TRINITY COUNTY REGIONAL WATER SUPPLY SYSTEM
SURFACE WATER CONVERSION
AND
SERVICE AREA EXPANSION

Turner Collie & Braden Inc.

Engineers • Planners • Project Managers

March 2000

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PRELIMINARY ENGINEERING FEASIBILITY REPORT
TRINITY COUNTY REGIONAL WATER SUPPLY SYSTEM
SURFACE WATER CONVERSION AND SERVICE AREA EXPANSION

PREPARED FOR
TRINITY RIVER AUTHORITY OF TEXAS

TC&B JOB NO. 15-46100-001
MARCH 2000

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EXECUTIVE SUMMARY

This study was undertaken to investigate modifications and/or alternatives to the current Trinity County Regional Water Supply System (TCRWSS) facilities to convert to surface water due to declining rates of production of the existing well field. Additionally, the study included a review of the feasibility of expanding the service area to include two new customers in addition to the six current TCRWSS customers.

The scope of the study included the evaluation of the following three alternatives:

- Convert the existing TCRWSS plant to a surface water treatment facility with supplemental groundwater supply.
- Obtain finished water from the Huntsville water treatment plant by pipeline transmission.
- Identify potential location(s) for a new TCRWSS surface water plant at a more centralized site in the service area, including the expanded service area created by the addition of the potential two new customers.

To determine the appropriate size for the treatment plant, water demand projections were prepared for the planning year 2010. The surface water plant capacity was based on the following criteria:

- Provide for the projected growth of the service area based on the customer provided rates of growth.
- Comply with the TNRCC 0.6 gpm per connection supply requirement.

For the purposes of this study, the capacity of the surface water plant required to provide water to the six existing customers is 3.5 mgd. For the alternative of adding the two potential customers to the system, the capacity increases to 4.1 mgd. The surface water plant capacity is based on the water demand projections less the contribution of the customer facilities and the existing Trinity Plant (400 gpm/0.58 mgd).

Based on the demonstrated success of conventional treatment technology on the Trinity River water at the TRA Huntsville and Livingston plants, the recommended treatment configuration is clarification followed by filtration and disinfection. An evaluation of membrane technology was performed as part of the process review. Based on the raw water quality in the Trinity River at the Lake Livingston area, membrane treatment is a viable option. Improvement of the raw water quality would be required prior to feeding the membranes. Consideration should be given to further evaluating the membrane option under the preliminary engineering phase of the project.

For the service condition of providing a 3.5 mgd surface water treatment plant to supply the six existing customers, an expansion of the existing Trinity plant is recommended. For the service condition of providing a 4.1 mgd plant to supply the six existing customers and the two potential new customers, a new centralized plant in the Sebastopol area is recommended.

SECTION I - INTRODUCTION

GENERAL

This report has been prepared pursuant to the Engineering Services Agreement dated April 28, 1999 between the Trinity River Authority of Texas (TRA) and Turner Collie & Braden Inc. (TC&B).

The purpose of the report is to investigate modifications and/or alternatives to the current Trinity County Regional Water Supply System (TCRWSS) facilities to convert to surface water due to declining rates of production of the existing well field. Additionally, the report includes a review of the feasibility of expanding the service area to include two new customers.

A similar report was prepared for a 1.0 mgd expansion of the Trinity plant by TC&B in 1990. This study and report are an extension of the 1990 report.

SCOPE AND OBJECTIVES

This report presents the findings of TC&B's evaluation of the expansion alternatives for the TCRWSS in accordance with the Basic Engineering Services contained in Article III of the Engineering Services Agreement. The Scope of Work includes the following tasks:

- Collect and evaluate background information related to the project.
- Collect and evaluate facility information at the TCRWSS plant and the Huntsville Regional Water Supply System (HRWSS) plant.
- Evaluate the water treatment equipment and process alternatives for converting the existing TCRWSS plant to a surface water treatment facility with supplemental groundwater supply.
- Evaluate the alternative of obtaining finished water from the HRWSS water treatment plant by pipeline transmission.
- Identify potential location(s) for a new TCRWSS surface water plant at a more centralized site in the service area, including the expanded service area created by the addition of the potential two new customers.
- Evaluate and recommend water treatment equipment and process alternatives for the new facilities identified above.
- Prepare estimates of probable costs for the study alternatives.
- Prepare and present a draft and final Preliminary Engineering Feasibility Report summarizing the findings and recommendations of the study.

Alternatives

Three alternatives are being evaluated to address the required supply capacity proposed for the TCRWSS. These alternatives include the following:

- Expansion of the existing Trinity plant facility.

- Expansion of the HRWSS plant and extension of the transmission pipeline along FM 980 to the Trinity plant.
- New centralized surface water treatment plant.

WATER SYSTEM OVERVIEW

The TCRWSS, which is owned and operated by TRA, supplies potable water to an essentially rural service area northeast of Huntsville, in the southwest portion of Trinity County, Texas. The general location of the TCRWSS is shown in *Exhibit 1*. The system, which began operation in September 1983, conveys finished water from the existing treatment plant to six existing customers: City of Trinity, City of Groveton, Westwood Shores Municipal Utility District, Trinity Rural Water Supply Corporation, Glendale Water Supply Corporation, and Riverside Water Supply Corporation. These water supply entities receive water into their system storage tanks for subsequent distribution. Several of the individual suppliers have existing water wells or treatment plants that are used as a backup water supply. *Exhibit 1A* shows the location and size of the TCRWSS components.

The study will also examine the feasibility of expanding the service area to include the Lake Livingston Water and Sewer Service Corporation and the Onalaska Water Supply Corporation.

TNRCC CRITERIA

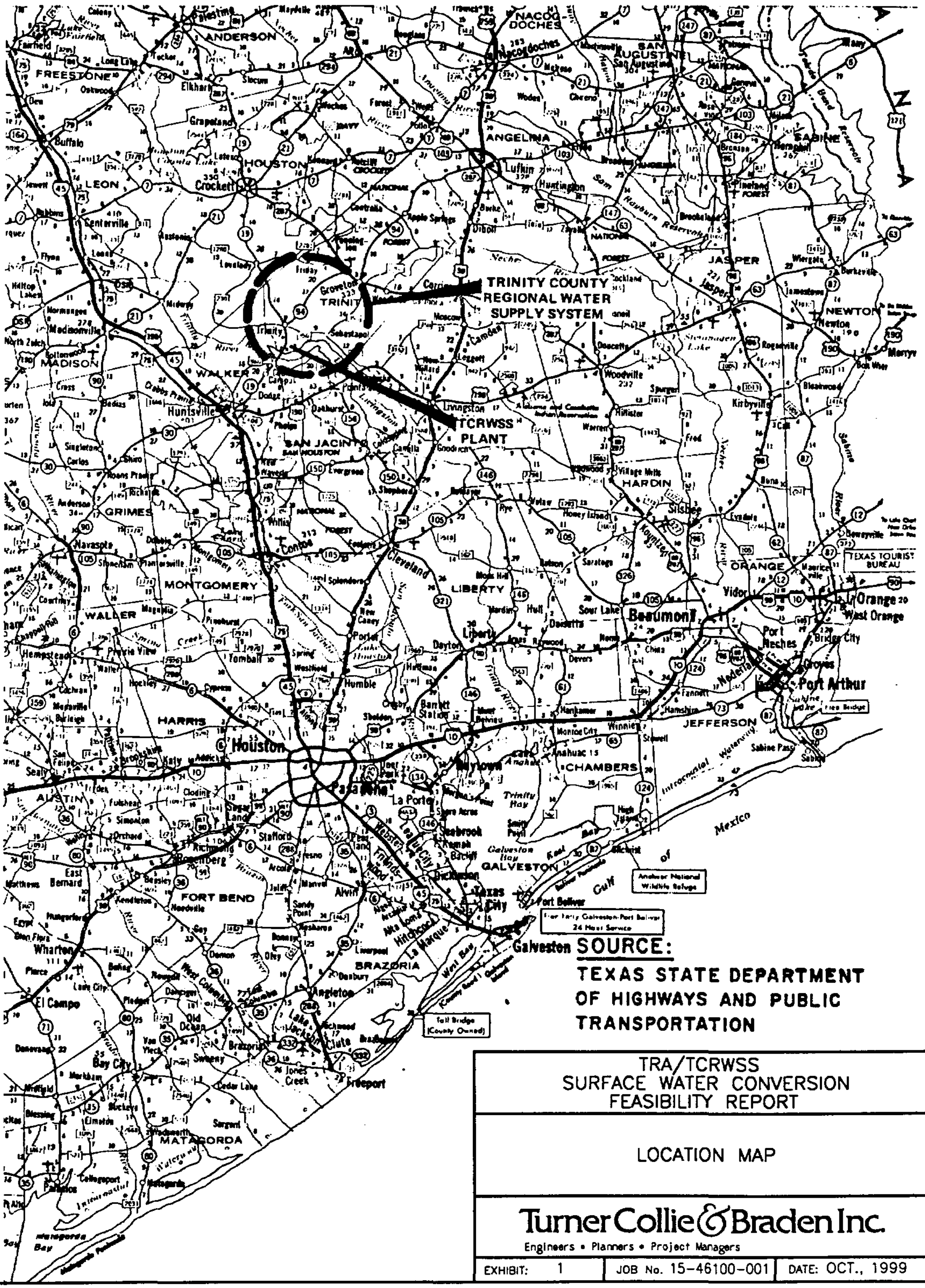
As required by the Texas Natural Resource Conservation Commission (TNRCC) regulation 30 TAC 290, the supply capacity of the TCRWSS plant is recommended to be at least 0.6 gallons per minute per connection, less the supply capacity of the individual customers. Furthermore, the peak pumping capacity required by TNRCC for the customer's system is at least 2.0 gallons per minute per connection.

For this study, the supply requirement of 0.6 gpm/connection will be used as the basis of determining the capacity of the plant.

The distribution pumping requirement of 2.0 gpm/connection will also be determined, but since the pumpage is provided by the individual customers and not TCRWSS no specific details or costs are included in this study for implementation of necessary improvements. This will be the responsibility of each individual customer.

WATER TRANSMISSION SYSTEM

An additional work task was added to the scope of this report to evaluate the water transmission system for the two water plant locations presented herein. The transmission system evaluation is discussed in *Appendix C*.



SOURCE:
TEXAS STATE DEPARTMENT
OF HIGHWAYS AND PUBLIC
TRANSPORTATION

TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT

LOCATION MAP

Turner Collie & Braden Inc.
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EXHIBIT: 1 | JOB No. 15-46100-001 | DATE: OCT., 1999

SECTION II - EXISTING FACILITIES

EXISTING TRINITY PLANT FACILITIES

The TCRWSS treatment plant is located immediately east of State Highway 19, between the cities of Riverside and Trinity. The facilities include an infiltration well field south of the plant site on the banks of Lake Livingston for water supply, with a 16-inch well collection line extending to the plant. The untreated water is metered as it enters the plant. Pre-treatment includes aeration by an induced draft aerator, disinfection using chlorine, and pH adjustment using caustic soda. The water flows by gravity from the aerator tower to a bank of four 10.5 foot diameter filters. Filtered water is collected in a common filtered water chamber and then flows to a 500,000 gallon reinforced concrete clearwell, with fluoridation and post-chlorination accomplished in the interconnecting piping.

The filtered water chamber also provides a source of water for backwashing, which is supplemented as required by a 500 gpm backwash pump that transfers water from the clearwell. Backwash wastewater flows from the filters by gravity to an in-ground, concrete-lined and covered 42,000 gallon backwash settling basin. A self-priming pump adjacent to the backwash basin allows transfer of settled water back to the head of the plant. Piping from the basin sump to a hose connection at grade is provided for removal of settled solids.

Three vertical turbine high service pumps, two rated at 700 gpm and one rated at 350 gpm, take suction from the clearwell and pump finished water to the customers via a pipeline transmission system. Pressure maintenance is provided by continuous operation of the various high service pumps with high pressure bypass to the clearwell.

EXISTING HRWSS PLANT FACILITES

The Huntsville Regional Water Supply System facility is a conventional sedimentation and filtration plant that began operation in 1980. The facility is rated at 8 mgd for potable water production and is currently undergoing an expansion of the Raw Water Pump Station and some plant components to increase the plant capacity to supply 6 mgd process water to a local industry. The raw water source is the Trinity River. The plant is owned and operated by TRA.

The Raw Water Pump Station consists of vertical turbine pumping units that convey water from the river to the plant. Following chemical additions, the raw water is treated in solids contact type clarifiers followed by dual media gravity filters for solids and microbiological contaminant removal. The treated water is stored in a 400,000 gallon clearwell for distribution to the City of Huntsville and the Texas Department of Criminal Justice (TDCJ) Estelle and Ellis Units. The finished water pump station consists of three pumps rated at 1,870 gpm. The pumps are housed in a single story metal building.

The existing HRWSS pipeline to the TDCJ units is a 20 inch ductile iron (class 250) transmission line operating with a pressure of approximately 75 psig leaving the HRWSS plant. The City of Huntsville has a contract with the TDCJ to supply 1.2 mgd to the Estelle and Ellis Units via the 20 inch transmission line.

OPERATING EXPERIENCE AT THE TRINITY PLANT

The TCRWSS Plant was placed into operation in September 1983. A review of operation and maintenance (O&M) information supplied by TRA indicates a somewhat variable annual production rate for the plant. For the years 1984-1998, the annual average production was 0.906 mgd, with a peaking factor of about 1.6 (peak day vs average day). Prior to 1988, the annual production rate was in excess of 1.0 mgd; however, during that year Lake Livingston dropped to an historical low, and production capacity from the TCRWSS plant was dramatically reduced as a result of the low lake level. Since that time, even though the production capacity for the plant has recovered, the system operation has never attained to the pre 1988 levels. As production for the plant decreased the O&M cost/1000 gallon increased, demonstrating the effects of various fixed costs. For example, prior to 1988, O&M cost were less than $1.00/1000 gallon while after that year the O&M costs have been around $1.30/1000 gallon. Since the TCRWSS customers are contractually obligated only for minimum debt service charges, reduced water consumption by one party shifts operational and treatment cost to the others.

