PILOT PROJECT PRELIMINARY REPORT FEASIBILITY ANALYSIS OF WATER SUPPLY FOR SMALL PUBLIC WATER SYSTEMS

RRA GUTHRIE-DUMONT
PWS ID# 1350001, CCN# 10202

Prepared for:

THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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AND

PARSONS

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EXECUTIVE SUMMARY

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

The Red River Authority (RRA) Guthrie-Dumont Water System (PWS ID# 1350001, CCN# 10202) was identified to participate in the pilot application of a methodology (or decision tree) to analyze water supply alternatives. The location of the RRA Guthrie-Dumont Water System is shown in Figure 1.1.

The RRA Guthrie-Dumont Water System supplies drinking water with nitrate concentrations that typically vary between 10 and 15 mg/L, exceeding the maximum contaminant level (MCL) for nitrates. The MCL for nitrate (as nitrogen) has been set at 10 milligrams per liter (mg/L) by the U.S. Environmental Protection Agency (USEPA) and the TCEQ. TCEQ plans to use the decision tree developed in this study as a guide for conducting similar future studies for other non-compliant PWSs.

The decision tree is a flow chart for conducting a feasibility study for a non-compliant PWS. The decision tree flow chart is shown in Figures 2.1 through 2.4. It begins with a process for defining the operating parameters of an existing PWS. If it is determined that the PWS cannot be optimized to correct its deficiency, the process includes the investigation of other supply alternatives, such as new groundwater sources, new surface water sources, and treatment alternatives. After feasible supply alternatives are identified, conceptual designs and cost estimates are prepared for each alternative. Preferred alternatives are then selected and subjected to more detailed investigation, including an investigation into the socio-political aspects of implementing the alternatives.

The study was initiated by collecting data to define the operating parameters of the RRA Guthrie-Dumont Water System. Data were collected from TCEQ files, from websites operated by TCEQ, USEPA, the RRA, and from the RRA Guthrie-Dumont Water System. A review of the existing operating parameters for the RRA Guthrie-Dumont Water System determined that optimization would not correct the nitrate violations. Specific data collected included:

- Groundwater data from existing wells (including quantity and quality data);
- Surface water data from regional planning documents for Region B, Brazos G, and Llano Estacado;
- Surface water data from the surface water availability model (WAM) for the White River;
- Financial data (*e.g.*, annual budget, financial statements, water rate structure, *etc*.) from the PWS;

- Demographic data from the 2000 Census and employment data from the U.S. Bureau of Labor Statistics; and
- Data on potential funding programs (*i.e.*, private, state, and federal) for compliance alternatives.

After data collection and review, a list of preliminary compliance alternatives was developed. Preliminary alternatives included connections to neighboring PWSs, development of new groundwater sources, development of new surface water sources, and treatment options for non-compliant water. The table below summarizes the compliance alternatives investigated for the RRA Guthrie-Dumont Water System.

Table ES.1 Summary of Preliminary Compliance Alternatives

Compliance Alternatives Considered	Red River Authority Guthrie-Dumont Water System
Connection to Neighboring Public Water Systems	• Install well at City of Matador well field near Roaring Springs and interconnect with City of Matador system. • Install well at City of Dickens well field and interconnect with City of Dickens system. • Install 2 wells at City of McAdoo well field and interconnect with City of McAdoo system.
New Groundwater Sources	• Seymour Aquifer wells • Permian wells
New Surface Water Sources	• White River - not feasible
Treatment of Existing Water Supply	• Install TDS treatment plant at King-Cottle well field • Centralized treatment of Dumont well field raw water • Point-of-entry treatment of Dumont well field raw water • Point-of-use treatment of Dumont well field raw water • Bottled water program (interim measure) • Treated water dispenser (interim measure)

Identification of preliminary compliance alternatives was followed by a more detailed assessment of the preferred or feasible alternatives for the RRA Guthrie-Dumont Water System. The detailed assessment included additional work to define the compliance alternatives (*e.g.*, identification of required components, assessment of reliability, and identification of political issues) and an analysis of cost and affordability.

The cost to implement the alternatives and an affordability analysis were developed to determine the financial impact of a compliance alternative, as measured by the fraction of median household income represented by the water bill, and the percent increase in water bills. Table 4.3 provides a summary of the detailed analysis performed for the various compliance alternatives. The analysis summarized in the table demonstrates a large range in costs for the alternatives considered. Figure 4.3 is a chart that summarizes the data from Table 4.3.

The feasibility study showed that all options are technically possible, some having more long-term reliability (*e.g.*, installation of a new compliance well) and some requiring more utility effort and customer support (*e.g.*, in-house visits and management for point-of-use treatment units). Connections to adjacent water systems or use of centralized treatments have good reliability. Providing treated bottled drinking water or water from a public dispenser are considered interim measures to be taken until a compliance alternative is implemented.

Installation of a new compliant well may be the best option. Since many systems in the region have nitrate problems, it may be possible to share the cost of this option with other PWSs. The new well or well field would need to be installed in an area where nitrate and other constituents are not above drinking water standards. To evaluate placement of a new well, existing sampling data from nearby wells can be used as indicators of groundwater conditions. Much of the existing sampling data were collected in the early 1970s and re-sampling is needed to verify the data.

The final step in evaluating feasible alternatives (although beyond the scope of this pilot project) is to consider other features of the alternatives such as socio-political issues, ease of operation, ability to reliably maintain compliance with all drinking water standards, availability and safety aspects of any needed supplies, environmental impacts, and any other factors deemed appropriate by the PWS. Once the other factors have been identified, affordability can be addressed in terms of:

- The PWS can be analyzed to determine the segment of the population that may have difficulty paying the necessary rates;
- Alternatives for addressing this segment of the population can then be considered such as: reduced fees for this segment, subsidized rates utility-wide, a voluntary good neighbor fund, connection with a charitable organization, *etc.*; and
- Rates can be structured to favor lower water users. The PWS can encourage those having trouble paying the necessary rates to use less water and thus save money.

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ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
BEG	Bureau of Economic Geology
CA	Chemical analysis
CAFO	Concentrated animal feeding operation
CCN	Certificate of Convenience and Necessity
CO	Correspondence
EDR	Electrodialysis reversal
FMT	Financial, managerial, and technical
GAM	Groundwater availability model
gpy	Gallons per year
gpm	Gallons per minute
HBR	Heterotrophic biological reduction
IX	Ion exchange
m^3/day	Cubic meters per day
MBfR	Membrane biofilm reactor
MCL	Maximum contaminant level
MF	Micro filtration
mg/L	Milligram per liter
mgd	Million gallons per day
MHI	Median household income
MIWA	Municipal and Industrial Water Authority
MOR	Monthly quality/quantity report
NLDC	National land cover dataset
NMEFC	New Mexico Environmental Financial Center
O&M	Operation and Maintenance
psi	Pounds per square inch
PVC	Polyvinyl chloride
PWS	Public water system
RO	Reverse osmosis
RRA	Red River Authority
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TSS	Total suspended solids
TWDB	Texas Water Development Board
USEPA	U.S. Environmental Protection Agency
WAM	Water availability model

SECTION 1
INTRODUCTION

The University of Texas Bureau of Economic Geology (BEG) and its subcontractor, Parsons Infrastructure & Technology Group Inc. (Parsons), have been contracted by the Texas Commission on Environmental Quality (TCEQ) to develop a general methodology for assisting the TCEQ and non-compliant Public Water Systems (PWS) in identifying and analyzing compliance options. The goal of the project is to provide TCEQ and Texas PWSs that exceed maximum contaminant levels (MCL) with feasibility studies to promote drinking water quality regulatory compliance using sound engineering and financial methods and data. The RRA Guthrie-Dumont Water System (PWS ID# 1350001, CCN# 10202) was identified as one of three subjects for the pilot application of the methodology, which also included:

- Northside Water Supply Corporation (WSC); and
- Red River Authority (RRA) Truscott-Gilliland Water System.

The location of the RRA Guthrie-Dumont Water System is shown in Figure 1.1 and is hereinafter collectively referred to as the "Study Area." Various water supply and planning jurisdictions are shown in Figure 1.2.

The RRA Guthrie-Dumont Water System supplies drinking water with nitrate concentrations that typically vary between 10 and 20 mg/L, exceeding the MCL for nitrates. The MCL for nitrate (as nitrogen) has been set at 10 milligrams per liter (mg/L) by the U.S. Environmental Protection Agency (USEPA) and the TCEQ. Nitrate levels in excess of the MCL have caused serious illness and sometimes death (USEPA Consumer Factsheet on Nitrates/Nitrites 2004). Drinking water health publications conclude that the most susceptible population to adverse nitrate health effects includes infants less than 6 months of age; women who are pregnant or nursing; and individuals with enzyme deficiencies or a lack of free hydrochloric acid in the stomach.

A central part of the scope of the project is to develop a decision tree that can be used as a guide for analyzing alternatives for non-compliant PWSs. This decision tree can then be used as a guide for conducting similar future studies for other PWSs. Other project tasks are as follows:

- Identifying available data sources;
- Gathering and compiling data;
- Conducting financial, managerial, and technical (FMT) evaluations of the selected PWSs;
- Performing a geologic and hydrogeologic assessment of the study area;
- Developing treatment and non-treatment compliance alternatives;

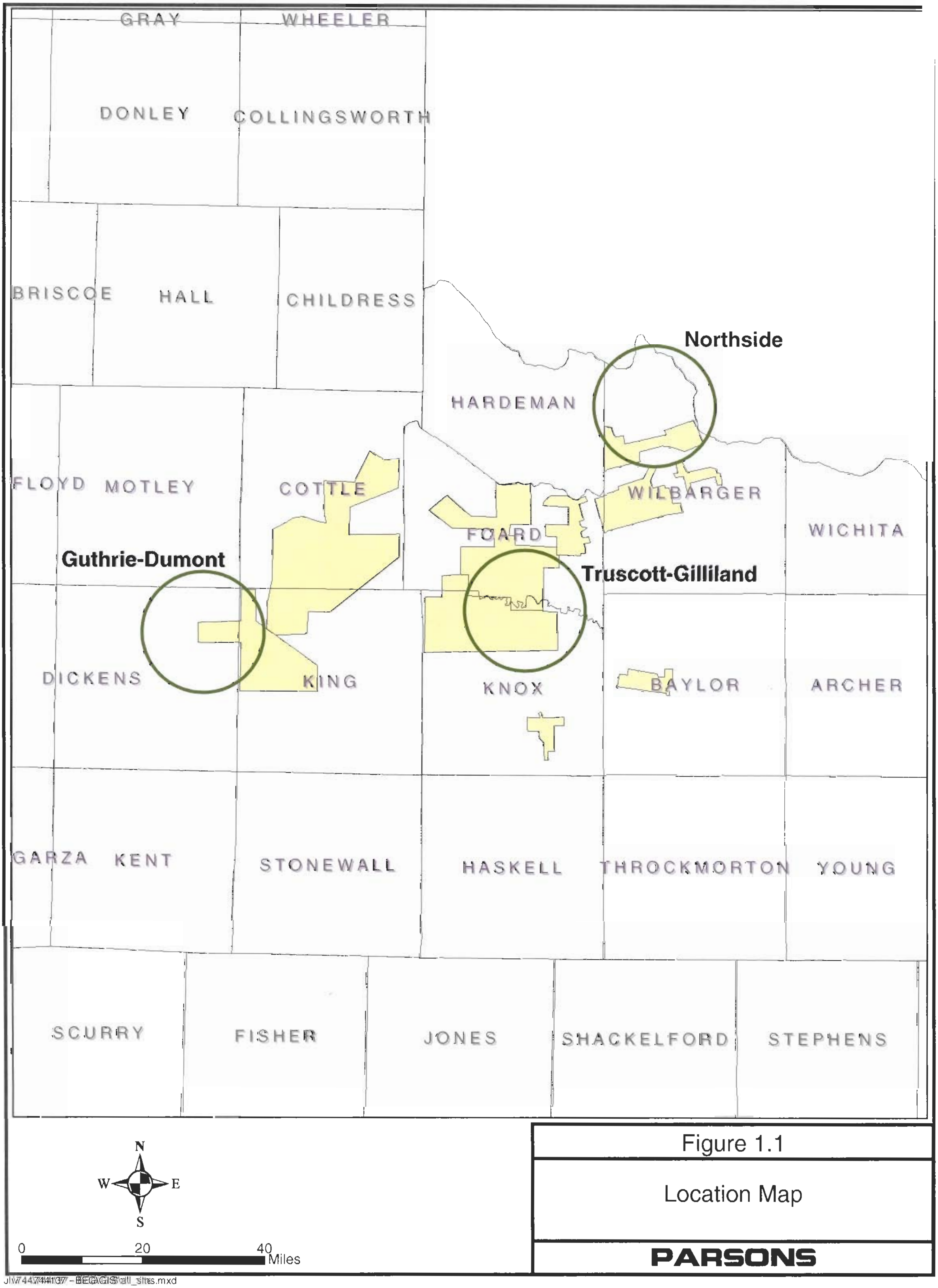

Figure 1.1

Location Map

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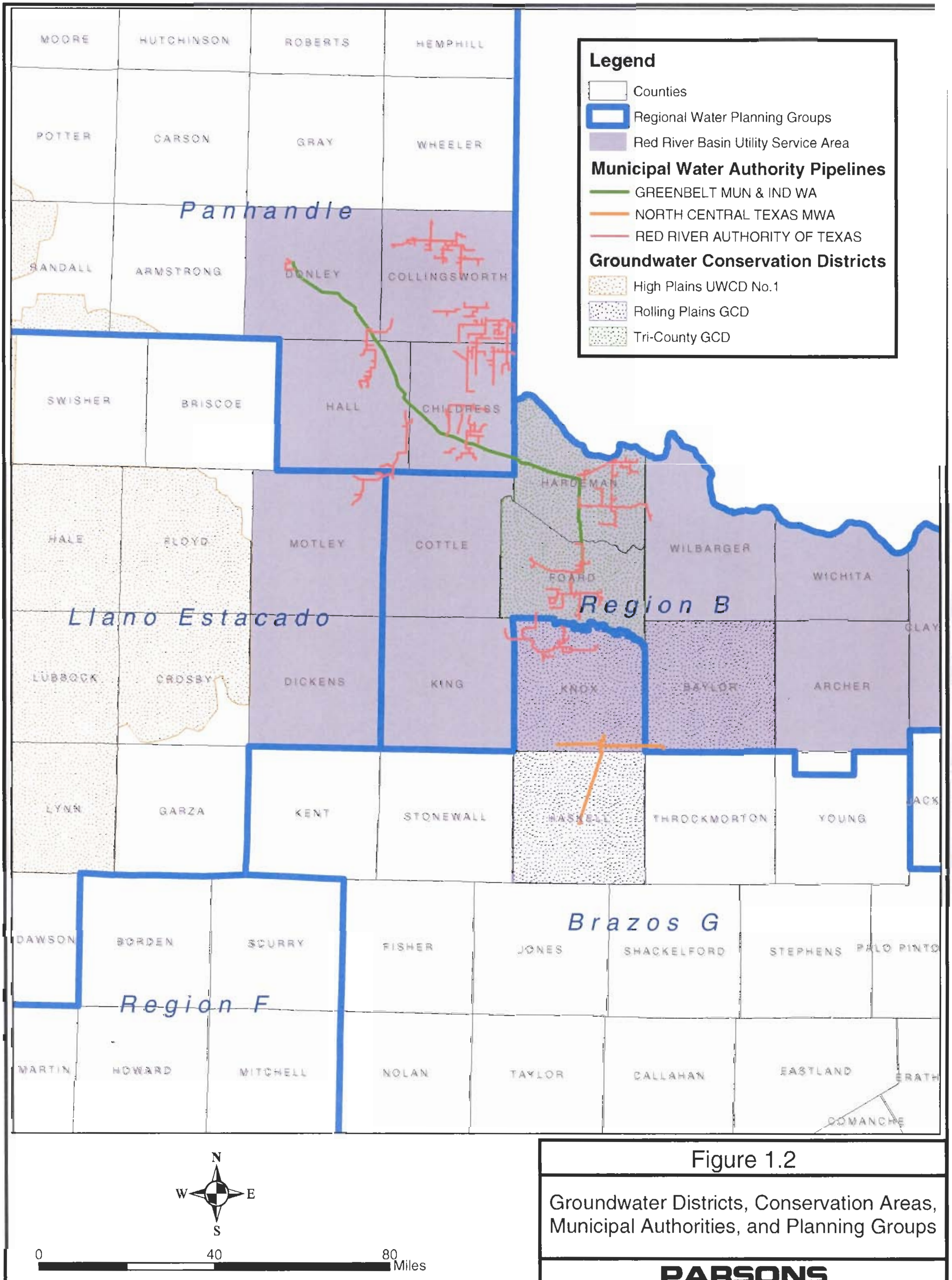

Figure 1.2

Groundwater Districts, Conservation Areas, Municipal Authorities, and Planning Groups

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- 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 nitrate abatement options. Section 2 describes the methodology used to develop and assess compliance alternatives. The groundwater sources of nitrate are addressed in Section 3. Findings for the RRA Guthrie-Dumont Water System, along with compliance alternatives development and evaluation, can be found in Section 4.

1.1 REGULATORY PERSPECTIVE

The Utilities & Districts and Public Drinking Water Sections of the TCEQ Water Supply Division are responsible for implementing the federal Safe Drinking Water Act requirements that 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 of rates for privately-owned water utilities.

This pilot project was conducted to assist in achieving these responsibilities.

1.2 NITRATE ABATEMENT OPTIONS

When a PWS exceeds the regulatory MCL, the PWS must take action to correct the violation. The MCL exceedance at the Guthrie-Dumont system is for nitrates.

1.2.1 Existing Public Water Supply Systems

A common approach to achieve 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.

1.2.1.1 Quantity

Quantity is used here in the sense of 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 just enough water to blend to achieve compliance should be considered. The exact blend ratio will depend on the quality of the water a potential supplier PWS can provide, and will likely vary over time.

If the supplier PWS does not have sufficient quantity, the non-complaint 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;
- Additional or larger-diameter piping;
- Additional storage tank volume;
- Higher-pressure pumps; or
- Upsized, or additional, disinfection equipment.

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

1.2.1.2 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 will need to look for a potential supplier PWS that obtains its water from a different aquifer or from a surface water source.

