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Cost Comparisons of Water Treatment Systems to Improve Water Quality for Municipal Use

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COST COMPARISIONS OF WATER TREATMENT SYSTEMS TO IMPROVE WATER QUALITY FOR MUNICIPAL USE

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Drinking water quality is the key factor for sustainability of life and well being of the human population. The quality of water in Texas High Plains generally is suitable for irrigation but doesn't meet the drinking water standards with respect to certain dissolved constituents (dissolved solids/salinity, fluorides, chlorides and sulfate).

Water treatment systems are costly and local communities have financial limitation to afford the required technology. Affordable water treatment facilities with low operating costs are needed to be introduced with an aim to implement cost effective solutions to water management problems. This study focuses on comparing operating costs and cost effectiveness of various drinking water treatment systems. It will serve as a tool to aid local communities' decision making process to implement cost effective systems. The results will also be helpful in addressing issues pertaining to water management and planning specially for municipal use.

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Cost Comparisons of Water Treatment Systems to Improve Water Quality for Municipal Use

Naveen C. Adusumilli and Lal K. Almas[1]

Introduction

The state of Texas has been divided into 16 Regional Water Planning Groups (RWPG's) by the Texas Water Development Board (TWDB) starting from Region A to Region P. Region A of Texas includes 21 counties of the Texas Panhandle. Population in Region A of Texas Panhandle has been estimated to increase from 355,832 in the year 2000 to 541,035 by the year 2060.With the growing population; demand for drinking water has also increased. Municipal water demand in Texas panhandle totals 85,193 ac-ft in the year 2000 and is projected to increase to 104,242 ac-ft, which equals 33,967 million gallons of water by the year 2060 (Texas Water Development Board).