The most significant operational experience at the TCRWSS plant has been the decline in production capability of the well field. The hydraulic limitation of the field became fairly significant in the summer of 1985, when low lake water levels impeded the operation of several wells. This condition was repeated again in the fall of 1988, when the record low level for Lake Livingston (5.75-feet below normal pool elevation) diminished the well field capacity to about 300-400 gpm. The low supply rate contributed to higher water costs for 1988 as described above. This pattern has continued as drought conditions have occurred during succeeding years (i.e., 1996 and 1998).

While there have been several test reports and analyses of the TCRWSS well field, a summary report by R.W. Harden and Associates, Inc. dated March 26, 1986 drew the following conclusion.

> "The hydraulic character of the alluvium in and adjacent to the Riverside well field limits the amount of water available to the well field under typical lake level conditions occurring in the last two years to approximate 1 mgd. The well field in its present configuration is not able to provide for future increased water needs. Also, substantially lower lake levels that have occurred in the past may result in a significantly reduced capacity of the well field as would any future decreases in specific capacity of the well."

The Harden report suggested various options that might be explored to restore adequate groundwater supply to the TCRWSS, including recharge channels or infiltration galleries to reinstate the capacity of the existing well field, construction of a supplemental shallow well field approximately twice the size of the existing field, or deep wells (presumably located a significant distance from the TCRWSS plant).

OPERATING RECORDS

Operating records for the three TRA water plants are included in *Appendix D.*

SECTION III - WATER DEMAND PROJECTIONS AND PLANT CAPACITY

METHODOLOGY

At the initial project meeting between TRA and TC&B, it was agreed the water study would be prepared based on projected water demands through the year 2010 and the new system would comply with the TNRCC supply criteria of 0.6 gpm per connection.

The service area for the study was the current service area of the six existing customers and the potential two new customers.

For assessing the 2010 requirements, three growth projections were used. The first projection was based on Texas Water Development Board (TWDB) published growth projections for the City customers, and TWDB "county-other" growth rates for the non-City customers. The second projection method was based on telephone conversation input on predicted growth from the customer representatives. The third method was based on a projection of the 1995-1999 average growth reported on a questionnaire completed by each of the customers. The TWDB projected growth for the customers was found to be around 0.5% per year. The 1995-1999 questionnaire average growth rates varied by customer but were generally in the 1.5% to 3.5% range. The customer provided projected growth rates generally fell between the TWDB and the questionnaire rates.

WATER DEMAND PROJECTIONS

After review of preliminary data with the TRA and the customers, the basis for sizing the new surface water plant was determined to be as follows:

- Provide for the projected growth of the service area based on the customer provided rates of growth.
- Comply with the TNRCC 0.6 gpm per connection supply requirement.

The water supply requirements to meet the above criteria are present in *Table III-1.* Data sheets presenting the customer provided rates of growth and the resulting water demand projections are located in *Appendix A.*

Distribution pumpage to meet the TNRCC 2.0 gpm per connection pumping requirement will be provided by the individual customers through their pumping and distribution systems. The distribution pumpage requirements of each customer are also presented in *Table III-1.*

TABLE III-1
SUMMARY OF TCRWSS WATER SUPPLY REQUIREMENTS AND CUSTOMER PUMPAGE REQUIREMENTS

Connection Projection for 2010 Based on Rate of Increase From Discussion with Customer

Customer	Year	Number Connections	TCRWSS Supply Reqm't in Addition to Current Customer Supply (gpm)	Customer Pumpage Reqm't in Addition to Current Customer Pumpage (gpm)
City of Trinity	1999	1740	527	2180
	2010	1899	623	2499
Trinity Rural Water Supply Corporation	1999	1120	492	1820
	2010	1724	855	3028
Glendale Water Supply Corporation	1999	310	-3	-280
	2010	410	57	-79
City of Groveton	1999	569	341	1138
	2010	601	361	1202
Westwood Shores MUD	1999	604	282	208
	2010	950	490	899
Riverside Water Supply Corporation	1999	1456	-30	2032
	2010	2105	359	3331
Subtotal Existing Customers	**1999**	**5799**	**1643**	**7378**
	2010	**7690**	**2744**	**10960**
Lake Livingston Water and Sewer Service Corporation	1999	424	254	98
	2010	527	316	304
Onalaska Water Supply	1999	1320	55	1800
	2010	1473	147	2105
Subtotal Potential New Customers	**1999**	**1744**	**309**	**1898**
	2010	**2000**	**463**	**2410**
Total Existing and Potential New Customers	**1999**	**7543**	**1952**	**9276**
	2010	**9690**	**3207**	**13369**

PLANT CAPACITY

Based on the water demands presented above and a joint decision between the TRA and customers to limit the supply of the TCRWSS current well field to 400 gpm (0.576 mgd), the plant capacity was identified as 3.38 mgd for the six existing customers and 4.04 mgd when including the two new potential customers. The plant capacity requirements for 1999 and 2010 are presented in *Table III-2* and *III-3*, respectively.

TABLE III-2
SUMMARY OF PLANT CAPACITY REQUIREMENTS
1999 DEMANDS

Service Area Description	Current TCRWSS Supply Capacity	Supply Required to Meet TNRCC (See Note 1)	Additional Plant Capacity Required to Satisfy Supply Requirement
Existing Customers	1050 gpm / 1.51 mgd	1643 gpm / 2.36 mgd	593 gpm / 0.85 mgd
Potential Customers	0 gpm / 0 mgd	309 gpm / 0.45 mgd	309 gpm / 0.45 mgd
Total	1050 gpm / 1.51 mgd	1952 gpm / 2.81 mgd	902 gpm / 1.30 mgd

Note 1: Additional supply is TCRWSS component and is equal to the TNRCC requirement less the customer facility contribution.

TABLE III-3
SUMMARY OF PLANT CAPACITY REQUIREMENTS
2010 DEMANDS

Service Area Description	Current TCRWSS Supply Capacity	Supply Required to Meet TNRCC (See Note 1)	Additional Plant Capacity Required to Satisfy Supply Requirement
Existing Customers	400 gpm / 0.58 mgd	2744 gpm / 3.95 mgd	2344 gpm / 3.38 mgd
Potential Customers	0 gpm / 0 mgd	463 gpm / 0.67 mgd	463 gpm / 0.67 mgd
Total	400 gpm / 0.58 mgd	3207 gpm / 4.62 mgd	2807 gpm / 4.04 mgd

Note 1: Additional supply is TCRWSS component and is equal to the TNRCC requirement less the customer facility contribution.

For the purposes of this study, the capacity of the surface water plant facilities required to provide water to the six existing customers is 3.5 mgd with a hydraulic capacity of 5.0 mgd.

For the alternative of adding the two potential customers to the system, the capacity increases to 4.1 mgd with a hydraulic capacity of 5.0 mgd.

The surface water plant capacity is based on the water demand projections less the contribution of the customer facilities and the existing Trinity Plant (400 gpm/0.58 mgd).

SECTION IV - PROCESS ALTERNATIVES AND TREATMENT EQUIPMENT

RAW WATER SUPPLY

The raw water source for the proposed surface water expansion is the Trinity River at Lake Livingston. Lake Livingston is a water supply reservoir with a total size of approximately 90,000 acres. The reservoir is impounded by the Livingston Dam and water from the lake is used for municipal and industrial water supply, recreation, and irrigation.

On an average annual basis, the new surface water plant would divert approximately 1,120 acre-feet per year (ac-ft/yr) of water from the Trinity River / Lake Livingston beginning as soon as 2001. The diversion will increase up to approximately 3,920 ac-ft/yr by the year 2010. It is assumed that the TRA currently has sufficient water rights and/or they will purchase them.

RAW WATER QUALITY

The Trinity River / Lake Livingston water is generally considered to be a good quality surface water supply, however turbidity levels are quite variable. Turbidities generally are lower in the eastern end of the lake. The water is also considered to be moderately hard, with total hardness (as $CaCO_3$) in the 75 - 150 parts per million (ppm) range. No raw water quality sampling or testing was performed as part of this investigation. Raw water quality data from the HRWSS treatment plant was used for the planned expansion.

FINISHED WATER QUALITY

In general, the finished water quality must meet standards for potability, bacteriological quality, and chemical quality. There are numerous regulations regarding the chemical quality of the finished water that a water treatment plant must meet. The principle regulations are the Safe Drinking Water Act (SDWA) and the Surface Water Treatment Rule (SWTR). Both of these regulations where written by the United States Environmental Protection Agency (EPA) in response to a mandate from Congress to regulate what is, and isn't in, drinking water. A summary of the SDWA regulations is included in *Appendix B*.

The Safe Drinking Water Act is the regulatory basis for providing a safe and reliable public drinking water supply. This act establishes water quality standards, treatment standards and monitoring requirements that are applicable to this project. The EPA has administrative responsibility for the Safe Drinking Water Act. The EPA establishes specific water quality limits and treatment goals and administers them through their rules. The existing Surface Water Treatment Rule specifies Maximum Contaminant Levels (MCL's) for a broad range of organic and inorganic contaminants. Organic and inorganic chemicals in a water supply pose a threat to the public health. The EPA has established the maximum contaminant level that can be present in drinking water while protecting the public health. The finished water produced by the Trinity WTP must be in compliance with these MCL's.

Potability

Potability are those properties of the finished water that are the most readily noticed and perceived by the customer. They include taste, odor, color, hardness, and clarity (turbidity). The turbidity of the finished water is used as a gross indicator of the performance of the treatment system. Current State regulations require the treatment system to produce water with a turbidity of less than or equal to 0.5 Nephelometric Turbidity Unit (NTU). The EPA passed new regulations in December 1998 that reduces the allowable turbidity to 0.3 NTU.

Bacteriological Quality

Water treated and distributed through a centralized distribution system must be of the highest quality to prevent the outbreak and spread of water-borne diseases. Consequently, the total treatment process must achieve at least a 99.9 percent (3-log) inactivation and/or removal of *Giardia Lamblia* cysts and at least 99.99 percent (4-log) inactivation and/or removal of viruses. Additionally, the water must be disinfected so that it is fecal coliform and *Escherichia Coli* free. To meet the bacteriological quality, the regulations require a minimum residual of 0.5 mg/l chloramine or 0.2 mg/l free chlorine, depending on disinfectant used.

PROCESS SELECTION

Required Treatment

The previous narrative defines the required finished water quality in terms of specific water quality parameters. The proposed water source, the Trinity River, is widely used as a public water supply. Multiple water providers, including the City of Huntsville use the river and impoundments as a source of drinking water. The raw water contains particulate inert and organic matter that are measured as turbidity, color, and taste. Standard treatment for these parameters includes clarification followed by filtration. Subsequent disinfection processes provide the microbiological protection required by the EPA.

Based on the demonstrated success of this treatment technology on this source water at the TRA Huntsville and Livingston plants, the recommended treatment configuration is clarification followed by filtration and disinfection. The recommended process is proposed to be implemented in the form of pre-engineered reactor clarifiers and filtration units for the following reasons:

- Lower capital costs in comparison to site specific engineered treatment facilities employing flocculation, sedimentation, and filtration.
- Previous successful experience by the TRA with this technology and type of equipment and the desire to use it on this project.

Design Capacity

Section III of this report provided background information on the development of the required plant capacity. In summary, the plant capacity for this project is 3.5 mgd. The intent of this capacity is to serve the maximum daily demand of the system. Delivering the peak day demand means that the treatment plant is sized to deliver the design flow over a period of 24 hours.

DISINFECTION EVALUATION

The purpose of disinfection is to destroy or otherwise inactivate microbiological pathogens including bacteria, cysts, and viruses that have not otherwise been removed in the treatment process. The most widely used disinfection system both historically and today is application of chlorine. The use of chlorine as an effective disinfectant for public water supplies began in the late 1800's to early 1900's. Since the mid-1900's, alternative disinfection systems such as chlorine dioxide, ozone, and chloramines have been developed and have been used effectively in both European and U.S. water treatment plants. UV radiation, bromine, iodine and bromine chloride have also been used as disinfectants, though not to the extent as the disinfectants previously mentioned.

Recent discoveries have shown that, in addition to destroying and deactivating pathogenic microorganisms, chlorine also reacts with natural organic compounds (humic and fulvic acids) and bromides found in surface waters to form trihalomethanes (THMs). The most common THMs are chloroform, dichlorobromomethane, dibromochloromethane and bromoform. THMs, or disinfection by-products (DBPs), if present in significant quantities, can cause cancer in laboratory animals, and as such, may have adverse health consequences for people. As a result, the EPA developed regulations to limit the exposure of populace to DBPs in drinking water. The combination of more stringent regulations and increased awareness of the health effects of chlorinated disinfection by-products has prompted the investigation and use of alternate disinfectants as well as alternate methods of chlorine application to reduce DBP levels.

Current federal drinking water regulations require 99.99% (4-log) removal/inactivation of viruses and 99.9% (3-log) removal/inactivation of *Giardia Lamblia*. Generally, a combination of both filtration and disinfection is used successfully to achieve a 4-log removal of viruses and a 3-log removal of bacteria. Since most filtration plants are granted a 2-log virus removal credit and a 2.5-log *Giardia Lamblia* removal credit, the remaining 2-log removal of viruses and 0.5-log removal of *Giardia Lamblia* must be achieved by disinfection.

Federal regulations had also established a limit of 0.10 mg/L for disinfection by-products, measured as annual average total trihalomethanes (TTHM). But new rules issued by the EPA on December 16, 1998, revised both the disinfection and disinfection by-product standards to provide both additional microbiological protection and reduced exposure to disinfection by-products. The new Enhanced Surface Water Treatment Rule (ESWTR) and the Disinfectant/Disinfection By-Product Rule (D/DBPR) establish a limit of 0.08 mg/L of TTHM and also a limit of 0.06 for total haloacetic acids (THAA). Public Water Systems that employ conventional filtration and serve 10,000 or more people must comply with the new regulations within 36 months. Based on the service area population projections and the proposed process, the Trinity WTP will be required to comply with the new regulations.

