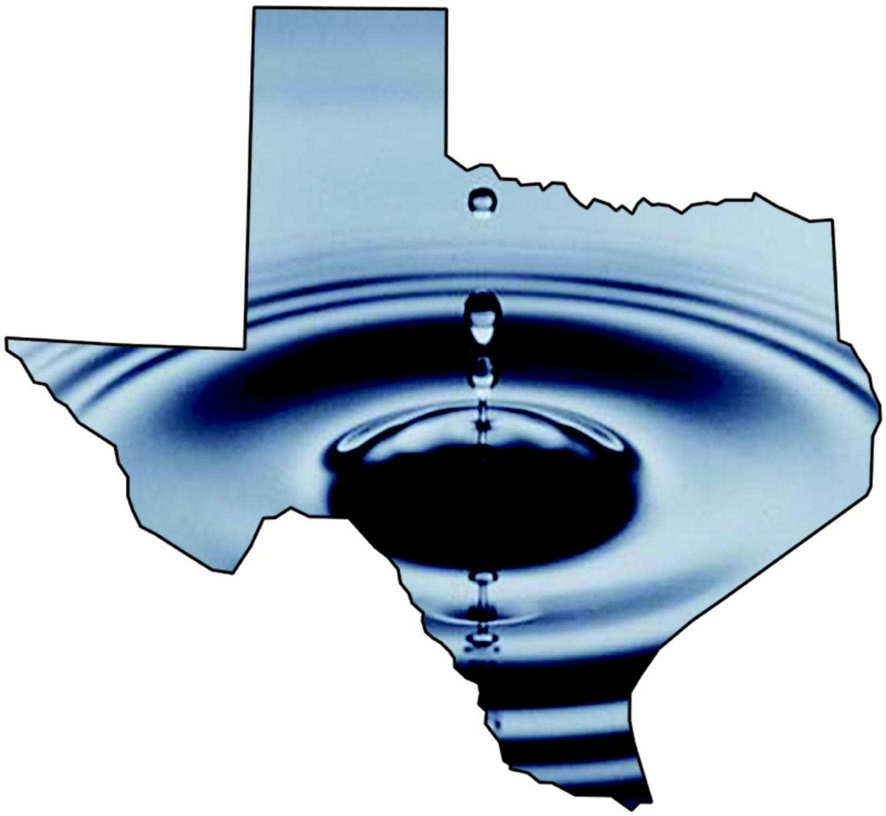
Utilizing Technology for Small Water Systems in Texas



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EXECUTIVE SUMMARY

The purpose of this report is to highlight water treatment technologies available for small water systems and to profile existing small community systems that can serve as a guiding force for other rural systems.

This report has been divided into two sections. The first section gives an overview of the various water treatment technologies that can be used by small water systems. It also addresses the barriers to utilizing these technologies and lessons learned by small water system operators.

Section 2 provides a two-page profile on 42 different small water systems spread across the State of Texas. This information was collected by faxing survey forms to small water system operators who were interested and willing to share detailed information about their system with others. This survey also provided input for information on the barriers to utilizing technologies and lessons learned by existing small water systems.

HIGHLIGHTS OF THE REPORT:

- No single water treatment technology can solve each and every water quality problem.

- The primary water treatment technologies for small water systems are:
    - Disinfection
    - Membrane Filtration
    - Adsorption
    - Corrosion Control
    - Lime Softening
    - Activated Alumina
    - Ion Exchange
    - Coagulation-flocculation
    - Oxidation-filtration
    - Aeration

- For any technology to be suitable for a small water system it is important to keep several factors in mind. These factors include quality of the source water, contaminants in the water, available capital, operating costs, maintenance costs, expertise needed to operate the system, water system safety, etc.

- It is necessary to comply with the Safe Water Drinking Act (SWDA) and other compliance requirements, such as the one announced on January 22, 2001 (with a compliance date of January 22, 2006) by U.S. Environmental Protection Agency (EPA) regarding the more-stringent arsenic standard of 10-µg/L in place of the previous 50-µg/L standard. Existing technologies that are used to remove or reduce arsenic primarily include: activated alumina, membrane filtration (electro dialysis and reverse osmosis), ion exchange, lime softening, coagulation-flocculation, and oxidation/filtration.

- With growth in population and industry the need for water is going to increase. It is important that consumers become aware of this and start using water more efficiently.

Three tools that can make this happen are outreach efforts, financial incentives & regulatory tools.

- The main barriers to utilizing water treatment technologies in small water systems are:
    - Lack of Resources,
    - Lack of Awareness,
    - Lack of Will, and
    - Government Policy.

- In conclusion, for small water systems to operate efficiently, it is:
    - Important to have good leadership,
    - Not a good idea to cut costs at the expense of water quality,
    - Imperative to have a vision and a long-term water plan,
    - Very useful to build partnerships and collaborations with other water systems,
    - Necessary to understand all the options available for water treatment and make decisions accordingly,
    - Crucial to communicate progress of the water system to public officials to secure funding in the future, and
    - Essential to always comply with federal and state regulations.

INTRODUCTION

Small communities in Texas are served by thousands of small water systems that city-dwellers have never heard of. These water systems are scattered all over the State and help bring safe drinking water to rural Texas.

Water systems can be broadly classified into small systems and large systems. Small systems are those that serve populations below 10,000 and large systems serve populations over 10,000.

There are thousands of public water systems in the State of Texas. The U.S. Environmental Protection Agency (EPA) classifies water systems as public if they supply at least 15 service connections or at least 25 people for at least 60 days every year. Public water systems can be further classified as:

- Community water systems – that supply drinking water to the same population all year round.
- Non-transient non-community water systems – that supply drinking water to at least 25 of the same people for at least 6 months each year. For example, schools, factories, and hospitals.
- Transient non-community water systems – that supply drinking water to transitory populations in nonresidential areas. Examples are motels, gas stations, and campgrounds that have their own water supply.

This report focuses on small, community water systems in the State of Texas. According to 2002 data from the Texas Commission on Environmental Quality (TCEQ), there are 4,366 community water systems in the State of Texas, out of these, 4,114 are classified as small systems because they serve a population of less than 10,000. Table 1 shows a breakdown of water source for community water systems of various sizes.

Table 1: Water Source for Community Water Systems of Various Sizes in Texas

Population Served	Ground Water (%)	Surface Water (%)	Both (%)	Total (%)
Under 500	44.85%	4.01%	1.40%	47.45%
501-3000	28.22%	8.61%	3.37%	33.46%
3001-10,000	10.72%	5.11%	2.52%	13.31%
10,001 – 100,000	3.64%	3.83%	2.29%	5.18%
More than 100,000	0.41%	0.57%	0.39%	0.60%

Source: Texas Commission on Environmental Quality (TCEQ), Austin, TX

All water systems that provide drinking water have to meet the standards laid out by the Safe Drinking Water Act (SDWA). SDWA was first passed by Congress in 1974, the law was then amended in 1986 and 1996. The purpose of SDWA is to ensure public health by regulating the nation's public drinking water supply. The EPA sets standards for drinking water to ensure consistent quality in the water supplies across the nation.

Grants are provided by EPA to states to not only implement drinking water programs but also to set up a special fund that is used to assist state public water systems in financing costs of improvement. Special consideration is given to small water systems as such systems might have a difficult time paying for improvements due to a smaller customer base.

Table 2 shows the maximum contaminant levels for inorganic contaminants that are allowed by EPA as of January 22, 2001.

Table 2: Maximum contaminant levels (MCL) for inorganic contaminants

Contaminant	MCL (mg/l)
Fluoride	4.0
Asbestos	7 Million Fibers/liter (longer than 10 µm)
Barium	2
Cadmium	0.005
Chromium	0.1
Mercury	0.002
Nitrate	10 (as Nitrogen)
Nitrite	1 (as Nitrogen)
Total Nitrate and Nitrite	10 (as Nitrogen)
Selenium	0.05
Antimony	0.006
Beryllium	0.004
Cyanide (as free Cyanide)	0.2
Thallium	0.002
Arsenic	0.01

Source: EPA, January 22, 2001, Washington, DC

PURPOSE OF THIS REPORT

The purpose of this report is to highlight water treatment technologies available for small water systems and to profile existing small community systems that can serve as a guiding force for other rural systems.

This report is divided into two sections. The first section gives an overview of the various water treatment technologies that can be used by small water systems. It also addresses the barriers to utilizing these technologies and lessons learned by small water system operators.

Section 2 provides a two-page profile on 42 different small water systems spread across the State of Texas. This information was collected by faxing survey forms to small water system operators who were interested and willing to share detailed information about their system with others. This survey also provided input for information on the barriers to utilizing technologies and lessons learned by existing small water systems.

TECHNOLOGIES FOR SMALL WATER SYSTEMS

Both surface and ground water are sources for drinking water supplies. These sources are vulnerable to contamination, primarily via wastewater discharges and urban and agricultural runoff. Texas has an extensive amount of agricultural land and also a lot of industries; pesticides, defoliation and nutrient enhancement used on agricultural land affects the quality of surface water through runoff, and the chemicals can also leach into ground water sources. Industrial solvents, especially volatile organic chemicals (VOCs) that are highly soluble in water, can easily contaminate ground water. These contaminants introduce disease-causing organisms into the public water supply, which then has to be treated to remove these contaminants and provide clean drinking water to the public.

According to the Texas Water Development Board (TWDB), the population of Texas will double by 2050, increasing from 21 million (in 2000) to about 40 million. This will lead to an increase in water demand from 17 million acre-feet in 2000 to 20 million acre-feet in 2050 (an 18% increase). This growing increase in demand for clean and safe drinking water is a major challenge for all drinking water systems in the state. Higher population means more contaminants being released into the water supply sources, which in turn means more treatment needed for cleaning water from these sources.

Population alone is not a challenge for water systems; compliance with new standards is another major challenge, especially for small water systems. The Safe Water Drinking Act (SWDA) requires public water systems to monitor drinking water quality and provide safe drinking water to its clients. The State of Texas has set primary and secondary standards for drinking water. Primary standards are established to protect the health of consumers by setting maximum contaminant levels (MCLs) for chemical and microbiological quality. Secondary standards are set to prevent the water from being objectionable with regard to taste, color and odor. The Texas Commission on Environmental Quality (TCEQ) works closely with those public water suppliers with monitoring results showing excessive bacteria. Such efforts have helped in an increase in compliance rates from 82% in 1995 to 97% in 2002.

U.S. EPA recently announced that the MCL of 50 micrograms per liter (µg/L) for arsenic is being reduced to 10-µg/L, and all systems have to comply by January 2006. Also, revisions to SDWA will require water systems to meet new MCLs for radium, gross alpha, and uranium by December 2005 (TNRCC 2002). Treating water for radioactive material is not as big a challenge as disposing off the radioactive waste is. This puts an immense legal and financial burden on both utilities and the state.

There is no single process that can be used to solve each and every water quality problem. Which technology or technologies should be used by a water system depends on factors such as, contaminants in the water, source of water, and the size of the water system. Many times small water systems purchase water and distribute it because it is not practical for them to have a water treatment plant as it might be too expensive and/or too cumbersome to operate and maintain.

Several technologies used for water treatment are presented in the following pages along with information on recycling gray water.

DISINFECTION

Disinfection inactivates pathogens in drinking water. Even though it is not effective towards all pathogens it is one of the most cost-effective methods of treating drinking water against waterborne diseases. The most common procedures used for disinfection are chemical disinfection and irradiation with ultraviolet (UV) light.

Chemical disinfectants include chlorine, chloramines, chlorine dioxide, and ozone. Free chlorine is the most widely used chemical disinfectant with chloramine a close second. Chlorination technology applications are available in solid, gaseous and liquid forms for even the smallest water system. Gaseous chlorination used at many small water systems is not among the best disinfection options due to the hazardous nature of the material. Even though chloramines possess certain advantages over other disinfectants, e.g., long residual effect and low production of disinfection byproducts, they have not been widely used in disinfection at small public water systems (EPA 1997).