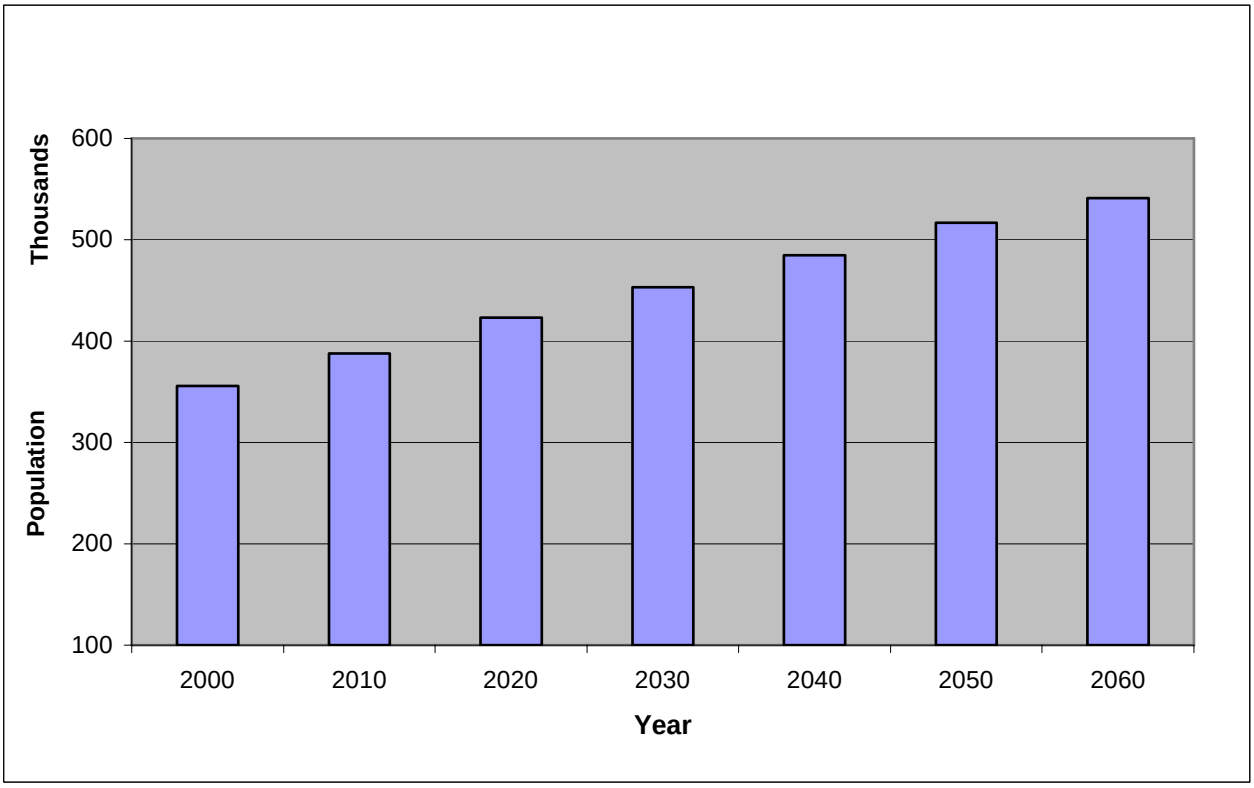

Figure 1: Population Projections for Texas Panhandle Water Planning Region (Region A) from 2000 - 2060

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Drinking water quality is the key factor for sustainability of life and well being of human population. Drinking water in Texas High Plains is obtained from surface water as well as from groundwater sources. The surface water supply is from Lake Meredith. The ground water supply is from the Ogallala Aquifer. The drinking water is a blend of both sources. The purpose of this blend (approximate ratio of 63% lake water to 37%well water) is to adjust mineral content of drinking water within state guidelines (Water Quality Report, 2005).

The cost of drinking water is rising and the reasons are aging infrastructure, public health standards, and expansion of service areas. In most cases, these increasing costs have caused water suppliers to raise their rates. However, despite rate increase, water is generally still a bargain compared to other utilities, such as electricity and phone service (congressional budget office study: Future investment in drinking water & waste water infrastructure, 2002). On average tap water costs are slightly more than $2 per 1,000 gallons, although the costs tend to be lower for large water systems, and higher for small systems (U.S Environmental Protection Agency).

Though water supplied to the municipalities meet all U.S. Environmental Protection Agency (EPA) and state drinking water health standards it may reasonably be expected to contain small amounts of contaminants. The presence of a certain level of contaminants does not necessarily indicate a health risk but some people may be more vulnerable to contaminants than the general population. Moreover, monitoring for certain contaminants is done less then once per year, assuming that the concentrations of these contaminants do not change frequently. As a solution to the problem mentioned above, home drinking water treatment systems with low operating costs should be introduced with an aim to implement cost effective solutions to make water quality improvements. This study provides information on cost analysis of home water treatment systems. The cost analysis of two treatment systems has been conducted. Costs include fixed investment, operational and maintenance costs.

Background Information

As water travels through the ground or over the surface of the land, it dissolves naturally occurring minerals and, picks up substances produced as a result of animal or human activities. Texas High Plains consist primarily of farm and ranch lands. Surface water contamination is mainly from agricultural practices. Other potential sources of contamination include fertilizers, pesticides and other agricultural chemicals, as well as run-off from Confined Animal Feeding Operations (CAFO's). Contamination of ground water is mainly from agricultural chemicals. Other potential contamination sources are CAFO's, septic systems; oil field related activities and abandoned private water wells (Water Quality Report, 2005).

Sediment is also a source of chemical contamination, as fertilizers and pesticides attach to it (Kenimer et al., 1989; Gianessi and peskin, 1981). Sediment carried by runoff from crops, forests, pasture, and range accounts for approximately 68 percent of total suspended solids in waterways **(**Gianessi and Peskin, 1981**).** Atmosphere is also one of the sources of contaminations to aquatic environments. Metal-containing particulates that are washed from the atmosphere by rain and snow are deposited in drainage basins and find their way into lakes and rivers. As of 1973, the total nationwide airborne particulate emissions were distributed basically among three

sources: 51 percent from industrial processes, 29 percent from fossil-fuel combustion, and 20 percent from miscellaneous burning practices (Magee and others, 1973).