The final versions of the ESWTR and D/DBPR were published in Federal Register on December 16, 1998 and included several notable changes to the existing regulations. The most notable changes are summarized as follows:

- The Turbidity Standard was reduced from 0.5 NTU to 0.3 NTU in 95 percent of samples.
- A 2-log removal of *Cryptosporidium* is required. A 2 log credit is given for well operated plants.
- The TTHM concentration was reduced to 0.08 mg/l.
- The total concentration of 5 Haloacetic Acids (THAA's) was established as 0.06 mg/l.
- The maximum concentration of Bromate was limited to 0.01 mg/l.
- Maximum Residual Disinfection Limits were established as follows:
  i. Chlorine: 4.0 mg/L.
  ii. Chloramine: 4.0 mg/L
  iii. Chlorine Dioxide: 0.8 mg/L

The EPA has defined a promulgation date of 2002 for an another set of rules to further revise the above standards. Proposed revisions include a reduction in the TTHM limit to 0.04 mg/L and a more stringent *Cryptosporidium* standard. The selection of equipment for the Trinity WTP is based on the revised ESWTR and D/DBPR rules rather than the potential regulations because the long-term rules are very tentative and may, or may not, come to fruition in 2002.

The TNRCC recognizes the following four disinfectant alternatives: chlorine, chloramines, chlorine dioxide and ozone. Chlorine disinfection refers to the application of gaseous chlorine or liquid bleach resulting in the formation of free chlorine species to destroy harmful microorganisms. Chloramines utilized in disinfection are formed by the combination of chlorine and ammonia in the treated water and thus requires a dual feed system. Chlorine dioxide is typically generated on site and is dosed in a manner similar to chlorine dosing. Like chlorine dioxide, ozone is generated on-site but is dosed using a specially designed reactor with a short contact time. Because ozone cannot be used as a residual disinfectant, chloramines are typically used in conjunction with ozone as the primary disinfectant to maintain a residual in the distribution system. A comparison of the four disinfectant alternatives is presented in *Table IV-1*.

TABLE IV-1

DISINFECTANT COMPARISON

	Chlorine Dioxide	**Ozone**	**Free Chlorine**	**Chloramine**
Disinfectant Strength-*Giardia Lamblia*	Excellent	Excellent	Excellent (as HOCl)	Moderate
Disinfectant Strength-Viruses	Excellent	Excellent	Excellent (as HOCl)	Low (Good at long contact times)
By Products: **- THM Formation** **- Others**	Unlikely Chlorinated aromatic compounds, chlorate, chlorite	Unlikely Aldehydes, aromatic carboxylic acids, phthalates	Yes Chlorinated and oxidized intermediates, chloramines and chlorophenols	Unlikely Unknown
Ease of Operation	Difficult, yet manageable	Moderate	Gas: Moderate Liquid: Easy	Moderate
Required Contact Time	Moderate	Short	Moderate	Long
Used for Residual Disinfectant in Distribution System	Yes	No-Alternate Required	Yes	Yes
Capital Cost	High	Low for Ozone, High Considering Additional Residual Disinfection System	Moderate	Moderate
Operating Cost	High	High	Low	Moderate
SOURCE: National Academy of Science (1980), EPA (1981), Lawrence et al. (1980).				

Since chlorine dioxide and chloramines are currently successfully used at the Huntsville and Livingston plants, they have been selected for the Trinity expansion. Since the four disinfectants discussed here are not totally effective against *Cryptosporidium* (which may be regulated in the next 5 years), a change in process may be required if *Cryptosporidium* becomes regulated.

CT Compliance Program

The Surface Water Treatment Rule requires conventional water treatment plants using surface waters to achieve a 3-log (99.9%) removal/inactivation of *Giardia Lamblia* cysts and a 4-log (99.99%) removal/inactivation of viruses between a point where the raw water is not subject to re-contamination by surface runoff and a point upstream of the first consumer. The first consumer for the Trinity WTP is the plant itself (water is used for potable uses inside the plant). Therefore, all disinfection must be accomplished prior to finished water pumping.

The SWTR Guidance Manual allows conventional treatment plants using filtration to take a 2.5-log removal/inactivation credit for *Giardia Lamblia* and a 2-log removal/inactivation credit for viruses. The remaining removal/inactivation (0.5-log for Giardia and 2-log for viruses) is accomplished by the combination of contact time and disinfectant residual concentration and is commonly referred to as CT. CT is the residual concentration (in mg/l) multiplied by the time (in minutes) that the disinfectant is in contact with the water. The time used in calculating CT is the time that 90 percent of the water will be exposed to disinfection and is referred to as T_{10}. T_{10} is calculated based on theoretical detention times at maximum operating flows and baffling factors from the SWTR Guidance Manual. The SWTR Guidance Manual defines the required CT as a function of inactivation ratio, water temperature, water pH, type of disinfectant, and type of organism (Giardia or viruses). This requirement will be addressed during the design phase of the project.

MEMBRANE TECHNOLOGY

Currently, the recommended treatment process for the Trinity water treatment plant generally consists of coagulation, clarification, filtration, and disinfection with chlorine compounds. Although the conventional treatment process is capable of meeting the current project goals, several trends have occurred in the water treatment industry that warrant further investigation because of their possible application to this project. The trends are fueled by new regulations and consumer demands. Anticipated future regulations combined with lower quality source water may render conventional plants incapable of providing the necessary treatment without significant modification in the future. The necessary modifications are usually add-on processes that result in both increased cost and increased overall process complexity and potentially a decrease in process reliability.

The new technologies in use and under development attempt to address the existing and anticipated needs of water treatment utilities in an economical manner. Membranes are one such technology. Membrane technology uses selectively permeable membranes to remove impurities from water. There are four general classes of membranes: 1) microfiltration, 2) ultrafiltration, 3) nanofiltration, and 4) reverse osmosis. Micro- and ultrafiltration membranes are classified as low-pressure membranes (<100 psi operating pressure) while nanofiltration and reverse osmosis are classified as high-pressure (>100 psi operating pressure), diffusion-controlled membranes.

The type of membrane dictates the selectivity of the process. Microfiltration with a pore size range of 0.1 to 5.0 microns provides a barrier to particles larger than 0.5 microns. Microfiltration is capable of removing most bacteria and both *Giardia* and *Cryptosporidium* cysts but is generally incapable of removing viruses, colloids, including many color forming compounds, or dissolved solids. However, microfiltration will remove these smaller particles to the extent the smaller particles are associated with larger diameter particles of a size able to be removed by the membrane. In general, low quality source water applied to microfiltration membranes should be pretreated to remove most of the suspended solids. Such reduction in the solids content reduces the likelihood that the membrane will clog and will reduce the chlorine demand of the treated water.

Ultrafiltration with a pore size range of 0.002 to 0.1 microns removes all particles greater than or equal to roughly 0.01 microns. Thus, ultrafiltration is capable of removing some colloids, including some color contributing colloidal particles, bacteria, most viruses and some organic compounds. Just as in microfiltration, low quality source water should be pretreated to reduce rapid clogging of the ultrafiltration membrane.

Nanofiltration membranes with nominal pore sizes of 0.001 microns provide a positive barrier to almost all viruses, all bacteria, and colloids and color forming compounds while retaining some ions in the treated water. The smaller pore size of nanofiltration membranes lends to a greater degree and frequency of clogging. The smaller pore size also decreases the permeate flux (treated water production rate), and increases the backwash frequency.

Reverse osmosis (RO), the highest pressure and most selective of the four membrane types, is capable of removing ions of low molecular weights, bacteria, colloids and viruses and produces permeate continually without the need to backwash. However, the water treated with an RO membrane must be of very high quality to deter membrane fouling. As such, significant pretreatment is generally required. Oftentimes, pretreatment for RO membranes includes inline microfiltration or ultrafiltration units to increase productivity and efficiency. In general, the high operating pressure and small pore size contribute to more rapid membrane degradation. As such, the life of an RO membrane is significantly less than microfiltration and ultrafiltration membranes. RO membranes must typically be replaced every 2-5 years depending upon the composition of the membrane.

Further evaluation of nanofiltration and reverse osmosis (high pressure systems) for treatment of Trinity River water is not deemed prudent at this time because neither technology is suited to direct treatment of the raw water source. Therefore, further evaluation and discussion will focus on low-pressure, micro-and ultrafiltration membrane technologies.

Relative to solids in the raw water, Trinity River would be considered a good quality raw water source, however turbidity levels are quite variable. As such both microfiltration and ultrafiltration membrane technologies are suitable for use in treating Trinity River raw water. However, raw water data available at this time indicates elevated levels of color. Neither microfiltration nor ultrafiltration is effective at consistently removing color in raw water without the addition of chemical pretreatment.

Another consideration in the use of micro- and ultrafiltration to treat Trinity River water is that the application of membrane treatment processes is vendor and raw water specific. This means that membrane performance for a particular raw water will vary with each brand of membrane. Therefore, specific membrane evaluations can only be made through pilot or full-scale studies using the proposed membrane or membranes to treat the actual raw water source. The TNRCC requires pilot plant studies prior to the use of membranes for the production of potable water.

Potential Membrane Advantages

In general, for high quality, low-turbidity waters, membrane technology can be used for direct treatment and thus avoid extensive pretreatment processes and simplify the treatment scheme. However, direct treatment of surface waters with elevated levels of color, TOC, and/or other contaminants will usually require some form of pretreatment. Depending on the source water, pretreatment may or may not include pre-filtration, pH adjustment, preoxidation, and coagulation/sedimentation. Pretreatment for membrane technologies generally requires fewer treatment chemicals and smaller doses of those chemicals when compared to traditional water treatment plants. As a result, the product water from a traditional water treatment plant contains higher levels of treatment chemicals than does the product water from membrane plants. Also, since fewer chemicals are applied to membrane processes as compared to conventional process, the quantity of solids to be processed in the waste streams is reduced.

Because of their small pore size, micro- and ultrafiltration membrane systems effectively remove pathogens from the treated water. Microfiltration and ultrafiltration membranes generally achieve full log removal of Giardia and 1-log to 3-log removal of viruses. However, regulatory agencies including the TNRCC adhere to a multiple barrier approach to ensure the health and welfare of the public. As such, full pathogen removal credits are not granted to membrane systems at this time. As such, disinfectants must still be used to obtain the remainder of the required removal as well as to maintain the required disinfectant residual in the distribution system. Generally, the amount of additional disinfectant is less than that required by a conventional water treatment plant. Consequently, membrane systems will not form disinfection by-products as readily as conventional treatment processes.

Other potential advantages with membrane technology are a smaller footprint, modularity of design, simple operation, and a higher degree of automation. These advantages contribute to both lower land and operation costs and facilitate treatment plant expansion.

Potential Membrane Disadvantages

While membrane technologies have many advantages, they also have potential problems. The problems that must be addressed in applying membrane technology to water treatment plants include membrane fouling, possible formation and management of a concentrated liquid waste stream, comparable to higher capital costs than conventional treatment, and membrane integrity monitoring.

RECOMMENDATIONS

For this study, conventional treatment using pre-engineered units similar to the HRWSS plant is recommended. Based on the final number of customers served by the plant, the plant capacity, and the time available for implementation of the new plant, the option of membrane technology should be further evaluated. This further evaluation should occur under the preliminary engineering phase of the project.

SECTION V - SURFACE WATER PLANT ADDITION AT TRINITY PLANT

EXPANSION APPROACH

For purposes of this evaluation, the existing TCRWSS groundwater supply and treatment facilities are assumed to remain functional and to have a rated capacity of 400 gpm (0.576 mgd). The plant upgrade would consist of a parallel, surface water treatment train designed in accordance with current TNRCC criteria. The surface water system was generally modeled after the HRWSS plant, given the similar raw water quality and considering TRA's operating experience and historical data from that facility. Information on the configuration of the Huntsville plant was supplied by TRA personnel and supplemented by a site visit and discussions with the HRWSS plant staff.

The existing TCRWSS aerator, filters, and associated piping were assumed to remain "dedicated" to the existing groundwater treatment train and were not considered integrable with a new surface water addition. The parallel treatment trains would be joined at the existing clearwell and existing high service pumps and related facilities would need to be compatible with the total finished water production capability of the upgraded plant. Other existing facilities, including the control/service building, chemical storage and feed equipment, and site improvements, would be integrated with the surface water train, if practical. Assumptions for utilization of these items are presented in this section.

RAW WATER SUPPLY FACILITIES

The selection of a potential raw water intake location and design of the associated facilities is one of the most critical aspects of this evaluation. The construction cost of this component is a significant portion of the overall surface water upgrade cost. Further, these costs are highly variable, depending on the actual physical characteristics of the river at the intake site, configuration of the intake and pump station facilities, and routing of the raw water pipeline to the TCRWSS plant.

Criteria for selection of a suitable raw water intake site include proper access to the main river channel at a location that is within a reasonable distance from the existing plant site. An initial review of the riverfront in the vicinity of the TCRWSS plant was performed using topographic maps and potential sites were subsequently reviewed in the field. Two locations were identified close to the plant site. The first raw water intake site is located just downstream of a south-to-west bend in the river, approximately 1,200 feet north-northeast of the existing plant. The second location is across Highway 19 from the plant at the site of what appears to be a drainage slough off the main river channel. Costs for the two locations will be similar. The final decision of which location to select may be based on property acquisition considerations. The location of the potential raw water pump stations is shown on *Exhibit 2.*

Given the potential for large, floating objects during flood events, a submerged water intake piped to a raw water pump station on the adjacent bank is preferred over a floating pump station or in-river structure. The water intake would be located several feet below the lowest expected water level and protected by a trash screen. Multiple intake points at various levels may be required and should be evaluated in the design phase. The pump station would consist of a reinforced concrete sump with submersible pumps. Ancillary items would include an access road, electrical service and controls. A 16-inch-diameter raw water pipeline would be constructed across State Highway 19 and the Missouri Pacific railroad, then southwest to the plant. The State is currently widening State Highway 19. During the design phase, the selected raw water pump station location and pipeline configuration must be carefully coordinated with the State. If the water plant is expanded beyond it's 3.5 mgd capacity, a second parallel raw water line would be required.