In some cases, a potential supplier PWS obtains its water from a different aquifer than the non-compliant PWS even though both PWSs are supplied by groundwater. For example, all four of the potential supplier PWSs for RRA Guthrie-Dumont obtain their water from aquifers other than the Seymour. This condition does not always guarantee that the supplier PWS will have satisfactory water. For example, King-Cottle WSC obtains its water from the Blaine Aquifer, which is acceptable from the standpoint of nitrate concentration, but is unacceptable from the standpoint of total dissolved solids (TDS). The other three potential supplier PWSs obtain their water from either an alluvial aquifer in the case of Dickens and Matador-Roaring Springs, or from the Ogallala Aquifer for McAdoo.

Surface water sources offer a potential higher-quality source. Many of the existing PWSs in the study area obtain surface water from either the Greenbelt Municipal and Industrial Water Authority (MIWA) or from North Central Texas Municipal Water Authority. Where these PWSs are neighbors, the non-compliant PWS will potentially need to deal with them as well as with the two water authorities that supply the surface water.

1.2.2 Potential for New Groundwater Sources

1.2.2.1 Existing Non-Public Supply Wells

Often there are wells not associated with PWSs located 10 miles or less from the non-compliant PWS. The current use of these wells may be irrigation, industrial purposes, domestic supply, stock watering, and other purposes. The process for investigating existing wells is as follows:

- Use existing data sources (see below) to identify wells in the areas that have satisfactory quality. For this study, the standards were set as follows:
  - Nitrate (as N) concentrations less than 8 mg/L,
  - Sulfate concentrations less than 300 mg/L, and
  - Total dissolved solids concentrations less than 1,000 mg/L.
- Review the recorded information about the well 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 that were eliminated from consideration were domestic and stock wells, dug wells, test holes, observation wells, seeps and springs, destroyed wells, wells used by other communities, *etc*. Look for wells that are of sufficient size and have been used for industrial or irrigation purposes. Often the database will include well yields, which may indicate the likelihood of a particular well being 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 promising, the owner(s) should be contacted to ascertain their willingness to work with the PWS. Once the owner agrees to participate with the program, questions about the wells could be posed. 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 gleaning as much information as possible from cooperative owners, the PWS would then narrow down the selection and sample selected wells and analyze for quality. Wells with good quality would then be potential candidates for test pumping. In some cases, a particular well may have to be

refurbished before test pumping. Information obtained from test pumping would then be used in combination with information about the general characteristics of the aquifer to determine whether a well at this location would be suitable as a supply source.

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

1.2.2.2 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 may be applied to indicate potential sources. Once a general area has been identified, land owners and regulatory agencies should be contacted to determine an exact location for a new well or well field.

1.2.3 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 for nitrates, rights may not need to be 100 percent available.

1.2.3.1 Existing Sources

"Existing 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 the first course of investigation. An existing source will be limited by its water rights, the safe yield of a reservoir or river, or by its water treatment 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, where they are available, water rights could perhaps be purchased.

In addition to securing the water supply from a source, the non-compliant PWS would have to arrange for the transmission of the water to the PWS. In some cases, this may require negotiations with, contracts with, and payments to an intermediate PWS. (An intermediate PWS is one whose 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.

1.2.3.2 New 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 to assist in the determination.
- Discussions with land owners to indicate potential treatment plant locations.
- 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 the more intensive planning (initially obtaining funding), permitting, land acquisition, and detailed designs.

1.2.4 Treatment

Reverse Osmosis (RO), Ion Exchange (IX) and Electrodialysis Reversal (EDR) are identified by USEPA as best available technology for removal of nitrates. RO and IX are also viable options for point-of-entry and point-of-use systems. A description of these technologies and three additional technologies for the removal of nitrates follows.

1.2.4.1 Reverse Osmosis

<u>Process</u> - 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 or polyamide thin film composite. Common membrane construction includes spiral wound or hollow fine fiber. Each material and construction method has specific benefits and limitations depending on the raw water characteristics and pre-treatment. A typical RO installation includes a high pressure feed pump; parallel first and second stage membrane elements (in pressure vessels); valving; and feed, permeate, and concentrate piping. All materials and construction methods

require regular maintenance. 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. The conventional RO treatment train for well water uses anti-scalant addition, micro-filtration (MF) RO membranes, chlorine disinfection, and clearwell storage. Surface water requires more intensive upstream treatment – flocculation, sedimentation, filtration. Additional treatment or management of the concentrate and the removed solids is necessary prior to off-site disposal.

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 dissolved solids is necessary to prevent scaling and chemical attack. Pre-treatment can include media filters to remove suspended particles; ion exchange softening or anti-scalant to remove hardness; 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 (micro) filters to remove any remaining suspended particles to protect membranes from upsets.

Maintenance - Monitor rejection percentage to ensure contaminant removal below MCL. 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.

Advantages

- Produces highest water quality.
- Can effectively treat 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 (<100 psi), compact, self-contained, single membrane units are available for small installations.

Disadvantages

- Relatively expensive to install and operate.
- Frequent membrane monitoring (for breakthrough) and maintenance; pressure, temperature, and pH requirements to meet membrane tolerances. May be chemically sensitive.
- Additional water usage depending on rejection rate.

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 case, 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 can be between 10 and 50 percent of the influent flow. If RO is to be employed, the process should first be pilot-tested. Pilot testing is needed to define design criteria, define capital and O&M costs, define the degree of pre-treatment required, obtain competitive bids, and to comply with current regulatory requirements for non-traditional treatment processes.

1.2.4.2 Ion Exchange

Process - In solution, salts separate into positively-charged cations and negatively-charged anions. Ion exchange is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that certain ions are preferentially adsorbed on the ion exchange resin. Operation begins with a fully recharged cation or anion resin bed, having enough positively or negatively charged ions to carry out the cation or anion exchange. Usually a polymer resin bed is composed of millions of spherical beads about the size of medium sand grains. As water passes through the resin bed, the positively or negatively charged ions are released into the water, being substituted or replaced with the contaminant ions in the water (ion exchange). When the resin becomes exhausted of positively or negatively charged ions, the bed must be regenerated by passing a strong, usually Sodium Chloride, solution over the resin bed, displacing the contaminant ions with Sodium ions for cation exchange and Chloride ions for anion exchange. Many different types of resins can be used to reduce dissolved contaminant concentrations. The IX treatment train for groundwater typically includes cation or anion resin beds, chlorine disinfection, and clearwell storage. Treatment trains for surface water may also include raw water pumps, debris screens, and gravity filters for pre-treatment. Additional treatment or management of the concentrate and the removed solids will be necessary prior to disposal.

Pre-treatment - Guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pre-treatment may be required to reduce excessive amounts of total suspended solids (TSS), iron, and manganese, which could plug the resin bed, and typically includes media or carbon filtration. Pre-treatment may also be required to remove sulfate that can interfere with nitrate removal.

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

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

Advantages

- Acid addition, degasification, and repressurization are not required.
- Ease of operation; highly reliable.
- Lower initial cost; resins will not wear out with regular regeneration.
- Effective; widely used.
- Suitable for small and large installations.
- Variety of specific resins are available for removing specific contaminants.

Disadvantages

- Requires salt storage; regular regeneration.
- Concentrate disposal.
- Usually not feasible with high levels of TDS.
- Resins are sensitive to the presence of competing ions.

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

If IX is to be employed, the process should first be pilot-tested. Pilot testing is needed to define design criteria, define capital and O&M costs, define the degree of pre-treatment required, obtain competitive bids, and to comply with current regulatory requirements for non-traditional treatment processes.

1.2.4.3 Electrodialysis Reversal

Process - EDR is an electrochemical process in which ions migrate through ion-selective semi-permeable membranes as a result of their attraction to two electrically charged electrodes. A typical EDR system includes a membrane stack with a number of cell pairs, each consisting of a cation transfer membrane, a demineralized flow spacer, an anion transfer membrane, and a concentrate flow spacer. Electrode compartments are at opposite ends of the stack. The influent feed water (chemically treated to prevent precipitation) and 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 50 percent of the TDS; therefore, for water with more than 1,000 mg/L TDS, blending with higher quality water or a second stage is required to meet 500 mg/L TDS. 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 increases membrane life, does not require 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. MF could be used in place of flocculation, sedimentation, and filtration. Additional treatment or management of the concentrate and the removed solids will be necessary prior to disposal.

Pre-treatment - Guidelines are available on acceptable limits on pH, organics, turbidity, and other raw water characteristics. EDR typically requires chemical feed to prevent scaling, acid addition for pH adjustment, and a cartridge filter for prefiltration.

Maintenance - EDR membranes are durable, can tolerate pH from 1-10, 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 spacer. If the chlorine is not removed, toxic chlorine gas may form. Depending on raw water characteristics, the membranes will 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 will 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 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.

Disadvantages

- Not suitable for high levels of Iron, Manganese, Hydrogen Sulfide, Chlorine, or hardness.
- Limited current density; current leakage; back diffusion.
- At 50 percent rejection of TDS per pass, process favors low TDS water.

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.

If EDR is to be employed, the process should first be pilot-tested. Pilot testing is needed to define design criteria, define capital and O&M costs, define the degree of pre-treatment required, obtain competitive bids, and to comply with current regulatory requirements for non-traditional treatment processes.

1.2.4.4 Distillation

Distillation heats water until it turns to steam. The steam travels through a condenser coil where it is cooled and returned to liquid. The nitrate remains in the boiler section. Distillation is energy-intensive in relation to the other processes, and not well suited for production of drinking water for either the centralized-treatment or point-of-use / point-of-entry applications.

Due to the lack of commercial applications for this technology, it will be eliminated from further consideration.

1.2.4.5 Heterotrophic Biological Reduction

Heterotrophic biological reduction (HBR) is the conversion of nitrogen-containing compounds in water, such as nitrate, nitrite, and ammonia, to one or more of the gaseous compounds: nitrogen, nitric oxide, or nitrous oxide. Heterotrophic facultative microorganisms perform this biochemical conversion using an energy source (typically some form of organic carbon) under anoxic conditions to reduce the nitrogen atom from any of its oxidized states to its reduced states, especially to its most stable form in nature, nitrogen gas.

Since nitrate contamination of groundwater became an increasing concern, several biological denitrification processes were evaluated in the 1990s for commercialization. The BioDen™ process was commercialized when it was first used on a small well system in Coyle, Oklahoma in December 1998 (capacity 150 m^3/day). The process operated for 2 years before another groundwater well was completed and the system was shut down. Nitrate removals were reported to be between 50 percent and 90 percent.

Process/control improvements have consistently produced 65 percent removals in subsequent pilot and demonstration tests where influent concentrations were on the order of 15 to 20 mg/L. The carbon/nitrogen ratio is the key control parameter. Activation of the microorganisms requires 4 to 6 weeks to reach design capacity. Typically, only a portion of the total water supply is treated. The treated water is then blended with untreated water to achieve the desired concentration.

The biological denitrification process should be located inside a building for freeze protection, but otherwise no temperature control is required. Detention time for water in the reactors is approximately 30 to 60 minutes. Backflushing of the reactor is required periodically, and can be automated or done manually. Backflushed wastewater can simply be discharged to sanitary sewers. No chemicals are required for the biological denitrification process other than the nutrients, which are primarily a carbon source (food-grade acetic acid works best) and phosphate. The Coyle, Oklahoma, plant used acetic acid as its carbon source.

Filtration of the biomass produced has been the major problem with the process. Slow sand filtration was used in the Coyle facility, which also provided some biodegradation of the biomass. For small systems, slow sand filtration may be adequate, but not for large, high flow systems. During pilot and demonstration tests in New York State, bag and cartridge filters, ceramic microfiltration and membrane microfiltration were tested. Bag and cartridge filtration was not successful, whereas microfiltration was successful. The only drawbacks to membrane microfiltration are periodic backflushing and chemical cleaning, as required by all other membrane processes.

Similar processes are common in wastewater treatment plants where both the microorganisms and the carbon source are already present in the wastewater. By contrast, biological denitrification processes have not been widely used in drinking water treatment because neither the microorganisms nor the carbon source are present in the raw water, and because the process has not been widely accepted for commercial scale implementation given the perception that cultivating bacteria in water is not an acceptable drinking water treatment technology. Due to the lack of commercial applications for this technology, it will be eliminated from further consideration.

1.2.4.6 Hollow-Fiber Membrane Biofilm Reactor

Hollow-fiber membrane biofilm reactor (MBfR) is a relatively new technology, still in the developmental phase. Unlike RO, IX, EDR, and HBR, MBfR reduces nitrate, perchlorate, and other contaminants without creating waste streams or leaving donor residuals that require special handling. In commercial applications, MBfR is expected to cost substantially less than all these processes.

The MBfR contains hollow-fiber membranes that are potted at both ends of the cylindrical module. Hydrogen gas is fed into the bore of the hollow fiber; the raw water is on the outside of the hollow fiber. The hydrogen passively diffuses through the membranes to serve as an electron donor for the biofilm that grows on the outside of the hollow fibers. The hydrogen does not bubble into the water, but is used by the microorganisms in the biofilm. Hydrogen is an ideal electron donor in that it is nontoxic, inexpensive, and sparsely soluble in water.

The biofilm on the outside of the hollow fiber develops from the indigenous bacteria present in the groundwater, and is not artificially inoculated or amended. The microorganisms in the biofilm that reduce nitrate contaminants using hydrogen gas (H_2) as their electron donor ($H_2 = 2H^+ + 2e^-$) perform the following:

$$2.5\ H_2 + NO_3^- \rightarrow 0.5\ N_2 + 2H_2^- + OH^-$$

Initial use and development of MBfR was conducted at Northwestern University under the direction of Bruce Rittman beginning in 2000. During the two initial steady-state denitrification studies, the influent nitrate concentrations were 10 and 12.5 mg nitrate per liter. With a liquid retention time of 40 minutes, the desired partial removals of nitrate between 76 percent and 92 percent were achieved with effluent hydrogen concentrations as low as 9 µg of hydrogen per liter. In February 2004, additional laboratory experiments with other groundwater demonstrated MBfR's ability to reduce nitrate from 19 mg/L to below detection limit of <0.2 mg/L within the first 24 hours. Additional development work is on-going, and it is anticipated the additional work will confirm that the MBfR process will provide drinking water denitrification at costs 25 percent to 50 percent below those of IX or HBD, and 50 percent to 75 percent less than those of RO processes.

Due to the lack of commercial applications for this technology, it will be eliminated from further consideration. However, further development may make the technology viable in the future.

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

Point-of-entry and point-of-use treatment systems can be used to provide compliant drinking water. For nitrate removal, these systems typically use small RO treatment units that are installed "under the sink" in the case of point-of-use, and where water enters a house or building in the case of point-of-entry. Point-of-entry and point-of-use 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 point-of-entry or point-of-use program for implementation, consultation with TCEQ will be required to address measurement and determination of level of compliance.

1.2.6 Water Delivery or Central Drinking Water Dispensers

Current USEPA regulations 40 CFR 141.101 prohibit the use of bottled water to achieve compliance with an MCL, except on a temporary basis. State regulations do not directly address the use of bottled water. Current use of bottled water in the non-compliant PWSs is on an extended temporary basis. Every 3 years the PWSs are required to present the TCEQ with estimates of the costs of piping compliant water to their systems. As long as the projected costs remain prohibitively high, the interim measure of bottled water provision 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 RO treatment units or could be compliant water that is delivered to the central point by truck.

Water delivery is currently used as an interim measure to provide the susceptible population (*e.g.*, expectant women, infant children) with water compliant with the nitrate MCL. As an interim measure for a small impacted population, providing delivered drinking water may be cost effective. If other contaminants become the subject of investigation, where the susceptible population is larger, the cost of water delivery would increase significantly.

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

The ideal system would:

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

SECTION 2
EVALUATION METHODOLOGY

2.1 DECISION TREE

The decision tree is a flow chart for conducting feasibility studies for the 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. Tree 3 starts with a comparison of the conceptual designs, selecting the two or three alternatives that appear to be most promising, and eliminating those alternatives which are obviously infeasible. 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, managerial, and economic aspects of the alternatives (one of the steps in Tree 3) are given in Tree 4 in Figure 2.4.

2.2 DATA SOURCES AND DATA COLLECTION

2.2.1 Data Search

2.2.1.1 Water Supply Systems

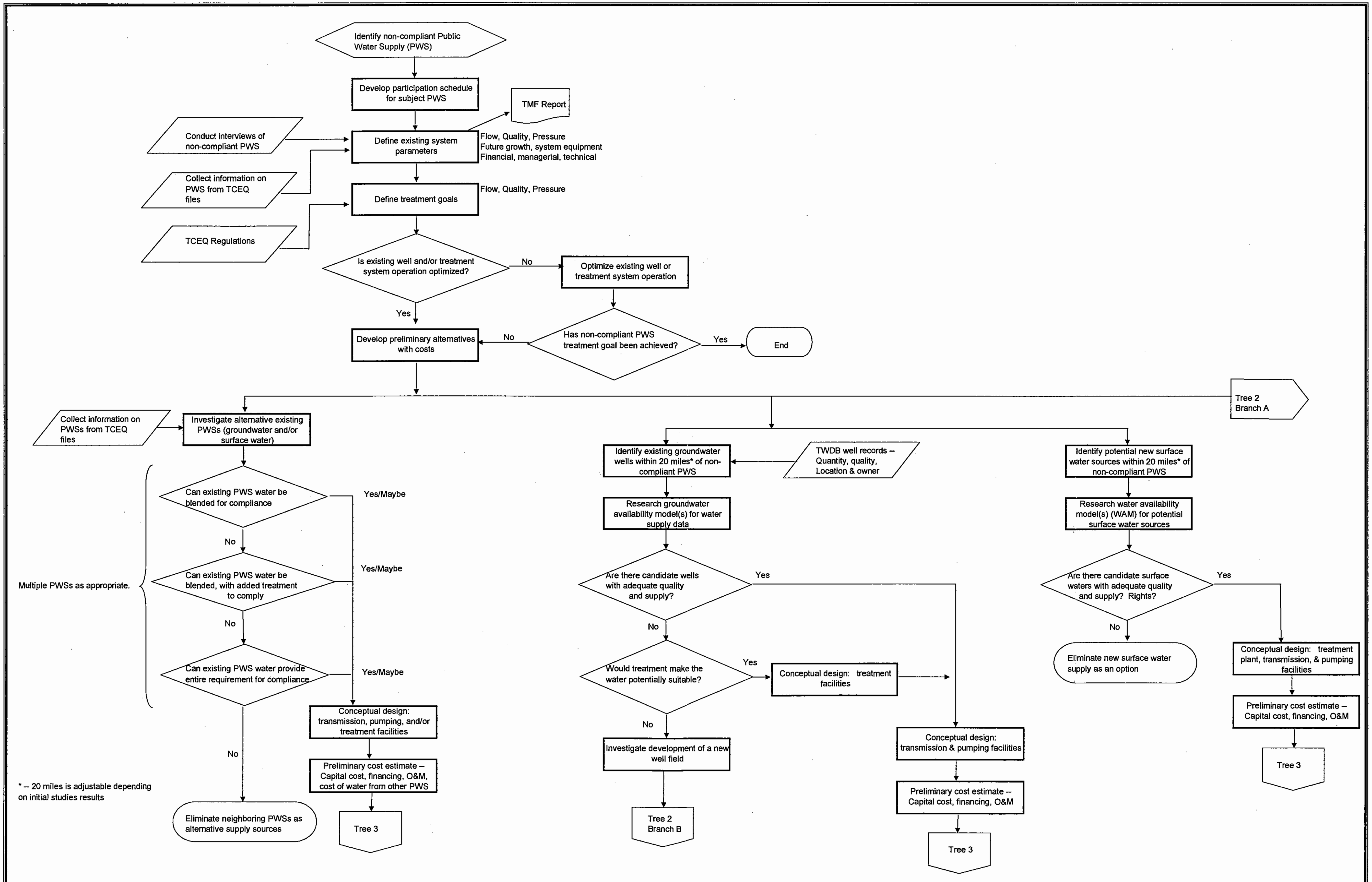
The TCEQ maintains a set of files on public water systems, utilities, and districts at its headquarters in Austin, Texas (currently in Building E). The files are organized under two identifiers -- a PWS identification number and a "Certificate of Convenience and Necessity" (CCN) number. The PWS identification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

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

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 RRA Guthrie-Dumont Water System, and the surrounding systems, Greenbelt MIWA, North Central Texas Municipal Water Authority, Water Conservation and Improvement Districts, and Groundwater Control Districts.

