425
Backflow Testing/Certification	EA	$ 105
Well Installation Unit Costs	**Unit**	**Unit Cost**
Well installation	*See alternative*	
Water quality testing	EA	$ 1,280
25 HP Well Pump	EA	$ 7,550
Well electrical/instrumentation	EA	$ 5,635
Well cover and base	EA	$ 3,075
Piping	EA	$ 3,075
100,000 gal ground storage tank	EA	$ 100,000
Electrical Power	$/kWH	$ 0.165
Building Power	kWH	11,800
Labor	$/hr	$ 60
Materials	EA	$ 1,540
Transmission main O&M	$/mile	$ 275
Tank O&M	EA	$ 1,025
POU/POE Unit Costs		
POU treatment unit purchase	EA	$ 615
POU treatment unit installation	EA	$ 155
POE treatment unit purchase	EA	$ 5,125
POE - pad and shed, per unit	EA	$ 2,050
POE - piping connection, per unit	EA	$ 1,025
POE - electrical hook-up, per unit	EA	$ 1,025
POU Treatment O&M, per unit	$/year	$ 230
POE Treatment O&M, per unit	$/year	$ 1,540
Treatment analysis	$/year	$ 205
POU/POE labor support	$/hr	$ 40
Dispenser/Bottled Water Unit Costs		
POE-Treatment unit purchase	EA	$ 7,175
POE-Treatment unit installation	EA	$ 5,125
Treatment unit O&M	EA	$ 2,050
Administrative labor	hr	$ 45
Bottled water cost (inc. delivery)	gallon	$ 1.00
Water use, per capita per day	gpcd	1.0
Bottled water program materials	EA	$ 5,125
10,000 gal ground storage tank	EA	$ 15,000
Site improvements	EA	$ 3,075
Potable water truck	EA	$ 75,000
Water analysis, per sample	EA	$ 205
Potable water truck O&M costs	$/mile	$ 3.00

Central Treatment Unit Costs	**Unit**	**Unit Cost**
General		
Site preparation	acre	$ 4,000
Slab	CY	$ 1,000
Building	SF	$ 60
Building electrical	SF	$ 8.00
Building plumbing	SF	$ 8.00
Heating and ventilation	SF	$ 7.00
Fence	LF	$ 15
Paving	SF	$ 2.00
General O&M		
Building power	kwh/yr	$ 0.165
Equipment power	kwh/yr	$ 0.165
Labor, O&M	hr	$ 40
Analyses	test	$ 200
Reject Pond		
Reject pond, excavation	CYD	$ 3
Reject pond, compacted fill	CYD	$ 7
Reject pond, lining	SF	$ 1.50
Reject pond, vegetation	SY	$ 1.50
Reject pond, access road	LF	$ 30
Reject water haulage truck	EA	$ 100,000
Reverse Osmosis		
Electrical	JOB	$ 40,000
Piping	JOB	$ 20,000
RO package plant	UNIT	$ 560,000
Transfer pumps (7.5 hp)	EA	$ 7,500
Permeate tank	gal	$ 3
RO materials and chemicals	kgal	$ 0.75
RO chemicals	year	$ 2,000
Backwash disposal mileage cost	miles	$ 1.50
Backwash disposal fee	1,000 gal/yr	$ 5.00
EDR		
Electrical	JOB	$ 50,000
Piping	JOB	$ 20,000
Product storage tank	gal	$ 3.00
EDR package plant	UNIT	$ 680,000
EDR materials	kgal	$ 0.48
EDR chemicals	kgal	$ 0.40
Backwash disposal mileage cost	miles	$ 1.50
Backwash disposal fee	1,000 gal/yr	$ 5.00
Transfer pumps (7.5 hp)	EA	$ 7,500

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.13. 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	***Greenwood Water System***
Alternative Name	***Purchase Water from City of Midland***
Alternative Number	***GW-1***

Distance from Alternative to PWS (along pipe)		11.5	miles
Total PWS annual water usage		52.925	MG
Treated water purchase cost	$	1.09	per 1,000 gals
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	10	n/a	n/a	n/a
PVC water line, Class 200, 06"	60,870	LF	$ 18	$ 1,095,660
Bore and encasement, 10"	400	LF	$ 240	$ 96,000
Open cut and encasement, 10"	500	LF	$ 130	$ 65,000
Gate valve and box, 06"	12	EA	$ 805	$ 9,800
Air valve	22	EA	$ 2,050	$ 45,100
Flush valve	12	EA	$ 1,025	$ 12,478
Metal detectable tape	60,870	LF	$ 2	$ 121,740
Subtotal				**$ 1,445,778**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 06"	2	EA	$ 835	$ 1,670
Gate valve, 06"	8	EA	$ 805	$ 6,440
Check valve, 06"	4	EA	$ 1,135	$ 4,540
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
5,000 gal feed tank	2	EA	$ 10,000	$ 20,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Backflow Preventor	-	EA	$ 3,425	$ -
Subtotal				**$ 135,370**
Subtotal of Component Costs				**$ 1,581,148**
Contingency	20%			$ 316,230
Design & Constr Management	25%			$ 395,287
TOTAL CAPITAL COSTS				**$ 2,292,665**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	11.5	mile	$ 275	$ 3,170
Subtotal				**$ 3,170**
Water Purchase Cost				
From PWS	52,925	1,000 gal	$ 1.09	$ 57,688
Subtotal				**$ 57,688**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.165	$ 3,896
Pump Power	187,249	kWH	$ 0.165	$ 30,915
Materials	2	EA	$ 1,540	$ 3,080
Labor	730	Hrs	$ 60.00	$ 43,800
Tank O&M	-	EA	$ 1,025	$ -
Backflow Test/Cert	-	EA	$ 105	$ -
Subtotal				**$ 81,691**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 107,348**

Table C.2

PWS Name *Greenwood Water System*
Alternative Name *New Well at Midland International Airport*
Alternative Number *GW-2*

Distance from PWS to new well location	27.0	miles
Estimated well depth	100	feet
Number of wells required	2	
Well installation cost (location specific)	$148	per foot
Pump Stations needed w/ 1 feed tank each	4	
On site storage tanks / pump sets needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	4	n/a	n/a	n/a
Number of Crossings, open cut	28	n/a	n/a	n/a
PVC water line, Class 200, 06"	142,518	LF	$ 18	$ 2,565,324
Bore and encasement, 10"	800	LF	$ 240	$ 192,000
Open cut and encasement, 10"	1,400	LF	$ 130	$ 182,000
Gate valve and box, 06"	29	EA	$ 805	$ 22,945
Air valve	29	EA	$ 2,050	$ 59,450
Flush valve	29	EA	$ 1,025	$ 29,216
Metal detectable tape	142,518	LF	$ 2	$ 285,036
Subtotal				**$ 3,335,972**
Pump Station(s) Installation				
Pump	8	EA	$ 8,000	$ 64,000
Pump Station Piping, 06"	4	EA	$ 835	$ 3,340
Gate valve, 06"	16	EA	$ 805	$ 12,880
Check valve, 06"	8	EA	$ 1,135	$ 9,080
Electrical/Instrumentation	4	EA	$ 10,250	$ 41,000
Site work	4	EA	$ 2,560	$ 10,240
Building pad	4	EA	$ 5,125	$ 20,500
Pump Building	4	EA	$ 10,250	$ 41,000
Fence	4	EA	$ 6,150	$ 24,600
Tools	4	EA	$ 1,025	$ 4,100
5,000 gal feed tank	4	EA	$ 10,000	$ 40,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Backflow Preventor	0	EA	$ 3,425	$ -
Subtotal				**$ 270,740**
Well Installation				
Well installation	200	LF	$ 148	$ 29,600
Water quality testing	4	EA	$ 1,280	$ 5,120
Well pump	2	EA	$ 7,550	$ 15,100
Well electrical/instrumentation	2	EA	$ 5,635	$ 11,270
Well cover and base	2	EA	$ 3,075	$ 6,150
Piping	2	EA	$ 3,075	$ 6,150
Subtotal				**$ 73,390**
Subtotal of Component Costs				**$ 3,680,102**
Contingency	20%			$ 736,020
Design & Constr Management	25%			$ 920,025
TOTAL CAPITAL COSTS				**$ 5,336,147**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	27.0	mile	$ 275	$ 7,423
Subtotal				**$ 7,423**
Pump Station(s) O&M				
Building Power	47,200	kWH	$ 0.165	$ 7,793
Pump Power	405,302	kWH	$ 0.165	$ 66,915
Materials	4	EA	$ 1,540	$ 6,160
Labor	1,460	Hrs	$ 60.00	$ 87,600
Tank O&M	-	EA	$ 1,025	$ -
Backflow Cert/Test	0	EA	$ 105	$ -
Subtotal				**$ 168,468**
Well O&M				
Pump power	39,099	kWH	$ 0.165	$ 6,455
Well O&M matl	2	EA	$ 1,540	$ 3,080
Well O&M labor	360	Hrs	$ 60	$ 21,600
Subtotal				**$ 31,135**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 171,824**