Pertinent topographic information for the potential raw water pump station and existing treatment plant sites as shown on *Exhibit 2* is as follows:

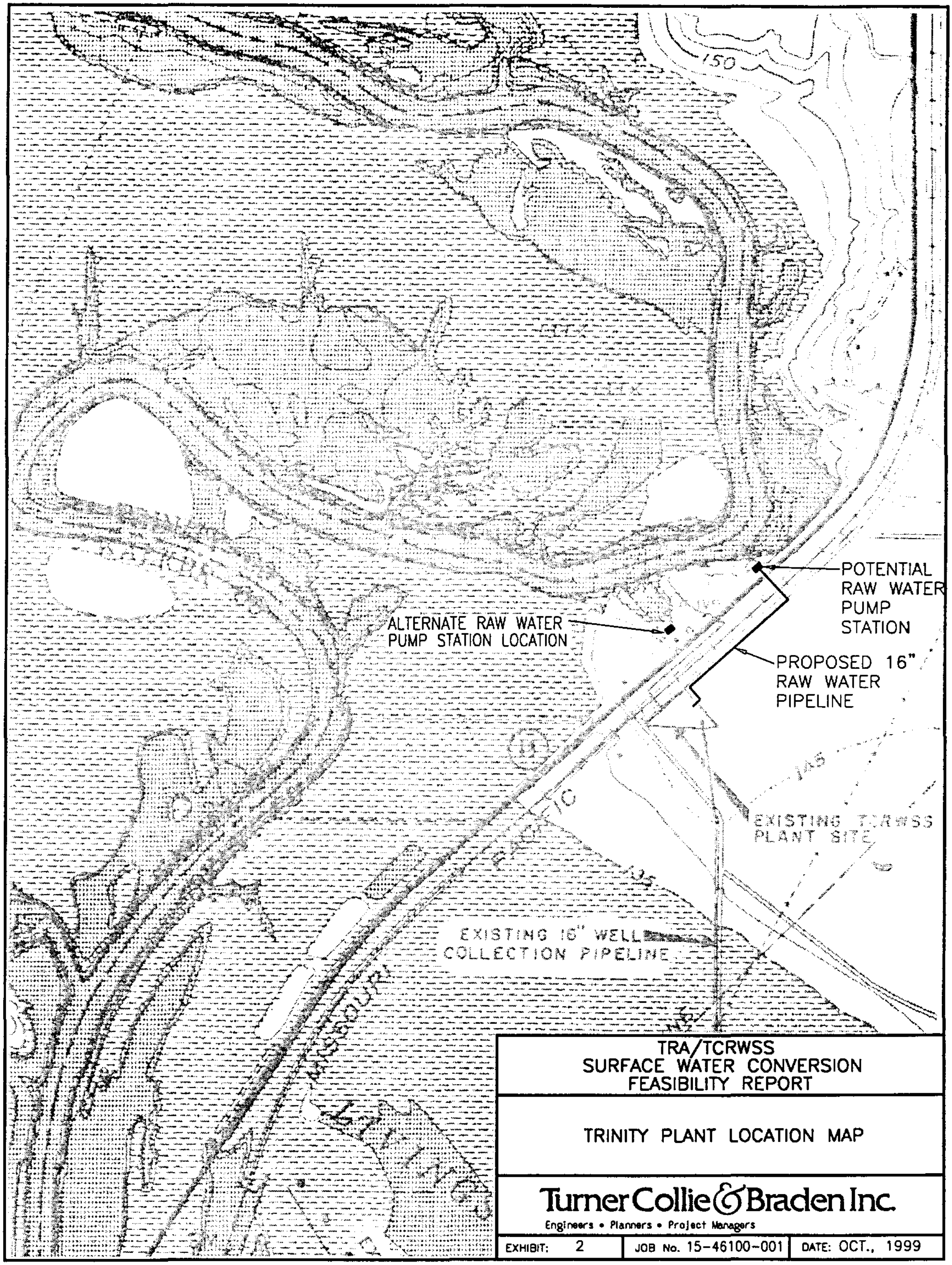
- Trinity River Normal Water Surface Elevation = 131 ft.
- Potential RW Pump Station Site Elevation = 150 ft.
- Alternate RW Pump Station Site Elevation = 140 ft.
- TCRWSS Plant Site Elevation = 144 ft.

SURFACE WATER TREATMENT SYSTEM

The surface water facility would generally consist of raw water flow measurement and control; chemical addition and in-line mixing; flocculation and sedimentation occurring in the proposed clarifier basin; additional chemical treatment, as required, following sedimentation; filtration; disinfection; and transfer to storage in the existing clearwell. Raw sludge from the clarifier and backwash wastewater solids would be pumped to lagoons for decanting and long term storage prior to disposal.

Given the relatively small size of the TCRWSS plant, pre-engineered treatment equipment is the most economical approach for the clarifier and filter units for this facility. Two water treatment equipment manufacturers (Infilco-Degremont Inc. (IDI) and US Filter) were contacted through local representatives for recommendations and budget estimates for clarification and filtration equipment for the TCRWSS upgrade. The responses from IDI and US Filter were similar in concept, configuration, and cost of the equipment and were used as the basis for site layout and probable construction costs. Both manufacturers offer circular, solids-contact type clarifiers with flocculation and settling zones combined in one basin. Two reactor clarifier costs have been obtained from the manufacturers. One for welded steel tanks, including equipment, and the second for equipment only. For the second condition of equipment only, concrete basins will be constructed for each unit. The cost of concrete basins is included in the cost estimate presented in Section VIII.

Filtration facilities would consist of multi-cell, dual media units with concrete basins. Two new backwash pumps would be required, with piping and valving provided to take water from the clearwell through the existing 18-inch suction piping and discharge to the backwash system at the new filters. Backwash wastewater would be piped from the filters to the existing backwash settling basin. The settling basin would be modified to allow variable decant and recycle of clarified


150
POTENTIAL RAW WATER PUMP STATION
ALTERNATE RAW WATER PUMP STATION LOCATION
PROPOSED 16" RAW WATER PIPELINE
145
EXISTING TCRWSS PLANT SITE
EXISTING 16" WELL COLLECTION PIPELINE
MISSOURI
TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT
TRINITY PLANT LOCATION MAP
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backwash water. A backwash wastewater transfer pump would pump settled solids from the basin sump to new sludge lagoons.

Treatment of surface water will require the addition of several chemicals not currently used at the TCRWSS plant, including alum and polymer for coagulation, lime for alkalinity adjustment, carbon for taste and odor, and chlorine dioxide and ammonia. New chemical metering pumps and storage tanks would be required for the surface water train. The existing chlorination and caustic systems will remain dedicated to the existing groundwater plant.

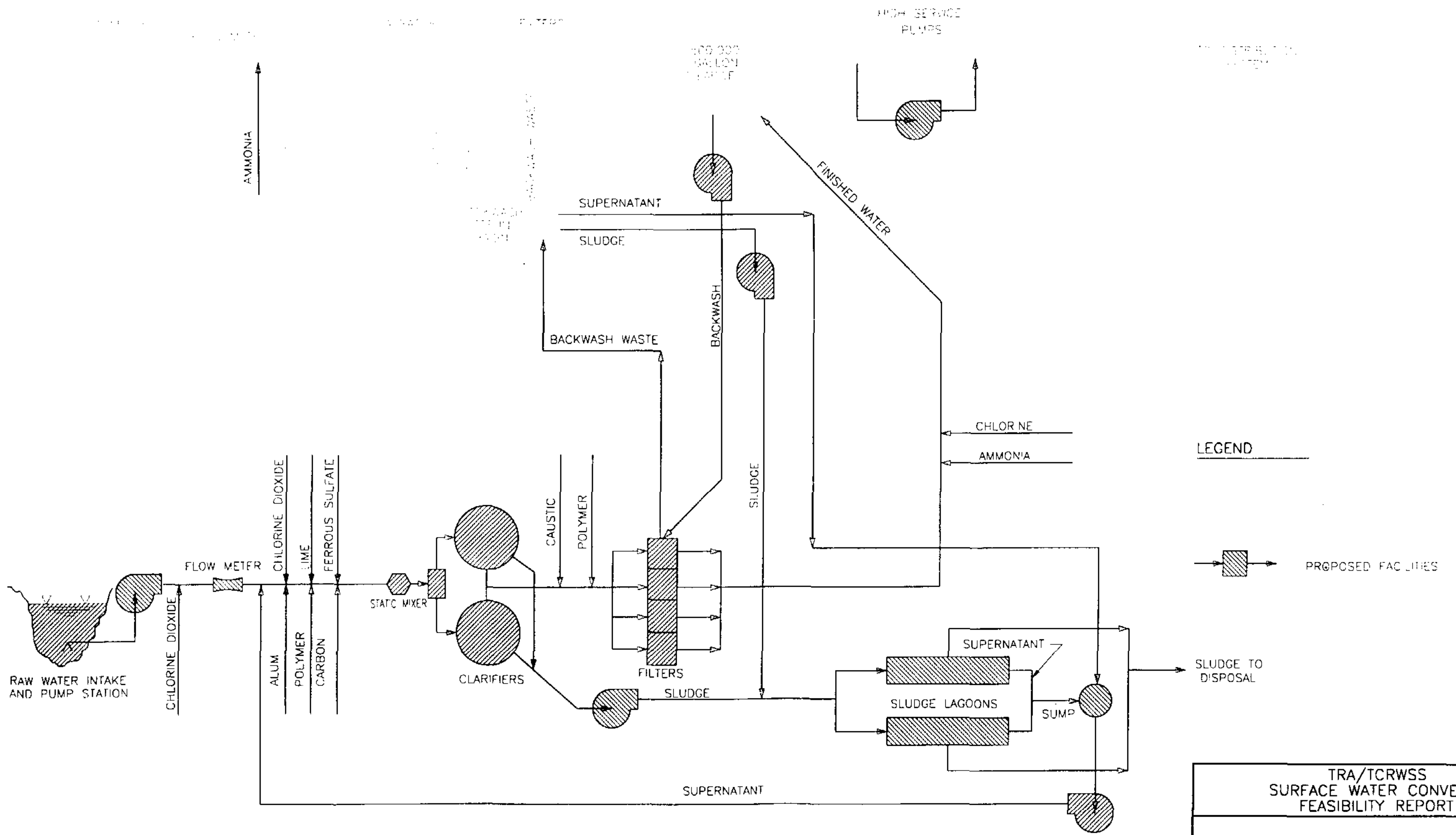
Each of the new chemicals require storage facilities and feed equipment, the latter preferably located indoors for protection from the elements. Given the limited space available in the existing TCRWSS building and the configuration of the site, a new chemical building would be added with the surface water upgrade. In addition to the new chemical feed systems, the building would house much of the electrical and motor control equipment associated with the plant expansion. Outdoor storage tanks will be required for alum and aqueous ammonia and should be located adjacent to the plant roadway to facilitate truck unloading. The physical location of the chemical building and other surface water treatment components is shown in *Exhibit 3*. The flow diagram for the upgraded plant is shown in *Exhibit 4*. Component sizing criteria are presented in *Table V-1* located at the end of this section.

FINISHED WATER STORAGE AND PUMPING FACILITIES

The existing clearwell, with a total volume of 500,000 gallons, is adequate for the expanded plant. There are three existing high service pumps, two rated for 700 gpm and the third rated for 350 gpm, providing a "firm" capacity of 1,050 gpm, or approximately 1.5 mgd. The high service pump station should be upgraded to a firm capacity of approximately 4.0 mgd to be compatible with the production capability of the improved TCRWSS plant. Two new vertical turbine pumps with a nominal rating of at least 1,200 gpm are required. The new pumps would be located adjacent to the existing units, with suction and discharge piping extended accordingly. Final pump selection during design phase will depend on an analysis of the distribution system and required operating pressures.

SLUDGE HANDLING FACILITIES

Raw sludge from the clarifier and settled solids from the backwash settling basin would be pumped to new lagoons for water volume reduction and storage. Two lagoons of earthen dike construction would be provided, with an area of about 0.6 acres each. Each lagoon would be fitted with inlet feed and takeoff piping, the latter consisting of a "swing joint" or similar device for variable level decanting. The decant or supernatant from the lagoons would flow to a sump for subsequent pumped recycle to the beginning of the surface water treatment train. Operation of the lagoons would alternate with one lagoon in continuous operation until filled when the second lagoon would be placed into service. Disposal of lagoon sludge would be on a contract basis, as has been the practice at the Huntsville plant.



TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT

PLANT FLOW DIAGRAM

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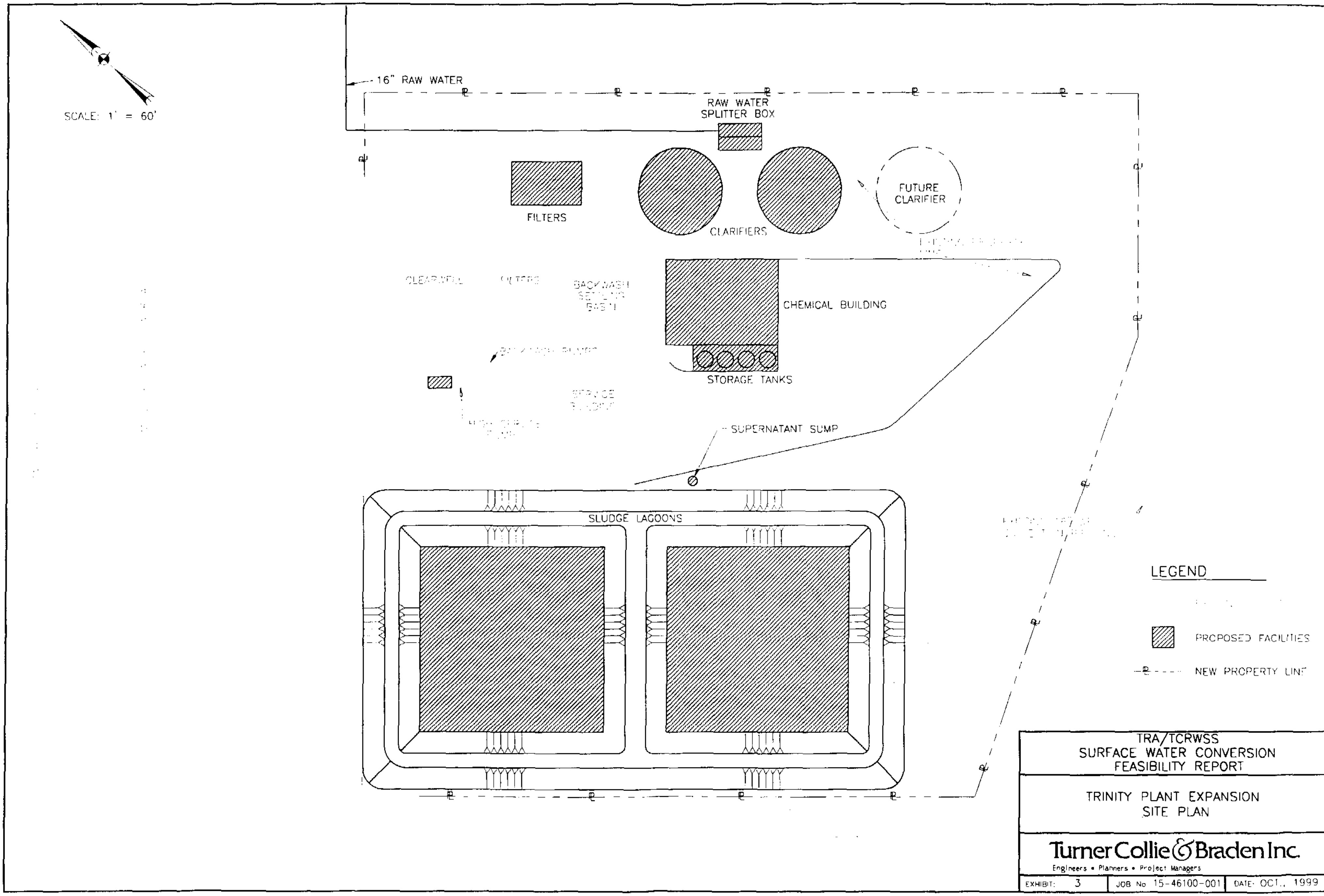
SCALE: 1" = 60'
16" RAW WATER
RAW WATER SPLITTER BOX
FILTERS
CLARIFIERS
FUTURE CLARIFIER
CHEMICAL BUILDING
STORAGE TANKS
SUPERNATANT SUMP
SLUDGE LAGOONS
LEGEND
PROPOSED FACILITIES
NEW PROPERTY LINE
TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT
TRINITY PLANT EXPANSION
SITE PLAN
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JOB No 15-46100-001
DATE: OCT., 1999