Figure 2.1
TREE 1 - EXISTING FACILITY ANALYSIS



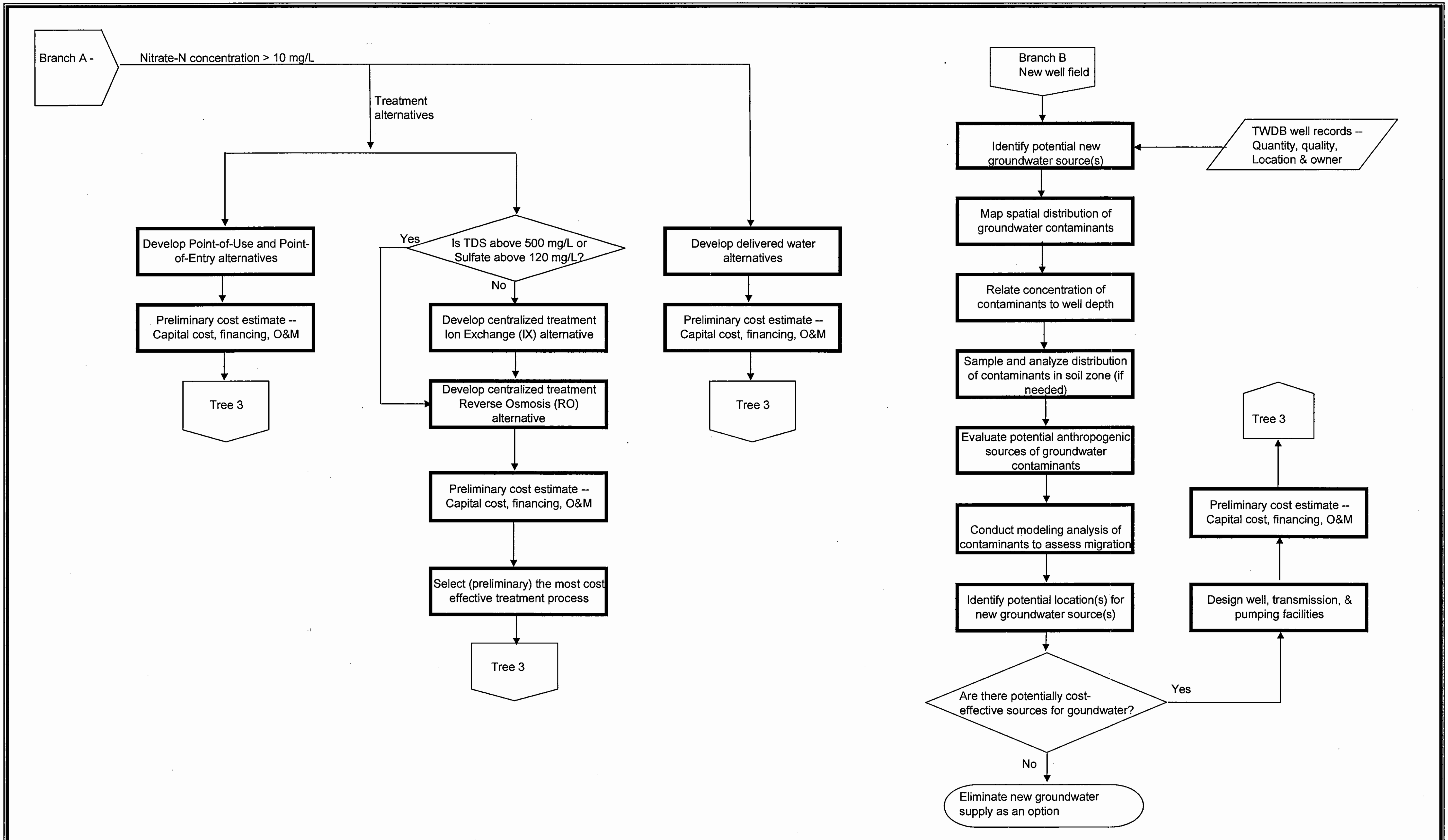

Branch A -
Nitrate-N concentration > 10 mg/L
Treatment alternatives
Develop Point-of-Use and Point-of-Entry alternatives
Preliminary cost estimate -- Capital cost, financing, O&M
Tree 3
Yes
Is TDS above 500 mg/L or Sulfate above 120 mg/L?
No
Develop centralized treatment Ion Exchange (IX) alternative
Develop centralized treatment Reverse Osmosis (RO) alternative
Preliminary cost estimate -- Capital cost, financing, O&M
Select (preliminary) the most cost effective treatment process
Tree 3
Develop delivered water alternatives
Preliminary cost estimate -- Capital cost, financing, O&M
Tree 3
Branch B
New well field
TWDB well records -- Quantity, quality, Location & owner
Identify potential new groundwater source(s)
Map spatial distribution of groundwater contaminants
Relate concentration of contaminants to well depth
Sample and analyze distribution of contaminants in soil zone (if needed)
Evaluate potential anthropogenic sources of groundwater contaminants
Conduct modeling analysis of contaminants to assess migration
Identify potential location(s) for new groundwater source(s)
Are there potentially cost-effective sources for goundwater?
Yes
Design well, transmission, & pumping facilities
Preliminary cost estimate -- Capital cost, financing, O&M
Tree 3
No
Eliminate new groundwater supply as an option

Figure 2.3
Tree 3 - PRELIMINARY ANALYSIS

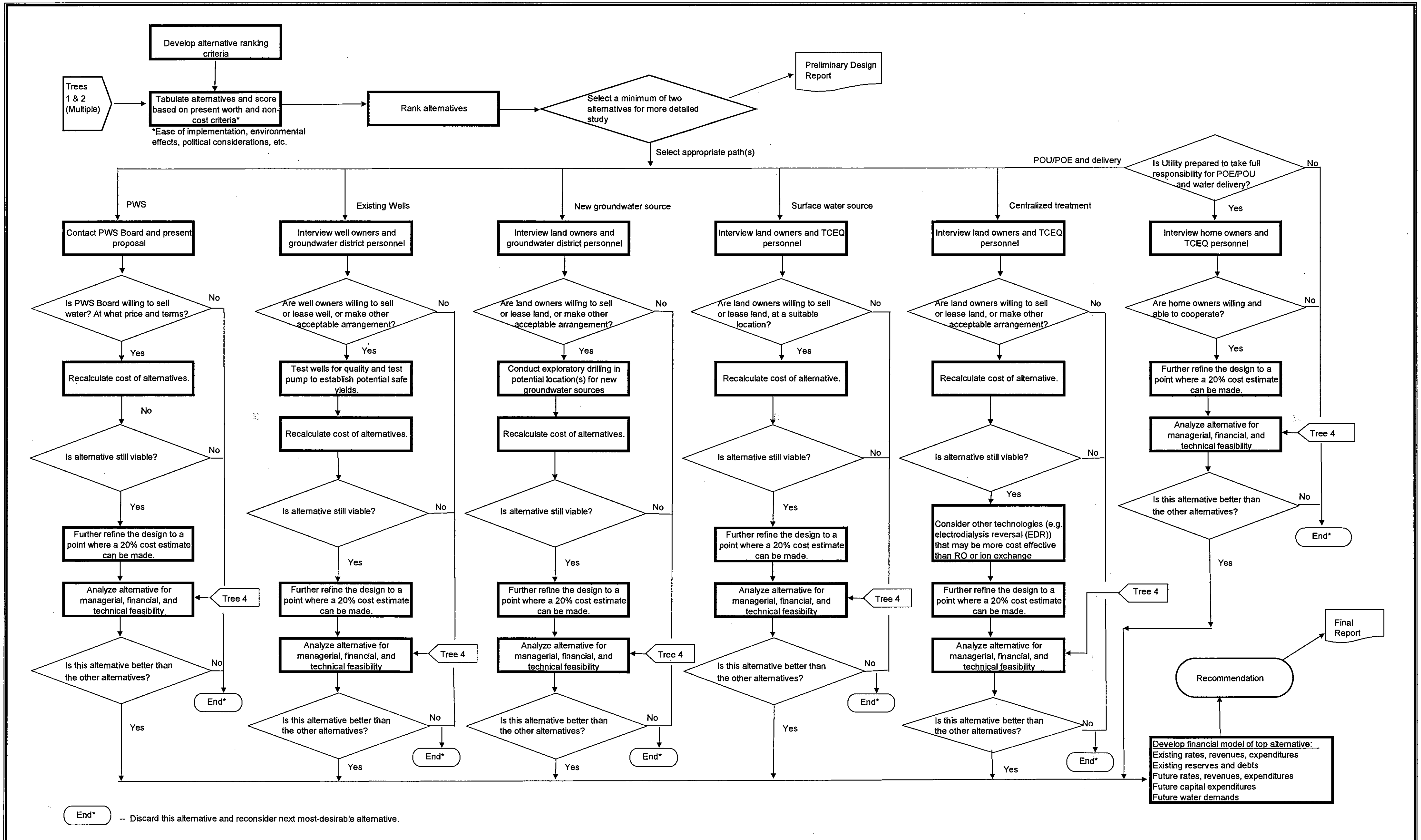
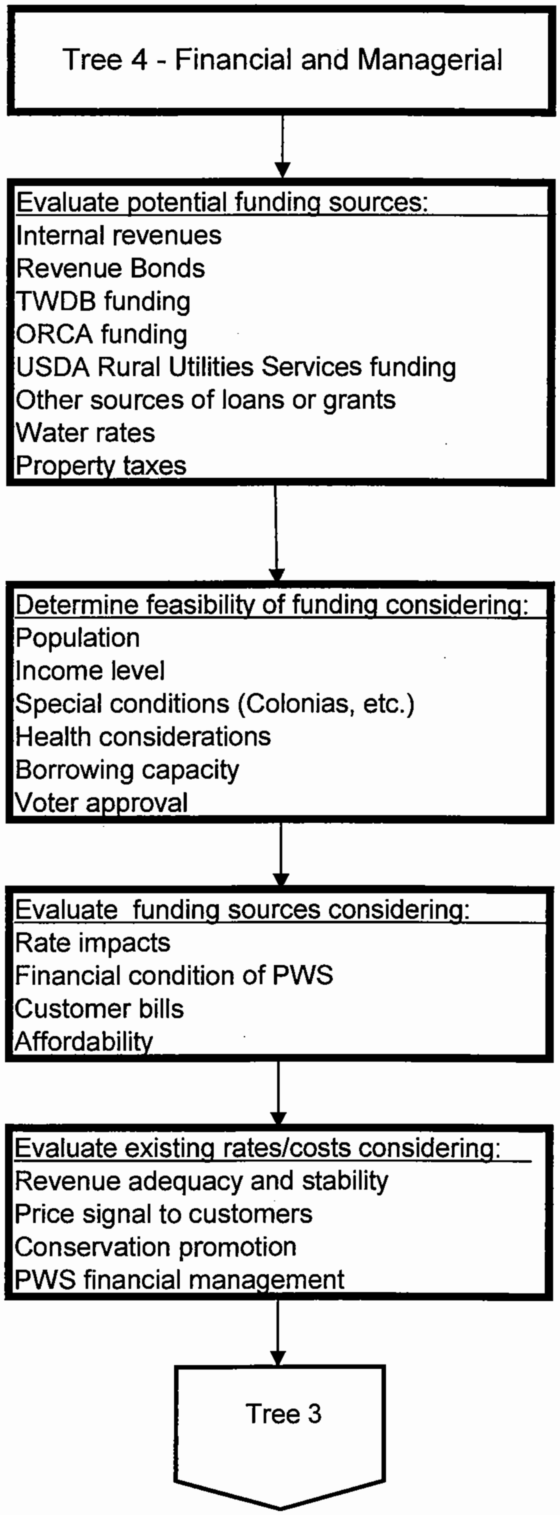


Figure 2.4
TREE 4 - FINANCIAL and MANAGERIAL



The following websites were consulted to list the water supply systems in the Study Area:

- Texas Commission on Environmental Quality
  www.tnrcc.state.tx.us/iwud/pws/index.cfm. Under "Advanced Search", type in the name(s) of the County(ies) in the study area to get a listing of the public water supply systems.
- USEPA Safe Drinking Water Information System
  www.epa.gov/safewater/data/getdata.html
- Red River Authority
  www.rra.dst.tx.us - General Info, Regional Information Center, "click on county," Water Systems. (Will link to a USEPA site.)

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. For this study, it was assumed that the nitrate concentration given in this database was the concentration of nitrate, with a molecular weight of 62. To convert to the same basis used for the MCL (Nitrate-N), the value given in the TWDB database was divided by 4.5.

2.2.1.3 Surface Water Sources

Regional planning documents for Region B, Brazos G, and Llano Estacado were consulted for lists of surface water sources.

2.2.1.4 Groundwater Availability Model

The TWDB has developed groundwater availability models (GAMs) for Texas. The GAMs are planning tools, and should be consulted as part of a search for new or supplementary water sources. However, the RRA Guthrie-Dumont Water System obtains groundwater from the Quartermaster Formation and Whitehorse Group which is not addressed by any of the GAMs that have been developed.

2.2.1.5 Water Availability Model

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

The water availability models provide information that assists TCEQ staff in determining whether to recommend the granting or denial of an application.

2.2.1.6 Financial Data

Financial data were collected for each of the three utilities through a site visit with each. Data sought for each 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:

- United States
- State of Texas
- King County

2.2.2 PWS Interviews

2.2.2.1 PWS Capacity Assessment Process

Assessment of the FMT capacity of the PWS was based on an approach developed by the New Mexico Environmental Finance Center (NMEFC). This methodology 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 who has a role in the FMT capacity of the system is asked the applicable standard set of questions individually. The interviewees are not given the questions in advance and are not told the answers others have provided. Also, most of the questions are open ended type questions so they are not asked in a fashion to indicate what would be the "right" or "wrong" answer. The interviews last between 45 minutes to an hour and 15 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 also made. A technical information form was created to capture this information. This form is contained in Appendix A. This information was considered supplemental to the interviews because it could serve 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 the 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 is asked the question, "Do you have a budget?" he or she may say, "yes" and the capacity assessor is 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 out that although a budget is present, operations personnel don't 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 is to determine which items that were noted as a potential deficiency truly have a negative effect on the system's operations. If a system has what appears to be a deficiency, but this deficiency is not creating a problem in terms of the operations or management of the system, it is not critical and may not need to be addressed as a high priority. As an example, the assessment may reveal that there appear to be insufficient staff members to operate the facility. However, it may also be revealed that the system is able to work around this problem by receiving assistance from a neighboring system so no severe problems result from the number of staff members. Although staffing may not be ideal, the system does not need to focus on this particular issue. The system needs to focus on items that are truly affecting operations. As an example of this type of deficiency, a system may lack a reserve account which can then lead the system to delay much-needed maintenance or repair on their storage tank. In this case, the system needs to address the reserve account issue so that proper maintenance can be completed.

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

2.2.2.2 Interview Process

The project team interviewed personnel at the RRA. The following RRA people were interviewed:

- Curtis Campbell, General Manager
- Henry Wied, Director of Operations
- Randy Cook, Regional Manager
- Tammy Clampitt, Controller
- Michael Carlson, District Manager (Operator)
- William Daniel, Vice President RRA Board

Each of these individuals was interviewed separately. All interviews were conducted in person, with the exception of William Daniel who was interviewed by telephone. Interview forms were completed during each interview.

2.3 ALTERNATIVE DEVELOPMENT AND ANALYSIS

The initial objective for compliance alternative development is to identify a comprehensive range of possible options that can be evaluated to determine which are the most promising for implementation. Once the possible alternatives have been identified, they must be defined in sufficient detail so that a preliminary cost estimate (capital and O&M costs) can be developed. The cost estimates are used to compare the affordability of compliance alternatives. 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. In general, PWSs farther than 20 miles from the non-compliant PWSs were not considered because the length of pipelines required would make the alternative cost prohibitive. The quality of water provided was also investigated. For 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 alternative source.

The neighboring PWSs were investigated to get an idea of the water sources they use and the quantity of water they might have 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

Existing non-public water supply wells with acceptable water quality within approximately 10 miles were identified. While the existing wells may or may not be appropriate for use as drinking water supply wells, they do provide information about the prevalence of compliant groundwater in the area. Also, many of the sample results in the database were from 10 or more years ago, and may not be representative of current conditions. It was not possible in the scope of this study to determine conclusively whether existing wells would be suitable or not, since sampling and test pumping would be required. In order 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 of the 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 and routings for the required system components. A capital cost estimate was then developed based on the preliminary design of the required system components. An annual O&M cost was also estimated to reflect the change (*i.e.*, from current expenditures) in O&M expenditures that would be needed if the alternative was implemented.

