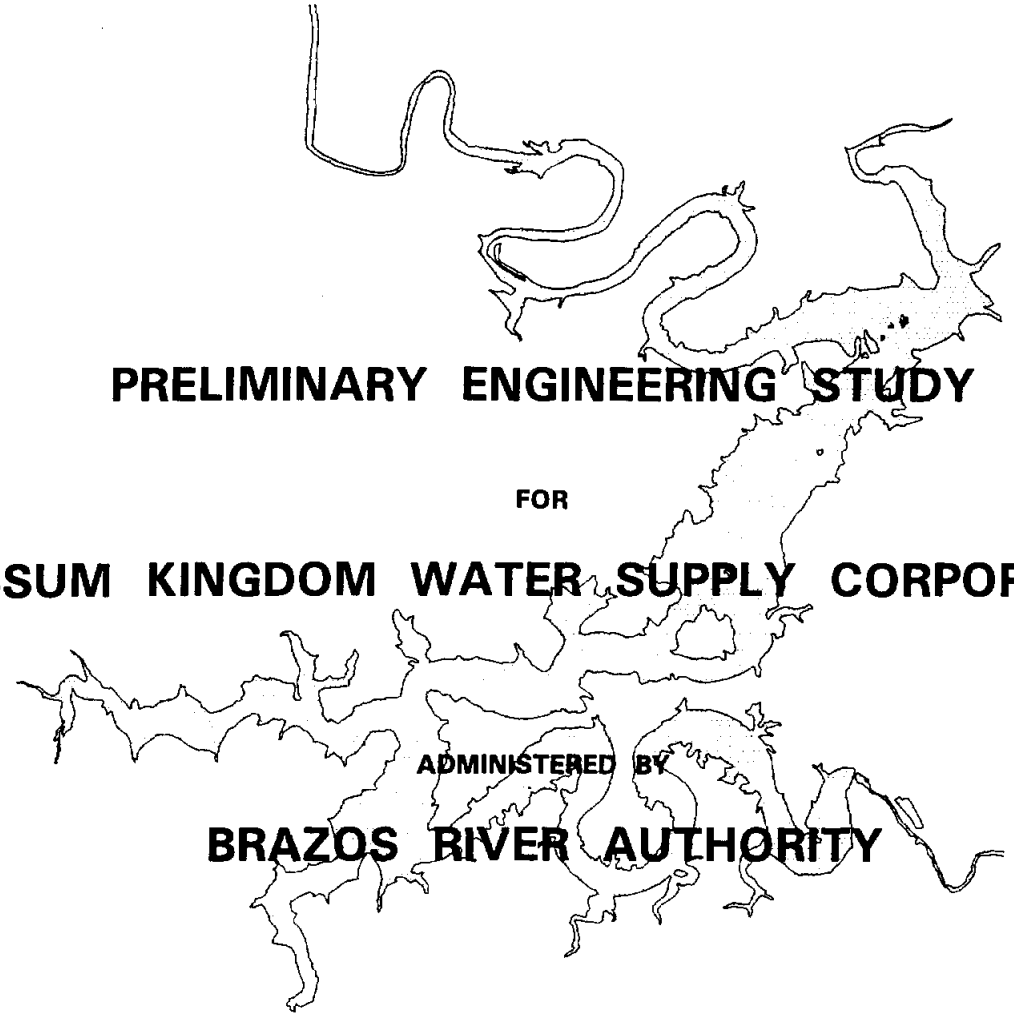
POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM



PRELIMINARY ENGINEERING STUDY

FOR

POSSUM KINGDOM WATER SUPPLY CORPORATION

ADMINISTERED BY

BRAZOS RIVER AUTHORITY

PREPARED BY

SHIMEK, JACOBS & FINKLEA
CONSULTING ENGINEERS
DALLAS, TEXAS

IN ASSOCIATION WITH

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WASTEWATER TECHNOLOGY SERVICE, INC.
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FEBRUARY, 1994

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February 15, 1994

Mr. Denis Qualls, E.I.T.
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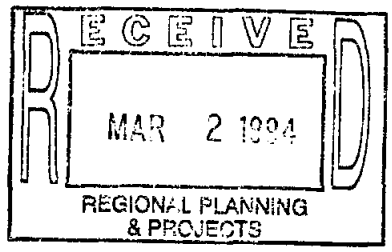

Re: Possum Kingdom Water Supply Corporation
Preliminary Engineering Study
Final Report

Dear Mr. Qualls:

We are delivering fifty-five (55) final copies of the Preliminary Engineering Study for the Possum Kingdom Regional Water Supply System prepared for the Possum Kingdom Water Supply Corporation. This document is for final distribution since it has been revised in accordance with the comments outlined in your January 21, 1994, review letter, along with the comments prepared by the Texas Water Development Board dated December 10, 1993.

This submittal completes our work as outlined in our engineering services contract with the Brazos River Authority. Our team of Shimek, Jacobs & Finklea, Reynolds-Hibbs & Associates and Wastewater Technology Service, Inc. has certainly enjoyed working with you, the Brazos River Authority and the Possum Kingdom Water Supply Corporation on this important project. The cooperation and input we received from you and the Brazos River Authority staff, Board Members of the Possum Kingdom Water Supply Corporation and local supporters of the regional study was invaluable.

Our team looks forward to assisting you and the Possum Kingdom Water Supply Corporation further as the proposed regional water system evolves.

Sincerely yours,

Ronald V. Conway

Ronald V. Conway, P.E.

cc: Mr. George Bailey, President, Possum Kingdom Water Supply Corporation
Reynolds-Hibbs & Associates
Wastewater Technology Service, Inc.

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POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

PRELIMINARY ENGINEERING REPORT

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This report presents the results of studies pertaining to the development of a regional water supply system to serve the Possum Kingdom Water Supply Corporation. The report evaluates the projected water needs of the Corporation; provides a variety of alternatives to meet those needs; provides details of the recommended regional system; and provides detailed cost estimates for all options evaluated. The purpose of this study is to evaluate and recommend the most cost effective solution for a regional water supply system in the Possum Kingdom Lake Area. It is also intended that the report provide the necessary preliminary engineering data to support a pre-application for funding assistance from a variety of funding sources. Funding options are discussed in detail in Section VI.

The study area includes approximately 310 miles of shoreline around Possum Kingdom Lake located in the Brazos River Basin in Palo Pinto, Stephens and Young Counties. This area is shown more specifically on Figure No. 1, in Section II.

It is estimated that the total number of potential system connections may be as high as 3,440, generating a maximum daily water supply demand of approximately 2.96 million gallons. This number of connections includes all the existing individual leased lots around the shores of the lake, many of which are seasonal. There are approximately 54 commercial camps and businesses around the lake. We have estimated these camps and businesses account for approximately 1,640 system connections. As it seems impractical to assume that all individual leased lots will participate in a regional water supply system, this study focused on several alternatives which consider various levels of individual participation. A survey conducted by the Brazos River Authority indicated that approximately 50% of the residences around the lake are interested in participating in the regional water supply system. At a 50% individual participation level, it is estimated that there would be approximately 2,752 system connections generating a maximum day system demand of approximately 2.37 million gallons.

Due to the seasonal nature of both the commercial operators and many of the residences around the lake, it seemed appropriate to investigate a regional water supply system that addressed the needs of the seasonal community it serves. Therefore, a system was evaluated which provided treatment plant capacity for an average day demand, of 1.19 MGD, transfer pump station and booster pump station for the maximum daily demand of 2.37 MGD, and a water distribution system designed for the maximum hourly demand. The average day plant is estimated to have ample capacity for all but the heaviest use days at the lake, which are typically Memorial Day, Fourth of July and Labor Day. During these peak use times, shortfalls in treatment plant capacity is proposed to be overcome by additional ground storage located at the treatment plant site. This non-traditional approach allows the

Possum Kingdom Water Supply Corporation to trade off expensive plant capacity for more economical ground storage, saving an estimated $2,800,000 in capital cost and approximately $244,000 on an annual cost basis.

Several sources of water supply were evaluated, for both treated water and raw water, in addition to treating surface water available from Possum Kingdom Lake. Consideration was given to hauling treated water from Graham; pumping treated water from Graham, Mineral Wells or Breckenridge; pumping raw water from Graham, and developing groundwater supplies. Evaluation of these options along with the option of "no action" resulted in treated surface water from Possum Kingdom Lake as the most economical and practical option for both the long term and short term.

Just as several water supply alternatives were evaluated, a variety of water distribution and transmissions systems were considered. In most cases, the maximum hourly demands as defined by the Texas Natural Resources Conservation Commission were utilized for sizing the proposed water distribution systems. The recommended water distribution system includes approximately 67 miles of water lines ranging in size from 2-1/2" diameter to 14" diameter as shown on Figure No. 5 in the Appendix of this report.

It is important to note that in no case has the anticipated water distribution system been sized for fire protection for either the individual or commercial customers. Fire protection requires systems to be designed with a minimum of 6-inch water lines, and generally a looped water distribution system. These requirements would increase the project cost well above the feasible level.

In brief, it has been concluded in this report that a regional water supply system designed to the parameters listed below would provide the most economical system for the majority of the Possum Kingdom Water Supply Corporation:

1. Treat surface water from Possum Kingdom Lake.

2. Utilize a modular treatment plant design with advanced demineralization, located near the South D & D Public Use Area (see Figures Nos. 3 and 4).

3. Size treatment plant for the average day demand for all commercial customers and approximately half of the individual leased lots around the lake (1.19 mgd).

4. Provide excess ground storage at a centralized location to meet the peak demands of the system during seasonal high demand periods (approximately 3.5 million gallons).

5. Size the water distribution system for the maximum hourly demands.

6. Size the transfer pump station, booster pump stations and elevated storage for the maximum daily demand.

The estimated initial capital cost of the system described above is approximately $8,507,000. This system would provide potable water service to all of the commercial operators, and half of the individual leases, on the north and east sides of Possum Kingdom Lake. Adding system improvements for service to the Gaines Bend, Hog Bend and Possum Kingdom State Park brings the regional system capital cost total to an estimated $10,144,000. We have estimated the annual operation and maintenance cost for this system, including raw water cost for Possum Kingdom Lake water, to be $601,000. Amortizing the capital cost over a 20 year period at an annual rate of 6%, and including annual operation and maintenance cost, brings the total estimated annual cost of the recommended system to approximately $1,485,000 per year. These cost estimates are presented for comparison in tabular form along with the other evaluated options in Tables 16 and 17 in Section VII of this report.

Based on the implementation schedule presented in Section VII, the regional system could be in place and operational in December of 1996. Careful planning is necessary to schedule right-of-way acquisition, preliminary and final engineering, permit applications, staff recruitment, bidding, construction and start up to meet this ambitious schedule.

I - INTRODUCTION

A. BACKGROUND

Possum Kingdom Lake was completed in 1941, and since that time its water has been used for many purposes such as power development, industry, recreation, irrigation and drinking water. Many individual treatment systems have been utilized over the past 50 years to improve the quality of the lake water for consumption. Over the same period of time, drinking water regulations have become increasingly more stringent. In August of 1991, the Texas Department of Health's Water Hygiene Division, now part of the Texas Water Commission (TWC), which is now a part of the Texas Natural Resources Conservation Commission (TNRCC), began notifying some of the public water supply systems around the lake that they did not comply with the current rules and regulations. The Attorney General's office also became involved in a few of these cases.

The water from the Lake is high in chlorides, sulfates and total dissolved solids, and requires costly advanced treatment to conform to current regulations for public water supplies. In an attempt to find economical solutions to provide acceptable potable water around the lake, the Possum Kingdom Water Supply Corporation was formed. The Corporation was established by several commercial operators in the area located around Possum Kingdom Lake. The Corporation subsequently contracted with the Brazos River Authority (BRA) to manage a Preliminary Engineering Study for a regional water supply system. The study is funded by the Corporation, the Texas Water Development Board (TWDB) and with in-kind services from the BRA.

On April 21, 1992, a meeting of commercial camps/operators was held in response to enforcement actions taken by the TWC and the Attorney General. At that time, the Corporation was formed to provide the basis to conduct a regional study to investigate a solution to the common problem of the commercial camps/operators; that of noncompliance with the TWC rules and regulations for public water systems. To encourage the commercial camps/operators as well as others to participate in this feasibility study, the TWC instituted bilateral compliance agreements, which obligate the individual who signs the agreement to participate with the Corporation, or face additional enforcement actions.

Several of the water systems have Attorney General action pending, and many more have impending TWC enforcement action. Consensus of the board of the Corporation, as well as the other area water systems, is that they do *not* want to provide unsafe water to their customers and patrons, and over the years, each system has individually tried to find a solution to the

potable water issue. Some compensate for a lack of complete treatment by providing, or making available, bottled water and warning their customers not to drink the tap water. Some systems installed and operate full reverse osmosis systems at considerable expense. Each system is currently independent of all others, except in a few circumstances. Independent systems of such small size do not lend themselves to economy of operation, nor to quality of treatment. Most water system operators desire to "get out of the water business", and back to their primary occupation, whether it be camp manager, or retail business owner.

Each lake property lessee or owner provides their own water, generating a large number of individual systems around the lake. A majority of these individuals pump directly out of the lake to provide water for bathing, toilets, and cleaning. Drinking water is either treated through the use of an individual water softening and/or reverse osmosis system or brought in from other sources such as bottled water or water hauled and stored in bulk tanks.

Possum Kingdom Lake water has been shown to be high in chlorides, sulfates, and total dissolved solids, all violations of the TWC secondary standards applicable to potable water systems placed in service after July, 1977. Additionally, all treatment processes for surface water must achieve removal or inactivation of Giardia cysts and removal or inactivation of viruses. However, as more extensively discussed in Section V, each of these constituents (chlorides, sulfates, total dissolved solids, Giardia cysts, and viruses) have their own specific health concerns. These health aspects are the primary issue behind the TWC rules and regulations concerning the provision of water for human consumption. While each water operator is legally required to provide safe, potable water for consumption by the public which they serve, individual residences are not regulated. This does not exempt these individuals, however, from any potential ill effects from the consumption of untreated water.

As previously discussed, many commercial operators and individuals use lake water for washing, bathing and sanitary plumbing facilities, and use bottled or hauled water for drinking. However, the separate supply of water for drinking does not satisfy current TWC regulations. The TWC definition of drinking water is "all water distributed by any agency or individual, public or private, for the purpose of human consumption or which may be used in the preparation of foods or beverages or for the cleaning of any utensil or article used in the course of preparation or consumption of food or beverages for human beings." Human consumption is defined by the TWC as "uses by humans in which water can be ingested into or absorbed by the human body. Examples of these uses include, but are not limited to drinking, cooking, brushing teeth, bathing, washing hands, washing dishes, and preparing foods."

Generally, complete treatment systems are limited to commercial operators. Most treatment systems on the lake which can meet current TWC standards for drinking water contain the following equipment:

(1) Raw water supply pumps and water lines to bring the water from the lake to the treatment facilities.

(2) Conventional treatment facilities to filter the water.

(3) Advanced treatment facilities to demineralize the water.

(4) Chemical disinfection facilities.

(5) Clear water storage for treated water.

(6) Water distribution pumps.

(7) Water distribution pipelines.

(8) Elevated water storage tanks or pressure tanks to maintain system pressure.

It is the desire of the TWC that all water users in Texas have drinking water which meets current standards. However, the TWC only regulates the public water systems. The TWC regulations state that a public water system "must have a potential for at least 15 service connections or serve at least 25 individuals at least 60 days out of the year." Although the definition excludes all the individual users around the lake, and even some of the commercial suppliers, it does include many commercial suppliers at camps, motels, restaurants, etc. This report addresses the feasibility of providing potable water meeting current and anticipated future regulations for users around Possum Kingdom Lake.

B. SCOPE OF STUDY

Shimek, Jacobs & Finklea, in association with Reynolds-Hibbs & Associates and Wastewater Technology Service, Inc., was retained by the BRA to perform the preliminary engineering study. In general, the scope of the Preliminary Engineering Study is as follows:

(1) Audit existing water supply systems operating in the Possum Kingdom Lake vicinity.

(2) Investigate alternative sources of water supply.

(3) Evaluate treatment processes available to treated water from Possum Kingdom Lake.

(4) Evaluate water distribution system alternatives.

(5) Prepare cost estimates for potential regional water supply systems.

(6) Evaluate funding alternatives and estimated costs to water customers.

Public meetings are to be held to review the draft report and receive public comments.

C. STUDY APPROACH

The following approach was used to evaluate the feasibility of a regional water supply system for the Possum Kingdom area:

(1) Meet with the Possum Kingdom Water Supply Corporation and the BRA to confirm study parameters and objections.

(2) Obtain information from the TWC to confirm current rules and regulations for public water systems.

(3) Review existing lake water quality information.

(4) Inventory existing water treatment, transmission, distribution and storage facilities utilizing American Water Works Association audit procedures.

(5) Obtain information concerning existing large water supply systems in the region and evaluate their potential for service at the lake.

(6) Identify and evaluate water treatment alternatives.

(7) Determine existing and future water system demands and computer model potential distribution systems to serve the lake area.

(8) Meet with BRA Possum Kingdom Lake project manager to discuss potential systems.

(9) Compile data obtained during study for inclusion in report.

(10) Analyze funding alternatives and determine proposed system cost with the assistance of the BRA staff.

A substantial amount of time was spent during the study visiting each commercial operations around the lake which have public water systems as identified by the TWC. Equipment was inventoried and information was obtained concerning the system's capacity and customer use. Information obtained during the field visits is summarized in Section IV of this report and is shown in more detail in the field survey summary in the Appendix of this report.

II. - PROJECT PLANNING AREA

A. INTRODUCTION

The project planning area is defined in the *Application to Texas Water Development Board, Austin, Texas, for Regional Water Supply Planning Grant for Possum Kingdom Regional Water Supply System, August, 1992*, by the Brazos River Authority, to include the 310 miles of shoreline of Possum Kingdom Lake. This is located in the Brazos River Basin, specifically in Palo Pinto, Stephens, and Young Counties.

This project was initiated in response to enforcement actions by the Texas Water Commission and the Attorney General against several public water systems within the planning area. Consequently, the project area was more narrowly defined to include the systems under the TWC bilateral compliance as well as commercial contributors to the Possum Kingdom Water Supply Corporation. Residential participation is included in a generalized manner, and will need to be more fully developed in a focused feasibility study.

B. LOCATION

Table 1 lists the commercial camps/businesses which participated in the study. Participant locations are shown graphically on Figure 1, *Location Map of Study Participants*.

TABLE 1

STUDY PARTICIPANTS

Map I.D. #	Commercial Operator
21	Bailey's Camp
27	Bass Hollow Lodge
4	The Bend Condominiums
28	Bobby Holder Memorial FFA Camp
2	Brazos River Authority - Sheppard Dam
3	The Cliffs
13	Camp Constantin
23	Cruse Lake Store
46	Erath County Electric Co-op
32	Faith in Action
29	Fox Hollow Camp
26	Gordon Simmons Service/Hardware Plus
11	Camp Grady Spruce: Main Camp and Ray Bean - YMCA
16	Camp Grady Spruce: Frontier Unit - YMCA
40	Groves Mechanical
58	Jessie's Acres
25	Jones MH Park
56	KOA Campground (PROPOSED)
36	Lakeshore Marina & RV Park
10	Lakeview Lodge
48	The Landing Condominiums
62	Lefty's Camp
49	Log Cabin Lodge
59	Long's Camp

Map I.D. #	Commercial Operator
45	Malt Shop
24	McDonald Investments
53	Ole Smokey Restaurant & Rainbow RV Park & Lodge
38	One Mountain Place
61	Pat & Uncle Herman's Camp
30	Phantom Hollow Marine
54	Pickwick Homeowner's Association
44	P.K. Lions Club
65	P.K. Lodge
51	Ponderosa Condominiums
31	Possum Hollow Camp
20	Possum Kingdom State Recreational Area
39	Possum Point Restaurant
66	Rock Creek Camp
18	Sandbar Village
5	Scenic Point Lodge
22	Shaker's Trailer Park/West Side Water Group
63	Sky Camp
42	The Trading Post
8	Villa Marina
57	Willow Beach Trailer Park & Resort
50	Willow Condominiums
52	The Winds Restaurant

The final study area includes only Stephens and Palo Pinto counties, since no participating commercial camps/businesses listed above are located in Young county. However, the City of Graham and Fort Belknap Water Supply Corporation, both located in Young County, are included for the option of providing potable water to the Possum Kingdom Water Supply Corporation.

C. GROWTH AREAS

Growth potential is limited around Possum Kingdom Lake. The Brazos River Authority controls leasing of the majority of the waterfront property and has indicated that there is no immediate plan to issue new leases for previously unleased property. Currently, canceled leases reverted back to the Brazos River Authority, and are not reissued. There are five future public areas planned, but once again, not in the immediate future. Privately owned areas, such as Gaines Bend, still have large amounts of undeveloped property and appear to have the largest growth potential around the lake.

Ultimate development of these areas, as well as any unused capacity of the commercial areas, have been included in the ultimate demand of a regional system. Areas with undeveloped shoreline could also be developed in the future in response to demand, if approved by the BRA.

The Brazos River Authority has indicated that only 50 to 75% of desirable shoreline has been developed (subdivided), and development of all or part of the remaining 25 to 50% could occur. It is difficult to speculate which, if any, of the potential growth areas will develop. The feasibility of a regional potable water supply system will therefore, be evaluated based on the current level of development (including any unused capacity of commercial areas) within the planning area. Future development can then be served by a regional system through properly planned phases. This approach, typically used in the development of rural water supply systems, protects the system's charter membership from the financial and operational problems associated with a system oversized to accommodate growth that never occurs.

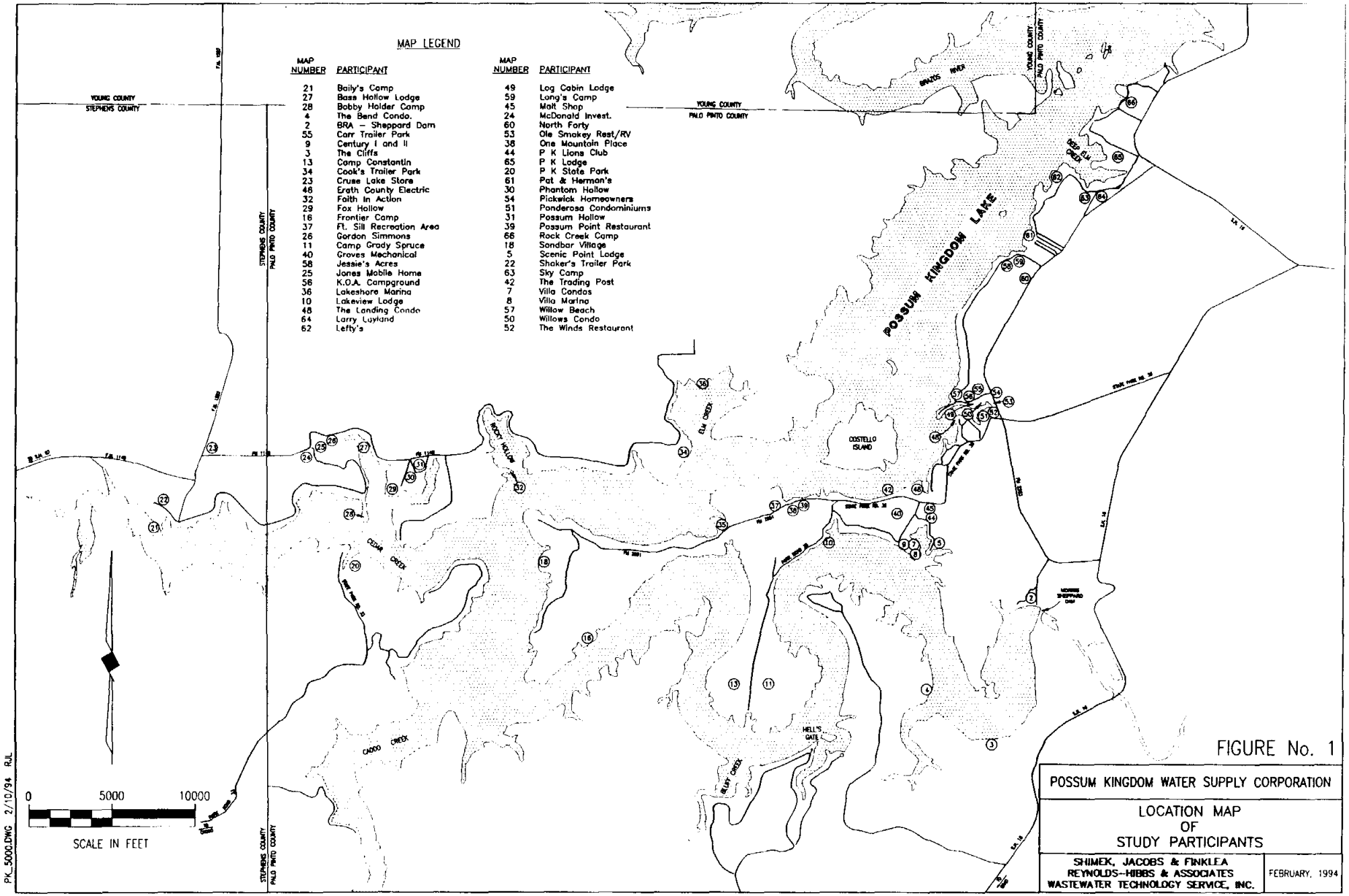

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FIGURE No. 1

POSSUM KINGDOM WATER SUPPLY CORPORATION

LOCATION MAP
OF
STUDY PARTICIPANTS

SHIMEK, JACOBS & FINKLEA
REYNOLDS–HIBBS & ASSOCIATES
WASTEWATER TECHNOLOGY SERVICE, INC.

FEBRUARY, 1994

III. - WATER REQUIREMENTS

A. INTRODUCTION

Water requirements for a regional water supply system depends on many different factors. In fact, the presence of a reliable regional water system will likely increase the population growth trends in the area and likewise the potable water requirements. Historical population and water usage records provide indications of future regional demands; however, these should be used as a trend guide only. Actual population projections and water use requirements for a system of this type require specific targets for the population to be served and for the ultimate system capacities. Therefore, it is important to analyze the water requirements accurately and concisely to properly determine the feasibility of a regional system. To that end, considerable effort has been extended to determine both water use requirements and projected system requirements within the planning area.

B. REGIONAL POPULATION PROJECTIONS

The estimating of future population growth for this region is difficult; past trends appear to be of little value since future changes in population will be influenced by many factors, including the development of adequate and reliable supplies of treated water. Additionally, population within the planning area is influenced by the BRA. Leasing of most waterfront property is controlled by the BRA, which also limits the size of commercial operations.

The Texas Water Development Board, Planning Division, Water Use and Projections Section, has expended considerable effort in projecting future population and water needs throughout the State, and their studies are currently the best information available on estimated population growth.

The rural population figures of the three county areas around Possum Kingdom Lake as developed by the Texas Water Development Board in their 1989 report are shown in Table 2. However, their projections of population were made for the purpose of arriving at overall water needs and may, or may not, be appropriate for use in designing and financing a Possum Kingdom Regional Water System.

TABLE 2

AREA POPULATION PROJECTIONS

Year	Palo Pinto County	Stephens County	Young County	Regional Totals
1985	10,326	3,093	6,044	19,463
1990	10,589	3,050	6,245	19,884
2000	13,122	3,503	6,967	23,592
2020	19,116	4,360	7,930	31,406
2040	22,078	5,366	8,247	35,691

There is a practical limit to the debt the Possum Kingdom Water Supply Corporation can obligate itself to serve future growth. Of course, these population estimates include areas of each County which are well outside the practical limits of the Possum Kingdom Water Supply Corporation service area. For this reason, the regional population projections for the study planning area are limited to those individual BRA leased lots immediately around Possum Kingdom Lake, businesses and developments around the lake, the Possum Kingdom State Park, Camp Constintin, the YMCA, Camp Grady Spruce and Frontier Camp.

Regional population figures, presented in Table 3, are derived from surveys of participating businesses and developments around the lake, 1992 maximum day headcount numbers at the public use facilities provided by the Brazos River Authority, and an estimated density of three (3) persons per unit on the individual leased lots. Surveys of businesses/developments participating in the study were conducted in the field using audit procedures provided by the American Water Works Association (AWWA). Population equivalents reported during the survey were verified against TWC and BRA records.

TABLE 3

PLANNING AREA POPULATION

	No. of Connections	Estimated Population Equivalent
Commercial Operators	1,640	8,794
Residential Customers	1,800	5,400
Totals	**3,440**	**14,194**

Again, it is important to note that the Brazos River Authority has indicated that it does not anticipate opening up any new areas in the near future for the purpose of individual leases around Possum Kingdom Lake. Further, as individual leased lots revert back to the control of the BRA, those lots are currently not available for leased use again. The BRA has indicated that

the five (5) remaining public use areas will be developed in the near future. Those areas have been included in the regional populations projections. For these reasons, the regional population projections tabulated above constitute the maximum population the Possum Kingdom Water Supply Corporation will likely serve.

C. REGIONAL WATER USE PROJECTIONS

During the course of this study, meetings were held with a representative of the Possum Kingdom Water Supply Corporation study participants to review available records and make an inspection of existing facilities. As previously discussed, AWWA audit materials were utilized during the on-site inspection of the commercial operators.

Almost all of the commercial operations that were surveyed do not maintain water use records. Similarly, since most residences provide their own water either by pumping lake water, using well water, or hauling water, there is no way to accurately identify the historical residential water use. Complicating the development of reliable water use projections is the wide fluctuation between commercial usage identified during the on-site survey and calculated usage based on TWC criteria as shown in Table 4. Additionally, a majority of residential properties around Possum Kingdom Lake are "weekend" users (estimated at 80%). Maximum demand, therefore, will most likely occur during only a few summer weekends.

TABLE 4

COMMERCIAL WATER USAGE COMPARISONS

Study Participant	Actual Usage	Calculated Usage (TWC Criteria)	% of Calculated Usage
A	3.4 gpm	29.2 gpm	12 %
AD	6.9 gpm	25.8 gpm	27 %
AN	10.4 gpm	17.4 gpm	60 %
AS	32.7 gpm	91.8 gpm	36 %
AV	34.5 gpm	90.8 gpm	38 %
BC	0.7 gpm	2.5 gpm	28 %
N	0.8 gpm	14.4 gpm	6 %
Q	20.2 gpm	14.5 gpm	139 %
R	< 0.1 gpm	0.6 gpm	17 %
V	4.7 gpm	7.0 gpm	67 %
W	35.8 gpm	12.8 gpm	280 %
X	20.0 gpm	8.2 gpm	244 %

Because of the variable commercial demands, it was concluded that the Texas Water Commission's minimum standards for maximum daily demands for supply and peak hourly demands for distribution be used for this study. Based on a review of the available records, this

is believed to be a conservative approach to the maximum daily and peak hourly demands on a regional water supply system.

In order to fully analyze the best approach for a regional water supply system, several alternatives were considered for the maximum number of participants in the system. In all approaches, it was assumed that 100 percent of the commercial operators such as businesses, camps, marinas, lodges and resorts will be customers of the system. Individual leased lots, representing residential use, were analyzed at participation levels of 0%, 20%, 50%, 80% and 100%.

Table 5 presents the water demand, associated with various levels of residential participation, that has been adopted for the design purposes of supply and distribution for each option evaluated. These values were determined by applying the Texas Water Commission's minimum standards to the number of potential system connections for each alternative.

TABLE 5

REGIONAL WATER USE PROJECTIONS
(All Options Assume 100% Participation by Commercial Operations)

Alternate Number	Percent of Leased Lot Participation	Number of Equivalent System Connections	Maximum Day Demand
1	100 %	3,440	2.96 MGD
2	80 %	3,170	2.74 MGD
3	50 %	2,752	2.37 MGD
4	20 %	2,686	2.20 MGD
5	0 %	1,640	1.42 MGD

A more detailed summary of the water use calculations for each option is shown in the Appendix.

The Possum Kingdom Water Supply Corporation, with the assistance of the Brazos River Authority, conducted a survey of residential leases to evaluate the support for a regional water supply system. The survey was conducted by mail, and results received indicate the most likely scenario is a 50 percent participation level in the regional water system by individuals. For that reason, the detailed analyses have focused in on a 50% level of participation. However, analyses were performed on individual participation at levels of 0%, 20%, 80% and 100%, which will be useful for the development of a focused feasibility study when residential participation is firmly established.

(1) **Commercial Operator Water Use Projections**

The water usage of most commercial businesses/camps is limited by the Brazos River Authority through commercial lease, which establishes the number and type of units, or by water contract, which establishes the maximum amount of water allowed to be taken from Possum Kingdom Lake annually. Some of these leases and water contracts allow for additional units, such as mobile home or recreational vehicle sites. These additional units have been included in the calculated usage. Commercial water use projections are based as discussed in Paragraph C above on the TWC minimum standards for average daily demand. Projections range from a low of 0.1 gpm (144 gpd) up to a high of 91.8 gpm (132,192 gpd). Commercial camps/businesses were calculated individually to aid in the conceptual design of a regional distribution system discussed in Section V of this report.

(2) **Residential Water Use Projections**

Residential water usage in this regional study is limited to the lots leased to individuals around the shoreline of the lake by the Brazos River Authority and those lots along the shoreline in the Gaines Bend area. The Cliffs residential development, located on the southern shore of the lake, just west of Morris Sheppard Dam, is not included in the regional water use projection calculations. The Cliffs is served by a water treatment plant designed with an ultimate capacity adequate to meet the needs of the development. To develop excess capacity to serve the entire lake as a regional treatment facility would require extensive plant expansion in addition to approximately one mile of additional large diameter water line (12" to 14" diameter) and an additional lake crossing. For these reasons, it is recommended that the regional system is best served by allowing the Cliff's development to continue to operate as an individual water system, separate from the regional system. Section IV-C of this report discusses the Cliff's treatment facility in greater detail.

An attempt was made to serve every leased lot around the lake. However, the southern portion of the Caddo Creek area, located at the western end of the lake, was not included due to the isolation of the area and sparsity of subdivided lots. Utilizing the Brazos River Authority's Map of Leased Land at Possum Kingdom Lake, regional water systems were designed to reach the lots for every alternative except the scenarios which serve the commercial operators only.

The total number of individual leased lots around the shores of Possum Kingdom Lake, including the lots available for lease in the Gaines Bend area, is approximately 1,800. Using the minimum 0.6 gallons per minute (gpm) per connection (TWC regulation)

generates a maximum daily residential demand of 1,080 gallons per minute or 1.56 million gallons per day (MGD).

Of course, a substantial portion of these leased lots are seasonal in use and would not consistently contribute to the maximum daily demand. However, it is reasonable to conclude that the maximum daily demand will occur during peak recreational times at the lake and a vast majority of the leased property will be occupied during those times.

Given the numerous factors that affect residential participation (including the results of the BRA's residential survey discussed in Paragraph C above) and water use projections in a regional water system such as the one proposed for the Possum Kingdom Lake Area, the residential water use projections were difficult to predict. Therefore, several alternatives were analyzed utilizing various levels of residential participation and consequently residential maximum daily and maximum hourly demands. Table 6 summarizes the residential water usage for maximum daily and peak hourly demands for the various scenarios considered.

TABLE 6

RESIDENTIAL WATER USE PROJECTIONS

Option Number	Percent of Residential Participation*	No. of Residential Connections	Maximum Day Usage	Peak Hour Usage
1	100 %	1,824	1.6 MGD	3.9 MGD
2	80 %	1,548	1.3 MGD	3.3 MGD
3	50 %	1,136	1.0 MGD	2.5 MGD
4	20 %	723	0.6 MGD	1.6 MGD
5	0 %	0	0 MGD	0 MGD

*NOTE: All options assume 100% participation by residential customers in the Hog Bend and Gaines Bend areas.

D. PROJECTED DEMANDS ON WATER TREATMENT FACILITIES

The projected demands on the water treatment facilities for the regional water supply system depends on the numerous alternatives which are under consideration in this study. In general, the calculated maximum daily water demand on the regional system ranges from a low of 1.4 MGD to a high of 3.0 MGD. In order to serve all of the commercial operations and at least half of the residential customers from a single source treatment facility, a maximum day capacity of 2.37 MGD is required. These capacities are based on the Texas Water Commissions minimum requirements for treatment capacities. In general, a maximum daily demand of 0.6 gpm per connection was used to generate the maximum day treatment capacities.

Developing a regional system to meet the varying demands of potential customers of the Possum Kingdom Water Supply Corporation provides a unique challenge. Commercial camps/businesses depend on the summer vacation months to fill their areas. Residential lots (with approximately 80% considered as "weekend" users) are also utilized more during the summer months, with peak occupancy over long holiday weekends. Peak demand is, therefore, likely to occur only 2 - 3 times per year over a 3 - 4 day period. During the winter months, particularly weekdays, the demand for potable water will be minimal.

Distribution systems must be capable of meeting peak demands. Water treatment facilities must provide adequate quantities of potable water for distribution. However, the traditional design of treatment facilities to provide maximum day demand will result in a facility that is under utilized during the majority of the year. In Section V, consideration will be given to developing the treatment facilities to meet average day demand, with increased storage to provide adequate supplies of potable water to meet maximum day conditions.

IV. - EXISTING WATER SUPPLY SYSTEMS

A. INTRODUCTION

The existing commercial operator's water supply systems were surveyed to determine their current treatment capabilities and associated deficiencies, according to the latest Texas Water Commission criteria. Materials used in the surveys were the American Water Works Association water audit forms, a preliminary survey conducted by the Brazos River Authority on commercial operators, and other available information including Texas Water Commission annual sanitary surveys.

Over 48 site interviews were conducted, as well as numerous phone calls, to obtain accurate information on each system. Information obtained in these surveys is located in various forms throughout this report. This section provides a summary of the information available on existing commercial water supply systems within the planning area. Residential systems used by individuals were not evaluated. A discussion of a "typical" residential system is presented in paragraph G.2 of Section V.

B. EXISTING WATER SUPPLIES

The commercial camps/businesses surveyed receive water from a variety of sources. Most use Possum Kingdom Lake water, treated or otherwise. A significant number of operators provide drinking water through the use of bottled water, such as Ozarka, or by hauling water from the City of Graham (water is stored in bulk storage tanks on-site). A small number of operators on the east side of Possum Kingdom Lake utilize groundwater, either primarily or as a secondary source. This groundwater is very shallow (15' to 60' in depth). Combinations of each of these sources is common, as operators try to comply with Texas Water Commission criteria, as well as provide water for the convenience of their customers.

C. EXISTING POTABLE WATER PRODUCTION FACILITIES

All water supply systems were evaluated using the latest Texas Water Commission Water Utilities Division *Rules and Regulations for Public Water Systems*, 1992. The first criteria applied to each system was to determine the specific type of water system. The following definitions were utilized:

> PUBLIC WATER SYSTEM - "A system for the provision to the public of piped water for human consumption, which includes all uses described under the definition for drinking water. Such a system must have a **potential for at least 15 service connections or serve at least 25 individuals at least 60 days out of the year** . . ."

COMMUNITY WATER SYSTEM - defined as "A public water system which has a **potential to serve at least 15 residential service connections on a year-round basis or serves at least 25 residents on a year-round basis.**"

NON-COMMUNITY WATER SYSTEM - "Any public water system which is not a community system."

Following these guidelines, the following table summarizes the water systems at Possum Kingdom Lake.