Chlorine dioxide is a good disinfectant for surface waters with odor and taste problems. An advantage of using chlorine dioxide is that the by-product of this disinfection process, chlorite, does not pose any significant adverse risk to human health. The use of chloramines and chlorine dioxide require careful monitoring and are more difficult to handle, hence their unpopularity with small water systems.

According to EPA, ozone is the most effective primary disinfectant for drinking water. Ozone reduces tastes and odors, and can help both small and large water systems in meeting increasingly strict regulations for contaminants. The cost of treating water with ozone is much higher as compared to chemical disinfectant treatments.

UV radiation has been found to be extremely effective against bacteria and viruses most likely to be found in ground water. Small amounts of UV radiation have a strong germicidal effect whereby micro-organisms such as viruses, bacteria, yeasts and fungi can be destroyed without using chemicals. UV technology is suitable for small water systems that treat ground water. Ease of installation, operation and maintenance make UV technology a viable option for small water systems. The biggest disadvantage of UV radiation use is that it cannot be accurately measured, hence its effectiveness cannot be determined. For this reason the use of UV radiation technology is not popular in the State of Texas.

Mixed oxidant disinfection is one of the emerging technologies in water treatment. It is also called “anodic disinfection” and it involves the electrolytic generation of mixed disinfectants. Oxidants, such as, ozone, chlorine dioxide, hypochlorite ion, hypochlorous acid, and elemental chlorine are generated by passing an electric current through a continuous-flow brine (salt) solution. This oxidant rich solution is then injected into the raw water for treatment.

Of all the disinfectants, free chlorine is the most popular among small water systems as it is easy to manage in comparison to the other disinfectants.

MEMBRANE FILTRATION

Membrane filtration technology is used for removing bacteria and other microorganisms, organic matter, and particulate materials from water. In this technology, membranes are used to filter water. Depending on the size of the pores in a membrane, filtration can be called microfiltration, ultrafiltration or nanofiltration with nanofiltration using the smallest pores. This technology involves driving water under pressure through a membrane where the impurties are retained and clean water passes through. Membranes can be made of various materials, such as, cellulose acetate, polypropylene, polyethylene, aromatic polyamides, polysulfone and other polymers.

Reverse osmosis is the finest form of filtration and is also known as hyperfiltration. This process allows the removal of particles as small as ions from a solution. Reverse osmosis is capable of rejecting inorganic ions, bacteria, salts, some organic compounds, sugars, proteins, dyes, and in some designs, microbiological contaminants. It is used to purify water and remove impurities in order to improve its color, taste and other properties. A semi-permeable (almost nonporous) membrane is used in this process, allowing water to pass through it, while rejecting the contaminants that remain. Most reverse osmosis technology uses a process known as crossflow to allow the membrane to continually clean itself.

Some of the things to keep in mind regarding membrane filtration are that filtration membranes require regular backwashing to prevent fouling of the membrane, and waste stream disposal is another significant problem.

The advantages of membrane filtration are: smaller area requirements, no need for chemical additives, few temperature effects, and continuous and automatic operation. In the membrane filtration processes it is important that the quality of the water source be good or it be pretreated. It is expected that as the complexity of conventional water treatment systems increases, membrane filtration will become more popular with small water systems.

ADSORPTION

The adsorption process involves accumulation of organic contaminants from the gaseous or liquid phase onto the surface of a solid substance; *in other words, it is the binding of molecules or particles to a solid surface*. Contaminants have a lower polarity than water, which results in them being less soluble in water. This also makes the contaminants more attracted to the non-polar solids. The less soluble the compound, the better it adsorbs onto the solid. This process of purification of water has been in use since biblical times and has become a useful tool for purification and separation.

Some of the commonly used adsorbent materials are activated carbon and synthetic resins, these are used widely in industrial applications and for purification of water and wastewater.

The most common solid used to remove contaminants is activated carbon. A base material such as bituminous coal is heated in the absence of air in order to carbonize it. It is then activated through oxidation. This process results in an extremely porous compound that has a high surface area per unit volume. Activated carbon has been used historically to remove taste and odor causing contaminants, however, recently it has become more popular to remove toxic or carcinogenic contaminants as well. It commonly comes in two forms, Particle Activated Carbon (PAC) and Granulated Activated Carbon (GAC).

Particle Activated Carbon (PAC): Individual grains of PAC are generally less than 50 micrometers in diameter, the small size allows for adsorption to occur rather quickly. However, in order for it to be effective it must touch all of the incoming water. Therefore it is usually added straight to the water line or mixing basin before the filtration process. Making sure that all the carbon particles are indeed filtered out is very important because even the slightest trace can result in the water turning gray. It could also cause any tests conducted on the water to show a higher concentration of contaminants than what really exist because there would be an abundance of these contaminants on the particles of carbon that weren't removed. The PAC method is fairly easy to implement in a small water system given that the plant has a process that includes mixing, precipitation and filtering.

Granulated Activated Carbon (GAC): Individual GAC particles range from .5 to 1.5 mm in diameter, these are packed into columns through which the water being treated flows. This allows for greater contact with the water than PAC, and therefore greater adsorption. The use of the column requires that large particles of matter be removed from the water beforehand, an alternative to this is using the GAC column as a filtration device as well. Another concern related to this process is that if exhausted columns are not regenerated/replaced promptly, the buildup of contaminants could seep into the treated water, rendering the treatment useless. GAC is also easy to employ in a small water system, however the need for new (as opposed to regenerated) activated carbon is necessary for drinking water and can raise the costs for such a system.

Competitive Adsorption: Another issue that applies to both PAC and GAC systems and the quality of drinking water is that of competitive adsorption. Competitive adsorption occurs when natural organic compounds compete with the contaminants for a place on the carbon. This problem can even escalate to the point that the natural compounds will displace the contaminants, therefore making the adsorption ineffective. In order to correct the effects of this phenomenon, steps must be taken to either remove the competing compound beforehand or ensure that there is enough carbon and that it is being switched out frequently.

CORROSION CONTROL

Lead and copper concentrations are high in waters that pass through lead or copper pipes and fittings. Corrosion control technologies are used to reduce such lead/copper concentrations and to prevent corrosion of the water distribution system. Most corrosion control techniques involve adding chemicals to modify the chemistry of the water so that a precipitate or stabilizing compound is formed on the surface of the pipe that comes in contact with water.

Some techniques for reducing the corrosion in a water system are, adjusting pH and alkalinity, softening the water with lime, making the water pass through a magnetic field, and changing the level of dissolved oxygen (this method is not commonly used to control corrosion). It is important to monitor any corrosion adjustment program so that dosage modification can be made as water characteristics change over time.

Corrosion can be controlled by using chemical feeders, by air stripping, or by using limestone contactors. Each of these techniques is discussed below.

Chemical feeders: This method involves feeding orthophosphates and polyphosphates into the water. Both aid in the reduction of concentrations of lead and iron at the tap. Orthophosphates, which are most effective at concentrations of 1 to 3 mg/liter as phosphate, are also useful for inhibiting the rate of iron corrosion. Polyphosphates, which degenerate to orthophosphates help in preventing iron corrosion which causes the water to turn red. Chemical feeders require careful monitoring because the slightest error in chemical feed, whether too much or too little, can result in diminished water quality. Though chemical feeders are readily available for use in small water systems, they are not the ideal method of corrosion control.

Air stripping: A second approach is useful on water that contains a high concentration of carbon dioxide (CO_2). It is ideally used on water with a low pH and high alkalinity. When the excess gas is removed by air stripping, the pH is raised and corrosivity is reduced. It is especially effective for controlling copper corrosion. Air stripping, however, could result in the oxidation of dissolved iron particles, therefore may be deemed unsuitable or may require an additional process to get rid of the precipitate. Also, if this method is not carefully monitored, it can result in excessive precipitated calcium carbonate in the pipe system. Though a reasonable system, for the points mentioned above, air stripping is not an ideal method of corrosion control in a small water system.

Limestone contactors: This process employs limestone contacts to achieve a higher pH level and alkalinity, thus reducing corrosivity. When corrosive water is passed over a limestone bed, it dissolves the calcium carbonate that is present in the limestone. This raises its pH and makes it less corrosive. The range of pH and alkalinity that can be achieved, however, depends on the water's original chemistry, therefore the quality of the water should be tested prior to using this method. Although limestone contacts do not require as much monitoring as the chemical feeders, they still need to be checked periodically to ensure that enough limestone remains on the contacts. Due to dissolving, the contacts need to be replaced from time to time. One of the major advantages of this approach is the fact that there is no chance of misdosing the chemicals because they are dispersed through dissolution, unlike the feeders, which may cease to function properly. Considering the fact that this method was conceived specifically for small water systems, it has been found to be extremely suitable for small water systems.

LIME SOFTENING

Calcium and magnesium in water cause hardness which in turn leads to scaling problems in water heaters. Hard water also causes soap to lather poorly. For these reasons many water utilities use the process of lime softening by which the pH of the water being treated is raised up to 10 or 11. Hence, removing calcium and magnesium to soften the water and make it more appealing to the consumer for domestic use.

Regulatory and process monitoring are necessary for this system. The plant operators must understand the chemistry behind lime softening because accuracy is key when dealing with raised pH levels. If there are any errors, it could result in the formation of limestone deposits on the filters.

Lime softening is used by many large water systems for treating surface waters. It may not be a viable technology for small water systems for surface water treatment due to the variable nature of surface water and the complex chemistry involved in the lime softening process. This technology can be used by small water systems for ground water treatment. Prefabricated equipment for lime softening is readily available for small water system use and has been employed successfully in the past. It is known to remove calcium, magnesium, manganese, radium, arsenic and oxidized iron.

ACTIVATED ALUMINA

Activated alumina is made by treating aluminum ore so that it becomes porous and highly adsorptive. Activated alumina helps in removing several water contaminants including fluoride, arsenic and selenium.

Activated alumina is used to remove negatively charged ions from water. The alumina's surface charge changes when exposed to different pH levels. At a pH of 9.5, it is not charged, anything above this level makes alumina negatively charged and anything below makes it positively charged.

Regeneration involves removal of the anions from the mineral's surface using a sodium hydroxide solution. Then, the alumina column must be returned to an acidic state. This is achieved by rinsing it in raw water and following that with an acid wash. In addition to this, the alumina dissolves over time, and eventually must be replaced.

Raw water quality is a major factor in the performance of this treatment. Therefore, it should be extensively examined prior to implementing this system. In addition, plant operators have to have full knowledge of the chemistry behind this technique in order to assure proper functioning. Further, proper disposal requirements make activated alumina a rather costly system. However, despite its cost and intricacy, activated alumina can be easily used in a small water system (NRC 1997).

ION EXCHANGE

Ion exchange is the process of removing charged inorganic contaminants from water using an ion exchange material. Ion exchange materials may consist of resins made from synthetic organic materials or from inorganic and natural polymeric materials. The surface of the resin contains charged functional groups. When the water being treated passes over the resin, electrostatic attraction causes the undesirable ions to exchange places with the ions that are present on the resin. There are two main types of ion exchange: anionic and cationic.

Anionic exchange removes contaminants such as nitrate, carbonate, dichromate, fluoride, selenate and selenite. These are replaced with either hydroxide or chloride ions, which are not harmful. When the anionic resin is fully saturated it can be regenerated using a sodium hydroxide or sodium chloride solution.

Cationic exchange is often used to soften the water. In addition to removing calcium and magnesium, it also removes ammonia ions, barium, radium, cadmium, lead and trivalent chromium. It is often the preferred method used for radionuclide removal. These elements are replaced with protons or sodium ions, in cases when sodium is considered an unfavorable addition, potassium ions are substituted instead.

Whether employing anionic or cationic exchange, the raw water quality must be taken into consideration. The water being treated cannot contain reduced solids, such as iron. When exposed to oxygen, these can precipitate and cause harm to the resin. The saturation of the resin must be monitored periodically in order to ensure proper functioning. Ion exchange waste is highly concentrated and has to be disposed of carefully.

Factors affecting the design of an ion exchange system include the presence of oil and grease, contaminant concentration, exchange capacity of the resin, suspended solids, metals, oxidant content, inorganic ions in ground water and the pH level of the water.