Table C.3

PWS Name	***Greenwood Water System***
Alternative Name	***New Well at Garden City Wtr Sys Glasscock Cnty***
Alternative Number	***GW-3***

Distance from PWS to new well location	29.9	miles
Estimated well depth	320	feet
Number of wells required	2	
Well installation cost (location specific)	$148	per foot
Pump Stations needed w/ 1 feed tank each	4	
On site storage tanks / pump sets needed	0	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	5	n/a	n/a	n/a
Number of Crossings, open cut	14	n/a	n/a	n/a
PVC water line, Class 200, 06"	157,810	LF	$ 18	$ 2,840,580
Bore and encasement, 10"	1,000	LF	$ 240	$ 240,000
Open cut and encasement, 10"	700	LF	$ 130	$ 91,000
Gate valve and box, 06"	32	EA	$ 805	$ 25,407
Air valve	47	EA	$ 2,050	$ 96,350
Flush valve	32	EA	$ 1,025	$ 32,351
Metal detectable tape	157,810	LF	$ 2	$ 315,620
Subtotal				**$ 3,641,308**
Pump Station(s) Installation				
Pump	8	EA	$ 8,000	$ 64,000
Pump Station Piping, 06"	4	EA	$ 835	$ 3,340
Gate valve, 06"	16	EA	$ 805	$ 12,880
Check valve, 06"	8	EA	$ 1,135	$ 9,080
Electrical/Instrumentation	4	EA	$ 10,250	$ 41,000
Site work	4	EA	$ 2,560	$ 10,240
Building pad	4	EA	$ 5,125	$ 20,500
Pump Building	4	EA	$ 10,250	$ 41,000
Fence	4	EA	$ 6,150	$ 24,600
Tools	4	EA	$ 1,025	$ 4,100
5,000 gal feed tank	4	EA	$ 10,000	$ 40,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Backflow Preventor	0	EA	$ 3,425	$ -
Subtotal				**$ 270,740**
Well Installation				
Well installation	640	LF	$ 148	$ 94,720
Water quality testing	4	EA	$ 1,280	$ 5,120
Well pump	2	EA	$ 7,550	$ 15,100
Well electrical/instrumentation	2	EA	$ 5,635	$ 11,270
Well cover and base	2	EA	$ 3,075	$ 6,150
Piping	2	EA	$ 3,075	$ 6,150
Subtotal				**$ 138,510**
Subtotal of Component Costs				**$ 4,050,558**
Contingency	20%			$ 810,112
Design & Constr Management	25%			$ 1,012,640
TOTAL CAPITAL COSTS				**$ 5,873,310**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	29.9	mile	$ 275	$ 8,219
Subtotal				**$ 8,219**
Pump Station(s) O&M				
Building Power	47,200	kWH	$ 0.165	$ 7,793
Pump Power	512,958	kWH	$ 0.165	$ 84,689
Materials	4	EA	$ 1,540	$ 6,160
Labor	1,460	Hrs	$ 60.00	$ 87,600
Tank O&M	-	EA	$ 1,025	$ -
Backflow Test/Cert	-	EA	$ 105	$ -
Subtotal				**$ 186,242**
Well O&M				$ 6,455
Pump power	39,099	kWH	$ 0.165	$ 3,080
Well O&M matl	2	EA	$ 1,540	$ 21,600
Well O&M labor	360	Hrs	$ 60	**$ 31,135**
Subtotal				
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 190,395**

Table C.4

PWS Name	***Greenwood Water System***
Alternative Name	***Purchase Water from City of Stanton***
Alternative Number	***GW-4***

Distance from Alternative to PWS (along pipe)		12.6	miles
Total PWS annual water usage		52.925	MG
Treated water purchase cost	$	1.65	per 1,000 gals
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	7	n/a	n/a	n/a
PVC water line, Class 200, 06"	66,445	LF	$ 18	$ 1,196,010
Bore and encasement, 10"	400	LF	$ 240	$ 96,000
Open cut and encasement, 10"	350	LF	$ 130	$ 45,500
Gate valve and box, 06"	13	EA	$ 805	$ 10,698
Air valve	16	EA	$ 2,050	$ 32,800
Flush valve	13	EA	$ 1,025	$ 13,621
Metal detectable tape	66,445	LF	$ 2	$ 132,890
Subtotal				**$ 1,527,519**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 06"	2	EA	$ 835	$ 1,670
Gate valve, 06"	8	EA	$ 805	$ 6,440
Check valve, 06"	4	EA	$ 1,135	$ 4,540
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
5,000 gal feed tank	2	EA	$ 10,000	$ 20,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Backflow Preventor	-	EA	$ 3,425	$ -
Subtotal				**$ 135,370**
Subtotal of Component Costs				**$ 1,662,889**
Contingency	20%			$ 332,578
Design & Constr Management	25%			$ 415,722
TOTAL CAPITAL COSTS				**$ 2,411,189**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	12.6	mile	$ 275	$ 3,461
Subtotal				**$ 3,461**
Water Purchase Cost				
From PWS	52,925	1,000 gal	$ 1.65	$ 87,326
Subtotal				**$ 87,326**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.165	$ 3,896
Pump Power	222,282	kWH	$ 0.165	$ 36,699
Materials	2	EA	$ 1,540	$ 3,080
Labor	730	Hrs	$ 60.00	$ 43,800
Tank O&M	-	EA	$ 1,025	$ -
Backflow Test/Cert	-	EA	$ 105	$ -
Subtotal				**$ 87,475**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 143,060**

Table C.5

PWS Name *Greenwood Water System*
Alternative Name *New Well at 10 Miles*
Alternative Number *GW-5*

Distance from PWS to new well location	10.0	miles
Estimated well depth	180	feet
Number of wells required	2	
Well installation cost (location specific)	$148	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	7	n/a	n/a	n/a
PVC water line, Class 200, 06"	52,800	LF	$ 18	$ 950,400
Bore and encasement, 10"	400	LF	$ 240	$ 96,000
Open cut and encasement, 10"	350	LF	$ 130	$ 45,500
Gate valve and box, 06"	11	EA	$ 805	$ 8,501
Air valve	14	EA	$ 2,050	$ 28,700
Flush valve	11	EA	$ 1,025	$ 10,824
Metal detectable tape	52,800	LF	$ 2	$ 105,600
Subtotal				**$ 1,245,525**
Pump Station(s) Installation				
Pump	4	EA	$ 8,000	$ 32,000
Pump Station Piping, 06"	2	EA	$ 835	$ 1,670
Gate valve, 06"	8	EA	$ 805	$ 6,440
Check valve, 06"	4	EA	$ 1,135	$ 4,540
Electrical/Instrumentation	2	EA	$ 10,250	$ 20,500
Site work	2	EA	$ 2,560	$ 5,120
Building pad	2	EA	$ 5,125	$ 10,250
Pump Building	2	EA	$ 10,250	$ 20,500
Fence	2	EA	$ 6,150	$ 12,300
Tools	2	EA	$ 1,025	$ 2,050
5,000 gal feed tank	2	EA	$ 10,000	$ 20,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Subtotal				**$ 135,370**
Well Installation				
Well installation	360	LF	$ 148	$ 53,280
Water quality testing	4	EA	$ 1,280	$ 5,120
Well pump	2	EA	$ 7,550	$ 15,100
Well electrical/instrumentation	2	EA	$ 5,635	$ 11,270
Well cover and base	2	EA	$ 3,075	$ 6,150
Piping	2	EA	$ 3,075	$ 6,150
Subtotal				**$ 97,070**
Subtotal of Component Costs				**$ 1,477,965**
Contingency	20%			$ 295,593
Design & Constr Management	25%			$ 369,491
TOTAL CAPITAL COSTS				**$ 2,143,049**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	10.0	mile	$ 275	$ 2,750
Subtotal				**$ 2,750**
Pump Station(s) O&M				
Building Power	23,600	kWH	$ 0.165	$ 3,896
Pump Power	163,939	kWH	$ 0.165	$ 27,066
Materials	2	EA	$ 1,540	$ 3,080
Labor	730	Hrs	$ 60.00	$ 43,800
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ 77,843**
Well O&M				
Pump power	70,378	kWH	$ 0.165	$ 11,619
Well O&M matl	2	EA	$ 1,540	$ 3,080
Well O&M labor	360	Hrs	$ 60	$ 21,600
Subtotal				**$ 36,299**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 81,690**

Table C.6

PWS Name *Greenwood Water System*
Alternative Name *New Well at 5 Miles*
Alternative Number *GW-6*