TABLE 7

SUMMARY OF EXISTING COMMERCIAL WATER SYSTEMS

Type Of System	Number Of Systems	Estimated Population Served
Groundwater/Community	6	788
Groundwater/Noncommunity	2	287
Surface Water/Community	13	1,746
Surface Water/Noncommunity	25	5,557
Not a Public Water System	8	381

Identifying the type of system is important in determining which Texas Water Commission criteria is applicable. For instance, while 200 gallons per connection of ground storage is required for all surface water systems, small groundwater systems, which have less than 50 connections, are not required to have ground storage capabilities, as long as other criteria are met.

While there is no such thing as a "typical" Possum Kingdom Lake commercial water treatment system, some generalities can be made. Most of the groundwater systems have more than one well, and chlorinate the water prior to distribution. The surface water systems are more varied, and can be further divided into two types of systems: (1) surface water treatment systems using one or more raw water pump to deliver the water to pressure tanks, which is then chlorinated, occasionally filtered but with insufficient size filters, and distributed; and (2) those systems which provide "advanced" treatment. Advanced treatment includes systems which utilize a water softener, a reverse osmosis system, or both. These advanced treatment systems commonly include numerous filters, as well as bulk storage capabilities. Systems identified as not meeting the definition of a public water supply

typically have water supply systems which range from no treatment to advanced treatment using water softening/reverse osmosis technology.

A majority of the commercial systems were in place prior to June, 1977, theoretically eliminating the required compliance with secondary standards such as chlorides, sulfates, and total dissolved solids. However, if any major upgrades or expansions are implemented at any of these existing facilities, compliance with current TWC regulations for secondary treatment will be required. Of all the systems surveyed, none were found to be in total compliance with Texas Water Commission criteria. Deficiencies varied from a total lack of water treatment to easily correctable defects such as color coding pipe and placing signs restricting access around the raw water intake.

Evaluation of the effectiveness of each of the water treatment systems could not be conducted due to a lack of water quality chemical analysis results. Therefore, the conclusion is drawn that conventional treatment, properly operated, will provide water that will meet primary standards, and advanced treatment, properly operated, will provide water that will meet secondary standards. Under this assumption, systems with facilities which meet Texas Water Commission criteria will be in compliance with State law, and capable of providing safe, potable water.

Complete treatment for surface water (Section 290.42.(d)) ". . . provides facilities for pretreatment disinfection, taste and odor control, continuous coagulation, sedimentation, filtration, covered clearwell storage and terminal disinfection of the water with chlorine or suitable chlorine compounds." Groundwater requires only disinfection if the water meets the drinking water standards (290.42.(b)). Facilities required if the groundwater does not meet the drinking water standards may include filtration, iron and manganese removal, or terminal disinfection.

Table 8 provides a summary of the deficiencies associated with the existing commercial water supply systems.

TABLE 8

SURVEY SUMMARY OF COMMERCIAL WATER TREATMENT SYSTEMS

Study Participant Designation	Deficiencies In Existing Public Water Supply Systems Identified During Site Visit																				
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21
A	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
B	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
D	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
E	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
F	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
G	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
H	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
I	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
J	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
K	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
L	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
M	♦	♦	♦	♦	♦	♦	♦			♦	♦	♦	♦		♦						
N	♦	♦	♦	♦	♦	♦			♦	♦	♦	♦	♦	♦	♦						
O	♦		♦						♦	♦						♦					
P		♦	♦	♦	♦	♦	♦	♦			♦	♦	♦	♦	♦						
Q														♦							
R			♦						♦		♦				♦		♦				

D1: Inadequate flow measuring devices
D2: Inadequate chemical injection
D3: Inadequate disinfection capabilities
D4: Non flash mixing/flocculation
D5: Non continuous coagulations
D6: No sedimentation
D7: inadequate filtration
D8: Inadequate bulk storage
D9: Inadequate pressure storage
D10: Inadequate raw water pump capacity
D11: Inadequate service pump capacity
D12: Inadequate treatment capacity
D13: No certified operator on duty or continuous chlorine/turbidity monitoring
D14: Improperly protected raw water intake
D15: Inadequate laboratory equipment
D16: Improperly protected wellhead
D17: Inadequate pressure
D18: insufficient raw water supply
D19: Possibly under the influence of surface water
D20: No sanitary easement
D21: No well driller's lob
D22: Inadequate chlorine residual

TABLE 8

SURVEY SUMMARY OF COMMERCIAL WATER TREATMENT SYSTEMS

Study Participant Designation	Deficiencies In Existing Public Water Supply Systems Identified During Site Visit																				
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21
S	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
U	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦				
V	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦			♦			
W					♦	♦			♦	♦	♦	♦	♦	♦	♦						
X		♦		♦	♦	♦							♦		♦						
Y	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
Z					♦		♦						♦		♦						
AB	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AC	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AD									♦			♦	♦	♦	♦						
AF	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AG	♦				♦		♦						♦		♦		♦				
AH			♦		♦		♦						♦		♦		♦				
AI	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AJ													♦		♦				♦	♦	♦
AK	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦				
AL	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						

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Study Participant Designation	Deficiencies In Existing Public Water Supply Systems Identified During Site Visit																				
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21
AN	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AO	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AP	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AQ	♦		♦	♦	♦	♦							♦		♦						
AR	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AS												♦		♦							
AT								♦	♦				♦		♦		♦				
AU	♦							♦	♦				♦		♦				♦		
AV	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AW	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AX	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AY	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
AZ	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦						
BA					♦		♦						♦		♦						
BB	♦			♦	♦	♦						♦	♦		♦						22

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One system which was not included in the above summary is the Cliffs Water Treatment Plant. The Cliffs Water Treatment Plant currently has a capacity of 100,000 gallons per day for irrigation water. The irrigation water is treated with a reverse osmosis unit, but is not disinfected, and is therefore considered non-potable and unsuitable for drinking water purposes. The treatment facility is currently operating at 50% capacity, due to restraints in the discharge permit for the brine by-product.

Ultimately, the treatment plant is designed to be capable of processing 1.15 million gallons per day of potable water. The original design utilized 5 stages of construction. The first phase would produce 250,000 gallons per day of potable water, the second phase would add additional capability of 150,000 gallons per day, and the third, fourth, and fifth phases would add an additional 250,000 gallons per day capacity each. When originally constructed, only a portion of the first phase was completed; 100,000 gallons per day non-potable irrigation water.

The Cliffs Water Treatment Plant was designed for a total of 1,250 residential sites, a golf course, club house and marina. Currently only the golf course and club house are on site. Estimates have been made by the General Manager of the Cliffs that the development will probably utilize only 30% of the total capacity. This would leave just over 800,000 gallons per day capacity, if the plant were expanded to the fullest extent possible.

Mr. G. E. (Bud) Marsh, P.E., designer of the water treatment system, has indicated that several components would be necessary to bring the water treatment plant up to potable drinking water capabilities. This includes a settling basin, additional reverse osmosis unit, and a minimum of 3 high service pumps. Also a second 12-inch pipeline would be required to deliver potable water from the treatment facility.

The initial apparent advantage of obtaining the Cliffs water treatment plant for use by the Possum Kingdom Water Supply Corporation fades once the facility is examined in the light of providing large quantities of potable water. Purchasing the water treatment plant, if it were possible to do so, would obtain for the Possum Kingdom Water Supply Corporation the following:

- Raw water intake, with high maintenance requirements;
- Building;
- 100,000 gallon bulk storage tank;
- 1,000 gallon pressure tank; and
- Plans for completion of the water treatment plant (approximately 7 years old).

Clearly, none of the treatment processes required to provide potable water are currently in place, and must be constructed. The Cliffs project engineer estimates the cost to bring the plant up to standards would be approximately $5,500,000. Construction of a new water treatment plant capable of providing the same 800,000 gallons of potable (Possum Kingdom Lake) water would cost approximately $2,500,000. In addition, the Cliff Treatment Plant is located just south of Morris Sheppard Dam in the very southwestern quadrant of the lake. To utilize only the excess 800,000 gallon capacity in this facility would require approximately one mile of additional linear feet of 8-inch and 10-inch diameter water line, a 1,000-foot long lake crossing along with an additional transfer pump station.

Another water treatment facility, also not included in the summary, which was considered as a source of potable water was the Fort Sill Recreation Area Water Treatment Plant. This facility has been out of service for many years, and its current condition is questionable, at best. The last sanitary survey, conducted by the Texas Water Commission in 1985, indicated that the allowable treatment capacity was 45 gpm, or 64,800 gallons per day. This could feasibly serve up to 75 connections. However, deficiencies noted in 1985 include the inability to meet secondary standards, inoperable intake, which was also located too close to a public dock, and improperly sealed clearwell storage. The primary deficiency, the inability to meet secondary standards, is a significant disadvantage in utilizing this facility in the overall water system. The cost to upgrade this facility to meet secondary standards, for only 75 connections, is prohibitive.

The Sportsman's World Water Treatment Plant was not surveyed for participation in the overall water system, as they specifically declined to be included in this study.

V. - WATER SUPPLY AND POTABLE WATER PRODUCTION ALTERNATIVES

A. INTRODUCTION

The scope of this study includes investigating various water supplies, treatment and distribution alternatives, all of which are designed to meet the intent of the Texas Water Commission standards for public water systems. To that end, several water supply and production alternatives were considered and analyzed, some viable and some not so viable but considered anyway. Those alternatives are presented in general in this section with detailed system analysis and cost estimates included in the Appendix.

B. APPLICABLE DESIGN CRITERIA

The design criteria for all alternatives for supply, treatment and distribution is from the Rules and Regulations for Public Water Systems, adopted in 1992 by the Texas Water Commission, Water Utilities Division. In general, all alternatives considered utilized surface water and included over 250 connections, therefore the following criteria for each system design was applied:

Raw Water Pump Capacity ..... 0.6 gpm per System Connection
Treatment Plant Capacity ..... 0.6 gpm per System Connection
High Service Pumps ..... 0.6 gpm per System connection
Water Distribution System Capacity ..... 1.5 gpm per System Connection
Minimum Allowable System Pressure ..... 35 psi
Fire Flows ..... None
Ground Storage Capacity ..... 100 gallons per System Connection
Elevated Storage Capacity ..... 100 gallons per System Connection

Minimum Water Line Sizes

Maximum Number of Connections	Minimum Line Size (Inches)
10	2
25	2.5
50	3
100	4
150	5
250	6
250	8 and Larger

C. FIRE PROTECTION

It is important to note that the regional water systems under consideration in this study **do not** include capacities for fire protection. In addition, cost estimates do not include any appurtenances for fire protection. This is not to say that a limited degree of fire protection could not be achieved during off-peak hours. Flush valves, which are typically provided in a rural water system, can furnish water for filling fire trucks. However, it should be clear to all parties that these systems do not meet the minimum requirements for fire protection.

Fire protection to the extent that homeowners' or commercial property owner's insurance will be reduced would not be accomplished just by having fire hydrants. The following items are required to lower a community's "key rate", which establishes the cost for fire insurance:

- Minimum of 6-inch diameter water lines;
- A maximum distance of 10 miles (measures over roads) to an approved fire station;
- Property to be protected must be within 750 feet of a 5,000 gallon reservoir or fire hydrant;
- The fire department must not have less than 10 men, with no less than 5 responding to calls. Regular drills, not business or social meetings, must be conducted twice a month; and
- Minimum requirements for fire fighting equipment must be met.

As shown by these items, fire protection requires more than fire hydrants. Other items which would be necessary would be the "looping" of water lines, as dead end lines are undesirable in a fire protection system.

D. WATER SUPPLY ALTERNATIVES

(1) Local Water Supply Alternatives

Local water supply alternatives now currently available are:

- Possum Kingdom Lake (surface water)
- Ground Water
- Hauled water (typically from Graham)

Possum Kingdom Lake water is readily available to the waterfront Brazos River Authority lessees, and is included in the lease for the property. Possum Kingdom Lake water is also available, by contract, to Brazos River Authority lessees not located on the water, and to the owners of deeded property around the lake. Quality of water, as has been discussed in other sections of this study, is poor. Quantity of water, however, is ample.

Ground Water is utilized in several commercial camps/businesses as well as in many individual residences. This ground water is unique to the Willow Beach area, and the source of water is reportedly the "Pickwick Springs" which were in existence before Possum Kingdom Lake was constructed. Wells in the area range from 16 to 60 feet in depth, making them all fall under the Texas Water Commission definition of potentially *under the influence of surface water.* The shallow depth also makes these wells susceptible to contamination.

Analysis of the maps of Major Aquifers and Minor Aquifers in the state of Texas, developed by the Texas Water Development Board, reveals no major or minor aquifers located in Palo Pinto, Stephens, or Young counties. There are numerous water bearing formations in the area, however most are of a quality not generally suitable for human consumption. Of the identified formations, none appear to be suitable as a raw water source, because of poor water quality, a lack of dependable water quantity (or yield), or a combination of both. The localized nature of the existing wells, as well as the yield limitations, make Ground Water an unattractive alternative for a water supply system.

The last alternative, hauled water, is generally not utilized by itself. Most systems that do not furnish complete treatment in their system provide drinking water through the use of commercial bottled water, or by hauled water brought in from the City of Graham. Potentially, this is an unlimited source; the quantity restricted only by the physical capabilities of the hauling trucks and Graham's ability to produce potable water.

(2) Regional Water Supply Alternatives

Numerous sources for regional water supply are available for the Possum Kingdom Regional Water Supply System. Those sources which were considered in this study are discussed below:

(a) Surface Water

Obviously, surface water is readily available for treatment and distribution. The commercial operators and individuals who lease lots from the Brazos River Authority already have Possum Kingdom Lake water rights included in their lease agreements. However, the Brazos River Authority has indicated a separate Water Rights Agreement with the Possum Kingdom Water Supply Corporation will be required. The estimated average daily demand for a regional system which serves all of the commercial operators and all of the residential lots is approximately 1.5 MGD or 4.6 acre-feet per day. The Brazos River Authority has estimated the cost of Possum Kingdom raw water to be $19.15 per acre-foot ($0.06 per 1,000 gallons). Possum Kingdom surface water, being high in chlorides, sulfates and total dissolved

solids, will require costly advanced treatment to conform to current TWC regulations.

(b) Ground Water

Ground Water near Possum Kingdom Lake is not available in quantities or quality that make this a economical, dependable or desirable alternative for a regional water supply system for the same reasons discussed in Paragraph C.1 above. Ground Water may be, in some cases, acceptable for small individual commercial operators; however, recent TWC regulations designed to improve water quality will likely cause the cost of maintaining a well site cost prohibitive for most individual operators.

Also, the shallow depth of the wells indicates that they may be under the influence of surface water. Should this prove to be the case, regulations for surface water treatment would be applicable. This includes full treatment, including facilities for:

- Pretreatment Disinfection;
- Taste and Odor Control;
- Continuous Coagulation;
- Sedimentation;
- Filtration;
- Covered Clearwell Storage; and
- Terminal disinfection of the water with chlorine or suitable chlorine compounds.

The limited quantity, in conjunction with the possibility of the requirement of full treatment, makes Ground Water unattractive as a source of raw water.

(c) Treated Water From the City of Graham

Graham Water Supply District

The City of Graham is located approximately 15 miles north of the western end of Possum Kingdom Lake. The City treats surface water from Lake Graham at its 2.0 mgd plant. This source is not high in chlorides and sulfates and consequently does not require costly advanced treatment. The Graham Treatment Plant currently has excess capacity of approximately 1.0 mgd and could be expanded to meet the ultimate needs of the Possum Kingdom Regional Water Supply System.

In order to transport the ultimate maximum daily demand from the Graham treatment facilities to a delivery point on the western end of Possum Kingdom Lake, approximately 85,000 linear feet of 14" diameter water transmission main is required, generally following a route along F.M. 1287. This includes a crossing of

the Brazos River. In addition, a 2 MGD treatment plant expansion is required at the Graham plant along with a pump station at the Graham facilities with a minimum of 2 - 225 HP transfer pumps and a 150 HP booster pump station approximately 2 miles south of Bunger. The point of delivery would be into ground storage tanks located immediately west of Highway 1287 near the intersection with Highway 1148 on the east. This is an ideal location from a hydraulics viewpoint in that it is relatively high ground for the Possum Kingdom Regional Water Supply System and the ground storage receiving tanks would act as elevated storage for the Possum Kingdom Regional Water System.

For the ultimate Possum Kingdom Regional System (3.0 mgd maximum day demand), the capital improvements cost to expand the Graham plant, construct transfer and booster pump stations and construct the necessary supply lines is estimated to be $6.7 million dollars. A detailed cost estimate on this option is included in the Appendix.

Graham water is currently priced at $1.60 per 1,000 gallons treated water.

(d) Other Regional Water Supplies

Several other water supply sources were considered in this study. After review none were determined to be economically feasible nor hydraulically practical. These other sources include the City of Mineral Wells, the City of Breckenridge, Stephens County Rural Water Supply Corporation and the Fort Belknap Water Supply Corporation.

The City of Mineral Wells, located approximately 27 miles east of Possum Kingdom Lake, has surface treated water currently available for $2.56 per 1,000 gallons. However, a rate study conducted for the City indicated a rate of $3.01 per 1,000 gallons is the true cost of the water. Conversations with the previous City Manager, Natalie Kelly, indicate that the City ultimately desires to sell water at the actual cost of $3.01 per 1,000 gallons. This does not include any capital cost required to transport the water from Mineral Wells to Possum Kingdom Lake.

The City of Breckenridge, located approximately 30 miles to the southwest of Possum Kingdom Lake provides treated surface water at a rate of $1.75 per 1,000 gallons. This supply would be available to a limited portion of Possum Kingdom Lake, namely the Possum Kingdom State Park, through the Stephens County Rural Water Supply Corporation. Existing Stephens County Supply Lines range in size from 3"-4" and reach as far east as the City of Caddo. Stephens County Water

Supply Corporation charges $5.00 per 1,000 gallons for supplying Breckenridge treated water.

Ft. Belknap Water Supply Corporation buys its treated water from the City of Graham and adds on $0.25 per 1,000 gallons to Graham's charge of $1.60 per 1,000 gallons. There appears to be no advantage in purchasing treated water from the Ft. Belknap Water Supply Corporation rather than purchasing treated water directly from the City of Graham.

E. WATER TREATMENT ALTERNATIVES

(1) General

Although the raw water in Possum Kingdom Lake has been widely used for consumption with little or no treatment, water produced and distributed by a public water system must meet all applicable standards set by the Texas Water Commission and the United States Environmental Protection Agency. The standards of the Safe Drinking Water Act of 1986 and the Surface Water Treatment Rule are those which now govern water treatment facilities. Although the water in the lake is well known for its general clarity, it is also well known for its high content of dissolved solids, primarily in the form of chlorides and sulfates. The concentration of these constituents must be reduced through a demineralization process.

All lake water distributed through a public water system must receive complete conventional treatment at a plant which provides facilities for pretreatment disinfection, taste and odor control, continuous coagulation, sedimentation, filtration, covered clearwell storage and terminal disinfection. In addition to the conventional treatment, the water from Possum Kingdom Lake requires advanced demineralization treatment. Normally the finished water pumped into the distribution system will be a blend of the filtered and demineralized water. This allows the most cost effective production of water which meets or exceeds the TWC regulations.

Finished water and approximate Possum Kingdom Lake raw water quality design values are as follows:

Constituent	Raw Water	Finished Water TWC Limit
Total Dissolved Solids (Mg/L)	1,900	1,000
Chlorides (Mg/L)	750	300
Sulfates (Mg/L)	400	300

Studies have shown that water with a total dissolved solids concentration of 1,000 Mg/L was rated between average and good. Finished water from this project should, therefore, be rated better than average by most people.

(2) Commercial Operator Treatment Facility Alternatives

Renovation of the existing commercial facilities to Texas Water Commission standards was considered. This could be performed in two different manners:

Each facility upgrade and operate independently, similar to the current situation. This is the default option if the "No Action" option is chosen by the Possum Kingdom Water Supply Corporation; or

Collectively improve each system and participate in a Water Supply Corporation for consolidation of daily operation and management responsibilities.

Since the Possum Kingdom Water Supply Corporation is in place, and is a viable legal entity, the collective system will be the one considered in this study. This collective system would utilize shared operators, as well as share in advantageous funding mechanisms which are available to the group as a whole.

There are three general types of treatment currently provided by the commercial camps/businesses, as discussed in Section IV. These include:

Typical Ground Water Systems;
Typical Surface Water Systems; and
Advanced Treatment Systems.

With these three extremely varied types of water treatment, different upgrade and operation costs exist.

By forming a single operating company, the total operating costs would be less than if each individual facility paid for the operations of each facility. Tabulated below are the estimated range of costs to upgrade the existing facilities. The variability of the costs is primarily a function of the flow rate of each facility. With a cooperative operations company, savings could be realized by purchasing chemicals and replacement parts in greater quantity. Furthermore, fewer personnel would be required to administer all of the facilities collectively versus individually.

Estimated Upgrade Costs - Commercial Treatment Systems

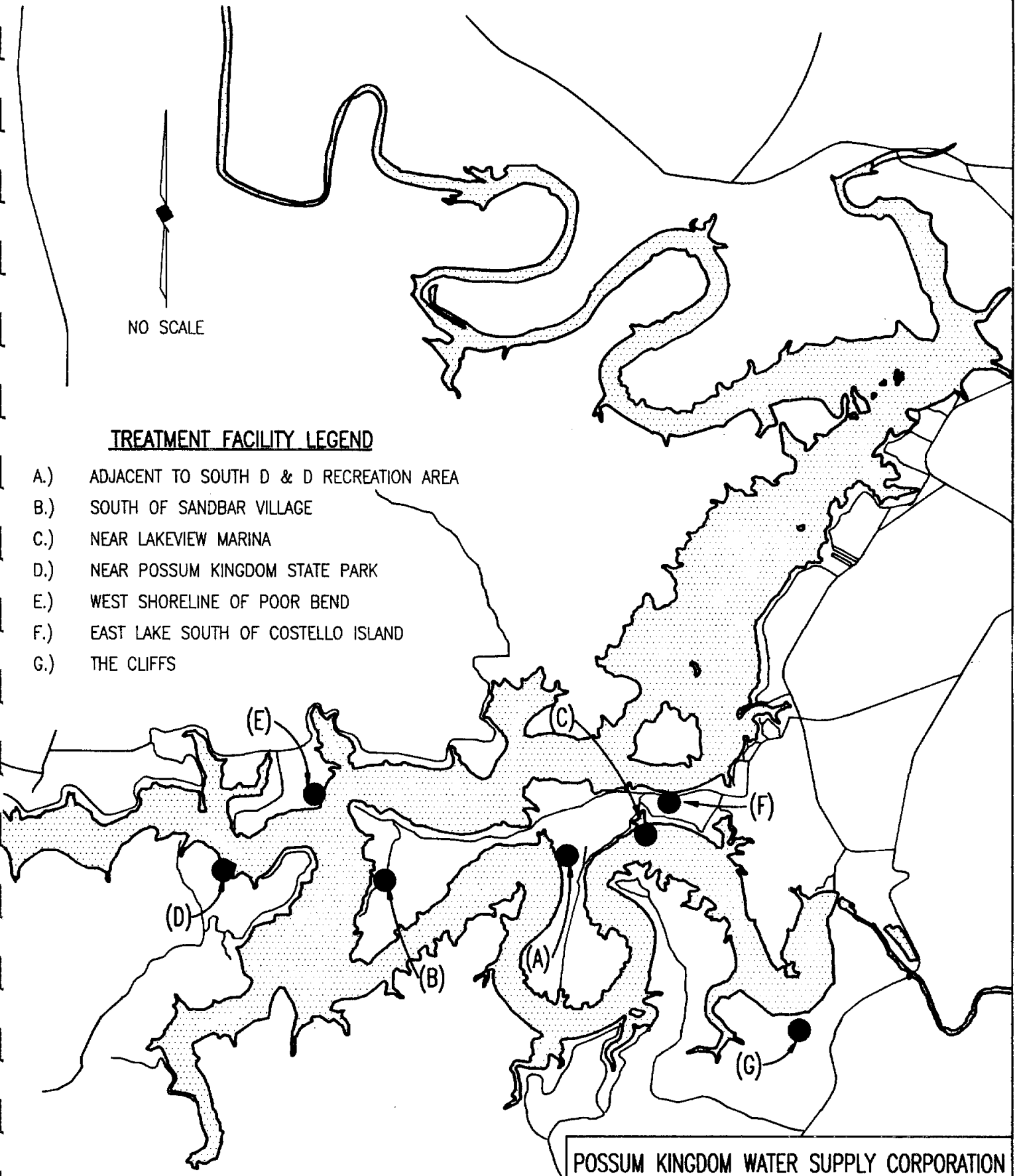
	Treatment System Capacity					
	1 GPM	1 - 14 GPM	15 - 29 GPM	30 - 44 GPM	45 - 60 GPM	60 GPM
Preliminary Treatment	N/A	$ 70,000	$100,000	$120,000	$135,000	$150,000
Advanced Treatment	$15,000	35,000	80,000	125,000	190,000	285,000
Total	**$15,000**	**$105,000**	**$180,000**	**$245,000**	**$325,000**	**$435,000**

Total capital cost to upgrade the individual systems is estimated to be approximately $8,400,000 for advanced treatment systems. Operation and maintenance costs, through the use of the common Possum Kingdom Water Supply Corporation with shared employees, is estimated to be $1,670,000 annually if all systems are operating advanced treatment units.

Costs to improve the facilities is a disadvantage to utilizing existing facilities. A majority of the existing facilities were in operation prior to July 1, 1977, the effective date of the *Drinking Water Standards Governing Drinking Water Quality and Reporting Requirements for Public Water Supply Systems.* Consequently, secondary constituent levels are theoretically only recommended. These secondary constituents include:

Constituent	Level
Chloride	300 mg/l
Color	15 color units
Copper	1.0 mg/l
Fluoride	2.0 mg/l
Foaming agents	0.5 mg/l
Hydrogen Sulfide	0.05 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 Threshold Odor No.
pH	7.0
Sulfate	300 mg/l
Total Dissolved Solids	1,000 mg/l
Zinc	5.0 mg/l

Historically, chlorides, sulfates, and total dissolved solids in Possum Kingdom Lake water have exceeded these recommended limits. Normally to remove constituents such as these requires advanced demineralization treatment, such as reverse osmosis or electrodialysis reversal. Even though the more stringent secondary requirements are not currently applicable, the TWC requires that any facility upgrade meet current requirements for advanced treatment. In addition, Ground Water considered under the influence of surface water is required to have complete treatment and, if necessary, advanced treatment.



POSSUM KINGDOM WATER SUPPLY CORPORATION

POSSUM KINGDOM LAKE

REGIONAL TREATMENT FACILITY ALTERNATIVES

SHIMEK, JACOBS & FINKLEA
REYNOLDS–HIBBS & ASSOCIATES
WASTEWATER TECHNOLOGY SERVICE, INC.

FEB., 1994

FIGURE No. 2

Additional disadvantages to upgrading the existing facilities include the chronic and continual need for repair and replacement of equipment, constant monitoring, and a less reliable water supply system. Operation of each existing facility, even updated to Texas Water Commission criteria, will require even more extensive continual repair and replacement of equipment than each operator is currently experiencing.

Comments from numerous commercial camp/business individuals during the on site interviews indicate they are longing to get away from the daily maintenance, monitoring and testing required of their system. All these individuals treat water only as a secondary consideration to their primary enterprise, and most indicated a willingness and desire to release themselves of this constant responsibility.

The existing systems, as they are currently operated, generally have the system owner or the overall commercial camp/business caretaker as the only maintenance personnel available to repair any problems. Since these individuals remain extremely busy with the primary function of the commercial camp/business, maintenance of the water system often takes a "back seat" to other concerns. This, in addition to the relatively isolated locations of some of these commercial camps/businesses, does not provide for a reliable water supply system.

(3) Regional Treatment Facility Alternatives

A regional treatment facility for the Possum Kingdom Water Supply System would consist of complete conventional treatment, followed by partial demineralization and blending to obtain potable water which meets or exceeds TWC water quality criteria. Several sites were identified and reviewed for the proposed treatment plant. Sites considered around the lake were:

(a) Adjacent to the South D & D Recreation area;
(b) Just South of the Sandbar Village;
(c) Near Lakeview Marina;
(d) Near Possum Kingdom State Park;
(e) West side of Poor Bend across the lake from Sandy Beach Park;
(f) East side of the lake across from Costello Island; and
(g) The Cliffs.

These site locations are shown on Figure No. 2, Regional Treatment Facility Alternatives.

Potential sites were selected based on their close proximity to deep lake water for the intake facilities and their location near the center of the proposed water distribution system. The site at the South D & D Recreation area was selected for development of this study since it was the most centrally located and was not close to any developed lake lots. This site is shown in Figure No. 3, Treatment Plant Site Vicinity Map.

Depending on the number of customers served by the regional system, the treatment plant would need to meet an estimated maximum day demand of between 1.4 and 3.0 million gallons. The lower figure would serve all the expected business connections only. The higher figure would serve all the expected business and residential customers on the lake.

As shown in Figure No. 4, Treatment Plant Process Schematic, the major elements of the treatment facilities would be the raw water intake and pump station, chemical taste and odor control, pretreatment chemical disinfection, rapid mix, coagulation and sedimentation (solids contact), filtration, demineralization, terminal disinfection, and clearwell storage. The filtered water and demineralized water would be blended to conform to water quality criteria and pumped into the distribution system through high service pumps.

The raw water intake must be located in water of sufficient depth to provide a supply of water during periods of drought when the lake level could be substantially lower than the normal pool level. A location close to shore is preferred to minimize the cost of the intake facilities. A cast-in-place concrete pumping platform supported by steel encased drilled piers is proposed for the regional facility. Vertical turbine pumps would be installed in suction barrels with several inlet ports to allow withdrawal of water from different lake levels. This would allow withdrawal of the best quality water to be treated. The raw water pipeline would be supported by the pump station access bridge. This bridge would also support the process wastewater line from the demineralizer.

A modular design treatment plant utilizing prefabricated steel basins was studied for use for the regional treatment facility. The basins and equipment would be furnished to the plant site partially assembled, and installed in a prefabricated metal building at the plant site. Instead of traditional coagulation and sedimentation basins, the modular facilities would utilize contact clarifiers to trap and remove coagulated particles. Contact flocculation and clarification occur as the coagulated particles move through a polyethylene filter media; these processes are enhanced by repeated contact with previously trapped solids. The flow of water passes from the contact clarifiers to a mixed media sand filter. The sands are hydraulically graded from course to fine in the direction of the flow to allow full depth filtration and increased solids storage. Utilization of this type of "package" plant will substantially reduce the treatment plant cost, provide a

treatment facility that is easy to operate and maintain, and secured in an enclosed building. Disadvantages associated with treatment plants which eliminate traditional coagulation and sedimentation processes include additional backwash requirements and the possibility that a successful pilot study may be required to receive approval from the Texas Water Commission. In addition the Possum Kingdom Lake water may prove to be too corrosive to use the standard painted steel basins. Stainless steel or concrete basins may be required to compensate for the lake water.

Several process alternatives were considered for the demineralization equipment. These include the following:

Reverse Osmosis (RO): A process that applies pressure to feed water, forcing the water molecules through a semipermeable membrane. The membrane is constructed to selectively pass water through its pores, while leaving behind dissolved impurities in a brine solution that is discharged as waste.

Electrodialysis Reversal (EDR): A system that uses electrical power to create positive and negative charges, which in turn attract positive and negative ions through membranes. One type of membrane passes positive ions, the other type passes negative ions. The net result is that the impurities tend to concentrate in a brine that in turn is discharged as waste. With the EDR process, polarity is reversed periodically to minimize electrode corrosion and prolong the operating life between membrane cleanings.

Other demineralization processes were considered but were rejected. A distillation process where there is evaporation of water, and condensation of vapor to produce a purified product water was considered, but rejected on the basis of high energy costs and equipment cost when compared to RO or EDR. Ion exchange, commonly referred to as a zeolite process, is another process where various ions are removed from water to reduce or change ion content. The waste stream from an ion exchange process contains additive ions in high concentrations, normally sodium and chloride. This would require treatment of the waste stream which makes ion exchange neither economically nor environmentally attractive.

There are a number of RO units in service around Possum Kingdom Lake. These range in size from less than one GPM at individual residences to 60 GPM at the Sportsman World development. The RO process has proven to be successful in demineralizing Possum Kingdom Lake water.

The BRA constructed a regional water treatment plant in 1989 on Lake Granbury, a lake on the Brazos River downstream of Possum Kingdom Lake. The raw water quality in the two lakes is very similar. The Granbury plant has conventional treatment followed by EDR for demineralization. The treatment plant was originally bid with either RO or EDR to be used. The bids included an extended ten year warranty and maintenance contract for the demineralization equipment. The EDR equipment was selected through this process.

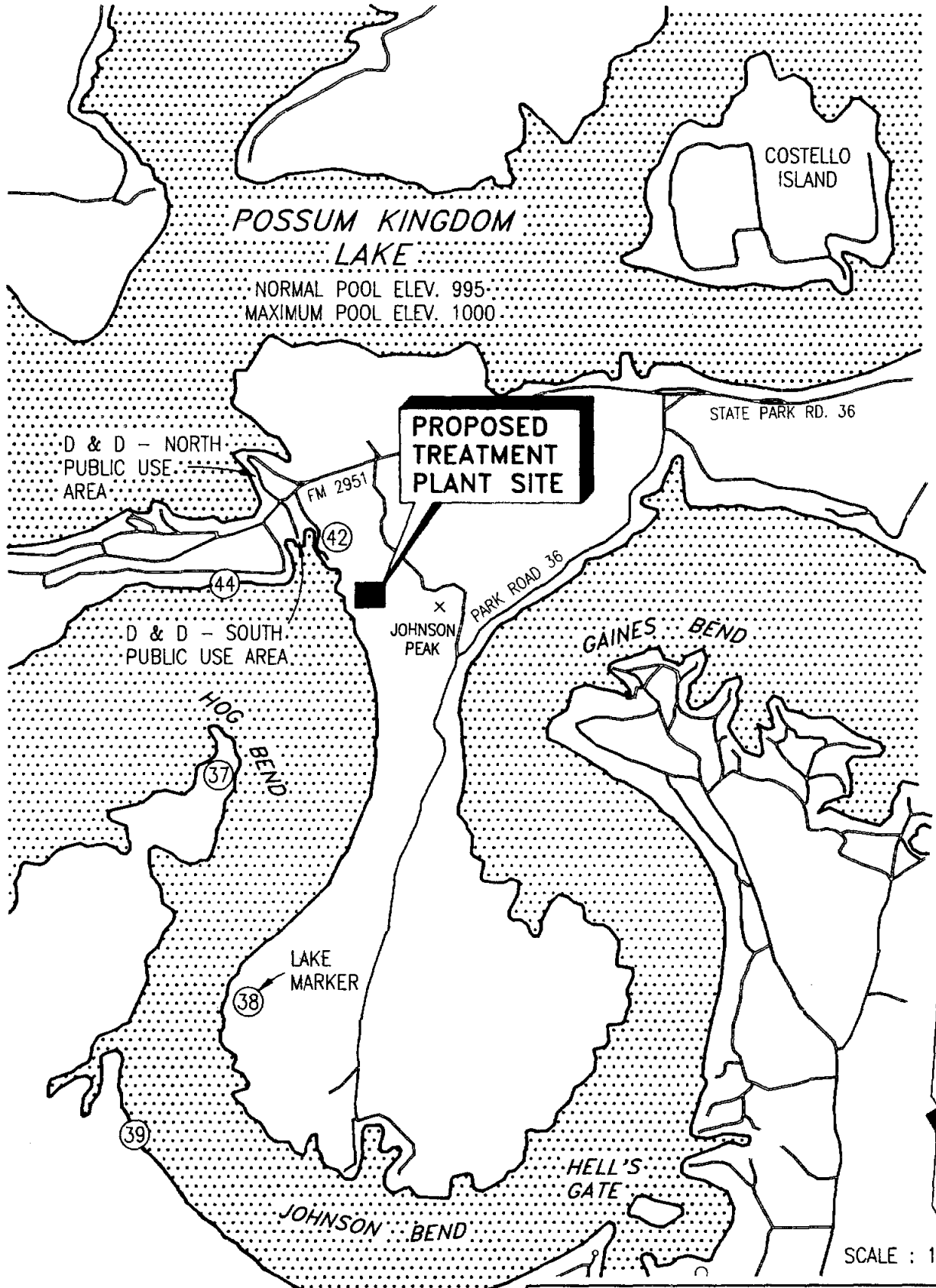
The BRA has now operated the Granbury plant for over three years, continually meeting or exceeding the TWC water quality criteria. Their staff is now well experienced in the operation of the EDR equipment, and the process of blending filtered and demineralized water. This experience will be invaluable to the operators of a regional treatment plant for treating Possum Kingdom Lake water.

(4) Estimated Cost of Treatment Options

The estimated cost of the proposed regional treatment facility was prepared utilizing construction costs from the Granbury plant and other water treatment plant improvements. In addition, manufacturers of the proposed package treatment equipment and demineralizer equipment provided estimating costs. An itemized cost estimate for a 3.0 MGD plant is as follows:

Raw Water Intake and Pumps	$ 800,000
Raw Water Supply Line	50,000
Treatment Facilities	3,600,000
Demineralization Facilities	2,400,000
Filtered Water Storage	150,000
Finished Water Storage	150,000
Process Waste Line	60,000
Sludge Lagoons	150,000
Subtotal	**$7,360,000**
Miscellaneous, Contingencies and Engineering	1,840,000
Total	**$9,200,000**

A tabulation of treatment costs for the various plant capacities considered for this report is included in the Appendix.



POSSUM KINGDOM WATER SUPPLY CORPORATION

POSSUM KINGDOM LAKE
TREATMENT PLANT SITE VICINITY MAP

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REYNOLDS–HIBBS & ASSOCIATES
WASTEWATER TECHNOLOGY SERVICE, INC.