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

2.3.3 New Surface Water Source

New surface water sources were investigated. Availability of adequate quality water was investigated for the main rivers in the study area (Brazos, Red, White, and Pease), as well as the major reservoirs. The TCEQ Water Availability Map for the White River was inspected, and the WAM was run, where appropriate. In general, it was found that surface water was not available in adequate quantities, and, even if it were, it would be of unacceptable quality, requiring extensive treatment for dissolved solids removal.

2.3.4 Treatment

Treatment technologies considered potentially applicable are RO and IX, since they are proven technologies with numerous successful installations for nitrate removal. Electrodialysis reversal was not deemed to be applicable in this study, since it is typically not applicable to waters with high TDS concentrations, and much of the groundwater in the Study Area has relatively high TDS. RO is generally more expensive than IX treatment, but is typically subject to less interference by dissolved constituents in the water.

RO treatment is considered for central treatment alternatives, as well as point-of-use and point-of-entry alternatives. IX treatment is considered for central treatment alternatives only. Both RO and IX treatment produce a liquid waste: a reject stream from RO treatment and a concentrate stream from IX 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 IX treatment is implemented. The treatment units were sized based on flow rates, and capital and annual O&M cost estimates were made based on the size of the treatment equipment required. Neighboring non-compliant PWSs were identified to look for opportunities where the costs and benefits of central treatment could be shared between systems.

Non-economic factors were also identified. Ease of implementation was considered, as well as the reliability for providing adequate quantities of compliant water. Additional factors were whether implementation of an alternative would require significant 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 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 the average annual household water bill for a PWS customer to the median household income for the area. Median household income data from the 2000 Census is used, at the most detailed level available for the community. Typically, county level data is used for small rural water utilities due to small population sizes. Annual water bills are determined for existing, base conditions, including consideration of additional rate increases needed under current conditions. Annual water bills are also calculated after adding incremental capital and operating costs for each of the alternatives to determine feasibility under several potential funding sources.

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

- Current Ratio = current assets divided by current liabilities provides insight into the ability to meet short term payments. For a healthy utility, the value should be greater than 1.0.
- Debt to Net Worth Ratio = total debt divided by net worth shows to what degree the 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 shows 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 Census is used as the basis for median household income. In addition to consideration of affordability, median household income 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, median household income for the State of Texas was $39,927, compared to the U.S. level of $41,994. With the sparse population base in the service areas, county data is the most reliable, and for many rural areas corresponds to census tract data.

2.4.3 Annual Average Water Bill

The annual average household water bill was calculated for the RRA Guthrie-Dumont Water System, 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 for the RRA Guthrie-Dumont Water System 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 RRA Guthrie-Dumont Water 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 reserve 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 for the RRA Guthrie-Dumont Water System in a table that shows the following according to alternative and funding source:

- Percentage that the average annual residential water bill represents of median annual household income
- The first year in which a water rate increase will 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 median household income (MHI) > 75 percent of state MHI, standard terms, currently at 3.8 percent interest for non-rated entities
    - 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

The results from the financial plan model are presented in a table that shows the percentage of median household income that is 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 rural utilities. Both state and federal agencies offer grant and loan programs to assist rural communities in meeting their infrastructure needs.

Within Texas, the following state agencies offer financial assistance:

- Texas Water Development Board (TWDB)
- Office of Rural Community Affairs (ORCA)
- Texas Department of Health (Texas Small Towns Environment Program)

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

- United States Department of Agriculture, Rural Utilities Service

- United States Housing and Urban Development

SECTION 3
UNDERSTANDING NITRATE IN THE SEYMOUR AQUIFER

3.1 NITRATE SOURCES

The geological portion of this study indicates that the source of nitrate in groundwater is the agricultural application of fertilizers. Additionally important are several localized nitrate sources, predominantly septic tanks and barnyards near rural residences and sewers in urban areas. Groundwater nitrate concentrations in the Seymour aquifer increase with increased percentage of row crop and urban land uses within a 1,000 meter buffer surrounding each well based on the TWDB database (Figure 3-1a) and decrease with increased percentages of rangeland, forest, pasture/hay, and small grains land uses (Figure 3-1b). TDS levels are generally not related to land use (Figures 3-1a, 3-1b). Soil sampling in agricultural areas with different types of crops revealed a reservoir of nitrate in the soil zone beneath dryland and irrigated wheat and cotton (Appendix C). Nitrate levels in soil in areas of irrigated and dryland alfalfa were low. Alfalfa is a legume and can fix nitrogen; however, the data suggest that rapid growth and frequent harvesting of alfalfa may deplete all available nitrogen. An anthropogenic rather than geologic source of nitrate is indicated by a general lack of relationships between nitrate and other major inorganic anions (Figure 3-2).

Leakage from centralized sewerage systems, septic tanks, and/or barnyards may provide local sources of nitrate contamination to nearby public water supply and domestic wells as suggested by previous work conducted (Harden, *et al.* 1978). Nitrate-N concentrations in groundwater wells associated with urban areas are statistically higher than in areas not associated with urban land uses (Figure 3-3). The population of domestic wells in the TWDB database shows consistently higher nitrate-N concentrations than irrigation wells, though differences between the two in general water quality are relatively small as indicated by the distribution of TDS (Figure 3-4).

Previous studies suggest that the primary source of nitrate in groundwater in the Seymour Aquifer is from natural sources (Bartolino 1994). High levels of groundwater nitrate prior to widespread application of fertilizers in the mid-1960s were attributed to oxidation of nitrogen that had built up in the soil zone over long times in nearby Runnels county (Kreitler 1975) or to nitrogen fixation by legume plants such as mesquite in the Seymour Aquifer (Bartolino 1994) and subsequent flushing of this nitrate into the underlying aquifer as a result of increased recharge rates from cultivation. Groundwater data from the TWDB database indicate high nitrate levels prior to 1950; however, the number of samples is low (130). Nitrate-N concentration profiles in soil in areas of native ecosystems that has never been cultivated were low (Appendix C). However, total nitrogen was not analyzed in these samples and may be high. Nitrate profiles in soil under native settings in semiarid/arid environments in other states (Nevada and Kansas) had very high nitrate concentrations in the soil profile, and data showed that these high nitrate levels were mobilized under irrigated agriculture (Hartsough, *et al*. 2001; Stonestrom, *et al*. 2003; Walvoord, *et al.* 2003). Current estimates of recharge (0.8 to 2.5 in/yr; mean 2 in/yr) for the Seymour Aquifer from the recently developed Groundwater Availability Model (Ewing, *et al*. 2004) suggest that this original source of nitrate should be flushed through the system in areas of coarse textured soil but could remain in areas of fine textured soil which may explain the relationship between nitrate-N concentrations in groundwater and soil texture (Figure 3-5).

3.2 PRACTICES NECESSARY TO REDUCE GROUNDWATER NITRATE CONCENTRATIONS

There are various approaches discussed in the literature for reducing nitrate derived from leaching of fertilizers. Currently fertilizers are generally applied one time prior to planting. Agricultural land uses account for 70.6 percent of the Seymour Aquifer area while irrigated areas constitute only 6.7 percent based on the National Land Cover Dataset (NLCD 1994).

To optimize fertilizer application so that crops use most of the applied fertilizers and leaching is minimized, studies suggest that fertilizer application should be split into multiple applications (2 – 4): pre-planting and post-planting. This may be a problem because the land is generally dry when fertilizers are applied prior to planting; however, precipitation after planting may make it difficult to apply fertilizers. If fertilizers are applied through irrigation water, the timing of application may not be difficult to control. The infrastructure does not seem to be available for aerial application of fertilizers in the Seymour regions. Additionally, multiple applications increase costs. The type of fertilizer applied may also influence the leaching rate. Slow release fertilizers should result in less leaching than fast release fertilizers; however, slow release fertilizers are generally more expensive. The timing of fertilizer application relative to water applications (precipitation or irrigation) may also be a critical factor in determining leaching. Although it may be difficult to control fertilizer applications relative to precipitation in dryland farming regions, irrigation applications may be controlled to minimize fertilizer leaching. The type of irrigation system plays a large role in controlling leaching: flood irrigation systems are more inefficient than center pivot systems and result in greater leaching. Subsurface drip irrigation systems are even more efficient than center pivot systems, and a study is being conducted by the Texas State Soil and Water Conservation Board to evaluate such a system in the Seymour region. Irrigating at rates determined by monitoring potential evapotranspiration or soil moisture should result in much less drainage than uniform irrigation rates and should be considered. Soil profiles in land in the Conservation Reserve Program have low nitrate levels (Appendix C), which indicate that if fertilizer is no longer applied the nitrate reservoir in the profile can be flushed out. The effects of these management practices on groundwater nitrate may take a long time to establish because of the time required for water to move through the unsaturated zone and through the groundwater system. With a recharge rate of 2 in/yr and average water content in the unsaturated zone of 10 percent by volume, the travel time through a 50-foot unsaturated zone would be 33 years.

3.3 HISTORICAL TRENDS IN NITRATE CONCENTRATIONS

Time series information from the TWDB database is limited. There are 2,283 wells in the TWDB database that are within the outcrop areas of the Seymour Aquifer. Of those, 1906 (83.5 percent) have only one water quality analysis record while only 135 (5.9 percent) have three or more nitrate-N concentrations reported through time. Most samples were collected and analyzed in the late 1960s (Wilbarger County, Jones County) or mid-1970s (Haskell County, Knox County). Individual wells showed increasing, decreasing, and variable trends through time.

Haskell and Knox Counties account for approximately 45 percent of the Seymour Aquifer nitrate-N data. Sampling was also generally more widely spread, both spatially and temporally, relative to the other pods and provides the best overall data set for a temporal analysis of nitrate-N concentrations. Analysis for the entire well population in these counties shows a significant general increase over time in nitrate-N concentrations and median concentrations that have generally been in excess of 10 mg/L (Figure 3-6a). However, approximately 30 percent of the data used in this analysis is from domestic wells, which may be subject to local contamination. Though much of the repeat sampling of individual wells occurred for domestic wells, an analysis that excludes domestic wells and which might reflect more ambient regional conditions, also suggests increasing concentrations with time and median concentrations also generally remained greater than 10 mg/L (Figure 3-6b). However, the significance of this regression is much lower and suggests that regional temporal trends in nitrate-N concentrations may not be significant.

3.4 NITRATE STRATIFICATION

Permian age formations underlay the Seymour Aquifer and generally do not contain water that, without treatment, is of suitable quality for a public water supply system, primarily as a result of elevated sulfate and/or TDS concentrations. Groundwater nitrate-N concentrations from the TWDB database were evaluated to determine if there is any distinct stratification of water chemistry with depth in the Seymour Aquifer that would allow shallower or deeper wells to be drilled to minimize nitrate levels.

The Seymour Aquifer is relatively thin. Saturated thickness generally ranges from less than 10 feet near pod boundaries to approximately 100 feet in a few locations near pod centers, and generally ranges from 20 to 60 feet. There is no obvious relationship between nitrate-N concentration and well depth (Figure 3-7). Median nitrate-N concentrations were grouped by well depth intervals to evaluate depth trends. The analysis indicates fairly uniform median nitrate-N levels with depth, with most median values near or exceeding 10 mg/L. Additionally, the middle 50 percent of the nitrate-N concentration distributions overlapped for all intervals indicating that drilling shallower or deeper wells within the Seymour Aquifer would not likely result in acceptable nitrate-N concentrations. The uniform nitrate-N concentrations with depth may be attributed in part to the high permeability of the Seymour Aquifer throughout its thickness and particularly in the gravel layer found at the base of the aquifer in many areas.

3.5 EXPERIENCE OF OTHER STATES

Groundwater nitrate contamination in other states surrounding Texas is generally not as widespread as it is in Texas. The following summarizes the state of knowledge with respect to nitrate in Oklahoma, Louisiana, New Mexico, and Arkansas.

Oklahoma: ambient groundwater monitoring program

- Range NO_3-N: 0.0 – 19.8 mg/L; Median NO_3-N: (400 samples, time)
- High nitrate located in west and northwest areas of the state
- Potential sources: fertilizers, septic tanks, and concentrated animal feeding operation (CAFO), primarily hog CAFOs

Louisiana: ambient groundwater monitoring program

- Range NO_3-N: < 0.05 – 0.63 mg/L (2001 – 2003)

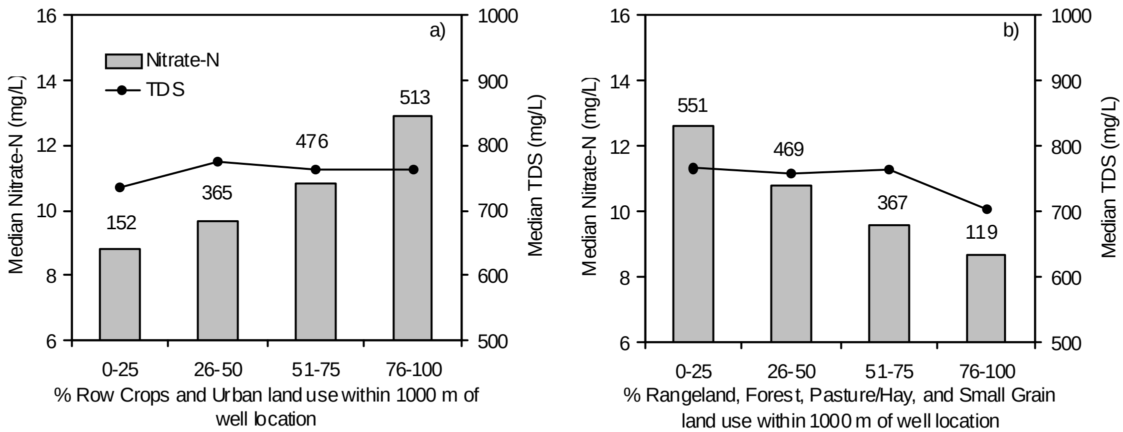
New Mexico: no ambient groundwater monitoring program

- Range NO_3-N: 0.0 - > 500 mg/L
- 200 nitrate plumes affecting 710 private and 82 public water supply wells (McQuillan, *et al*. 2004)
- Potential sources: natural, CAFOs, septic tank, and sewer systems
- USEPA study of 94 dairies: 36 percent have NO_3-N = 10 mg/L NO_3-N; waste lagoons responsible for NO_3-N = 100 mg/L NO_3-N
- Large capacity septic tank study: 50 percent = 10 mg/L NO_3-N in groundwater

Arkansas: no ambient groundwater monitoring program

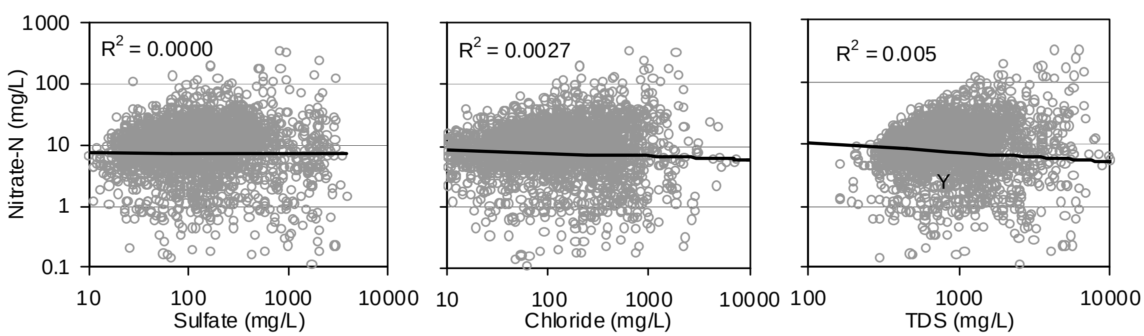
- Range NO_3-N: < 0.00 – =60 mg/L (2001 – 2003) (high in NW part of state)
- Southeast part of state mostly confined aquifers; nitrate does not reach aquifers or is denitrified in aquifers.
- Potential sources: septic systems, sewers, fertilizers, CAFOs

Figure 3-1 Nitrate Concentrations and Land Use



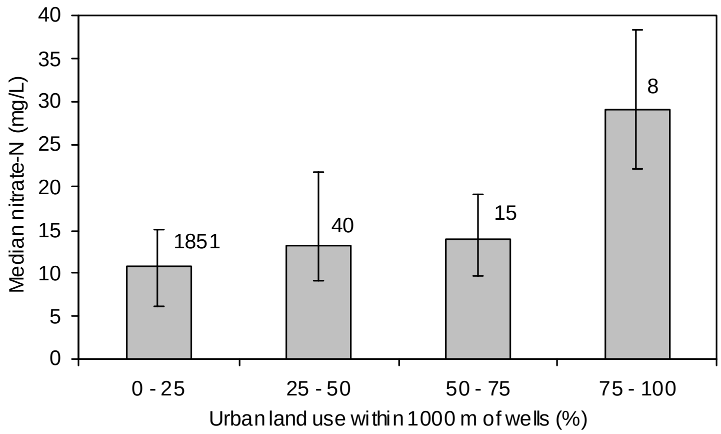
Median nitrate-N and TDS concentrations in groundwater in relation to land use within a 1,000 meter radius of well locations for a) the combined percentages of row crops (NLCD code 82) and urban (NLCD codes 21, 22, 23, 85) land use categories and (b) the combined percentages of rangeland (NLCD codes 51, 71), forest (NLCD codes 41, 42, 43) and the remaining agricultural (NLCD codes 81, 83) land use categories. The complementary analyses account for an average of 99 percent of the area within 1,000 meters of all wells. Numbers indicate the quantity of wells within each group.

Figure 3-2 Correlation of Nitrate with TDS, Chloride, and Sulfate



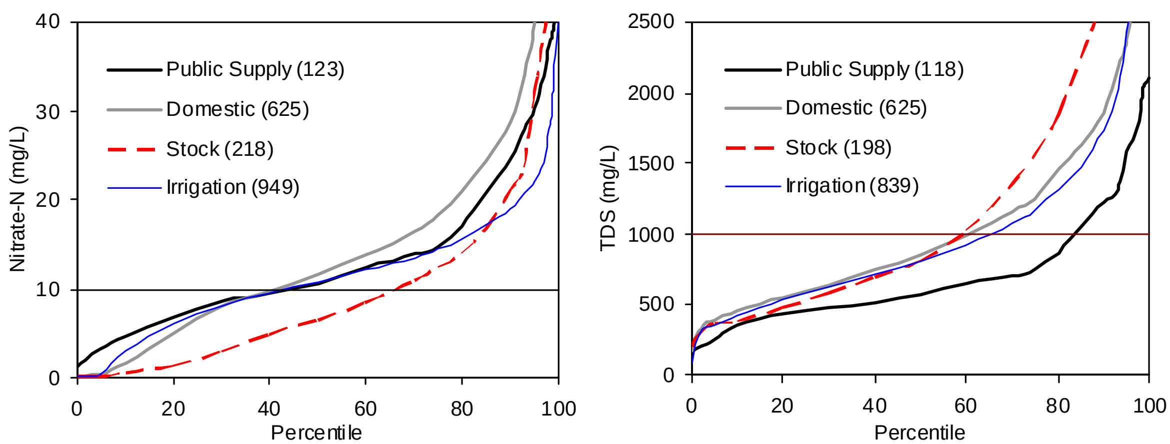
Relationship between nitrate-N and sulfate, chloride, and TDS for 3,417 groundwater samples in the Seymour Aquifer. (Source: TWDB database).