Distance from PWS to new well location	5.0	miles
Estimated well depth	180	feet
Number of wells required	2	
Well installation cost (location specific)	$148	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	4	n/a	n/a	n/a
PVC water line, Class 200, 06"	26,400	LF	$ 18	$ 475,200
Bore and encasement, 10"	200	LF	$ 240	$ 48,000
Open cut and encasement, 10"	200	LF	$ 130	$ 26,000
Gate valve and box, 06"	5	EA	$ 805	$ 4,250
Air valve	7	EA	$ 2,050	$ 14,350
Flush valve	5	EA	$ 1,025	$ 5,412
Metal detectable tape	26,400	LF	$ 2	$ 52,800
Subtotal				**$ 626,012**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 06"	1	EA	$ 835	$ 835
Gate valve, 06"	4	EA	$ 805	$ 3,220
Check valve, 06"	2	EA	$ 1,135	$ 2,270
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
5,000 gal feed tank	1	EA	$ 10,000	$ 10,000
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Subtotal				**$ 67,685**
Well Installation				
Well installation	360	LF	$ 148	$ 53,280
Water quality testing	4	EA	$ 1,280	$ 5,120
Well pump	2	EA	$ 7,550	$ 15,100
Well electrical/instrumentation	2	EA	$ 5,635	$ 11,270
Well cover and base	2	EA	$ 3,075	$ 6,150
Piping	2	EA	$ 3,075	$ 6,150
Subtotal				**$ 97,070**
Subtotal of Component Costs				**$ 790,767**
Contingency	20%			$ 158,153
Design & Constr Management	25%			$ 197,692
TOTAL CAPITAL COSTS				**$ 1,146,613**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	5.0	mile	$ 275	$ 1,375
Subtotal				**$ 1,375**
Pump Station(s) O&M				
Building Power	11,800	kWH	$ 0.165	$ 1,948
Pump Power	81,969	kWH	$ 0.165	$ 13,533
Materials	1	EA	$ 1,540	$ 1,540
Labor	365	Hrs	$ 60.00	$ 21,900
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ 38,921**
Well O&M				
Pump power	70,378	kWH	$ 0.165	$ 11,619
Well O&M matl	2	EA	$ 1,540	$ 3,080
Well O&M labor	360	Hrs	$ 60	$ 21,600
Subtotal				**$ 36,299**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 41,394**

Table C.7

PWS Name	***Greenwood Water System***
Alternative Name	***New Well at 1 Mile***
Alternative Number	***GW-7***

Distance from PWS to new well location	1.0	miles
Estimated well depth	180	feet
Number of wells required	2	
Well installation cost (location specific)	$148	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
PVC water line, Class 200, 06"	5,280	LF	$ 18	$ 95,040
Bore and encasement, 10"	-	LF	$ 240	$ -
Open cut and encasement, 10"	50	LF	$ 130	$ 6,500
Gate valve and box, 06"	1	EA	$ 805	$ 850
Air valve	1	EA	$ 2,050	$ 2,050
Flush valve	1	EA	$ 1,025	$ 1,082
Metal detectable tape	5,280	LF	$ 2	$ 10,560
Subtotal				**$ 116,082**
Pump Station(s) Installation				
Pump	-	EA	$ 8,000	$ -
Pump Station Piping, 06"	-	EA	$ 835	$ -
Gate valve, 06"	-	EA	$ 805	$ -
Check valve, 06"	-	EA	$ 1,135	$ -
Electrical/Instrumentation	-	EA	$ 10,250	$ -
Site work	-	EA	$ 2,560	$ -
Building pad	-	EA	$ 5,125	$ -
Pump Building	-	EA	$ 10,250	$ -
Fence	-	EA	$ 6,150	$ -
Tools	-	EA	$ 1,025	$ -
5,000 gal feed tank	-	EA	$ 10,000	$ -
100,000 gal ground storage tank	-	EA	$ 100,000	$ -
Subtotal				**$ -**
Well Installation				
Well installation	360	LF	$ 148	$ 53,280
Water quality testing	4	EA	$ 1,280	$ 5,120
Well pump	2	EA	$ 7,550	$ 15,100
Well electrical/instrumentation	2	EA	$ 5,635	$ 11,270
Well cover and base	2	EA	$ 3,075	$ 6,150
Piping	2	EA	$ 3,075	$ 6,150
Subtotal				**$ 97,070**
Subtotal of Component Costs				**$ 213,152**
Contingency	20%			$ 42,630
Design & Constr Management	25%			$ 53,288
TOTAL CAPITAL COSTS				**$ 309,071**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline O&M				
Pipeline O&M	1.0	mile	$ 275	$ 275
Subtotal				**$ 275**
Pump Station(s) O&M				
Building Power	-	kWH	$ 0.165	$ -
Pump Power	-	kWH	$ 0.165	$ -
Materials	-	EA	$ 1,540	$ -
Labor	-	Hrs	$ 60.00	$ -
Tank O&M	-	EA	$ 1,025	$ -
Subtotal				**$ -**
Well O&M				
Pump power	70,378	kWH	$ 0.165	$ 11,619
Well O&M matl	2	EA	$ 1,540	$ 3,080
Well O&M labor	360	Hrs	$ 60	$ 21,600
Subtotal				**$ 36,299**
O&M Credit for Existing Well Closure				
Pump power	63,731	kWH	$ 0.165	$ (10,522)
Well O&M matl	2	EA	$ 1,540	$ (3,080)
Well O&M labor	360	Hrs	$ 60	$ (21,600)
Subtotal				**$ (35,202)**
TOTAL ANNUAL O&M COSTS				**$ 1,372**

Table C.8

PWS Name *Greenwood Water System*
Alternative Name *Central Treatment - Reverse Osmosis*
Alternative Number *GW-8*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit Purchase/Installation				
Site preparation	0.80	acre	$ 4,000	$ 3,200
Slab	53	CY	$ 1,000	$ 52,500
Building	1,050	SF	$ 60	$ 63,000
Building electrical	1,050	SF	$ 8	$ 8,400
Building plumbing	1,050	SF	$ 8	$ 8,400
Heating and ventilation	1,050	SF	$ 7	$ 7,350
Fence	600	LF	$ 15	$ 9,000
Paving	4,000	SF	$ 2	$ 8,000
Electrical	1	JOB	$ 40,000	$ 40,000
Piping	1	JOB	$ 20,000	$ 20,000
Reverse osmosis package including:				
High pressure pumps - 20 hp				
Cartridge filters and vessels				
RO membranes and vessels				
Control system				
Chemical feed systems				
Freight cost				
Vendor start-up services	1	UNIT	$ 560,000	$ 560,000
Transfer pumps	2	EA	$ 7,500	$ 15,000
Permeate tank	-	gal	$ 3	$ -
Feed Tank	20,000	gal	$ 3	$ 60,000
Reject pond:				
Excavation	11,650	CYD	$ 3.00	$ 34,950
Compacted fill	9,320	CYD	$ 7.00	$ 65,240
Lining	23,300	SF	$ 1.50	$ 34,950
Vegetation	3,100	SY	$ 1.50	$ 4,650
Access road	1,550	LF	$ 30.00	$ 46,500
Subtotal of Design/Construction Costs				**$ 1,041,140**
Contingency	20%			$ 208,228
Design & Constr Management	25%			$ 260,285
Reject water haulage truck	2	EA	$ 100,000	$ 200,000
TOTAL CAPITAL COSTS				**$ 1,709,653**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit O&M				
Building Power	9,500	kwh/yr	$ 0.165	$ 1,568
Equipment power	193,000	kwh/yr	$ 0.165	$ 31,845
Labor	2,000	hrs/yr	$ 40.00	$ 80,000
RO materials and Chemicals	53,100	kgal	$ 0.75	$ 39,825
Analyses	24	test	$ 200	$ 4,800
Subtotal				**$ 158,038**
Backwash Disposal				
Disposal truck mileage	56,600	miles	$ 1.50	$ 84,900
Backwash disposal fee	17,695	kgal/yr	$ 5.00	$ 88,476
Subtotal				**$ 173,376**
TOTAL ANNUAL O&M COSTS				**$ 331,414**

Table C.9

PWS Name *Greenwood Water System*
Alternative Name *Central Treatment - Electro-dialysis Reversal*
Alternative Number *GW-9*

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Reverse Osmosis Unit Purchase/Installation				
Site preparation	0.60	acre	$ 4,000	$ 2,400
Slab	38	CY	$ 1,000	$ 37,500
Building	750	SF	$ 60	$ 45,000
Building electrical	750	SF	$ 8	$ 6,000
Building plumbing	750	SF	$ 8	$ 6,000
Heating and ventilation	750	SF	$ 7	$ 5,250
Fence	500	LF	$ 15	$ 7,500
Paving	3,500	SF	$ 2	$ 7,000
Electrical	1	JOB	$ 50,000	$ 50,000
Piping	1	JOB	$ 20,000	$ 20,000
EDR package including:				
Feed and concentrate pumps				
Cartridge filters and vessels				
EDR membrane stacks				
Electrical module				
Chemical feed systems				
Freight cost				
Vendor start-up services	1	UNIT	$ 680,000	$ 680,000
Transfer pumps	2	EA	$ 7,500	$ 15,000
Permeate tank	-	gal	$ 3.00	$ -
Feed Tank	20,000	gal	$ 3.00	$ 60,000
Reject pond:				
Excavation	7,650	CYD	$ 3.00	$ 22,950
Compacted fill	6,120	CYD	$ 7.00	$ 42,840
Lining	15,300	SF	$ 1.50	$ 22,950
Vegetation	2,500	SY	$ 1.50	$ 3,750
Access road	1,250	LF	$ 30.00	$ 37,500
Subtotal of Design/Construction Costs				**$ 1,071,640**
Contingency	20%			$ 214,328
Design & Constr Management	25%			$ 267,910
Reject water haulage truck	2	EA	$ 100,000	$ 200,000
TOTAL CAPITAL COSTS				**$ 1,753,878**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
EDR Unit O&M				
Building Power	7,000	kwh/yr	$ 0.165	$ 1,155
Equipment power	290,000	kwh/yr	$ 0.165	$ 47,850
Labor	1,800	hrs/yr	$ 40.00	$ 72,000
Materials	53,100	kgal	$ 0.48	$ 25,488
Chemicals	53,100	kgal	$ 0.40	$ 21,240
Analyses	24	test	$ 200	$ 4,800
Subtotal				**$ 172,533**
Backwash Disposal				
Disposal truck mileage	37,300	miles	$ 1.50	$ 55,950
Backwash disposal fee	11,653	kgal/yr	$ 5.00	$ 58,265
Subtotal				**$ 114,215**
TOTAL ANNUAL O&M COSTS				**$ 286,748**