FEB., 1994

FIGURE NO. 3

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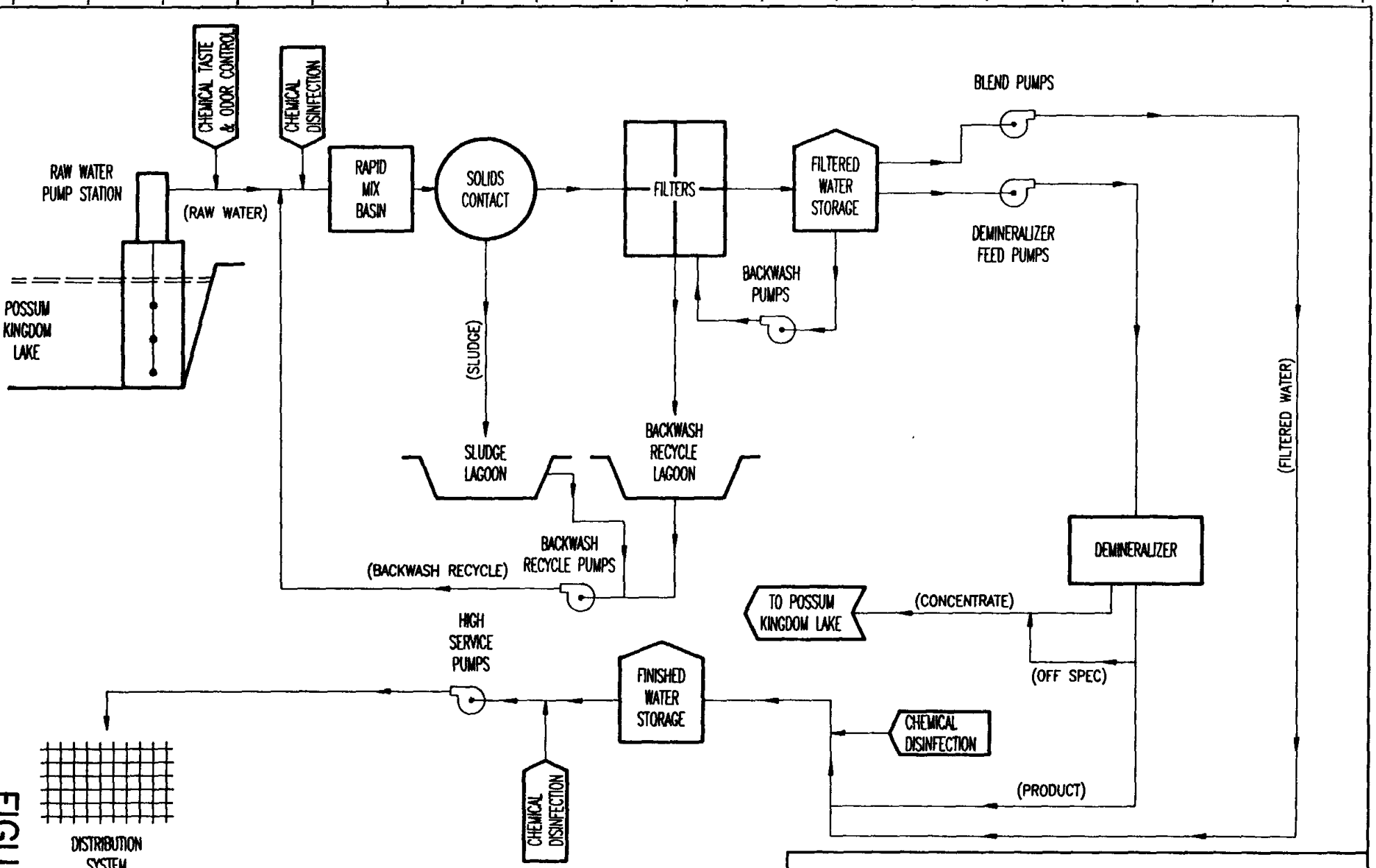

FIGURE NO. 4

POSSUM KINGDOM WATER SUPPLY CORPORATION

REGIONAL WATER SUPPLY SYSTEM
TREATMENT PLANT PROCESS SCHEMATIC

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REYNOLDS–HIBBS & ASSOCIATES
WASTEWATER TECHNOLOGY SERVICE, INC.

AUG., 1993

PROC-SCH.DWG

F. WATER DISTRIBUTION SYSTEM OPTIONS

(1) General

From the onset of this study, it was concluded that a regional water distribution system, at a minimum, should be planned which would serve all the commercial operators around the lake. Although numerous distribution system options were considered initially, it was seen rather quickly that an option that included as many individual leased lots as practical was the desirable approach. This is generally the case due to the varied locations of the commercial operators. A regional system to serve all commercial operators requires pipelines as far west as Bailey's Camp and as far east as Rock Creek Camp. These two points are approximately 13 miles apart straight line distance, and require at least one lake crossing to avoid an additional 37 miles of pipeline along the south shore line of the lake. Individual leased lots dot the lake between these commercial operations locations. In many instances, adding as many as 50 individual leased lots had no affect on the required distribution pipe size.

For each option described below, a water distribution master plan was developed and hydraulically analyzed utilizing the Cybernet Version 2.10 Water Distribution System Computer Program. System demands were calculated for every junction node in each option. In order to insure the planning of the minimum system required, the flow in each pipe was first calculated (using 1.5 gpm per connection) and the pipe sized to the minimum pipe diameter allowed per number of connections served as directed by the TWC regulations. This, of course, was not always the best hydraulic solution to the system and often this initial pipe size was increased in order to meet the minimum system pressure of 35 psi at all points in the system during the maximum hourly demands.

The following sections describe in general each option analyzed in this study. Consideration was given to size and length of pipes required, location and capacity of ground storage and elevated storage, and number of lake crossings required.

The summary tabulations included in the Appendix provide a more detailed look at the specific breakdown between residential and commercial customers and the specific number of connections included in the water system construction. In addition, a detailed cost estimate for each option considered is included in the Appendix. The regional water system cost estimate includes pipelines, pump stations, a treatment plant, ground storage and elevated storage of adequate capacity for the proposed distribution system and necessary system appurtenances.

It should be noted that these optional water distribution systems may not reflect the final system design. The size and locations of the pipe lines may vary somewhat when detailed

design of the system is completed and as any additional options develop. The primary purpose of these different analysis is to assist in determining the most cost effective approach to developing a regional water supply system. Once the best approach is determined by all parties involved, it is highly recommended that the approach be revisited and fine-tuned prior to moving into a design and construction phase of a water distribution system. It is anticipated that further analysis of the best approach will likely result in an overall system savings. However, minimizing the size of the distribution systems will result in higher delivery pressures requiring larger pumps and higher power cost. Minimizing the system's initial capital cost and long term operating and maintenance cost is the ultimate goal of this study.

Due to the segmented nature of the system and the necessity of crossing the lake several times in order to serve all customers from a single source treatment plant, consideration was given to analyzing and consequently constructing the regional distribution system in several phases. Each phase consist of areas isolated from the main eastern shoreline of the lake, such as Gaines Bend, Hog Bend and the Possum Kingdom State Park. In all options, the approach was that these remote areas could be added to the system at a later time. With the extreme expense involved in crossing the lake with water lines of adequate size to meet minimum TWC regulations, it was also assumed in all options that the participation level in these remote areas would be 100 percent of the individual leased lots. It is not practical nor economically feasible to cross the lake for partial participation in the regional system by a handful of the residents. Therefore, service to Gaines Bend, Hog Bend and Possum Kingdom State Park is considered as additive alternatives to each option presented. A detailed breakdown of each additive alternative system demand and cost estimate is included in the Appendix.

(2) <u>Distribution System Options</u>

Option No. 1: 100% Participation by Commercial Operators
0% Participation by Individual Leased Lots
Water Treatment Plant Near D & D - South Public Use Area

From an initial capital cost approach, this option is by far the least expensive of all the options considered. However, without the participation of any of the individual leased lot customers, the capital cost per system connection is one of the highest of the options analyzed.

This option requires a maximum daily demand of 1.42 MGD which is assumed to be provided by a single source supply consisting of a treatment facility located near D & D - South public use area. The maximum hourly demand is estimated to be 3.52 mgd. This

option includes a 1.4 MGD treatment plant, raw water intake structure, approximately 47 miles of pipe lines of various sizes, three separate lake crossings, approximately 177,000 gallons of ground storage, 165,000 gallons of elevated storage, and four booster pump stations. This system will serve approximately 1,640 customers. The estimated capital cost, including distribution system lines, lake crossings, pump stations, treatment plants, booster pumps, elevated storage and ground storage is approximately $8,270,000. These cost do not include raw water cost and annual operation and maintenance cost.

Option No. 2: 100% Participation by Commercial Operators
100% Participation by Individual Leased Lots
Water Treatment Plant Near D & D - South Public Use Area

This option is considered to be the ultimate system. It is designed to serve 100 percent of the commercial operators at their ultimate development along with all of the individual leased lots along the lake shoreline. It provides for a single source water supply located near the D & D - South public use area. Ultimate maximum daily demand for this system is approximately 2.96 MGD, with an anticipated maximum hourly demand of 6.64 MGD. This option includes a 3.0 MGD treatment plant, raw water intake structure, approximately 67 miles of water distribution lines of various sizes, four separate lake crossings, six booster pump stations, 300,000 gallons of ground storage and no less than 285,000 gallons of elevated storage. This system will serve approximately 2,839 commercial and residential connections in the initial phase and ultimately approximately 3,440 connections.

It is estimated the capital cost of the initial phase of this regional system, including plant construction, supply line, transfer pump stations, booster pump stations, elevated storage, ground storage and distribution system lines and one lake crossing is approximately $13,880,000. Adding distribution lines, lake crossings and elevated storage to serve the Possum Kingdom State Park, Gaines Bend and Hog Bend brings the system's total capital cost to $15,518,000.

Option No. 3: 100% Participation by Commercial
100% Participation by Individual Leased Lots
Single Source Supply - City of Graham Treated Water

This option is similar to Option No. 2 in that it is designed to serve the ultimate population around the shores of Possum Kingdom Lake. It differs from Option No. 2 only by the fact that the source of supply for treated water is from the City of Graham. This option requires an ultimate expansion of the Graham Water Treatment Plant on the order of

approximately 2.0 mgd. Graham has reported that it currently has an excess capacity of 1.0 mgd. Whether that capacity is available long term for use by the Possum Kingdom Water Supply Corporation has yet to be determined.

In order to transport the 2.96 mgd maximum daily demand from Graham to a point of delivery on Possum Kingdom Lake, a 15.5 mile long, 14" diameter treated water supply line is required along with a high head transfer pump station at the Graham Treatment Plant and a 150 HP booster pump station located approximately halfway between Graham and Possum Kingdom Lake.

It is estimated the capital cost of the initial phase of this regional system, including plant expansion, supply line, transfer pump stations, booster pump stations, elevated storage, ground storage and distribution system lines and one lake crossing is approximately $13,106,000. Adding distribution lines, lake crossings and elevated storage to serve the Possum Kingdom State Park, Gaines Bend and Hog Bend brings the system's total capital cost to $14,750,000. These cost do not include treated water cost and annual operation and maintenance cost.

Option No. 4: 100% Participation by Commercial Operators
100% Participation by Individual Leased Lots
Dual Source of Supply
City of Graham (West Lake)
Possum Kingdom Treated Surface Water (East Lake)

This option was considered in order to evaluate the potential for cost savings by dividing the source of the treated water supply in order to eliminate some of the lake crossings, which of course, add considerable cost to the distribution systems. The system was divided into the East Lake and the West Lake (or north side). The East Lake System is proposed to receive its treated water from a 2.07 mgd treatment plant located near D & D - South public use area. The West Lake System is proposed to receive its treated water through a 10" supply line from the City of Graham. This option requires the expansion of the Graham plant and the construction of a new plant on the shores of Possum Kingdom Lake. As for lake crossings, this does eliminate the need to cross the lake near Sandy Beach, at a savings of approximately $200,000. However, these savings are lost on the fact that a treatment plant is still required at Possum Kingdom Lake and a plant expansion would ultimately be necessary at Graham, along with 15.5 miles of 10" supply line from Graham to Possum Kingdom Lake.

Other than the elimination of the one lake crossing, this option is basically the same as Nos. 2 and 3. The total maximum day demand is 2.96 mgd with a maximum hour demand of approximately 6.64 MGD. The breakdown of system demands for each separate system is more fully detailed in the summary tabulations included in the Appendix. The estimated capital cost for both the east and west initial systems combined is approximately $15,858,000. This includes construction of the required distribution systems, treatment plant and treatment plant expansion, a 10" supply line from Graham, ground storage and elevated storage facilities, two transfer pump stations, and approximately six booster pump stations. The addition of service to Possum Kingdom State Park, Gaines Bend and Hog Bend brings the two systems' capital cost to a total of $17,495,000. Again, these costs do not include the cost for raw water or the operation and maintenance cost for the treatment facilities and associated pump stations and booster pump stations.

Option No. 5: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lots
Water Treatment Plant Located Near D & D - South Public Use Area

This option is considered to be the most reasonable approach for a regional water system for various reasons. First, the results of the survey of the individual leased lot owners around the lake, conducted by the Brazos River Authority, indicate that approximately half of those responding would connect onto a regional system if one was available and it was economically feasible to do so. Second, a single source supply from a treatment plant located geographically near the center of the distribution system offers economy in sizing water lines and pump cost. In addition a substantial portion of the cost of building and operating treatment facilities is fixed and does not vary with the amount of water treated. There is, therefore, a considerable economic advantage to consolidating the treatment of water at one plant. This has the effect of minimizing operating cost, as well as reducing plant construction cost to a minimum.

This system assumes a single source supply located near D & D - South public use area. The maximum daily demand is estimated to be 2.4 mgd in the initial phase, which includes capacity for Gaines Bend, Hog Bend and Possum Kingdom State Park. The estimated peak hourly demand is 5.16 mgd. The number of customers in the first phase is estimated to be 2151 connections with approximately 2752 connections in the ultimate system. This analysis includes 67 miles of distribution lines (same as Options Nos. 2 & 3), one lake crossing, 210,000 gallons of elevated storage and 210,000 gallons of ground storage and three booster pump stations in addition to the transfer pump station located at the proposed treatment plant facilities.

It is estimated the capital cost of the initial phase of this regional system, including treatment plant construction, transfer pump stations, booster pump stations, elevated storage, ground storage and distribution system lines and one lake crossing is approximately $11,302,000. Adding distribution lines, three additional lake crossings and elevated storage to serve the Possum Kingdom State Park, Gaines Bend and Hog Bend brings the system's total capital cost to $12,939,000. These cost do not include raw water cost and annual operation and maintenance cost.

Option No. 6: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lot Customers
Single Source of Treated Water Supply from the City of Graham

Since the results of the survey conducted by the Brazos River Authority indicate that the most likely level of participation by individual lot lessees around the lake is at most 50%, it seemed appropriate to evaluate all reasonable options at that level of participation. This option is similar to Option No. 3 in that it assumes the source of treated water is the City of Graham. It differs from Option No. 3 by providing capacity for only 50% of the residential lot owners around the lake. The ultimate maximum day system demand for this option is 2.37 MGD. Again this option would require the expansion of the existing Graham Treatment Plant facilities by approximately 1.37 MGD, assuming of course that the additional capacity of 1.0 MGD that exists now is available.

In order to transport the 2.37 MGD maximum daily demand from Graham to a point of delivery on Possum Kingdom Lake, a 15.5 mile long 12-inch diameter treated water supply line is required along with a high head transfer pump station at the Graham Treatment Plant and a booster pump station located approximately halfway between Graham and Possum Kingdom Lake.

It is estimated the capital cost of the initial phase of this regional system, including plant expansion, supply line, transfer pump station, booster pump stations, elevated storage, ground storage, distributions system lines and one lake crossing is approximately $10,808,000. Adding distribution system lines, lake crossings, elevated storage and booster pumps to serve Possum Kingdom State Park, Gaines Bend and Hog Bend brings the system's total capital cost to $12,444,000. These cost do not include treated water cost and annual operation and maintenance cost.

Option No. 7: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lot Customers
Dual Points of Supply:
(1) West Lake - Graham Treated Water
(2) East Lake - Possum Kingdom Treated Water

As in Option No. 6, this option provides for the maximum daily demand for up to 50% of the residential lot lessees and all of the commercial operators. However, in order to avoid an additional lake crossing and take advantage of the higher quality water available in nearby Graham, this option provides for treatment facilities at Possum Kingdom Lake which serve only the east lake businesses and residences and expansion of the Graham treatment facilities for those on the west side of the lake. A smaller plant could be constructed on the peninsula which would serve the east lake only and avoid the need to cross the lake with a large diameter water line, while the City of Graham treatment facilities would provide treated water for those on the west side of the lake.

The total maximum daily demand for this option is the same as Options 5, 6, and 8 at 2.37 MGD. The breakdown of each individual system is detailed more fully in the Appendix. The estimated capital cost for both the east and west systems combined is approximately $11,570,000. This includes the construction of the required distribution systems, treatment plant expansion at Graham, treatment plant construction at Possum Kingdom, a 10-inch supply line from Graham, ground storage and elevated storage facilities, two transfer pump stations, and approximately six booster pump stations. The addition of service to the Possum Kingdom State Park, Gaines Bend and Hog Bend brings the two system's estimated capital cost to a total of $13,206,000. Again, these estimated capital costs do not include the cost of raw water, or the operation and maintenance cost for the treatment facilities and associated pump stations and booster pump stations.

Option No. 8: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lot Customers
Single Source of Raw Water Supply from the City of Graham

This option is similar to Option No. 6 in that the single source of supply is Graham. However, in this option, raw water from Graham is transported to the proposed treatment facilities located on the west shore of Possum Kingdom Lake. With this option, the need for advanced treatment is eliminated by treating water received from Lake Graham, thus reducing the regional treatment plant cost. A transfer pump station, booster pump station and raw water supply line is still required form the City of Graham. The estimated total initial capital cost for this option is $12,073,000. The addition of service to Possum Kingdom State Park, Gaines Bend and Hog Bend brings the system's total capital cost to approximately $13,710,000.

Option No. 9: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lot Customers
Single Source of Treated Water Supply from the City of Graham

Average Day Approach: This approach is more fully detailed in Section G: **Non-Traditional Alternatives - Average Day Alternative**

This option is similar to Option No. 6 in that the single source of treated water is from the City of Graham. However, in this option, only the average day demand capacity is provided at the treatment plant. The balance of supply required to meet the maximum daily demand is met by an increase in storage. The estimated total initial capital cost for this option is $9,647,000. The addition of service to Possum Kingdom State Park, Gaines Bend and Hog Bend brings the total capital cost to approximately $11,284,000.

Option No. 10: 100% Participation by Commercial Operators
50% Participation by Individual Leased Lot Customers
Single Source of Treated Water Supply from Possum Kingdom Lake

Average Day Approach: This approach is more fully detailed in Section G: **Non-Traditional Alternatives - Average Day Alternative**

This option is similar to Option No. 5 in that the single source of treated water is from a treatment plant located near D & D - South Public Use Are. However, in this option, only the average day demand capacity is provided at the treatment plant. The balance of supply required to meet the maximum daily demand is met by an increase in storage. The estimated total initial capital cost for this option is $8,508,000. The addition of service to Possum Kingdom State Park, Gaines Bend and Hog Bend brings the total capital cost to approximately $10,144,000.

Table 9 below summarizes and compares each option and the associated capital cost for the options which include 100% participation by both commercial operators and residences. Table 10 summarizes each option and associated capital cost for those options which include 50% residential participation.

TABLE 9

WATER DISTRIBUTION SYSTEM ALTERNATIVES

CAPITAL COST COMPARISON – TABULATION
100% Residential Participation

Option No.	Description	Total Number Of System Connections	Maximum Daily Pumpage and Treatment Requirements	Estimated System Capital Cost ($)
1	100% Commercial Operators Participation			
	0% Individual Leased Lot Participation			
	Single Source of Supply & Treatment			
	Located near South D & D	1,640	1.42 MGD	$8,270,641
2	100% Commercial Operators Participation			
	100% Individual Leased Lot Participation			
	Single Source of Supply & Treatment			
	Located near South D & D	2,839 Conn.	2.96 MGD	$13,881,681
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park	153	0	$330,000
	Total System	**3,440**	**2.96**	**$15,517,974**
3	100% Commercial Operators Participation			
	100% Individual Leased Lot Participation			
	Single Source of Supply and Treatment			
	From Graham located near Cruse Lake Store	2,839	2.96 MGD	$13,106,109
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park	153	0	$330,000
	Total System	**3,440**	**2.96**	**$14,742,402**
4	100% Commercial Operators Participation			
	100% Individual Leased Lot Participation			
	Dual Supply Points			
	1. West Lake – Graham	895	0.9 MGD	$5,533,984
	2. East Lake – Treatment Plant	1,944	2.07 MGD	$10,323,841
	Subtotal:	**2,839**	**2.97 MGD**	**$15,857,825**
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**3,440**	**2.97 MGD**	**$17,494,118**

TABLE 10

WATER DISTRIBUTION SYSTEM ALTERNATIVES
CAPITAL COST COMPARISON – TABULATION
50% Residential Participation

Option No.	Description	Total Number Of System Connections	Maximum Daily Pumpage and Treatment Requirements	Estimated System Capital Cost ($)
5	100% Commercial Operators Participation 50% Individual Leased Lot Participation Single Source of Supply & Treatment Located near South D & D	2,151	2.37 MGD	$11,302,414
	Add Gaines Bend @ 100%:	263	0	$648,709
	Add Hog Bend @ 100%:	185	0	$657,584
	Add Possum Kingdom State Park @ 100%	153	0	$330,000
	Total System	**2,752**	**2.37**	**$12,938,707**
6	100% Commercial Operators Participation 50% Individual Leased Lot Participation Single Source of Treated Supply From Graham, located near Cruse Lake Store	2,151	2.37 MGD	$10,807,799
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**2,752**	**2.37 MGD**	**$12,444,092**
7	100% Commercial Operators Participation 50% Individual Leased Lot Participation Dual Supply Points:			
	1. West Lake – Graham	661	0.70	$3,883,721
	2. East Lake – Treatment Plant	1,490	1.67	$7,685,782
	Subtotal:	**2,151**	**2.37 MGD**	**$11,569,503**
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**2,752**	**2.37 MGD**	**$13,205,796**
8	100% Commercial Operators Participation 50% Individual Leased Lot Participation Single Source of RAW water Supply From Graham, located near Cruse Lake Store	2,151	2.37 MGD	$12,072,799
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**2,752**	**2.37 MGD**	**$13,709,092**
9	100% Commercial Operators Participation 50% Individual Leased Lot Participation Single Source of Treated Water Supply From Graham Average Day Approach	2,151	1.19 MGD	$9,647,224
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**2,752**	**1.19 MGD**	**$11,283,517**
10	100% Commercial Operators Participation 50% Individual Leased Lot Participation Single Source of Treated Water Supply From PK Treatment Plant Average Day Approach	2,151	1.19 MGD	$8,507,839
	Add Gaines Bend:	263	0	$648,709
	Add Hog Bend:	185	0	$657,584
	Add Possum Kingdom State Park:	153	0	$330,000
	Total System	**2,752**	**1.19 MGD**	**$10,144,132**

G. NON-TRADITIONAL ALTERNATIVES

As directed by the Brazos River Authority (BRA), consideration of alternate methods of installing the distribution lines and furnishing potable water were explored.

Non-traditional methods of installing the distribution lines were examined due to the large amounts of line needing to be installed in the rock that is common to the Possum Kingdom Lake area. These include:

- In-lake installation; and
- Above-grade installation.

Non-traditional methods of furnishing potable water evaluated are:

- Trucking (Hauling) potable water from the City of Graham;
- Peak storage at each connection, with average day water use production; and
- Overall average day water use production, with centralized peak storage.

Advantages and disadvantages of each alternative are expanded upon in the following sections, as they relate specifically to the Possum Kingdom Water Supply Corporation.

(1) In-Lake Installation

Description: In-lake installation involves laying the pipe in the lake along the bank. Double-walled High Density Polyethylene (HDPE) pipe would be used. Double-walled pipe is required by the TWC Design Criteria (31 TAC 290.44 (f) (2)) to minimize the potential for contamination of the potable water by the untreated lake water. Concrete blocks would be installed around the pipe to provide anchoring to prevent the pipe from floating and minimize pipe movement due to wave action. Service taps would be made as the pipe is being installed. Service lines would be buried approximately 18 inches below grade before exiting the lake. The probable cost for this non-traditional pipeline distribution system for a residential participation level of 50 percent, is estimated to be $14,800,000. This is compared to an estimated pipeline distribution system cost of $1,770,000 for the more traditional method of pipeline construction. A detailed cost estimate for this alternative distribution pipeline construction method is shown in Table 11.

Advantages: One advantage to this method of installation is that the difficulty of laying pipe in rock is avoided. Excavating in rock requires special equipment and procedures. With trench installation the pipe bedding material would have to be imported from off-site. Also, if the pipe is installed in the lake any difficulties of right-of-way acquisition would be avoided.

Disadvantages: Disadvantages to this option include higher costs, greater potential for water contamination, and an increase in the potential for damage to the pipe.

Unit costs for double-walled HDPE pipe are approximately 10 times those of single wall pipe. Furthermore, double-walled pipe is more difficult to install than single wall pipe.

Although double-walled pipe is used there exists a greater potential for contamination of the potable water by the untreated lake water if the pipe were laid in the lake. With the transmission pipe laid in the lake, there will always exist the potential for mechanical damage to or deterioration of the pipe to occur. Therefore, a leak could easily occur in the pipe and would be difficult to detect.

Although the pipe would be laid approximately 10 feet below the lake surface, it is possible that the pipe could be damaged. Deep draft boats, boat anchors, wave action, or other actions could damage the pipe resulting in water leaking out of or into the pipe.

(2) **Above-Grade Installation**

Description: For above-grade installation the pipe is laid on the ground and covered with soil for freeze protection. The pipe would be secured to the ground as needed for thrust restraint. Also, identification signs would be placed at set intervals and at strategic locations. The probable cost for this non-traditional pipeline construction method for a residential participation level of 50 percent, is estimated to be $2,280,000. Again, this is compared to an estimated pipeline distribution system cost of $1,770,000 for a more traditional method of pipeline construction. A detailed cost estimate for this alternative distribution pipeline construction method is shown in Table 12.

Advantages: Installation of the transmission system may be easier; however, material and construction costs are generally higher. It would also be easier to locate the line in the future for taps or repairs.

Disadvantages: One of the major disadvantages is the increased risk of breakage and subsequent contamination of the potable water supply. With the pipe so readily accessible at the surface it would be extremely easy for the pipe to be damaged by vandals, varmints or accidents. In addition, roadway and driveway crossings would still require the more traditional methods of pipeline installation. At the 50 percent residential participation level, there is estimated to be 2,752 system connections. If each connection has a 10-foot wide drive, requiring 20-foot of buried pipe to cross under the drive, the distribution system would still require approximately 55,000 linear feet of buried pipe, or 20% of the total system. This estimate does not include buried pipe required to cross under other private roads, public roads or parking lots. Finally, it is unlikely that the TWC would approve such an installation due to the increased risk to human health.

TABLE 11

NON-TRADITIONAL ALTERNATIVES
IN-LAKE INSTALLATION - CONSTRUCT DISTRIBUTION PIPE IN LAKE

Item	Quantity	Unit	Unit Cost		Total	Total Cost
			Material	Install		
2" Pipe	7,436	L.F.	$11.00	$2.15	$13.15	$97,783
2.5" Pipe	40,643	L.F.	$11.00	$2.80	$13.80	$560,873
3" Pipe	33,080	L.F.	$20.00	$3.65	$23.65	$782,342
4" Pipe	55,031	L.F.	$38.00	$4.60	$42.60	$2,344,321
6" Pipe	73,886	L.F.	$56.00	$6.55	$62.55	$4,621,569
8" Pipe	43,030	L.F.	$74.00	$8.90	$82.90	$3,567,187
10" Pipe	8,427	L.F.	$110.00	$17.20	$127.20	$1,071,914
12" Pipe	7,228	L.F.	$146.00	$20.20	$166.20	$1,201,294
14" Pipe	1,694	L.F.	$184.00	$25.20	$209.20	$354,385
8" Lake Crossing	2000	L.F.			$100.00	$200,000
			Subtotal			**$14,801,669**
			Contingencies @		20%	$2,960,334
			Engineering @		15%	$2,220,250
			Total			**$19,982,252**

TABLE 12

NON-TRADITIONAL ALTERNATIVES
ABOVE-GROUND INSTALLATION - CONSTRUCT DISTRIBUTION PIPE AT GRADE

Item	Quantity	Unit	Unit Cost		Total	Total Cost
			Material	Install		
2" Pipe	7,436	L.F.	$0.51	$1.85	$2.36	$17,549
2.5" Pipe	40,643	L.F.	$0.51	$2.50	$3.01	$122,335
3" Pipe	33,080	L.F.	$1.10	$3.25	$4.35	$143,898
4" Pipe	55,031	L.F.	$1.50	$4.00	$5.50	$302,671
6" Pipe	73,886	L.F.	$2.95	$4.85	$7.80	$576,311
8" Pipe	43,030	L.F.	$4.90	$6.50	$11.40	$490,542
10" Pipe	8,427	L.F.	$7.60	$14.00	$21.60	$182,023
12" Pipe	7,228	L.F.	$10.60	$16.00	$26.60	$192,265
14" Pipe	1,694	L.F.	$12.80	$20.00	$32.80	$55,563
8" Lake Crossing	2,000	L.F.			$100.00	$200,000
			Subtotal			**$2,283,157**
			Contingencies @		20%	$456,631
			Engineering @		15%	$342,474
			Total			**$3,082,262**

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(3) **Trucking Alternative**

Another solution for the Possum Kingdom Water Supply Corporation is to purchase potable water from Graham, Breckenridge, or Mineral Wells. The water would be transported via trucks to storage tanks for distribution. Graham was chosen as the supply source due to its close proximity to the lake, and its lower cost of potable water, for comparison purposes only. This does not exclude the other sources; the other potable water sources will be examined in closer detail, should this prove to be a viable option.

For this scenario, only business connections are provided treated water. Using the Texas Water Commission criteria, the average daily demand for the businesses is calculated to be approximately 600,000 gallons. Potable water would then be distributed to the businesses from 20 storage tanks, optimumly located around the lake. The average storage tank capacity is 30,000 gallons.

(i) **Trucking Contract**

The first trucking option is to contract with an independent trucking firm. Several water transport companies have quoted prices for their vehicles being used in a similar fashion. The cost is typically $1.50 per mile. The average round trip for delivering water is approximately 40 miles, for a cost of $60 per load. Tanker trucks are restricted by weight, and trailer capacity, to carry approximately 6,000 gallons each load. The average water demand requires 100 tanker truck loads a day. This translates to a minimum estimated cost of $6,000 per day.

The City of Graham currently sells potable water for $9.00 for the first 2,000 gallons and $1.60 for each additional 1,000 gallons. The cost for water for the average day usage of 600,000 gallons would be approximately $960.

Capital outlay for this option is the 20 bulk storage tanks at a cost of approximately $1,600,000. The minimal amount of distribution lines required to connect each business is included in this cost.

Combining the transportation cost, water cost and capital cost amortized over 20 years at 6% gives an approximate total of $7,480.00 a day, for an **annual cost of $2,730,000**.

(ii) **Trucking - In House**

The second trucking option is for the Possum Kingdom Water Supply Corporation to own and operate the transport trucks. A round trip time of 2 hours is estimated to allow the truck to drive to Graham, load with water, return to Possum Kingdom

Lake, and unload the water into the storage tanks. Using an 8 hour day, each tanker truck will be capable of 4 round trips per day. To transport 600,000 gallons, 25 tanker trucks will be required.

Following is a list of operation and maintenance costs estimated from information typical of trucking companies experienced in transporting large volumes:

Daily Costs:

Drivers (25 @ $80.00 per day)	$ 2,000
Variable Haul Costs (4,000 miles/day)	3,360
Maintenance (trucks & facility)	290
Vehicle Replacement Program (replace all trucks every 10 yrs)	750
Potable Water	960
Total Expense Per Day	**$ 7,360**
Total Annual Expense	**$2,690,000**

Initial capital costs must also be considered. These include the purchase of 25 trucks and trailers, a storage and maintenance facility, and a fueling terminal. Also the bulk storage tanks, which will also require pressure (pump station) capabilities, must be constructed. These costs are estimated as follows:

Initial Investment Costs:

Equipment (25 trucks)	$1,500,000
Fueling and Maintenance Facility	500,000
Storage/Pressure Stations (20 @ $80,000 each)	1,600,000
Total Capital Cost	**$3,600,000**

These costs have been included in Table 16 for comparison with other options.

(4) Average Day Alternative

Another option is considered in response to the observation that while the peak day must be provided for by the water treatment facility and distribution system, the peak day will realistically only be achieved on weekends during the summer. This creates the inefficient and uneconomical predicament of a large treatment facility that will not be fully utilized during the remaining portion of the year. Discussion with the Texas Water Commission indicated that they would be willing to consider a reduction in water treatment production if balanced by an increase in storage to allow for maximum day usage.

A cost-effective solution to meet the requirements of this non-traditional system is the construction of a water treatment plant capable of meeting average day demands over a reasonable operational period with maximum day demand supplied from excess storage. The average day usage was estimated to be half of the maximum demand for commercial camps/operators and residential customers. Site visits to the individual operators indicated that extended peak water usage was generally only seen during the summer holidays; specifically, Memorial Day, Independence Day and Labor Day, which occur in conjunction with a weekend. These three day holidays created excessive demands on the individual water systems, which then tapered off for the remainder of the week. Comparing the average usage to the maximum usage, the amount of storage to allow for 3 consecutive days of usage is determined, this approach is developed as follows:

Maximum Day Demand (2752 connections x 0.6 gpm/conn.) ..... 2.38 MGD
Treatment Plant Design Capacity ..... 1.19 MGD

Business Connections	1,463 x 0.3 gpm	=	0.63 mgd
Individual Connections	688 x 0.3 gpm	=	0.30 mgd
Gaines Bend	263 x 0.3 gpm	=	0.11 mgd
Hog Bend	185 x 0.3 gpm	=	0.08 mgd
Possum Kingdom State Park	153 x 0.3 gpm	=	0.07 mgd
			1.19 mgd

Difference (required to be obtained from storage) ..... 1.19 MGD
Increased Storage Required (3 day holiday weekend) 1.19 mgd x 3 days... 3.57 MG

(a) Individual Storage Sites

Storage was placed at each commercial camp/operator, and was sized only for them. A pump station, including a minimum of 2 pumps, hypochlorination facilities, and pressure storage, must accompany each storage tank. Due to the varied size and capacity of each system, the following ranges are given:

Storage Tank Capacity ..... 20,000 To 200,000 Gallons
Pressure Tank Capacity ..... 4.8" = 180 To 3,500 Gallons

These systems include:

- Bulk Storage capacity
- Pressure Tank capacity
- Service Pumps
- Housing Structure
- Installation
- Piping, Fencing, Disinfection, etc.

The range of costs for each of the commercial camps/operators storage systems is from $49,500 to $99,500 *for construction only*. **The sum cost of all storage and pump station facilities is $2,297,000.** This significantly outweighs the reduced cost for decreased water treatment plant capacity and smaller water distribution lines. There are also many disadvantages to this option, the main one being the heavy maintenance and operation responsibilities associated with *over 35* pump stations.

(b) Centralized Storage

A centralized location of storage tank/pump station facilities was also explored and found to be more efficient. Due to the spread out nature of the commercial camps/operators layout, the water distribution lines would remain at their original large size. The efficiency would come from having only one large or several small storage tank at the water treatment plant. Disinfection systems can be designed to provide adequate residuals prior to distribution of water. One storage tank, large enough to hold the additional water required during a 3-day peak period, would cost less than $650,000, but would significantly reduce the capital cost of the water treatment plant. Locating the storage tank at the water treatment plant also eliminates the need of additional pump stations.

Treatment processes would be sized for average day use, while the high service distribution system pumps, as well as the distribution system lines would be sized to handle the peak day demand.

In this scenario, the operations and maintenance costs would be significantly less than for a treatment plant designed for peak day use. The treatment plant would also be more efficient. A steady flow of water closer to the design range of flow would be processed, eliminating frequent on/off operation that is costly and inefficient.

H. EVALUATION OF NO ACTION

(1) Commercial Operations

Continuing to operate all water systems as they currently exist is the "No Action" option. Under this option, each commercial camp/business continues to operate their respective water supply and distribution systems. This option has advantages and disadvantages which must be explored, since this is the "default" option for those systems which choose not to participate in the Possum Kingdom Water Supply Corporation.

There is a temporary financial advantage to the "No Action" option. If each facility continues to operate its own system, there is no additional expense for construction and operation of the new treatment, transmission, and distribution systems. Therefore, operational expenses for the short term will theoretically remain at their current levels.

Disadvantages for the "No Action" option can be grouped into three categories. These three categories are legal, economic, and health concerns.

The most significant disadvantage to the "No Action" option is the considerable legal implications for the commercial camps/businesses. The majority of the commercial camps/businesses were required to sign a bilateral compliance agreement with the Texas Water Commission. This agreement, at a minimum, generally required each commercial camp/business to:

- Provide proof of membership in the Possum Kingdom Water Supply Corporation;
- Maintain a 1.0 mg/l chlorine residual in the distribution system;
- Monitor the daily chlorine residual with a DPD test kit;
- Post notices of noncompliance with TWC standards at each water outlet; and
- Enter into a new bilateral compliance agreement after the preliminary engineering report is received by the Texas Water Commission which includes either a compliance schedule for implementing the regional plan OR an accelerated compliance schedule specific to the individual system to come into compliance with the Texas Health & Safety Code.

Legal actions by the Texas Water Commission and/or the Attorney General include the potential of fines of up to $25,000 per day per violation.

Another disadvantage for the "No Action" option which is closely related to the legal implication is the economic implications. These include increasing operating costs, in addition to the potentially significant regulatory fines as mentioned in the preceding paragraph. If each system is allowed to continue to operate, the various components of the water supply and distribution system will continue to deteriorate. Eventually, each will require replacement at significant cost to each commercial camp/business. Most importantly is the profound economic impact the severe fines would have on the individual commercial camps/businesses, as expressed by these individuals during the interviews.

Although not readily obvious to individuals residing at Possum Kingdom Lake, health concerns are also an important disadvantage of the "No Action" option. There are two types of potential health concerns for the existing systems. One is acute or immediate health impacts and the other is chronic or long-term health impacts.

Potential acute health impact include gastrointestinal diseases and toxic contamination. If the water supply becomes contaminated by human or animal wastes the potential exists for these contaminates to enter the distribution system and infect humans. Typically, these gastrointestinal infections are short term and more discomforting than life-threatening. However, acute, life threatening diseases such as dysentery and hepatitis can be transmitted through the water system and present a real risk to users of the water. These health impacts can be minimized by proper treatment of the raw water. It is also possible for toxic chemicals to contaminate the drinking water supply. Gasoline, pesticides, herbicides or many other commonly available chemicals in the area could easily contaminate the Ground Water and/or Possum Kingdom Lake water (surface water). In sufficient quantities, these types of chemicals pose an immediate threat to human and animal life.

Chronic health impacts include development of cancers and human development effects. Should the water supply become contaminated with low levels of certain chemicals and the water is ingested by humans over several years, the potential for chronic health impacts exists. Low levels of pesticides, herbicides and other commonly used chemicals are known to cause cancers in humans. Other contaminates such as nitrates (currently being tested by the Texas Water Commission in numerous Possum Kingdom water systems) and lead have been linked to methemoglobinemia and reduced brain development in children, respectively.

(2) Residential Systems

Advantages and disadvantages of the "No Action" option are similar for the individual systems. The short term financial advantage to the "No Action" option is applicable, since the individuals would not have to come up with the initial membership fee that will be required to join in the Possum Kingdom Water Supply Corporation. However, if an individual declines to participate in the proposed water system, and desires at a later date to join, the membership fee will be augmented with an additional tap fee.

Disadvantages for individual residential systems under this scenario include convenience, health, and economics. Currently, individual residences are using the following options, with the associated disadvantages:

- Pumping straight or filtered Possum Kingdom Lake water into the home for bathing, cleaning and sanitation purposes; Potable water must be hauled in or purchased for drinking and cooking purposes.

- Pumping straight or filtered Possum Kingdom Lake water into the home for bathing, cleaning and sanitation purposes, and utilizing a small Softener and/or Reverse Osmosis system for drinking and cooking purposes; Softeners and Reverse Osmosis systems require disproportionately high amounts of maintenance for the amount of water produced.

- Having water hauled in and stored in small (500 gallon) tanks, raised slightly off the ground to provide enough head (pressure) to distribute the water through the household plumbing; Associated problems are inadequate pressure, dependency on the water haulers to service the tank, and relatively high cost per gallon.

- Individual water well; Uncertainty of supply and potential for contamination.