Ion exchange effectively removes more than 90 percent of barium, cadmium, chromium (III), silver, radium, nitrites, selenium, arsenic (V), chromium (VI), and nitrate. Ion exchange is available in point-of-entry or point-of-use devices as well as in full-scale operational plants and is readily adaptable to small water system use. It is usually the best choice for small systems that need to remove radionuclides (NDWC, 1997).

COAGULATION-FLOCCULATION

Colloids are very small-sized pollutants generally in the range of 0.000001 mm to 0.001 mm. They are usually negatively charged and thus repel each other. They are also very stable. The technologies used for removing colloids is called coagulation-flocculation. Coagulation destabilizes colloids by neutralizing the forces/charges that keep them apart. Once neutralized, particles no longer repel each other and can be brought together. Flocculation is the agglomeration of smaller coagulated particles to form a larger floc leading to better separation from aqueous medium. This is achieved by addition of a flocculant that bridges particles to form a larger floc. In short, coagulation-flocculation mechanisms are used to make larger particles out of smaller particles which allows easier removal by sedimentation and easier removal by filtration.

Most widely used coagulants are aluminum and iron salts. Aluminum salts are cheaper than iron salts but iron salts work over a larger range of pH as compared to aluminum salts. Iron salts also have better floc qualities as compared to aluminum salts. Lime and synthetic polymers are also used as coagulants.

It is important to monitor turbidity and pH measurement in any coagulation-flocculation treatment plant. It is also important to have uniform water flow rates otherwise trapped floc can pass through the filters into the treated water. Small water systems usually have start-stop operations which are not conducive to coagulation-flocculation treatment. This technology is available as packaged plants, this has encouraged small water systems to use it under suitable conditions.

OXIDATION/FILTRATION

Iron and manganese are common in groundwater supplies used by many small water systems. Exceeding the suggested maximum contaminant levels (MCL) usually results in discolored water, laundry and plumbing fixtures. This, in turn, results in consumer complaints and a general dissatisfaction with the water utility. There are secondary standards set for iron and manganese, but these are not health related and are not enforceable. The secondary (aesthetic) MCLs for iron and manganese are 0.3 milligrams per liter (mg/l) and 0.05 mg/l, respectively.

Small amounts of iron are often found in water because of the large amount of iron present in the soil and because corrosive water will pick up iron from pipes. Clothing washed in water containing excessive iron may become stained a brownish color. The taste of beverages, such as tea and coffee, may also be affected by iron. Manganese produces a brownish color in laundered clothing, leaves black particles on fixtures and as with iron, affects the taste of beverages, including coffee and tea. Well water from the faucet or tap is usually clear and colorless. However, when water containing colorless, dissolved iron is allowed to stand in a cooking container or comes in contact with a sink or bathtub, the iron combines with oxygen from the air to form reddish-brown particles (commonly called rust). Manganese forms brownish-black particles. These impurities can give a metallic taste to water or to food. The rusty or brown stains on plumbing fixtures, fabrics, dishes and utensils cannot be removed by soaps or detergents. Bleaches and alkaline builders (often sodium phosphate) can make the stains worse. Over time, iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the quantity and pressure of the water supply. Iron and/or manganese in water create problems common to many water supply systems. When both are present beyond recommended levels, special attention should be paid to the problem (NDWC 1998).

The most prevalent technology for removing iron and manganese from ground water sources is oxidation/filtration. The process involves oxidizing the iron and/or manganese to be removed, this causes a precipitate to be formed. The precipitated material is then filtered. For instance, to remove iron the oxidation causes the dissolved iron to turn to rust and make the water cloudy red. Once the iron has rusted, it is a particle that can be mechanically filtered. Some of the popular oxidants are chlorine, ozone and potassium permanganate. Chlorine is both a disinfecting agent and an oxidizing agent.

Oxidation/filtration technology does not require extensive monitoring and is inexpensive. Hence, it serves well for small water systems.

AERATION

Aeration mixes air with water to volatilize contaminants (turn them to vapor). The volatilized contaminants are either released directly to the atmosphere or treated and released. Aeration is used to remove volatile organic chemicals and can also remove radon.

Some of the common types of aeration are: packed column aeration, diffused aeration, multiple tray aeration and mechanical aeration. Each of these techniques is discussed below.

Packed column aeration (PCA) or packed tower aeration (PTA) is a waterfall aeration process that drops water over a medium within a tower to mix the water with air. The medium is designed to break the water into tiny droplets and to maximize its contact with tiny air bubbles for removal of the contaminant. Air is also blown in from underneath the medium to enhance this process. Systems using PCA may need pretreatment to remove iron, solids and biological growth to prevent clogging of the packing material. Post treatment, such as the use of a corrosion inhibitor, may also be needed to reduce corrosive properties in water due to increased dissolved oxygen from the aeration process.

In a diffused aeration system, a diffuser bubbles air through a contact chamber for aeration. The diffuser is usually located near the bottom of the chamber. The air introduced through the diffuser, usually under pressure, produces fine bubbles that create water-air mixing turbulence as they rise through the chamber. The main advantage of diffused aeration systems is that they can be created from existing structures, such as storage tanks.

Multiple tray aeration directs water through a series of trays made of slats, perforations or wire mesh. A blower introduces air from underneath the trays. Multiple tray aeration units have less surface area than PCA units. This type of aeration is not as effective as PCA and can experience clogging from iron and manganese, biological growth, and corrosion problems. Multiple tray aeration units are readily available from packaged plant manufacturers.

Mechanical aeration uses mechanical stirring mechanisms to mix air with the water. These systems can effectively remove volatile organic chemicals (VOCs). Mechanical aeration units need large amounts of space because they demand long detention times for effective treatment. As a result, they often require open-air designs, which can freeze in cold climates. These units also can have high energy requirements. However, mechanical aeration systems are easy to operate and are less susceptible to clogging from biological growth than PCA systems. Aeration systems can be installed for a fairly small cost and are suitable for small water systems.

RECYCLING GRAY WATER

Gray water is untreated wastewater from bathtubs, showers, lavatory fixtures, wash basins, washing machines and laundry tubs. It does not include wastewater from toilets, urinals, kitchen sinks, dishwashers or laundry water from soiled diapers. Wastewater from municipal, industrial, agricultural or a combination of all these can be recycled and put to good use. Examples of water reuse include municipal reclaimed water for golf course irrigation and treated industrial wastewater for manufacturing and cooling purposes. In agriculture, reuse could include the collection of surface runoff in ponds for supplemental irrigation or livestock watering (TWDB 2002).

Several small water systems in Texas treat gray water and use it for different purposes. The City of Marfa has been treating gray water for over 60 years and they use it to irrigate land for cattle grazing. The treatment system uses Imhoff tanks in which water flows through baffles and gets oxygenated. This treated water works well for irrigating grass for cattle but the treatment is not good enough for golf courses as the chemicals in the water can burn the greens.

Another city that has been using gray water for irrigation is the City of Childress. They use gray water to irrigate their cotton crops. Not much treatment is required for this water because TCEQ allows irrigation of non-edible crops with gray water that has undergone minimal treatment. Currently, the wastewater is processed through a facultative lagoon system. In this system, water is pumped into a lagoon where the sediments settle down and then the water is sent to a holding pond from where it is used for irrigation. The city is also looking into using gray water for a municipal golf course. In this case the water will have to be filtered, chlorinated and aerated to make it suitable for watering the golf course.

With growth in population and industry the need for water is going to increase. It is important that consumers become aware of this and start using water more efficiently. According to Gerston, et. al., three tools that can make this happen are:

- Outreach and educational effort: This can be achieved by informing the consumers about water reuse via utility bill stuffers, media outlets, public events and speaking engagements.
- Financial incentives: These can be used to reward efficient water users with rebates or send a warning in the form of a price signal to water-wasters.
- Regulatory tools: These include plumbing fixture rules and landscaping ordinances, which may be an appropriate way of producing water savings.

BARRIERS TO UTILIZING TECHNOLOGIES FOR SMALL WATER SYSTEMS

Under ideal conditions, small and rural water systems throughout the state would operate with the utmost efficiency and efficacy. They would, like their larger counterparts, have the best technology at their disposal, providing their customers with a steady supply of quality water. But in Texas (as in any other state) what is real is never quite close to the ideal.

Several barriers exist that can delay or prevent the implementation and operation of a water system. Small and rural water supply managers live in and work with a variety of conditions that can complicate the normal functioning of their systems. Some of these include preexisting environmental conditions, expensive technologies for water treatment and lack of funds. These conditions can be mitigated by larger systems, since their size may better equip them, but small and rural water systems face a unique set of barriers towards their efficient implementation and operation.

A survey of small water systems was conducted to collect information on the various aspects of the system, barriers to implementing technology, and lessons learned by small water system operators/managers. From the survey responses and a cursory overview of water-related literature, it is readily discernible that cognitive and systemic barriers to the implementation of effective infrastructure in small and rural water systems exist. These barriers can be categorized into the following areas:

- ***lack of resources***
- ***lack of awareness***
- ***lack of will***
- ***government policy***

Most survey respondents mentioned by and large one thing: money. Indeed, *lack of resources* is the major barrier facing small water systems. This situation is due primarily to the structure and historical nature of the water industry, as well as the economies of scale inherent in their operation. First, the structure of the water industry poses an eternally vexing challenge to system operators because the industry is essentially one of perennial rising costs. On the one hand, water systems are not providing the same product that they provided twenty or even ten years ago, water quality has by and large improved dramatically. Regulations such as the Federal Safe Water Drinking Act and a concerted effort by federal, state and local agencies have made this possible. On the other hand, along with this improvement in water quality are increases in costs associated with tighter regulations, more personnel for facility operation and maintenance, more training and capacity development to properly operate modern water systems, and the ever-important need for routine infrastructure improvements.

Historically, the water industry has been viewed as being under priced, meaning the cost of providing service has been greater than the revenue generated from the sale of the service itself. The challenge water systems face is providing affordable drinking water services, but not under-pricing the rates for that service. Rates for drinking water must be a function of the cost of providing that service and the customer's ability to pay. Finding a desirable medium between these two factors is a very difficult challenge that small water systems continue to face, a challenge that continually threatens their operation, ability to generate revenue, and attractiveness for external financing.

Economies of scale pose a surmountable challenge for small water systems. Unlike larger water utilities, smaller systems lack a sizable customer base. Many of the systems surveyed serviced small mobile home parks or subdivisions with less than a hundred connections. Due to the lack of a large base of customers, small water systems are not able to generate enough revenue to pay additional technical staff, make infrastructure improvements, pay debts, or even meet all water standards. Indeed, one survey respondent stated that the water system he operated had been in the red for the past ten years. Among the small water system landscape, it is rare to find a system operator that can conduct independent laboratory verification of water technologies, let alone divert resources away for other such research. According to the Drinking Infrastructure Water Needs Survey conducted by EPA in 1997, small water systems are less likely to be able to access outside capital to finance facility improvements because they lack the cash flow, contrary to their larger counterparts.

Another major set of barriers that water systems face is a *lack of awareness* among system operators of the problems facing them and the tools at their theoretical disposal. Many small and rural water system operators lack the necessary expertise and knowledge regarding water infrastructure. Small water system operators may also, and to varying degrees be unaware of the severity of environmental, regulatory and infrastructure problems facing their systems.

The cause of these varies: many survey respondents stated that they took over or bought the water system "as is," and have out of necessity continued operations without major changes to the system. Many system managers expressed that they wore different hats in the community, and found their time constrained by other activities. Other system operators claimed self-ignorance regarding the exact mechanics behind system operations, again alluding to a predetermined set of operating procedures they followed.

Most small and rural water systems, it should be noted, are run not only with tight resources and budgets, but also in areas of modest economic growth or potential. Given historical trends in rural Texas, the availability of information may be scarce or nonexistent for small water system operators to peruse concerning newer methodologies or assistance mechanisms available from federal and state agencies (such as revolving loan funds or development grants). The applicability of such programs or technologies is then contingent on them being aware of these, which in many cases they are not.