TABLE V-1

FACILITIES DESIGN SUMMARY
SURFACE WATER TREATMENT ADDITION AT TRINITY PLANT

1.	Plant Capacity	
	Design	3.5 mgd/2,431 gpm
	Maximum Hydraulic Capacity	5.0 mgd/3,472 gpm
2.	Raw Water Pump Station	
	Number of Pumps	3
	Rated Capacity, each	1,225 gpm
	Station Capacity, firm	2450 gpm/3.5mgd
	Pipeline to Plant	16 inch
3.	Clarifier	
	Type	Reactor Clarifier
	Number of Units	2
	Total Detention Time	2.9 hours
	Net Surface Area	1,859 square feet
	Rise Rate	0.93 gpm/s.f.
	Reaction Zone Detention Time	60 minutes
4.	Filters	
	Type	Dual Media
	Number of Cells	4
	Total Surface Area	808 s.f.
	Filter Rate	3.0 gpm/s.f.
5.	Clearwell	
	Existing Size	500,000 gallons
	Increase Capacity	None
6.	Filter Backwash Pumps	
	Backwash Rate	20 gpm/s.f.
	Pump Rate	As required by mfr.

7. Clarifier Sludge Transfer Pumps

Average Sludge Production	17,500 gpd
Maximum Sludge Production	35,000 gpd
Number of Pumps	2
Rated Capacity, each	300 gpm

8. Sludge Lagoons

Number of Lagoons	2
Volume per Lagoon	958,000 gallons

9. Supernatant Recycle Pumps

Maximum Supernatant Return	60,000 gpd
Number of pumps	2
Rated Capacity, each	80 gpm

10. Water Distribution Pumps

Number of Existing Pumps	3
Rated Capacity, P-1 and P-2	700 gpm
Rated Capacity, P-3	350 gpm
Number of Proposed Pumps	2
Rated Capacity, P-4 and P-5	1,200 gpm
HSPS Capacity, firm	2950 gpm/4.2 mgd

11. Alum Feed System

Type	48% solution
Average Dosage	75 mg/l
Number of Pumps	2
Pump Rate	1-100 gph
Storage Tank Volume	20,000 gallons/30 days

12. Caustic Feed System

Type	50% solution
Average Dosage	50 mg/l
Number of Pumps	2
Pump Rate	1-65 gph
Storage Tank Volume	7,500 gallons/30 days

13. Coagulant Aid Polymer Feed System

Type	liquid, cationic
Average Dosage	2 mg/l
Number of Feed Units	2

	Polymer Feed Rate	0.04-1.2 gph
	Storage Drums	55 gallons
14.	<u>Filter Aid Polymer Feed System</u>	
	Type	liquid, anionic
	Average Dosage	1.5 mg/l
	Number of Feed Units	2
	Polymer Feed Rate	0.04-1.0 gph
	Storage Drums	55 gallons
15.	<u>Activated Carbon Feed System</u>	
	Type	dry powder
	Maximum Dosage	10 mg/l
	Day Tank Capacity	2 @ 500 gallons each
	Number of Pumps	2
	Pump Rate	1-100 gph
16.	<u>Ammonia Feed System</u>	
	Type	aqueous, 28% solution
	Average Dosage	0.7 mg/l
	Number of Pumps	2
	Pump Rate	0.05 – 3 gph
	Storage Tank	500 gallons/30 days
17.	<u>Lime Feed System</u>	
	Type	dry powder
	Average Usage	160 lbs/day
	Day Tank Capacity	200 gallons
	Number of Pumps	2
	Pump Rate	0-25 gph
18.	<u>Ferrous Chloride Feed System</u>	
	Type	agueous, 39% solution
	Average Dosage	20 mg/l
	Number of Pumps	2
	Pump Rate	0-15 gph
	Storage Tank	7,500 gallons/30 days

19. Chlorine

Type	gas supply, solution feed
Average Dosage	1.0 mg/l
Maximum Usage	170 lbs/day

20. Chlorine Dioxide

Type	solution feed
Average Dosage	2.0 mg/l
Maximum Usage	85 lbs/day

SECTION VI - EXPANSION OF HRWSS PLANT AND FINISHED WATER PIPELINE EXTENSION

EXPANSION APPROACH

To supply the 3.5 mgd required for the TCRWSS, several areas of the HRWSS plant require expansion and/or improvement. The plant is currently rated at 6 mgd average and 8 mgd peak. The current rated plant capacity is committed to supplying existing customers. An expansion is underway at the plant to provide process water for a local industry. This expansion will not provide additional capacity for the TCRWSS. A review was conducted of each major process at the plant to identify where expansion would be required to supply water to TCRWSS. Four major areas of expansion were identified: raw water supply, treatment equipment, chemical feed systems, and finished water storage and pumping. Component sizing criteria for the expansion equipment are included in *Table VI-1* located at the end of this section.

RAW WATER SUPPLY FACILITIES

An additional raw water supply pump would be required at the raw water pump station. A 2780 gpm (4.0 mgd) vertical turbine unit is recommended to match the equipment planned under the current expansion. In order to maintain current system operating pressures in the raw water system, the existing 30 inch raw water line would require a parallel line to convey the additional flow to the plant. A parallel 20 inch raw water line is required to maintain similar operating pressures.

SURFACE WATER TREATMENT SYSTEM

The plant's three reactor clarifiers, each rated at 4.6 MGD, are dedicated to existing customers. A new fourth clarifier would be required for the TCRWSS demand. A unit similar to the existing units is planned. Similarly, the gravity filters are dedicated to existing customers and a new filter unit would be required for the TCRWSS demand. A four cell covered unit is planned. Other components of the treatment system (backwash pumps, sludge handling pumps, storage lagoons) are considered adequate for the addition of the TCRWSS demand.

CHEMICAL FEED SYSTEMS

A review of the current chemical feed systems identified expansions or additions would be required for the following systems:

- Alum (feed pumps and storage tank)
- Caustic (feed pumps and storage tank)
- Coagulant Aid Polymer (feed pumps and storage tank)
- Ammonia (feed pump)
- Chlorine (500 lb/day unit)
- Chlorine Dioxide (modify existing equipment)

The other chemical systems (activated carbon, lime, and ferrous chloride) are adequate for the planned expansion.

FINISHED WATER STORAGE AND PUMPING FACILITIES

The existing 400,000 gallon clearwell requires an additional 175,000 gallons to comply with TNRCC criteria. A reinforced concrete clearwell structure would be located adjacent to the existing clearwell. Two additional high service pumps each rated at 2400 gpm would be required to pump the expansion flow. The pumps would be housed in a metal building similar to the existing pump station.

PIPELINE EXTENSION

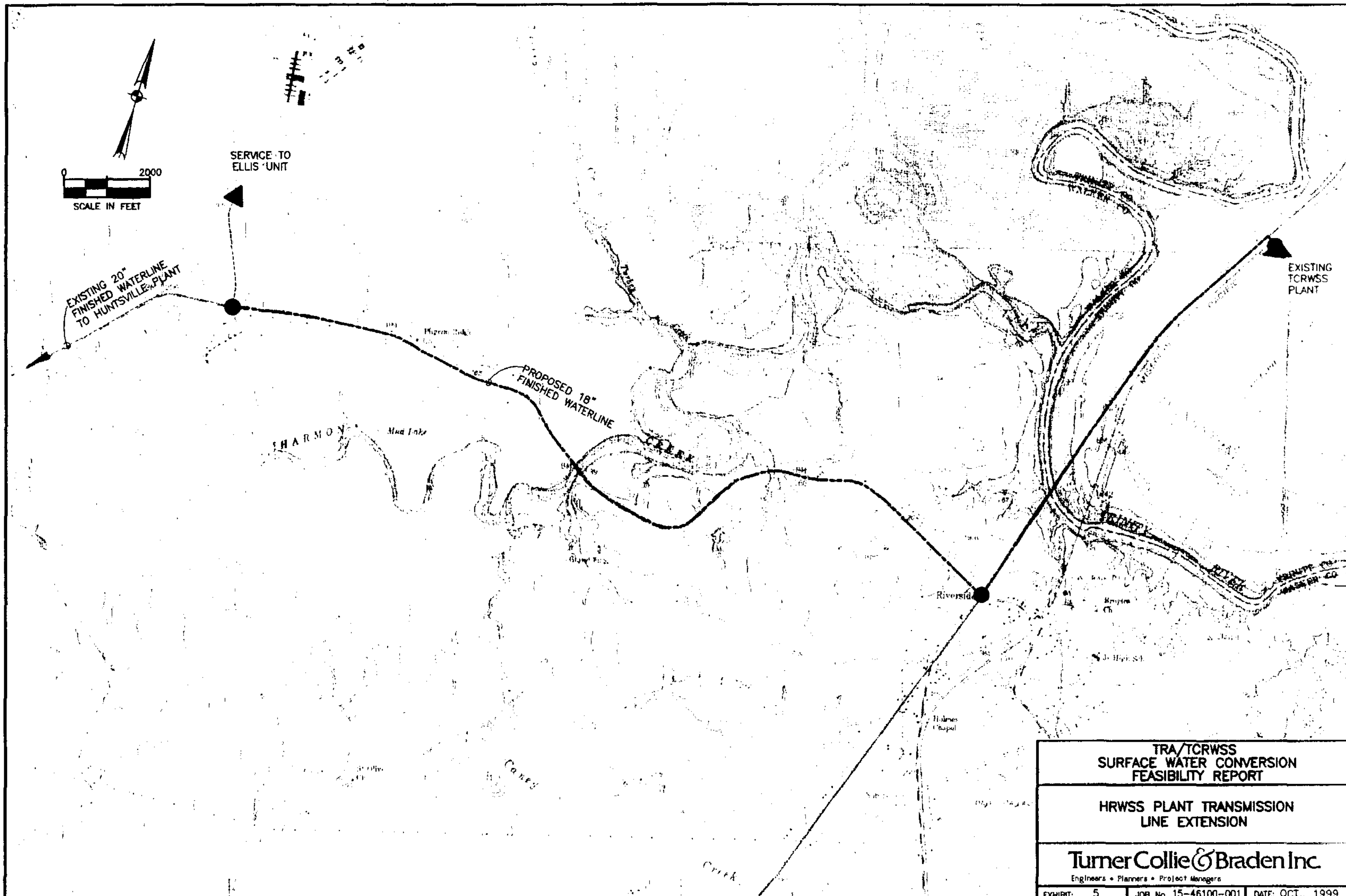
In order to convey the treated water from the HRWSS plant to the TCRWSS plant, an extension is required of the finished water transmission line that currently conveys water to the TDCJ units along FM 980. In sizing the line, the TDCJ demand used for this study was 1.2 mgd per the TDCJ contract with the City of Huntsville.

Several line sizes and flow rates were evaluated as part of this study. In order to maintain similar operating pressures in the line for 3.5 mgd, a 14 inch extension would be required from the current end of the line at the Ellis Unit to the Trinity plant. System pressures in the 20 inch /14 inch line would need to be increased by approximately 10 psig to accommodate the increased flow. To provide 5.0 mgd capacity, an 18 inch extension is required with no adjustment to current system operating pressures. The length of the pipeline extension is approximately 32,000 feet.

An 18 inch line is recommended for the transmission line extension. The route of the 18 inch line is shown in *Exhibit 5.*

Pertinent topographic information for this alternative as shown on *Exhibit 5* is as follows:

- Trinity River Normal Water Surface Elevation = 131 ft.
- HRWSS Raw Water Pump Station Elevation = 154 ft.
- HRWSS Plant Site Elevation = 265 ft.
- Existing 20" Pipeline - N. G. Elevation at entrance to Ellis Unit = 200 ft.
- Proposed 18" Pipeline - N. G. Elevation at Riverside = 190 ft.
- TCRWSS Plant Site Elevation = 144 ft.



TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT

HRWSS PLANT TRANSMISSION
LINE EXTENSION

Turner Collie & Braden Inc.
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EXHIBIT: 5 | JOB No. 15-46100-001 | DATE: OCT., 1999

TABLE VI-1

FACILITIES DESIGN SUMMARY
EXPANSION OF HRWSS PLANT AND
FINISHED WATER PIPELINE EXTENSION

1.	Plant Capacity	
	Design	3.5 mgd/2,431 gpm
	Maximum Hydraulic Capacity	5.0 mgd/3,472 gpm
2.	Raw Water Pump Station	
	Number of Pumps	1
	Rated Capacity (match current expansion sizes)	2780 gpm/4.0 mgd
	Current Pipeline to Plant	30 inch, reach of 36 inch
	Additional Pipeline to Expand to 3.5 mgd	20 inch
3.	Clarifier	
	Type	Reactor Clarifier
	Number of Units	2
	Total Detention Time	2.9 hours
	Net Surface Area	1,859 square feet
	Rise Rate	0.93 gpm/s.f.
	Reaction Zone Detention Time	60 minutes
4.	Filters	
	Type	Dual Media
	Number of Cells	4
	Total Surface Area	808 s.f.
	Filter Rate	3.0 gpm/s.f.
5.	Clearwell	
	Existing Size	500,000 gallons
	Increase Capacity	175,000 gallons
6.	Filter Backwash Pumps	
	Backwash Rate	20 gpm/s.f.
	Pump Rate	As required by mfr.

7.	Clarifier Sludge Transfer Pumps	
	Expansion Requirement	None (gravity flow)
8.	Sludge Lagoons	
	Number of Current Lagoons	3
	Expansion Requirements	None
9.	Supernatant Recycle Pumps	
	Expansion Requirements	None
10.	Water Distribution Pumps	
	Number of Existing Pumps	3
	Rated Capacity Existing Pumps	1,870 gpm/ 2.7 mgd
	Number of Proposed Pumps	2
	Rated Capacity, P-4 and P-5	2,400 gpm/3.5 mgd each
11.	Alum Feed System	
	Type	48% solution
	Average Dosage	75 mg/l
	Number of Pumps	2
	Pump Rate	1-100 gph
	Storage Tank Volume	20,000 gallons/30 days
12.	Caustic Feed System	
	Type	50% solution
	Average Dosage	50 mg/l
	Number of Pumps	2
	Pump Rate	1-65 gph
	Storage Tank Volume	7,500 gallons/30 days
13.	Coagulant Aid Polymer Feed System	
	Type	liquid, cationic
	Average Dosage	2 mg/l
	Number of Feed Units	2
	Polymer Feed Rate	0.04-1.2 gph
	Storage Drums	55 gallons
14.	Filter Aid Polymer Feed System	
	Expansion Requirements	None

15. <u>Activated Carbon Feed System</u>

Expansion Requirements	None

16. <u>Ammonia Feed System</u>

Type	aqueous, 28% solution
Average Dosage	0.7 mg/l
Number of Pumps	1
Pump Rate	0.05 – 3 gph
Storage Tank Expansion Requirement	None

17. <u>Lime Feed System</u>

Expansion Requirements	None

18. <u>Ferrous Chloride Feed System</u>

Type	agueous, 39% solution
Average Dosage	20 mg/l
Expansion Requirements	None

19. <u>Chlorine</u>

Type	gas supply, solution feed
Average Dosage	2.0 mg/l
Expansion Requirements	500 lb/day unit

20. <u>Chlorine Dioxide</u>

Type	solution feed
Average Dosage	1.0 mg/l
Expansion Requirements	Minor equipment upgrades

SECTION VII - NEW CENTRALIZED SURFACE WATER PLANT

LOCATION CRITERIA

The location of a new centralized surface water plant was evaluated based on the addition of the two potential customers on the east side of the TCRWSS service area and the benefit gained by the addition of a second pressure distribution point to the system. Two potential locations were identified, one south of Sebastopol and the second along FM 356 at White Rock Creek. The locations of the two potential sites are shown on *Exhibit 6*.

Pertinent topographic information for the potential raw water pump station and the proposed treatment plant sites as shown on *Exhibit 6* is as follows:

- Trinity River Normal Water Surface Elevation = 131 ft.
- Proposed RW Pump Station Site Elevation = 150 ft.
- Proposed Water Plant Site Elevation = 200 ft.
- Alternate RW Pump Station Site Elevation = 150 ft.
- Alternate Water Plant Site Elevation = 170 ft.

RAW WATER SUPPLY FACILITIES

A new raw water supply facility similar to the station proposed under the Trinity plant expansion would be required. Due to site elevations, the White Rock Creek station would be similar in operating head to the station proposed at the Trinity plant. The Sebastopol station would require a higher head pump to accommodate the higher plant elevation.

A submerged water intake piped to a raw water pump station on the adjacent bank is preferred over a floating pump station or in-river structure. The water intake would be located several feet below the lowest expected water level and protected by a trash screen. Multiple intake points at various levels may be required and should be evaluated in the design phase. The pump station would consist of a reinforced concrete sump with submersible pumps. Ancillary items would include an access road, electrical service and controls. A 16-inch-diameter raw water pipeline would be constructed across country to the plant. A waterline easement would be required for the raw water line.

SURFACE WATER TREATMENT SYSTEM

A system similar to the Trinity plant expansion is proposed for the new plant. The surface water facility would generally consist of raw water flow measurement and control; chemical addition and in-line mixing; flocculation and sedimentation occurring in the proposed clarifier basin; additional chemical treatment, as required, following sedimentation; filtration; disinfection; and transfer to storage in the existing clearwell. Raw sludge from the clarifier and backwash wastewater solids would be pumped to lagoons for decanting and long term storage prior to disposal. The flow diagram for the upgraded plant is similar to the Trinity Plant expansion alternative as shown in *Exhibit 4*, except there are no existing facilities. Component sizing criteria are presented in *Table VII-1* located at the end of this section.

Given the relatively small size of the TCRWSS plant, pre-engineered treatment equipment is the most economical approach for the clarifier and filter units for this facility. Two water treatment equipment manufacturers (Infilco-Degremont Inc. (IDI) and US Filter) were contacted through local representatives for recommendations and budget estimates for clarification and filtration equipment for the TCRWSS upgrade. The responses from IDI and US Filter were similar in concept, configuration, and cost of the equipment and were used as the basis for site layout and probable construction costs. Both manufacturers offer circular, solids-contact type clarifiers with flocculation and settling zones combined in one basin. Two reactor clarifier costs have been obtained from the manufacturers. One for welded steel tanks, including equipment, and the second for equipment only. For the second condition of equipment only, concrete basins will be constructed for each unit. The cost of concrete basins is included in the cost estimate presented in Section VIII.

Filtration facilities would consist of multi-cell, dual media units with concrete basins. Two backwash pumps would be required, with piping and valving provided to take water from the clearwell and discharge to the backwash system at the new filters. Backwash wastewater would be piped from the filters to a backwash settling basin. The settling basin would allow variable decant and recycle of clarified backwash water. A backwash wastewater transfer pump would pump settled solids from the basin sump to new sludge lagoons.

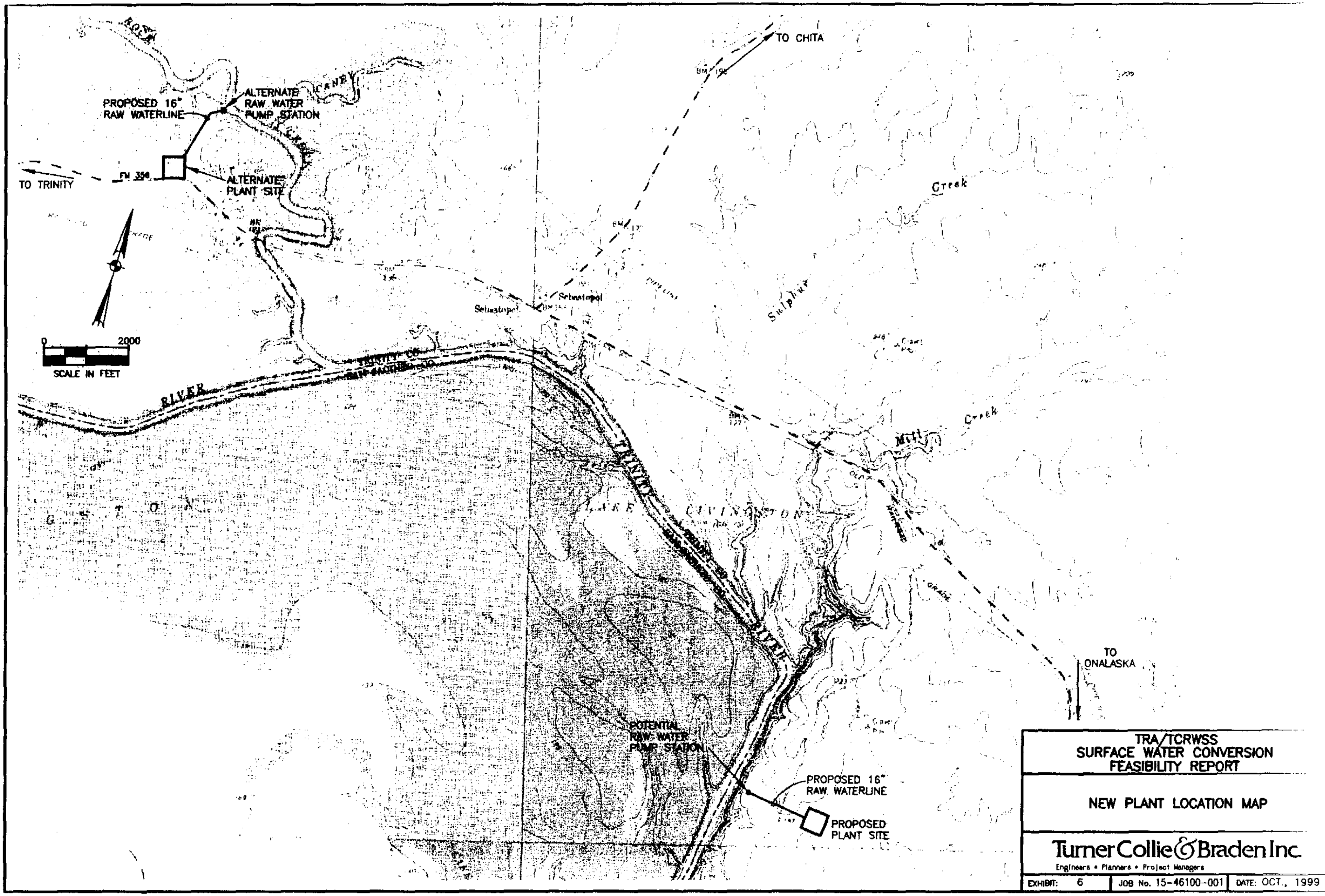
Treatment of surface water will require the addition of several chemicals not currently used at the TCRWSS plant, including alum and polymer for coagulation, lime for alkalinity adjustment, carbon for taste and order, and chlorine dioxide. New chemical metering pumps and storage tanks would be required for the surface water train.

Each of the new chemicals require storage facilities and feed equipment, the latter preferably located indoors for protection from the elements. A new chemical building is planned. In addition to the new chemical feed systems, the building would house the plant electrical and motor control equipment. Outdoor chemical storage tanks would be located adjacent to the plant roadway to facilitate truck unloading.

Jar tests and/or a pilot study of the clarifier and filter units may be necessary to obtain information for final design.

FINISHED WATER STORAGE AND PUMPING FACILITIES

A new clearwell and high service pump station would be required with the new plant. A 500,000 gallon concrete clearwell is proposed with a 3.5 mgd high service pump station. Either vertical



TRA/TCRWSS
SURFACE WATER CONVERSION
FEASIBILITY REPORT

NEW PLANT LOCATION MAP

Turner Collie & Braden Inc.
Engineers • Planners • Project Managers

EXHIBIT: 6	JOB No. 15-46100-001	DATE: OCT., 1999

turbine or horizontal split case pumps would be used for high service. The selection would be made during final design based on the required discharge pressure of the plant.

SLUDGE HANDLING FACILITIES

New sludge facilities would be required for the plant. Raw sludge from the clarifier and settled solids from the backwash settling basin would be pumped to new lagoons for water volume reduction and storage. Two lagoons of earthen dike construction would be provided, with an area of about 0.6 acres each. Each lagoon would be fitted with inlet feed and takeoff piping, the latter consisting of a "swing joint" or similar device for variable level decanting. The decant or supernatant from the lagoons would flow to a sump for subsequent pumped recycle to the beginning of the surface water treatment train. Operation of the lagoons would alternate with one lagoon in continuous operation until filled when the second lagoon would be placed into service. Disposal of lagoon sludge would be on a contract basis, as has been the practice at the Huntsville plant.