All the listed types of systems have a high degree of inconvenience associated with them, either in the maintenance aspect, or the lack of capacity of potable water for such functions as automatic dishwashers, ice makers, and washing machines.

Health concerns are the same as those which were raised in the previous paragraphs. While health issues have not appeared to be an issue during the field study, there is the possibility of acute or chronic health impacts, as there is with any water of unknown quality.

Economic consequences are of primary importance to the individuals who returned surveys sent out by the Brazos River Authority in 1992. The individual systems, as outlined above, have served many residences for many years, at seemingly "no cost". However, no water supply, whether treated or untreated, is free.

Table No. 13 summarizes the annual maintenance cost for a typical private residential water system for a 15 year period.

TABLE NO. 13

TYPICAL RESIDENTIAL WATER SYSTEM MAINTENANCE COST

Material	Average Cost	Expected Life
Raw Water Pump	$ 825.00	5 yrs.
Water Heater	350.00	3 yrs.
Piping	125.00	5 yrs.
Treatment Systems		
Filters	850.00	10 yrs.
RO System	100.00	2 yrs.
Softener	700.00	15 yrs.
Electricity	120.00	1 yr.

Assuming 8% for inflation and interest, the total present cost for operating the system for 15 years is $4,126. This present cost, amortized over 15 years, equates to approximately $482 per year or $40 per month.

VI. - FINANCIAL DATA

A. INTRODUCTION

The finance and institutional structures portion of this report was not prepared in order to make a specific recommendation to the Possum Kingdom Water Supply Corporation. The section was prepared to describe the various alternatives available to the Possum Kingdom Water Supply Corporation in funding a regional water supply project and identifying institutional structures within the State to create a regional water supply system.

B. FINANCIAL OPTIONS

There are a variety of financing options available to fund regional water supply systems. Financing alternatives range from partial grants to loans. Financing can also range from private financing to Federal financing administered by regional and Federal agencies. There are several financing alternatives, two of which are not currently available but could be in the very near future. The alternatives presently available include the following:

- Economic Development Administration Grant
- Farmers Home Administration Loan/Grant
- Private Financing

The following subsections will briefly describe each of the financing alternatives listed above.

(1) Economic Development Administration Grant

The Economic Development Administration makes available funds to "support projects designed to alleviate conditions of substantial and persistent unemployment and underemployment in economically distressed areas and regions of the nation and to address economic dislocations resulting from sudden, major job losses." (Federal Register Vol. 57, No. 23) Economic Development Administration funding would be made available through the West Central Texas Economic Development District.

The Economic Development Administration may provide direct grants not to exceed 50% of the estimated project cost. However, under certain circumstances, the Economic Development Administration participation may amount to as much as 80% of the project cost. Applicants are required to provide a local share from acceptable sources including, but not limited to, cash, local government general obligation or

revenue bonds, Community Development Block Grant (CBDG) entitlement funds or balance of State awards, Farmers Home Administration loans, and other public and private financing, including donations. The local share is not required to be in hand at the time of the application but must be firmly committed.

To be eligible for Economic Development Assistance, a redevelopment area must be experiencing at least one of the three following economic problems:

- 24 Month Unemployment Rate: Very high unemployment - at least 12% over a two-year period, according to the Department of Labor statistics

- Per Capita Income: Low per capita income, 75% of the national average or less

- Chronic distress or failure to keep pace with average national growth trends in three of the following four criteria:

  - Five-Year Unemployment Rate: A five-year average rate of unemployment that is greater than the national average.

  - Five-Year Employment Growth: A five-year rate of employment growth that is less than the national average. The beginning and ending periods are referenced in the heading of the Long Term Economic Distress eligibility report.

  - Percent Change in Population: A six-year rate of growth in population that is less than the national average. If the area is in an Metropolitan Statistical Area or NECMA, the 1980 to 1986 U.S. average is 7.2%. If the area is not in an MSA or NECMA, the 1980 to 1986 U.S. average is 3.9%.

  - Dollar Change of Per Capita Index: A six-year absolute dollar change in the per capita income that is less than the national average. If the area is in an MSA or NECMA, the 1979 to 1985 U.S. average change is $3,794. If the area is not in an MSA or NECMA, the 1979 to 1985 U.S. Average is $2,472.

Table No. 14 summarizes the percent population change, per capita income unemployment rate and employment growth for Palo Pinto, Stephens and Young Counties.

TABLE NO. 14

ECONOMIC COMPARISON BY COUNTY

Area	1982 - 1988 % Population Change	1987 Current Per Capita Income	Per Capita Income as % of U.S. 1987 Average	24 Month Unemployment Rate	12 Month Unemployment Rate	3 Month Unemployment Rate	5 Year Employment Growth
U.S. Average	7.5	$11,924	--	7.1	7.4	6.9	4.6
Palo Pinto	-0.2	$9,403	78.9	8.2	8.7	8.8	3.3
Stephens	-9.3	$8,479	71.1	4.9	5.7	5.2	-12.3
Young	-10.0	$11,209	94.0	6.8	7.8	7.1	-3.9

SOURCE: GEO Summary-State-County-Large Cities Data as of December 31, 1992

The information in the above table shows that the Possum Kingdom area is not keeping pace with the national growth trends. This indicates that the Possum Kingdom area may qualify for grant assistance from the Economic Development Administration.

(2) Farmers Home Administration

The Farmers Home Administration (FmHA) has been providing funding to small towns and rural areas for a variety of projects for many years. The FmHA is authorized to provide financial assistance for water and waste disposal facilities in towns and rural areas with a population less than 10,000. The financial assistance available through the FmHA consists of loans and grants, in various combinations. The maximum grant amount possible through the FmHA is 75%, with a 25% loan. The grant amount is determined by several factors. One of the main factors is the median annual household income. The mean annual household income for Palo Pinto and Stephens Counties is below $21,634, which could qualify for the maximum grant amount. Young County's median annual household income is above the $21,634 but below $27,043, which could qualify for a 55% grant. If the entire area does not qualify for the same grant assistance amount, the grant would be proportioned to the number of connections in the areas qualifying for the various grant amounts.

COUNTY	MEDIAN ANNUAL HOUSEHOLD INCOME
Palo Pinto	$20,389
Stephens	$19,203
Young	$21,710
Potential Percent Grant/Loan with Median Annual Household Income	
75%/25%	< $21,634
55%/45%	< $27,043

The FmHA can provide assistance to public entities such as municipalities, counties, special districts, Indian tribes, and not for profit corporations. Priority will be given to public entities in areas smaller than 5,500 people to restore a deteriorating water supply or to improve, enlarge or modify a water facility or an inadequate waste disposal facility. Preference will also be given to requests which involve merging small facilities and those serving low-income communities. Applicants must meet the following criteria:

(a) Be unable to obtain needed funds from other sources at reasonable rates and terms;

(b) Have legal capacity to borrow and repay loans, to pledge security for loans, and to operate and maintain the facilities or services;

(c) Be financially sound and able to manage the facility effectively; and

(d) Have a financially sound facility based on taxes, assessments, revenue fees or other satisfactory sources of income to pay all facility costs, including operation and maintenance, and to retire the indebtedness and maintain reserves.

(3) Private Financing

Private financing would be available through almost any lending institution, such as a bank. Because the system is new the loan would be considered an unsecured loan. The life of the loan would be relatively short, approximately seven to ten years. The short life of the loan would dictate a higher monthly payment schedule. The interest rate would be slightly lower than FmHA loan rates. Banks would be wary of long-term fixed rates and would prefer a floating rate. Floors and ceilings could be negotiated into the loan agreement.

As mentioned previously, there are financing alternatives that are not currently available but may be in the very near future. Two alternatives include the Texas Water Development Board and the Rural Electric Administration. A brief description is provided in the following subsections.

(4) Texas Water Development Board

The Texas Water Development Board (TWDB) administers the water supply account of the water development fund. The water supply account does not currently have any

funds available but the TWDB could issue special bonds to obtain funding. The TWDB's interest rate is 50 points (1/2%) above the market rate.

Congress is also investigating the possibility of appropriating monies to fund water supply systems through a Drinking Water Revolving Fund. The funding would resemble the existing State Revolving Fund Program administered by the Texas Water Development Board. This funding mechanism may be attached to the regulations of the Clean Water Act or the Safe Drinking Water Act. It is unclear at this time whether the Environmental Protection Agency or the Corps of Engineers would administer the funding. It is possible that this funding source could be available as early as 1994.

(5) Rural Electric Administration

Both the House of Representatives and the Senate have passed legislation to merge the Rural Electric Administration (REA) into the Rural Development Administration. This move will broaden the Rural Electric Administration's scope of interest to include water and wastewater. The merger would make available Rural Development Administration funding available to the REA for electric, communications, water and wastewater projects.

Federal funding for water system projects may be available from other sources than the Economic Development Administration and the FmHA. The Texas Office of State-Federal Relations (TOSFR) is currently investigating alternative federal funding sources. The results of the TOSFR investigations will be made available to the Water Supply Corporation when they become available.

C. INSTITUTIONS

There are several institutions available to implement a regional water supply system. Each of the institutions summarized in Table No. 15, has the inherent authority to provide water services and either has the authority to provide wastewater services or can obtain that authority. The institutional structures included in the table are:

River Authority
Regional District
Water Control and Improvement District
Fresh Water Supply District
Municipal Utility District
Water Improvement District

Special Utility District
Water Supply Corporation (Article 1434A)

The information in Table No. 15 was taken from a report prepared for the Texas Water Development Board by Arthur Young & Company in 1987, entitled "Evaluation of Financial, Legal and Institutional Factors Affecting the Provision of Water and Sewerage Services." The information summarized in the table includes the following:

- **Type of Entity** - The name of the institution and which specific statute, special act or article in the Texas Constitution gives the entity its legal authority

- **Water/Wastewater Powers** - describes the powers each entity has with respect to the provision of water and/or wastewater services.

- **Method of Creation** - describes how each institution is formed.

- **Management Control** - describes the number and qualifications of the directors, supervisors, etc., their terms, and their method of selection.

- **Capital Financing Authority** - describes the authority each entity has to levy tax, issue revenue bonds, or combination of tax/revenue debt and what restrictions or privileges accompany that authority.

- **Operation and Maintenance Financing** - describes how each of the entities can fund its operation and maintenance through rates, maintenance taxes, standby fees, special assessment, or debt issuance.

- **Annexation** - describes the powers that are given to each entity to add territory and how this is accomplished.

- **Exclusion** - describes how service areas can be excluded.

- **Service Area Limits** - describes what limits there are in providing water/wastewater within or without each entity's boundaries and whether a certificate of convenience and necessity (CCN) is necessary.

- **Eminent Domain** - describes what powers the entity has to condemn land or acquire to land rights both within and without its boundaries.

The Arthur Young & Company sent out a survey questionnaire and conducted on-site interviews of each institutional structure in the 1987 report to the Texas Water Development Board. As a result of the on-site interviews it was found that,

> "Water supply corporations and private water companies appear to experiencing the greatest amount of problems. Water supply corporations, usually located in rural areas, expressed significant concern over (1) their ability to fund improvements, (2) the need for monies necessary to put in larger line sizes to correct fire protection and supply problems caused by putting in 2-inch lines with FmHA funds, (3) their lack of exemption from ad valorem and sales taxes and (4) the high cost of servicing customers in sparsely populated areas..."

As indicated above, there are a variety of financing alternatives and institutional structures available to implement a regional water supply system. With the available financing alternatives it is possible and very likely that low-cost funding is available that will make a regional system feasible.

TABLE NO. 15

INSTITUTIONS

Type of Entity	Water/Wastewater Power	Method of Creation	Management Control	Capital Financing Authority	Operation and Maintenance Financing	Annexation	Exclusion	Service Area Limits	Eminent Domain
RIVER AUTHORITY Texas Constitution Article XVI Section 59 Various Special Laws	Generally has both water and wastewater powers	Generally by special act of legislature	Number of Qualification Determined by special act Term Determined by special act Method of section elected by special act usually appointed by Governor, confirmed by Senate. Determined by special act usually appointed by Governor, confirmed by Senate.	Tax Debt Generally, no authority to issue tax debt. Revenue Debt Usually, no limit on amount, limits-rate (15%), term (usually 40 years). Usually requires Attorney General approval. Combination Tax/Revenue Debt Usually not authorized term (usually 40 years). Usually requires Attorney General approval. Combination Tax/Revenue Debt Usually not authorized.	Rates Specific authority to impose rates. Rates not required by the TWC unless complaint filed by purchaser of water and if water is surface water. Wastewater rates not regulated. Maintenance Tax Usually not Authority Standby Fees Usually not specific Authority Special Assessment Usually has no authority Debt Issuance Usually has authority to issue debt for operation and maintenance expenses.	Boundaries usually fixed by legislation with no provision for annexation.	Usually cannot exclude land.	Often has specific authority to serve outside its boundaries.	Usually has power to acquire land or any interest therein within or without its boundaries.
REGIONAL DISTRICT Texas Constitution Article XVI Section 59 Texas Water Code Chapter 50, Subchapter M	Has both water and wastewater powers	Board of two or more municipal districts may jointly petition; owner of 2,000 or more continuous acres may petition; Commissioner courts of one or more counties may petition; or the governing body of any city may petition the TWC for creation.	Number and Qualification Five directors - residents of the state and at least 21 years old. Term Four year staggered terms (permanent directors) Method of selection Elected by voters in the District.	Tax Debt May be issued unlimited in amount. Limits: rate 15%, term 40 years, must be approved by voters, the TWC and the Attorney Genera. Revenue Debt Notes/Bonds may be issued in unlimited amounts. Limits: rate 15%, term 20 years, bonds 40 years, voter approval not required for notes or bonds. TWC and Attorney General approval required for bonds. Combination Tax/Revenue Debt May be issued unlimited in amount. Limits: rates 15%, term 40 years, must be approved by voters, the TWC and the Attorney General.	Rates Has authority to impose all necessary charges. Maintenance Tax Has authority to levy a maintenance tax only after approved by voters. Standby Fees Has authority to impose all necessary standby fees. Special Assessment No specific authority for special assessment, but has general authority to impose. Debt Issuance Has authority to issue bonds for expenses related to operation and repair. Issue bonds for expenses related to operation and repair.	Land may be added by petition followed by hearing and board action.	Before first tax bond authorization election, land may be excluded upon board initiative or upon petition from a landowner.	May serve areas inside or outside its boundaries.	No specific provisions in the TWC
WATER CONTROL AND IMPROVEMENT DISTRICT Texas Constitution Article XVI, Section 59 Texas Water Code Chapter 51	District has water power and may acquire wastewater power from the TWC	By county commissioners court for single county district and by the TWC for multi county districts, after hearing upon petition signed by 50% or majority in value of land-owners in district.	Number and Qualification Five directors - residents of the state, at least 21 years of age, own land in district and not disqualified. Term Four year staggered terms. Method of selection Initial directors appointed by county commissioners, subsequent directors elected by voters in district.	Tax Debt District bonds unlimited. Limits - rate 15%, term 40 years, requires voter, TWC and Attorney General approval. Revenue Debt Notes may be issued in unlimited amounts. Limits - rate 15%, term 20 years, notes do not require voter, TWC, or Attorney General approval. Bonds may be issued in unlimited amounts. Limits - rate 15%, term 40 years, requires voter, TWC and Attorney General approval. Combination Tax/Revenue Debt Limits - rate 15%, term 40 years, requires voter, TWC and Attorney General approval.	Rates Unlimited authority to impose charges for services rendered. Maintenance Tax After election, has authority to levy maintenance tax. Standby Fees A renewable charge on undeveloped property may be adopted Special Assessment No specific authority. Debt Issuance Has limited authority to issue debt to fund Operation and Maintenance expenses.	Land may be added upon petition of landowner and board action; land may be added by petition of landowners in designated areas.	Before initial bond authorization election, must hold hearing and exclude and form district.	May serve areas inside or outside its boundaries.	May use eminent domain to acquire a fee simple or assessment on public or private land inside or outside the district.

TABLE NO. 15

INSTITUTIONS

Type of Entity	Water/Wastewater Power	Method of Creation	Management Control	Capital Financing Authority	Operation and Maintenance Financing	Annexation	Exclusion	Service Area Limits	Eminent Domain
FRESH WATER SUPPLY DISTRICT Texas Constitution Article XVI, Section 59 Texas Water Code Chapter 53	Has water powers; may acquire wastewater powers after election if otherwise unavailable	By election ordered by county commissioners court, after hearing upon petition signed by 50% or majority of landowners in district.	Number of Qualification Five supervisors - resident of district, owners of land in district, at least 21 years of age, and not disqualified. Term Initial supervisor hold office until 1st or 2nd general election; subsequent supervisors Four year staggered term Method of Selection Initial and subsequent supervisors elected by voters i the district	Tax Debt May be issued unlimited in amount. Limits: rate 15%, term 40 years, requires voter and Attorney General approval. Revenue Debt May be issued unlimited in amount. Limits rate 15%, term 40 years, notes do not require voter, TWC and Attorney General approval. Bonds require Attorney General approval. Combination Tax/Revenue Debt May be issued unlimited in amount. Limits: rate 15%, term 40 years, requires voter and Attorney General approval.	Rates Has authority to impose rates for the sale of water to pay for Operation and Maintenance expenses. Maintenance Tax After election, has authority to levy maintenance tax Standby Fees No express authority. Special Assessment No specific authority Debt Issuance Bonding authority contemplates capital improvements, but is general in nature; maybe interpreted to local authority for Operation and Maintenance bonds.	Land may be added by board action after hearing upon petition of 50% of majority of landowners in area to be annexed; or 50 landowners if more than 50 own land; election necessary to finalize.	Provision exist for exclusion of land.	Has authority to construct and maintain improvements inside and outside its boundaries.	May use eminent domain to acquire a fee simple or easement across public or private land inside or outside the district.
MUNICIPAL UTILITY DISTRICT Texas Constitution Article XVI, Section 59 Texas Water Code Chapter 54	Has both water and wastewater powers	By TWC after hearing upon petition signed by 50% or majority in value of land-owners in district.	Number of Qualification Five directors - resident of state, on land or qualified voter in district, at least 21 years of age, not disqualified. Term Initial temporary directors, serve until 1st or 2nd general election, Permanent, four year staggered terms Method of Selection Initially appointed by TWC, Permanent, elected by voters i district.	Tax Debt Unlimited amounts. Limits, rate 15%, term 40 years, requires voter, TWC and Attorney General approval. Revenue Debt Notes/bonds may be issued in unlimited amounts. Limits, rate 15%, term 40 years, notes do not need approval, bonds require TWC and Attorney General approval. Combination Tax/Revenue Debt Unlimited amounts. Limits, rate 15%, term 40 years, require voter, TWC and Attorney General approval.	Rates Has authority to impose all necessary charges. Maintenance Tax After election, has authority to levy maintenance tax. Standby Fees A renewable charge on undeveloped property may be adopted. Special Assessment No specific Authority Debt Issuance Has authority to issue bonds for Operation and Maintenance expenses.	Land may be added by board action after hearing upon petition of 50% or majority of landowners in area to be annexed; election necessary to finalize.	Before first bond authorization, land may be excluded by board action, after hearing based upon petition or board initiative.	May serve areas inside and outside its boundaries.	May use eminent domain to acquire a fee simple or easement inside or within five miles of district boundaries.
WATER IMPROVEMENT DISTRICT Texas Constitution Article XVI Section 59 Texas Water Code Chapter 55	District has only water powers	Similar to water control and improvement district.	Number of Qualification Five directors - resident to state, own land in district, more than 21 years of age. Term Four year terms may be staggered. Method of Selection Initial and subsequent directors elected by voters in district.	Tax Debt District bonds unlimited. Limits - rate 15%, term 40 years, requires voter, TWC and Attorney General approval, with requirements for validation Revenue Debt District bonds unlimited. Limits - rate 15%, term 40 years, requires TWC and Attorney General approval. Combination Tax/Revenue Debt District bonds unlimited. Limits - rate 15%, term 40 years, requires voter, TWC and Attorney General approval, with requirements for validation.	Rates Has authority to impose charges for use and sale of water and other Maintenance Tax No express authority. Standby Fees No express authority. Special Assessment Assessments may be imposed for Operation and Maintenance expenses. Debt Issuance Has authority to issue debt for Operation and Maintenance expenses. Does require voter approval.	Land may be added by board action upon petition by individual landowner; defined area may be added by petition of 50% majority of landowners in defined area.	Before issuance of bonds, land may be excluded by board action after hearing upon petition by landowner; land may be excluded upon petition of owner of at least ten areas after election.	May serve areas inside or outside its boundaries.	May use eminent domain to condemn any property interests located inside or outside the district on private or public land.

TABLE NO. 15

INSTITUTIONS

Type of Entity	Water/Wastewater Power	Method of Creation	Management Control	Capital Financing Authority	Operation and Maintenance Financing	Annexation	Exclusion	Service Area Limits	Eminent Domain
SPECIAL UTILITY DISTRICT Texas Constitution Article XVI Section 59 Texas Water Code Chapter 65	Has both water and wastewater powers	By TWC upon request by board of nonprofit water supply corporation created under Article 1434a prior to January 1, 1985.	Number of Qualification Five to eleven directors, at least 18 years of age, own land, user of facilities or qualified voter in district Term Any term up to three years as determined by initial board of directors. Method of Selection Initial directors appointed by TWC; subsequent directors elected by majority vote within the district.	Tax Debt No Authority Revenue Debt Unlimited amounts. Limits, 15%, term 40 years, requires TWC and Attorney General approval. Combination Tax/Revenue Debt No Authority	Rates Specific authority to impose rates. Rates not regulated by TWC unless complaint filed by purchaser and if water is surface water, wastewater rates are regulated. Maintenance Tax No Authority Standby Fees Specific authority to impose standby fees. Special Assessment No Authority. Debt Issuance Has authority to issue revenue debt to pay Operation and Maintenance expenses.	Land may be annexed upon petition by majority of land owners in area to be annexed.	Under certain circumstances, may exclude land on its own motion or on a petition field by landowners.	May serve areas inside its boundaries and outside boundaries provided the district does not duplicate a service of another public agency.	May use eminent domain to condemn any property interests located inside or outside the district on private or public land.
ARTICLE 1434a WATER SUPPLY CORPORATION Texas Revised Civil Statutes Annotated Article 1434a; Article 1396	Has both water and wastewater power	By adoption of articles of incorporation by three or more persons and filing the Secretary of State	Number and Qualification Any number of directors up to 21, no specific qualifications Term Three year staggered terms. Method of Selection Initial, specified in articles of incorporation, subsequent elected by shareholders/members of corporation.	Tax Debt No Authority Revenue Debt Unlimited amounts, rates limited by usury laws, no limit on terms. No approval necessary. Combination Tax/Revenue Debt No Authority	Rates Has authority to adopt rates without approval of TWC; TWC may assume jurisdiction upon petition of rate-payers Maintenance Tax No authority Standby Fees No specific authority Special Assessment No authority Debt Issuance Has authority to issue revenue debt for Operation and Maintenance expenses.	Not Applicable	Not Applicable	Must obtain CCN for original service area; may extend lines without CCN unless within certified area of another utility.	Right of eminent domain to acquire sites for plants and facilities and to acquire rights-of-way and shall have the right to use the rights-of-way of the public highways of the State for the laying of pipelines.

VII - SUMMARY OF VIABLE ALTERNATIVES

A. INTRODUCTION

A wide range of alternatives to meet the water supply needs of the project planning area have been reviewed. Alternatives for both water supply and potable water production were evaluated using current Texas Water Commission (TWC) standards for public water systems. In addition, non-traditional alternatives for meeting water supply and potable water production requirements have also been developed in this Report.

The TWC will, on a case-by-case basis, consider exceptions to current rules and regulations. To be considered for an exception, non-traditional alternatives must be technically sound and provide for the public's interest in a safe, affordable water supply. Non-traditional alternatives considered for the Possum Kingdom Water Supply Corporation (PKWSC) include:

- Alternate methods of distribution water line installation;
- Purchased potable water transported via trucks to storage tanks for distribution;
- Distribution system sized for maximum hour-day requirements, with peak demands met from regional storage systems; and/or
- Water treatment facilities designed for average-day production with maximum demands met from centralized storage.

The forth alternative, providing potable water treatment facilities capable of meeting average-day demand with maximum day requirements provided for centralized storage, has been shown to be cost effective. This non-traditional alternative meets the seasonal needs of the Possum Kingdom Water Supply Corporation of maximum water use during summer holiday weekends and minimum demands during winter months.

B. REGIONAL WATER SUPPLY SYSTEM

The focus of this Study has been to evaluate the feasibility of developing a regional water supply system to serve the commercial camps/businesses around Possum Kingdom Lake. Additionally, the impact of residential customers of varying levels of participation has been evaluated.

(1) Commercial Camps/Businesses

Traditional options and non-traditional alternatives to provide commercial camp/business operators with potable water are recapped in Table 16 below. Included in the summary table are estimated annual operation and maintenance (O&M) costs and estimated total annual costs.

TABLE 16

COMMERCIAL CAMP/BUSINESS MEMBERS
COMPARISON OF VIABLE ALTERNATIVES
(Excludes Residential Participation)

Distribution System Option No.	Description	Capital Cost(1)	O & M(2)	Costs of Water(3)	Total Annual Cost(4)
1	Possum Kingdom Water Treatment Plant	$8,270,000	555,000	$ 15,000	$1,290,000
1a	Graham Treated Water	10,142,000	275,000	403,000	1,562,000
N/A	Renovation of Existing Commercial Treatment Facilities	8,400,000	1,670,000	N/A	2,400,000
N/A	Trucking - Contract	1,600,000	2,190,000	403,000	2,730,000
N/A	Trucking - "In-house"	3,600,000	2,340,000	403,000	3,060,000
	Average Day	6,480,000	555,000	15,000	896,000

(1) Capital Cost are from detailed Engineer's Estimate included in the Appendix.

(2) Treatment and/or distribution costs for an average of 600,000 gallons per day as presented in the Appendix.

(3) Cost of water is based on annual average demand of 600,000 gallons/day; a raw water rate of $0.06 per 1000 gallons from Possum Kingdom; a treated water rate of $1.60 per 1000 gallons from Graham.; and a 15% water loss rate.

(4) Total annual cost equals capital cost amortized over 20 years at 6%, plus annual O&M, plus cost of water.

At an estimated total annual cost of $1,290,000.00, a regional water supply system developed around a water treatment plant at Possum Kingdom Lake is approximately one-half the cost of other options evaluated.

(2) **Residential Customers**

Serving commercial camps/businesses through a regional water supply system will require an extensive distribution water line network. These water lines will be easily accessible to residential properties around Possum Kingdom Lake.

Residential property users face concerns for potable water similar to commercial camps/businesses, although without the requirement for compliance with TWC rules and regulations. Based on the Brazos River Authority's residential survey, approximately 50% of individual leased lots around the shores of Possum Kingdom Lake would be interested in connecting to a regional water supply system.

Options to include residential customers in a Possum Kingdom Regional Water Supply System are recapped in Table 17. Included in the summary table are estimated annual operation and maintenance costs and estimated total annual costs.

Gaines Bend, Hog Bend and the Possum Kingdom State Park are included in the options presented at a 100% participation level.

Due to the isolated nature and the need to construct a lake crossing in order to provide service to each of these areas, 100% residential participation is necessary for cost effective service.

TABLE 17

REGIONAL WATER SYSTEM WITH 50% RESIDENTIAL PARTICIPATION COMPARISON OF VIABLE OPTIONS

Option No.	Alternatives	Capital Cost (1)	O&M(2)	Costs of Water(3)	Total Annual Cost(4)
10	Possum Kingdom Water Treatment Plant Average-Day Design	$10,144,000	$585,000	$ 16,000	$ 1,485,000
6	Treated Water From Graham	12,444,000	275,000	437,000	1,800,000
5	Possum Kingdom Water Treatment Plant	12,939,000	680,000	16,000	1,825,000
9	City of Graham, Average-Day Delivery	11,284,000	275,000	437,000	1,695,000
N/A	Blended Lake Graham/Possum Kingdom Water Treatment Plant Average-Day Design	11,550,000	520,000	72,000	1,600,000
7	Dual Supply: West Lake - Graham Treated Water East Lake - Possum Kingdom Treated Water	13,206,000	595,000	314,000	2,060,000
8	Raw Water from Graham	13,710,000	680,000	16,000	1,891,000

(1) Capital Cost are from Table 10, Section V and detailed Engineer's Estimate included in the Appendix. Capital Cost include Gaines Bend, Hog Bend and Possum Kingdom State Park at 100% participation.

(2) Treatment and/or distribution costs for an average of 600,000 gallons per day as presented in the Appendix.

(3) Cost of water is based on annual average demand of 600,000 gallons/day and a raw water rate of $0.06 per 1000 gallons from Possum Kingdom and a treated water rate of $1.60 per 1000 gallons from Graham.

(4) Total annual cost equals capital cost amortized over 20 years at 6%, plus annual O&M, plus cost of water.

All of these options are comparable in estimated total annual costs. Construction of a water treatment plant for treatment of Possum Kingdom Lake water, sized for meeting average-day production requirements with maximum day demands met from storage (a non-traditional alternative), is the most cost-effective option at $1,485,000 per year.

C. ESTIMATED USER COSTS

A detailed evaluation of user cost could not be developed within the scope of this Study. As it is unknown at this time how many meters the system will ultimately have. However, general analysis of potential rate structures can be performed. Development of any rate structure should be based on the following criteria:

- Equality or Fairness
- Impact on Customers
- Avoidance of Discriminatory Relationships
- Conservation
- Legality
- Simplicity
- Implementation
- Competitiveness

The Possum Kingdom Water Supply Corporation will have a unique situation. Due to the seasonal nature of water use, revenue from water sales will be generated primarily during summer months. Debt requirements during the winter, if debt service revenue is included in the unit price of water actually used, will be met only if summer water use meets or exceeds projections. It is recommended therefore, that the Possum Kingdom Water Supply Corporation consider a rate structure which generates dept service and fixed operational costs from monthly base rates. Operation and maintenance costs associated with the production and distribution of potable water will be recovered in the cost per thousand gallons, or volume charge. This approach is a departure from rate structures typically used in urban areas, where debt service can be a significant part of water volume charges.

(1) Commercial Camps/Business Members

Development of a base rate structure for commercial camp/business members of the Possum Kingdom Water Supply Corporation must consider the wide variation in demands. Using TWC criteria, demand varies from a low of 0.1 gpm (144 gpd) up to 91.8 gpm (132,200 gpd). Any rate structure developed must consider the allocation of system capacity for each individual commercial operator. Based on capacity, six user classes for commercial operators could be utilized:

- Less than 1,500 gallons per day
- 1,501 gpd to 20,000 gpd
- 20,001 gpd to 40,000 gpd
- 40,001 gpd to 60,000 gpd
- 60,001 gpd to 85,000 gpd
- Over 85,000 gpd

Estimated costs for commercial operators to renovate their existing facilities for compliance with TWC regulations and primary/secondary drinking water standards are included in Table 16. Table 18 shows the estimated annual costs for individual treatment system renovations allocated between various user classes. Costs reflect debt service required for installation of an advanced treatment system plus estimated operation and maintenance costs.

TABLE 18

EVALUATION OF RENOVATING EXISTING COMMERCIAL TREATMENT FACILITIES ALLOCATED USER COSTS

Commercial User Class	Estimated Number In User Class [1]	Total Annual Cost[2]	Estimated Monthly Cost
Less than 1,500 gpd	10	$ 37,000	$ 310
1,501 - 20,000 gpd	22	820,000	3,100
20,001 - 40,000 gpd	12	670,000	4,650
40,001 - 60,000 gpd	5	370,000	6,150
60,001 - 85,000 gpd	3	280,000	7,750
Over 85,000 gpd	2	225,000	9,375
Total:	**54**	**$2,402,000**	**31,335**

(1) From field survey of study participants.

(2) Capital cost amortized over 20 years at 6% plus annual O&M costs, see Table 16, Total Annual Cost for Renovation of Existing Facilities.

The recommended option for meeting the needs of only the commercial camp/business members of the Possum Kingdom Water Supply Corporation is a regional water supply system with a central treatment plant at Possum Kingdom Lake, treating only Possum Kingdom Lake water. Estimated annual costs for the recommended option are approximately one-half of the cost required for each individual commercial operator to upgrade their facility using advanced treatment technology. General monthly costs for individual user classes can, therefore, be estimated as presented in Table 19.

TABLE 19

REGIONAL WATER SUPPLY SYSTEM - ESTIMATED MONTHLY COSTS CENTRALIZED TREATMENT FACILITIES

Commercial User Class	Estimated Number In User Class [1]	Total Annual Cost[2]	Estimated Monthly Cost
Less than 1,500 gpd	10	$ 37,000	$ 165
1,501 - 20,000 gpd	22	820,000	1,650
20,001 - 40,000 gpd	12	670,000	2,465
40,001 - 60,000 gpd	5	370,000	3,260
60,001 - 85,000 gpd	3	280,000	4,110
Over 85,000 gpd	2	225,000	4,970

NOTE: These costs do not include residential participation.

(1) From field survey of study participants.

(2) Capital cost amortized over 20 years at 6% plus annual O&M costs, see Table 16, Total Annual Cost for Renovation of Existing Facilities.

It must be noted that the costs developed and presented are based on limited information and estimated financing. Additionally, costs do not reflect grant funds, if available to finance the project. Detailed projections can be developed in a focused engineering study once project variables are defined.

(2) Residential Customers

Residential users of a Possum Kingdom regional water system have been evaluated. The addition of residential users is advantageous to the Possum Kingdom Water Supply Corporation only if, through their involvement, project costs are reduced for commercial camp/business members. Cost reductions due to the economy of scale with residential customers are attractive.

Approximately 80% of residential properties around Possum Kingdom lake are used as weekend or vacation retreats. Typically, financing agencies will not consider these customers in calculating rate structures. Experience has shown that part-time users of regional water systems are not as reliable as permanent residents for remaining actively connected to the system. The issue of part-time users will need to be developed in a focused engineering study if residential participation is pursued.

This section has focused on the feasibility of a regional water supply system with 50% residential participation. The cost of residential participation at this level can be evaluated, using the best option, as follows:

From Table 17, it is shown that the estimated total annual cost of the most economical regional water system which serves at least half of the residential lots around the lake is $1,581,000 per year. The treatment plant for this option is sized at 1.19 MGD for average day capacity with excess storage provided to meet the maximum daily demand. Plant capacity is pro-rated between residential and commercial customers as follows:

1,112 Residential Customers	x	0.3 gpm	=	0.48 MGD (40%)
1,640 Commercial Customers	x	0.3 gpm	=	0.71 MGD (60%)
				1.19 MGD

Based on capacity of the system utilized, including 50% of the residential customers in the system would account for approximately 40% of the system is annual cost. This participation would significantly reduce the system's annual cost for the commercial customers. The estimated commercial customer's annual cost is calculated as follows:

$$\$1,581,000 \times 60\% = \$943,000$$

This annual cost is significantly less than any option presented in Table 16, where the residential participation is not included.

VIII - CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

Commercial camps/businesses around Possum Kingdom Lake are each faced with the challenge of providing potable water meeting State and Federal rules and regulations for public water systems. Most commercial camps/businesses around the lake have entered into bilateral compliance agreements with the Texas Water Commission (TWC). This Study has focused on the feasibility of providing potable water meeting current and anticipated future regulations for users around Possum Kingdom Lake.

The feasibility of developing a regional water supply system has been evaluated with both traditional options and non-traditional alternatives. This Report has shown that a regional distribution system served by a centralized treatment plant at Possum Kingdom Lake, treating Possum Kingdom Lake water, can be developed to meet the needs of commercial camps/businesses. Total annual cost for this system is estimated to be $1,290,000.

Including residential customers in the regional water system was concluded to be cost effective. If residential properties are to be served by a regional system, a non-traditional alternative of meeting average-day requirements at the treatment facility, with maximum day demands met from storage, is recommended for a residential participation level of 50%. The annual cost for this approach is estimated to be $1,581,000 and results in a potential capital cost savings of approximately $2,795,000 and an annual cost savings of approximately $244,000 over the more traditional maximum day approach.

The feasibility of developing a regional water supply system has been developed based on estimated participants, both commercial and residential. Currently, there are no "members" of the Possum Kingdom Water Supply Corporation. Membership in the Possum Kingdom Water Supply Corporation must be established before a focused engineering study can be prepared. A focused engineering study will be required by most funding agencies to establish detailed costs and rate structures based on the option developed and the number of customers to be served.

B. ROLE OF THE POSSUM KINGDOM WATER SUPPLY CORPORATION

The Board of Directors of the Possum Kingdom Water Supply Corporation will need to address the following questions:

- Why does the water system exist?
- To whom will it provide water?
- At what cost, to the customer, will water be provided?
- How will water be provided to customers, and under what conditions?

Answers to these questions will help define the Possum Kingdom Water Supply Corporation's "mission statement" or "statement of purpose". This provides the Board and staff with direction by providing a structure for making base decisions. In addition, defining the Corporation's mission will help maintain the Corporation's ultimate purposes, instead of focusing on daily problems, and provide each person an understanding of their role and responsibility in carrying out the objectives of the Possum Kingdom Water Supply Corporation.

As stated above, the actual number of members (and their corresponding user class) is critically important. Once a firm number of members is known, a focused engineering report should be initiated. While the focused engineering report is being prepared, the Board should begin to develop and enact rules and regulations affecting the operation of the Corporation. These rules and regulations will include:

- The conditions under which water service is provided by the system to each customer;
- The responsibilities of the water system to the customer; and
- The customers' responsibilities for receipt of service and the water system.

Also included will be such items as water rate schedules, connection fees and deposits, conditions for connecting new customers, and billing procedures.

In addition to rules and regulations, a long-range plan should be developed. This is essential to ensure that future improvements, future operation expenses, replacement of worn-out equipment, and potential emergencies are anticipated.

After financial commitments are made by those desiring to be members, and a focused engineering study identifies the specific alternative which is most cost-effective, the decision must be made by the members as to continue on with the project or not. Even after the decision is made to proceed with the design of the Possum Kingdom Public Water System and bids are

received to construct the improvements, final decision must be made by the members to actually build the project.

Once the Possum Kingdom Water Supply Corporation is a functioning organization, regularly scheduled, publicly announced meetings will be held, according to the "Open Meeting Act". It will be at these meetings the membership will be given the opportunity to vote on proceeding with the project at the appropriate times. These meetings will also provide an open forum for any comments by concerned individuals.

C. FINANCIAL CONSIDERATIONS

There are numerous economic factors affecting financing of water system improvements. The largest factor is customer demand. The area under consideration in the Study has in-place an existing demand for potable water meeting applicable regulations. Other factors to be considered include per capita water usage and how customers will react to increases in rates. After the system is established, newer areas of development (which will be attracted by the facilities) and requests for additional meters will cause additional financial burdens. These elements will play a prominent role in selecting financial alternatives.

Volume charges (cost of water per thousand gallons) are recommended to be based on costs to produce and distribute water. Because of the seasonal nature of water use around Possum Kingdom Lake, debt service requirements and fixed O&M costs should be recovered from base rates established for each user class. A seventh user class, for residential customers, will be required if non-commercial memberships are accepted by the Corporation.

The Possum Kingdom Water Supply Corporation will also need to address the following financial items while developing the focused engineering study:

- Development of a comprehensive facility master plan;
- Determination of capital requirements;
- Securing of funding source(s);
- Determination of annual revenue requirements;
- Development of a rate structure; and
- Evaluation of the financial plan on customers.