The above situation highlights an observed phenomenon: water system managers are not readily accessing existing tools at their disposal being provided by outside sources. That is, small and rural water system operators – from the principal manager to the governing boards – in many instances are lacking the necessary training to adequately prepare for and handle water issues or crises that may arise. This cannot be under-emphasized: training at all levels of water system management, including governing and oversight bodies, is essential for capacity development since it empowers all stakeholders and reinforces the communality of their work. Water board members may lack the proper capacity training because, as was pointed out, serving on the boards is not a full-time responsibility; in most small and rural towns, water officials wear many different hats. This lack of capacity development, in this respect, can have a stagnating effect; in many cases, water officials are not prepared to "think outside of the box," when it comes to choosing new (risky) technologies or sticking with the established norm. Again, training and capacity development programs do exist – federal, state and other entities offer development training programs and seminars – but they are not being accessed to the extent that they should.

Thirdly, culled from informal conversations with survey respondents and EPA officials is a perceived *lack of will* among some small water systems. By this term, it is understood that water system operators face very human challenges, within and out, concerning the current capacity and future potential of their water systems. Perhaps a better way to summarize this is, "people are afraid of change." Survey respondents mentioned time and time again that they were sticking to what works out of inertia primarily. That is, past precedent dictates current policy, be it system security measures or the application of new technologies. In interviewing survey respondents, some pointed out that they were aware of newer and more efficient technologies, for example, but had no interest in reviewing or implementing them because this implied costs or they were satisfied with their current setup. One survey respondent claimed that system operators in the area clung to older and less efficient technologies and changed these or their practices only when prodded, usually by changing regulations or deadlines in meeting these. Rather than explore longer-term cost-cutting mechanisms or implement fairly easy changes in water sanitation technologies, these system operators preferred "what works already," even if what works is not always what is best. Even with the example of a better technology in place, that produced better-tasting water for instance, surrounding water systems did not contemplate reviewing a change in system technologies.

Another corollary to this is the fact that many water systems are led not only by a system operator but by a board or overseeing entity, where politico-administrative concerns are necessarily a factor. Whereas a system operator may be considered forward-thinking and willing to try new procedures or technologies, he must still deal with a board that may not see eye-to-eye with him. In many instances, as several system operators expressed, their role in their respective communities tends to have political overtones. Approval of implementing a new technology, for example, may then depend on a whole slew of factors that are in no way related to the efficiency and efficacy of the water system.

Lastly, one cannot disregard the influence that *government policy* has on the functioning of small water systems. One survey respondent referred to government water policy as a tangled web of responsibility. Responsibility for making and implementing environmental policies and programs – of which water policy is part and parcel of – is currently divided among several actors. The institutions affecting the drinking water industry include decision-making bodies, public policy boards, and administrative practices at the federal, state, and local levels of government; their regulations can be complex both in substance and in form, which further compounds the problem. Their actions (or inactions) can hinder small water systems from further developing their capacity, remaining sustainable, and continually improving their service as water demand increases.

From the perspective of many small and rural water systems, there is little or no coordination between the three levels of government. Nor is there adequate coordination between government and the private sector. This tangled situation is not just a one-sided street; there is also little known about what works and more importantly, what does not work for small and rural water systems, since data on small systems is sparse and is collected infrequently (as compared with data collection on larger, metropolitan areas). Those government agencies that set water policy then do not have sufficient data to formulate clearer guidelines for smaller systems, whose operating conditions are decidedly different from their larger counterparts.

While government policy regarding drinking water must be followed, the intent of the law may at times get lost under regulations and guidelines that burden some small water systems. Stringent drinking water mandates that call for dramatic decreases in water contaminants can adversely affect small and rural water systems that lack capital resources or are unable to access financing options. Some situations arise where water boards must heed guidelines and regulations of numerous and oftentimes conflicting local entities whose jurisdiction covers the water system. Furthermore, it is no surprise that small water systems feel pressure from drinking water primacy agencies, rate setting bodies, and other resource agencies, such as permitting and financing authorities. Consequently, policymakers should keep in mind that government water policies may inadvertently affect the operation of small water systems in a negative manner. It may become increasingly important to reduce institutional burdens brought about by government policy on small water systems, without sacrificing essential regulatory oversight and public-health protection. Improved institutional efficiency will benefit both governmental agencies and water systems.

Ensuring that a water system has the proper managerial, technical and financial capacity to operate and provide quality service is central to the success of the water system. Each component complements the next to form a well-rounded system, but ensuring that these components are firmly in place is closer to the ideal than the real. This is unfortunately so given that the cognitive and systemic barriers mentioned above persist across the small water system landscape, and they will continue to hinder the smooth interconnectedness among these components. Water costs will rise. Pipes will routinely need maintenance. System operators will need training and be aware of new methods and technologies available.

This problematic dynamic has no easy answer. According to the USDA report *Understanding Rural America*, the diversity of small and rural communities makes understanding and assessing their needs no easy task. "There is no single recipe" or "one size fits all" policy or process that works in addressing the challenges faced by small rural communities, and by extension, the small rural water systems that service them. However, being aware of what barriers exist is a positive step toward addressing what can be done to alleviate them.

LESSONS LEARNED

In our water survey, respondents were given the opportunity to state any lessons learned in the implementation and operation of their water system, as well as additional comments that may aid other water system managers/operators. Several valuable lessons can be gleaned from their responses as well as from informal follow-up interviews.

First of all, it is clear that for a water system to be efficient or operate with the least amount of barriers, it must have a good leader. Leadership is a critical factor. Water systems can be large or small, urban or rural, falling apart or brimming with new technologies – but what makes them ultimately work is the leadership at the helm. Essentially, leaders are individuals or groups who care about the water system, the community it serves, and their future.

Regarding any common set of characteristics of successful leaders, they tend to reflect the values of the community and to know what works there. Good leaders are committed to their communities. They are generally good communicators, have the ability to bring about change and set things in motion, and are committed to making their (or a group's) vision a reality. They also tend to know how to engage, respect, and empower others and are able to find new or leverage existing resources. Some of the best leaders we observed are not afraid of change or taking risks with new technologies or methods of operating their systems.

(Because leadership is so important, many seek to encourage and nurture it. Federal and state agencies, as well as several nonprofit groups, offer capacity training and development programs.)

Cutting costs is the hallmark of a good water system manager. However, it is also very important to keep in mind the overall efficiency of the water system when reducing fixed costs. One survey respondent offered that cutting costs can lead to broken down equipment and undependable employees. While this is not the norm, it does highlight the need to be pragmatic regarding cost reductions, as the line between cutting costs and cutting quality is very thin.

A number of respondents stated that for a water system to work for the community, it is essential for the system to have a plan (and by extension, for the plan to be implemented). Plans are needed in the water industry because, as a nonrenewable resource, we cannot tap into lakes, rivers or wells indefinitely and indiscriminately: the water will run out. Though many water systems are established organizations in their communities, starting a new water system can be "an expensive endeavor," in the words of one survey respondent – one that requires much planning and foresight.

Typical components of a plan include: vision, goals, action items, and time frame. Time frames for plans typically range from 5 to 20 years. Plans are essential in that they represent a consensus view of the water system's role in the community. The greatest challenge associated with planning the growth and development of a water system is to ensure that the recommendations called for within a plan are implemented and that the plan does not sit on a shelf gathering dust in some office.

It is also important to allow for reasonable flexibility to take into account changes in technology, approaches, guidelines or regulations, or in the environment. The best plans allow for the incorporation of new information, reflect the needs of the water system, and have the commitment of the community behind them.

Another important lesson mentioned by survey respondents centered around the idea of "sustainability." While definitions differ, it generally means viewing economic, environmental, and social values as complementary and interdependent and working to sustain all three over time. Too often in the past, environmental and economic and social issues have polarized people, making it impossible to achieve a common vision of sustainability. Instead, there must be widespread recognition in the community that people and nature can coexist, through the use of innovative technologies, for example, that minimize what we take out from the environment. This can pave the way for partnerships of diverse interests to form around a sustainable vision.

Given the lack of economies of scale in the operation of small and rural water systems, many survey respondents sang the praises of partnerships and collaborative exchanges with other water systems as a means of offsetting financial constraints. Essential ingredients for effective partnerships include: focusing on common interests, respecting each participant's points of view and specific backgrounds, being able to learn about others' needs and positions, and above all building trust. The important thing is to pull together a partnership that is of manageable size, creates synergy, and represents the key interests of the water systems. One specific survey respondent mentioned that as part of a water authority entity, his water system was able to implement a water treatment technology based on the results of tests of different technologies that the water authority undertook. Another stated that by pulling together resources, several water systems in his community were able to leverage more funds to build a water treatment plant that services their area. Such programs would otherwise not have been available to small water systems that lack the pull or resources individually.

Along this thread, some survey respondents stated that good tools are essential to the success of their water system. Tools are broadly defined to include informative "how to" guides, funding sources and computer monitoring and modeling programs (such as SCADA-supervisory control and automatic data acquisition). The sources of funds and technical assistance vary widely, from corporate, government, to nonprofit organizations. Moreover, given the wide array of treatment technologies available to water systems, one survey respondent offered the following advice, "[S]tart with a good system. Buy the best stuff and you'll have little trouble down the way." Still another respondent stated that a water system should use the best materials, although these may prove costly initially, they pay for themselves in the long-run and with less down-time. Financial constraints notwithstanding, numerous good tools are available for small water systems to choose from.

Knowing how to use these tools is another key lesson learned by our survey respondents. In essence, water system personnel should know the mechanics of their system very well, from the collection of water, its treatment and distribution. For example, one survey respondent stated that if too much liquid chlorine is used to disinfect water, it is possible that the plastic water lines will deteriorate. A fellow survey respondent mentioned that preventive maintenance of all equipment is important and can cut down costs. Another stated that those using reverse osmosis technologies should have a firm understanding; otherwise, they risk wasting money and not maximizing efficiencies. Still another stated that when installing or repairing water mains, it is helpful to have pictures of what is inside the ground so that any accidents or mistakes can be avoided. Though these examples are quite specific in scope, they clearly show that system operators must be keenly aware of how their water systems work.

In addition, to secure funds for capital improvement programs for example, water systems would benefit from having systems in place to measure and communicate progress. Appropriate measures not only keep water issues front and center; as they are met they also allow water system operators to share successes and highlight new challenges that may require additional sources of funding to mete out these challenges.

Progress can be measured in many ways and communicated through meetings, brochures, internet sites, annual reports, news releases, etc. The important thing is to make sure that the appropriate measures of progress (often referred to as indicators) are selected, and that information on these indicators is shared with the relevant stakeholders. Measurements of progress should be associated with achieving goals set for the water system in terms of quality, efficiency and efficacy.

In terms of groups to whom progress should be communicated, elected local and state officials and clients serviced by the water system are at the top of the list. In addition, small water system managers can use the information collected to leverage more funds that may be needed.

Several water system managers also mentioned time and again that a water system needs to be in (or on the road to) compliance with federal and state regulations. In Texas, small water systems must heed the federal Safe Water Drinking Act as well as regulations by the U.S. EPA, and the Texas Commission on Environmental Quality (TCEQ). Noncompliance can result in negative outcomes, the worst being shut down and not being able to service their community.

Lastly, many survey respondents tended to have a quite optimistic philosophy: any success, however small, fuels future, larger ones. It is important, according to small water system managers, to start small and demonstrate success before working on a larger scale. Success can come in many forms, such as reducing costs as a result of new disinfection technologies to using different pipes that require less maintenance. For this reason, demonstration projects are often a popular choice to showcase what works and the best way to implement it.

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PROFILES OF SOME SMALL WATER SYSTEMS IN THE STATE OF TEXAS

For this section of the report a survey was designed to get input from small community water systems in the State of Texas. A database of small water systems was obtained from TCEQ and the system operators/managers were contacted to see their willingness in participating in the survey. Those interested in participating and sharing information about their water system were faxed a copy of the survey. Questions relating to water source, storage capacity, delivery mechanism, safety issues, lessons learned and water treatment technologies were included in the survey. The following pages present a two-page profile of all the small community water systems that willingly filled out the survey form and sent it back to be included in this report.