Table C.10

PWS Name ***Greenwood Water System***
Alternative Name ***Point-of-Use Treatment***
Alternative Number ***GW-10***

Number of Connections for POU Unit Installation 267 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POU-Treatment - Purchase/Installation				
POU treatment unit purchase	267	EA	$ 615	$ 164,205
POU treatment unit installation	267	EA	$ 155	$ 41,385
Subtotal				**$ 205,590**
Subtotal of Component Costs				**$ 205,590**
Contingency	20%			$ 41,118
Design & Constr Management	25%			$ 51,398
Procurement & Administration	20%			$ 41,118
TOTAL CAPITAL COSTS				**$ 339,224**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POU materials, per unit	267	EA	$ 230	$ 61,410
Contaminant analysis, 1/yr per unit	267	EA	$ 205	$ 54,735
Program labor, 10 hrs/unit	2,670	hrs	$ 40	$ 106,800
Subtotal				**$ 222,945**
TOTAL ANNUAL O&M COSTS				**$ 222,945**

Table C.11

PWS Name ***Greenwood Water System***
Alternative Name ***Point-of-Entry Treatment***
Alternative Number ***GW-11***

Number of Connections for POE Unit Installation 267 connections

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
POE-Treatment - Purchase/Installat				
POE treatment unit purchase	267	EA	$ 5,125	$ 1,368,375
Pad and shed, per unit	267	EA	$ 2,050	$ 547,350
Piping connection, per unit	267	EA	$ 1,025	$ 273,675
Electrical hook-up, per unit	267	EA	$ 1,025	$ 273,675
Subtotal				**$ 2,463,075**
Subtotal of Component Costs				**$ 2,463,075**
Contingency	20%			$ 492,615
Design & Constr Management	25%			$ 615,769
Procurement & Administration	20%			$ 492,615
TOTAL CAPITAL COSTS				**$ 4,064,074**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
O&M				
POE materials, per unit	267	EA	$ 1,540	$ 411,180
Contaminant analysis, 1/yr per uni	267	EA	$ 205	$ 54,735
Program labor, 10 hrs/unit	2,670	hrs	$ 40	$ 106,800
Subtotal				**$ 572,715**
TOTAL ANNUAL O&M COSTS				**$ 572,715**

Table C.12

PWS Name ***Greenwood Water System***
Alternative Name ***Public Dispenser for Treated Drinking Water***
Alternative Number ***GW-12***

Number of Treatment Units Recommended 2

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Public Dispenser Unit Installation				
POE-Treatment unit(s)	2	EA	$ 7,175	$ 14,350
Unit installation costs	2	EA	$ 5,125	$ 10,250
Subtotal				**$ 24,600**
Subtotal of Component Costs				**$ 24,600**
Contingency	20%			$ 4,920
Design & Constr Management	25%			$ 6,150
TOTAL CAPITAL COSTS				**35,670**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Treatment unit O&M, 1 per unit	2	EA	$ 2,050	$ 4,100
Contaminant analysis, 1/wk per ui	104	EA	$ 205	$ 21,320
Sampling/reporting, 1 hr/day	730	HRS	$ 60	$ 43,800
Subtotal				**$ 69,220**
TOTAL ANNUAL O&M COSTS				**$ 69,220**

Table C.13

PWS Name *Greenwood Water System*
Alternative Name *Supply Bottled Water to 100% of Population*
Alternative Number *GW-13*

Service Population	800	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	292,000	gallons

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Implementation				
Initial program set-up	500	hours	$ 45	$ 22,500
Subtotal				**$ 22,500**
Subtotal of Component Costs				**$ 22,500**
Contingency	20%			$ 4,500
TOTAL CAPITAL COSTS				**$ 27,000**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water purchase costs	292,000	gals	$ 1.00	$ 292,000
Program admin, 9 hrs/wk	468	hours	$ 45	$ 21,060
Program materials	1	EA	$ 5,125	$ 5,125
Subtotal				**$ 318,185**
TOTAL ANNUAL O&M COSTS				**$ 318,185**

Table C.14

PWS Name ***Greenwood Water System***
Alternative Name ***Central Trucked Drinking Water***
Alternative Number ***GW-14***

Service Population	800	
Percentage of population requiring supply	100%	
Water consumption per person	1.00	gpcd
Calculated annual potable water needs	292,000	gallons
Travel distance to compliant water source	10	miles

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Storage Tank Installation				
10,000 gal ground storage tank	1	EA	$ 15,000	$ 15,000
Site improvements	1	EA	$ 3,075	$ 3,075
Potable water truck	1	EA	$ 75,000	$ 75,000
Subtotal				**$ 93,075**
Subtotal of Component Costs				**$ 93,075**
Contingency	20%			$ 18,615
Design & Constr Management	25%			$ 23,269
TOTAL CAPITAL COSTS				**$ 134,959**

Annual Operations and Maintenance Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Program Operation				
Water delivery labor, 4 hrs/wk	208	hrs	$ 60	$ 12,480
Truck operation, 1 round trip/wk	1,050	miles	$ 3.00	$ 3,151
Water purchase	292	1,000 gals	$ 1.09	$ 318
Water testing, 1 test/wk	52	EA	$ 205	$ 10,660
Sampling/reporting, 2 hrs/wk	104	hrs	$ 60	$ 6,240
Subtotal				**$ 32,849**
TOTAL ANNUAL O&M COSTS				**$ 32,849**

APPENDIX D
EXAMPLE FINANCIAL MODEL

Greenwood

Number of Alternatives 14 Selected from Results Sheet

Input Fields are Indicated by:

General Inputs		
Implementation Year	2009	
Months of Working Capital	0	
Depreciation	$ -	
Percent of Depreciation for Replacement Fund	0%	
Allow Negative Cash Balance (yes or no)	No	
Median Household Income	$ 43,388	Greenwood
Median HH Income -- Texas	$ 39,927	
Grant Funded Percentage	0%	Selected from Results
Capital Funded from Revenues	$ -	

	Base Year Growth/Escalation	2007
Accounts & Consumption		
Metered Residential Accounts		
Number of Accounts	0.0%	267
Number of Bills Per Year		12
Annual Billed Consumption		52,925,000
Consumption per Account Per Pay Period	0.0%	16,518
Consumption Allowance in Rates		-
Total Allowance		-
Net Consumption Billed		52,925,000
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%	52,925,000
Unaccounted for Water		-
Percentage Unaccounted for Water		0.0%

Greenwood

Number of Alternatives 14 Selected from Results Sheet

Input Fields are Indicated by:

Residential Rate Structure	Allowance within Tier	
	-	
Estimated Average Water Rate ($/1000gallons)		$ 3.79
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%	158,992
Other 4	0.0%	-
Incremental O&M for Alternative	0.0%	-
Total Operating Expenses		158,992
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 Greenwood
Alternative Number = 14
Funding Source = Loan/Bond

		2007	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
		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		-	-	134,959	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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		-	-	134,959	132,499	129,892	127,128	124,198	121,093	117,801	114,311	110,613	106,692	102,536	98,131	93,461	88,512	83,265	77,703	71,808	65,559	58,935	51,914	44,472	36,583	28,220	19,356	9,960	0	0	0	0
Principal		-	-	2,460	2,607	2,764	2,930	3,106	3,292	3,489	3,699	3,921	4,156	4,405	4,670	4,950	5,247	5,562	5,895	6,249	6,624	7,021	7,443	7,889	8,362	8,864	9,396	9,960	-	-	-	-
Interest	6.00%	-	-	8,098	7,950	7,794	7,628	7,452	7,266	7,068	6,859	6,637	6,402	6,152	5,888	5,608	5,311	4,996	4,662	4,308	3,934	3,536	3,115	2,668	2,195	1,693	1,161	0	0	0	0	0
Total Debt Service		-	-	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	9,960	0	0	0	0
New Balance		-	-	132,499	129,892	127,128	124,198	121,093	117,801	114,311	110,613	106,692	102,536	98,131	93,461	88,512	83,265	77,703	71,808	65,559	58,935	51,914	44,472	36,583	28,220	19,356	9,960	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	2.90%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Cashflow Projections for Greenwood
Alternative Number = 14
Funding Source = Loan/Bond