Figure 3-3 Nitrate Concentrations Related to Urban Land Use



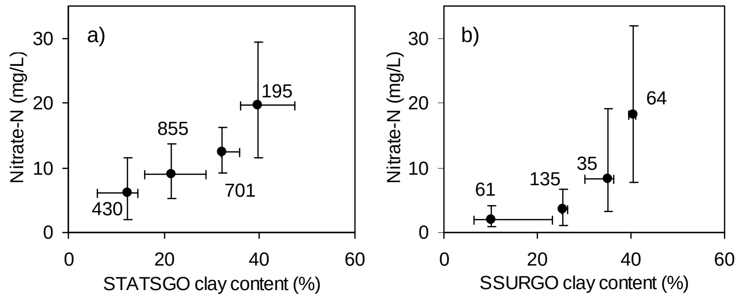
Median nitrate-N concentrations in groundwater in relation to the percentage of Urban (NLCD codes 21, 22, 23, 85) land use categories within a 1000 m radius of the well locations. Values represent the number of wells within each group. Error bars represent the middle 50 percent (*i.e.*, median ±25 percent) within each group. The population means are statistically different to $p<0.01$.

Figure 3-4 Nitrate and TDS Concentrations Related to Primary Well Use



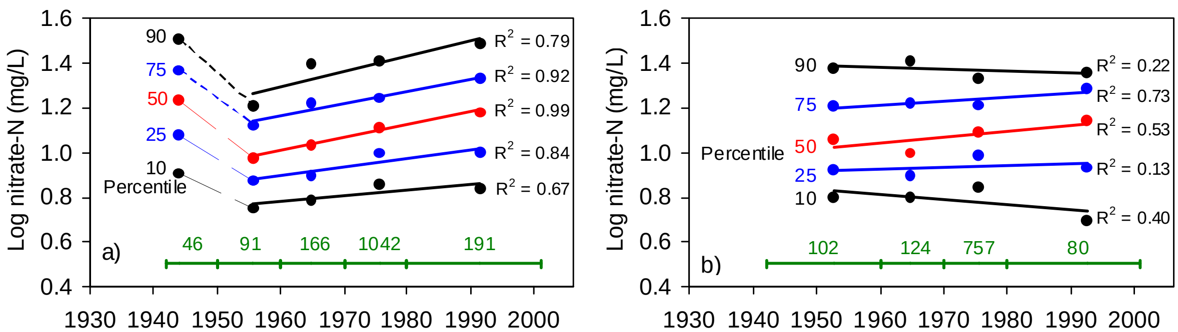
Distribution of nitrate-N and TDS concentrations in the Seymour Aquifer as a function of primary well use. Numbers in parenthesis indicate number of wells in each category. The most recent water sample for each well was used in the analysis.

Figure 3-5 Nitrate Concentrations Related to Soil Clay Content



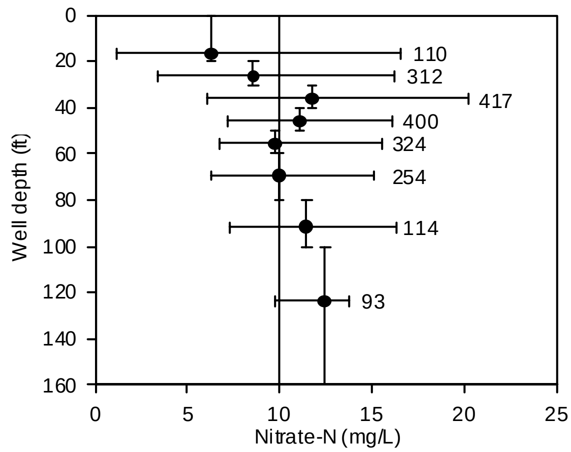
Relationship between nitrate-N concentrations in groundwater and average soil clay content at well locations in a) the entire Seymour Aquifer based on generalized soil data from the State Soil Geographicsoil database and b) outcrop areas of the Seymour Aquifer in Jones County based on detailed soil data from the Soil Survey Geographic soil database. Numbers indicate quantity of wells in each group. Points are plotted at the average clay content versus median groundwater nitrate-N concentration for each group. X error bars indicate the range of clay content values for each group, and Y error bars indicate the middle 50 percent range (*i.e.*, median ± 25 percent) of nitrate-N concentrations for each group.

Figure 3-6 Temporal Trends of Nitrate Concentrations



Temporal trends of log nitrate-N by percentile distribution for a) all wells, and b) excluding domestic wells in the Haskell and Knox Counties pod of the Seymour Aquifer. Range bars and values at the bottom of the figures, respectively, indicate the sample periods and number of samples within each period. Points are plotted at the average sample date within each range. Solid lines represent linear regression fits to the data and R^2 values are also shown. The slopes of the median (50th percentile) regression lines are significant to a) $p<0.01$ and b) $p<0.27$.

Figure 3-7 Relationship Between Nitrate Concentration and Depth



Relationship between nitrate-N concentrations and well depth in the Seymour Aquifer. Points are plotted at the median nitrate-N concentration and average well depth for each group. Numbers indicate the quantity of wells in each group. X error bars indicate the middle 50 percent range (*i.e.*, median ± 25 percent) of nitrate-N concentrations in each group and Y error bars indicate the range of well depths in each group. The latest sample for each well was used in the analysis.

SECTION 4
ANALYSIS OF THE RRA GUTHRIE-DUMONT PWS

4.1 DESCRIPTION OF EXISTING SYSTEM

4.1.1 Existing System

The Red River Authority (RRA) Guthrie-Dumont water system is diagrammed in Figure 4.1. Three wells (#22-19-302, 22-19,303, 22-20-101), each approximately 260 feet deep, are completed in the Quartermaster Formation and Whitehorse Group (Code 310QRMW). Nitrate concentrations are slightly above the MCL of 10 mg/L. Total dissolved solids are slightly above 700 mg/L, which is well below the MCL of 1000 mg/L. The wells discharge into a storage tank at the Dumont well field in Dickens County. The water is chlorinated before flowing into the storage tank. Water flows eastward by gravity from the tank through a 4-inch diameter line. Flow to Dumont first passes through the Dumont storage tank. The town of Guthrie has a similar arrangement. There is an abandoned tank at Pitchfork Ranch, which was fed directly off the pipeline.

The system was not designed to remove nitrates; therefore, system optimization will not result in a reduction in nitrate concentration.

Additional background information on the system is in a report by RRA entitled *Guthrie-Dumont Water System Nitrate Reduction Plan*, February 7, 2003 (included in Appendix D), and in *Public Water Supply Regulatory Program, Regulated Entity Data* (included in Appendix D). The total storage in the *Regulated Entity Data* is incorrectly shown as 164,000 gallons. It should be 144,000 gallons because the Pitchfork Ranch Storage Tank is out of service.

Basic system information is as follows:

- Population served: 250
- Connections: 140
- Average daily flow: 0.105 mgd
- Maximum daily flow: 0.17 mgd
- Total production capacity: 0.24 mgd
- Typical nitrate range: 10 to 15 mg/L

The RRA deals with nitrate non-compliance through a program that reimburses customers for bottled water in households that include expectant mothers or children less than one year old.

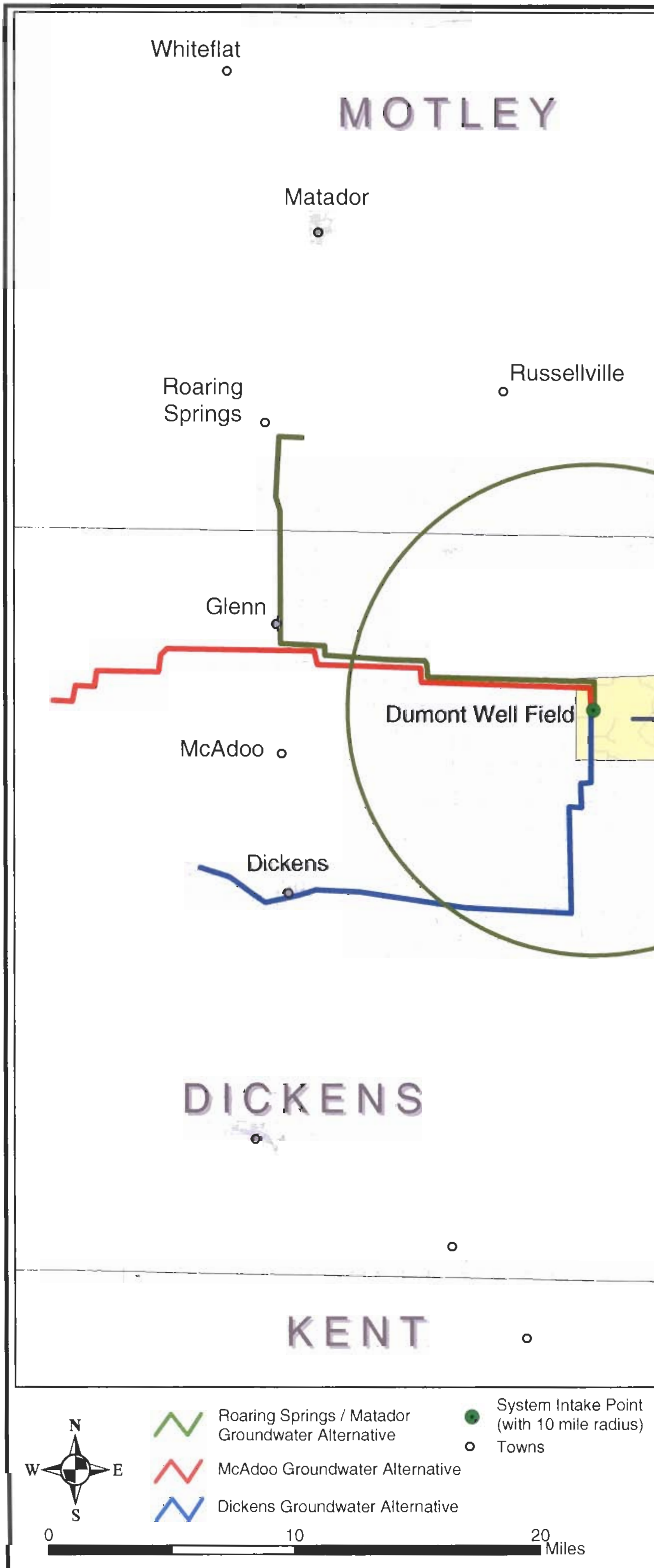


Figure 4.1

Guthrie - Dumont

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4.1.2 Capacity Assessment for RRA Guthrie-Dumont

The RRA Guthrie-Dumont water system is owned and operated by the Red River Authority. It has the same operational, financial, and managerial structure as the Truscott-Gilliland water system, including the same operator. Because both systems have the same personnel and structure, the capacity assessment applies to both systems.

4.1.2.1 General Structure

The RRA is overseen by a Board of Directors that contains nine members appointed by the Governor. The RRA has a General Manager, who answers directly to the Board. For the water utility operations, there is a Director of Operations, two Regional Managers (one for the east section of the River and one for the west section of the River), and 12 District Managers. There is also a Controller who handles the bookkeeping, annual audits, and financial aspects of the water systems.

The District Managers are the operators of the water systems in their districts. They may operate several water systems that are located in close proximity to one another. The District Managers report to a Regional Manager. The Regional Manager assists the operators, facilitates the required compliance monitoring, and provides training and general support to the District Managers. The Regional Managers report to the Director of Operations who provides assistance, training, regulation information, and other related services to the Regional Managers. The Director of Operations reports to the General Manager.

4.1.2.2 General Assessment of Capacity

Based on the assessment, the overall capacity of the RRA is quite good. Communications between employees, and between employees and the Board was excellent. In general, there is a tremendous amount of agreement between answers, indicating that everyone is operating under the same philosophy.

4.1.2.3 Positive Aspects of Capacity

In assessing capacity, it is as important to note the positive aspects of capacity as related to capacity. It is important for systems to be aware of the characteristics that either make them a well-run system or that lead them towards being a well-run system so that they can continue to do these activities or increase them. The factors below are positive aspects of the RRA.

- Communications – There is excellent communications at all levels within the RRA. The answers to the questions during the interview process were extremely consistent indicating that every level of the operation knows the procedures and expectations. The communications between staff and the Board are also excellent.
- Staffing and Organizational Structure – The RRA, through its use of District Managers, Regional Managers, and Director of Operations, has been able to

operate many systems effectively with a very small staff. The operation was described by one interviewee as "lean and mean" and this appears to be the case. The support provided to the operators through the Regional Managers and the buddy system (pairing up District Managers to cover each other and share on-call duties) is extremely efficient and effective. This type of structure relies upon the RRA's ability to hire dedicated and capable staff. The staff has appropriate certifications and receives training by attending monthly meetings with the Texas Water Utilities Associations, monthly trainings with the Regional Manager, and trainings that are offered by other trainers.

- Interloan Fund – The RRA has been able to establish an Interloan Fund to assist water systems when there are needed repairs to the system. This fund loans money to the systems at the rate of 8 percent interest.
- Knowledge of SDWA and TCEQ Current and Future Regulations – The RRA exhibited a high degree of knowledge of current and future regulations. The General Manager keeps staff well informed of new and existing regulations, procedures, and policies and this information is effectively passed through the staff to the District Managers.
- Rate and Budget Reviews – The RRA does a budget and rate review annually and then looks at increasing rates on a 5-year cycle. It is important for water systems to look at finances frequently. Also, the RRA has an independent financial audit performed annually.

4.1.2.4 Capacity Deficiencies

The following capacity deficiencies were noted in conducting the assessment.

- Insufficient Reserves – The budgets of the water systems are not structured to have reserve accounts. Because of this lack of reserve account, money has not been collected in a fund that could have been used to pay for the needed nitrate removal system or an alternative method of addressing the nitrate issue. Reserve accounts also reduce the need to borrow money from the interloan fund and help cover other needed repairs or replacements.
- Planning – RRA has a 5-year capital improvement planning process. In addition, RRA participated in the "Water for Texas" regional planning process. However, RRA has not developed a long-range capital improvement program (*e.g.*, 20-year process) to fully examine its long-term needs. In this particular case, the lack of long-term planning may have limited the PWS's ability to address the nitrate compliance issue.
- Water Quality Goals – The RRA does not have clear water quality goals for the water systems, such as maintenance of a specific chlorine residual. The major aspect of the issue related to goals, however, is that the water system does not have clear goals for meeting the nitrate standard. The lack of goals on this parameter may be impacting the system's ability or willingness to

consider alternatives to meeting this standard (alternatives other than the current bottled water program).

- Water Losses – There are considerable water losses (25 percent) at the RRA Guthrie-Dumont Water System. When there are high water losses, the system is producing considerably more water than it needs to which increases the overall expense in terms of production. This situation is magnified if a nitrate treatment system is employed. The system will be treating considerably more water than is actually needed due to the losses, which may make the project less feasible economically. If the losses can be minimized, the system can achieve both water conservation and reduced costs.

4.1.2.5 Potential Capacity Concerns

The following items were concerns regarding capacity but there are no particular operational, managerial, or financial problems that can be attributed to these items. The main areas to concentrate on are listed above in the capacity deficiency section. Addressing these items may assist the system in further improving the system's overall operation.

- Policy Regarding Disinfectant Residual Monitoring – There is no clear policy directive on how often chlorine residuals must be checked. For maximum public health protection it is important to check residuals daily to ensure that there is indeed continuous chlorine monitoring. In this case, there have not been coliform violations, but if residuals are not checked daily, the chlorination system can go out without the operator being aware. If this occurs at the same time as a line break or some other condition, there is the potential for contamination.
- Source Water Protection – The RRA does not currently have a source water protection plan in place for either system. They are not opposed to doing one; they are having difficulties using the source water assessment to develop the plan. It is important to develop and institute protection measures to ensure that the supply is protected to the maximum extent possible.

4.2 ALTERNATIVE WATER SOURCE DEVELOPMENT

4.2.1 Identification of Alternative Existing Public Water Supply Sources

Table 4.1 is a list of the existing public water supply systems within approximately 20 miles of the Guthrie Well Field. These systems are shown in Figure 4.1.

Table 4.1 Existing Groundwater-Supplied Public Water Supply Systems

System Name	Capacity (MGD)	Max daily usage (MGD)	Limitations
City of Matador	1.656	0.53	Wells in Roaring Springs
City of Roaring Springs	0.30	0.10	
City of Dickens	0.32	0.18	Alluvial wells
Roaring Springs Youth Camp			TDS = 3,000+
King-Cottle WSC	1.73	0.60	TDS = 1,200+
McAdoo WSC	0.07	.03	Ogallala Aquifer

4.2.1.1 Cities of Matador and Roaring Springs

The City of Matador operates two 12-inch diameter wells, approximately 110 feet deep completed in the Quaternary Alluvium (Code 110 ALVM). The wells (#22-02-714 and -715) are east of the City of Roaring Springs, approximately 8 miles south of Matador. The wells are rated at 430 gpm and 360 gpm. There are two backup wells within the City limits rated at 180 gpm each, completed in the Quartermaster Formation (Code 310QRRM). The back-up wells are #12-58-803 and –807. These wells have high nitrate and high TDS issues.

There is one TWDB water quality report for well #22-02-714 that indicates low nitrates and TDS concentration less than 600 mg/L. Quality reports for nearby well #22-02-712, operated by the City of Roaring Springs, indicate that the nitrate concentration has dropped to acceptable limits since 1975 and TDS concentrations are below 500 mg/L.