D. IMPLEMENTATION SCHEDULE

Development of a regional water supply system will require a coordinated effort between the Possum Kingdom Water Supply Corporation Board of Directors, the Texas Water Commissions, the water supply corporation's engineering consultant and attorney, and the selected funding agency(ies). It is recommended that the Possum Kingdom Water Supply Corporation Board proceed immediately with a Charter Membership drive to establish an actual number of participants for a regional system. At the close of the membership drive, a focused engineering study should be initiated by the Board.

A recommended implementation schedule for development of a regional water supply system serving the Possum Kingdom Lake area is presented below.

December, 1993 • Engineers present draft copy of this Study to the Possum Kingdom Water Supply Corporation.

Dec. 93 -Jan. 94 • Public Review and Comment Period.

February, 1994 • Final Report Submittal.

March, 1994 • The Possum Kingdom Water Supply Corporation initiates a Charter Membership drive.

September, 1994 • Charter Membership closes. The Possum Kingdom Water Supply Corporation authorizes Engineers to proceed with a focused engineering study.

• The Possum Kingdom Water Supply Corporation selects funding agency(ies) and initiates applications.

• The Possum Kingdom Water Supply Corporation begins to develop and enact rules and regulations affecting operation of the Corporation.

December, 1994 • Engineers present preliminary findings of the Focused Engineering Study to the Brazos River Authority Possum Kingdom Water Supply Corporation and/or contracted Public Agency.

Dec 94 - Feb 95 • Review of focused engineering study preliminary findings.

April, 1995	•	Focused engineering study final report submittal.
May, 1995	•	The Possum Kingdom Water Supply Corporation decides on the recommendation; authorized Engineers to develop preliminary design documents.
August, 1995	•	Engineers present preliminary design documents.
Aug. - Oct. 1995	•	Review of preliminary design documents by: Possum Kingdom Water Supply Corp. Texas Water Development Board Texas Natural Resource Conservation Commission Brazos River Authority Funding Agencies
November, 1995	•	Treatment plant pilot study.
December, 1995	•	The Possum Kingdom Water Supply Corporation authorizes final design of the Project.
September, 1996	•	Engineers submit final design documents.
Sept - Nov 1996	•	Final plan review and approvals. Possum Kingdom Water Supply Corp. Texas Water Development Board Texas Natural Resource Conservation Commission Brazos River Authority Funding Agencies
December, 1996	•	The Possum Kingdom Water Supply Corporation secures financing.
Jan. - Feb., 1997	•	Advertise and award bids for construction.
Apr 97 - Oct 98	•	Complete Construction of the regional water supply system.

E. CONCLUSION

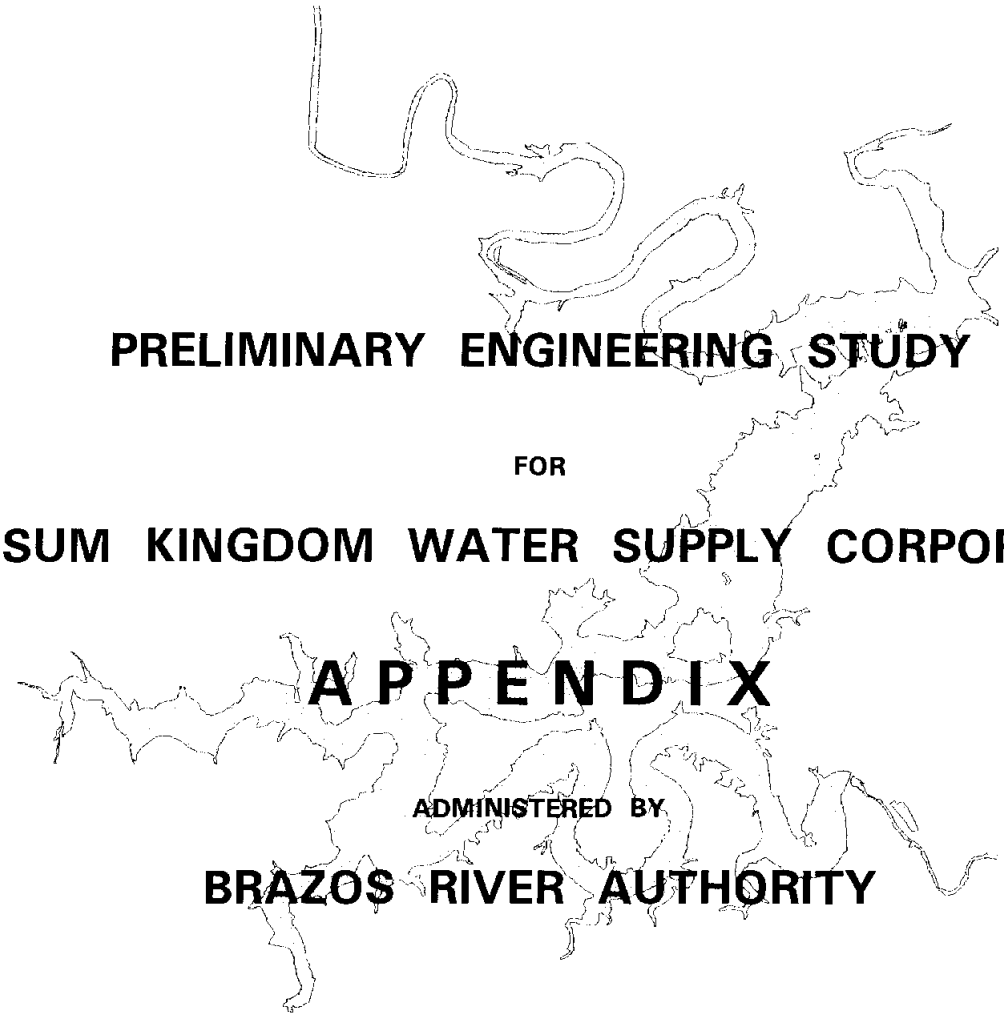
New systems are not immediately faced with economic factors that eventually impact the system. These factors include deterioration of the infrastructure, more stringent environmental requirements, customer demands of improvements, lack of Federal assistance, legal restrictions and the utility's procedure for addressing these changing needs. A progressive utility will find financing and a rate structure that addresses the deterioration of its facilities. These rate structures should provide the necessary funds to create a capital improvements fund to finance needed improvements. Environmental regulations continue to become more stringent which, in turn, require utility compliance. This compliance will have associated costs which will be passed on to the customer. Although federal mandates are increasing, financing from the Federal Government is declining. Customer demands for improved service will also become an increased component in capital improvements. Legal restrictions can eliminate potential financing options. The management philosophy of the utility will play a leading role in identifying components of the capital plan facilities and how these costs are to be financed and recovered from customers.

The Possum Kingdom Water Supply Corporation faces several unique challenges. In a developed area, oversizing of facilities to accommodate future growth is costly and can lead to a heavy financial burden on members if the growth does not occur. Similarly, oversizing to accommodate potential customers which choose not to participate in the Corporation as a Charter Member can result in a financial burden on members. Developing a regional system which includes residential users is further complicated for the Possum Kingdom Water Supply Corporation since approximately 80% of the residential properties are weekend or vacation retreats. These properties are typically less reliable for staying connected to a regional system than permanent residents.

Also challenging is the fact that a majority of the water front property is owned by the Brazos River Authority and leased to commercial/residential users. Funding agencies may require documentation to insure proposed debt repayment structures do not exceed lease terms.

Gaines Bend, Hog Bend and the Possum Kingdom State Park will require special attention from the Board of Directors. Potable water service to each of these areas requires an individual lake crossing. Estimates developed in this report have assumed 100% participation of potential connections in these areas. It may not be cost effective to service Gaines Bend and Hog Bend if actual connections fall significantly short of full participation.

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM



PRELIMINARY ENGINEERING STUDY

FOR

POSSUM KINGDOM WATER SUPPLY CORPORATION

APPENDIX

ADMINISTERED BY

BRAZOS RIVER AUTHORITY

PREPARED BY

SHIMEK, JACOBS & FINKLEA
CONSULTING ENGINEERS
DALLAS, TEXAS

IN ASSOCIATION WITH

REYNOLDS - HIBBS & ASSOCIATES
CONSULTING ENGINEERS
ABILENE, TEXAS

WASTEWATER TECHNOLOGY SERVICE, INC.
ROSENBERG, TEXAS

FEBRUARY, 1994

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

APPENDIX TO PRELIMINARY ENGINEERING REPORT

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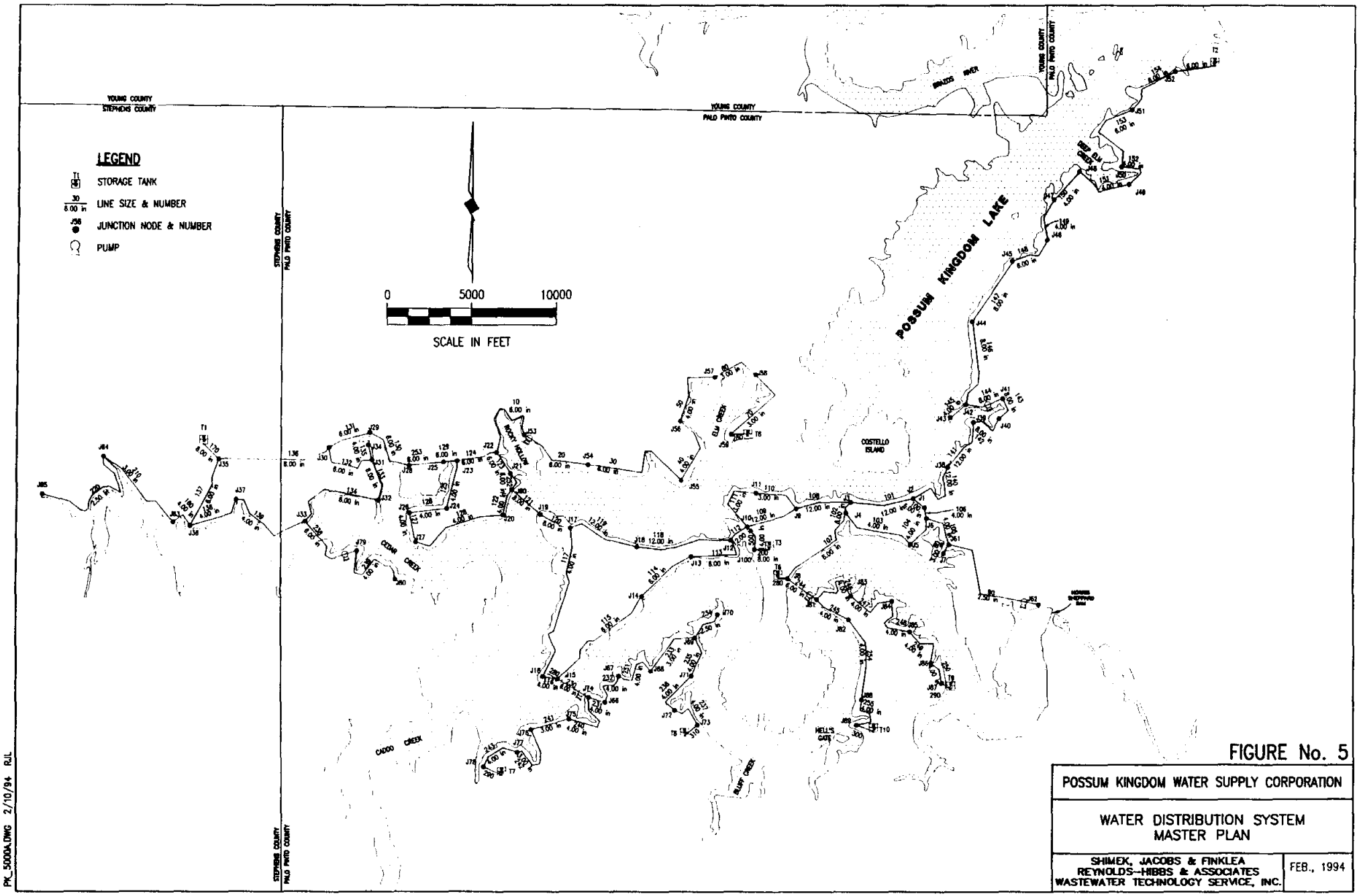


FIGURE No. 5

POSSUM KINGDOM WATER SUPPLY CORPORATION

WATER DISTRIBUTION SYSTEM MASTER PLAN

SHIMEK, JACOBS & FINKLEA
REYNOLDS-HIBBS & ASSOCIATES
WASTEWATER TECHNOLOGY SERVICE, INC.

FEB., 1994

PK_5000A.DWG 2/10/94 RJL

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

FIELD SURVEY SUMMARY

conducted for the:

POSSUM KINGDOM WATER SUPPLY CORPORATION
through the BRAZOS RIVER AUTHORITY

STUDY PARTICIPANT A

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/15/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Three centrifugal pumps take water from Possum Kingdom Lake, through 3 hypochlorinators to 3 pressure tanks which feed 3 pressure sand filters. The filtered water goes through the large pressure tank, which feeds the distribution system.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving transient accommodation units
Total Number of Connections: 49
Number & Type of Seasonal Units: 11 cabins, 32 MH/cabins
Number & Type of Permanent Units: 1 office/restaurant, 5 MH
Population Estimate (source of estimate): 175 (Texas Water Commission)
Recorded Water Usage: estimated 1992 peak: 150,000 gal in June
Calculated Water Demand: 30 x 18 gpd + 48 x .6 gpm = 29.2 gpm

EXISTING FEATURES OF FACILITY

Raw pump capacity: 3 - 45 gpm jet
Chlorination: peak of 58 gal/month of 10% Na hypochlorite (3 chlorinators)
Pressure Tank: 3 - 82 gal, 1 - 500 gal
Filters: 3 pressure sand, 3'Ø, 4' tall
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

Study Participant A, (continued)

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving transient accommodation units system, for a total treatment capacity of 29.4 gpm.

Raw Pump Capacity: 29.4 gpm with the largest pump out of service
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 490 gallons (N/A)
Filters: 29.4 gpm
Service Pumps: 2 or more service pumps with a total capacity of 49 gpm
Clearwell Storage Capacity: 1000 gallons
Total Storage Capacity: 1715 gallons (includes required 1000 gallon minimum clearwell storage)

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT B

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/14/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Two centrifugal raw water pumps deliver water, which is chlorinated, into a pressure tank which feeds the distribution system.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving transient accommodation units
Total Number of Connections: 15
Number & Type of Seasonal Units: 6 cabins, 7 MH
Number & Type of Permanent Units: 1 restaurant/office/store, 1 house
Population Estimate (source of estimate): 80 (Texas Water Commission)
Recorded Water Usage: hauls approx. 3000 gal/year for restaurant/office/store
Calculated Water Demand: 30 x 18 gpd + 14 x .6 gpm = 8.8 gpm

Study Participant B, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 30 gpm jet pump 1½hp, and 1 back-up (same)
Chlorination: 1 gal/month 20% chlorine
Pressure Tank: 1 - 80 gal, 1 - 300 gal
Filters: none
Service Pumps: none
Storage Capacity: 1250 gal (hauled)
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving transient accommodation units system, for a total treatment capacity of 9 gpm.

Raw Pump Capacity: 9 gpm with the largest pump out of service
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 9 gpm
Service Pumps: 2 or more service pumps with a total capacity of 15 gpm per unit
Clearwell Storage Capacity: 1000 gallons
Total Storage Capacity: required 1000 gallon clearwell storage

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT C

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes, but not a public water system
Date of Engineering Site Visit: 5/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: None; raw water is pumped by a centrifugal pump, which supplies the pressure tank, providing water to the sinks and toilets

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 1
Number & Type of Seasonal Units: 1
Number & Type of Permanent Units: 0
Population Estimate (source of estimate): 35 (Texas Water Commission and conversation with Camp Coordinator)
Recorded Water Usage: unknown
Calculated Water Demand: 35 persons (average visit) x 42 gallons/person = 1.0 gpm

Study Participant C, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 10 gpm, ½hp centrifugal
Chlorination: not added
Pressure Tank: 1 - 42 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No deficiencies; Not a Public Water System

STUDY PARTICIPANT D

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 160 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 160 persons x 6 gallons per person = 0.7 gpm

Study Participant D, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.7 gpm.

Raw Pump Capacity: 0.7 gpm with the largest pump out of service
Transfer Pump Capacity: 0.7 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.7 gpm
Service Pumps: 2.1 gpm
Clearwell Storage Capacity: 480 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT E

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 10 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 10 persons x 6 gallons per person = 0.1 gpm

Study Participant E, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.1 gpm.

Raw Pump Capacity: 0.1 gpm with the largest pump out of service
Transfer Pump Capacity: 0.1 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.1 gpm
Service Pumps: 0.3 gpm
Clearwell Storage Capacity: 30 gallons (50% of maximum daily demand)
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT F

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 70 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 70 persons x 6 gallons per person = 0.3 gpm

Study Participant F (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.3 gpm.

Raw Pump Capacity: 0.3 gpm with the largest pump out of service
Transfer Pump Capacity: 0.3 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.3 gpm
Service Pumps: 0.9 gpm
Clearwell Storage Capacity: 210 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT G

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 916 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 916 persons x 6 gallons per person = 3.8 gpm

Study Participant G, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 3.8 gpm.

Raw Pump Capacity: 3.8 gpm with the largest pump out of service
Transfer Pump Capacity: 3.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 3.8 gpm
Service Pumps: 11.4 gpm
Clearwell Storage Capacity: 2750 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT H

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 700 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 700 persons x 6 gallons per person = 2.9 gpm

Study Participant H, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 2.9 gpm.

Raw Pump Capacity: 2.9 gpm with the largest pump out of service
Transfer Pump Capacity: 2.9 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 2.9 gpm
Service Pumps: 8.7 gpm
Clearwell Storage Capacity: 2100 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT I

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 123 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 123 persons x 6 gallons per person = 0.5 gpm

Study Participant G, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.5 gpm.

Raw Pump Capacity: 0.5 gpm with the largest pump out of service
Transfer Pump Capacity: 0.5 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.5 gpm
Service Pumps: 1.5 gpm
Clearwell Storage Capacity: 370 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT J

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 666 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 666 persons x 6 gallons per person = 2.8 gpm

Study Participant J, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 2.8 gpm.

Raw Pump Capacity: 2.8 gpm with the largest pump out of service
Transfer Pump Capacity: 2.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 2.8 gpm
Service Pumps: 8.4 gpm
Clearwell Storage Capacity: 2000 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT K

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: none
Population Estimate (source of estimate): 210 (estimated by owner's personnel)
Recorded Water Usage: unknown
Calculated Water Demand: 210 persons x 6 gallons per person = 0.9 gpm

Study Participant K, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.9 gpm.

Raw Pump Capacity: 0.9 gpm with the largest pump out of service
Transfer Pump Capacity: 0.9 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.9 gpm
Service Pumps: 2.7 gpm
Clearwell Storage Capacity: 630 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT L

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake to service restroom facilities.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 2
Number & Type of Seasonal Units: 1 office
Number & Type of Permanent Units: 1 house
Population Estimate (source of estimate): 10 (estimated)
Recorded Water Usage: unknown
Calculated Water Demand: 5 persons x 18 gallons per person + 1 x 0.6 gpm = 0.7 gpm

Study Participant L, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.7 gpm.

Raw Pump Capacity: 0.7 gpm with the largest pump out of service
Transfer Pump Capacity: 0.7 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.7 gpm
Service Pumps: 2.1 gpm
Clearwell Storage Capacity: 480 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT M

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/28/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is filtered, transferred to storage for distribution for sinks, toilets, showers, etc. Bottled water is brought in for human consumption

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water/Community
Total Number of Connections: 18
Number & Type of Seasonal Units: 1 public restroom
Number & Type of Permanent Units: 14 houses, 2 MH, 1 office
Population Estimate (source of estimate): 16 x 3 = 48 (permanent); 150 people (restroom, assumed) (estimated, using the BRA headcount numbers for 1992)
Recorded Water Usage: use approximately 150 3-gallon bottles a month ($700/month to Ozarka)
Calculated Water Demand: (16 x 0.6 gpm) + (1 x 18 gal/person) + (150 people x 6 gallons/person) = 10.2 gpm

Study Participant M, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 9hp pumps
Chlorination: none added
Pressure Tank: none
Filters: 1 pressure sand filter, unknown capacity
Service Pumps: none
Storage Capacity: 16,000 gallons elevated storage
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water/Community system, for a total treatment capacity of 10.8 gpm.

Raw Pump Capacity: 10.8 gpm with the largest pump out of service
Transfer Pump Capacity: 10.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): N/A (1800 gallons)
Filters: 10.8 gpm
Service Pumps: 2 or more pumps with a total capacity of 36 gpm per connection
Clearwell Storage Capacity: 900 gallons
Total Storage Capacity: 3600 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, inadequate laboratory equipment.

STUDY PARTICIPANT N

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Flow measurement, filtration, reverse osmosis, terminal disinfection, and covered clearwell storage.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 24
Number & Type of Seasonal Units: 24 condominiums in 4 buildings
Number & Type of Permanent Units: assume no permanent residents
Population Estimate (source of estimate): 72 (estimated from the number of condominiums)
Recorded Water Usage: 1214 gpd average during Nov, Dec, Jan, & part of Feb
Calculated Water Demand: 24 x 0.6 = 14.4 gpm

Study Participant N. (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 25 gpm
Chlorination: yes
Pressure Tank: 1 - 82 gal
Filters: unknown
Service Pumps: 1 - 18 gpm
Storage Capacity: 2 - 3500 gal
Additional Treatment/Capabilities: RO system

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 14.4 gpm.

Raw Pump Capacity: 14.4 gpm with the largest pump out of service
Transfer Pump Capacity: 14.4 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 480 gallons (N/A)
Filters: 14.4 gpm
Service Pumps: 2 or more pumps with a total capacity of 48 gpm
Clearwell Storage Capacity: 1200 gallons
Total Storage Capacity: 4800 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT O

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? did not return survey
Date of Engineering Site Visit: 6/3/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: no reply

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake.

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 14
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: authorized for 14 MH
Population Estimate (source of estimate): 42 (estimated using 3 persons per connection per Texas Water Commission standards)
Recorded Water Usage: none
Calculated Water Demand: 14 x 0.6 gpm = 8.4 gpm

Study Participant O, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: unknown
Pressure Tank: unknown
Filters: unknown
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: unknown

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate disinfection capabilities, inadequate pressure storage, inadequate raw water pump capacity, improperly protected wellhead.

STUDY PARTICIPANT P

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? unknown
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Pretreatment disinfection, taste and odor control, filtration, RO system, covered clearwell storage, terminal disinfection, and pressure tanks, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 10
Number & Type of Seasonal Units: 10 condominiums
Number & Type of Permanent Units: no permanent residents
Population Estimate (source of estimate): 30 (estimated using 3 persons per connection per Texas Water Commission standards)
Recorded Water Usage: unknown
Calculated Water Demand: 10 x 0.6 gpm = 6 gpm

Study Participant P, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 21 gpm submersible, 2 - 10 gpm centrifugal
Chlorination: hypochlorinator injects chlorine prior to filters, and into ground storage
Pressure Tank: 2 - 80 gal fiberglass
Filters: 2 - 16" pressure mixed media (2 gpm/sf)
Service Pumps: 1 - 35 gpm, 1½hp
Storage Capacity: 1200 gal
Additional Treatment/Capabilities: softener, 3000 gpd RO System

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate pressure storage, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT Q

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/20/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Possum Kingdom Lake water receives complete treatment plus reverse osmosis treatment

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 22
Number & Type of Seasonal Units: kitchen, 7 cabins, 13 shower facilities
Number & Type of Permanent Units: 1 house
Population Estimate (source of estimate): 475 (Gene Hacker, Camp Ranger)
Recorded Water Usage: peak of 904,400 gal in 6/92
Calculated Water Demand: 475 x 42 gpd + 1 x 0.6 gpm = 14.5 gpm

Study Participant Q, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 25 gpm at 220 TDH
Chlorination: pre- and super-; in 7/92, used 78 gal 12.5% Na hypochlorite
Pressure Tank: 30 gal (for ranger's use, not in service)
Filters: 2 - 14 gpm pressure dual-media
Service Pumps: no (small one for ranger's house)
Storage Capacity: 2 - 42,000 gal; 1 - 22,000 gal; all treated as elevated
Additional Treatment/Capabilities: 7/92 used 38 gal concentrated muriatic acid, RO system, superchlorinates, continuous turbidity/chlorine monitoring, automatic shut-down

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 14.5 gpm.

Raw Pump Capacity: 14.5 gpm with the largest pump out of service
Transfer Pump Capacity: 14.5 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 14.5 gpm
Service Pumps: 43.5 gpm
Clearwell Storage Capacity: 10,400 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): None

STUDY PARTICIPANT R

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: unknown

EXISTING TREATMENT PROCESS: No treatment is conducted, receives treated water from Graham

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 1 restaurant
Population Estimate (source of estimate): 50 (Texas Water Commission sanitary survey)
Recorded Water Usage: 2500 gal/month, during spring
Calculated Water Demand: 50 x 18 gpd = 0.6 gpm

Study Participant R, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: none
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: 2 - ½hp
Storage Capacity: 1 - 3000 gal; 1 - 1300 gal
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.6 gpm.

Raw Pump Capacity: 0.6 gpm with the largest pump out of service
Transfer Pump Capacity: 0.6 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.6 gpm
Service Pumps: 1.8 gpm
Clearwell Storage Capacity: 450 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate disinfection capabilities, inadequate pressure storage, inadequate service pump capacity, inadequate laboratory equipment, inadequate operating pressure.

STUDY PARTICIPANT S

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: N/A
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is pumped from Possum Kingdom Lake.

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 5
Number & Type of Seasonal Units: none
Number & Type of Permanent Units: 4 houses, 1 office
Population Estimate (source of estimate): 4 x 3 + 1 x 10 = 22 (estimated using TWC criteria & assuming 10 persons in the office/day)
Recorded Water Usage: unknown
Calculated Water Demand: 4 x 0.6 gpm + 10 x 18 gpd/person = 2.5 gpm

Study Participant S. (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: unknown
Pressure Tank: unknown
Filters: unknown
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT T

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: unknown

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 9
Number & Type of Seasonal Units: 9 buildings
Number & Type of Permanent Units: 0
Population Estimate (source of estimate): maximum of 45 (BRA contract) (BRA Contract limits capacity)
Recorded Water Usage: none
Calculated Water Demand: 45 x 42 gallons/person = 1.3 gpm

Study Participant T, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: unknown
Pressure Tank: unknown
Filters: unknown
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: unknown

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): unknown

STUDY PARTICIPANT U

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water pumps deliver water to the hypochlorinator, through the pressure tank, and on to the distribution system

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 86
Number & Type of Seasonal Units: 11 RV, 56 MH, 10 cabin units
Number & Type of Permanent Units: 1 home, restaurant, 2 cabins, 5 MH
Population Estimate (source of estimate): 200 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown, hauls 1000 gal approx every 3 weeks in summer
Calculated Water Demand: 0.6 gpm x 85 conn + 18 gpd/pers x 50 people = 51.6 gpm

Study Participant U, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 90 gpm submersible; 1 - 5hp, 75 gpm centrifugal; 1 - 2hp, 40 gpm vertical turbine
Chlorination: 55 gal/month from AMPI
Pressure Tank: 550 gal
Filters: none
Service Pumps: none
Storage Capacity: 2 - 500 gal for hauled water
Additional Treatment/Capabilities: hauls water for cabins & restaurant

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 51.6 gpm under normal rated design flow.

Raw Pump Capacity: 51.6 gpm with the largest pump out of service
Transfer Pump Capacity: 51.6 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 1720 gallons
Filters: 51.6 gpm under normal rated design flow
Service Pumps: 2 or more pumps with a total capacity of 172 gpm
Clearwell Storage Capacity: 4300 gallons
Total Storage Capacity: 17200 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment. Inadequate pressure on hauled water system.

STUDY PARTICIPANT V

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is filtered and chlorinated and conveyed through the pressure tank. The water is transmitted to the storage tank prior to distribution.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 12
Number & Type of Seasonal Units: 2 MH
Number & Type of Permanent Units: 2 retail bldgs, 7 houses/MH, MH park
Population Estimate (source of estimate): 30 (Texas Water Commission sanitary survey)
Recorded Water Usage: max of 210,000 gal in July
Calculated Water Demand: 7.0 gpm

Study Participant V, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 20 gpm at 60 psi
Chlorination: 21 gal last quarter
Pressure Tank: 120 gal
Filters: none
Service Pumps: 1 -20 gpm
Storage Capacity: 1 - 9600 gal elevated
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 7.2 gpm.

Raw Pump Capacity: 7.2 gpm with the largest pump out of service
Transfer Pump Capacity: 7.2 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 240 gallons (1200 gallons)
Filters: 7.2 gpm
Service Pumps: 2 or more pumps with a total capacity of 24 gpm
Clearwell Storage Capacity: 600 gallons
Total Storage Capacity: 2400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Insufficient raw water supply. Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT W

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/20/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: *"in compliance"*

EXISTING TREATMENT PROCESS: Pretreatment disinfection, flash mixing and flocculation, filtration, covered clearwell storage, and terminal disinfection

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 33 (main)
Number & Type of Seasonal Units: 8 rock bldgs (16/ea), 21 tents (10/ea), 4 restrooms/showers
Number & Type of Permanent Units: 2 houses
Population Estimate (source of estimate): 440 (estimated using Texas Water Commission criteria.)
Recorded Water Usage: max flow 51,600 gpd on July 27, 1992
Calculated Water Demand: 440 x 42 gpd = 12.8 gpm

Study Participant W, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 5hp, 40 gpm centrifugals
Chlorination: pre- & post-chlorination; July 92, used 176 gal
Pressure Tank: none
Filters: 2 or 4 dual media pressure
Service Pumps: 2 - 40 gpm
Storage Capacity: 2 - 21,000 gal in service; 2 - 21,000 gal tanks not plumbed in yet
Additional Treatment/Capabilities: superchlorination is planned after new tanks in service

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 12.8 gpm.

Raw Pump Capacity: 12.8 gpm with the largest pump out of service
Transfer Pump Capacity: 12.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 12.8 gpm
Service Pumps: 38.4 gpm
Clearwell Storage Capacity: 9240 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No continuous coagulation, no sedimentation, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT X

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/20/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: *"in compliance"*

EXISTING TREATMENT PROCESS: Pretreatment disinfection, filtration, covered clearwell storage, and terminal disinfection.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 34
Number & Type of Seasonal Units: 28 tents (10/ea), 4 staff rentals
Number & Type of Permanent Units: 2 staff houses
Population Estimate (source of estimate): 280 (Texas Water Commission sanitary survey)
Recorded Water Usage: max of 28,800 gpd on 8/6/92; (20 gpm)
Calculated Water Demand: 280 x 42 gpd = 8.2 gpm

Study Participant X, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 7.5hp 40 gpm
Chlorination: pre- & post-(super), 74 gal in July, 92
Pressure Tank: none
Filters: 2 - 28"D x 4'high; 1 - 42"D x 5' high
Service Pumps: none
Storage Capacity: 4 - 21,000 gal
Additional Treatment/Capabilities: superchlorination

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 8.2 gpm.

Raw Pump Capacity: 8.2 gpm with the largest pump out of service
Transfer Pump Capacity: 8.2 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 8.2 gpm
Service Pumps: 24.6 gpm
Clearwell Storage Capacity: 5880 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No taste and odor control, flash mixing, flocculation, continuous coagulation, sedimentation, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT Y

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 6/2/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water passes through an activated charcoal filter prior to the softener. Softened water is chlorinated and is distributed through the pressure tank.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 4
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 1 store, 1 restaurant, 1 apt, 1 MH
Population Estimate (source of estimate): 50 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 50 x 12 gpd + 2 x 0.6 gpm + 35 x 18 gpd = 2.1 gpm

Study Participant Y, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 10 gpm submersible
Chlorination: 2 hypochlorinators
Pressure Tank: 1 - 40 gallon
Filters: 1 - 3 cf (8 gpm)
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: 8 gpm softener

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 2.1 gpm.

Raw Pump Capacity: 2.1 gpm with the largest pump out of service
Transfer Pump Capacity: 2.1 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 2.1 gpm
Service Pumps: 6.3 gpm
Clearwell Storage Capacity: 1500 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT Z

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: *"well"*

EXISTING TREATMENT PROCESS: Well water is disinfected prior to the pressure tanks and distribution.

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 16
Number & Type of Seasonal Units: 4 MH/houses
Number & Type of Permanent Units: 11 MH/houses, 1 beer joint
Population Estimate (source of estimate): 60 (estimated using Texas Water Commission criteria)
Recorded Water Usage: none
Calculated Water Demand: 15 x 1.5 gpm + 30 x 18 gpd = 22.9 gpm

Study Participant Z, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 3hp
Chlorination: 3 gal/wk bleach
Pressure Tank: 2 - 200 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none; filtrate study performed

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of < 50 connections without ground storage.

Raw Pump Capacity: 24 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 800 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No coagulation with direct filtration is provided, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AA

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 6/3/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: no reply

EXISTING TREATMENT PROCESS: None provided, water supplied to the bulk tank by another study participant, is gravity feed to connections

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 9
Number & Type of Seasonal Units: 6 MH, potential of TOTAL of 40 MH
Number & Type of Permanent Units: 1 MH, 2 stores
Population Estimate (source of estimate): 7 x 3 + 30 = 51 (information obtained from outside sources)
Recorded Water Usage: unknown
Calculated Water Demand: Potential of 30 x 12 gpd + 40 x 0.6 gpm = 24.3 gpm, current 30 x 12 gpd + 7 x 0.6 gpm = 4.5 gpm

Study Participant AA, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: none
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: 3000 gal tank
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 4.5 gpm.

Raw Pump Capacity: 4.5 gpm with the largest pump out of service
Transfer Pump Capacity: 4.5 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 180 gallons (900 gallons per connection)
Filters: 4.5 gpm
Service Pumps: 2 or more pumps with a total capacity of 18 gpm
Clearwell Storage Capacity: 450 gallons
Total Storage Capacity: 1800 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Same as the supplier.

STUDY PARTICIPANT AB

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is disinfected prior to distribution from the pressure tank.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity
Total Number of Connections: 62
Number & Type of Seasonal Units: 5 cabins, 1 meeting hall, 48 RV, 7 MH
Number & Type of Permanent Units: 1 store/apt.
Population Estimate (source of estimate): 186 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 61 x .6 gpm + 30 x 18 gpd = 37 gpm

Study Participant AB, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 5hp submersible
Chlorination: 100 gal/year (7%)
Pressure Tank: 1 - 1000 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity system, for a total treatment capacity of 37 gpm.

Raw Pump Capacity: 37 gpm with the largest pump out of service
Transfer Pump Capacity: 37 gpm
Pressure Tank Capacity (Elevated Storage): 1240 gallons (6200 gallons)
Filters: 37 gpm
Service Pumps: 2 or more pumps with a total capacity of 124 gpm
Clearwell Storage Capacity: 3100 gallons
Total Storage Capacity: 12400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AC

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/20/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: no

EXISTING TREATMENT PROCESS: Raw water is obtained from Possum Kingdom Lake by 3 submersible pumps, which discharge into 3 pressure tanks, only 1 pump/pressure tank has chlorination.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity
Total Number of Connections: 33
Number & Type of Seasonal Units: 8 cabins, 5 motel units, 3 houses (TWC counts as 10 units since each sleeps 10), 8 RV
Number & Type of Permanent Units: 1 restaurant, 1 motel unit
Population Estimate (source of estimate): 100 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 32 x 0.6 gpm + 20 pers/day x 18 gpd = 19.5 gpm

Study Participant AC, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 3 - submersible; 2 - 1½hp, 1 - 1hp
Chlorination: chlorine tablets used in motel unit only
Pressure Tank: 2 - 42 gal, 1 - 80 gal(in motel)
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity system, for a total treatment capacity of 19.5 gpm.

Raw Pump Capacity: 19.5 gpm with the largest pump out of service
Transfer Pump Capacity: 19.5 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 660 gallons (3300 gallons)
Filters: 19.5 gpm
Service Pumps: 2 or more pumps with a total capacity of 66 gpm
Clearwell Storage Capacity: 1650 gallons
Total Storage Capacity: 6600 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AD

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 5/30/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Filtration, water softening, Reverse Osmosis, terminal disinfection, covered clearwell storage, and pressure storage with service pumps.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 43
Number & Type of Seasonal Units: 7 double (4 bdrm, 2 bath) condominiums, 34 standard condominiums
Number & Type of Permanent Units: 1 MH (caretaker), 1 condominium
Population Estimate (source of estimate): 144 (Texas Water Commission sanitary survey)
Recorded Water Usage: peak day of 10,000 gallons on July 4, 1992 (6.9 gpm)
Calculated Water Demand: 43 x 0.6 gpm = 25.8 gpm

Study Participant AD, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 1 or 1½ hp submersible pumps
Chlorination: use 4 cups per 25 hour run, have standby chlorinator
Pressure Tank: 2 - 75 gallon
Filters: 2 cartridge filters on raw water, 1 3'Ø
Service Pumps: 2 - 1 hp ≈ 20 gpm each
Storage Capacity: 1 - 10,000 gallon tank always in use, 2 - 2500 gallon tanks used on weekends only
Additional Treatment/Capabilities: softener, RO system (300 gal/hour), flowmeter

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 25.8 gpm.

Raw Pump Capacity: 25.8 gpm with the largest pump out of service
Transfer Pump Capacity: 25.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 860 gallons (4300 gallons)
Filters: 25.8 gpm
Service Pumps: 2 or more pumps with a total capacity of 86 gpm
Clearwell Storage Capacity: 2150 gallons
Total Storage Capacity: 8600 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate treatment and pressure tank capacity, no lab test equipment and the raw water intake is located directly under the boat dock adjacent to boat launch, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AE

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? unknown
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: no

EXISTING TREATMENT PROCESS: N/A

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 8
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 8 MH
Population Estimate (source of estimate): 24 (estimated using Texas Water Commission criteria)
Recorded Water Usage: none
Calculated Water Demand: 8 x 0.6 gpm = 4.8 gpm

Study Participant AE, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: unknown
Pressure Tank: unknown
Filters: unknown
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: unknown

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): N/A

STUDY PARTICIPANT AF

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: phone conversation 6/7/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: no reply

EXISTING TREATMENT PROCESS: Raw water passes through a DE filter, and is distributed through the pressure tank to the 4 connections that are supplied.

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System currently, Surface Water - Community
Total Number of Connections: 26
Number & Type of Seasonal Units: 24 cabins
Number & Type of Permanent Units: 2 cabins
Population Estimate (source of estimate): 26 x 3 = 78 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 26 x 0.6 gpm = 15.6 gpm

Study Participant AF, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 16 gpm
Chlorination: none
Pressure Tank: 70 gallons
Filters: DE filter of unknown size
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable. However, the following requirements are used on the assumption of this system being classified as a Surface Water - Community system, for a total treatment capacity of 15.6 gpm.

Raw Pump Capacity: 15.6 gpm with the largest pump out of service
Transfer Pump Capacity: 15.6 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 520 gallons (2600 gallons)
Filters: 15.6 gpm
Service Pumps: 2 or more pumps with a total capacity of 52 gpm
Clearwell Storage Capacity: 1300 gallons
Total Storage Capacity: 5200 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AG

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Groundwater is disinfected and distributed through pressure tanks

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 27
Number & Type of Seasonal Units: 21 MH/cabins
Number & Type of Permanent Units: 6 MH/cabins
Population Estimate (source of estimate): 27 x 3 = 81 (estimated using Texas Water Commission Criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 27 x 1.5 gpm = 40.5 gpm

Study Participant AG, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 1½hp (1 per well); 2hp ruth berry pump for 3rd well or lake water
Chlorination: unknown amount, have not been using long
Pressure Tank: 4 - 120 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of < 50 connections without ground storage.