Estimated At Sept. 30 of Each Year

	Growth/ Escalation	2007	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
		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
CASH FLOW PROJECTIONS																																
Beginning Unrestricted Cash Balance		$ -	41,377	41,377	30,820	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(0)	0	0	0
RECEIPTS																																
Operating Revenues																																
Water Base Rate-- Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 1 -- Res	100,000	200,369	200,369	200,369	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	201,801	191,841	191,841	191,841	191,841
Water: Tier 2 -- Res	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 3 -- Res	200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 4 -- Res	300,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmetered Residential		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water Base Rate - Non Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 1 -- NR	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 2 -- NR	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 3 -- NR	200,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Water: Tier 4 -- NR	300,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unmetered Non Residential		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sewer Sales		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 1		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 2		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other 3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Revenues		$ 200,369	$ 200,369	$ 200,369	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 202,398	$ 201,801	$ 191,841	$ 191,841	$ 191,841	$ 191,841
Capital Receipts																																
Grants Received		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SRF Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank/Interfund Loan Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUS Loan Proceeds		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bond Proceeds		-	-	134,959	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Receipts		-	-	134,959	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Receipts		200,369	200,369	335,328	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	201,801	191,841	191,841	191,841	191,841
EXPENDITURES																																
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%	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992	158,992
Other 4	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Incremental O&M for Alternative	0.0%	-	-	-	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849	32,849
Total Operating Expenses		158,992	158,992	158,992	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841	191,841
Non-Operating Income/Expenditures																																
Interest Income	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Income	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Expense	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transfers In (Out)	0.0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Non-Operating		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Debt Service																																
Existing		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed:																																
Revenue Bonds		-	-	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	9,960	0	0	0	0
State Revolving Fund		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RUS Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Debt Service		-	-	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	10,557	9,960	0	0	0	0
Capital Expenditures	$ 134,959																															
Funded From Revenues/Reserves	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded From Grants	0%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded From SRF Loans		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from Bank/Interfund Loans		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from RUS Loan		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Funded from Bonds		-	-	134,959	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Capital Expenditures		-	-	134,959	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Expenditures		158,992	158,992	304,508	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	202,398	201,801	191,841	191,841	191,841	191,841
What Water Rev Needs to be		(158,992)	(158,992)	(169,549)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(202,398)	(201,801)	(191,841)	(191,841)	(191,841)	(191,841)
Water Rate Increase		0.00%	0.00%	0.00%	1.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.30%	-4.94%	0.00%	0.00%	0.00%
Net Cash Flow		41,377	41,377	30,820	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(0)	0	0	0	0
Reserves:																																
Working Capital (Months O&M)	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Replacement Reserve		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Required Reserves		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average Annual Water Bill	$ 758	$ 750	$ 750	$ 750	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 758	$ 756	$ 719	$ 719	$ 719	$ 719
Median Household Income		$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388	$ 43,388
Maximum % of MHI	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Percentage Rate Increase Compared to Current	1.0%		0.0%	0.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.7%	-4.3%	-4.3%	-4.3%	-4.3%

APPENDIX E
ANALYSIS OF SHARED SOLUTIONS FOR OBTAINING WATER FROM MIDLAND

E.1 OVERVIEW OF METHOD USED

There are a few small PWSs with water quality problems located in the vicinity of the Greenwood WS that could benefit from joining together and cooperating to share the cost for obtaining compliant drinking water. This cooperation could involve creating a formal organization of individual PWSs to address obtaining compliant drinking water, consolidating to form a single PWS, or having the individual PWSs taken over or bought out by a larger regional entity.

The small PWSs with water quality problems near the Greenwood WS are listed in Table E.1, along with their average water consumption and estimates of the capital cost for each PWS to construct an individual pipeline. It is assumed for this analysis that all the systems would participate in a shared solution.

This analysis focuses on compliance alternatives related to obtaining water from large water providers interested in providing water outside their current area, either by wholesaling to PWSs, or by expanding their service areas. This type of solution is most likely to have the best prospects for sustainability, and a reliable provision of compliant drinking water.

The purpose of this analysis is to approximate the level of capital cost savings that could be expected from pursuing a shared solution versus a solution where the study PWS obtains compliant drinking water on its own. Regardless of the form a group solution would take, water consumers would have to pay for the infrastructure needed for obtaining compliant water. To keep this analysis as straightforward and realistic as possible, it is assumed the individual PWSs would remain independent, and would share the capital cost for the infrastructure required. Also, to maintain simplicity, this analysis is limited to estimating capital cost savings related to pipeline construction, which is likely to be by far the largest component of the overall capital cost. A shared solution could also produce savings in O&M expenses as a result of reduction in redundant facilities and the potential for shared O&M resources, and these savings would have to be evaluated if the PWSs are interested in implementing a shared solution.

There are many ways pipeline capital costs could be divided between participating PWSs, and the final apportioning of costs would likely be based on negotiation between the participating entities. At this preliminary stage of analysis it is not possible to project results from negotiations regarding cost sharing. For this reason, three methods are used to allocate cost between PWSs in an effort to give an approximation of the range of savings that might be attainable for an individual PWS.

Method A is based on allocating capital cost of the shared pipeline solution proportionate to the amount of water used by each PWS. In this case, the capital cost for the shared pipeline and the necessary pump stations is estimated, and then this total capital cost is allocated based on the fraction of the total water used by each PWS. For example, PWS #1 has an average daily water use of 0.1 mgd and PWS #2 has an average daily use of 0.3 mgd. Using this method, PWS #1 would be allocated 25 percent of the capital cost of the shared solution. This method is a reasonable method for allocating cost when all the PWSs are different in size but are relatively equidistant from the shared water source.

Method B is also based on allocating capital cost of the shared pipeline solution proportionate to the amount of water used by the PWSs. However, rather than allocating the *total* capital cost of the shared solution between each participating PWS, this approach splits the shared pipeline into segments and allocates flow-proportional costs to the PWSs using each segment. Costs for a pipeline segment are not shared by a PWS if the PWS does not use that particular segment. For example, PWS #1 has an average daily water use of 0.3 mgd and PWS #2 has an average daily use of 0.2 mgd. A 3-mile long pipeline segment is common to both PWSs, while PWS #2 requires an additional 4-mile segment. Using this method, PWS #2 would be allocated 40 percent of the cost of the 3-mile segment and 100 percent of the cost of the 4-mile segment. This method is a reasonable method for allocating cost when all the PWSs are different in size and are located at different distances from the shared water source.

Method C is based on allocating capital cost of the shared pipeline solution proportionate to the cost each PWS would have to pay to obtain compliant water if it were to implement an individual solution. In this case, the total capital cost for the shared pipeline and the necessary pump stations is estimated as well as the capital cost each PWS would have for obtaining its own pipeline. The total capital cost for the shared solution is then allocated between the participating PWSs based on what each PWS would have to pay to construct its own pipeline. For example, the individual solution cost for PWS #1 is $4 million and the individual solution cost for PWS #2 is $1 million. Using this method, PWS #1 would be allocated 80 percent of the cost of the shared solution. This method is a reasonable method for allocating cost when the PWS are located at different distances from the water source.

For any given PWS, all three of these methods should generate costs for the shared solution that produce savings for the PWS over an individual solution. However, for different PWSs participating in a shared solution, each of these three methods can produce savings of varying magnitudes: for one PWS, Method A might show the best cost savings while for another Method C might provide the best savings. For this reason, this range is considered to be representative of possible savings that could result from an agreement that should be fair and equitable to all parties involved.

E.2 SHARED SOLUTION FOR OBTAINING WATER FROM MIDLAND

This alternative would consist of constructing a 2.5-mile 6-inch joint pipeline from the Midland city limits to Valley View MHP and then a 7-mile 6-inch pipeline to the three Greenwood systems with Greenwood WS being one of the three. The pipeline routing is shown in Figure E.1 at the end of this appendix. It is assumed three pump stations would be required to transfer the water from a Midland main distribution line to the four PWSs.

The capital costs for each pipe segment and the total capital cost for the shared pipeline are summarized in Table E.2. Table E.3 shows the capital costs allocated to each PWS using Method A. Table E.4 shows the capital costs allocated to each PWS using Method B. Table E.5 shows the allocation of pipeline capital costs to each of the PWSs using Method C, as described above. Table E.6 provides a summary of the pipeline capital costs estimated for each PWS, and the savings that could be realized compared to developing individual pipelines. More detailed cost estimates for the pipe segments are shown at the end of this appendix in Tables E.7 through E.17.

Based on these estimates, the range of pipeline capital cost savings to Greenwood WS could be between $385,000 and $1.058 million if they were to implement a shared solution like this, which would be a savings between 19 to 52 percent. These estimates are hypothetical and are only provided to approximate the magnitude of potential savings if this shared solution is implemented as described.