These records indicate that an acceptable groundwater source is available in the area east of Roaring Springs. The Roaring Springs wells are too small; however, the City of Matador wells appear capable of serving the RRA Guthrie-Dumont system. If further study indicates, the existing two City of Matador wells could be augmented by an additional well. The distance between Roaring Springs and Dumont is approximately 25 miles along roads, and 16 miles cross-country.

4.2.1.2 City of Dickens

The City of Dickens has two wells (#22-17-909 and –910) completed in the Quaternary Alluvium (Code 110 ALVM) approximately 3 miles west of town. These wells produce low-nitrate water with a TDS concentration of approximately 500 mg/L. The production rate is 225 gpm which is approximately what would be required (213 gpm) if the City were to add RRA Guthrie-Dumont to its service area. The addition of RRA Guthrie-Dumont would require the addition of at least one more well, to allow for one well being out of service. The distance to Dumont is approximately 24 miles.

TWDB records show that the City also has three other wells (#22-25-301, 22-25-302, #22-17-903), also completed in the Quaternary Alluvium. In 1969, these wells produced water with Nitrate-N at a concentration of approximately 8 mg/L and TDS at 600 mg/L. The "Use Code" for these wells, as well as the two in the previous paragraph, indicates that these wells are for public supply, although it appears as though they are no longer in use.

4.2.1.3 King-Cottle WSC

King-Cottle (K-C) WSC serves the area between Guthrie and Paducah. The water source is the Blaine Gypsum (Code 313BLIN), which is typically characterized by high-salinity water. The wells are approximately 200 feet deep, and are located immediately south of the King County-Cottle County line. TWDB records from the mid 1980s to the late 1990s show these wells producing water with Nitrate-N concentration of up to 8 mg/L with a TDS concentration of up to 1,300 mg/L. A 2002 TNRCC report noted a TDS concentration of the treated water of 1,249 mg/L, and a recent Water Quality Analysis indicated a TDS concentration of 941 mg/L and a Nitrate N concentration of 8.35.

The system appears to have sufficient capacity in terms of well production. The required production is 261 gpm, and two of the wells have been tested and are capable of producing 700 gpm. Installed well pump capacity is 1,200 gpm.

Blending K-C WSC water with RRA Guthrie-Dumont water would yield a borderline product. One would be diluting the TDS of K-C WSC water with RRA Guthrie-Dumont water and diluting the nitrates of RRA Guthrie-Dumont water with K-C WSC water. The product would be borderline compliant. Further, to make blending feasible, a transmission main approximately 36 miles long (along public roads) would be required to transport K-C WSC water to the Dumont well field.

A possibly more feasible option would be for K-C WSC to partner with RRA and install an RO unit at the K-C WSC supply point to reduce the TDS to below 1,000 mg/L and to install a pipeline along Highway 83 to Guthrie. The K-C WSC wells would supply all of the water for RRA Guthrie-Dumont, and the Dumont well field would be used for emergencies only. The combined system would serve 1,000 people with 580 connections, with a maximum daily usage of 0.8 million gallons and an average consumption of 0.4 million gallons.

A large ranch, 6666, is located north and northwest of Guthrie. The ranch constructed a water supply line from the K-C WSC to the ranch headquarters near Guthrie. The ranch uses the water for irrigation, livestock, and domestic water supply to the ranch headquarters. There may be an opportunity to work with the ranch in obtaining use of the line.

4.2.1.4 McAdoo WSC

McAdoo WSC serves McAdoo Township. The water source is the Ogallala Aquifer (Code 121OGLL), which is characterized by high-quality water. The wells (#23-24-307 and 23-24-308) are approximately 360 and 480 feet deep, respectively. The wells are small, with flows of 20 and 28 gpm; however, they indicate the presence of an excellent ground water source. The distance to Dumont is approximately 28 miles.

4.2.2 Potential for New Groundwater Sources

4.2.2.1 Existing Non-Public Supply 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 also have problems with nitrate, it may be possible to share in the cost and effort of identifying compliant groundwater and constructing well fields.

There are a number of wells, not associated with public supply systems, located within approximately 20 miles of the Dumont well field that have nitrate concentrations less than 8 mg/L and acceptable sulfate and TDS concentrations. These wells are primarily used for stock watering, and may not be appropriate for use as supply wells for the RRA Guthrie-Dumont system. They do provide information about groundwater quality in the surrounding areas. The wells and their characteristics are given in Table 4.2. The well locations are shown in Figure 4.2.

Table 4.2 Summary of Non-Public Water Supply Wells

County	Well Number	Owner	Dia, In.	Aquifer Code	Aquifer Name	Use	NO_3-N, mg/L	TDS, mg/L	Remarks
Dickens	22 10 701	Gary Bridge	8	110ALVM	Quaternary Alluvium	Irrigation 10 hp	4.6	464	1997 sample
Dickens	22 10 916	D.R. Hale	--	110ALVM	Quaternary Alluvium	Domestic, livestock	6.4	469	1969 sample
Dickens	22 18 202	R.W. Howard	--	110ALVM	Quaternary Alluvium	Domestic, livestock	4.6	546	1968 sample
Dickens	22 12 701	None on record	--	110ALVM	Quaternary Alluvium	Unused	7.7	470	1997 sample
Dickens	22 18 502	Edwards	N/A	121OGLL	Ogallala	Stock watering	5.1	979	Seep/Spring.

- The first three wells are located approximately 11 miles to the west of the Dumont well field. The records indicate good quality water derived from an alluvial formation. Potentially significant flow in well 22-10-701 is indicated by the well diameter and the size of the irrigation pump in the well.

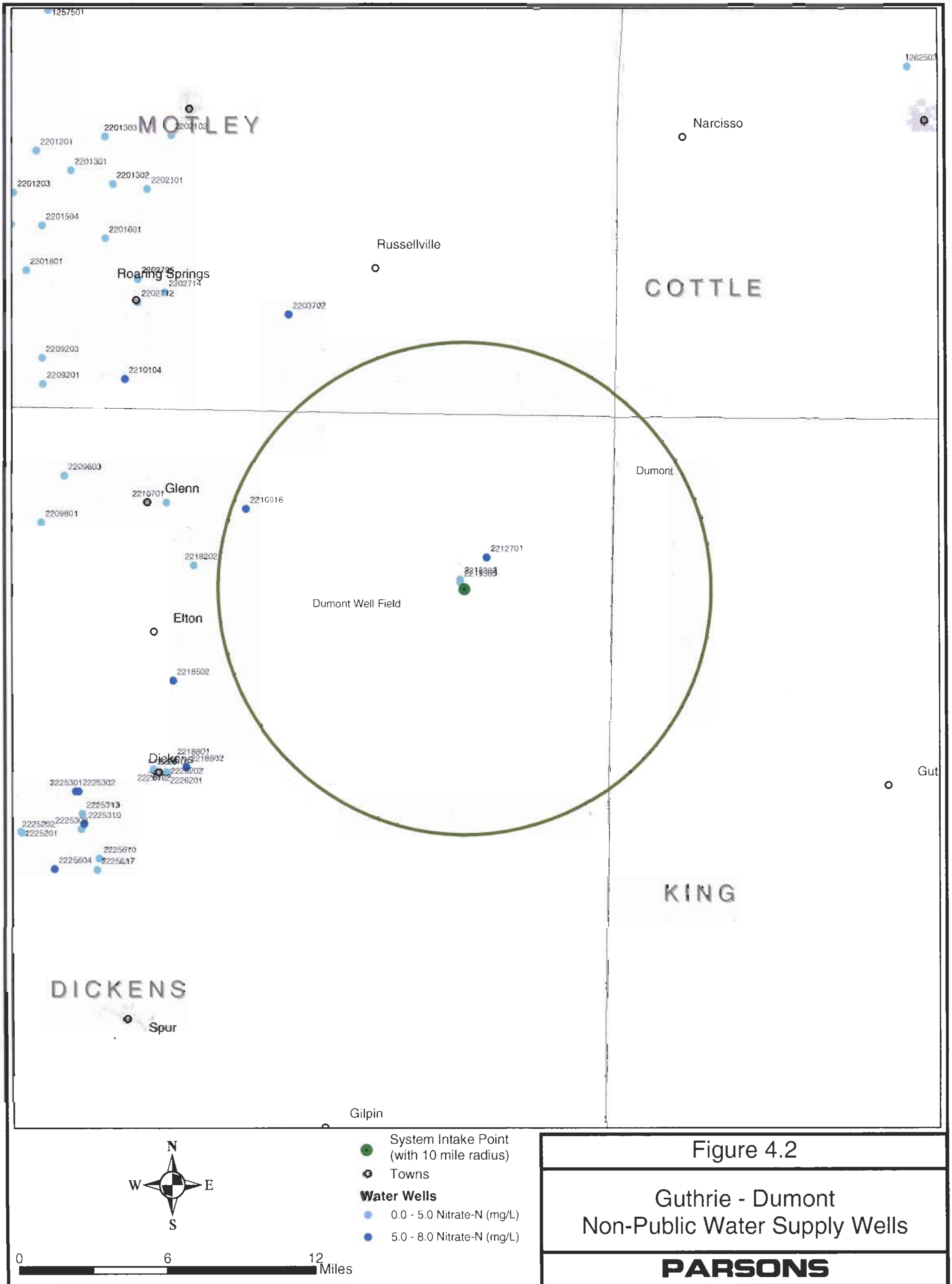

Figure 4.2

Guthrie - Dumont
Non-Public Water Supply Wells

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- Well 22-12-701 is approximately 2 miles northeast of the Dumont well field. There is no owner of record, yet it was sampled fairly recently. The nitrate concentration is fairly high. This well could potentially augment the existing three wells.
- Well 22-18-502 is actually a seep or spring. The record shows the spring as being of Ogallala Aquifer origin; however, the TDS concentration is uncharacteristically high for water from that aquifer. This source is not suitable for further investigation.

Installation of a new well within 1, 5 or 10 miles of the system intake point is likely to be the best option for obtaining compliant water. As a result, existing wells with good water quality should be investigated, even though water quality data for these wells are dated and need to be verified.

Other wells with nitrate-N less than the MCL were identified in King County, Dickens County, and Cottle County. Many wells were removed from further consideration because of high TDS concentrations (greater than 2,500 mg/L). The low nitrate/high TDS wells identified were: 22-28-401 and 22-35-202 in Dickens County; 22-22-702, 22-24-101, 22-30-101 in King County; and 22-14-105 in Cottle County. Alternatives that address new groundwater sources are GD-9, GD-10, and GD-11.

4.2.2.2 Results of Groundwater Availability Modeling

The RRA Guthrie-Dumont Water System obtains groundwater from the Quartermaster Formation and Whitehorse Group which is not addressed by any of the GAMs that have been developed. As a result, a GAM was not run to assist in locating groundwater sources for RRA Guthrie-Dumont system. The Draft Seymour GAM report was consulted to provide basic information about groundwater resources in the RRA Guthrie-Dumont area.

4.2.2.3 General Aquifer Indications

There are 89 wells listed in the TWDB water quality database within approximately a 20-mile radius of the RRA Guthrie-Dumont well field that include analyses for nitrate, sulfate, and TDS concentrations. Of these wells, 49 percent are completed in the Seymour Aquifer (alluvium), 48 percent are completed in Permian formations (including Dockum and Blaine), and the remaining wells are completed in the Ogallala (two wells). Using prioritized screening criteria indicated in Section 4.2.2.1, 34 percent of all wells provide acceptable quality water. Most of the failures in the Seymour wells are due to high nitrate-N concentrations while most failures in the Permian wells are due to elevated sulfate or TDS. Sample analysis dates range from 1938 to 2001, though most (70 percent) of the analyses were performed before 1980 and may not reflect current conditions.

Aquifer	Number of Wells	Passing	Nitrate-N >8 mg/L	Sulfate >300 mg/L or TDS >1000 mg/L
Seymour (alluvium)	44	16	19	9
Ogallala	2	2	0	0
Dockum	15	9	5	1
Blaine	6	0	2	4
Other Permian	22	3	7	12
Total	89	30	33	26

The Blaine Aquifer underlies portions of Cottle and King Counties to the northeast and east of Dickens County. Water quality is generally very poor in the Blaine due to high sulfate and TDS; however, there are Blaine wells that produce acceptable water. The TWDB database has water quality information on 43 Blaine Aquifer wells in Cottle and King Counties that include analyses for nitrate, sulfate, and TDS. Approximately 70 percent of the samples were collected between 1980 and 2001 and should generally reflect current conditions. Median nitrate-N is very low (2.3 mg/L), but median sulfate (1,512 mg/L) and TDS (2,443 mg/L) are very high. Six wells (14 percent) in the Blaine have acceptable water quality, indicating the Blane aquifer should be considered a potential groundwater source, but investigation will be required to find areas with high water quality.

The Ogallala Aquifer underlies western portions of Dickens and Motley Counties and counties to the west. This aquifer has the potential to supply water to RRA Guthrie-Dumont, provided the pipeline costs are not prohibitive. The TWDB database has water quality information on 229 wells completed in the Ogallala Aquifer in Crosby, Dickens, Floyd, and Motley Counties that include analyses for nitrate, sulfate, and TDS. The latest samples for each of these wells had median values of nitrate-N (0.9 mg/L), sulfate (35 mg/L) and TDS (403 mg/L) that indicate generally excellent water quality. Only four wells (2 percent) fail the screening criteria, three for elevated nitrate-N and one for elevated TDS. Sample dates range from 1938 to 2001, with 68 percent evenly distributed between 1980 and 2001, and generally indicate no temporal degradation of water quality.

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 will ensure the well characteristics are known and the well construction meets standards for drinking water wells.

4.2.3 Potential for New Surface Water Sources

There are no natural surface water supplies within 20 miles of RRA Guthrie-Dumont system capable of providing a year round source of drinking water.

The City of Spur, situated just outside the 20 mile radius, is supplied by the White River Municipal Water District, which obtains its surface water from the White River Reservoir which is 15 miles farther west. The City has a contract for a minimum of 115,000,000 gallons per year (gpy) (352 ac-ft), whereas their average usage is 110,000,000 (335 ac-ft).

The Regional Water Plan for the Llano Estacado indicates that 1,700 ac-ft/year is supplied from the White River Reservoir, and that the reservoir can supply 4,000 ac-ft/year when at conservation pool level. The Water Availability Map for the Brazos River shows, however, that unappropriated flows for new uses are available at most 25 percent of the time. This precludes use of water from White River Reservoir, unless the rights are purchased.

4.2.4 Options for Detailed Consideration

The options for further consideration are as follows:

1. Install another well at the Matador well field in Roaring Springs, and pipe groundwater to Dumont. Interconnect the two systems (at Roaring Springs) for standby capacity when one well is out of service (Alternative GD-1).

2. Install another well at Dickens and pipe to Dumont. Interconnect the two systems for standby capacity when one well is out of service (Alternative GD-2).

3. Install 2 new wells at McAdoo and pipe to Dumont. Interconnect the two systems for standby capacity when one well is out of service (Alternative GD-3).

4. Partner with King-Cottle WSC on the installation of a TDS removal system at King-Cottle WSC well field. The system would be large enough to provide all of the RRA Guthrie-Dumont System. Install a transmission main to RRA Guthrie-Dumont or make arrangements to share the existing 6666 Ranch pipeline from King-Cottle WSC to Guthrie (Alternative GD-4).

4.3 TREATMENT OPTIONS

4.3.1 Centralized Treatment Systems

Centralized treatment of the well field water is identified as a potential option. Both RO and IX could be potentially applicable. The central RO treatment alternative is Alternative GD-7, and the central IX treatment alternative is Alternative GD-8.

4.3.2 Point-of-Entry Systems

Point-of-entry treatment using RO technology is valid for nitrate removal. The point-of-entry RO treatment alternative is GD-6.

4.3.3 Point-of-Use Systems

Point-of-use treatment using RO technology is valid for nitrate removal. The point-of-use RO treatment alternative is GD-5.

4.3.4 Bottled water

The current method of dealing with the nitrate issue is to instruct expectant mothers to drink bottled water and to use bottled water for infant children. Red River Authority currently reimburses people for bottled water if they meet the criteria. A modification to this system would be to have Red River Authority pay for the bottled water and to deliver bottled water to the homes of the affected population. The community is small and people know each other; however, 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 GD-12, GD-13, GD-14, and GD-15. It should be noted that provision of bottled water is considered an interim measure to be used until a compliance alternative is implemented.

4.4 ALTERNATIVE DEVELOPMENT AND ANALYSIS

A number of potential alternatives for compliance with the MCL for nitrate 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 E contains cost estimates for the compliance alternatives.

4.4.1 Alternative GD-1: Roaring Springs/Matador Groundwater

This alternative consists of the installation of an additional well in the City of Matador well field located near Roaring Springs. The groundwater may have nitrate concentrations sufficiently low to make blending with Dumont well field water possible. For this alternative to be feasible, an additional well will have to be installed to ensure adequate supply when a well is taken out of service for maintenance or repair.

This alternative would require the construction of a pipeline from the Matador well field to the existing intake point for the RRA Guthrie-Dumont system. A pump station would also be required to overcome pipe friction and the elevation differences between Roaring Springs and Dumont. The pipeline would be approximately 25 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pipeline would have to cross several streams and roads. The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the RRA Guthrie-Dumont system, since the incremental cost would be relatively small, and it would provide operational flexibility.

Since the wells would be interconnected at the well field, this alternative has by nature a structural regional component. This alternative would also present a starting point for organizational regionalization. Organizational regionalization could be accomplished by combining two or three of the Roaring Springs, Matador, and RRA Guthrie-Dumont systems. This could reduce the overall cost for management and administration of the systems. This would also increase the overall customer base, strengthening financial capability. A combined system would also result in shared cost for pipelines and other common/shared infrastructure.

The estimated capital cost for this alternative includes the cost to construct the pipeline and pump station. The estimated O&M cost for this alternative includes the difference in O&M cost to for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field and operating the additional well at Roaring Springs, 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 $1.3 million, and the estimated annual O&M cost for this alternative without blending is $25,000. If blending is performed, the annual O&M cost for this alternative could be reduced because of reduced pumping costs. Additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

Reliability of supply of adequate amounts of compliant water under this alternative should be good. Adding a well, and combining use with the City of Matador increases the reliability of supply. From RRA Guthrie-Dumont's perspective, this alternative would be characterized as easy to operate and repair, since O&M of wells, pipelines, and pump stations is well understood, and RRA Guthrie-Dumont currently operates a system with these components. If blending is performed, the operational complexity will increase.

The feasibility of this alternative is dependant on the cooperation of the City of Matador in sharing their well field.