3-G.W.C. Inc., Water System

Location Comal County

Contact Person G.K. Groves

Address 3030 FM 306
New Braunfels, TX 78132

Phone (830) 629-4273

E-mail -

Service Area Rural Subdivision in New Braunfels

Population Served 200-250

Water Connections Served

Type of Connection		#
Residential	Yes	86
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	Edwards Aquifer
Other	No	

Water Quality Excellent

Annual Operating Cost -

Number of Wells
2

Age of Wells
24 yrs.& 8 yrs.

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

Valves and pumps

Delivery Mechanism Pipe

Barriers to Implementation None

3-G.W.C. Inc., Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1983
	People Served	200 +	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection at the 3-G.W.C. Inc., Water System

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 6"

Material Used PVC

Quantity of Water Reserves	Unlimited Aquifer
Storage Capacity	30,000 gallons
Safety Measures in Place	Locks on gates and doors and the owner lives on site.
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Always start out with a good system. Buy the best stuff and you'll have little trouble down the way.

Additional Comments

Bartonville Water Supply Corporation

Location	Denton County	
Contact Person	Tony Mauldin	
Address	1911 E. Jeter Rd. Bartonville, TX 76226	***E-mail***
Phone	(817) 430-3541	-
Service Area	Serving 20 sq. miles	
Population Served	6,000	

Water Connections Served

Type of Connection		#
Residential	Yes	1,900
Commercial	Yes	25
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 250 gallons

Primary Water Source

Surface	Yes	
Ground	Yes	
Other	No	

Number of Wells
10
Age of Wells
10yrs. to 35 yrs.

Water Quality Excellent

Annual Operating Cost $1,800,000 (includes purchase)

Project is:	
Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $100,000

Project Aspects Requiring Maintenance

Pumps, motors, tanks, pipeline and grounds

Delivery Mechanism Booster pumps and elevated storage

Barriers to Implementation Opposition to the construction of elevated storage tank.

Bartonville Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1968
	People Served	6,000	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 24"

Material Used PVC, ductile iron, asbestos, cement

Quantity of Water Reserves	Enough to double current connections
Storage Capacity	Currently 4.1 million gallons
Safety Measures in Place	24/7 monitoring, remote operation SCADA
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 7

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Starting a new water system is an expensive endeavor and it needs planning and foresight.

Additional Comments
Taking care of business. Have established emergency interconnections with neighbouring public water system. Diesel generator capabilites for power.
We have received superior rating by TCEQ.

Bethel - Ash Water Supply Corporation

Location Henderson County

Contact Person Joe Allison

Address 801 N. Palestine
Athens, TX 75751

Phone (903) 675-8466

E-mail -

Service Area Bethal - Ash WSC

Population Served 100

Water Connections Served

Type of Connection		#
Residential	Yes	33
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 174 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1

Age of Wells
Currently being drilled

Water Quality Excellent

Annual Operating Cost $322,000 (start-up cost)

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $2,500

Project Aspects Requiring Maintenance

Reading meters and repairing leaks

Delivery Mechanism Pipe

Barriers to Implementation None

Bethel - Ash Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1980
	People Served	100	***Efficiency of System***	Effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used in 5 wella and Chlorine gas is used in 2 wells for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	440,000 gallons
Safety Measures in Place	Fence around wells and locks on the wells and gates.
Fire Fighting Capability	Yes
Fire Codes Being Met	No

Pump Stations Yes ***Number of Pumps*** 7

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Capital is always a problem, hence planning should be done with this in mind.

Additional Comments
Bethel-Ash WSC is a non-profit member-owned rural water company.

Borden County Water System

Location	Borden County
Contact Person	Van L. York
Address	P.O. Box 156 Gail, TX 79738
Phone	(806) 756-4391
E-mail	-
Service Area	Gail
Population Served	175

Water Connections Served

Type of Connection		#
Residential	Yes	90
Commercial	Yes	5
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 2

Age of Wells 20 yrs.

Water Quality Excellent

Annual Operating Cost $70,000

Project is:	
Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $25,000

Project Aspects Requiring Maintenance

Pumps, lines and meters

Delivery Mechanism Gravity

Barriers to Implementation Money and State regulations

Borden County Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1976
	People Served	175	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system

Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 6"

Material Used PVC, Concrete

Quantity of Water Reserves	-
Storage Capacity	150,000 gallons
Safety Measures in Place	
Fire Fighting Capability	Yes
Fire Codes Being Met	No

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant	No
Long-term Water Plan in Place	No

Lessons Learned

Additional Comments

Brice Lesley Water Supply Corporation

Location	Hall County	
Contact Person	Ann Byars	
Address	P.O. Box 60 Lakeview, TX 79239	***E-mail***
Phone	(806) 867-2111	-
Service Area	Rural Area	
Population Served	100	

Water Connections Served

Type of Connection		#
Residential	Yes	44
Commercial	No	0
Other (Specify)	Yes	45
Cattle		

Daily Average Water Consumption Per Capita Unknown

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
2
Age of Wells
37yrs., 6 yrs.

Water Quality Good

Annual Operating Cost $55,000

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $15,000

Project Aspects Requiring Maintenance

Mostly lines

Delivery Mechanism Pump, tower and transmission lines

Barriers to Implementation -

Brice Lesley Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1967
	People Served	100	***Efficiency of System***	Neutral
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system

Chlorine gas is used for disinfection at the Brice Lesley Water System Corporation.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter Varies

Material Used PVC

Quantity of Water Reserves	Unknown
Storage Capacity	75,000 gallons
Safety Measures in Place	Normal procedures - fences and locks
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place Yes

Lessons Learned

Additional Comments

We have 180 miles of line that is in need of repair and not enough customers to pay for it. We are trying to get a grant.

Central Bowie County Water Supply Corporation

Location Bowie County

Contact Person Hal Harris

Address P.O. Box 306
New Boston, TX 75570

Phone (903) 628-5601

E-mail cbcwsc@aol.com

Service Area Central and western Bowie county

Population Served 7,000

Water Connections Served

Type of Connection		#
Residential	Yes	2,240
Commercial	Yes	30
Other (Specify)	Yes	10

Schools, Government Offices

Daily Average Water Consumption Per Capita -

Primary Water Source		
Surface	Yes	Lakes Wright Pattman and Millwood
Ground	No	
Other	No	

Number of Wells -

Age of Wells -

Water Quality Excellent

Annual Operating Cost $9,50,000

Project is:	
Labor Intensive	No
Capital Intensive	No

Operator Skill	
Basic	Yes
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $25,000

Project Aspects Requiring Maintenance

Distribution lines, valves and equipment

Delivery Mechanism Elevated tanks and centrifugal pumps

Barriers to Implementation None

Central Bowie County Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1972
	People Served	7,000	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used PVC

Quantity of Water Reserves	None
Storage Capacity	9,861,000 gallons
Safety Measures in Place	Fence and locks on doors and gates
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 4

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments

Coleman County Water Supply

Location	Coleman County
Contact Person	Davey Thweatt
Address	214 Santa Anna Ave. Coleman, TX 76834
E-mail	-
Phone	(915) 625-2133
Service Area	Coleman County and parts of Taylor, Runnels, Callahan & Brown counties
Population Served	5,300

Water Connections Served

Type of Connection		#
Residential	Yes	2,100
Commercial	Yes	40
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 125 gallons

Primary Water Source

Surface	Yes	Lake Coleman
Ground	No	
Other	No	

Number of Wells
-
Age of Wells
-

Water Quality Excellent

Annual Operating Cost $800,000

Project is:	
Labor Intensive	No
Capital Intensive	Yes

Operator Skill	
Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $50,000

Project Aspects Requiring Maintenance

Pump stations and water lines

Delivery Mechanism Pumping through 800 miles of distribution lines

Barriers to Implementation -

Coleman County Water Supply

Technologies implemented at the Water System

1) Technology	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-
2) Technology	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-

Details about technology used in this water system

SCADA system which monitors 27 different locations at the central office
No water treatment is done on site. The water is purchased.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1" to 10"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	825,000 gallons
Safety Measures in Place	All pump stations are fenced and locked
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 15

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned

The SCADA system we installed in 1995 has improved the operation of leak system. I would recommend all water systems to use it.

Additional Comments

We purchase treated water from the City of Coleman.

Community Water Well and Pipeline Project, Yancey WSC

Location	Medina County
Contact Person	Scott 'Skip' Traeger
Address	P.O. Box 127 Yancey, TX 78886
E-mail	-
Phone	(830) 741-5264
Service Area	TCEQ CCN # 163-0021
Population Served	1,200

Water Connections Served

Type of Connection		#
Residential	Yes	192
Commercial	No	0
Other (Specify)	Yes	90

90 Live Stock, Hunting, Recreational

Daily Average Water Consumption Per Capita 110 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
2
Age of Wells
25yrs., 10 yrs.

Water Quality Excellent

Annual Operating Cost $500,000

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

Delivery Mechanism Waterwell, elevated storage and PVC pipes

Barriers to Implementation Cost to maintain non-profit corporation is steep

Community Water Well and Pipeline Project, Yancey WSC

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1978
	People Served	1,200	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 4" to 8"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	700,000 gallons
Safety Measures in Place	Meet State and Federal requirments
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 8

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Be careful with the use of Chlorine as it is a dangerous chemical.
Watch out for the critters.

Additional Comments

Craft - Turney Water Supply Corporation

Location	Cherokee County	
Contact Person	Loretta Sorenson	
Address	P.O. Box 1616 Jacksonville, TX 75766	***E-mail***
Phone	(903) 586-9301	craft-turney@cox-internet.com
Service Area	Jacksonville	
Population Served	4,608	

Water Connections Served

Type of Connection		#
Residential	Yes	1,533
Commercial	Yes	3
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 161 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	Yes	Purchase from city

Water Quality Good

Annual Operating Cost -

Number of Wells
2
Age of Wells
2 yrs.

Project is:	
Labor Intensive	Yes
Capital Intensive	-

Operator Skill

Basic	No
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

System

Delivery Mechanism Pipe

Barriers to Implementation -

Craft - Turney Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1965
	People Served	4,626	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1" to 10"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	690,300 gallons
Safety Measures in Place	Fence is locked up
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 4

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Cost to maintain a non-profit organization is very high.

Additional Comments
It is important to be in compliance with TCEQ & TRWA.

Crawleys Water System

Location	Chambers County
Contact Person	Walter Gray
Address	1904 Wright Blvd. Baytown, TX 77520
Phone	(281) 427-5788
E-mail	-
Service Area	11 rental houses
Population Served	24

Water Connections Served

Type of Connection		#
Residential	Yes	16
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 65 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1
Age of Wells
25 yrs.

Water Quality Good

Annual Operating Cost $2,000

Project is:	
Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $2,000

Project Aspects Requiring Maintenance

None

Delivery Mechanism Water well pump

Barriers to Implementation None

Crawleys Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	-
	People Served	24	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2"

Material Used PVC

Quantity of Water Reserves None

Storage Capacity -

Safety Measures in Place Locks on well yard

Fire Fighting Capability No
Fire Codes Being Met -

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments

Dixonville Subdivison Water System

Location	Austin County	
Contact Person	Billy Dixon	
Address	624 North Dixon Wallis, TX 77485	***E-mail***
Phone	(979) 478-7200	-
Service Area	Rural Near Wallis	
Population Served	45+	

Water Connections Served

Type of Connection		#
Residential	Yes	15
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 184 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
2
Age of Wells
24 yrs., 21 yrs

Water Quality Excellent

Annual Operating Cost $850

Project is:	
Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $100

Project Aspects Requiring Maintenance

-

Delivery Mechanism 2" main line, 3/4" service line to houses

Barriers to Implementation None-constructed prior to TCEQ supervision/control

Dixonville Subdivison Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	2000
	People Served	45	***Efficiency of System***	Effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2"

Material Used PVC

Quantity of Water Reserves	172 gallons
Storage Capacity	172 gallons
Safety Measures in Place	Locked buildings and touring the wells
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Construct strong buildings over well heads and build strong storage tanks.

Additional Comments
Owner/manager lives on site who is intersted in the welfare of the tenants it serves (tenants are not charged for the water).