Many observations suggest that treating water can prevent problems associated with human health. Based on the epidemiological evidence and experimentation on laboratory animals, the U.S. Public Health Service has established maximum contaminant levels (MCLs) allowable in drinking water .The effect of contaminants on human health can be classified as either acute or chronic. A substance causing serious illness or death of an individual within 36-48 hours after exposure is considered acute. Chronic effect is a long-term effect on health due to frequent exposure to small amounts of toxic substances. Examples of chronic health effects would be kidney and liver disease, cancer, mental illness, etc.

The study is limited to two treatment systems; they are water treatment by distillation and culligan water treatment system that uses reverse osmosis method to treat the drinking water. In Distillation method distillers in the unit boil the water by using heat and convert water into steam. Steam later condenses back into water, which is then collected in a pure form. Distillation removes almost all of the impurities in water. Reverse Osmosis systems purify water by forcing pressurized water through a very fine membrane. This movement through a semi permeable membrane blocks the transport of various salts and solutes.

Data Sources

Data on municipal water demand projections for the years 2000 to 2060 and population growth projections for the years 2000 to 2060 were obtained from Texas Water Development Board (TWDB). Data on the size of an average American family and the amount of water used in gallons per day per person for drinking, which were used to calculate the various costs was obtained from U.S. census bureau; census 2004 and from Reeves Journal march 2006 edition respectively. Information on different cost aspects of home water treatment units were collected from various dealers in and around Amarillo and Canyon.

Cost Comparison and Analysis

Annualized cost of the distillation system, assuming a useful life of 10 years with an interest rate of 6 percent has been estimated and is approximately $136. In addition to the purchase cost, there are annual operational costs. These costs include cost of electricity, and repair and maintenance cost of the system. Annual operation costs depend on the amount of distilled water used daily. The major component of operation cost is electricity. A power rate of $0.1 per kWh was assumed to calculate the energy costs. The total energy cost is a major component of the operation cost and is approximately $0.29 per gallon of water treated and would be $1,051 per year considering that a 1200-watt distiller produces 10 gallons per day. In addition, repair and maintenance cost were assumed to be 15% of the purchase price of the unit per year and is approximately $0.04 per gallon. Annualized cost of the unit as well as the operation costs, which include electricity and, repair and maintenance cost have been combined to determine the total costs associated with the system. Total cost of the unit is $1,337, estimated by combining annualized cost, operation cost, and repair and maintenance cost which are $136, $1,051 and $150 respectively.

Culligan is a company that sells and rents drinking water systems. Culligan water treatment unit uses reverse osmosis method to treat water. Reverse osmosis has become a common method for treatment of household drinking water. Reverse osmosis system uses a series of filters to reduce many microscopic impurities and chemical elements. Total cost of culligan water treatment systems on a rental basis is approximately $284,estimated by combining annualized cost, operational cost and, repair and maintenance cost.

Table 1: Fixed and Variable Cost of Water Treatment Systems on Yearly Basis

Treatment System	Annualized cost	Operation cost	Repair & Maintenance cost	Total cost/year	Cost /gallon
Distillation	$136	$1,051	$150	$1,337	$0.37
Culligan	$11	$0	$273	$284	$0.16

Assuming 50 percent of the population in the Region A of the Texas Panhandle uses either one of the systems, i.e. out of 350,000 population in Region A of Texas Panhandle if 58,334 families use either one of the system, the total amount spent for obtaining quality drinking water would be approximately $78 million with distillation unit and $17 million with culligan water treatment unit. The total amount of savings in dollars by using culligan water treatment unit instead of distillation unit is $61 million. Data has been collected on the number of households having culligan units in this area and there are approximately 10,000 households with culligan water treatment units. This indicates that there is a market potential for water treatment companies. Expansion of their market requires more units and more personnel and this in turn would help in generating more job opportunities in the area.

Conclusion:

The study is limited to compare operation and repair and maintenance costs of two different home water treatment units. The total cost of culligan unit and distillation unit per year has been estimated and the amount of savings per year in dollars by using culligan water treatment unit is approximately $61 million. These home water treatment units are used to treat water that already meets the drinking water standards. But this water has certain dissolved constituents, which may indicate a health risk. This study shows that it would be economical to use culligan water units rather than distillation units to treat drinking water and there is more market for water treatment companies and this would in turn lead to generate more job opportunities.

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