Raw Pump Capacity: 40.5 gpm per connection
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 1350 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No coagulation with direct filtration, no flow meters,inadequate system pressure, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AH

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: *"wells"*

EXISTING TREATMENT PROCESS: Groundwater is distributed through use of pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 62
Number & Type of Seasonal Units: 20 MH, 20 RV
Number & Type of Permanent Units: 20 MH, 1 store, 1 beauty shop
Population Estimate (source of estimate): 220 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 60 x .6 gpm + 40 x 12 gpd/pers = 36.3 gpm

Study Participant AH, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - ¾hp, 1 - 1hp one main well; 1 ¾hp on inside well
Chlorination: none
Pressure Tank: 3 - 100 gal
Filters: none in use, old one not tied in, previously used on lake system
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of 50 - 250 connections.

Raw Pump Capacity: 36.3 gpm per connection
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 1240 gallons (6200 gallons)
Filters: N/A
Service Pumps: 2 or more pumps having a total capacity of 124 gpm
Clearwell Storage Capacity: N/A
Total Storage Capacity: 12400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No coagulation with direct filtration and inadequate system pressure, no laboratory equipment, no chlorination, no continuous chlorine/turbidity monitoring

STUDY PARTICIPANT AI

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 6/8/93 telephone conversation
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Raw water is pumped through a pressure tank to the restaurant.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 3
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 1 restaurant, 1 sheriff office, 1 MH
Population Estimate (source of estimate): 30 (assume) (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 30 x 18 gpd = 0.4 gpm

Study Participant AI, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown size
Chlorination: none, but plan to install
Pressure Tank: 1 tank of unknown size
Filters: plan to install charcoal & sand filter
Service Pumps: none
Storage Capacity: 1 600 gallon haul water tank, plan to install 1000 gallon tank (hauled)
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 0.4 gpm.

Raw Pump Capacity: 0.4 gpm with the largest pump out of service
Transfer Pump Capacity: 0.4 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 0.4 gpm
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: 270 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AJ

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/16/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: *"on well"*

EXISTING TREATMENT PROCESS: Groundwater is chlorinated and distributed through pressure tanks

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 27
Number & Type of Seasonal Units: 17 MH, 2 houses, 7 RV
Number & Type of Permanent Units: 1 restaurant
Population Estimate (source of estimate): 26 x 3 + 30 = 108 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 26 x 1.5 gpm + 30 x 18 gpd = 39.4 gpm

Study Participant AJ, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 2hp & 1 standby (2hp)
Chlorination: 2 gal/wk bleach
Pressure Tank: 2 - 150 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of < 50 connections without ground storage.

Raw Pump Capacity: 39.4 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 1350 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Possibly under the influence of surface water, no sanitary easement, no well driller's log, no laboratory equipment, no continuous chlorine/turbidity monitoring

STUDY PARTICIPANT AK

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is chlorinated and distributed through the pressure tank.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving transient accommodation units
Total Number of Connections: 37
Number & Type of Seasonal Units: 30 RV, 2 sets restrooms (for 18 tent sites, no water), 2 cabins, 1 pavilion with sink, boat shop(currently closed)
Number & Type of Permanent Units: 1 doublewide MH, 1 store
Population Estimate (source of estimate): 160 (owner, during the site visit)
Recorded Water Usage: unknown
Calculated Water Demand: 36 x 0.6 gpm + 20 x 12 gpd = 21.8 gpm

Study Participant AK, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 submersible, unknown size
Chlorination: 1 gal bleach every 3 weeks during late spring
Pressure Tank: 1 - 66 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving transient accommodation units system, for a total treatment capacity of 21.8 gpm.

Raw Pump Capacity: 21.8 gpm with the largest pump out of service
Transfer Pump Capacity: 21.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 370 gallons (N/A)
Filters: 21.8 gpm
Service Pumps: 2 or more service pumps with a total capacity of 37.0 gpm
Clearwell Storage Capacity: 1000 gallons
Total Storage Capacity: 1295 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment. Inadequate system pressure.

STUDY PARTICIPANT AL

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: phone conversation 6/7/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is pumped into pressure tanks, which distribute to the connections

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 92
Number & Type of Seasonal Units: 26 MH/cottages (camp), 10 MH/houses (deeded)
Number & Type of Permanent Units: 26 MH/cabins (camp), 30 MH/houses (deeded)
Population Estimate (source of estimate): 106 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 92 x 0.6 gpm = 55.2 gpm

Study Participant AL, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 3 - submersible 27 gpm/ea
Chlorination: unknown
Pressure Tank: 3 - *rated at* 120 gallon each
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 55.2 gpm.

Raw Pump Capacity: 55.2 gpm with the largest pump out of service
Transfer Pump Capacity: 55.2 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 1840 gallons (9200 gallons)
Filters: 55.2 gpm
Service Pumps: 2 or more pumps with a total capacity of 184 gpm
Clearwell Storage Capacity: 4600 gallons
Total Storage Capacity: 18400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AM

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: None required, treated water is obtained from another study participant

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 40
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: approx. 40 MH
Population Estimate (source of estimate): 120 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 40 x 0.6 gpm = 24 gpm (included with another study participant)

Study Participant AM, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: none
Chlorination: none
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 24 gpm (included with another study participant).

Raw Pump Capacity: 24 gpm with the largest pump out of service (included with another study participant)
Transfer Pump Capacity: 24 gpm (included with another study participant)
Pressure Tank Capacity (Elevated Storage): 800 gallons (4000 gallons)
Filters: 24 gpm (included with another study participant)
Service Pumps: 2 or more pumps with a total capacity of 80 gpm (included with another study participant)
Clearwell Storage Capacity: 2000 gallons (included with another study participant)
Total Storage Capacity: 8000 gallons (included with another study participant)

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No treatment provided

STUDY PARTICIPANT AN

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/21/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is chlorinated and delivered to the covered clearwell storage through pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 29
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 29 MH/houses
Population Estimate (source of estimate): 60 (Texas Water Commission sanitary survey)
Recorded Water Usage: approx. 15,000 gpd in summer (amt on water contract with BRA)
Calculated Water Demand: 29 x .6 gpm = 17.4 gpm

Study Participant AN, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 20 gpm submersible; 1 - 75 gpm centrifugal
Chlorination: 36 gal bleach/week
Pressure Tank: 2 - 80 gal
Filters: none
Service Pumps: 1 - 52 gpm, 5hp
Storage Capacity: 2 - 10,000 gal; 1 - 30,000 gal not in use
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 17.4 gpm.

Raw Pump Capacity: 17.4 gpm with the largest pump out of service
Transfer Pump Capacity: 17.4 gpm
Pressure Tank Capacity (Elevated Storage): 580 gallons (2900 gallons)
Filters: 17.4 gpm
Service Pumps: 2 or more pumps with a total capacity of 58 gpm
Clearwell Storage Capacity: 1450 gallons
Total Storage Capacity: 5800 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AO

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is pumped through a pressure tank to the building

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 3
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 3
Population Estimate (source of estimate): approx. 150 ()
Recorded Water Usage: none
Calculated Water Demand: 150 x 18 gpd = 1.9 gpm

Study Participant AO, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: unknown
Pressure Tank: unknown
Filters: unknown
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: unknown

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 1.9 gpm.

Raw Pump Capacity: 1.9 gpm with the largest pump out of service
Transfer Pump Capacity: 1.9 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 1.9 gpm
Service Pumps: 5.7 gpm
Clearwell Storage Capacity: 1350 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AP

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/15/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is chlorinated and distributed through pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 50
Number & Type of Seasonal Units: 19 MH, 21 cabins, 1 triplex, 2 cabins, 2 rental MH
Number & Type of Permanent Units: 3 MH
Population Estimate (source of estimate): 50 units x 3 = 150 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 50 x 0.6 gpm = 30 gpm

Study Participant AP, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 25 gpm, 3hp submersible
Chlorination: approx. 20 gal in October, 1992 (from AMPI)
Pressure Tank: Have 3, only use 2 (140 gal)
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 30 gpm.

Raw Pump Capacity: 30 gpm with the largest pump out of service
Transfer Pump Capacity: 30 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 1000 gallons (5000 gallons per connection)
Filters: 30 gpm
Service Pumps: 2 or more pumps with a total capacity of 100 gpm
Clearwell Storage Capacity: 2500 gallons
Total Storage Capacity: 10000 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AQ

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: N/A

EXISTING TREATMENT PROCESS: Taste and odor control, filtration, reverse osmosis system, covered clearwell storage, and terminal disinfection.

CONNECTION/POPULATION ESTIMATES

Type of System: Not a Public Water System
Total Number of Connections: 8
Number & Type of Seasonal Units: 7 condos
Number & Type of Permanent Units: 1 condo
Population Estimate (source of estimate): 8 x 3 = 24 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 8 x 0.6 gpm = 4.8 gpm

Study Participant AQ, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 18 gpm submersible
Chlorination: chlorinate after RO system
Pressure Tank: 2 - 75 gal
Filters: sand & cartridge filters
Service Pumps: 1 13.5 gpm
Storage Capacity: 1 - 10,000 gal
Additional Treatment/Capabilities: RO system designed for total of 40 units

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

This system does not meet the requirements to be a Public Water System, therefore, the current rules and regulations are not applicable.

Raw Pump Capacity: N/A
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): N/A (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No prechlorination due to use of RO system, no metering of water use, no flash mixing, flocculation, continuous coagulation, or sedimentation, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AR

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is chlorinated and filtered before distribution through pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 92
Number & Type of Seasonal Units: 17 cabins, 4 homes, 28 camping sites, MH park (40 MH)
Number & Type of Permanent Units: 1 restaurant, 2 homes
Population Estimate (source of estimate): 91 x 3 + 1 x 50 = 325 (estimated using Texas Water Commission criteria)
Recorded Water Usage: 1500 gpd peak (estimate by owner)
Calculated Water Demand: 91 x 0.6 gpm + 50 x 18 gpd = 55.2 gpm

Study Participant AR, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 3 - 40 gpm centrifugal
Chlorination: 3 chlorinators, 55 gal/month from AMPI
Pressure Tank: 3 - 82 gal, 1 - 250 gal
Filters: 6 pressure sand filters
Service Pumps: none
Storage Capacity: 1 -1200 gal (hauled)
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 55.2 gpm.

Raw Pump Capacity: 55.2 gpm with the largest pump out of service
Transfer Pump Capacity: 55.2 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 1840 gallons (9200 gallons)
Filters: 55.2 gpm
Service Pumps: 2 or more pumps with a total capacity of 184 gpm
Clearwell Storage Capacity: 4600 gallons
Total Storage Capacity: 18400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AS

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/14/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Pretreatment disinfection, taste and odor control, flash mixing, flocculation, continuous coagulation, sedimentation, filtration, covered clearwell storage, and terminal disinfection, continuous chlorine/turbidity monitoring.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity
Total Number of Connections: 153
Number & Type of Seasonal Units: 6 cabins, 1 store, 1 office, 1 maint. bldg, 58 RV, 5 restrooms (4 with showers), 61 campsites with water, 13 tentsites without water, 2 houses
Number & Type of Permanent Units: 3 MH, 2 houses
Population Estimate (source of estimate): 200 (estimated using Texas Water Commission criteria)
Recorded Water Usage: March 1993 peak 47,100 gpd
Calculated Water Demand: 153 x 0.6 gpm = 91.8 gpm

Study Participant AS, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 30 gpm 25 hp submersible
Chlorination: 50 - 75 gal/month (17.9%)
Pressure Tank: none
Filters: 2 3½' Ø pressure sand
Service Pumps: 2 - 5hp, 30 gpm
Storage Capacity: 1 - 80,000 gal
Additional Treatment/Capabilities: upflow clarifier, add alum & caustic, continuous chlorine/turbidity monitors

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity system, for a total treatment capacity of 91.8 gpm.

Raw Pump Capacity: 91.8 gpm with the largest pump out of service
Transfer Pump Capacity: 91.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 3060 gallons (15300 gallons)
Filters: 91.8 gpm
Service Pumps: 2 or more pumps with a total capacity of 306 gpm
Clearwell Storage Capacity: 7650 gallons
Total Storage Capacity: 30600 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate treatment capacity, cannot meet secondary standards with conventional treatment, lack of restricted access around intake.

STUDY PARTICIPANT AT

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/27/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Reverse osmosis to water provided by another study participant.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 1
Number & Type of Seasonal Units: none
Number & Type of Permanent Units: 1 restaurant
Population Estimate (source of estimate): 35 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 35 x 18 gallons/person = 0.4 gpm included with another study participant

Study Participant AT, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: none
Chlorination: ½ cup bleach/month
Pressure Tank: none
Filters: fiber cartridge filter, followed by activated carbon cartridge filter
Service Pumps: ½hp centrifugal pump (10 gpm)
Storage Capacity: 2 - 200 gal
Additional Treatment/Capabilities: RO system approx. 85 - 100 gpd

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system.

Raw Pump Capacity: included with another study participant
Transfer Pump Capacity: included with another study participant
Pressure Tank Capacity (Elevated Storage): included with another study participant
Filters: included with another study participant
Service Pumps: included with another study participant
Clearwell Storage Capacity: included with another study participant
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No pressure storage, inadequate storage facilities, no testing conducted (Cl), inadequate operating pressure, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AU

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/16/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Groundwater is chlorinated and delivered to the ground storage tank through the pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 76
Number & Type of Seasonal Units: 9 cabins, 12 RV, 53 MH
Number & Type of Permanent Units: 1 MH, 1 store
Population Estimate (source of estimate): 244 (assuming 2 person for 23 double beds, 3 persons/MH) (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 75 x 0.6 gpm + 20 x 12 gpd = 45.2 gpm

Study Participant AU, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 17 gpm
Chlorination: total of 4 gal/week bleach
Pressure Tank: 3 - 85 gal
Filters: none
Service Pumps: 1 - 20 gpm (pumps to ground storage tank)
Storage Capacity: 12,600 gal
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of 50 - 250 connections.

Raw Pump Capacity: 45.2 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 1520 gallons (7600 gallons)
Filters: N/A
Service Pumps: 2 or more pumps having a total capacity of 152 gpm
Clearwell Storage Capacity: N/A
Total Storage Capacity: 15200 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Groundwater possibly under the influence of surface water. No flowmeters, minor deficiencies with ground storage and pressure tanks, and wells, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT AV

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 6/3/92
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is pumped by either of the 3 pumps, chlorinated and distributed through the use of the two pressure tanks. Flow meters meter the amount of pumped water.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 152
Number & Type of Seasonal Units: 10 cabins, 96 MH, (proposed: 30 RV sites, public restroom)
Number & Type of Permanent Units: 14 MH, 1 office/store
Population Estimate (source of estimate): 250 (Texas Water Commission sanitary survey)
Recorded Water Usage: 49,700 gallons on 7/14/1991 (34.5 gpm)
Calculated Water Demand: 151 x 0.6 gpm + 20 x 12 gpd/person = 90.8 gpm

Study Participant AV, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 centrifugal (estimated at 2hp, 15 gpm/ea), 1 submersible, another submersible on order
Chlorination: 2 chlorinators in use, 2 standby chlorinators
Pressure Tank: 1 - 140 gallon, 1 - 87 gallons
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 90.8 gpm.

Raw Pump Capacity: 90.8 gpm with the largest pump out of service
Transfer Pump Capacity: 90.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 3040 gallons (15200 gallons)
Filters: 90.8 gpm
Service Pumps: 2 or more pumps with a total capacity of 304 gpm
Clearwell Storage Capacity: 7600 gallons
Total Storage Capacity: 30400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AW

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/16/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water is filtered, chlorinated, and distributed with pressure tanks.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity
Total Number of Connections: 45
Number & Type of Seasonal Units: 26 rooms, 15 RV
Number & Type of Permanent Units: 1 restaurant, 3 MH
Population Estimate (source of estimate): 115 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 44 x 0.6 gpm + 30 x 18 gpd = 26.8 gpm

Study Participant AW, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 20 gpm submersible
Chlorination: unknown amt of chlorox bleach
Pressure Tank: 1 - 35 gal, 1 - 120 gal
Filters: 1 pressure sand, 2 inline filters after leaving pumphouse
Service Pumps: 1 - 15 gpm (hauled)
Storage Capacity: 4000 gal for hauled water
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity system, for a total treatment capacity of 26.8 gpm.

Raw Pump Capacity: 26.8 gpm with the largest pump out of service
Transfer Pump Capacity: 26.8 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 900 gallons (4500 gallons)
Filters: 26.8 gpm
Service Pumps: 2 or more pumps with a total capacity of 90 gpm
Clearwell Storage Capacity: 2250 gallons
Total Storage Capacity: 9000 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AX

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/12/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: no

EXISTING TREATMENT PROCESS: Raw water is chlorinated and pumped to the pressure tank and distributed.

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Community
Total Number of Connections: 17
Number & Type of Seasonal Units: 12 MH/cabins
Number & Type of Permanent Units: 5 MH
Population Estimate (source of estimate): 40 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 17 x 0.6 gpm = 10.2 gpm

Study Participant AX, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 3hp submersible
Chlorination: 2 gal/week bleach
Pressure Tank: 1 - 100 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Community system, for a total treatment capacity of 10.2 gpm.

Raw Pump Capacity: 10.2 gpm with the largest pump out of service
Transfer Pump Capacity: 10.2 gpm
Pressure Tank Capacity (Elevated Storage): 340 gallons (1700 gallons)
Filters: 10.2 gpm
Service Pumps: 2 or more pumps with a total capacity of 34 gpm
Clearwell Storage Capacity: 850 gallons
Total Storage Capacity: 3400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AY

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/16/93, 6/3/93
Known Site Visit by TWC: no
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: The submersible pump delivers water to the pressure filter, which is chlorinated and delivered to the holding tank before distribution

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity
Total Number of Connections: 22
Number & Type of Seasonal Units: 8 cabins, 6 MH, 8 RV
Number & Type of Permanent Units: 0
Population Estimate (source of estimate): 66 (estimated using TWC criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 22 x 0.6 gpm = 13.2 gpm

Study Participant AY, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 submersible
Chlorination: new chlorinator
Pressure Tank: unknown
Filters: new charcoal & sand filter
Service Pumps: unknown
Storage Capacity: unknown
Additional Treatment/Capabilities: unknown

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity system, for a total treatment capacity of 13.2 gpm.

Raw Pump Capacity: 13.2 gpm with the largest pump out of service
Transfer Pump Capacity: 13.2 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 440 gallons (2200 gallons)
Filters: 13.2 gpm
Service Pumps: 2 or more pumps with a total capacity of 44 gpm
Clearwell Storage Capacity: 1100 gallons
Total Storage Capacity: 4400 gallons

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT AZ

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/15/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: No treatment provided except chlorination

CONNECTION/POPULATION ESTIMATES

Type of System: Surface water - Noncommunity serving other than transient accommodation units
Total Number of Connections: 2
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 1 store, 1 house
Population Estimate (source of estimate): 100 (Texas Water Commission sanitary survey)
Recorded Water Usage: unknown
Calculated Water Demand: 1 x 0.6 gpm + 100 x 12 gpd = 1.4 gpm

Study Participant AZ, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 1 - 10 gpm, 1hp submersible
Chlorination: 5 gal/week chlorine bleach
Pressure Tank: 1 - 36 gal
Filters: none
Service Pumps: none
Storage Capacity: none
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Surface water - Noncommunity serving other than transient accommodation units system, for a total treatment capacity of 1.4 gpm.

Raw Pump Capacity: 1.4 gpm with the largest pump out of service
Transfer Pump Capacity: 1.4 gpm with the largest pump out of service
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: 1.4 gpm
Service Pumps: 4.2 gpm
Clearwell Storage Capacity: 1000 gallons
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate flow measuring devices, inadequate chemical injection, inadequate disinfection capabilities, no flash mixing/flocculation, no continuous coagulation, no sedimentation, inadequate filtration, inadequate bulk storage, inadequate pressure storage, inadequate raw water pump capacity, inadequate service pump capacity, inadequate treatment capacity, no certified operator on duty or continuous chlorine/turbidity monitoring, improperly protected raw water intake, inadequate laboratory equipment.

STUDY PARTICIPANT BA

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: 4/21/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Groundwater is chlorinated and distributed through the storage tank.

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Noncommunity serving transient accommodation units
Total Number of Connections: 20
Number & Type of Seasonal Units: 14 RV, 5 MH
Number & Type of Permanent Units: 1 restaurant
Population Estimate (source of estimate): 87 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 19 x 1.0 gpm + 30 x 18 gpd = 19.4 gpm

Study Participant BA, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: unknown
Chlorination: chlorinate an unknown amount
Pressure Tank: none
Filters: none
Service Pumps: none
Storage Capacity: 1 - 1000 gal
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Noncommunity serving transient accommodation units system, for size category of < 100 accommodation units without ground storage.

Raw Pump Capacity: 19.4 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): No coagulation with direct filtration, no laboratory equipment, no continuous chlorine/turbidity monitoring

STUDY PARTICIPANT BB

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? unknown
Date of Engineering Site Visit: visited with operator 4/20/93
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: Raw water intake pumps, raw water pressure tank, pressure sand filter, water softener, fiber filter (Reverse Osmosis), terminal chlorination prior to storage in ground storage tanks. One service pump and one pressure tank distribute water to the system.

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Community
Total Number of Connections: 25
Number & Type of Seasonal Units: 19 condominium units
Number & Type of Permanent Units: 6 condominium units
Population Estimate (source of estimate): 75 (estimated using Texas Water Commission criteria)
Recorded Water Usage: unknown
Calculated Water Demand: 25 x 1.5 gpm = 37.5 gpm

Study Participant BB, (continued)

EXISTING FEATURES OF FACILITY

Raw pump capacity: 2 - 1½hp submersible
Chlorination: 1½ gal/month 5.25% Na Hypochlorite, 2 chlorinators
Pressure Tank: 2 - 80 gal
Filters: 2 pressure sand filters, 2 gpm/sf allowed
Service Pumps: 1 - 25 gpm, 1hp
Storage Capacity: 2 - 2100 gal, only use 1
Additional Treatment/Capabilities: Water Softener, RO System

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Community system, for size category of < 50 connections without (adequate capacity) ground storage.

Raw Pump Capacity: 37.5 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 1250 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): Inadequate chlorine residual, inadequate treatment plant capacity, no metering, no flocculation, continuous coagulation, or sedimentation, no laboratory equipment, no continuous chlorine/turbidity monitoring, or certified operator on duty when plant in operation.

STUDY PARTICIPANT BC

PARTICIPATION IN PRELIMINARY ENGINEERING STUDY

Participating in Study? yes
Date of Engineering Site Visit: none as of this date
Known Site Visit by TWC: yes
Bilateral Compliance Agreement Signed with TWC: yes

EXISTING TREATMENT PROCESS: unknown

CONNECTION/POPULATION ESTIMATES

Type of System: Groundwater - Noncommunity serving other than transient accommodation units
Total Number of Connections: 7
Number & Type of Seasonal Units: 0
Number & Type of Permanent Units: 7 businesses
Population Estimate (source of estimate): 200 (Texas Water Commission sanitary survey)
Recorded Water Usage: maximum of 1000 gpd (0.7 gpm)
Calculated Water Demand: 200 x 18 gallons/person = 2.5 gpm

Study Participant BC, (continued)

EXISTING FEATURES OF FACILITY

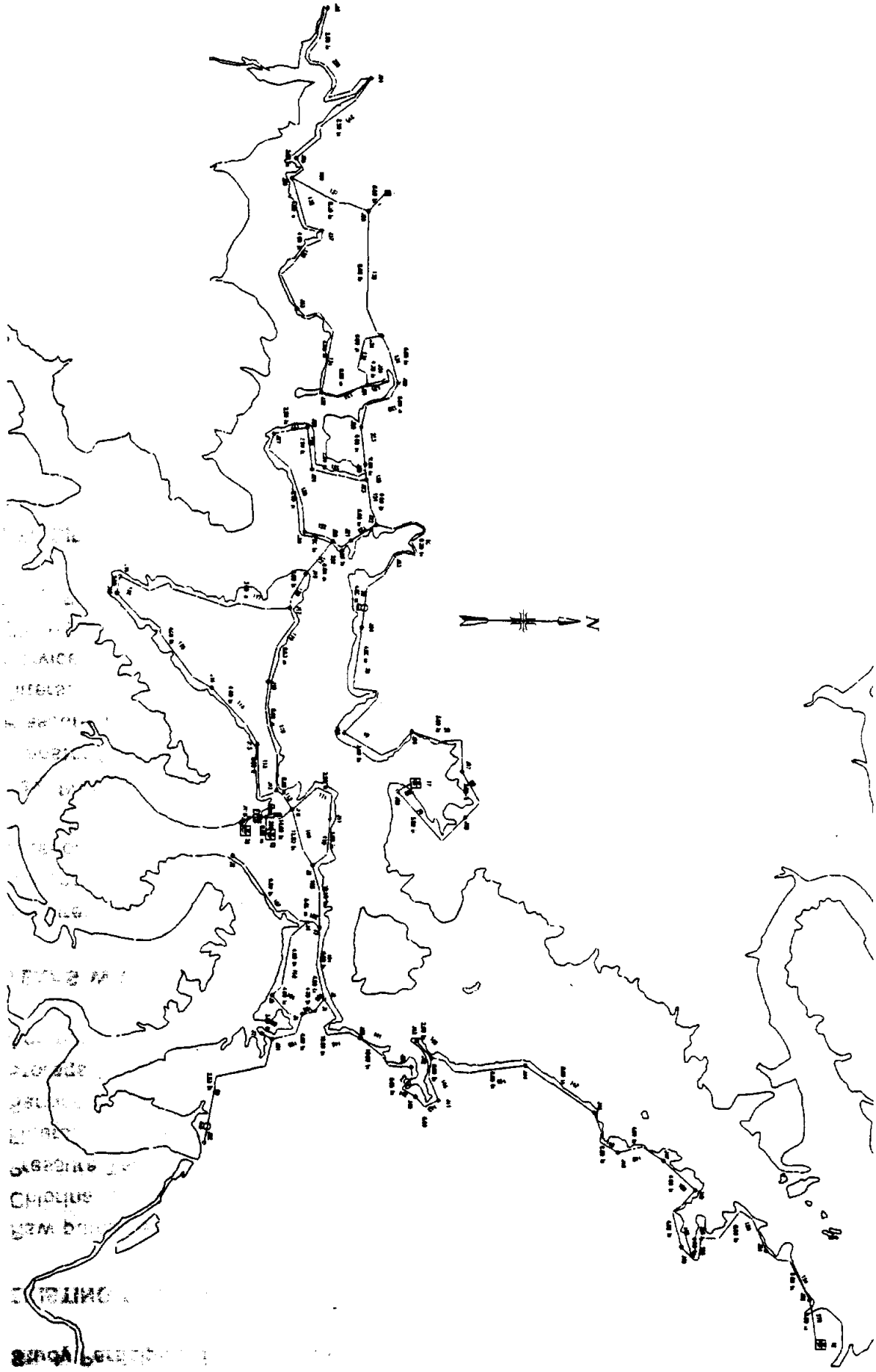
Raw pump capacity: 1 - ½hp, 6 gpm submersible
Chlorination: 1 hypochlorinator
Pressure Tank: 1 - 42 gallon, 1 - 80 gallon
Filters: none
Service Pumps: 1 - ¾hp, 15 gpm
Storage Capacity: 1000 gallons
Additional Treatment/Capabilities: none

TEXAS WATER COMMISSION REQUIREMENTS FOR FACILITY

Requirements are based on this system being classified as a Groundwater - Noncommunity serving other than transient accommodation units system, for size category of < 300 persons per day.

Raw Pump Capacity: 2.5 gpm
Transfer Pump Capacity: N/A
Pressure Tank Capacity (Elevated Storage): 220 gallons (N/A)
Filters: N/A
Service Pumps: N/A
Clearwell Storage Capacity: N/A
Total Storage Capacity: N/A

DEFICIENCIES IN EXISTING TREATMENT PROCESS (Using TWC Criteria): unknown



U N I T S S P E C I F I E D

FLOWRATE ..... = million gallons/day
HEAD (HGL) ..... = feet
PRESSURE ..... = psig

O U T P U T O P T I O N D A T A

OUTPUT SELECTION: THE FOLLOWING RESULTS ARE INCLUDED IN THE TABULATED OUTPUT

ALL CLOSED PIPES ARE NOTED
ALL PIPES WITH PUMPS
FOLLOWING PIPES

10	20	30	40	50	60	70	80	90	100	101	102	103
104	105	106	107	108	109	110	111	112	113	114	115	116
117	118	119	120	121	122	123	124	125	126	127	128	129
130	131	132	133	134	135	136	137	138	139	140	141	142
143	144	145	146	147	148	149	150	151	152	153	154	160
170	200	210	220	252	253	270	280	290	300	500		

FOLLOWING JUNCTION NODES

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	26
27	28	29	30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49	50	51	52
53	54	55	56	57	58	59	61	62	63	64	65	88
100	110											

MAXIMUM AND MINIMUM PRESSURES = 25

S Y S T E M C O N F I G U R A T I O N

NUMBER OF PIPES .....(p) = 76
NUMBER OF JUNCTION NODES .....(j) = 67
NUMBER OF PRIMARY LOOPS .....(l) = 5
NUMBER OF BOUNDARY NODES .....(f) = 5
NUMBER OF SUPPLY ZONES .....(z) = 1

****
S I M U L A T I O N R E S U L T S
****

The results are obtained after 4 trials with an accuracy = 0.00019

S I M U L A T I O N D E S C R I P T I O N

CyberNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
Run Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
Drawing: PIPE_50R

9-1	0.19	1010.00	108	109	110	
10-1	0.07	1020.00	109	111	112	500
11-1	0.03	1010.00	110	111		
12-1	0.06	1010.00	112	113	118	
13-1	0.03	1010.00	113	114		
14-1	0.03	1015.00	114	115		
15-F	0.22	1005.00	115	116		
16-1	0.05	1005.00	116	117		
17-1	0.33	1020.00	117	119	120	
18-1	0.05	1060.00	118	119		
19-1	0.03	1000.00	120	121		
20-1	0.02	1040.00	122	128		
21-1	0.03	1020.00	123	252		
22-1	0.02	1020.00	10	123	124	
23-1	0.01	1010.00	124	125	129	
24-1	0.01	1020.00	125	126		
25-1	0.24	1010.00	129	253		
26-1	0.02	1010.00	126	127		
27-1	0.05	1010.00	127	128		
28-1	0.24	1025.00	130	253		
29-1	0.06	1010.00	130	131		
30-1	0.02	1100.00	131	132	136	
31-1	0.01	1010.00	132	133	135	
32-1	0.03	1010.00	133	134		
33-F	0.19	1010.00	134	139		
34-1	0.01	1010.00	135			
35-1	0.00	1100.00	136	137	170	
36-1	0.18	1010.00	137	138	160	
37-1	0.02	1010.00	138	139		
38-1	0.05	1020.00	140	141		
39-1	0.19	1010.00	141	142		
40-1	0.06	1010.00	142	143		
41-1	0.15	1010.00	143	144		
42-1	0.31	1005.00	144	145	146	
43-1	0.02	1005.00	145			
44-1	0.05	1005.00	146	147		
45-1	0.11	1005.00	147	148		
46-1	0.26	1010.00	148	149		
47-1	0.02	1010.00	149	150		
48-1	0.09	1010.00	150	151		
49-1	0.08	1010.00	151	152		
50-1	0.16	1005.00	152	153		
51-1	0.11	1010.00	153	154		
52-1	0.03	1020.00	154	270		
53-1	0.02	1020.00	10	20		
54-1	0.05	1020.00	20	30		
55-1	0.03	1050.00	30	40		
56-1	0.02	1020.00	40	50		
57-1	0.03	1040.00	50	60		
58-1	0.01	1050.00	60	70		
59-1	0.02	1030.00	70	280		
61-1	0.00	1010.00	80	90	105	
62-1	0.03	1110.00	90			
63-1	0.03	1020.00	160	210		
64-1	0.03	1005.00	210	220		
65-1	0.01	1005.00	220			
88-1	0.00	1010.00	121	122	252	
100-F	0.00	1010.00	200	290	500	
110-1	0.00	0.00	290	300		

26-1	0.02	1097.47	1010.00	87.47	37.90
27-1	0.05	1096.19	1010.00	86.19	37.35
28-1	0.24	1132.88	1025.00	107.88	46.75
29-1	0.06	1167.77	1010.00	157.77	68.37
30-1	0.02	1200.54	1100.00	100.54	43.57
31-1	0.01	1195.62	1010.00	185.62	80.44
32-1	0.03	1192.81	1010.00	182.81	79.22
33-F	0.19	1188.82	1010.00	178.82	77.49
34-1	0.01	1195.56	1010.00	185.56	80.41
35-1	0.00	1236.19	1100.00	136.19	59.02
36-1	0.18	1212.85	1010.00	202.85	87.90
37-1	0.02	1200.42	1010.00	190.42	82.52
38-1	0.05	1114.43	1020.00	94.43	40.92
39-1	0.19	1102.84	1010.00	92.84	40.23
40-1	0.06	1149.13	1010.00	139.13	60.29
41-1	0.15	1139.27	1010.00	129.27	56.02
42-1	0.31	1128.42	1005.00	123.42	53.48
43-1	0.02	1126.71	1005.00	121.71	52.74
44-1	0.05	1097.50	1005.00	92.50	40.08
45-1	0.11	1092.56	1005.00	87.56	37.94
46-1	0.26	1086.69	1010.00	76.69	33.23
47-1	0.02	1088.70	1010.00	78.70	34.10
48-1	0.09	1091.96	1010.00	81.96	35.52
49-1	0.08	1118.85	1010.00	108.85	47.17
50-1	0.16	1156.30	1005.00	151.30	65.56
51-1	0.11	1189.52	1010.00	179.52	77.79
52-1	0.03	1226.07	1020.00	206.07	89.30
53-1	0.02	1116.83	1020.00	96.83	41.96
54-1	0.05	1242.16	1020.00	222.16	96.27
55-1	0.03	1205.89	1050.00	155.89	67.55
56-1	0.02	1161.67	1020.00	141.67	61.39
57-1	0.03	1137.79	1040.00	97.79	42.37
58-1	0.01	1133.19	1050.00	83.19	36.05
59-1	0.02	1130.00	1030.00	100.00	43.33
61-1	0.00	1099.25	1010.00	89.25	38.67
62-1	0.03	1223.15	1110.00	113.15	49.03
63-1	0.03	1199.61	1020.00	179.61	77.83
64-1	0.03	1147.05	1005.00	142.05	61.56
65-1	0.01	1141.37	1005.00	136.37	59.09
88-1	0.00	1134.07	1010.00	124.07	53.77
100-F	0.00	1233.92	1010.00	223.92	97.03
110-1	0.00	1029.56			

X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
100	97.03	1	31.80
54	96.27	46	33.23
52	89.30	7	33.45
10	88.70	47	34.10
36	87.90	48	35.52
12	86.74	58	36.05

141	38	39	1.09	11.59	0.00	0.00	3.10	3.22
142-PU	39	40	0.91	16.57	62.86	0.00	4.02	6.76
143	40	41	0.85	9.86	0.00	0.00	3.76	5.97
144	41	42	0.70	10.85	0.00	0.00	3.11	4.22
145	42	43	0.02	1.71	0.00	0.00	0.79	1.30
146	42	44	0.38	30.92	0.00	0.00	2.97	5.38
147	44	45	0.33	4.93	0.00	0.00	1.46	1.04
148	45	46	0.22	5.87	0.00	0.00	1.73	1.98
149	46	47	-0.04	2.00	0.00	0.00	0.76	0.70
150	47	48	-0.06	3.26	0.00	0.00	1.07	1.32
151	48	49	-0.15	26.89	0.00	0.00	2.62	6.89
152	49	50	-0.22	37.45	0.00	0.00	3.97	14.80
153	50	51	-0.39	33.22	0.00	0.00	3.05	5.67
154	51	52	-0.50	36.55	0.00	0.00	3.92	9.03
160	36	63	0.08	13.24	0.00	0.00	2.38	8.06
170-BN	35	0	-1.11	13.81	0.00	0.00	4.90	9.77
200-BN	100	0	-1.44	16.08	0.00	0.00	6.36	15.84
210	63	64	0.05	52.56	0.00	0.00	2.11	7.96
220	64	65	0.01	5.69	0.00	0.00	0.53	0.61
252	21	88	-0.27	3.68	0.00	0.00	2.12	2.89
253	28	25	0.27	6.32	0.00	0.00	2.11	2.86
270-BN	52	0	-0.53	23.93	0.00	0.00	4.15	10.03
280-BN	59	0	-0.01	0.00	0.00	0.00	0.04	0.00
290-PU	110	100	2.08	1.06	205.42	0.00	5.90	10.62
300-BN	110	0	-2.08	0.44	0.00	0.00	4.10	4.37
500	10	100	-3.52	9.23	0.00	0.00	5.09	5.45

J U N C T I O N N O D E R E S U L T S

JUNCTION NUMBER	EXTERNAL DEMAND (mgd)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
1-F	0.00	1123.40	1050.00	73.40	31.80
2-1	0.05	1130.90	1020.00	110.90	48.06
3-1	0.03	1190.16	1010.00	180.16	78.07
4-1	0.15	1186.41	1010.00	176.41	76.45
5-1	0.19	1118.46	1030.00	88.46	38.33
6-1	0.03	1117.79	1030.00	87.79	38.04
7-1	0.12	1087.20	1010.00	77.20	33.45
8-F	0.36	1156.70	1040.00	116.70	50.57
9-1	0.19	1206.40	1010.00	196.40	85.11
10-1	0.07	1224.68	1020.00	204.68	88.70
11-1	0.03	1199.44	1010.00	189.44	82.09
12-1	0.06	1210.17	1010.00	200.17	86.74
13-1	0.03	1207.15	1010.00	197.15	85.43
14-1	0.03	1197.52	1015.00	182.52	79.09
15-F	0.22	1099.22	1005.00	94.22	40.83
16-1	0.05	1100.01	1005.00	95.01	41.17
17-1	0.33	1155.02	1020.00	135.02	58.51
18-1	0.05	1177.03	1060.00	117.03	50.71
19-1	0.03	1144.29	1000.00	144.29	62.53
20-1	0.02	1125.36	1040.00	85.36	36.99
21-1	0.03	1130.39	1020.00	110.39	47.84
22-1	0.02	1126.61	1020.00	106.61	46.20
23-1	0.01	1126.52	1010.00	116.52	50.49
24-1	0.01	1105.91	1020.00	85.91	37.23
25-1	0.24	1126.56	1010.00	116.56	50.51

26-1	0.02	1097.47	1010.00	87.47	37.90
27-1	0.05	1096.19	1010.00	86.19	37.35
28-1	0.24	1132.88	1025.00	107.88	46.75
29-1	0.06	1167.77	1010.00	157.77	68.37
30-1	0.02	1200.54	1100.00	100.54	43.57
31-1	0.01	1195.62	1010.00	185.62	80.44
32-1	0.03	1192.81	1010.00	182.81	79.22
33-F	0.19	1188.82	1010.00	178.82	77.49
34-1	0.01	1195.56	1010.00	185.56	80.41
35-1	0.00	1236.19	1100.00	136.19	59.02
36-1	0.18	1212.85	1010.00	202.85	87.90
37-1	0.02	1200.42	1010.00	190.42	82.52
38-1	0.05	1114.43	1020.00	94.43	40.92
39-1	0.19	1102.84	1010.00	92.84	40.23
40-1	0.06	1149.13	1010.00	139.13	60.29
41-1	0.15	1139.27	1010.00	129.27	56.02
42-1	0.31	1128.42	1005.00	123.42	53.48
43-1	0.02	1126.71	1005.00	121.71	52.74
44-1	0.05	1097.50	1005.00	92.50	40.08
45-1	0.11	1092.56	1005.00	87.56	37.94
46-1	0.26	1086.69	1010.00	76.69	33.23
47-1	0.02	1088.70	1010.00	78.70	34.10
48-1	0.09	1091.96	1010.00	81.96	35.52
49-1	0.08	1118.85	1010.00	108.85	47.17
50-1	0.16	1156.30	1005.00	151.30	65.56
51-1	0.11	1189.52	1010.00	179.52	77.79
52-1	0.03	1226.07	1020.00	206.07	89.30
53-1	0.02	1116.83	1020.00	96.83	41.96
54-1	0.05	1242.16	1020.00	222.16	96.27
55-1	0.03	1205.89	1050.00	155.89	67.55
56-1	0.02	1161.67	1020.00	141.67	61.39
57-1	0.03	1137.79	1040.00	97.79	42.37
58-1	0.01	1133.19	1050.00	83.19	36.05
59-1	0.02	1130.00	1030.00	100.00	43.33
61-1	0.00	1099.25	1010.00	89.25	38.67
62-1	0.03	1223.15	1110.00	113.15	49.03
63-1	0.03	1199.61	1020.00	179.61	77.83
64-1	0.03	1147.05	1005.00	142.05	61.56
65-1	0.01	1141.37	1005.00	136.37	59.09
88-1	0.00	1134.07	1010.00	124.07	53.77
100-F	0.00	1233.92	1010.00	223.92	97.03
110-1	0.00	1029.56			

X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
100	97.03	1	31.80
54	96.27	46	33.23
52	89.30	7	33.45
10	88.70	47	34.10
36	87.90	48	35.52
12	86.74	58	36.05

13	85.43	20	36.99
9	85.11	24	37.23
37	82.52	27	37.35
11	82.09	26	37.90
31	80.44	45	37.94
34	80.41	6	38.04
32	79.22	5	38.33
14	79.09	61	38.67
3	78.07	44	40.08
63	77.83	39	40.23
51	77.79	15	40.83
33	77.49	38	40.92
4	76.45	16	41.17
29	68.37	53	41.96
55	67.55	57	42.37
50	65.56	59	43.33
19	62.53	30	43.57
64	61.56	22	46.20
56	61.39	28	46.75

; U M M A R Y O F I N F L O W S A N D O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM BOUNDARY NODES
(-) OUTFLOWS F

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 1
0% Residential

I. ANALYSIS CONDITIONS

1) Single Source Supply
2) 100% Participation by Commercial Camps/Businesses
3) 0% Participation by Residential
4) Maximum Day to the Bends Condominiums
5) Maximum Day to Possum Kingdom State Park (0.13 MGD)

II. NUMBER OF SYSTEM CONNECTIONS: 1,640 Connections

Commercial Camps/Businesses	1,463 Connections
Bends Condominiums	24 Connections
Possum Kingdom State Park	153 Connections
	1,640 Connections

III. MAXIMUM DAY DEMAND:

1,640 conn x 0.6 gpm = 984 gpm = **1.42 MGD**

IV. MAXIMUM HOURLY DEMAND:

1,640 conn x 1.5 gpm = = **3.54 MGD**

V. STORAGE

Ground Storage	1,640 conn x	100 gal/conn	= 164,000 gal.
Elevated Storage	1,640 conn x	100 gal/conn	= 164,000 gal.
Pressure Tanks	1,640 conn x	20 gal/conn	= 32,800 gal.