East Fork Special Utility District

Location	Collin County	
Contact Person	Charlotte Waddill	
Address	1355 Troy Rd Wylie, TX 75098	***E-mail***
Phone	(972) 442-7572	efwater@aol.com
Service Area	East Fork CCN	
Population Served	6,132	

Water Connections Served

Type of Connection		#
Residential	Yes	1,747
Commercial	Yes	5
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 67 gallons

Primary Water Source

Surface	Yes	North Texas Municipal Water District
Ground	No	
Other	No	

Number of Wells
-
Age of Wells
-

Water Quality Excellent

Annual Operating Cost Not available at this time

Project is:	
Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost Not available at this time

Project Aspects Requiring Maintenance

-

Delivery Mechanism Pipe

Barriers to Implementation Finalizing loan through government bidding process

East Fork Special Utility District

Technologies implemented at the Water System

1) ***Technology***	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-
2) ***Technology***	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-

Details about technology used in this water system

We only deliver water. North Texas Municipal Water District does the treatment.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 14" and less

Material Used -

Quantity of Water Reserves	1.9 million gallons
Storage Capacity	1.9 million gallons
Safety Measures in Place	Fences and light
Fire Fighting Capability	Yes
Fire Codes Being Met	No

Pump Stations Yes ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place No

Lessons Learned

Additional Comments

English Community Rehab. Water System

Location Red River County

Contact Person John L. Ragsdill

Address Rt. 4 Box 72
Claeksville, TX 75426

E-mail -

Phone (903) 427-2891

Service Area Red River County-English Community

Population Served 220

Water Connections Served

Type of Connection		#
Residential	Yes	63
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 39.5 gallons

Primary Water Source		
Surface	No	
Ground	Yes	
Other	No	

Number of Wells 2

Age of Wells 30+ yrs.

Water Quality Poor

Annual Operating Cost $30,000

Project is:	
Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill	
Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $30,000

Project Aspects Requiring Maintenance

Wells, pump station and distribution

Delivery Mechanism PVC pipe

Barriers to Implementation Waiting on grant, waiting on TCEQ

English Community Rehab. Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1966
	People Served	220	***Efficiency of System***	Least effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system

Chlorine gas is used for disinfection.

0

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1" and up

Material Used PVC

Quantity of Water Reserves	Not determinable/Shallow wells
Storage Capacity	25,000 gallons
Safety Measures in Place	Fencing, locks and normal pumpsite precautions
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant No

Long-term Water Plan in Place Yes

Lessons Learned

Don’t waste money drilling shallow wells. Don't use 1" PVC for distribution. Abandon (2) shallow wells. Replace all distribution and mains. Replace all mechanical meters with touch read.

Additional Comments

We consolidated with English WSC because they were out of complicance. Red River WSC is trying to secure a grant to completely rebuild this system

Frognot WSC

Location	Collin County	
Contact Person	Robert Todd	
Address	9329 CR 628 Blue Ridge, TX 75424	***E-mail***
Phone	(972) 752-5798	-
Service Area	65 sq. miles CCN# 0430035	
Population Served	1,800	

Water Connections Served

Type of Connection		#
Residential	Yes	513
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 45 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
2
Age of Wells
38 yrs., 17 yrs.

Water Quality Excellent

Annual Operating Cost Unknown at this time

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	No

Annual Maintenance Cost Unknown at this time

Project Aspects Requiring Maintenance
Pump, motor and line maintenance

Delivery Mechanism Pump stations

Barriers to Implementation -

Frognot WSC

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1965
	People Served	1,800	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 6"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	220,000 gallons
Safety Measures in Place	Usual safegaurds and public reports anything suspicious
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 2

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments
Regarding questions on cost of operating project and cost of annual maintenance, we are in the very early stages of this project so these numbers are unknown at this time.

Garden Acres Water System

Location Gregg County

Contact Person Linda Duncan

Address 1225 W. Marshall
Longview, TX 75604

E-mail -

Phone (903) 753-8088

Service Area Garden Acres subdivision

Population Served 149

Water Connections Served

Type of Connection		#
Residential	Yes	49
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 83 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 2

Age of Wells 35 yrs.

Water Quality Excellent

Annual Operating Cost -

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $12,486

Project Aspects Requiring Maintenance

Pumps and electrical lines

Delivery Mechanism PVC pipe

Barriers to Implementation -
No

Garden Acres Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	-
	People Served	149	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system

Liquid Chlorine works best when applied at night (when the well is not active).
Liquid Chlorine is great for clarification and purification of water.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1" to 3"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	6,000 gallons
Safety Measures in Place	System has a 6" chain link fence around the pumps, wells and electrical connections
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place Yes

Lessons Learned

Use the best materials - even though it costs more initially, it pays itself in the longrun with less downtime

Additional Comments

If too much liquid chlorine is used it will deteriorate the plastic water lines.

Graham East Water Supply Corporation

Location	Young County	
Contact Person	Rhonda Dougless	
Address	P.O. Drawer 1330 Graham, TX 76450	***E-mail***
Phone	(940) 549-0361	-
Service Area	East of Graham	
Population Served	675	

Water Connections Served

Type of Connection		#
Residential	Yes	230
Commercial	Yes	20
Other (Specify)	Yes	2
Industrial Sites		

Daily Average Water Consumption Per Capita 120 gallons

Primary Water Source

Surface	Yes	Purchased from City of Graham
Ground	No	
Other	No	

Number of Wells -

Age of Wells -

Water Quality Excellent

Annual Operating Cost $110,000

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $10,000

Project Aspects Requiring Maintenance

Tank and line maintenance

Delivery Mechanism PVC pipe

Barriers to Implementation Organization of prospective members and completing

Graham East Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1970
	People Served	675	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used PVC

Quantity of Water Reserves	70,000 gallons
Storage Capacity	70,000 gallons
Safety Measures in Place	All protection standards established by TCEQ
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned
The introduction of chloramines by the city of Graham may completely eleminate or significantly reduce clorination requirments at our pump station

Additional Comments
No superior technoogies, but serving rural customers with quality water for over 30 years is a challenge.

Grey Forest Water System

Location Helotes County

Contact Person Keith Schneider

Address P.O. Box 258
Helotes, TX 78023

Phone (210) 695-8781

E-mail kschneider@greyforestutilites.com

Service Area Grey Forest

Population Served 870

Water Connections Served

Type of Connection		#
Residential	Yes	191
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 55,000 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality Excellent

Annual Operating Cost $18,073

Number of Wells
2

Age of Wells
9 yrs.

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $576

Project Aspects Requiring Maintenance

Wells

Delivery Mechanism Elevated tank

Barriers to Implementation None

Grey Forest Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	-
	People Served	300	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 6"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	157,500 gallons
Safety Measures in Place	Six foot fence with barbed wire on top
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments

Hi Texas Water System

Location Hutchinson County

Contact Person Terry Gollihugh

Address P.O. Box 716
Fritch, TX 79036

Phone (806) 857-3117

E-mail -

Service Area Fritch

Population Served 2,000

Water Connections Served

Type of Connection		#
Residential	Yes	1,000
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 5

Age of Wells 40+ yrs.

Water Quality Excellent

Annual Operating Cost -

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $100,000

Project Aspects Requiring Maintenance

All aspects

Delivery Mechanism Booster pumps and water lines

Barriers to Implementation -

Hi Texas Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1963
	People Served	2,000	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 6"

Material Used PVC

Quantity of Water Reserves	530,000 gallons
Storage Capacity	530,000 gallons
Safety Measures in Place	Operator knowledge, all the TCEQ safeguards
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 3

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Preventive maintenance of all equipment is important.

Additional Comments
Variable speed pumps and professional attitude of our operator

Indian Lodge Water System

Location	Bosque County
Contact Person	Tim Jones
Address	127 PR 1200 Kopperl, TX 76652
Phone	(254) 889-3643
E-mail	indianlodge@htcomp.net
Service Area	Indian lodge development
Population Served	85

Water Connections Served

Type of Connection		#
Residential	Yes	41
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 200 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 1

Age of Wells 50 yrs.

Water Quality Excellent

Annual Operating Cost -

Project is:

Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	No
Advanced	No

Annual Maintenance Cost $1,100

Project Aspects Requiring Maintenance

Underground piping

Delivery Mechanism Gravity feed - Pipes

Barriers to Implementation TCEQ required some changes to the engineer's plans

Indian Lodge Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1992
	People Served	40	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	4,000 gallons
Safety Measures in Place	Locks, fences and gates
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant -
Long-term Water Plan in Place No

Lessons Learned
Follow all the rules and regulations laid out by TCEQ.

Additional Comments

Lake Valley Water Company

Location	Wilson County
Contact Person	R.L. Smith
Address	P.O. Box 428 La Vernia, TX 78121
Phone	(830) 947-3108
E-mail	romabrit@juno.com
Service Area	Las Palomas subdivision
Population Served	280

Water Connections Served

Type of Connection		#
Residential	Yes	62
Commercial	Yes	1
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 2

Age of Wells 6 yrs., 14 yrs.

Water Quality Excellent

Annual Operating Cost $22,000

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $6,000

Project Aspects Requiring Maintenance

Pressure pumps, filters, purifiers and chlorinator

Delivery Mechanism Automate air pressure tank to supply pipes

Barriers to Implementation -

Lake Valley Water Company

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1988
	People Served	280	***Efficiency of System***	Very effective
2)	***Technology***	Anthralite/sand filter	***Year Implemented***	1996
	People Served	-	***Efficiency of System***	Very effective

Details about technology used in this water system

Chlorine gas is used for disinfection and so is sand filtration. Both are very effective methods of treating water.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 4" to 12"

Material Used PVC

Quantity of Water Reserves	Limitless - underground
Storage Capacity	34,000 gallons
Safety Measures in Place	All gates and doors are locked and the plant storage is fenced
Fire Fighting Capability	Partly
Fire Codes Being Met	No

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place Yes

Lessons Learned

After drilling well, always clean and clarify water.

Additional Comments

Hydrants are used in some areas for fire fighting.

Little Creek Acres Water System

Location	Hunt County	
Contact Person	George Stebens	
Address	7243 County Road 3512 Quinlan, TX 75474	***E-mail***
Phone	(903) 883-2416	stebens@ev1.net
Service Area	Small subdivision	
Population Served	78	

Water Connections Served

Type of Connection		#
Residential	Yes	26
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 180 gallons

Primary Water Source

Surface	No	
Ground	Yes	Water Well
Other	No	

Number of Wells
6
Age of Wells
25yrs. to 27 yrs.

Water Quality Excellent

Annual Operating Cost More than it takes in

Project is:	
Labor Intensive	Yes
Capital Intensive	-

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

Delivery Mechanism Pressure tank and pump

Barriers to Implementation -

Little Creek Acres Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1974
	People Served	78	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 3"

Material Used PVC, Plastic

Quantity of Water Reserves	Unknown
Storage Capacity	10,000 gallons
Safety Measures in Place	8ft fence, reverse flow valve, patrol once a day
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Every meter should have a return check valve to keep the water from running back into the line.

Additional Comments
The cost is high but people have water to use. It is good to use big storage tanks.

Live Oak Bend Civic Water Supply Corporation

Location	Matagorda County	
Contact Person	Don Dumm	
Address	47 Live Oak Bend Sargent, TX 77414	***E-mail***
Phone	(979) 244-2973	doubledum@earthlink.net
Service Area	Live Oak Bend	
Population Served	260	

Water Connections Served

Type of Connection		#
Residential	Yes	116
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	No	
Other	Yes	Deep Wells 500 Ft. & 450 Ft.

Number of Wells
2
Age of Wells

Water Quality Good

Annual Operating Cost $20,000

Project is:	
Labor Intensive	No
Capital Intensive	No

Operator Skill	
Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $8,500

Project Aspects Requiring Maintenance

Clorinating equipment, flushing and cleaning storage tanks

Delivery Mechanism Pressure tanks at each well site

Barriers to Implementation -

Live Oak Bend Civic Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	-
	People Served	All	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 4"

Material Used PVC

Quantity of Water Reserves	Unknown
Storage Capacity	35,000 gallons
Safety Measures in Place	Locked hurricane fence and security lights
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 2

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned

Additional Comments
Live Oak Bend community is 80% 2nd home-week end occupants and 20% full time residents.