Table E.1
Summary Information for PWSs Participating in Shared Solution

PWS	PWS #	Average Water Demand (gpd)	Water Demand as Percent of Total	Pipeline Capital Cost for Individual Solutions for Greenwood WS	Percent of Sum of Capital Costs for Individual Solutions for Greenwood WS
Valley View MHP	1650007	5600	3%	$ 448,056	9%
Greenwood WS	1650078	145000	70%	$ 2,035,626	41%
Greenwood Ventures	1650006	15000	7%	$ 1,216,699	25%
Greendwood ISD	1650035	43000	21%	$ 1,248,440	25%
Totals		**208600**	**100%**	**$ 4,948,821**	**100%**

Notes: (a) Costs for Valley View MHP, Greenwood Ventures and Greenwood ISD are provided in Tables E.15, E.17 and E.18.
Costs for Greenwood WS to Midland (one of the alternatives for the PWS) are provided in Appendix C.

Table E.2
Capital cost for Shared Pipeline from Midland

Pipe Segment	Capital Cost
Pipe 1	$ 603,664
Pipe 2	$ 1,510,987
Pipe 3	$ 38,151
Pipe A	$ 73,627
Pipe B	$ 94,801
Pipe C	$ 16,050
Pipe D	$ 37,568
Totals	**$ 2,374,848**

Notes: (b) Pipes 1, 2 and 3 are identified as Main Links 1, 2 and 3, respectively, and are common to both PWSs.
The lettered pipes connect each PWS to the Main Link.

Table E.3
Pipeline Capital Cost Allocation by Method A
Shared Pipeline Assesment for Greenwood WS

PWS	PWS #	Percentage Based On Flow	Total Costs
Valley View MHP	1650007	3%	$ 63,754
Greenwood WS	1650078	70%	$ 1,650,781
Greenwood Ventures	1650006	7%	$ 170,770
Greendwood ISD	1650035	21%	$ 489,542
	Totals	**100%**	**$ 2,374,848**

Table E.4
Pipeline Capital Cost Allocation by Method B
Shared Pipeline Assesment for Greenwood WS

Pipeline Segment	Pipe Segment Capital Cost	Valley View MHP		Greenwood WS		Greenwood Ventures		Greendwood ISD	
		Percent Allocation Based on Water Use	Allocated Cost	Percent Allocation Based on Water Use	Allocated Cost	Percent Allocation Based on Water Use	Allocated Cost	Percent Allocation Based on Water Use	Allocated Cost
Pipe 1	$ 603,664	3%	$ 16,206	70%	$ 419,613	7%	$ 43,408	21%	$ 124,437
Pipe 2	$ 1,510,987	0%	$ -	71%	$ 1,079,276	7%	$ 111,649	21%	$ 320,061
Pipe 3	$ 38,151	0%	$ -	0%	$ -	26%	$ 9,867	74%	$ 28,284
Pipe A	$ 73,627	100%	$ 73,627	0%	$ -	0%	$ -	0%	$ -
Pipe B	$ 94,801	0%	$ -	100%	$ 94,801	0%	$ -	0%	$ -
Pipe C	$ 16,050	0%	$ -	0%	$ -	100%	$ 16,050	0%	$ -
Pipe D	$ 37,568	0%	$ -	0%	$ -	0%	$ -	100%	$ 37,568
Totals	**$ 2,374,848**		**$ 89,832**		**$ 1,593,690**		**$ 180,974**		**$ 510,351**

Table E.5
Pipeline Capital Cost Allocation by Method C
Shared Pipelilne Assessment for Greenwood WS

PWS	PWS #	Cost for Individual Pipelines	Percentage based on Individual Solutions	Allocated Capital Cost
Valley View MHP	1650007	$ 448,056	9%	$ 215,014
Greenwood WS	1650078	$ 2,035,626	41%	$ 976,859
Greenwood Ventu	1650006	$ 1,216,699	25%	$ 583,872
Greendwood ISD	1650035	$ 1,248,440	25%	$ 599,103
	Totals	**$ 4,948,821**	**100%**	**$ 2,374,848**

Table E.6
Pipeline Capital Cost Summary
Shared Pipelilne Assessment for Greenwood WS

PWS	Individual Pipeline Capital Costs	Shared Solution Capital Cost Allocation			Shared Solution Cost Savings			Shared Solution Percentage Savings		
		Method A	**Method B**	**Method C**	**Method A**	**Method B**	**Method C**	**Method A**	**Method B**	**Method C**
Valley View MHP	$ 448,056	$ 63,754	$ 89,832	$ 215,014	$ 384,301	$ 358,223	$ 233,042	86%	80%	52%
Greenwood WS	$ 2,035,626	$ 1,650,781	$ 1,593,690	$ 976,859	$ 384,845	$ 441,936	$ 1,058,767	19%	22%	52%
Greenwood Ventures	$ 1,216,699	$ 170,770	$ 180,974	$ 583,872	$ 1,045,929	$ 1,035,725	$ 632,828	86%	85%	52%
Greendwood ISD	$ 1,248,440	$ 489,542	$ 510,351	$ 599,103	$ 758,898	$ 738,089	$ 649,337	61%	59%	52%
Totals	**$ 4,948,821**	**$ 2,374,848**	**$ 2,374,848**	**$ 2,374,848**	**$ 2,573,973**	**$ 2,573,973**	**$ 2,573,973**			

Table E.7

Main Link # 1
Total Pipe Length 2.46 miles
Number of Pump Stations Needed 1
Pipe Size 06" inches

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	2	n/a	n/a		n/a	
PVC water line, Class 200, 06"	13,008	LF	$	18	$	234,144
Bore and encasement, 12"	200	LF	$	240	$	48,000
Open cut and encasement, 12"	100	LF	$	130	$	13,000
Gate valve and box, 06"	3	EA	$	805	$	2,415
Air valve	3	EA	$	2,050	$	6,150
Flush valve	3	EA	$	1,025	$	3,075
Metal detectable tape	13,008	LF	$	2.00	$	26,016
Subtotal					**$**	**332,800**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 06"	2	EA	$	835	$	1,670
Gate valve, 06"	4	EA	$	805	$	3,220
Check valve, 06"	2	EA	$	1,135	$	2,270
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
20,000 gal ground storage tank	1	EA	$	25,000	$	25,000
Subtotal					**$**	**83,520**
Subtotal of Component Costs					**$**	**416,320**
Contingency	20%				$	83,264
Design & Constr Management	25%				$	104,080
TOTAL CAPITAL COSTS					**$**	**603,664**

Table E.8

Main Link # 2
Total Pipe Length 7.05 miles
Number of Pump Stations Needed 2
Pipe Size 06" inches

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	8	n/a	n/a		n/a	
PVC water line, Class 200, 06"	37,199	LF	$	18	$	669,582
Bore and encasement, 12"	200	LF	$	240	$	48,000
Open cut and encasement, 12"	400	LF	$	130	$	52,000
Gate valve and box, 06"	8	EA	$	805	$	6,440
Air valve	8	EA	$	2,050	$	16,400
Flush valve	8	EA	$	1,025	$	8,200
Metal detectable tape	37,199	LF	$	2.00	$	74,398
Subtotal					**$**	**875,020**
Pump Station(s) Installation						
Pump	4	EA	$	8,000	$	32,000
Pump Station Piping, 06"	4	EA	$	835	$	3,340
Gate valve, 06"	8	EA	$	805	$	6,440
Check valve, 06"	4	EA	$	1,135	$	4,540
Electrical/Instrumentation	2	EA	$	10,250	$	20,500
Site work	2	EA	$	2,560	$	5,120
Building pad	2	EA	$	5,125	$	10,250
Pump Building	2	EA	$	10,250	$	20,500
Fence	2	EA	$	6,150	$	12,300
Tools	2	EA	$	1,025	$	2,050
20,000 gal ground storage tank	2	EA	$	25,000	$	50,000
Subtotal					**$**	**167,040**
Subtotal of Component Costs					**$**	**1,042,060**
Contingency	20%				$	208,412
Design & Constr Management	25%				$	260,515
TOTAL CAPITAL COSTS					**$**	**1,510,987**

Table E.9

Main Link # 3
Total Pipe Length 0.30 miles
Number of Pump Stations Needed 0
Pipe Size 04" inches

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	-	n/a	n/a		n/a	
PVC water line, Class 200, 04"	1,609	LF	$	12	$	19,308
Bore and encasement, 10"	-	LF	$	240	$	-
Open cut and encasement, 10"	-	LF	$	130	$	-
Gate valve and box, 04"	1	EA	$	710	$	710
Air valve	1	EA	$	2,050	$	2,050
Flush valve	1	EA	$	1,025	$	1,025
Metal detectable tape	1,609	LF	$	2.00	$	3,218
Subtotal					**$**	**26,311**
Pump Station(s) Installation						
Pump	-	EA	$	8,000	$	-
Pump Station Piping, 04"	-	EA	$	550	$	-
Gate valve, 04"	-	EA	$	710	$	-
Check valve, 04"	-	EA	$	755	$	-
Electrical/Instrumentation	-	EA	$	10,250	$	-
Site work	-	EA	$	2,560	$	-
Building pad	-	EA	$	5,125	$	-
Pump Building	-	EA	$	10,250	$	-
Fence	-	EA	$	6,150	$	-
Tools	-	EA	$	1,025	$	-
5,000 gal ground storage tank	-	EA	$	10,000	$	-
Subtotal					**$**	**-**
Subtotal of Component Costs					**$**	**26,311**
Contingency	20%				$	5,262
Design & Constr Management	25%				$	6,578
TOTAL CAPITAL COSTS					**$**	**38,151**