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 1 Single Source Supply – Possum Kingdom Lake
100% Business Participation
0% Residential Participation

MAX DAY DEMAND: 1.42 MGD
CONNECTIONS 1640 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	1,643		$2.50	$4,108
2.5	17,136	L.F.	$3.25	$55,691
3	42,181	L.F.	$4.50	$189,813
4	67,570		$4.00	$270,278
6	58,984		$6.50	$383,397
8	34,483		$7.45	$256,897
10	16,049		$12.00	$192,588
12	2,648		$16.00	$42,368
6" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
6" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
6" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
	246,693	**L.F.**		**$1,995,139**

System Appurtenances	12% of Pipe Cost			$239,417
2"–3" meter	64	Ea.	$750.00	$48,000
ELEVATED STORAGE	164,000	GAL.	$1.50	$246,000
GROUND STORAGE	165,000	GAL	$0.30	$49,500
TREATMENT PLANT	1.42	MGD	$2,680,000	$3,800,000
DISTRIBUTION PUMPS				
High Service Pumps	40	HP	$1,500.00	$60,000
High Service Pumps	20	HP	$1,500.00	$30,000
High Service Pumps	20	HP	$1,500.00	$30,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
SUBTOTAL:				**$6,538,056**
Contingencies	15.00%			$980,708
Engineering	10.00%			$751,876
TOTAL:				**$8,270,641**

Filename: Cost_Or.wk1

OPERATION AND MAINTENANCE COST

OPTION: Possum Kingdom Raw Water Treatment Plant

0% Residential

Item	Plant	System	Total
Personnel	$150,000	$100,000	$250,000
Utilities	$54,000	$30,000	$84,000
Structures/Fixed Equipment	$47,000	$20,000	$67,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$49,000		$49,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000		$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$369,000**	**$186,000**	**$555,000**

Cost of Water: $0.060 /1000 gallons

Assume 15% loss: $0.069 /1000 gallons

Filename: O&M.wk1

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

POSSUM KINGDOM TOTAL SYSTEM
OPTION NO. 2 AND OPTION NO. 3

I. ANALYSIS CONDITIONS

1) Single Source Supply
2) 100% Participation by Businesses and Individuals
3) Maximum Day to Gaines Bend (0.22 MGD))
4) Maximum Day to Hog Bend (0.16 MGD)
5) Maximum Day to Possum Kingdom State Park (0.13 MGD)
6) Gaines Bend, Hog Bend and Possum Kingdom State Park are treated as separate systems, with their own elevated storage in this analysis, the Maximum Day Demand and ground storage is provided for these areas.

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	1,463 Connections
Individual Connections	1,376 Connections
Gaines Bend	263 Connections
Hog Bend	185 Connections
Possum Kingdom State Park	153 Connections
	3,440 Connections

III. MAXIMUM DAY DEMANDS

Business	1,463	conn	x	0.6 gpm	=	878 gpm	=	1.26 MGD
Individuals	1,376	conn	x	0.6 gpm	=	825 gpm	=	1.19 MGD
Gaines Bend	263	conn	x	0.6 gpm	=	158 gpm	=	0.22 MGD
Hog Bend	185	conn	x	0.6 gpm	=	111 gpm	=	0.16 MGD
Possum Kingdom State Park	153	conn	x	0.6 gpm	=	92 gpm	=	0.13 MGD
								2.96 MGD

IV. MAXIMUM HOUR DEMAND

Business	1,463	x	1.5 gpm	=	3.16 MGD
Individuals	1,376	x	1.5 gpm	=	2.97 MGD
Gaines Bend				=	0.22 MGD
Hog Bend				=	0.16 MGD
Possum Kingdom State Park				=	0.13 MGD
					6.64 MGD

V. STORAGE

Elevated Storage	2,839	conn	x	100 gallons/conn.	=	284,000 gal
Ground Storage	2,839	conn	x	100 gallons/conn.	=	300,000 gal ±

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 2 — 100% Participation, Single Source of Supply – Possum Kingdom Lake
100% Business Participation
100% Residential Participation

MAX DAY: 2.96 MGD
CONNECTIONS 2839 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2.5	17,751	L.F.	$3.25	$57,690
3	23,742	L.F.	$4.50	$106,841
4	72,662	L.F.	$4.00	$290,646
6	87,503	L.F.	$6.50	$568,769
8	34,750	L.F.	$7.45	$258,888
12	32,153	L.F.	$16.00	$514,448
14	1,694	L.F.	$20.00	$33,880
8" LAKE CROSSING	2000	L.F.	$100.00	$200,000
	272,255	**L.F.**		**$2,031,161**

System Appurtenances	12% of Pipe Cost			$243,739
3/4" Meters	1,376	EA.	$385.00	$529,760
2"–3" Meters	64	EA.	$750.00	$48,000
ELEVATED STORAGE	284,000	GAL.	$1.50	$426,000
GROUND STORAGE	300,000	GAL	$0.30	$90,000
TREATMENT PLANT	2.96	MGD	$2,500,000	$7,360,000
DISTRIBUTION PUMPS				
High Service Pumps	60	HP	$1,500.00	$90,000
High Service Pumps	40	HP	$1,500.00	$60,000
High Service Pumps	40	HP	$1,500.00	$60,000
Booster pumps	7.5	HP	$2,000.00	$15,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
SUBTOTAL:				**$10,973,661**
Contingencies	15.00%			$1,646,049
Engineering	10.00%			$1,261,971
TOTAL:				**$13,881,681**

Filename: pk_cost.wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 3 Single Source of Supply from City of Graham
100% Business Participation
100% Residential Participation

MAX DAY: 2.96 MGD
CONNECTIONS 2839 CONN.

Pipe Diameter		Quantity	Units	Unit Cost	Extended Amount
	2.5	17,751	L.F.	$3.25	$57,690
	3	23,742	L.F.	$4.50	$106,841
	4	72,662	L.F.	$4.00	$290,646
	6	87,503	L.F.	$6.50	$568,769
	8	34,750	L.F.	$7.45	$258,888
	12	32,153	L.F.	$16.00	$514,448
	14	1,694	L.F.	$20.00	$33,880
8" LAKE CROSSING		2000	L.F.	$100.00	$200,000
		272,255	**L.F.**		**$2,031,161**
14" SUPPLY LINE		**85,000**	**L.F**	**$27.00**	**$2,295,000**

System Appurtenances	12% of Pipe Cost			$519,139
3/4" Meters	1,376	EA.	$385.00	$529,760
2"–3" Meters	64	EA.	$750.00	$48,000
ELEVATED STORAGE	285,000	GAL.	$1.50	$427,500
GROUND STORAGE	300,000	GAL	$0.30	$90,000
TREATMENT PLANT EXPANSION	2.96	MGD	$1,250,000	$3,700,000
GRAHAM SUPPLY PUMPS				
High Service Pumps	100	HP	$1,500.00	$150,000
High Service Pumps	100	HP	$1,500.00	$150,000
High Service Pumps	50	HP	$1,500.00	$75,000
Booster Pumps	50	HP	$2,000.00	$100,000
Booster Pumps	50	HP	$2,000.00	$100,000
Booster Pumps	50	HP	$2,000.00	$100,000
DISTRIBUTION PUMPS				
Booster Pumps	5	HP	$2,000.00	$10,000
Booster Pumps	7.5	HP	$2,000.00	$15,000
Booster Pumps	10	HP	$2,000.00	$20,000
SUBTOTAL:				**$10,360,561**
Contingencies	15.00%			$1,554,084
Engineering	10.00%			$1,191,464
TOTAL:				**$13,106,109**

Filename: Grm_Cost.wk1

OPERATION AND MAINTENANCE COST

OPTION: Possum Kingdom Raw Water Treatment Plant

100% Commercial

100% Residential

Item	Plant	System	Total
Personnel	$250,000	$100,000	$350,000
Utilities	$50,000	$50,000	$100,000
Structures/Fixed Equipment	$75,000	$35,000	$110,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$75,000		$75,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$25,000		$25,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$20,000	$40,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$524,000**	**$226,000**	**$750,000**

Cost of Water: $0.060 /1000 gallons

Assume 15% loss: $0.069 /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Graham Treated Water

100% Residential

Item	Plant	System	Total
Personnel	$0	$100,000	$100,000
Utilities	$0	$75,000	$75,000
Structures/Fixed Equipment	$0	$35,000	$35,000
Vehicles	$0	$10,000	$10,000
Treatment Supplies	$0	$0	$0
Office and Laboratory	$0	$10,000	$10,000
Regulatory Agency	$0	$0	$0
Miscellaneous	$0	$10,000	$10,000
Insurance	$0	$25,000	$25,000
Legal and Accounting	$0	$5,000	$5,000
Equipment Rental	$0	$5,000	$5,000
Total	**$0**	**$275,000**	**$275,000**

Cost of Water: $1.600 /1000 gallons

Assume 15% loss: $1.840 /1000 gallons

Filename: O&M.wk1

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 4

East Lake System – 100% Participation

POSSUM KINGDOM TREATED WATER

I. ANALYSIS CONDITIONS

1) System for East Side of Lake
2) Serves 100% of Businesses
3) Serves 100% of Residential
4) Maximum Day to Hog Bend
5) Maximum Day to Gaines Bend
6) All Supply from Possum Kingdom Treatment Plant near D & D – South

II. NUMBER OF SYSTEM CONNECTIONS

East Lake	
Business Connection	1,068 Connections
Individual Connections	876 Connections
Hog Bend	185 Connections
Gaines Bend	263 Connections
Total East Lake:	**2,392 Connections**

III. MAXIMUM DAY DEMANDS

East Lake	1,944 conn x 0.6 gpm =	1,166 gpm =	1.68 MGD
Hog Bend	185 conn x 0.6 gpm =	111 gpm =	0.16 MGD
Gaines Bend	263 conn x 0.6 gpm =	158 gpm =	0.22 MGD
Total:			**2.06 MGD**

IV. MAXIMUM HOUR DEMAND

East Lake	1,944 conn x 1.5 gpm =	2,916 gpm =	4.20 MGD
Hog Bend	=	111 gpm =	0.16 MGD
Gaines Bend	=	157 gpm =	0.22 MGD
			4.58 MGD

V. STORAGE

Elevated Storage	1,944 conn x	100 gallons/conn. =	194,400 gal
Ground Storage	1,944 conn x	100 gallons/conn. =	195,000 gal

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 4
West Lake System – 100% Participation

I. ANALYSIS CONDITIONS

1) System for West Side of Lake only
2) Serves 100% of Business
3) Serves 100% of Residential
4) Maximum Day to Possum Kingdom State Park
5) All Supply from Graham Treatment Plant

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	419 Connections
Individual Connections	476 Connections
Possum Kingdom State Park	153 Connections
Total West Lake:	**1,048 Connections**

III. MAXIMUM DAY DEMANDS

West Lake	895 conn x 0.6 gpm	=	537.0 gpm	=	0.77 MGD
Possum Kingdom State Park	153 conn x 0.6 gpm	=	91.8 gpm	=	0.13 MGD
	Total Maximum Day:		**628.8 gpm**		**0.90 MGD**

IV. MAXIMUM HOUR DEMAND

West Lake	870 conn x 1.5 gpm	=	1,305.0 gpm	or	1.93 MGD
Possum Kingdom State Park	(Max. Day)		91.8 gpm	or	0.13 MGD
	Total Maximum Day:		**1,396.8 gpm**		**2.06 MGD**

V. STORAGE

Elevated Storage	895 conn x	100 gallons/conn.	= 89,500 gal
Pressure Tank	895 conn x	20 gallons/conn.	= 17,900 gal
Ground Storage	895 conn x	100 gallons/conn.	= 100,000 gal

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 4

Dual Source of Supply; East Lake – Possum Kingdom Supply
West Lake – Graham

100% Business Participation
100% Residential Participation

MAX DAY DEMAND: 2.07 MGD
CONNECTIONS 1944 CONN.

EAST LAKE

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2.5	8,406	L.F.	$3.25	$27,320
3	8,107	L.F.	$4.50	$36,482
4	34,987	L.F.	$4.00	$139,946
6	45,659	L.F.	$6.50	$296,784
8	24,632	L.F.	$7.45	$183,511
12	19,646	L.F.	$16.00	$314,336
14	1,694	L.F.	$20.00	$33,880
	143,131	**L.F.**		**$1,032,258**

3/4" meter	876	Ea.	385	$337,260
2"+ meter	1068	Ea.	750	$801,000
System Appurtenances		12% of Pipe cost		$123,871
ELEVATED STORAGE	194,500	GAL.	$1.50	$291,750
GROUND STORAGE	200,000	GAL	$0.30	$60,000
TREATMENT PLANT	2.07	MGD	$2,580,000	$5,350,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	2.5	HP	$2,000.00	$5,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$8,161,139**
Contingencies	15.00%			$1,224,171
Engineering	10.00%			$938,531
TOTAL:				**$10,323,841**

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 4

Dual Source of Supply; East Lake – Possum Kingdom Supply
West Lake – Graham
100% Business Participation
100% Residential Participation

MAX DAY DEMAND: 0.9 MGD
CONNECTIONS 895 CONN.

WEST LAKE

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2.5	10,357	L.F.	$3.25	$33,659
3	23,866	L.F.	$4.50	$107,395
4	30,152	L.F.	$4.00	$120,608
6	32,785	L.F.	$6.50	$213,105
8	27,174	L.F.	$7.45	$202,448
10" SUPPLY LINE	85,000	L.F.	$16.00	$1,360,000
	209,334	**L.F.**		**$2,037,215**
3/4" meters	476	Ea.	$385.00	$183,260
2"+ meters	419	Ea.	$750.00	$314,250
System Appurtenances		12% of Pipe Cost		$244,466
ELEVATED STORAGE	87,000	GAL.	$1.50	$130,500
GROUND STORAGE	100,000	GAL	$0.30	$30,000
TREATMENT PLANT EXPAN.	0.9	MGD	$1,250,000	$1,125,000
SUPPLY LINE PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	50	HP	$2,000.00	$100,000
Booster pumps	25	HP	$2,000.00	$50,000
DISTRIBUTION PUMPS				
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	5	HP	$1,500.00	$7,500
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$4,374,691**
Contingencies	15.00%			$656,204
Engineering	10.00%			$503,089
TOTAL:				**$5,533,984**

Filename: 'WestCost.wk1

OPERATION AND MAINTENANCE COST

OPTION: West Lake – Graham 0.9 MGD

East Lake – Possum Kingdom Water Treatment Plant

100% Residential

Item	Plant	System	Total
Personnel	$175,000	$100,000	$275,000
Utilities	$45,000	$60,000	$105,000
Structures/Fixed Equipment	$55,000	$35,000	$90,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$56,000		$56,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000		$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$15,000	$20,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$395,000**	**$236,000**	**$631,000**

Cost of Water: $1.600 /1000 gallons – Graham

Assume 15% loss: $1.840 /1000 gallons – Graham

Cost of Water: $0.060 /1000 gallons – Possum Kingdom

Assume 15% loss: $0.069 /1000 gallons – Possum Kingdom

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 5, OPTION NO. 6, & OPTION NO. 8
50% Residential

I. ANALYSIS CONDITIONS

1) 50% Residential Participation
2) Maximum Day to Gaines Bend (100%) = 0.22 MGD
3) Maximum Day to Hog Bend (100%) = 0.16 MGD
4) Maximum Day to Possum Kingdom State Park (100%) = 0.13 MGD
5) All Supply from Single Source near D & D South or City of Graham

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	1,463 Connections
Individual Connections	688 Connections
Gaines Bend (100%)	263 Connections
Hog Bend (100%)	185 Connections
Possum Kingdom State Park (100%)	153 Connections
	2,752 Connections

III. MAXIMUM DAY DEMANDS

2,151 conn x 0.6 gpm = 1,291 gpm	=	1.86 MGD
Gaines Bend	=	0.22 MGD
Hog Bend	=	0.16 MGD
Possum Kingdom State Park	=	0.13 MGD
		2.37 MGD

IV. MAXIMUM HOUR DEMAND

2,151 conn x 1.5 gpm = 3,227 gpm	=	4.65 MGD
Gaines Bend (Maximum Day)	=	0.22 MGD
Hog Bend (Maximum Day)	=	0.16 MGD
Possum Kingdom State Park	=	0.13 MGD
		5.16 MGD

V. STORAGE

Elevated Storage	2,151 conn x	100 gallons/conn.	= 210,000 gal
Ground Storage	2,151 conn x	100 gallons/conn.	= 210,000 gal

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 5

Single Source Supply – Possum Kingdom Lake
100% Business Participation
50% Residential Participation

MAX DAY DEMAND: 2.37 MGD
CONNECTIONS 2151 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	40,643	L.F.	$3.25	$132,089
3	33,080	L.F.	$4.50	$148,861
4	55,031	L.F.	$4.00	$220,123
6	73,886	L.F.	$6.50	$480,259
8	43,030	L.F.	$7.45	$320,572
10	8,427	L.F.	$12.00	$101,124
12	7,228	L.F	$16.00	$115,648
14	1,694	L.F	$20.00	$33,880
8" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
	272,455	**L.F.**		**$1,771,147**

3/4" meters	688		$385.00	$264,880
2"–3" meters	63		$750.00	$47,250
System Appurtenances		12% of Pipe Cost		$212,538
ELEVATED STORAGE	210,500	GAL.	$1.50	$315,750
GROUND STORAGE	210,500	GAL	$0.30	$63,150
TREATMENT PLANT	2.37	MGD	$2,560,000	$6,070,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	10	HP	$2,000.00	$20,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
SUBTOTAL:				**$8,934,714**
Contingencies	15.00%			$1,340,207
Engineering	10.00%			$1,027,492
TOTAL:				**$11,302,414**

Filename: 50R_Cost.wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 6

Treated water from Graham
100% Business Participation
50% residencial participation

MAX DAY DEMAND: 2.37 MGD
CONNECTIONS 2151 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	40,643	L.F.	$3.25	$132,089
3	33,080	L.F.	$4.50	$148,861
4	55,031	L.F.	$4.00	$220,123
6	73,886	L.F.	$6.50	$480,259
8	43,030	L.F.	$7.45	$320,572
10	8,427	L.F.	$12.00	$101,124
12	7,228	L.F	$16.00	$115,648
14	1,694	L.F	$20.00	$33,880
8" Lake Crossing	2,000	L.F.	$100.00	$200,000
12" Supply Line from Graham	85,000	L.F.	$20.00	$1,700,000
Pipeline Subtotal:	**357,455**	**L.F.**		**$3,471,147**

3/4" meters	688		$385.00	$264,880
2"–3" meters	63		$750.00	$47,250
System Appurtenances		12% of Pipe Cost		$416,538
ELEVATED STORAGE	210,500	GAL.	$1.50	$315,750
GROUND STORAGE	210,500	GAL	$0.30	$63,150
TREATMENT PLANT EXPAN.	2.37	MGD	$1,310,000	$3,100,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	10	HP	$2,000.00	$20,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
GRAHAM SUPPLY PUMPS				
High Service Pumps	100		$1,500.00	$150,000
High Service Pumps	100		$1,500.00	$150,000
High Service Pumps	50		$1,500.00	$75,000
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
SUBTOTAL:				**$8,543,714**
Contingencies	15.00%			$1,281,557
Engineering	10.00%			$982,527
TOTAL:				**$10,807,799**

Filename: GRM_50.wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 8

Raw water from Graham
100% Business Participation
50% Residential Participation

MAX DAY DEMAND: 2.37 MGD
CONNECTIONS 2151 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	40,643	L.F.	$3.25	$132,089
3	33,080	L.F.	$4.50	$148,861
4	55,031	L.F.	$4.00	$220,123
6	73,886	L.F.	$6.50	$480,259
8	43,030	L.F.	$7.45	$320,572
10	8,427	L.F.	$12.00	$101,124
12	7,228	L.F	$16.00	$115,648
14	1,694	L.F	$20.00	$33,880
8" Lake Crossing	2,000	L.F.	$100.00	$200,000
12" Supply Line from Graham	85,000	L.F.	$20.00	$1,700,000
Pipeline Subtotal:	**357,455**	**L.F.**		**$3,471,147**
3/4" meters	688		$385.00	$264,880
2"–3" meters	63		$750.00	$47,250
System Appurtenances		12% of Pipe Cost		$416,538
ELEVATED STORAGE	210,500	GAL.	$1.50	$315,750
GROUND STORAGE	210,500	GAL	$0.30	$63,150
TREATMENT PLANT	2.37	MGD	$1,730,000	$4,100,000
(No secondary treatment)				
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	10	HP	$2,000.00	$20,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
GRAHAM SUPPLY PUMPS				
High Service Pumps	100		$1,500.00	$150,000
High Service Pumps	100		$1,500.00	$150,000
High Service Pumps	50		$1,500.00	$75,000
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
SUBTOTAL:				**$9,543,714**
Contingencies	15.00%			$1,431,557
Engineering	10.00%			$1,097,527
TOTAL:				**$12,072,799**

Filename: GRM_50RW.wk1

OPERATION AND MAINTENANCE COST

OPTION: Possum Kingdom Raw Water Treatment Plant

50% Residential

Item	Plant	System	Total
Personnel	$200,000	$100,000	$300,000
Utilities	$65,000	$40,000	$105,000
Structures/Fixed Equipment	$66,000	$30,000	$96,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$69,000		$69,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$25,000		$25,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$474,000**	**$206,000**	**$680,000**

Cost of Water: $0.060 /1000 gallons

Assume 15% loss: $0.069 /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Graham Treated Water

50% Residential

Item	Plant	System	Total
Personnel	$0	$100,000	$100,000
Utilities	$0	$75,000	$75,000
Structures/Fixed Equipment	$0	$35,000	$35,000
Vehicles	$0	$10,000	$10,000
Treatment Supplies	$0	$0	$0
Office and Laboratory	$0	$10,000	$10,000
Regulatory Agency	$0	$0	$0
Miscellaneous	$0	$10,000	$10,000
Insurance	$0	$25,000	$25,000
Legal and Accounting	$0	$5,000	$5,000
Equipment Rental	$0	$5,000	$5,000
Total	**$0**	**$275,000**	**$275,000**

Cost of Water: $1.600 /1000 gallons

Assume 15% loss: $1.840 /1000 gallons

Filename: O&M.wk1

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 7
West Lake System – 50% Residential

I. ANALYSIS CONDITIONS

1) 100% Participation ..... Business
2) 50% Participation ..... Individual
3) Maximum Day to Possum Kingdom State Park

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	419 Connections
Individual Connections (50%)	242 Connections
Subtotal: West Lake System	**661 Connections**
Possum Kingdom State Park	153 Connections
	814 Connections

III. MAXIMUM DAY DEMANDS

West Lake System	661 conn x 0.6 gpm	=	396.6 gpm	or	0.57 MGD
Possum Kingdom State Park	153 conn x 0.6 gpm	=	91.8 gpm	or	0.13 MGD
	Total Maximum Day:		**488.4 gpm**		**0.70 MGD**

IV. MAXIMUM HOUR DEMAND

West Lake System	661 conn x 1.5 gpm	=	991.5 gpm	or	1.43 MGD
Possum Kingdom State Park	(Use Max. Day)	=	91.5 gpm	or	0.13 MGD
	Total Maximum Day:		**1,083.0 gpm**		**1.56 MGD**

V. STORAGE

Elevated Storage	661 conn	x	100 gallons/conn.	=	66,100 gal
Pressure Tank	661 conn	x	20 gallons/conn.	=	13,220 gal
Ground Storage	661 conn	x	100 gallons/conn.	=	66,100 gal

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 7
East Lake System – 50% Residential

I. ANALYSIS CONDITIONS

1) 100% Participation ..... Business
2) 50% Participation ..... Leased Lots
3) Maximum Day to Gaines Bend (0.16 MGD)
4) Maximum Day to Hog Bend (0.22 MGD)

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	1,044 Connections
Individual Connections (50%)	446 Connections
Subtotal: East Lake System	**1,490 Connections**
Hog Bend (100%)	185 Connections
Gaines Bend (100%)	263 Connections
	1,938 Connections

III. MAXIMUM DAY DEMANDS

East Lake System	1,490 conn x 0.6 gpm	=	894 gpm	or	1.29 MGD
Hog Bend	185 conn x 0.6 gpm	=	111 gpm	or	0.16
Gaines Bend	263 conn x 0.6 gpm	=	158 gpm	or	0.22 MGD
	Total Maximum Day:				**1.67 MGD**

IV. MAXIMUM HOUR DEMAND

East Lake System	1,490 conn x 1.5 gpm	=	2,235 gpm	or	3.22 MGD
Hog Bend (Max. Day)					0.16 MGD
Gaines Bend (Max. Day)					0.22 MGD
					3.60 MGD

V. STORAGE TANKS

Elevated Storage	1,490 conn. x	100 gallons/conn.	= 149,000 gal
Pressure Tank	1,490 conn. x	20 gallons/conn.	29,800 gal
Ground Storage	1,490 conn. x	100 gallons/conn.	= 149,000 gal

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 7

Dual Source of Supply; East Lake – Possum Kingdom Supply
West Lake – Graham

100% Business Participation
50% Residential Participation

MAX DAY DEMAND: 1.67 MGD
CONNECTIONS 1490 CONN.

EAST LAKE

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	11,926.2	L.F.	$3.25	$38,760
3	13,310	L.F.	$4.50	$59,895
4	30,014.6	L.F.	$4.00	$120,058
6	51,335	L.F.	$6.50	$333,678
8	19,964.3	L.F.	$7.45	$148,734
10	4,191	L.F.	$12.00	$50,292
12	7,128	L.F.	$16.00	$114,048
14	1,694	L.F.	$20.00	$33,880
	146,999	**L.F.**		**$917,935**

3/4" meter	438		385	$168,630
2"+ meter	32		750	$24,000
System Appurtenances		12% of Pipe Cost		$110,152
ELEVATED STORAGE	150,000	GAL.	$1.50	$225,000
GROUND STORAGE	150,000	GAL	$0.30	$45,000
TREATMENT PLANT	1.67	MGD	$2,630,000	$4,400,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	15	HP	$2,000.00	$30,000
Booster pumps	2.5	HP	$2,000.00	$5,000
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$6,075,717**
Contingencies	15.00%			$911,358
Engineering	10.00%			$698,707
TOTAL:				**$7,685,782**

Filename: 50Reast$.wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 7

Dual Source of Supply; East Lake – Possum Kingdom Supply
West Lake – Graham
100% Business Participation
50% Residential Participation

MAX DAY DEMAND: 0.7 MGD
CONNECTIONS 661 CONN.

WEST LAKE

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2.5	21,336	L.F.	$3.25	$69,341
3	20,292	L.F.	$4.50	$91,313
4	19,249	L.F.	$4.00	$76,996
6	62,658	L.F.	$6.50	$407,276
8	562	L.F.	$7.45	$4,187
10" SUPPLY LINE	85,000	L.F.	$16.00	$1,360,000
	209,096	**L.F.**		**$2,009,112**

3/4"meter	238	EA.	385	$91,630
2"+ meter	32	EA.	750	$24,000
System Appurtenances		12% of Pipe Cost		$241,093
ELEVATED STORAGE	63,200	GAL.	$1.50	$94,800
GROUND STORAGE	65,000	GAL	$0.30	$19,500
TREATMENT PLANT EXPAN.	0.5	MGD	$750,000	$375,000
SUPPLY PUMPS				
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	25	HP	$2,000.00	$50,000
Booster pumps	25	HP	$2,000.00	$50,000
DISTRIBUTION PUMPS				
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	0	HP	$1,500.00	$0
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$3,070,135**
Contingencies	15.00%			$460,520
Engineering	10.00%			$353,066
TOTAL:				**$3,883,721**

Filename: 50Rwest$.wk1

MAXIMUM DIMENSIONS	
Number of pipes	1000
Number of pumps	250
Number junction nodes	1000
Flow meters	250
Boundary nodes	100
Variable storage tanks	250
Pressure switches	250
Regulating Valves	250
Items for limited output	1000
limit for non-consecutive numbering	10010

Cybernet version 2.10d. SN: 1572030464-1000

Extended Description:

FILENAME: PIPE_50R.DWG
This run represents the ultimate PK Water Supply Corp. water distribution system at the maximum hourly demand condition. This analysis assumes 50% participation from individual lot owners and 100% participation from businesses around the lake.
The total maximum hourly demand is approximately ~~4.75~~ 5.16 MGD MGD.
This is based on a max. hour demand of 1.5 gpm per each connection to the system.
The estimated maximum daily demand is approximately ~~1.9~~ 2.37 MGD
This is bsed on a max. day demand of 0.6 gpm per each connection to the system.

In This analysis, the MAXIMUM DAILY DEMAND of ~~1.9~~ 2.37 MGD is met by pumpage at the treatment plant located near lake marker 42 at Hog Bend. No additional supply from other sources is considered.

The difference in the MAX. DAY DEMAND and the MAX. HOUR DEMAND is met with elevated or ground storage. Two tanks have been included in this model:

- Tank no. 1 is located at the west end of the lake near The Cruse Lake Store.
- Tank no. 2 is located at the east end of the lake near Rock Creek Camp.
- Tank no. 3 is located at the treatment plant site.

These tanks supply approximately 2.9 MGD during the maximum hourly condition.

****
SUMMARY OF ORIGINAL DATA
****

CyberNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
Run Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
Drawing: PIPE_50R

PIPELINE DATA

STATUS CODE: XX -CLOSED PIPE BN -BOUNDARY NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE

PIPE NUMBER	NODE NOS. #1	#2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.	BND-HGL (ft)
10	22	53	6292.0	6.0	140.00	0.00	
20-PU	53	54	4887.3	4.0	140.00	0.00	
30	54	55	8171.9	4.0	140.00	0.00	
40	55	56	4739.9	3.0	140.00	0.00	
50	56	57	4763.0	3.0	140.00	0.00	
60	57	58	3272.5	3.0	140.00	0.00	
70	58	59	5761.8	3.0	140.00	0.00	
80	7	61	671.0	3.0	140.00	0.00	
90-PU	61	62	8406.2	2.5	140.00	0.00	
00	1	2	957.0	4.0	140.00	0.00	
101	2	3	4191.0	8.0	140.00	0.00	
02	3	4	847.0	8.0	140.00	0.00	
03	4	5	4983.0	4.0	140.00	0.00	
104	5	6	2189.0	4.0	140.00	0.00	
105	6	61	2580.6	4.0	140.00	0.00	
06	6	1	715.0	4.0	140.00	0.00	
07	4	8	6138.0	6.0	140.00	0.00	
108	3	9	3652.0	12.0	140.00	0.00	
09	9	10	3476.0	12.0	140.00	0.00	
10	9	11	3113.0	2.0	140.00	0.00	
111	10	11	4323.0	2.0	140.00	0.00	
112	10	12	1441.0	8.0	140.00	0.00	
13	12	13	4158.0	8.0	140.00	0.00	
114	13	14	4213.0	6.0	140.00	0.00	
115	14	15	8019.0	4.0	140.00	0.00	
16	15	16	990.0	2.5	140.00	0.00	
17	16	17	10450.0	3.0	140.00	0.00	
118	12	18	6347.0	8.0	140.00	0.00	
119	18	17	4719.0	8.0	140.00	0.00	
20	17	19	2211.0	6.0	140.00	0.00	
121	19	88	2465.1	6.0	140.00	0.00	
122	20	88	1778.7	3.0	140.00	0.00	
23	21	22	1694.0	6.0	140.00	0.00	
24	22	23	2684.0	6.0	140.00	0.00	
125	23	24	3234.0	2.5	140.00	0.00	
26	24	26	2442.0	2.5	140.00	0.00	
27	26	27	1936.0	2.5	140.00	0.00	
128	27	20	6380.0	2.5	140.00	0.00	
129	23	25	904.2	6.0	140.00	0.00	
30	28	29	3740.0	6.0	140.00	0.00	
31	29	30	2871.0	6.0	140.00	0.00	

132	30	31	4004.0	6.0	140.00	0.00	
133	31	32	2805.0	6.0	140.00	0.00	
134	32	33	6435.0	6.0	140.00	0.00	
135	31	34	1012.0	4.0	140.00	0.00	
136	30	35	7469.0	8.0	140.00	0.00	
137	35	36	4840.0	6.0	140.00	0.00	
138	36	37	3839.0	4.0	140.00	0.00	
139	37	33	5907.0	4.0	140.00	0.00	
140	2	38	4730.0	10.0	140.00	0.00	
141	38	39	3597.0	10.0	140.00	0.00	
142-PU	39	40	2453.0	8.0	140.00	0.00	
143	40	41	1650.0	8.0	140.00	0.00	
144	41	42	2574.0	8.0	140.00	0.00	
145	42	43	1309.0	2.5	140.00	0.00	
146	42	44	5742.0	6.0	140.00	0.00	
147	44	45	4752.0	8.0	140.00	0.00	
148	45	46	2970.0	6.0	140.00	0.00	
149	46	47	2860.0	4.0	140.00	0.00	
150	47	48	2475.0	4.0	140.00	0.00	
151	48	49	3905.0	4.0	140.00	0.00	
152	49	50	2530.0	4.0	140.00	0.00	
153	50	51	5863.0	6.0	140.00	0.00	
154	51	52	4048.0	6.0	140.00	0.00	
160	36	63	1643.4	3.0	140.00	0.00	
170-BN	35	0	1413.5	8.0	140.00	0.00	1250.00
200-BN	100	0	1015.3	8.0	140.00	0.00	1250.00
210	63	64	6601.1	2.5	140.00	0.00	
220	64	65	9344.5	2.5	140.00	0.00	
252	21	88	1273.8	6.0	140.00	0.00	
253	28	25	2207.7	6.0	140.00	0.00	
270-BN	52	0	2385.0	6.0	140.00	0.00	1250.00
280-BN	59	0	100.0	6.0	140.00	0.00	1130.00
290-PU	110	100	100.0	10.0	140.00	0.00	
300-BN	110	0	100.0	12.0	140.00	0.00	1030.00
500	10	100	1694.0	14.0	140.00	0.00	

U M P D A T A

HERE IS A PUMP IN LINE 20 - USEFUL POWER = 5.00
HERE IS A PUMP IN LINE 90 - USEFUL POWER = 1.00
HERE IS A PUMP IN LINE 142 - USEFUL POWER = 10.00
HERE IS A PUMP IN LINE 290 - USEFUL POWER = 75.00

U N C T I O N N O D E D A T A

JUNCTION NUMBER	EXTERNAL DEMAND (mgd)	JUNCTION ELEVATION (ft)	CONNECTING PIPES		
1-F	0.00	1050.00	100	106	
2-1	0.05	1020.00	100	101	140
3-1	0.03	1010.00	101	102	108
4-1	0.15	1010.00	102	103	107
5-1	0.19	1030.00	103	104	
6-1	0.03	1030.00	104	105	106
7-1	0.12	1010.00	80		
8-F	0.36	1040.00	107		

OPERATION AND MAINTENANCE COST

OPTION: West Lake – Graham 0.7 MGD

East Lake – Possum Kingdom Water Treatment Plant

50% Residential

Item	Plant	System	Total
Personnel	$150,000	$100,000	$250,000
Utilities	$54,000	$50,000	$104,000
Structures/Fixed Equipment	$52,000	$30,000	$82,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$54,000		$54,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000		$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$379,000**	**$216,000**	**$595,000**