Luella Water Supply Corporation

Location	Grayson County
Contact Person	Warren Williams
Address	36 LWSC Rd. Sherman, TX 75090
Phone	(903) 892-9084
E-mail	-
Service Area	West to home
Population Served	2,000-2,500

Water Connections Served

Type of Connection		#
Residential	Yes	99
Commercial	Yes	1
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 83 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality Good

Annual Operating Cost $340,000

Number of Wells
6
Age of Wells
5 yrs. to 36 yrs.

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $100,000

Project Aspects Requiring Maintenance

Lines, tanks and wells

Delivery Mechanism Pressure pumps with pressure tanks

Barriers to Implementation None

Luella Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1970
	People Served	2,000 +	***Efficiency of System***	Effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1.5" to 6"

Material Used PVC

Quantity of Water Reserves	Plenty
Storage Capacity	1.1 million gallons
Safety Measures in Place	Security lights, observation and community watch
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 6

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned

Additional Comments

Martindale WSC & WTP

Location	Caldwell County	
Contact Person	Steven Fonville	
Address	P.O. Box 175 Martindale, TX 78655	***E-mail***
Phone	(512) 357-6951	martwsc@sanmarcos.net
Service Area	CCN contains the city of Martindale	
Population Served	2,400	

Water Connections Served

Type of Connection		#
Residential	Yes	760
Commercial	Yes	40
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 65.5 gallons

Primary Water Source

Surface	Yes	Wells
Ground	Yes	Guadalupe, San Marcos Rivers
Other	No	

Number of Wells
2
Age of Wells
3 yrs.

Water Quality Excellent

Annual Operating Cost $317,482

Project is:

Labor Intensive	No
Capital Intensive	Yes

Operator Skill

Basic	No
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $42,765

Project Aspects Requiring Maintenance

Membrane repairs/cleaning, air compressor maintenance and auxilliary equipment maintenance

Delivery Mechanism High service pumps

Barriers to Implementation Old Shallow Wells

Martindale WSC & WTP

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	2001
	People Served	2,400	***Efficiency of System***	Very effective
2)	***Technology***	Membrane Filtration	***Year Implemented***	2001
	People Served	2,400	***Efficiency of System***	Very effective

Details about technology used in this water system

Membrane ultra filtration (Koch). Disinfection (mixed oxidant MIOX system)

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 12"

Material Used PVC/AC

Quantity of Water Reserves	296 acre feet/year
Storage Capacity	300,000 gallons
Safety Measures in Place	Main equipment is inside fenced building; intruder alarms; exterior lighting
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant	Yes
Long-term Water Plan in Place	Yes

Lessons Learned

Compare several proprietary systems. Get a good engineer.
Partnering with regional water entities leads to economies of scale.

Additional Comments

Rural WSCs are not required to meet fire-flow requirements under their operational bylaws. However, pressure & flow rates can be maintained due to our ownership/connection to a regional WTP. All subdivisions are now required to build to fire codes.

Matagorda Waste Disposal & Water Supply Corporation

Location Matagorda County

Contact Person Joann Marek

Address P.O. Box 674
Matagorda, TX 77457

Phone (979) 863-7261

E-mail -

Service Area 3 sq. miles in Matagorda

Population Served 1,200

Water Connections Served

Type of Connection		#
Residential	Yes	375
Commercial	Yes	10
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality Excellent

Annual Operating Cost -

Number of Wells 2

Age of Wells 13yrs., 1 yr.

Project is:

Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

Motors, pumps and chlorinator

Delivery Mechanism Water lines

Barriers to Implementation Money

Matagorda Waste Disposal & Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1985
	People Served	1,200	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 6"

Material Used Plastic

Quantity of Water Reserves	64,00 gallons
Storage Capacity	64,000 gallons
Safety Measures in Place	Gates are locked
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 2

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned

Additional Comments

New Alsace Water Supply Corporation

Location	Medina County	
Contact Person	Sandra Porter	
Address	205 CR 479 Castroville, TX 78009	***E-mail***
Phone	(830) 931-3852	mayna2cnc@hotmail.com
Service Area	CCN 12558 - West of Castroville	
Population Served	150	

<u>Water Connections Served</u>

Type of Connection		#
Residential	Yes	58
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1
Age of Wells
20 yrs.

Water Quality Excellent

Annual Operating Cost $15,000

Project is:	
Labor Intensive	No
Capital Intensive	No

<u>Operator Skill</u>

Basic	Yes
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $6,000

Project Aspects Requiring Maintenance

Maintaing well and pumps. Also, any pipe leaks that occur in the system.

Delivery Mechanism Submercible pump

Barriers to Implementation Getting an engineer to install tank took one year.

New Alsace Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1983
	People Served	150	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter	6"
Material Used	PVC

Quantity of Water Reserves	-
Storage Capacity	19,900 gallons
Safety Measures in Place	Fence around well that is kept locked and latches to storage tanks are locked
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 2 booster pumps

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned
Our problems are mainly due to time consuming busy work. Needed to comply with governmental regulatory agencies plus the need to produce additional water rights due to creation of the Edwards Aquifer authority which controls how much water we can pump.

Additional Comments
The actual water distribution and maintaining our system are relatively simple . We have added additional storage capicity for water as our system has grown.
We have a superior board of directors who keep our system up to date and runnig smoothly.

Nocona Hills Water Supply Corporation

Location	Montague County
Contact Person	James C Wallace, Jr.
Address	102 Nocona Drive Nacona, TX 76255
E-mail	-
Phone	(940) 825-3895
Service Area	Nocona hills addition
Population Served	450

Water Connections Served

Type of Connection		#
Residential	No	372
Commercial	No	0
Other (Specify)	Yes	2

Motel and Club House Pool

Daily Average Water Consumption Per Capita 180 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 4

Age of Wells 1yr. to 30 yrs.

Water Quality Excellent

Annual Operating Cost $179,312

Project is:

Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $95,000

Project Aspects Requiring Maintenance

Pumps, valves, chlorinators, meters, pick up truck, valve boxes, etc.

Delivery Mechanism Gravity-Two elevated storage tanks at same altitude

Barriers to Implementation Money

Nocona Hills Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1973
	People Served	450	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 6"

Material Used PVC

Quantity of Water Reserves	220,000 gallons
Storage Capacity	220,000 gallons
Safety Measures in Place	As directed by TCEQ
Fire Fighting Capability	Yes
Fire Codes Being Met	No

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Don't try to cut costs as this will lead to broken down equipment and undependable employees.

Additional Comments
It is important to employ a good, dependable operator for the system.

North Hardin Water Supply Corporation

Location	Hardin County	
Contact Person	Stanley Gore	
Address	P.O. Box 55 Silsbee, TX 77656	***E-mail***
Phone	(409) 385-7355	nhwsc@aol.com
Service Area	Rural Silsbee	
Population Served	7,800	

Water Connections Served

Type of Connection		#
Residential	Yes	2,350
Commercial	Yes	7
Other (Specify) Industrial	Yes	4

Daily Average Water Consumption Per Capita 87 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
4
Age of Wells
3yrs. to 27 yrs.

Water Quality Excellent

Annual Operating Cost $850,000

Project is:	
Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $225,000

Project Aspects Requiring Maintenance

Lines, tanks and wells

Delivery Mechanism Elevated tower and booster pump

Barriers to Implementation -

North Hardin Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Coagulation	***Year Implemented***	1980
	People Served	7,800	***Efficiency of System***	Effective
2)	***Technology***	Disinfection	***Year Implemented***	1982
	People Served	7,800	***Efficiency of System***	Very effective

Details about technology used in this water system

Chlorine gas is used for disinfection.

Independent lab certification is used to make sure adequate technologies are being used.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	465,000 gallons
Safety Measures in Place	Fencing, security alarms and personal observation
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 2

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place Yes

Lessons Learned

Do not be afraid to try new chemicals or techniques where possible.

A cooperative board is key.

Additional Comments

One should be aggressive in trying new things.

Try new technologies and stick to the ones that work or show promise.

Penelope Water Supply Corporation

Location Hill County

Contact Person Mary Dvorak
Address P.O. Box 102
Penelope, TX 76676
Phone (254) 533-2486

E-mail -

Service Area Within City Limits of Penelope

Population Served 240

Water Connections Served

Type of Connection		#
Residential	Yes	96
Commercial	Yes	1
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 120 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality Excellent

Annual Operating Cost -

Number of Wells
1
Age of Wells
44 yrs.

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost -

Project Aspects Requiring Maintenance

Broken water lines

Delivery Mechanism Metered

Barriers to Implementation Lack of funds.

Penelope Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1959
	People Served	210	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1" to 3"

Material Used PVC and metal pipes

Quantity of Water Reserves	1 deep well
Storage Capacity	30,000 gallons
Safety Measures in Place	Surrounded by chain link fence with barbed wire on top
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Be sure to do research and know the pitfalls.

Additional Comments
It is important for rural areas to have access to running water, pipe water or a water system.

Pettus Municipal Utility District Water System

Location	Bee County
Contact Person	Mrs. Leroy Pargmann
Address	P.O. Box 153 Pettus, TX 78148
Phone	(361) 375-2263
E-mail	-
Service Area	Pettus Townsite - Mineral Heights
Population Served	978

Water Connections Served

Type of Connection		#
Residential	Yes	221
Commercial	Yes	8
Other (Specify)	Yes	9

2 Schools, 6 Churches, 1 Community Center

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	No	
Ground	Yes	Wells
Other	No	

Number of Wells
3
Age of Wells
23 yrs. to 41 yrs.

Water Quality Excellent

Annual Operating Cost $79,093

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $25,544

Project Aspects Requiring Maintenance

RO and leaks in lines

Delivery Mechanism Water mains

Barriers to Implementation Inhouse learning process due to lack of training

Pettus Municipal Utility District Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1962
	People Served	978	***Efficiency of System***	Least effective
2)	***Technology***	Membrane Filtration	***Year Implemented***	1999
	People Served	978	***Efficiency of System***	Neutral

Details about technology used in this water system

We use disinfection, membrane filtration, oxidation and reverse osmosis. The last 3 treatment technologies have been in place since 1999.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used PVC, cement

Quantity of Water Reserves	375,000 gallons
Storage Capacity	235,000 gallons
Safety Measures in Place	Locked fences around wells
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes

Long-term Water Plan in Place Yes

Lessons Learned

Firm understanding of reverse osmosis is very important.

Additional Comments

Oxidation technology was used in Oct 1999, it served 978 people and scale was neutral. Reverse Osmosis technology was used in Oct 1999 served 978 people and scale was least effective

Pine Grove Water System

Location	Harris County
Contact Person	D. Ray Young
Address	17230 Huffmeister Cypress, TX 77429
Phone	(281) 373-0500
E-mail	dry@waterengineers.com
Service Area	Pine Grove subdivision
Population Served	150

Water Connections Served

Type of Connection		#
Residential	Yes	50
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 70-75 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1
Age of Wells
19 yrs.