Table E.10

Segment A

Valley View MHP

Private Pipe Size	04"	
Total Pipe Length	0.46	miles
Total PWS annual water usage	2,044,000.0	Gallons
Number of Pump Stations 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	2	n/a	n/a		n/a	
PVC water line, Class 200, 04"	2,428	LF	$	12	$	29,136
Bore and encasement, 10"	-	LF	$	240	$	-
Open cut and encasement, 10"	100	LF	$	130	$	13,000
Gate valve and box, 04"	1	EA	$	710	$	710
Air valve	1	EA	$	2,050	$	2,050
Flush valve	1	EA	$	1,025	$	1,025
Metal detectable tape	2,428	LF	$	2.00	$	4,856
Subtotal					**$**	**50,777**
Pump Station(s) Installation						
Pump	-	EA	$	8,000	$	-
Pump Station Piping, 04"	-	EA	$	550	$	-
Gate valve, 04"	-	EA	$	710	$	-
Check valve, 04"	-	EA	$	755	$	-
Electrical/Instrumentation	-	EA	$	10,250	$	-
Site work	-	EA	$	2,560	$	-
Building pad	-	EA	$	5,125	$	-
Pump Building	-	EA	$	10,250	$	-
Fence	-	EA	$	6,150	$	-
Tools	-	EA	$	1,025	$	-
5,000 gal ground storage tank	-	EA	$	10,000	$	-
Subtotal					**$**	**-**
Subtotal of Component Costs					**$**	**50,777**
Contingency	20%				$	10,155
Design & Constr Management	25%				$	12,694
TOTAL CAPITAL COSTS					**$**	**73,627**

Table E.11

Segment B

Greenwood WS

Private Pipe Size	06"	
Total Pipe Length	0.52	miles
Total PWS annual water usage	52,925,000.0	Gallons
Number of Pump Stations 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	
PVC water line, Class 200, 06"	2,750	LF	$	18	$	49,500
Bore and encasement, 12"	-	LF	$	240	$	-
Open cut and encasement, 12"	50	LF	$	130	$	6,500
Gate valve and box, 06"	1	EA	$	805	$	805
Air valve	1	EA	$	2,050	$	2,050
Flush valve	1	EA	$	1,025	$	1,025
Metal detectable tape	2,750	LF	$	2.00	$	5,500
Subtotal					**$**	**65,380**
Pump Station(s) Installation						
Pump	-	EA	$	8,000	$	-
Pump Station Piping, 06"	-	EA	$	835	$	-
Gate valve, 06"	-	EA	$	805	$	-
Check valve, 06"	-	EA	$	1,135	$	-
Electrical/Instrumentation	-	EA	$	10,250	$	-
Site work	-	EA	$	2,560	$	-
Building pad	-	EA	$	5,125	$	-
Pump Building	-	EA	$	10,250	$	-
Fence	-	EA	$	6,150	$	-
Tools	-	EA	$	1,025	$	-
30,000 gal ground storage tank	-	EA	$	40,000	$	-
Subtotal					**$**	**-**
Subtotal of Component Costs					**$**	**65,380**
Contingency	20%				$	13,076
Design & Constr Management	25%				$	16,345
TOTAL CAPITAL COSTS					**$**	**94,801**

Table E.12

Segment C

Greenwood Ventures

Private Pipe Size	04"	
Total Pipe Length	0.01	miles
Total PWS annual water usage	5,475,000.0	Gallons
Number of Pump Stations 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	
PVC water line, Class 200, 04"	56	LF	$	12	$	672
Bore and encasement, 10"	-	LF	$	240	$	-
Open cut and encasement, 10"	50	LF	$	130	$	6,500
Gate valve and box, 04"	1	EA	$	710	$	710
Air valve	1	EA	$	2,050	$	2,050
Flush valve	1	EA	$	1,025	$	1,025
Metal detectable tape	56	LF	$	2.00	$	112
Subtotal					**$**	**11,069**
Pump Station(s) Installation						
Pump	-	EA	$	8,000	$	-
Pump Station Piping, 04"	-	EA	$	550	$	-
Gate valve, 04"	-	EA	$	710	$	-
Check valve, 04"	-	EA	$	755	$	-
Electrical/Instrumentation	-	EA	$	10,250	$	-
Site work	-	EA	$	2,560	$	-
Building pad	-	EA	$	5,125	$	-
Pump Building	-	EA	$	10,250	$	-
Fence	-	EA	$	6,150	$	-
Tools	-	EA	$	1,025	$	-
5,000 gal ground storage tank	-	EA	$	10,000	$	-
Subtotal					**$**	**-**
Subtotal of Component Costs					**$**	**11,069**
Contingency	20%				$	2,214
Design & Constr Management	25%				$	2,767
TOTAL CAPITAL COSTS					**$**	**16,050**

Table E.13

Segment D

Greendwood ISD

Private Pipe Size	04"	
Total Pipe Length	0.21	miles
Total PWS annual water usage	15,695,000.0	Gallons
Number of Pump Stations 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
PVC water line, Class 200, 04"	1,116	LF	$ 12	$ 13,392
Bore and encasement, 10"	-	LF	$ 240	$ -
Open cut and encasement, 10"	50	LF	$ 130	$ 6,500
Gate valve and box, 04"	1	EA	$ 710	$ 710
Air valve	1	EA	$ 2,050	$ 2,050
Flush valve	1	EA	$ 1,025	$ 1,025
Metal detectable tape	1,116	LF	$ 2.00	$ 2,232
Subtotal				**$ 25,909**
Pump Station(s) Installation				
Pump	-	EA	$ 8,000	$ -
Pump Station Piping, 04"	-	EA	$ 550	$ -
Gate valve, 04"	-	EA	$ 710	$ -
Check valve, 04"	-	EA	$ 755	$ -
Electrical/Instrumentation	-	EA	$ 10,250	$ -
Site work	-	EA	$ 2,560	$ -
Building pad	-	EA	$ 5,125	$ -
Pump Building	-	EA	$ 10,250	$ -
Fence	-	EA	$ 6,150	$ -
Tools	-	EA	$ 1,025	$ -
10,000 gal ground storage tank	-	EA	$ 15,000	$ -
Subtotal				**$ -**
Subtotal of Component Costs				**$ 25,909**
Contingency	20%			$ 5,182
Design & Constr Management	25%			$ 6,477
TOTAL CAPITAL COSTS				**$ 37,568**

Table E.14

This sheet calculates the cost of servicing Valley View by itself.

Segment A

Valley View MHP

Private Pipe Size	04"	
Total Pipe Length	2.92	miles
Total PWS annual water usage	2,044,000.0	Gallons
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	**Quantity**	**Unit**	**Unit Cost**		**Total Cost**	
Pipeline Construction						
Number of Crossings, bore	-	n/a	n/a		n/a	
Number of Crossings, open cut	2	n/a	n/a		n/a	
PVC water line, Class 200, 04"	15,436	LF	$	12	$	185,232
Bore and encasement, 10"	-	LF	$	240	$	-
Open cut and encasement, 10"	100	LF	$	130	$	13,000
Gate valve and box, 04"	4	EA	$	710	$	2,840
Air valve	3	EA	$	2,050	$	6,150
Flush valve	4	EA	$	1,025	$	4,100
Metal detectable tape	15,436	LF	$	2.00	$	30,872
Subtotal					**$**	**242,194**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 04"	2	EA	$	550	$	1,100
Gate valve, 04"	4	EA	$	710	$	2,840
Check valve, 04"	2	EA	$	755	$	1,510
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
5,000 gal ground storage tank	1	EA	$	10,000	$	10,000
Subtotal					**$**	**66,810**
Subtotal of Component Costs					**$**	**309,004**
Contingency	20%				$	61,801
Design & Constr Management	25%				$	77,251
TOTAL CAPITAL COSTS					**$**	**448,056**