TABLE VII-1

FACILITIES DESIGN SUMMARY
NEW CENTRALIZED SURFACE WATER PLANT

1.	Plant Capacity	
	Design	3.5 mgd/2,431 gpm
	Maximum Hydraulic Capacity	5.0 mgd/3,472 gpm
2.	Raw Water Pump Station	
	Number of Pumps	3
	Rated Capacity, each	1,225 gpm
	Station Capacity, firm	2450 gpm/3.5mgd
	Pipeline to Plant	16 inch
3.	Clarifier	
	Type	Reactor Clarifier
	Number of Units	2
	Total Detention Time	2.9 hours
	Net Surface Area	1,859 square feet
	Rise Rate	0.93 gpm/s.f.
	Reaction Zone Detention Time	60 minutes
4.	Filters	
	Type	Dual Media
	Number of Cells	4
	Total Surface Area	808 s.f.
	Filter Rate	3.0 gpm/s.f.
5.	Clearwell	
	Size	500,000 gallons
6.	Filter Backwash Pumps	
	Backwash Rate	20 gpm/s.f.
	Pump Rate	As required by mfr.
7.	Clarifier Sludge Transfer Pumps	
	Average Sludge Production	17,500 gpd
	Maximum Sludge Production	35,000 gpd
	Number of Pumps	2
	Rated Capacity, each	300 gpm

8. Sludge Lagoons

Number of Lagoons	2
Volume per Lagoon	958,000 gallons

9. Supernatant Recycle Pumps

Maximum Supernatant Return	60,000 gpd
Number of pumps	2
Rated Capacity, each	80 gpm

10. Water Distribution Pumps

Number of Pumps	3
Rated Capacity	1,215 gpm
HSPS Capacity, firm	2430 gpm/3.5 mgd

11. Alum Feed System

Type	48% solution
Average Dosage	75 mg/l
Number of Pumps	2
Pump Rate	1-100 gph
Storage Tank Volume	20,000 gallons/30 days

12. Caustic Feed System

Type	50% solution
Average Dosage	50 mg/l
Number of Pumps	2
Pump Rate	1-65 gph
Storage Tank Volume	7,500 gallons/30 days

13. Coagulant Aid Polymer Feed System

Type	liquid, cationic
Average Dosage	2 mg/l
Number of Feed Units	2
Polymer Feed Rate	0.04-1.2 gph
Storage Drums	55 gallons

14. Filter Aid Polymer Feed System

Type	liquid, anionic
Average Dosage	1.5 mg/l
Number of Feed Units	2
Polymer Feed Rate	0.04-1.0 gph
Storage Drums	55 gallons

15. Activated Carbon Feed System

Type	dry powder
Maximum Dosage	10 mg/l
Day Tank Capacity	2 @ 500 gallons each
Number of Pumps	2
Pump Rate	1-100 gph

16. Ammonia Feed System

Type	aqueous, 28% solution
Average Dosage	0.7 mg/l
Number of Pumps	2
Pump Rate	0.05 – 3 gph
Storage Tank	500 gallons/30 days

17. Lime Feed System

Type	dry powder
Average Usage	160 lbs/day
Day Tank Capacity	200 gallons
Number of Pumps	2
Pump Rate	0-25 gph

18. Ferrous Chloride Feed System

Type	agueous, 39% solution
Average Dosage	20 mg/l
Number of Pumps	2
Pump Rate	0-15 gph
Storage Tank	7,500 gallons/30 days

19. Chlorine

Type	gas supply, solution feed
Average Dosage	1.0 mg/l
Maximum Usage	170 lbs/day

20. Chlorine Dioxide

Type	solution feed
Average Dosage	2.0 mg/l
Maximum Usage	85 lbs/day

SECTION VIII – FACILITY COSTS

PROBABLE CAPITAL COST ESTIMATES

This section presents the probable capital cost estimates for the three expansion alternatives based on conventional treatment. The capital cost estimates include engineering, land acquisition, administrative costs, and facility construction plus a 20 percent contingency. The engineering costs include surveying, geotechnical investigations, preliminary engineering, and final design. Estimated land acquisition costs were assumed to be $10,000 per acre. Construction costs were developed using bid tabulations for similar projects, equipment manufacturer's budget estimates, and conceptual estimating based on unit prices obtained from RS Means, 1999.

The probable capital cost estimate for a 3.5 mgd surface water plant addition at the existing Trinity plant is presented in *Table VIII-1*. The estimated project cost is $6,760,000 or $1.93 per gallon. If the plant capacity is increased to 4.1 mgd to service the two new potential customers, then the estimated project cost is $7,900,000.

The probable capital cost estimate for a 3.5 mgd expansion of the HRWSS plant and extension of the FM 980 transmission pipeline is presented in *Table VIII-2*. The estimated project cost is $11,283,000 or $3.22 per gallon

The probable capital cost estimate for a new 3.5 mgd centralized surface water plant is presented in *Table VIII-3*. The estimated project cost is $7,754,000 or $2.22 per gallon. If the plant capacity is increased to 4.1 mgd to service the two new potential customers, then the estimated project cost is $9,100,000.

ANTICIPATED FINISHED WATER COSTS

The TRA operates two surface water plants in the Lake Livingston area, the HRWSS plant and the Livingston Regional Water Supply System (LRWSS) plant. The current finished water costs for the plants are $1.37/1000 gallons and $1.88/1000 gallons, respectively. Although the raw water quality at the Trinity plant location is expected to be similar to the raw water quality experienced at the HRWSS plant, the Trinity plant would be smaller and the high service pumps would operate at a higher pressure requiring additional power. The anticipated finished water costs for the new Trinity plant are expected to be similar to the costs experienced at the LRWSS plant.

TRANSMISSION SYSTEM COSTS

In addition to the cost for a plant expansion or a new plant, there may be costs for improvements to the finished water transmission system to convey the increased water capacity required by the expansion from the plant to the customers. The transmission system improvements for the Trinity and HRWSS expansion alternatives would be the same. The transmission system improvements for a new plant in the Sebastopol area may be more extensive than the improvements for the Trinity plant since the new location is at the end of the current system where the line sizes are the smallest.

An evaluation of the transmission system was not included in the current scope of work. The transmission system requirements will require evaluation in subsequent phases of the project.

PROBABLE MEMBRANE SYSTEM COSTS

The option of using a membrane treatment system was discussed in Section IV. Based on the raw water quality in the Trinity River at the Lake Livingston area, a membrane system is a viable option. Based on manufacturer's budget cost data provided by IDI and US Filter, the equipment membrane component of the plant would be approximately $3,500,000. Based on a review of Trinity River water by two membrane manufacturers, improvement of the raw water quality would be required prior to feeding the membranes. However, since no data is currently available on the specific improvements required for the raw water, an allowance for chemical additions was the only process included in the cost for the membrane system. The probable capital cost of a membrane system is estimated to be in the order of $7,000,000 to $8,000,000. For this option a minimum three month pilot study is recommended to provide information necessary for a full scale design.

TABLE VIII - 1
PROBABLE CAPITAL COST ESTIMATE
3.5 MGD EXPANSION OF THE TRINITY PLANT

DESCRIPTION	ESTIMATED COST
Raw Water Intake and Pump Station	$700,000
Raw Water Pipeline	$145,000
Clarifier	$820,000
Filter	$855,000
Sludge Handling Facilities	$100,000
Chemical Systems	$925,000
Finished Water Distribution	$130,000
Electrical and Instrumentation/Controls	$500,000
Sitework/Miscellaneous	$550,000
Subtotal Project Cost	$4,725,000
Contingency (20 percent)	$945,000
Engineering	$850,000
Land Acquisition	$45,000
Total Capital Cost	$6,565,000
Legal and Administrative Fees (3 percent)	$195,000
TOTAL PROJECT COST	$6,760,000

TABLE VIII - 2
PROBABLE CAPITAL COST ESTIMATE
3.5 MGD EXPANSION OF THE HRWSS PLANT

DESCRIPTION	ESTIMATED COST
Raw Water Pump Station	$92,000
Raw Water Pipeline	$1,656,000
Clarifier	$785,000
Filter	$855,000
Sludge Handling Facilities	$0
Chemical Systems	$175,000
Finished Water Distribution	$368,000
Electrical and Instrumentation/Controls	$100,000
Sitework/Miscellaneous	$240,000
Subtotal Plant Project Cost	$4,271.000
FM 980 Pipeline Extension	$3,670,000
Subtotal Project Cost	$7,941,000
Contingency (20 percent)	$1,588,000
Engineering	$1,429,000
Land Acquisition	$0
Total Capital Cost	$10,958,000
Legal and Administrative Fees (3 percent)	$325,000
TOTAL PROJECT COST	$11,283,000

TABLE VIII - 3
PROBABLE CAPITAL COST ESTIMATE
3.5 MGD NEW CENTALIZED SURFACE WATER PLANT

DESCRIPTION	ESTIMATED COST
Raw Water Intake and Pump Station	$755,000
Raw Water Pipeline	$135,000
Clarifier	$820,000
Filter	$855,000
Sludge Handling Facilities	$100,000
Chemical Systems	$925,000
Finished Water Distribution	$775,000
Electrical and Instrumentation/Controls	$500,000
Sitework/Miscellaneous	$550,000
Subtotal Project Cost	$5,415,000
Contingency (20 percent)	$1,083,800
Engineering	$975,000
Land Acquisition	$55,000
Total Capital Cost	$7,528,800
Legal and Administrative Fees (3 percent)	$226,000
TOTAL PROJECT COST	$7,754,000

SECTION IX – CONCLUSIONS AND RECOMMENDATIONS

Based on the probable capital cost estimates presented in Section VIII for the three alternatives, the HRWSS plant expansion and pipeline extension alternative is not considered a viable alternative due to the high construction cost. The costs for a raw water pipeline addition and the approximate six mile extension of the transmission line from the Ellis Unit to the Trinity plant are the primary components contributing to the higher cost for this alternative.

The capitol costs for the other two alternatives are fairly similar. The size of the two facilities and the treatment equipment would be approximately the same for either location. The raw water quality in the Sebastopol areas may be better than the Trinity location since turbidity levels are reported to be lower on the east side of the lake. It is expected that the distribution system improvements would be more costly for a Sebastopol location than a Trinity location. The major advantage to the Sebastopol location would be providing service to the two potential new customers. It would also provide a second pressure distribution point for the system which would improve overall system operation.

For the service condition of providing a 3.5 mgd plant to supply the six existing customers, an expansion of the existing Trinity plant is recommended. Note that this alternative may require improvements to the distribution system and those costs are not addressed in this study.

For the service condition of providing a 4.1 mgd plant to supply the six existing customers and the two potential new customers, a new centralized plant in the Sebastopol area is recommended. Note that this alternative will require improvements to the distribution system and those costs are not addressed in this study.

APPENDIX A

WATER DEMAND PROJECTIONS

Water Supply and Distribution Pumpage Analysis
Customer **City of Trinity**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	1665	1672	1680	1705	1740
% Increase in Conn/Year		0.420	0.478	1.488	2.053
Customer Requested Growth Projection					0.80%
Projected Increase in Connections 2000 - 2010					159
Total Projected Connections Year 2010					1899

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	1.11%
98	225
1838	1965

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	1740	517	1044	527
2010	1899	517	1140	623

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	1740	1300	3480	2180
2010	1899	1300	3799	2499

Water Supply and Distribution Pumpage Analysis
Customer **Trinity Rural Water Supply Corporation**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	825	900	1093	1094	1120
% Increase in Conn/Year		9.091	21.444	0.091	2.377
Customer Requested Growth Projection					4.00%
Projected Increase in Connections 2000 - 2010					604
Total Projected Connections Year 2010					1724

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	8.25%
63	1559
1183	2679

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	1120	180	672	492
2010	1724	180	1035	855

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	1120	420	2240	1820
2010	1724	420	3448	3028

Water Supply and Distribution Pumpage Analysis
Customer **Glendale Water Supply Corporation**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	280	290	299	304	310
% Increase in Conn/Year		3.571	3.103	1.672	1.974
Customer Requested Growth Projection					2.58%
Projected Increase in Connections 2000 - 2010					100
Total Projected Connections Year 2010					410

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	2.58%
17	100
327	410

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	310	189	186	-3
2010	410	189	246	57

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	310	900	620	-280
2010	410	900	821	-79

Water Supply and Distribution Pumpage Analysis
Customer **City of Groveton**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	514	536	547	562	569
% Increase in Conn/Year		4.280	2.052	2.742	1.246
Customer Requested Growth Projection					0.50%
Projected Increase in Connections 2000 - 2010					32
Total Projected Connections Year 2010					601

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	2.58%
32	184
601	753

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	569	0	341	341
2010	601	0	361	361

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	569	0	1138	1138
2010	601	0	1202	1202

Water Supply and Distribution Pumpage Analysis
Customer **Westwood Shores MUD**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	527	544	564	588	604
% Increase in Conn/Year		3.226	3.676	4.255	2.721
Customer Requested Growth Projection					4.20%
Projected Increase in Connections 2000 - 2010					346
Total Projected Connections Year 2010					950

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	3.47%
34	275
638	879

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	604	80	362	282
2010	950	80	570	490

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	604	1000	1208	208
2010	950	1000	1899	899

Water Supply and Distribution Pumpage Analysis
Customer **Riverside Water Supply Corporation**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	no data	1317	1354	1421	1456
% Increase in Conn/Year			2.809	4.948	2.463
Customer Requested Growth Projection					3.41%
Projected Increase in Connections 2000 - 2010					649
Total Projected Connections Year 2010					2105

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.90%	3.41%
151	649
1607	2105

Water Supply Requirements

Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	1456	904	874	-30
2010	2105	904	1263	359

Water Pumpage Requirements

Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	1456	880	2912	2032
2010	2105	880	4211	3331

Water Supply and Distribution Pumpage Analysis
Customer **Lake Livingston Water and Sewer Service Corporation**
TNRCC Supply Requirement: 0.6 gal per min per connection (total)
TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	530	508	592	525	424
% Increase in Conn/Year		-4.151	16.535	-11.318	-19.238
Customer Requested Growth Projection					2.00%
Projected Increase in Connections 2000 - 2010					103
Total Projected Connections Year 2010					527

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
0.50%	-4.54%
24	-170
448	254

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	424	0	254	254
2010	527	0	316	316

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	424	750	848	98
2010	527	750	1054	304

Water Supply and Distribution Pumpage Analysis

Customer **Onalaska Water Supply**

TNRCC Supply Requirement: 0.6 gal per min per connection (total)

TNRCC Pumpage Requirement: 2.0 gal per min per connection (total)

Connections Served					
Year	1995	1996	1997	1998	1999
Connections	1180	1220	1270	1288	1320
% Increase in Conn/Year		3.390	4.098	1.417	2.484
Customer Requested Growth Projection					1.00%
Projected Increase in Connections 2000 - 2010					153
Total Projected Connections Year 2010					1473

For Reference Only	
TWDB Growth Projection	Questionnaire Growth Projection
1.10%	2.85%
169	478
1489	1798

Water Supply Requirements				
Year	Number Conn	Current Supply By Customer (gpm)	TNRCC .6 gpm per conn	Customer Shortfall -- TCRWSS Provides (gpm)
1999	1320	737	792	55
2010	1473	737	884	147

Water Pumpage Requirements				
Year	Number Conn	Current Pumpage By Customer (gpm)	TNRCC 2.0 gpm per conn	Customer Shortfall -- Customer Provides (gpm)
1999	1320	840	2640	1800
2010	1473	840	2945	2105

APPENDIX B

SDWA REGULATIONS SUMMARY

Safe Drinking Water Act Regulations Summary

Regulations	Maximum Contaminant Level Goal (MCLG), mg/L	Maximum Contaminant Level (MCL), mg/L	Monitoring Requirements	Notes
Stage 1 Disinfectants and Disinfection Byproducts Rule				Compliance schedule: December 2001 for public water systems (PWSs) serving more than 10,000; December 2003 for PWSs serving less than 10,000.
Disinfectants				
Chlorine	maximum residual disinfectant level goal (MRDLG) - 4	maximum residual disinfectant level (MRDL) - 4	Chlorine/Chloramines - monitor at the same sample locations as the Total Coliform Rule. Compliance based on running annual arithmetic average of monthly averages.	
Chloramines	MRDLG - 4	MRDL - 4		
Chlorine Dioxide	MRDLG - 0.8	MRDL - 0.8	Chlorine Dioxide and Chlorite daily sample at distribution system entry point	
Disinfection By-products				
Trihalomethanes				
Chloroform	0	-		
Bromodichloromethane	0	-		
Dibromochloromethane	0.06	-		
Bromoform	0	-		
Total trihalomethanes (TTHM's)	-	0.080	TTHM and HAA5 - four quarterly samples. Compliance based on running annual average.	
Haloacetic Acids				
Dichloroacetic acid	0	-		

Safe Drinking Water Act Regulations Summary

Trichloroacetic acid	0.3	-		
Total haloacetic acids plus monochloroacetic acid and mono- and dibromoacetic acids (HAA5)	-	0.060	Same as TTHM.	
Bromate	0	0.010	One sample per month (ozone systems only) and running annual average.	
Chlorite	0.8	1.0	Same as chlorine dioxide.	
Total Organic Carbon	-	Treatment technique	Source and treated water TOC samples once per month.	The removal of TOC to reduce the formation of DBPs is achieved by the treatment technique of enhanced coagulation or enhanced softening that specifies the percentage of influent TOC that must be removed based on the raw water TOC and alkalinity levels.