Water Quality Excellent

Annual Operating Cost $11,390

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $2,472

Project Aspects Requiring Maintenance

Pressure controls

Delivery Mechanism Booster pumps and distribution piping

Barriers to Implementation Availability of capital

Pine Grove Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1984
	People Served	150	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2.5" to 4"

Material Used PVC

Quantity of Water Reserves	None
Storage Capacity	16,000 gallons
Safety Measures in Place	Entry restraint fencing, padlocked doors and openings in tank
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned
Reliability of solenoid metering pumps for bleach(10% sodium hypochlorite) is improved with semi-annual preservative maintenance

Additional Comments
Telephone dialer to alert operator of reduced pressure helps improve reliability

RCH Water Supply Corporation

Location	Rockwall County	
Contact Person	Robin Bailey	
Address	P.O. Box 2034 Rockwall, TX 75087	***E-mail***
Phone	(972) 772-0120	trbailey@gte.net
Service Area	Rockwall, Chisholm and Heath	
Population Served	3,750	

Water Connections Served

Type of Connection		#
Residential	Yes	748
Commercial	Yes	3
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 700 gallons

Primary Water Source

Surface	Yes	
Ground	No	
Other	No	

Water Quality Excellent

Annual Operating Cost -

Number of Wells
-
Age of Wells
-

Project is:

Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	Yes
Advanced	Yes

Annual Maintenance Cost $35,300

Project Aspects Requiring Maintenance

Pump stations, elevated towers and water lines

Delivery Mechanism Master meter

Barriers to Implementation None

RCH Water Supply Corporation

Technologies implemented at the Water System

1) Technology	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-
2) Technology	-	***Year Implemented***	-
People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Treated water is purchased and distributed.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 8"

Material Used PVC

Quantity of Water Reserves	800,000 gallons
Storage Capacity	800,000 gallons
Safety Measures in Place	Intruder resistance fence, locking mechanism, daily checks and lights
Fire Fighting Capability	Yes
Fire Codes Being Met	No

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
-

Additional Comments

Rio Blanco Estates Water System

Location	Lubbock County	
Contact Person	Angie Goodman or Robert Goodman	
Address	P.O. Box 2463 Lubbock, TX 79401	***E-mail***
Phone	(806) 740-0970	agoodman@acgcotton.com
Service Area	22 acres of lake lots	
Population Served	20-25	

Water Connections Served

Type of Connection		#
Residential	Yes	25
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita Varies greatly

Primary Water Source

Surface	Yes	White River MUD
Ground	No	
Other	No	

Water Quality Good

Annual Operating Cost $2,000

Number of Wells
-
Age of Wells
-

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $1,500

Project Aspects Requiring Maintenance

Testing

Delivery Mechanism Plastic pipe

Barriers to Implementation None

Rio Blanco Estates Water System

Technologies implemented at the Water System

1)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
We purchase water and supply it. We do not do any treatment.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter -

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	-
Safety Measures in Place	All reasonable measures
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations No ***Number of Pumps*** -

Water System is Safe Water Drinking Act Compliant	No
Long-term Water Plan in Place	Yes

Lessons Learned

Additional Comments
We are served by White River municipal water district.
We purchase and then resell the water.

Roving Medows Utilites Water System

Location	Harris County
Contact Person	Stephen P. Kerbs
Address	11700 Padok Rd Houston, TX 77094
Phone	(281) 456-0883
E-mail	-
Service Area	Private owned public water and sewer system
Population Served	195

Water Connections Served

Type of Connection		#
Residential	Yes	60
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 55 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality Excellent

Annual Operating Cost $15,000

Number of Wells
2
Age of Wells
15 yrs., 5 yrs.

Project is:	
Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $6,000

Project Aspects Requiring Maintenance

Pressure tanks, lines and pumps

Delivery Mechanism PVC pipe

Barriers to Implementation Local Mud

Roving Medows Utilites Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1982
	People Served	195	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 4"

Material Used PVC

Quantity of Water Reserves	5,000 gallons
Storage Capacity	5,000 gallons
Safety Measures in Place	Locks
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 2

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
Technology must become less expensive to be used in smaller systems.

Additional Comments

San Diego Municipal District #1

Location Duval County

Contact Person Vic Casas, Jr.
Address 200 S. Dr. E.E. Dunlap Hwy.
San Diego, TX 78384
Phone (361) 279-3357

E-mail sdmudtx@yahoo.com

Service Area City of San Diego

Population Served 5,000 +

Water Connections Served

Type of Connection		#
Residential	Yes	1,981
Commercial	Yes	129
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 8,000 gallons/month/household

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 6
Age of Wells 5 yrs. to 40 yrs.

Water Quality Good

Annual Operating Cost $130,000

Project is:

Labor Intensive	Yes
Capital Intensive	Yes

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $130,000

Project Aspects Requiring Maintenance
All infrastructure

Delivery Mechanism Well water pumped (electrical) to 56 PSI to mains

Barriers to Implementation Funding

San Diego Municipal District #1

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1965
	People Served	5,000+	***Efficiency of System***	Effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter	3/4" to 12"
Material Used	PVC

Quantity of Water Reserves	1.5 million gallons
Storage Capacity	1.95 million gallons
Safety Measures in Place	Daily inspections
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations	Yes	***Number of Pumps***	1

Water System is Safe Water Drinking Act Compliant	Yes
Long-term Water Plan in Place	Yes

Lessons Learned
Try to plan for the future in a way that you can loop the main lines so that there is equal water pressure in future expansions.

Additional Comments
None

South Jasper Co. Water Supply Corporation

Location Jasper County

Contact Person Gaylon Chesser

Address P.O. Box 1939
Buna, TX 77612

Phone (409) 994-3723

E-mail sjcwsc@aol.com

Service Area Gum Slough Area, S. on Hwy 62, West to Evadale

Population Served 365

Water Connections Served

Type of Connection		#
Residential	Yes	-
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 47 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 1

Age of Wells 4 yrs.

Water Quality Excellent

Annual Operating Cost $17,487

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $1,085

Project Aspects Requiring Maintenance

Standpipe tank

Delivery Mechanism Submersible pump

Barriers to Implementation Money

South Jasper Co. Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1995
	People Served	All	***Efficiency of System***	Very effective
2)	***Technology***	Oxidation	***Year Implemented***	1995
	People Served	-	***Efficiency of System***	Effective

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 6"

Material Used PVC

Quantity of Water Reserves	68,000 gallons
Storage Capacity	141,000 gallons
Safety Measures in Place	Meet state requirements.
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant No
Long-term Water Plan in Place Yes

Lessons Learned
Never undersize a project, line, storage, etc.

Additional Comments
Do not meet SWDA but we have an exception which we are presently working on.

Spring Valley Water Supply Corporation

Location McLennan County

Contact Person Ken Mays

Address P.O. Box 1240
Hewitt, TX 76643

Phone (254) 857-4720

E-mail kmaysthuddriver@earthlink.net

Service Area In Central Texas near Waco

Population Served 1,580

Water Connections Served

Type of Connection		#
Residential	Yes	520
Commercial	Yes	7
Other (Specify)	No	0

Daily Average Water Consumption Per Capita -

Primary Water Source

Surface	Yes	
Ground	Yes	
Other	No	

Water Quality Excellent

Annual Operating Cost -

Number of Wells
2

Age of Wells
35 yrs.

Project is:

Labor Intensive	No
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $41,250

Project Aspects Requiring Maintenance

Distribution pumps, pipes and wells

Delivery Mechanism Pumps and pipes

Barriers to Implementation None

Spring Valley Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1965
	People Served	527	***Efficiency of System***	Very effective
2)	***Technology***	Electrodialysis	***Year Implemented***	1999
	People Served	527	***Efficiency of System***	Neutral

Details about technology used in this water system
We use proven technology and cannot afford to experiment.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 4" to 8"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	292,000 gallons
Safety Measures in Place	Alarm system on each plant and neighbors watch
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 4

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
We are a small system and cannot afford to expirement with unproven equipment. We stay with proven technology.

Additional Comments
In small water operations it must be kept simple in order to deliver affordable water. Small systems cannot afford things such as SCADA and electronic meters.

Treetop Utilites Inc., Water System

Location	Parker County	
Contact Person	Tom Crew	
Address	4646 Mansfield Hwy. Forthworth, TX 76119	***E-mail***
Phone	(817) 535-4802	tom.crew@texsunelectric.com
Service Area	Treetop Estates	
Population Served	50-70	

Water Connections Served

Type of Connection		#
Residential	Yes	18
Commercial	No	0
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 130 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1
Age of Wells
15 yrs.

Water Quality Fair

Annual Operating Cost $10,000

Project is:

Labor Intensive	No
Capital Intensive	-

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $2,000

Project Aspects Requiring Maintenance

Pump and underground line

Delivery Mechanism Booster Pump

Barriers to Implementation -

Treetop Utilites Inc., Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1993
	People Served	51	***Efficiency of System***	Neutral
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 8"

Material Used PVC

Quantity of Water Reserves	-
Storage Capacity	50,000 gallons
Safety Measures in Place	Standard required by State
Fire Fighting Capability	Yes
Fire Codes Being Met	Yes

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments

Umbarger Community Water Supply Corporation

Location	Randall County	
Contact Person	Roger Batenhorst	
Address	P.O. Box 45 Umbarger, TX	***E-mail***
Phone	(806) 499-3436	rbkb83@hotmail.com
Service Area	Umbarger	
Population Served	180	

<u>Water Connections Served</u>

Type of Connection		#
Residential	Yes	49
Commercial	Yes	16
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 161 gallons/house

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells
1
Age of Wells
28 yrs.

Water Quality Excellent

Annual Operating Cost $5,000

Project is:	
Labor Intensive	No
Capital Intensive	No

<u>Operator Skill</u>

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $3,100

Project Aspects Requiring Maintenance

Meter replacement

Delivery Mechanism Pressure tank

Barriers to Implementation -

Umbarger Community Water Supply Corporation

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	-
	People Served	All	***Efficiency of System***	Effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 6"

Material Used PVC

Quantity of Water Reserves	50,000 gallons
Storage Capacity	50,000 gallons
Safety Measures in Place	Fenced yard
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place No

Lessons Learned

Additional Comments

VFW Lakeside Post 7873 Water System

Location	Grayson County
Contact Person	Bill McLain
Address	250 VFW Drive Pottsboro, TX 75076
Phone	(903) 786-2400
E-mail	-
Service Area	Lakeside
Population Served	180

Water Connections Served

Type of Connection		#
Residential	Yes	90
Commercial	Yes	1
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 100 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Number of Wells 1

Age of Wells 60 yrs.

Water Quality Good

Annual Operating Cost $1,800

Project is:

Labor Intensive	Yes
Capital Intensive	No

Operator Skill

Basic	Yes
Intermediate	No
Advanced	No

Annual Maintenance Cost $1,800

Project Aspects Requiring Maintenance

Filters

Delivery Mechanism Ground pipes

Barriers to Implementation None

VFW Lakeside Post 7873 Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1980
	People Served	180	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Liquid Chlorine is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 1.5"

Material Used PVC

Quantity of Water Reserves	Unknown (Trinity Aquifier)
Storage Capacity	25,000 gallons
Safety Measures in Place	Chain, link fences, locked buildings
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 1

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
It is important to read and know about the various technologies available to small water systems.

Additional Comments

Water Services Inc., Water System

Location	Comal County	
Contact Person	Lorna Bodley	
Address	P.O. Box 421 Bulverde, TX 78163	***E-mail***
Phone	(830) 980-3774	waterinc@gvtc.com
Service Area	Rural Areas around San Antonio	
Population Served	5,520	

Water Connections Served

Type of Connection		#
Residential	Yes	1,830
Commercial	Yes	10
Other (Specify)	No	0

Daily Average Water Consumption Per Capita 200 gallons

Primary Water Source

Surface	No	
Ground	Yes	
Other	No	

Water Quality	Good	***Number of Wells*** 30
Annual Operating Cost	$2,88,000	***Age of Wells*** 1yr. to 43 yrs.

Project is:	
Labor Intensive	-
Capital Intensive	No

Operator Skill

Basic	No
Intermediate	Yes
Advanced	No

Annual Maintenance Cost $400,000

Project Aspects Requiring Maintenance

All components

Delivery Mechanism	Pumps
Barriers to Implementation	None

Water Services Inc., Water System

Technologies implemented at the Water System

1)	***Technology***	Disinfection	***Year Implemented***	1962
	People Served	All	***Efficiency of System***	Very effective
2)	***Technology***	-	***Year Implemented***	-
	People Served	-	***Efficiency of System***	-

Details about technology used in this water system
Chlorine gas is used for disinfection.

Any Innovative strategies being used for gray water (water reuse) No

Pipes

Diameter 2" to 8"

Material Used Cast Iron/PVC

Quantity of Water Reserves	500,000 gallons/yr.
Storage Capacity	5,000-65,000 gallons
Safety Measures in Place	Texas State requirments
Fire Fighting Capability	No
Fire Codes Being Met	-

Pump Stations Yes ***Number of Pumps*** 9+

Water System is Safe Water Drinking Act Compliant Yes
Long-term Water Plan in Place Yes

Lessons Learned
It is important to keep State regulations and cost of implementation in mind before getting into this business.

Additional Comments