4.4.2 Alternative GD-2: Dickens Groundwater

This alternative consists of the installation of an additional well at the City of Dickens well field. The groundwater may have nitrate concentrations sufficiently low to make blending with Dumont well field water possible. For this alternative to be feasible, an additional well will have to be installed to ensure adequate supply when a well is taken out of service for maintenance or repair.

This alternative would require the construction of a pipeline from the Dickens well field to the existing intake point for the RRA Guthrie-Dumont system. A pump station would also be required to overcome pipe friction and the elevation differences between Roaring Springs and Dumont. The pipeline would be approximately 25 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pipeline would have to cross a highway, and several streams and roads. The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the RRA Guthrie-Dumont system, since the incremental cost would be relatively small, and it would provide operational flexibility.

Since the wells would be interconnected at the well field, this alternative has by nature a structural regional component. This alternative would also present a starting point for organizational regionalization. Organizational regionalization could be accomplished by combining the City of Dickens and RRA Guthrie-Dumont systems. This could reduce the overall cost for management and administration of the systems. This would also increase the overall customer base, strengthening financial capability. A combined system would also result in shared cost for pipelines and other common/shared infrastructure.

The estimated capital cost for this alternative includes the cost to construct the pipeline and pump station. The estimated O&M cost for this alternative includes the difference in O&M cost to for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field and operating the additional well at Dickens, 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 $1.4 million, and the estimated annual O&M cost for this alternative without blending is $21,000. If blending is performed, the annual O&M cost for this alternative could be reduced because of reduced pumping costs. Additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

Reliability of supply of adequate amounts of compliant water under this alternative should be good. Adding a well and combining use with the City of Dickens increases the reliability of supply. From RRA Guthrie-Dumont's perspective, this alternative would be characterized as easy to operate and repair, since O&M of wells, pipelines, and pump stations is well understood, and RRA Guthrie-Dumont currently operates a system with these components. If blending is performed, the operational complexity will increase.

The feasibility of this alternative is dependant on the cooperation of the City of Dickens in sharing their well field.

4.4.3 Alternative GD-3: McAdoo Groundwater

This alternative consists of the installation of two additional wells at the McAdoo WSC well field. The groundwater may have nitrate concentrations sufficiently low to make blending with Dumont well field water possible. For this alternative to be feasible, two additional wells will have to be installed to increase the capacity of the well field and to ensure adequate supply when a well is taken out of service for maintenance or repair.

This alternative would require the construction of a pipeline from the McAdoo well field to the existing intake point for the RRA Guthrie-Dumont system. A pump station would also be required to overcome pipe friction and the elevation differences between McAdoo and Dumont. The pipeline would be approximately 26 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pipeline would have to cross a highway, and several streams and roads. The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the RRA Guthrie-Dumont system, since the incremental cost would be relatively small, and it would provide operational flexibility.

Since the wells would be interconnected at the well field, this alternative has by nature a structural regional component. This alternative would also present a starting point for organizational regionalization. Organizational regionalization could be accomplished by combining the McAdoo and RRA Guthrie-Dumont systems. This could reduce the overall cost for management and administration of the systems. This would also increase the overall customer base, strengthening financial capability. A combined system would also result in shared cost for pipelines and other common/shared infrastructure.

The estimated capital cost for this alternative includes the cost to construct the pipeline and pump station. The estimated O&M cost for this alternative includes the difference in O&M cost to for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field and operating the additional wells at McAdoo, 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 $1.6 million, and the estimated annual O&M cost for this alternative without blending is $27,000. If blending is performed, the annual O&M cost for this alternative could be reduced because of reduced pumping costs. Additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

Reliability of supply of adequate amounts of compliant water under this alternative should be good. Adding a well and combining use with McAdoo WSC increases the reliability of supply. From RRA Guthrie-Dumont's perspective, this alternative would be characterized as easy to operate and repair, since O&M of wells, pipelines, and pump stations is well understood, and RRA Guthrie-Dumont currently operates a system with these components. If blending is performed, the operational complexity will increase.

The feasibility of this alternative is dependent on the cooperation of the McAdoo WSC in sharing its well field.

4.4.4 Alternative GD-4: King-Cottle Treated Groundwater

This alternative consists of installation of a treatment plant at the King-Cottle WSC well field to reduce TDS concentrations, and a pump station and pipeline to transfer treated water to RRA Guthrie-Dumont. The treated groundwater may have nitrate concentrations sufficiently low to make blending with Dumont well field water possible. The existing King-Cottle WSC well field appears to have sufficient capacity to supply both the King-Cottle WSC and RRA Guthrie-Dumont systems.

This alternative would require the construction of an RO treatment plant to reduce TDS in the King-Cottle WSC well field water, along with a pipeline to the existing intake point for the RRA Guthrie-Dumont system. A pump station would also be required to overcome pipe friction and the elevation differences between the King-Cottle WSC well field and Dumont. The pipeline would be approximately 17 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pipeline would have to cross a highway, and several streams and roads. The pump station would include two pumps, including one standby, and would be housed in a building. It is assumed the pumps and piping would be installed with capacity to meet all water demand for the RRA Guthrie-Dumont system, since the incremental cost would be relatively small, and it would provide operational flexibility.

This alternative has significant opportunity for regionalization since the King-Cottle and RRA Guthrie-Dumont systems would both use treated water produced by the treatment plant. Organizational regionalization could be accomplished by combining the King-Cottle and RRA Guthrie-Dumont systems. This could reduce the overall cost for management and administration of the systems. This would also increase the overall customer base, strengthening financial capability. A combined system would also result in shared cost for pipelines and other common/shared infrastructure.

The estimated capital cost for this alternative includes the cost to construct the treatment plant, pipeline, and pump station. The estimated O&M cost for this alternative includes O&M for the treatment plant, the pipeline, and pump station, plus a reduction to reflect cessation of operation of the Dumont wells. For this estimate, the capital and O&M costs for the treatment plant were assumed to be split between King-Cottle WSC and RRA Guthrie-Dumont, based on water demand. Accordingly, approximately 25 percent of the treatment plant cost was allocated to RRA Guthrie-Dumont. The estimated capital cost for this alternative is $1.1 million, and the estimated annual O&M cost for this alternative without blending is $113,000. If blending is performed, the annual O&M cost for this alternative could be reduced because of reduced pumping costs. Additional costs would be incurred for equipment to ensure proper blending, and additional monitoring to ensure the finished water is compliant.

Reliability of supply of adequate amounts of compliant water under this alternative is good, since RO treatment is a common and well understood treatment technology. However, the O&M efforts required for the central RO treatment plant will be significant, and King-Cottle and RRA Guthrie-Dumont personnel are inexperienced in this type of work. If blending is performed, the operational complexity will increase further.

The feasibility of this alternative is dependant on the cooperation of the King-Cottle WSC.

4.4.5 Alternative GD-5: Point-of-Use Treatment

This alternative consists of the continued operation of the Dumont well field, plus treatment of water to be used for drinking or food preparation at the point of use to remove nitrate. The purchase, installation, and maintenance of point-of-use 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 the installation of the point-of-use treatment units in houses and other buildings that provide drinking or cooking water. RRA Guthrie-Dumont 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 Guthrie-Dumont or contract personnel into the houses of customers. As a result, the cooperation of customers will be important for success in implementation of this alternative. The treatment units could be installed so that they could be accessed without house entry, but that would complicate the installation and increase costs.

Point-of-use nitrate treatment processes typically produce liquid waste streams that are equal in volume to the treated water and require disposal. These waste streams result in an increased overall volume of water used. Point-of-use systems have the advantage that a minimum volume of water (only that for human consumption) is treated. This minimizes the size of the treatment units, the increase in water required, and the waste for disposal. For this alternative, it is assumed that the increase in water consumption is insignificant in terms of supply cost, and that the waste stream can be recovered for reuse or discharged to the house septic system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes the cost to purchase and install the point-of-use 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 $164,000, and the estimated annual O&M cost for this alternative is $59,000. For the cost estimate, it is assumed that one point-of-use treatment unit will be required for each of the 140 existing connections to the RRA Guthrie-Dumont system.

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

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

4.4.6 Alternative GD-6: Point-of-Entry Treatment

This alternative consists of the continued operation of the Dumont well field, plus treatment of water as it enters residences to remove nitrate. 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 point-of-entry treatment units at houses and other buildings that provide drinking or cooking water. RRA Guthrie-Dumont would be responsible for purchase and maintenance of the treatment units, including membrane and filter replacement, periodic sampling, and necessary repairs. The plumbing in houses should be investigated to ensure that the aggressive water that will result from RO treatment will not cause damage. It may also be desirable to modify piping so that water for non-consumptive uses can be withdrawn upstream of the treatment unit. The point-of-entry treatment units will be installed outside of the houses, so that entry will not be necessary for O&M. Some cooperation from customers will be necessary for installation and maintenance of the treatment systems.

Point-of-entry nitrate treatment processes typically produce liquid waste streams that are equal in volume to the treated water and require disposal. These waste streams result in an increased overall volume of water used. Point-of-entry systems treat a greater volume of water than point-of-use systems. For this alternative, it is assumed that the increase in water consumption is insignificant in terms of supply cost, and that the waste stream can be recovered for reuse or discharged to the house septic system.

This alternative does not present options for a regional solution.

The estimated capital cost for this alternative includes the cost to purchase and install the point-of-entry 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 $2.5 million, and the estimated annual O&M cost for this alternative is $104,000. For the cost estimate, it is assumed that one point-of-entry treatment unit will be required for each of the 140 existing connections to the RRA Guthrie-Dumont system.

Reliability of supply of adequate amounts of compliant water under this alternative are fair, but better than point-of-use 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 home. Additionally, the O&M efforts required for the point-of-entry systems will be significant, and RRA Guthrie-Dumont personnel are inexperienced in this type of work. From RRA Guthrie-Dumont's perspective this alternative would be characterized as more difficult to operate due to the on-property requirements and the large number of individual units.

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

4.4.7 Alternative GD-7: Central RO Treatment

The system would continue to pump water from the Dumont well field, and would treat the water through an RO system prior to distribution. For this option, a fraction of the raw water would be treated and then combined with the untreated stream to obtain overall compliant water. The RO process concentrates impurities in the reject stream. This stream must be disposed. As a result, 11 percent more raw water will be required to produce the same amount of finished water. It is assumed that the three existing wells are capable of producing the additional water, with minimal increase in operating cost.

This alternative consists of constructing the RO treatment plant at the existing Dumont Pump Station. The plant comprises a 400 square foot building with a paved driveway, the pre-constructed RO plant on a skid, two transfer pumps, a 20,000-gallon tank for storing the treated water, and a 260,000-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 existing above-grade storage tank would continue to be used to accumulate feed water from the well field. The entire facility is fenced. The capital cost includes purchase of a water truck-trailer to periodically haul reject water to a disposal point 20 miles distant.

The estimated capital cost for this alternative is $460,000, and the estimated annual O&M cost is $85,000.

Reliability of supply of adequate amounts 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 Red River Authority personnel would require training with reverse osmosis.

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

4.4.8 Alternative GD-8: Central Ion Exchange Treatment

The system would continue to pump water from the Dumont well field and would treat the water through an IX system prior to distribution. Water would be blended in a manner similar to that of RO as a means of extending the time between regenerations of the IX resin beds. Water in excess of that currently produced (770,000 gpy) will be required for backwashing the resin beds.

The IX treatment plant, located at the Dumont well field, features a 400 square foot building with a paved driveway, the pre-constructed IX plant on a skid, two transfer pumps, a 20,000-gallon tank for storing the treated water, a 10,000-gallon tank for storing spent backwash water, and a 10,000-gallon tank for storing regenerant. The regenerant tank would be fitted with a dry-salt feeder and a mixer to allow the addition and dissolution of dry sodium chloride regenerant. The treated water would be chlorinated and stored in the new treated water tank prior to being pumped into the distribution system. The existing above-grade storage tank would continue to be used to accumulate feed water. The entire facility is fenced.

The estimated capital cost for this alternative is $370,000, and the estimated annual O&M cost is $78,000. The difference in capital cost between this alternative and the RO alternative is primarily due to the purchase of a water truck for hauling wastewater under the RO alternative. The purchase of a truck under the central IX alternative was not considered necessary because the volume of wastewater to be hauled appears to be feasibly handled by periodic truck rental. The estimates assumed that spent regenerant could be disposed in the Truscott Brine Reservoir. Backwash water would be released at a point 20 miles from the site.

Reliability of supply of adequate amounts of compliant water under this alternative is good, since IX treatment is a common and well-understood treatment technology. IX treatment does not require high pressures, but can be affected by interfering constituents in the water. The O&M efforts required for the central IX treatment plant may be significant, and RRA personnel would require training with ion exchange.

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

4.4.9 Alternative GD-9: New Wells at 10 Miles

This alternative consists of the installation of three new wells within 10 miles of RRA Guthrie-Dumont that would produce compliant water in place of the water produced by the Dumont well field. Blending is not considered to be an option since the new well is expected to be installed in the Seymour aquifer, which is characterized by relatively high nitrate concentrations, and would not be feasible for blending with the groundwater currently produced. 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. In order to address a range of solutions, three different well alternatives are developed, assuming the new well is located within 10 miles, 5 miles, and 1 mile from the existing intake point.

This alternative would require the construction of three new 260-foot wells, a new pump station with storage tank near the new wells, and a pipeline from the new wells/tank to the existing intake point for the RRA Guthrie-Dumont system. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 10 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pump station would include two pumps, including one standby, and would be housed in a building.

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

The estimated capital cost for this alternative includes the cost to install the wells, and construct the pipeline and pump station. The estimated O&M cost for this alternative includes the cost for O&M for the pipeline and pump station, plus an amount for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field. The estimated capital cost for this alternative is $981,000, and the estimated annual O&M cost for this alternative is $14,000.

Reliability of supply of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From RRA Guthrie-Dumont's perspective, this alternative would be similar to operate as the existing system. RRA Guthrie-Dumont has experience with O&M of wells, pipelines and pump stations.

The feasibility of this alternative is dependant 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 the alternate groundwater source will not be found on RRA Guthrie-Dumont controlled land, so landowner cooperation will be required.

4.4.10 Alternative GD-10: New Wells at 5 Miles

This alternative consists of the installation of three new wells within 5 miles of RRA Guthrie-Dumont that would produce compliant water in place of the water produced by the Dumont well field. Blending is not considered to be an option since the new well is expected to be installed in the Seymour aquifer, which is characterized by relatively high nitrate concentrations, and would not be feasible for blending with the groundwater currently produced. 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 the construction of three new 260-foot wells, a new pump station with storage tank near the new wells, and a pipeline from the new wells/tank to the existing intake point for the RRA Guthrie-Dumont system. The pump station and storage tank would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 5 miles long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pump station would include two pumps, including one standby, and would be housed in a building.

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

The estimated capital cost for this alternative includes the cost to install the wells, and construct the pipeline and pump station. The estimated O&M cost for this alternative includes the cost for O&M for the pipeline and pump station, plus an amount for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field. The estimated capital cost for this alternative is $749,000, and the estimated annual O&M cost for this alternative is of $12,000.

Reliability of supply of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From RRA Guthrie-Dumont's perspective, this alternative would be similar to operate as the existing system. RRA Guthrie-Dumont has experience with O&M of wells, pipelines and pump stations.

The feasibility of this alternative is dependant 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 the alternate groundwater source will not be found on RRA Guthrie-Dumont controlled land, so landowner cooperation will be required.

4.4.11 Alternative GD-11: New Wells at 1 Mile

This alternative consists of the installation of three new wells within 1 mile of RRA Guthrie-Dumont that would produce compliant water in place of the water produced by the Dumont well field. Blending is not considered to be an option since the new well is expected to be installed in the Seymour aquifer, which is characterized by relatively high nitrate concentrations, and would not be feasible for blending with the groundwater currently produced. 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. In order to address a range of solutions, three different well alternatives are developed, assuming the new well is located within 10 miles, 5 miles, and 1 mile from the existing intake point.

This alternative would require the construction of three new 260-foot wells, a new pump station, and a pipeline from the new wells/ to the existing intake point for the RRA Guthrie-Dumont system. The pump station would be necessary to overcome pipe friction and changes in land elevation. For this alternative, the pipeline is assumed to be approximately 1 mile long, and would be a 6-inch PVC line that discharges to the existing storage tank at the Dumont well field. The pump station would include two pumps, including one standby, and would be housed in a building.

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

The estimated capital cost for this alternative includes the cost to install the wells, and construct the pipeline and pump station. The estimated O&M cost for this alternative includes the cost for O&M for the pipeline and pump station, plus an amount for plugging and abandoning (in accordance with TCEQ requirements) the Dumont well field. The estimated capital cost for this alternative is $468,000, and the estimated annual O&M cost for this alternative is $3,000.

Reliability of supply of adequate amounts of compliant water under this alternative should be good, since water wells, pump stations and pipelines are commonly employed. From RRA Guthrie-Dumont's perspective, this alternative would be similar to operate as the existing system. RRA Guthrie-Dumont has experience with O&M of wells, pipelines and pump stations.

The feasibility of this alternative is dependant 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 the alternate groundwater source will not be found on RRA Guthrie-Dumont controlled land, so landowner cooperation will be required.

4.4.12 Alternative GD-12: Public Dispensers for Treated Drinking Water

This alternative consists of the continued operation of the Dumont well field, plus dispensing treated water for drinking and cooking at two publicly accessible locations. Implementing this alternative would require the purchase and installation of two treatment units where customers would be able to come and fill their own containers. This alternative also includes notifying the 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 pickup 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.

RRA Guthrie-Dumont would be responsible for maintenance of the treatment unit, including membrane and filter replacement, periodic sampling, and necessary repairs. A method for disposal of the reject waste stream produced by the treatment system will have to be found. 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 the cost to purchase and install the treatment systems to be used for the drinking water dispensers. 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 $44,000, and the estimated annual O&M cost for this alternative is $13,000.

Reliability of supply 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. RRA Guthrie-Dumont has not provided this type of service in the past. From RRA Guthrie-Dumont's perspective this alternative would be characterized as relatively easy to operate, since these types of treatment units are highly automated, and there is only one unit.

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

4.4.13 Alternative GD-13: 100 Percent Bottled Water Delivery

This alternative consists of the continued operation of the Dumont well field, 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 of the customers in the system. It is expected that RRA Guthrie-Dumont will find it most convenient and economical to contract a bottled water service. The bottle delivery program will 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 RRA Guthrie-Dumont 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 $4,000, and the estimated annual O&M cost for this alternative is $334,000. For the cost estimate, it is assumed that each person requires 2.5 gallons of bottled water per day.