Table E.15

Segment B
Greenwood WS

Private Pipe Size	06"	
Total Pipe Length	10.03	miles
Total PWS annual water usage	52,925,000.0	Gallons
Number of Pump Stations Needed	3	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 06"	52,957	LF	$ 18	$ 953,226
Bore and encasement, 12"	-	LF	$ 240	$ -
Open cut and encasement, 12"	50	LF	$ 130	$ 6,500
Gate valve and box, 06"	11	EA	$ 805	$ 8,855
Air valve	11	EA	$ 2,050	$ 22,550
Flush valve	11	EA	$ 1,025	$ 11,275
Metal detectable tape	52,957	LF	$ 2.00	$ 105,914
Subtotal				**$ 1,108,320**
Pump Station(s) Installation				
Pump	6	EA	$ 8,000	$ 48,000
Pump Station Piping, 06"	6	EA	$ 835	$ 5,010
Gate valve, 06"	12	EA	$ 805	$ 9,660
Check valve, 06"	6	EA	$ 1,135	$ 6,810
Electrical/Instrumentation	3	EA	$ 10,250	$ 30,750
Site work	3	EA	$ 2,560	$ 7,680
Building pad	3	EA	$ 5,125	$ 15,375
Pump Building	3	EA	$ 10,250	$ 30,750
Fence	3	EA	$ 6,150	$ 18,450
Tools	3	EA	$ 1,025	$ 3,075
30,000 gal ground storage tank	3	EA	$ 40,000	$ 120,000
Subtotal				**$ 295,560**
Subtotal of Component Costs				**$ 1,403,880**
Contingency	20%			$ 280,776
Design & Constr Management	25%			$ 350,970
TOTAL CAPITAL COSTS				**$ 2,035,626**

Table E.16

Segment C
Greenwood Ventures

Private Pipe Size	04"	
Total Pipe Length	9.82	miles
Total PWS annual water usage	5,475,000.0	Gallons
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost		Total Cost	
Pipeline Construction						
Number of Crossings, bore	-	n/a	n/a		n/a	
Number of Crossings, open cut	1	n/a	n/a		n/a	
PVC water line, Class 200, 04"	51,872	LF	$	12	$	622,464
Bore and encasement, 10"	-	LF	$	240	$	-
Open cut and encasement, 10"	50	LF	$	130	$	6,500
Gate valve and box, 04"	11	EA	$	710	$	7,810
Air valve	10	EA	$	2,050	$	20,500
Flush valve	11	EA	$	1,025	$	11,275
Metal detectable tape	51,872	LF	$	2.00	$	103,744
Subtotal					**$**	**772,293**
Pump Station(s) Installation						
Pump	2	EA	$	8,000	$	16,000
Pump Station Piping, 04"	2	EA	$	550	$	1,100
Gate valve, 04"	4	EA	$	710	$	2,840
Check valve, 04"	2	EA	$	755	$	1,510
Electrical/Instrumentation	1	EA	$	10,250	$	10,250
Site work	1	EA	$	2,560	$	2,560
Building pad	1	EA	$	5,125	$	5,125
Pump Building	1	EA	$	10,250	$	10,250
Fence	1	EA	$	6,150	$	6,150
Tools	1	EA	$	1,025	$	1,025
5,000 gal ground storage tank	1	EA	$	10,000	$	10,000
Subtotal					**$**	**66,810**
Subtotal of Component Costs					**$**	**839,103**
Contingency	20%				$	167,821
Design & Constr Management	25%				$	209,776
TOTAL CAPITAL COSTS					**$**	**1,216,699**

Table E.17

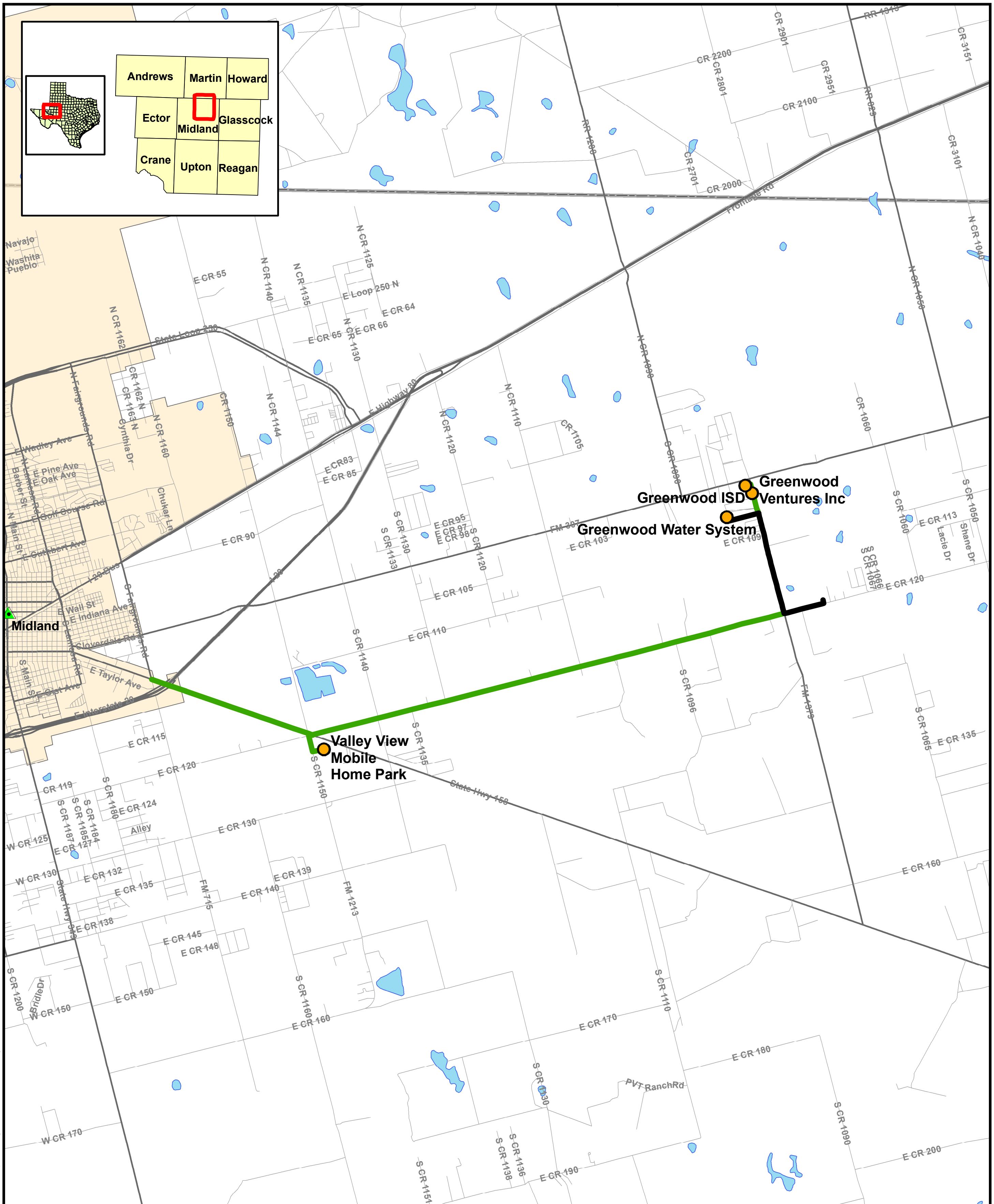
Segment D

Greendwood ISD

Private Pipe Size	04"	
Total Pipe Length	10.03	miles
Total PWS annual water usage	15,695,000.0	Gallons
Number of Pump Stations Needed	1	

Capital Costs

Cost Item	Quantity	Unit	Unit Cost	Total Cost
Pipeline Construction				
Number of Crossings, bore	-	n/a	n/a	n/a
Number of Crossings, open cut	1	n/a	n/a	n/a
PVC water line, Class 200, 04"	52,932	LF	$ 12	$ 635,184
Bore and encasement, 10"	-	LF	$ 240	$ -
Open cut and encasement, 10"	50	LF	$ 130	$ 6,500
Gate valve and box, 04"	11	EA	$ 710	$ 7,810
Air valve	11	EA	$ 2,050	$ 22,550
Flush valve	11	EA	$ 1,025	$ 11,275
Metal detectable tape	52,932	LF	$ 2.00	$ 105,864
Subtotal				**$ 789,183**
Pump Station(s) Installation				
Pump	2	EA	$ 8,000	$ 16,000
Pump Station Piping, 04"	2	EA	$ 550	$ 1,100
Gate valve, 04"	4	EA	$ 710	$ 2,840
Check valve, 04"	2	EA	$ 755	$ 1,510
Electrical/Instrumentation	1	EA	$ 10,250	$ 10,250
Site work	1	EA	$ 2,560	$ 2,560
Building pad	1	EA	$ 5,125	$ 5,125
Pump Building	1	EA	$ 10,250	$ 10,250
Fence	1	EA	$ 6,150	$ 6,150
Tools	1	EA	$ 1,025	$ 1,025
10,000 gal ground storage tank	1	EA	$ 15,000	$ 15,000
Subtotal				**$ 71,810**
Subtotal of Component Costs				**$ 860,993**
Contingency	20%			$ 172,199
Design & Constr Management	25%			$ 215,248
TOTAL CAPITAL COSTS				**$ 1,248,440**



Legend

- Study System
- PWS's
- Cities
- City Limits
- Counties
- Major Road
- Minor Road
- CRMWA Pipeline
- Lubbock Pipeline
- Grass Valley Pipeline
- GW/GI/GV/VV - 1
- Existing Pipeline

N

Miles
0 0.75 1.5

Figure E.1

GREENWOOD WS, GREENWOOD ISD, GREENWOOD VENTURES & VALLEY VIEW MHP TO MIDLAND

Shared Pipeline Alternative

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