Cost of Water: $1.600 /1000 gallons – Graham

Assume 15% loss: $1.840 /1000 gallons – Graham

Cost of Water: $0.060 /1000 gallons – Possum Kingdom

Assume 15% loss: $0.069 /1000 gallons – Possum Kingdom

Filename: O&M.wk1

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

OPTION NO. 9 & OPTION NO. 10

I. ANALYSIS CONDITIONS

1) Single Source Supply from Graham or Possum Kingdom Lake
2) 50% Residential Participation
3) 100% Commercial Participation
4) Average Day Demand Approach

II. NUMBER OF SYSTEM CONNECTIONS

Commercial Camps/Businesses	1,463 Connections
Residential Connections	688 Connections
Gaines Bend (100% participation)	263 Connections
Hog Bend (100% participation)	185 Connections
Possum Kingdom State Park (100% participation)	153 Connections
	2,752 Connections

III. AVERAGE DAY DEMANDS

Commercial Camps/Businesses	1,463 conn x 0.30 gpm	=	0.63 MGD
Residential Connections	688 conn x 0.30 gpm	=	0.30 MGD
Gaines Bend (100%)	263 conn x 0.30 gpm	=	0.11 MGD
Hog Bend (100%)	185 conn x 0.30 gpm	=	0.08 MGD
Possum Kingdom State Park (100%)	153 conn x 0.30 gpm	=	0.07 MGD
Total:			**1.19 MGD**

IV. STORAGE

Elevated Storage = 2,151 conn x 100 gallons/conn. = 210,000 gal

Ground Storage = Maximum Day Demand − Average Day Demand x 3 Days
= (2.38 MGD − 1.19 MGD) x 3 days = 3.57 MGD

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 9

Treated water from Graham
50% residencial participation
Average Day Demand Approach

AVE DAY DEMAND: 1.19 MGD
CONNECTIONS 2,151 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	40,643	L.F.	$3.25	$132,089
3	33,080	L.F.	$4.50	$148,861
4	55,031	L.F.	$4.00	$220,123
6	73,886	L.F.	$6.50	$480,259
8	43,030	L.F.	$7.45	$320,572
10	8,427	L.F.	$12.00	$101,124
12	7,228	L.F	$16.00	$115,648
14	1,694	L.F	$20.00	$33,880
8" Lake Crossing	2,000	L.F.	$100.00	$200,000
10" Supply Line from Graham	85,000	L.F.	$16.00	$1,360,000
Pipeline Subtotal:	**357,455**	**L.F.**		**$3,131,147**
3/4" meters	688		$385.00	$264,880
2"–3" meters	63		$750.00	$47,250
System Appurtenances		12% of Pipe Cost		$375,738
ELEVATED STORAGE	210,500	GAL.	$1.50	$315,750
GROUND STORAGE	3,570,000	GAL	$0.20	$714,000
TREATMENT PLANT EXPAN.	1.19	MGD	$1,760,000	$2,100,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	10	HP	$2,000.00	$20,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
GRAHAM SUPPLY PUMPS				
High Service Pumps	50		$1,500.00	$75,000
High Service Pumps	50		$1,500.00	$75,000
High Service Pumps	25		$1,500.00	$37,500
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
Booster pumps	50		$2,000.00	$100,000
SUBTOTAL:				**$7,626,264**
Contingencies	15.00%			$1,143,940
Engineering	10.00%			$877,020
TOTAL:				**$9,647,224**

Filename: GRM_50AV wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION NO: 10

Single Source Supply – Possum Kingdom Lake
100% Business Participation
50% Residential Participation
Average Day Approach

AVE. DAY DEMAND: 1.19 MGD
CONNECTIONS 2151 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
2	7,436	L.F.	$2.50	$18,590
2.5	40,643	L.F.	$3.25	$132,089
3	33,080	L.F.	$4.50	$148,861
4	55,031	L.F.	$4.00	$220,123
6	73,886	L.F.	$6.50	$480,259
8	43,030	L.F.	$7.45	$320,572
10	8,427	L.F.	$12.00	$101,124
12	7,228	L.F	$16.00	$115,648
14	1,694	L.F	$20.00	$33,880
8" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
	272,455	**L.F.**		**$1,771,147**
3/4" meters	688		$385.00	$264,880
2"–3" meters	63		$750.00	$47,250
System Appurtenances		12% of Pipe Cost		$212,538
ELEVATED STORAGE	210,500	GAL.	$1.50	$315,750
GROUND STORAGE	3,570,000	GAL	$0.20	$714,000
TREATMENT PLANT	1.19	MGD	$2,700,000	$3,210,000
DISTRIBUTION PUMPS				
High Service Pumps	50	HP	$1,500.00	$75,000
High Service Pumps	25	HP	$1,500.00	$37,500
High Service Pumps	25	HP	$1,500.00	$37,500
Booster pumps	10	HP	$2,000.00	$20,000
Booster pumps	5	HP	$2,000.00	$10,000
Booster pumps	5	HP	$2,000.00	$10,000
SUBTOTAL:				**$6,725,564**
Contingencies	15.00%			$1,008,835
Engineering	10.00%			$773,440
TOTAL:				**$8,507,839**

Filename: OPT_10$.wk1

OPERATION AND MAINTENANCE COST

OPTION: Possum Kingdom Raw Water Treatment Plant

Average Day Design

50% Residential

Item	Plant	System	Total
Personnel	$150,000	$100,000	$250,000
Utilities	$54,000	$40,000	$94,000
Structures/Fixed Equipment	$52,000	$30,000	$82,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$54,000		$54,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000		$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$379,000**	**$206,000**	**$585,000**

Cost of Water: $0.060 /1000 gallons

Assume 15% loss: $0.069 /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Graham Treated Water

Average Day

50% Residential

Item	Plant	System	Total
Personnel	$0	$100,000	$100,000
Utilities	$0	$75,000	$75,000
Structures/Fixed Equipment	$0	$35,000	$35,000
Vehicles	$0	$10,000	$10,000
Treatment Supplies	$0	$0	$0
Office and Laboratory	$0	$10,000	$10,000
Regulatory Agency	$0	$0	$0
Miscellaneous	$0	$10,000	$10,000
Insurance	$0	$25,000	$25,000
Legal and Accounting	$0	$5,000	$5,000
Equipment Rental	$0	$5,000	$5,000
Total	**$0**	**$275,000**	**$275,000**

Cost of Water: $1.600 /1000 gallons

Assume 15% loss: $1.840 /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Graham Treated Water

0% Residential

Item	Plant	System	Total
Personnel	$0	$100,000	$100,000
Utilities	$0	$75,000	$75,000
Structures/Fixed Equipment	$0	$35,000	$35,000
Vehicles	$0	$10,000	$10,000
Treatment Supplies	$0	$0	$0
Office and Laboratory	$0	$10,000	$10,000
Regulatory Agency	$0	$0	$0
Miscellaneous	$0	$10,000	$10,000
Insurance	$0	$25,000	$25,000
Legal and Accounting	$0	$5,000	$5,000
Equipment Rental	$0	$5,000	$5,000
Total	**$0**	**$275,000**	**$275,000**

Cost of Water: $1.600 /1000 gallons

Assume 15% loss: $1.840 /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Blended Lake

Graham/Possum Kingdom Lake Raw Water Treatment Plant

50% Residential

Item	Plant	System	Total
Personnel	$150,000	$100,000	$250,000
Utilities	$35,000	$40,000	$75,000
Structures/Fixed Equipment	$30,000	$30,000	$60,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$30,000	$0	$30,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000	$0	$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$314,000**	**$206,000**	**$520,000**

Cost of Water: /1000 gallons

Assume 15% loss: /1000 gallons

Filename: O&M.wk1

OPERATION AND MAINTENANCE COST

OPTION: Blended Lake

Graham/Possum Kingdom Lake Raw Water Treatment Plant

50% Residential

Average Day

Item	Plant	System	Total
Personnel	$150,000	$100,000	$250,000
Utilities	$35,000	$40,000	$75,000
Structures/Fixed Equipment	$30,000	$30,000	$60,000
Vehicles	$4,000	$6,000	$10,000
Treatment Supplies	$30,000	$0	$30,000
Office and Laboratory	$15,000	$5,000	$20,000
Regulatory Agency	$20,000	$0	$20,000
Miscellaneous	$6,000	$4,000	$10,000
Insurance	$20,000	$15,000	$35,000
Legal and Accounting	$2,000	$3,000	$5,000
Equipment Rental	$2,000	$3,000	$5,000
Total	**$314,000**	**$206,000**	**$520,000**

Cost of Water: /1000 gallons – Graham

Assume 15% loss: /1000 gallons – Graham

Filename: O&M.wk1

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

ADDITIVE ALTERNATE
Gaines Bend Area

I. ANALYSIS CONDITIONS

1) 100% Participation from Business
2) 100% Participation from Residential

II. NUMBER OF SYSTEM CONNECTIONS

Business Connection	24 Connections
Individual Connections	239 Connections
	263 Connections

III. MAXIMUM DAY DEMANDS

263 conn x 0.6 gpm = 158 gpm = 0.22 MGD

IV. MAXIMUM HOUR DEMAND

263 conn x 1.5 gpm = 395 gpm = 0.57 MGD

V. PRESSURE TANK/ELEVATED STORAGE REQUIREMENTS

Elevated Storage	263	x	100	=	26,300 gal
Pressure Tank	263	x	20	=	5,260 gal

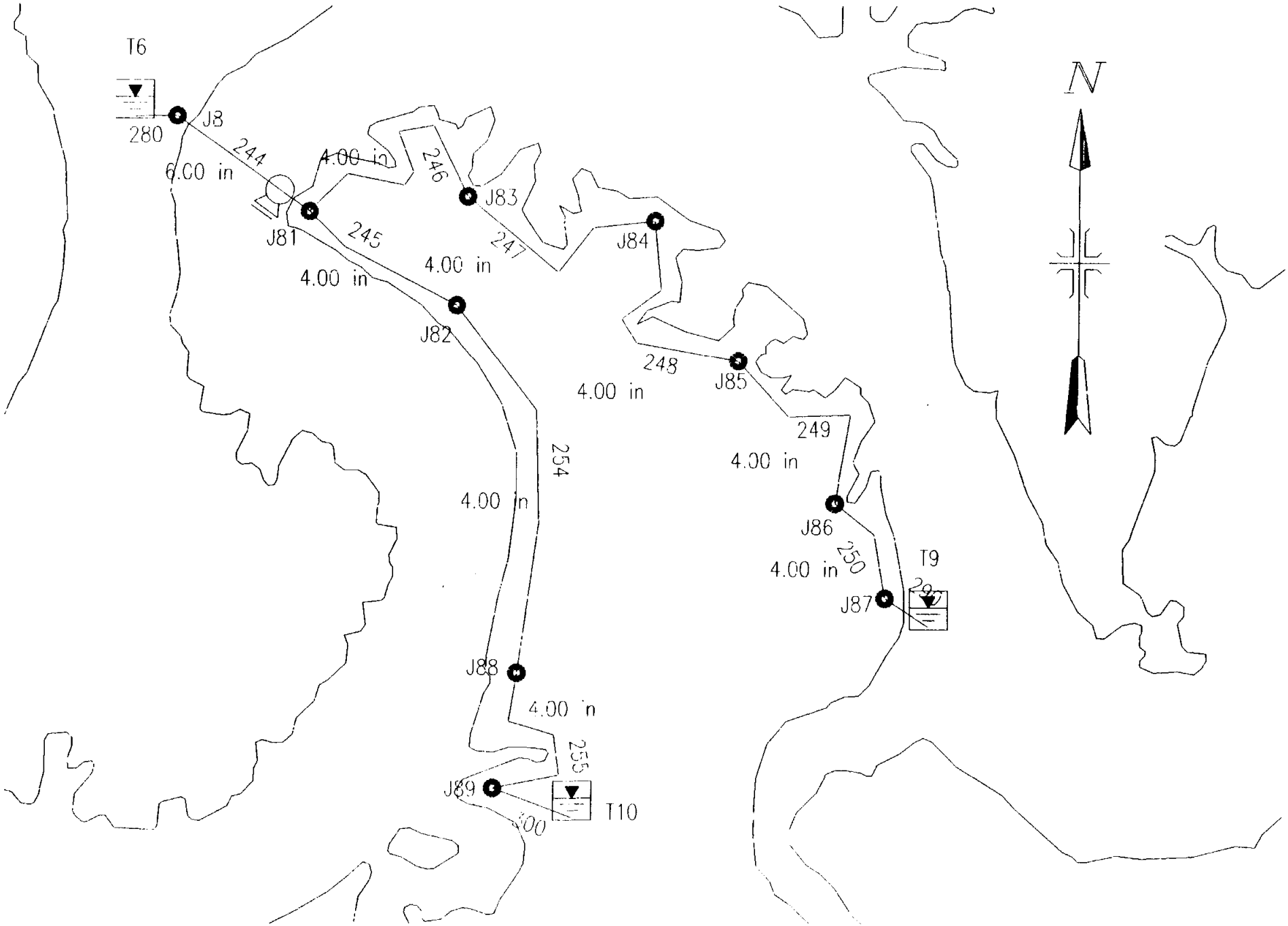
POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

OPTION: GAINES_BEND
100% Business Participation
100% Residential Participation

MAX DAY DEMAND: 0.22 MGD
CONNECTIONS 263 CONN.

Pipe Diameter	Quantity	Units	Unit Cost	Extended Amount
4	26,269	L.F.	$4.00	$105,076
6	2,345.2	L.F.	$6.50	$15,244
6" LAKE CROSSING	2,000	L.F.	$100.00	$200,000
SUBTOTAL:	**30,614**	**L.F.**		**$320,320**

3/4" meters	263	Ea.	$385.00	$101,255
System Appurtenances		12% of Pipe Cost		$38,438
PRESSURE TANKS	10,000	GAL.	$1.50	$15,000
GROUND STORAGE	26,000	GAL	$0.30	$7,800
TREATMENT PLANT	0	MGD	$3,500,000	$0
DISTRIBUTION PUMPS				
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	0	HP	$1,500.00	$0
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$512,813**
Contingencies	15.00%			$76,922
Engineering	10.00%			$58,974
TOTAL:				**$648,709**



GAINES BEND WATER DISTRIBUTION SYSTEM MAP

MAXIMUM DIMENSIONS	
Number of pipes	1000
Number of pumps	250
Number junction nodes	1000
Flow meters	250
Boundary nodes	100
Variable storage tanks	250
Pressure switches	250
Regulating Valves	250
Items for limited output	1000
limit for non-consecutive numbering	10010

Cybernet version 2.10d. SN: 1572030464-1000

Extended Description:

FILENAME: GAIN_B.DWG

This run represents the ultimate PK Water Supply Corp. water distribution system at the maximum hourly demand condition for the Gains Bend area. This analysis assumes 100% participation from individual lot owners and 100% participation from businesses around the lake.
The total maximum hourly demand is approximately 0.57 MGD. This is based on a max. hour demand of 1.5 gpm per each connection to the system.
The estimated maximum daily demand is approximately 0.22 MGD. This is bsed on a max. day demand of 0.6 gpm per each connection to the system.

In This analysis, the MAXIMUM DAILY DEMAND of 0.22 MGD is met by pumpage at the treatment plant located near lake marker 42 near D&D South. No additional supply from other sources is considered.

The difference in the MAX. DAY DEMAND and the MAX. HOUR DEMAND is met with elevated or pressure tanks.
Two tanks have been included in this model:

Tank no. 1 is located on the east side of the Gains Bend penensula near The Bends Condominiums
Tank no. 2 is located at the west side of the Gains Bend penensula near Hell's Gate.

These tanks supply approximately 0.34 MGD during the maximum hourly condition.

L N I T S S P E C I F I E D

FLOWRATE ..... = million gallons/day
HEAD (HGL) ..... = feet
PRESSURE ..... = psig

O U T P U T O P T I O N D A T A

C TPUT SELECTION: THE FOLLOWING RESULTS ARE INCLUDED IN THE TABULATED OUTPUT

ALL CLOSED PIPES ARE NOTED
ALL PIPES WITH PUMPS
FOLLOWING PIPES
244 245 246 247 248 249 250 254 255 280 290 300
FOLLOWING JUNCTION NODES
8 81 82 83 84 85 86 87 88 89

WARNING NUMBER REQUESTED FOR MAXIMUM AND MINIMUM PRESSURES
CANNOT EXCEED ONE HALF THE NUMBER OF JUNCTIONS

MAXIMUM AND MINIMUM PRESSURES = 5

S Y S T E M C O N F I G U R A T I O N

NUMBER OF PIPES .....(p) = 12
NUMBER OF JUNCTION NODES .....(j) = 10
NUMBER OF PRIMARY LOOPS .....(l) = 0
NUMBER OF BOUNDARY NODES .....(f) = 3
NUMBER OF SUPPLY ZONES .....(z) = 1

****
S I M U L A T I O N R E S U L T S
****

The results are obtained after 6 trials with an accuracy = 0.00007

S T M U L A T I O N D E S C R I P T I O N

CyberNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
Run Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
Dr wing: GAINS_B

P PELINE R E S U L T S

STATUS CODE: XX -CLOSED PIPE BN -BOUNDARY NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (mgd)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
244	8	81	0.16	2.46	0.00	0.00	1.23	1.05
245	81	82	-0.01	0.08	0.00	0.00	0.15	0.03
246	81	83	0.11	17.30	0.00	0.00	2.02	4.24
247	83	84	0.02	0.51	0.00	0.00	0.33	0.15
248	84	85	-0.06	4.09	0.00	0.00	1.00	1.14
249	85	86	-0.13	17.87	0.00	0.00	2.33	5.51
250	86	87	-0.19	18.28	0.00	0.00	3.39	11.07
254	82	88	-0.05	6.11	0.00	0.00	0.94	1.19
255	88	89	-0.13	16.25	0.00	0.00	2.28	6.10
280-BN	8	0	-0.16	0.00	0.00	0.00	1.23	1.05
290-BN	87	0	-0.24	0.02	0.00	0.00	1.90	2.36
300-BN	89	0	-0.17	0.01	0.00	0.00	1.35	1.26

J U N C T I O N N O D E R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (mgd)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
8-1	CONSTANTINE/	0.00	1130.00	1040.00	90.00	39.00
81-1	GAINS BEND	0.05	1127.54	1010.00	117.54	50.93
82-1	GAINS BEND	0.05	1127.62	1010.00	117.62	50.97
83-1	GAINS BEND	0.09	1110.24	1010.00	100.24	43.44
84-1	GAINS BEND	0.08	1109.73	1010.00	99.73	43.21
85-1	GAINS BEND	0.08	1113.82	1010.00	103.82	44.99
86-1	GAINS BEND	0.06	1131.69	1020.00	111.69	48.40
87-1	THE BEND CON	0.05	1149.98	1050.00	99.98	43.32
88-1	GAINS BEND	0.08	1133.73	1050.00	83.73	36.28
89-1	GAINS BEND	0.04	1149.99	1050.00	99.99	43.33

1 A X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
82	50.97	88	36.28
81	50.93	8	39.00
86	48.40	84	43.21
85	44.99	87	43.32
83	43.44	89	43.33

S U M M A R Y O F I N F L O W S A N D O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM BOUNDARY NODES
(-) OUTFLOWS FROM THE SYSTEM INTO BOUNDARY NODES

****
SUMMARY OF ORIGINAL DATA
****

CyberNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
F n Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
I awing: GAINS_B

P I P E L I N E D A T A

S ATUS CODE: XX -CLOSED PIPE BN -BOUNDARY NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE

PIPE JMBER	NODE NOS. #1	#2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.	BND-HGL (ft)
244	8	81	2345.2	6.0	140.00	0.00	
245	81	82	2526.7	4.0	140.00	0.00	
246	81	83	4083.2	4.0	140.00	0.00	
247	83	84	3385.8	4.0	140.00	0.00	
248	84	85	3576.1	4.0	140.00	0.00	
249	85	86	3245.0	4.0	140.00	0.00	
250	86	87	1652.2	4.0	140.00	0.00	
254	82	88	5137.0	4.0	130.00	0.00	
255	88	89	2663.0	4.0	130.00	0.00	
280-BN	8	0	0.1	6.0	140.00	0.00	1130.00
290-BN	87	0	10.0	6.0	140.00	0.00	1150.00
300-BN	89	0	10.0	6.0	140.00	0.00	1150.00

J I N C T I O N N O D E D A T A

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (mgd)	JUNCTION ELEVATION (ft)	CONNECTING PIPES		
8-1	CONSTANTINE/	0.00	1040.00	244	280	
81-1	GAINS BEND	0.05	1010.00	244	245	246
82-1	GAINS BEND	0.05	1010.00	245	254	
83-1	GAINS BEND	0.09	1010.00	246	247	
84-1	GAINS BEND	0.08	1010.00	247	248	
85-1	GAINS BEND	0.08	1010.00	248	249	
86-1	GAINS BEND	0.06	1020.00	249	250	
87-1	THE BEND CON	0.05	1050.00	250	290	
88-1	GAINS BEND	0.08	1050.00	254	255	
89-1	GAINS BEND	0.04	1050.00	255	300	

PIPE NUMBER	FLOWRATE (mgd)
280	0.16
290	0.24
300	0.17

NET SYSTEM INFLOW = 0.57
NET SYSTEM OUTFLOW = 0.00
NET SYSTEM DEMAND = 0.57

**** CYBERNET SIMULATION COMPLETED ****

DATE: 6/ 9/1993
TIME: 13:26:47

POSSUM KINGDOM REGIONAL WATER SUPPLY SYSTEM

ADDITIVE ALTERNATE
Hog Bend Area

I. ANALYSIS CONDITIONS

1) 100% Participation ..... Business
2) 100% Participation ..... Residential

II. NUMBER OF SYSTEM CONNECTIONS

All Residential ..... 185 Connections

III. MAXIMUM DAY DEMANDS (Pumpage)

185 x 0.6 gpm = 111 gpm = 0.16 MGD

IV. MAXIMUM HOUR DEMAND

185 x 1.5 gpm = 277.5 gpm = 0.40 MGD

V. PRESSURE TANK/ELEVATED STORAGE REQUIREMENTS (TWC)

Elevated Storage	185	x	100	=	18,500 gal
Pressure Tank	185	x	20	=	3,700 gal

POSSUM KINGDOM WATER SUPPLY CORPORATION
WATER DISTRIBUTION SYSTEM
ENGINEER'S ESTIMATE

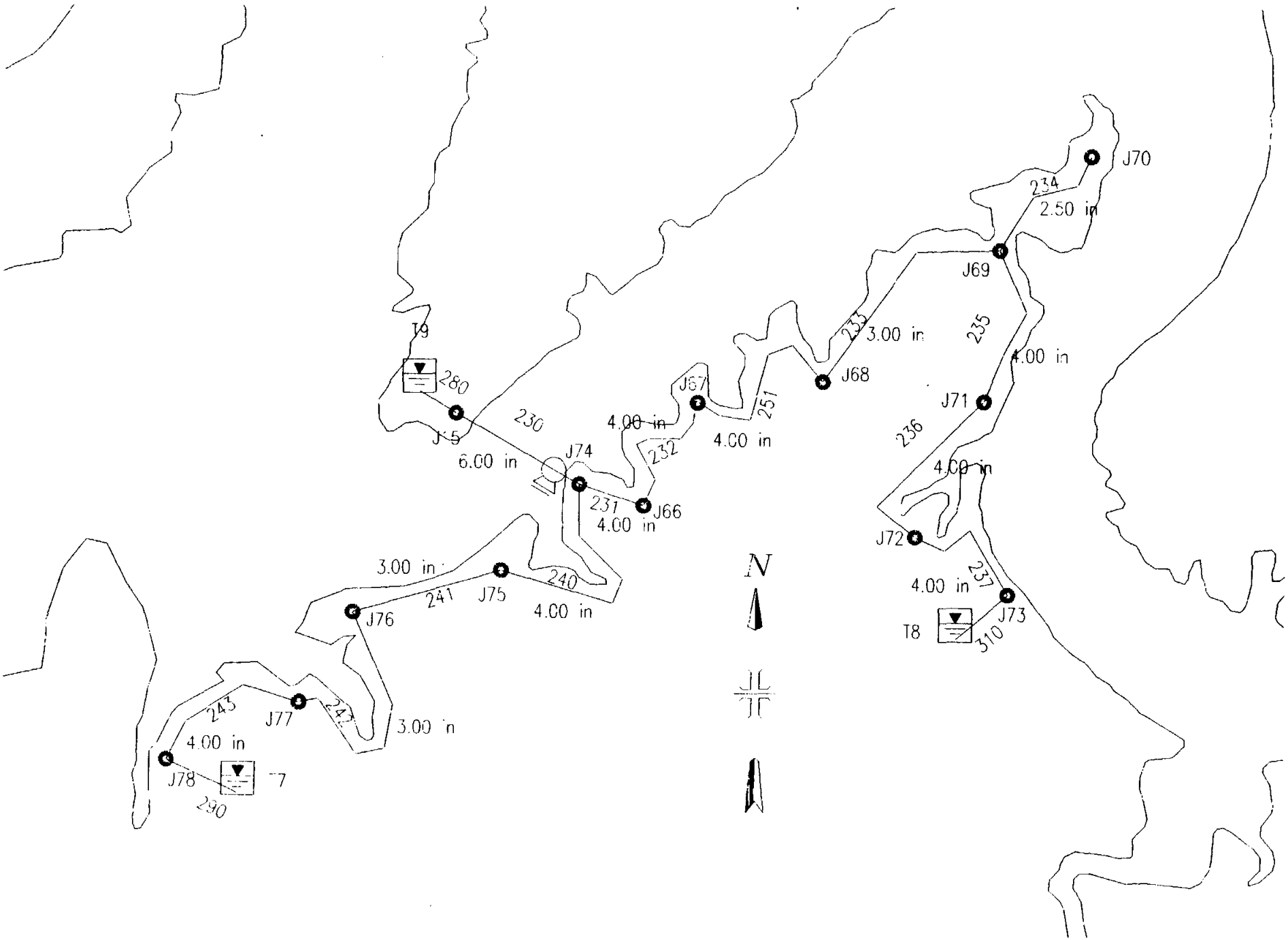
OPTION: HOG _BEND
100% Business Participation
100% Residential Participation

MAX DAY DEMAND: 0.16 MGD
CONNECTIONS 185 CONN.

Pipe Diameter		Quantity	Units	Unit Cost	Extended Amount
	2.5	2,341.9		$3.25	$7,611
	3	10,921.9	L.F.	$4.50	$49,149
	4	22,496.1	L.F.	$4.00	$89,984
	6	2,362.8		$6.50	$15,358
6" LAKE CROSSING		2,000	L.F.	$100.00	$200,000
		40,123	**L.F.**		**$362,102**

3/4" meters	185	Ea.	$385.00	$71,225
System Appurtenances		12% of Pipe Cost		$43,452
PRESSURE TANKS	5,000	GAL.	$1.50	$7,500
GROUND STORAGE	18,500	GAL	$0.30	$5,550
TREATMENT PLANT	0	MGD	$3,500,000	$0
DISTRIBUTION PUMPS				
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	10	HP	$1,500.00	$15,000
High Service Pumps	0	HP	$1,500.00	$0
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
Booster pumps	0	HP	$2,000.00	$0
SUBTOTAL:				**$519,830**
Contingencies	15.00%			$77,974
Engineering	10.00%			$59,780
TOTAL:				**$657,584**

Filename: HogBend$.wk1



HOG BEND WATER DISTRIBUTION SYSTEM MAP

MAXIMUM DIMENSIONS	
Number of pipes	1000
Number of pumps	250
Number junction nodes	1000
Flow meters	250
Boundary nodes	100
Variable storage tanks	250
Pressure switches	250
Regulating Valves	250
Items for limited output	1000
limit for non-consecutive numbering	10010

Cybernet version 2.10d. SN: 1572030464-1000

Extended Description:

FILENAME: HOG_BEND.DWG
This run represents the ultimate PK Water Supply Corp. water distribution system at the maximum hourly demand condition for the Hog Bend area. This analysis assumes 100% participation from individual lot owners and 100% participation from businesses around the lake.
The total maximum hourly demand is approximately 0.40 MGD. This is based on a max. hour demand of 1.5 gpm per each connection to the system.
The estimated maximum daily demand is approximately 0.16 MGD. This is bsed on a max. day demand of 0.6 gpm per each connection to the system.

In This analysis, the MAXIMUM DAILY DEMAND of 0.16 MGD is met by pumpage at the treatment plant located near lake marker 42 at Hog Bend. No additional supply from other sources is considered.

U N I T S S P E C I F I E D

FLOWRATE ..... = million gallons/day
HEAD (HGL) ..... = feet
PRESSURE ..... = psig

O U T P U T O P T I O N D A T A

O TPUT SELECTION: THE FOLLOWING RESULTS ARE INCLUDED IN THE TABULATED OUTPUT

ALL CLOSED PIPES ARE NOTED
ALL PIPES WITH PUMPS
FOLLOWING PIPES
230 231 232 233 234 235 236 237 240 241 242 243 251
280 290 310
FOLLOWING JUNCTION NODES
15 66 67 68 69 70 71 72 73 74 75 76 77
78

WARNING NUMBER REQUESTED FOR MAXIMUM AND MINIMUM PRESSURES
CANNOT EXCEED ONE HALF THE NUMBER OF JUNCTIONS

MAXIMUM AND MINIMUM PRESSURES = 7

S Y S T E M C O N F I G U R A T I O N

NUMBER OF PIPES .....(p) = 16
NUMBER OF JUNCTION NODES .....(j) = 14
NUMBER OF PRIMARY LOOPS .....(l) = 0
NUMBER OF BOUNDARY NODES .....(f) = 3
NUMBER OF SUPPLY ZONES .....(z) = 1

****
S I M U L A T I O N R E S U L T S
****

Th.. results are obtained after 5 trials with an accuracy = 0.00305

S I M U L A T I O N D E S C R I P T I O N

Sy erNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
Run Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
Drawing: HOG_BEND

P I P E L I N E R E S U L T S

STATUS CODE: XX -CLOSED PIPE BN -BOUNDARY NODE PU -PUMP LINE

CV -CHECK VALVE RV -REGULATING VALVE TK -STORAGE TANK

PIPE NUMBER	NODE NOS. #1	#2	FLOWRATE (mgd)	HEAD LOSS (ft)	PUMP HEAD (ft)	MINOR LOSS (ft)	LINE VELO. (ft/s)	HL/ 1000 (ft/ft)
230	15	74	0.10	1.13	0.00	0.00	0.80	0.48
231	74	66	0.10	3.96	0.00	0.00	1.82	3.50
232	66	67	0.07	4.87	0.00	0.00	1.29	1.85
233	68	69	-0.03	4.93	0.00	0.00	0.86	1.22
234	69	70	0.04	11.02	0.00	0.00	1.59	4.70
235	69	71	-0.12	13.29	0.00	0.00	2.17	4.84
236	71	72	-0.14	21.08	0.00	0.00	2.52	6.40
237	72	73	-0.17	21.34	0.00	0.00	3.05	9.13
240	74	75	0.00	0.00	0.00	0.00	0.02	0.00
241	75	76	-0.05	8.20	0.00	0.00	1.45	3.20
242	76	77	-0.08	35.04	0.00	0.00	2.39	8.12
243	77	78	-0.09	7.88	0.00	0.00	1.61	2.79
251	68	67	-0.02	0.70	0.00	0.00	0.40	0.21
280-BN	15	0	-0.15	0.00	0.00	0.00	1.20	1.00
290-BN	78	0	-0.11	0.01	0.00	0.00	0.87	0.56
310-BN	73	0	-0.19	0.01	0.00	0.00	1.48	1.48

J U N C T I O N N O D E R E S U L T S

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (mgd)	HYDRAULIC GRADE (ft)	JUNCTION ELEVATION (ft)	PRESSURE HEAD (ft)	JUNCTION PRESSURE (psi)
15-1	PUBLIC USE 1	0.05	1100.00	1005.00	95.00	41.17
66-1	BRA LEASED L	0.03	1094.91	1005.00	89.91	38.96
67-1	BRA LEASED L	0.05	1090.04	1005.00	85.04	36.85
68-1	BRA LEASED L	0.05	1089.34	1005.00	84.34	36.55
69-1	BRA LEASED L	0.06	1094.27	1005.00	89.27	38.68
70-1	BRA LEASED L	0.04	1083.25	1005.00	78.25	33.91
71-1	BRA LEASED L	0.02	1107.56	1005.00	102.56	44.44
72-1	BRA LEASED L	0.03	1128.64	1005.00	123.64	53.58
73-1	BRA LEASED L	0.01	1149.99	1005.00	144.99	62.83
74-1	BRA LEASED L	0.00	1098.87	1005.00	93.87	40.68
75-1	BRA LEASED L	0.05	1098.87	1005.00	93.87	40.68
76-1	BRA LEASED L	0.03	1107.07	1005.00	102.07	44.23
77-1	BRA LEASED L	0.01	1142.11	1005.00	137.11	59.42
78-1	BRA LEASED L	0.02	1149.99	1005.00	144.99	62.83

1 A X I M U M A N D M I N I M U M V A L U E S

P R E S S U R E S

JUNCTION NUMBER	MAXIMUM PRESSURES (psi)	JUNCTION NUMBER	MINIMUM PRESSURES (psi)
78	62.83	70	33.91
73	62.83	68	36.55
77	59.42	67	36.85

72	53.58	69	38.68
71	44.44	66	38.96
76	44.23	74	40.68
15	41.17	75	40.68

S U M M A R Y O F I N F L O W S A N D O U T F L O W S

(+) INFLOWS INTO THE SYSTEM FROM BOUNDARY NODES
( ) OUTFLOWS FROM THE SYSTEM INTO BOUNDARY NODES

PIPE NUMBER	FLOWRATE (mgd)
280	0.15
290	0.11
310	0.19

NET SYSTEM INFLOW = 0.45
N T SYSTEM OUTFLOW = 0.00
N T SYSTEM DEMAND = 0.45

**** CYBERNET SIMULATION COMPLETED ****

D TE: 6/ 9/1993
TIME: 11:27:36

****
SUMMARY OF ORIGINAL DATA
****

CyberNet Version 2.10d. Copyright 1991,92 Haestad Methods Inc.
Run Description: MAXIMUM HOURLY DEMANDS (1.5 GPM PER CONNECTION)
Drawing: HOG_BEND

PIPELINE DATA

STATUS CODE: XX -CLOSED PIPE BN -BOUNDARY NODE PU -PUMP LINE
CV -CHECK VALVE RV -REGULATING VALVE

PIPE NUMBER	NODE NOS. #1	#2	LENGTH (ft)	DIAMETER (in)	ROUGHNESS COEFF.	MINOR LOSS COEFF.	BND-HGL (ft)
230	15	74	2362.8	6.0	140.00	0.00	
231	74	66	1130.8	4.0	140.00	0.00	
232	66	67	2635.6	4.0	140.00	0.00	
233	68	69	4042.5	3.0	140.00	0.00	
234	69	70	2341.9	2.5	140.00	0.00	
235	69	71	2746.7	4.0	140.00	0.00	
236	71	72	3292.3	4.0	140.00	0.00	
237	72	73	2338.6	4.0	140.00	0.00	
240	74	75	4242.7	4.0	140.00	0.00	
241	75	76	2564.1	3.0	140.00	0.00	
242	76	77	4315.3	3.0	140.00	0.00	
243	77	78	2821.5	4.0	140.00	0.00	
251	68	67	3287.9	4.0	140.00	0.00	
280-BN	15	0	0.1	6.0	140.00	0.00	1100.00
290-BN	78	0	10.0	6.0	140.00	0.00	1150.00
310-BN	73	0	10.0	6.0	140.00	0.00	1150.00

JUNCTION NODE DATA

JUNCTION NUMBER	JUNCTION TITLE	EXTERNAL DEMAND (mgd)	JUNCTION ELEVATION (ft)	CONNECTING PIPES		
15-1	PUBLIC USE 1	0.05	1005.00	230	280	
66-1	BRA LEASED L	0.03	1005.00	231	232	
67-1	BRA LEASED L	0.05	1005.00	232	251	
68-1	BRA LEASED L	0.05	1005.00	233	251	
69-1	BRA LEASED L	0.06	1005.00	233	234	235
70-1	BRA LEASED L	0.04	1005.00	234		
71-1	BRA LEASED L	0.02	1005.00	235	236	
72-1	BRA LEASED L	0.03	1005.00	236	237	
73-1	BRA LEASED L	0.01	1005.00	237	310	
74-1	BRA LEASED L	0.00	1005.00	230	231	240
75-1	BRA LEASED L	0.05	1005.00	240	241	
76-1	BRA LEASED L	0.03	1005.00	241	242	
77-1	BRA LEASED L	0.01	1005.00	242	243	
78-1	BRA LEASED L	0.02	1005.00	243	290	

POSSUM KINGDOM WATER SUPPLY CORPORATION
TREATMENT PLANT CAPACITY

COST COMPARISON

Item No.	Description	Treatment Plant Cost By Capacity					
		1.2 MGD	1.4 MGD	1.7 MGD	2.1 MGD	2.4 MGD	3.0 MGD
1	Raw Water Intake & Pumps	$450,000	$600,000	$600,000	$700,000	$800,000	$800,000
2	Raw Water Supply Line	$30,000	$40,000	$40,000	$45,000	$50,000	$50,000
3	Treatment Facilities	$1,400,000	$1,680,000	$2,040,000	$2,520,000	$2,880,000	$3,600,000
4	Demineralization	$1,000,000	$1,120,000	$1,360,000	$1,680,000	$1,920,000	$2,400,000
5	Filtered Water Storage	$90,000	$100,000	$100,000	$115,000	$120,000	$150,000
6	Finished Water Storage	$90,000	$100,000	$100,000	$115,000	$120,000	$150,000
7	Process Waste Line	$55,000	$60,000	$60,000	$60,000	$60,000	$60,000
8	Sludge Lagoons	$95,000	$100,000	$100,000	$115,000	$120,000	$150,000
	TOTALS:	**$3,210,000**	**$3,800,000**	**$4,400,000**	**$5,350,000**	**$6,070,000**	**$7,360,000**

NOTE: These costs are for plants requiring secondary treatment and do not include contingencies or engineering.

Filename: Plant_$.wk1

POSSUM KINGDOM WATER SUPPLY CORPORATION
TREATMENT PLANT CAPACITY

COST COMPARISON

Item No.	Description	Treatment Plant Cost By Capacity					
		1.2 MGD	1.4 MGD	1.7 MGD	2.1 MGD	2.4 MGD	3.0 MGD
1	Raw Water Intake & Pumps	$450,000	$600,000	$600,000	$700,000	$800,000	$800,000
2	Raw Water Supply Line	$30,000	$40,000	$40,000	$45,000	$50,000	$50,000
3	Treatment Facilities	$1,400,000	$1,680,000	$2,040,000	$2,520,000	$2,880,000	$3,600,000
4	Demineralization	$1,000,000	$1,120,000	$1,360,000	$1,680,000	$1,920,000	$2,400,000
5	Filtered Water Storage	$90,000	$100,000	$100,000	$115,000	$120,000	$150,000
6	Finished Water Storage	$90,000	$100,000	$100,000	$115,000	$120,000	$150,000
7	Process Waste Line	$55,000	$60,000	$60,000	$60,000	$60,000	$60,000
8	Sludge Lagoons	$95,000	$100,000	$100,000	$115,000	$120,000	$150,000
	TOTALS:	**$3,210,000**	**$3,800,000**	**$4,400,000**	**$5,350,000**	**$6,070,000**	**$7,360,000**

NOTE: These costs are for plants requiring secondary treatment and do not include contingencies or engineering.

Filename: Plant_$.wk1