Reliability of supply 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 RRA Guthrie-Dumont.

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

4.4.14 Alternative GD-14: 25 Percent Bottled Water Delivery

This alternative consists of the continued operation of the Dumont well field, 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 only the susceptible population in the system. For this alternative, it is assumed that serving the susceptible population will result in providing bottled drinking water to 25 percent of the served population. It is expected that RRA Guthrie-Dumont will find it most convenient and economical to contract a bottled water service. The bottle delivery program will 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.

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 $4,000, and the estimated annual O&M cost for this alternative is $86,000. For the cost estimate, it is assumed that each person requires 2.5 gallons of bottled water per day.

Reliability of supply 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 RRA Guthrie-Dumont.

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

4.4.15 Alternative GD-15: Public Dispenser for Trucked Drinking Water

This alternative consists of continued operation of the Dumont well field, plus dispensing compliant water for drinking and cooking at a publicly accessible location. The compliant water would be purchased from the Cities of Roaring Springs, Matador, or Dickens, 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.

RRA Guthrie-Dumont 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 cooperation and action from customers in order to be effective.

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

The estimated capital cost for this alternative includes the cost to purchase a water truck and to construct the storage tank to be used for the drinking water dispenser. The estimated O&M cost for this alternative includes O&M for the truck, maintenance for the tank, water quality testing, record keeping, and water purchase. The estimated capital cost for this alternative is $103,000, and the estimated annual O&M cost for this alternative is $10,000.

The reliability of an adequate supply of compliant water under this alternative is fair, because of the large amount of effort required from the customers and the associated inconvenience. RRA Guthrie-Dumont has not provided this type of service in the past. From the perspective of RRA Guthrie-Dumont, 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.

4.4.16 Summary of Alternatives

Table 4.3 provides a summary of the key features of each alternative for RRA Guthrie-Dumont.

Table 4.3 Summary of Compliance Alternatives for RRA Guthrie-Dumont

Alt. No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost[1]	Total Annualized Cost[2]	Reliability	System Impact	Remarks
GD-1	Install well at C. of Matador well field near Roaring Springs and interconnect with C. of Matador system.	- New well - Pump station - 25-mile pipeline	$1.3 million	$25,000	$161,000	Good	N	C. of Matador must be willing to cooperate. Possibility to join with C. of Matador and/or Roaring Springs. Blending may be possible.
GD-2	Install well at C. of Dickens well field and interconnect with C. of Dickens system.	- New well - Pump station - 25-mile pipeline	$1.4 million	$21,000	$167,000	Good	N	C. of Dickens must be willing to cooperate. Possibility to join with C. of Dickens. Blending may be possible.
GD-3	Install 2 wells at C. of McAdoo well field and interconnect with C. of McAdoo system.	- 2 new wells - Pump station - 26-mile pipeline	$1.6 million	$27,000	$191,000	Good	N	C. of McAdoo must be willing to cooperate. Possibility to join with C. of McAdoo. Blending may be possible.
GD-4	Install TDS treatment plant at King-Cottle well field	- Central TDS treatment plant - Pump station - 17-mile pipeline	$1.1 million	$113,000	$224,000	Good	T	Would be able to share treatment plant cost with King-Cottle. Possibility to join with King-Cottle system. Blending may be possible.
GD-5	Continue operation of Dumont well field, and point-of-use treatment	- Point-of-use treatment units.	$164,000	$59,000	$76,000	Fair	T, M	Only one compliant tap in home. Cooperation of residents required for installation, maintenance, and testing.
GD-6	Continue operation of Dumont well field, and point-of-entry treatment	- Point-of-entry treatment units.	$2.5 million	$104,000	$366,000	Good	T, M	All home taps compliant and less resident cooperation required.

Alt. No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost[1]	Total Annualized Cost[2]	Reliability	System Impact	Remarks
GD-7	Continue operation of Dumont well field with central RO treatment	- Central RO treatment plant	$460,000	$85,000	$132,000	Good	T	No nearby system to possibly share treatment plant cost.
GD-8	Continue operation of Dumont well field with central IX treatment	- Central IX treatment plant	$370,000	$78,000	$116,000	Good	T	No nearby system to possibly share treatment plant cost.
GD-9	Install new compliant well within 10 miles	- New well - Storage tank - Pump station - 10-mile pipeline	$981,000	$14,000	$115,000	Good	N	May be difficult to find well with good water quality.
GD-10	Install new compliant well within 5 miles	- New well - Storage tank - Pump station - 5-mile pipeline	$748,000	$12,000	$89,000	Good	N	May be difficult to find well with good water quality.
GD-11	Install new compliant well within 1 mile	- New well - 1-mile pipeline	$468,000	$3,000	$51,000	Good	N	May be difficult to find well with good water quality.
GD-12	Continue operation of Dumont well field, but furnish 2 public dispensers for treated drinking water	- 2 water treatment and dispenser units	$44,000	$13,000	$18,000	Fair/interim measure	T	Does not provide compliant water to all taps, and requires a lot of effort by customers.
GD-13	Continue operation of Dumont well field, but furnish bottled drinking water for all customers	- Set up bottled water system	$4,000	$334,000	$334,000	Fair/interim measure	M	Does not provide compliant water to all taps, and requires customers to order and use. Management of program may be significant.
GD-14	Continue operation of Gilliland well	- Set up bottled water	$4,000	$86,000	$87,000	Fair/interim measure	M	Does not provide compliant water to all taps, and requires

Alt. No.	Alternative Description	Major Components	Capital Cost[1]	Annual O&M Cost[1]	Total Annualized Cost[2]	Reliability	System Impact	Remarks
	field, but furnish bottled drinking water for susceptible population	system						customers to order and use. Management of program and identification of susceptible population may be significant.
GD-15	Continue operation of Dumont well field, but furnish a public dispenser for trucked drinking water	- Construct storage tank and dispenser - Purchase potable water truck	$103,000	$10,000	$20,000	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 E
2 – 15-year return period and 6 percent interest

4.5 COST OF SERVICE AND FUNDING ANALYSIS

To evaluate the financial impact of implementing the compliance alternatives for RRA Guthrie-Dumont, a 30-year financial planning model was developed. This model can be found in Appendix F. The financial model is based on estimated cash flows for the RRA Guthrie-Dumont, with and without implementation of the compliance alternatives. Data for such models are derived from established budgets, audited financial reports, and published water tariffs, and consumption data.

4.5.1 Financial Plan Development

4.5.1.1 RRA Guthrie-Dumont Financial Data

Copies of the annual budget and the audited financial reports were made available by RRA. While each of the water systems within RRA has its accounts tracked and separate records are kept for each, RRA combines funds for all its water districts. RRA Guthrie-Dumont, with substantial deposits, has been "covering" deficit positions of other RRA water districts. On September 30, 2003, RRA Guthrie-Dumont had unrestricted cash reserves of over $280,000, which would be sufficient to fund several of the alternatives without outside funding sources.

4.5.1.2 Current Financial Position

4.5.1.2.1 Cash Flow Needs

Per the 2003 audited financial reports, all of RRA Guthrie-Dumont's 126 customers were being charged a base fee of $28.75 per month, which included the first 2,000 gallons of consumption. The next 8,000 gallons were charged at $2.15 per 1,000 gallons, while all consumption above 10,000 gallons per month was charged at $3.50 per 1,000 gallons. Beginning 2005, RRA Guthrie-Dumont's ten commercial customers will pay a separate rate: a base fee of $55.00 per month which includes consumption of 55,000 gallons, a water rate of $4.25 per 1,000 gallons for consumption between 50,000 and 100,000, and a water rate of $6.20 per 1,000 gallons for consumption in excess of 100,000 gallons per month.

The current average annual water bill for RRA Guthrie-Dumont customers is estimated to be $782, or about 2.2 percent of annual household income of $35,625. With its favorable reserve position, RRA Guthrie-Dumont will not need to raise water rates for several years, although ultimately without rate increases the surplus balance will be drawn down to zero, requiring a future rate increase. With additional expenditures to correct water quality issues, RRA Guthrie-Dumont customers will eventually need to pay higher water bills, but in many of the alternatives rate increases would not be needed for many years into the future, due to RRA Guthrie-Dumont's exceptionally strong current financial position.

Unaccounted-for-water for RRA Guthrie-Dumont is estimated to be 25.3%, which is better than most small water utilities but still in excess of the 10-15% considered to be a reasonable goal for well run utilities. Reducing the unaccounted-for-water would further enhance RRA Guthrie-Dumont's strong financial position by reducing costs to produce and deliver water to its customers.

4.5.1.2.2 Ratio Analysis

Current Ratio = 7.37

RRA Guthrie-Dumont's has an exceptional Current Ratio, with its current asset of $249,200 well in excess of current liabilities of $3,300. This is an exceptionally strong financial position.

Debt to Net Worth Ratio = 0.10

Again, this ratio indicates that the RRA Guthrie-Dumont system is in an exceptionally strong financial position, with its Net Worth of $369,500 well in excess of debt of $38,000. The RRA Guthrie-Dumont system has generated positive net income over a number of years.

Operating Ratio = 1.44

According the 2003 Audited Financial Reports, Guthrie-Dumont had Operating Revenues of about $105,300, compared to Operating Expenses of $72,965, earning sufficient revenue to be able to pay its debt and fund much of its future capital requirements.

4.5.1.3 Financial Plan Results

Each of the compliance alternatives for RRA Guthrie-Dumont was evaluated, with emphasis on the impact on affordability (expressed as a percentage of household income), and 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.

For SRF funding options, customer MHI compared to the state average determines the availability of subsidized loans. Since the MHI for the customers of RRA Guthrie-Dumont was not available, county-wide data were used. King County, in which the RRA Guthrie-Dumont water district is located, had a household income of $35,625 according to the 2000 Census compared to a statewide average of $39,927. With incomes at about 89 percent of the state average, RRA Guthrie-Dumont would not qualify for an interest rate reductions under the SRF. Repayment over 20 years is standard for SRF loans.

Results of the financial impact analysis are provided in Table 4.4, and Figure 4.3. Figure 4.3 provides a bar chart that, in terms of the yearly billing to an average customer (12,929 gallons/month consumption), shows the following:

- Current yearly billing,
- Projected yearly billing including rate increases to maintain financial viability and also for implementing the various compliance alternatives.

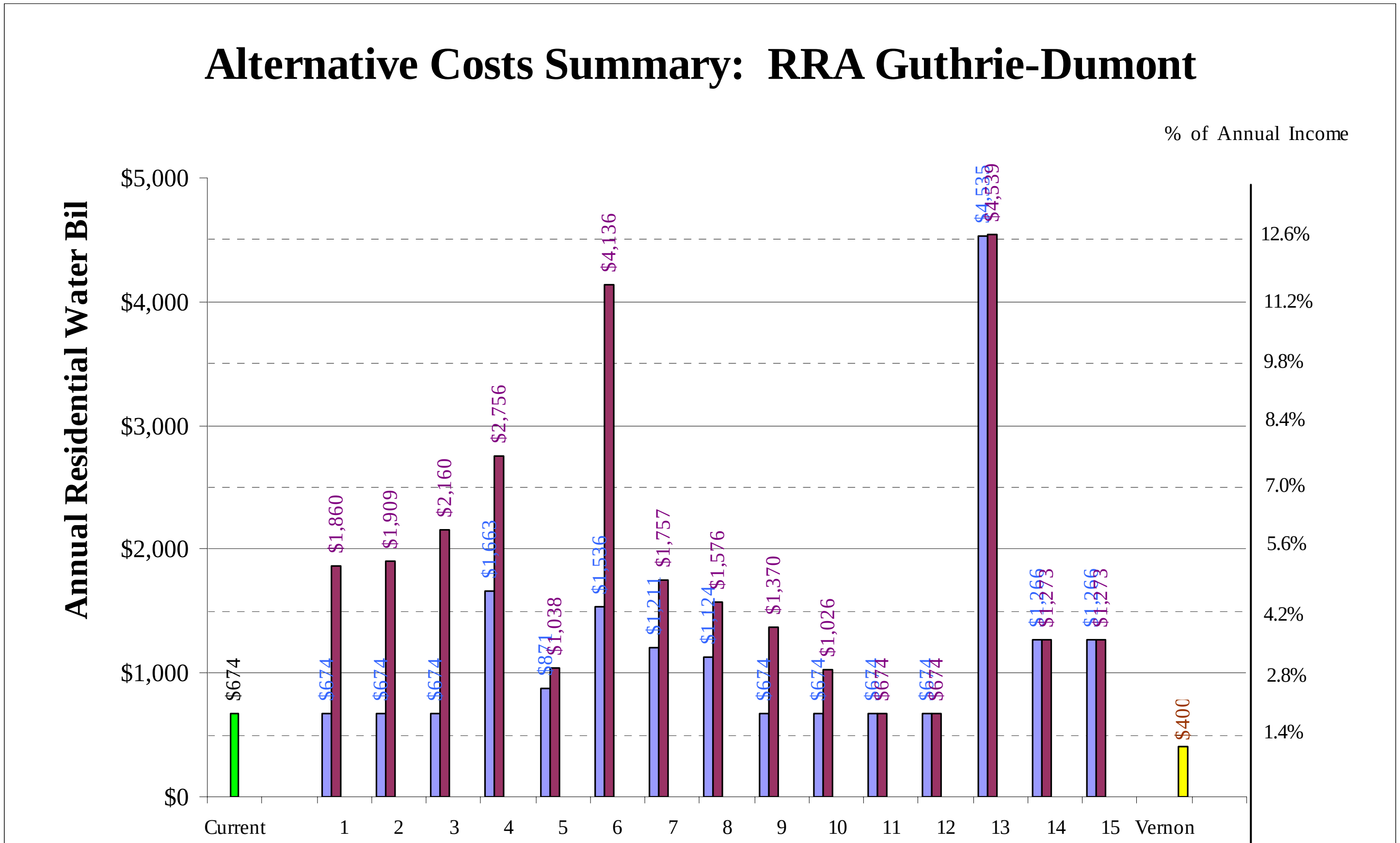
The two bars shown for each compliance alternative represent the maximum rate increases necessary assuming 100 percent grant funding and 100 percent loan/bond funding. Most funding options will fall between 100 percent grant and 100 percent loan/bond funding, with the exception of 100 percent revenue financing. If existing reserves are insufficient to fund a compliance alternative, rates would have to be raised ahead of implementation of the compliance alternative to allow the accumulation of sufficient reserves, in order to avoid larger but temporary rate increases during the years the compliance alternative is implemented.

Table 4.4 Financial Impact on Households for RRA Guthrie-Dumont

	Funding Source #	0	1	2	3	4	5
		All Revenue	100% Grant	75% Grant	50% Grant	SRF	Loan/ Bond
ALTERNATIVES							
GD-1	% of Income	19.3%	1.9%	1.9%	3.1%	4.8%	5.2%
	Year	2006	0	0	2014	2010	2009
	Rate Increase %	917.4%	0.0%	0.0%	64.0%	151.7%	175.8%
GD-2	% of Income	21.0%	1.9%	1.9%	3.1%	4.9%	5.4%
	Year	2006	0	0	2014	2010	2009
	Rate Increase %	1011.6%	0.0%	0.0%	63.9%	157.2%	183.1%
GD-3	% of Income	24.3%	1.9%	2.4%	3.8%	5.5%	6.1%
	Year	2006	0	2027	2012	2009	2009
	Rate Increase %	1181.2%	0.0%	27.7%	99.9%	191.2%	220.3%
GD-4	% of Income	16.8%	4.7%	5.4%	6.2%	7.4%	7.7%
	Year	2006	2011	2010	2009	2008	2008
	Rate Increase %	787.6%	146.6%	187.1%	227.6%	289.1%	308.6%
GD-5	% of Income	2.4%	2.4%	2.6%	2.7%	2.9%	2.9%
	Year	2016	2027	2023	2020	2018	2017
	Rate Increase %	29.1%	29.1%	35.3%	41.5%	50.9%	53.9%
GD-6	% of Income	43.6%	4.3%	6.1%	8.0%	10.7%	11.6%
	Year	2006	2012	2009	2008	2007	2007
	Rate Increase %	2202.9%	127.8%	224.1%	320.5%	466.7%	513.2%
GD-7	% of Income	4.9%	3.4%	4.0%	4.3%	4.8%	4.9%
	Year	2006	2014	2012	2011	2010	2010
	Rate Increase %	156.3%	79.6%	108.8%	126.1%	152.2%	160.6%

	Funding Source #	**0**	**1**	**2**	**3**	**4**	**5**
		All Revenue	**100% Grant**	**75% Grant**	**50% Grant**	**SRF**	**Loan/ Bond**
ALTERNATIVES							
GD-8	% of Income	3.8%	3.2%	3.5%	3.9%	4.3%	4.4%
	Year	2007	2015	2014	2013	2011	2011
	Rate Increase %	98.3%	66.6%	83.9%	105.7%	127.1%	133.8%
GD-9	% of Income	13.1%	1.9%	1.9%	1.9%	3.4%	3.9%
	Year	2006	0	0	0	2013	2012
	Rate Increase %	590.2%	0.0%	0.0%	0.0%	79.3%	103.2%
GD-10	% of Income	8.8%	1.9%	1.9%	1.9%	2.6%	2.9%
	Year	2006	0	0	0	2020	2016
	Rate Increase %	366.0%	0.0%	0.0%	0.0%	38.4%	52.1%
GD-11	% of Income	3.7%	1.9%	1.9%	1.9%	1.9%	1.9%
	Year	2006	0	0	0	0	0
	Rate Increase %	95.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GD-12	% of Income	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
	Year	0	0	0	0	0	0
	Rate Increase %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GD-13	% of Income	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%
	Year	2007	2007	2007	2007	2007	2007
	Rate Increase %	572.5%	12.7%	572.6%	572.8%	573.0%	573.0%
GD-14	% of Income	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
	Year	2013	2014	2013	2013	2013	2013
	Rate Increase %	88.2%	87.7%	88.3%	88.5%	88.7%	88.7%
GD-15	% of Income	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
	Year	0	0	0	0	0	0
	Rate Increase %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Figure 4.3 Alternative Costs Summary: RRA Guthrie-Dumont



Current Rates:	
Monthly (includes 2,000 gallons):	$28.75
2,000-10,000 gallons:	$2.15/1000 gallons
Over 10,000 gallons	$3.50/1000 gallons
Median Household Income	$35,625
Average Monthly Residential Usage	12,929 gallons

SECTION 5
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