Safe Drinking Water Act Regulations Summary

Interim Enhanced Surface Water Treatment Rule				Applicable only to surface water or ground water under the direct influence (GWUDI) of surface water systems that serve 10,000 or more people.
Cryptosporidium	0	99% removal required for systems with filters		
Turbidity	N/A	At no time can turbidity go above 5 nephelolometric turbidity units (NTU). Systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month.	Conventional and direct filtration systems must measure combined filter effluent turbidity at least every four hours and continuously monitor turbidity of each individual filter.	
Surface Water Treatment Rule				
Giardia lamblia	0	99.9% removal/inactivation	For turbidity, grab samples at least every four hours or continuous monitoring. Continuous chlorine residual required for systems >3,300. One to four grab samples per day are allowed for systems <3,300.	Must maintain a disinfectant residual greater than 0.2 mg/L entering the distribution system and a detectable level throughout the distribution system.
Enteric viruses	0	99.99% removal/inactivation		
Legionella	0	no limit		
Heterotrophic Plate Count	N/A	No more than 500 bacterial colonies per milliliter		
Turbidity	N/A	At no time can turbidity go above 5 nephelolometric turbidity units (NTU). Systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month.		

Safe Drinking Water Act Regulations Summary

Total Coliform Rule				
Total coliforms	0	No more than 5% samples total coliform-positive in a month[1]	For both surface waters and groundwaters, the total number and location of samples is based on the population served and a system-specific sampling plan.	
Fecal coliforms	0	Every sample that has total coliforms must be analyzed for fecal coliforms. There cannot be any fecal coliforms.		
E. Coli	0	-		
Lead	0	Action Level[2] = 0.015	For lead and copper, after corrosion controls are initiated or optimized, follow-up monitoring is every six months. Systems that continuously meet the Action Levels can reduce monitoring to annually and then to every three years.	All systems exceeding either the lead or copper Action Levels must provide corrosion control treatment and public education. Systems > 50,000 must optimize corrosion control.
Copper	1.3	Action Level[2] = 1.3		
Inorganic Chemicals[3]				
Organic Chemicals[3]				
Radionuclides[3]				
Information Collection Rule[3]				

1 For water systems that collect fewer than 40 routine samples per month, no more than one sample can be total coliform-positive.

2 For lead and copper, the Action Level cannot be exceeded in more than 10% of the tap water samples.

3 See Additional Safe Drinking Water Act Regulations table.

Additional Safe Drinking Water Act Regulations

Regulations	Maximum Contaminant Level Goal (MCLG), mg/L	Maximum Contaminant Level (MCL), mg/L	Monitoring Requirements	Notes
Inorganic Chemicals			Once per year for surface waters. Once every three years for groundwater for IOC's, not including Asbestos, Lead and Copper, Nitrate, Nitrite, and Radionuclides.	
Antimony	0.006	0.006		
Arsenic	none	0.05		
Asbestos (fiber > 10μm)	7 million fibers per liter	7 MFL	Once every nine years.	
Barium	2.0	2.0		
Beryllium	0.004	0.004		
Cadmium	0.005	0.005		
Chromium (total)	0.1	0.1		
Copper	1.3	Action Level = 1.3	Same as lead.	
Cyanide (as free cyanide)	0.2	0.2		
Fluoride	4.0	4.0		
Lead	zero	Action Level = 0.015	After corrosion controls are initiated or optimized, follow-up monitoring is every six months. Systems that continuously meet the Action Levels can reduce monitoring to annually and then to every three years.	All systems exceeding either the lead or copper Action Levels must provide corrosion control treatment and public education. Systems > 50,000 must optimize corrosion control.
Inorganic mercury	0.002	0.002		
Nickel	-	0.1		
Nitrate (measured as nitrogen)	10.0	10.0	Groundwater annually; Surface water quarterly.	
Nitrite (measured as nitrogen)	1.0	1.0	One sample every three years.	
Selenium	0.05	0.05		
Thallium	0.0005	0.002		

Additional Safe Drinking Water Act Regulations

Organic Chemicals				
Acrylamide	zero	See note 1 below	For synthetic organic compounds: monitoring requirements are four quarterly samples every three years. After one round of no detects, systems >3,300 reduce to two samples per year every three years. While systems <= 3,300 reduce to one sample every three years. Monitoring may be reduced or eliminated based upon results of a vulnerability assessment.	
Alachlor	zero	0.002		
Aldicarb	-	0.003		
Aldicarb Sulfone	-	0.003		
Aldicarb Sulfoxide	-	0.004		
Atrazine	0.003	0.003		
Benzene	zero	0.005		
Benzo(a)pyrene	zero	0.0002		
Carbofuran	0.04	0.04		
Carbon Tetrachloride	zero	0.005		
Chlordane	zero	0.002		
Chlorobenzene	0.1	0.1		
2,4-D	0.07	0.07		
Dalapon	0.2	0.2		
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002		
o-Dichlorobenzene	0.6	0.6		
p-Dichlorobenzene	0.075	0.075	For volatile organic compounds: monitoring requirements are four quarterly samples during the first three years. If there are no detects, then monitoring reduces to once per year. After three years of no detects, monitoring decreases to once every three years. Monitoring may be reduced based upon the results of a vulnerability assessment.	
1,2-Dichloroethane	zero	0.005		
1,1-Dichloroethylene	0.007	0.007		
cis-1,2-Dichloroethylene	0.07	0.07		
trans-1,2-Dichloroethylene	0.1	0.1		
Dichloromethane	zero	0.005		
1,2-Dichloropropane	zero	0.005		
Di(2-ethylhexyl)adipate	0.4	0.4		
Di(2-ethylhexyl)phthalate	zero	0.006		
Dinoseb	0.007	0.007		
Dioxin (2,3,7,8 -TCDD)	zero	0.00000003		
Diquat	0.02	0.02		
Endothall	0.1	0.1		
Endrin	0.002	0.002		
Epichlorohydrin	zero	See note 1 below		
Ethylbenzene	0.7	0.7		
Ethylene Dibromide	zero	0.00005		

Additional Safe Drinking Water Act Regulations

Glyphosate	0.7	0.7		
Heptachlor	zero	0.0004		
Heptachlor Epoxide	zero	0.0002		
Hexachlorobenzene	zero	0.001		
Hexachlorocyclopentadiene	0.05	0.05		
Lindane	0.0002	0.0002		
Methoxychlor	0.04	0.04		
Oxamyl (Vydate)	0.2	0.2		
Polychlorinated Biphenyls (PCBs)	zero	0.0005		
Pentachlorophenol	zero	0.001		
Picloram	0.5	0.5		
Simazine	0.004	0.004		
Styrene	0.1	0.1		
Tetrachloroethylene	zero	0.005		
Toluene	1.0	1.0		
Total Trihalomethanes (TTHM)	none	0.08		
Toxaphene	zero	0.003		
2,4,5-TP (Silvex)	0.05	0.05		
1,2,4-Trichlorobenzene	0.07	0.07		
1,1,1-Trichloroethane	0.20	0.2		
1,1,2-Trichloroethane	0.003	0.005		
Trichloroethylene	zero	0.005		
Vinyl Chloride	zero	0.002		
Xylenes (total)	10.0	10.0		

Additional Safe Drinking Water Act Regulations

Radionuclides				
Beta particles and photon emitters	none	4 millirems per year	Every four years - quarterly samples.	
Gross alpha particle activity	none	15 picocuries per liter (pCi/L)	Every four years - quarterly samples.	
Radium 226 and Radium 228 (combined)	none	5 pCi/L	Every four years - quarterly samples.	
Information Collection Rule				
Disinfectant residuals, trihalomethanes, haloacetic acids, haloacetonitriles, haloketones, chloral hydrate, chlorite, chlorate, bromide, bromate, total organic halides (TOX), total organic carbon (TOC), viruses, coliforms, Giardia, Cryptosporidium.	-	-	Applicable to: public water systems using surface water to monitor monthly for 18 months for both disinfection by-products (DBPs) and microbials (pop. >= 100,000); public water systems using groundwater to monitor monthly for 18 months for only DBPs (pop.>=100,000); public water systems using groundwater to perform treatment studies (pop. 50,000 to < 100,000).	The Information Collection Rule requires certain PWSs to gather D/DBP and microbial information from their treatment processes. The information collected will be sent directly to the USEPA and will become the basis for future regulations.
Consumer Confidence Reports (CCR) Rule				
Requires public water systems to prepare and distribute CCR to their customers annually.	-	-		

1 Each water system must certify, in writing, to the state (using third party or manufacturer's certification) that when acrylamide and epichlorohydrin are used in drinking water systems, the combination (or product) of dose and monomer level does not exceed the levels specified, as follows:

Acrylamide = 0.05% dosed at 1 mg/L (or equivalent)
Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent)

APPENDIX C

WATER TRANSMISSION SYSTEM EVALUATION

Turner Collie & Braden Inc.
Engineers • Planners • Project Managers

P.O. Box 130089
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713 780-4100
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March 15, 2000

Mr. Jim Sims, P.E.
Regional Manager
Trinity River Authority of Texas
1117 10th Street
Huntsville, Texas 77342

Re: **Trinity County Regional Water Supply System**
Surface Water Conversion and Service Area Expansion
TC&B Project No. 15-46100-001

Subject: **Transmission System Analysis**
TC&B Project No. 15-46100-002

Dear Mr. Sims:

This letter summarizes the results of the transmission system analysis that was authorized on December 6, 1999 as an additional work task associated with the above-referenced project. The purpose of the analysis was to identify the requirements for an expanded water transmission system that would supply the 2010 demands identified in the referenced report.

The methodology followed in the analysis is as follows:

- Develop a model that simulates the existing TCRWSS transmission system and pressure/flow conditions. The purpose of this simulation is to confirm that the model is accurate.

- Modify the existing system model to evaluate the expansion alternatives.

- Perform steady-state models of the expansion alternatives that address 2010 customer demands for the six current customers and potential customers. Of the two potential customers discussed in the referenced report, only Lake Livingston WSSC was included in the analysis. Onalaska was assumed to not be joining the TCRWSS for modeling purposes at this time.

- Perform steady stated runs to identify 2010 pump station and transmission system improvements for each alternative.

- A service pressure of 10 psi was established at the top of the customer's tank to allow for the customer's on-site piping losses.

The analysis of the transmission system addresses five scenarios as follows.

- Current Conditions: The Current Condition scenario simulates the existing system configuration (pipe diameters and lengths, pump ratings, pressure regulator settings) and the current actual demands as obtained from TCRWSS.

- Alternative 1 models the Surface Water Plant Addition at Trinity Plant for the six existing customers for 2010 demands presented in the referenced report.

- Alternative 1A models the Surface Water Plant Addition at Trinity Plant for the six existing customers and the addition of Lake Livingston WSSC at Oakridge II for the 2010 demands presented in the referenced report.

- Alternative 2 models the New Centralized Surface Water plant at Sebastopol with the Trinity Plant remaining in service for the six existing customers for the 2010 demands presented in the referenced report.

- Alternative 2A models the New Centralized Surface Water plant at Sebastopol with the Trinity Plant remaining in service for the six existing customers and the addition of Lake Livingston WSSC at Oakridge II for the 2010 demands presented in the referenced report.

The analyses were performed using the PIPE2000 computer model. The Hazen-Williams C factors used for the transmission lines are presented in Table 1.

Table 1 - Hazen-Williams C Factors

Line Size and Condition	Hazen-Williams C Factor
3", 6", 8" old and new	120
10" old and new	110
16" old pipe	130
16", 18", 20", 24" new pipe	140

The demands and elevations at each customer are presented in Table 2. The demands for the current condition are based on information received from TCRWSS. Demands for the 2010 alternatives are based on Table III-1, Summary of TCRWSS Water Supply Requirements And Customer Pumpage Requirements, as presented in the referenced report.

Table 2 - System Elevations and Demands

Customer	Elevation (top of the tank) (ft)	Demand – Current Condition (gpm)	Alternatives 1 & 2 Demand – 2010 Condition (gpm)	Alternatives 1A & 2A Demand - 2010 Condition (gpm)
Riverside	254	21	359	359
City of Trinity	348	283	623	623
Glendale	347	21	57	57
City of Groveton	340	174	361	361
Chita (Trinity Rural)	421	44	359	359
Oakridge I (Lake Livingston WSSC)	164	71 (1)	0	0
Oakridge II (Lake Livingston WSSC)	224	N/A	0	316
Westwood Shores MUD	195	104	490	490
Lake L Acres (Trinity Rural)	409	60	496	496
Onalaska	Not Included	0	0	0
Total Demand		778 (1.1 mgd)	2745 (3.95 mgd)	3061 (4.4 mgd)

(1) Currently part of the City of Trinity's allocation.

Summary of Current Conditions Model

The line size diameters, pump operating points, and the pressure regulating settings were obtained form the system design plans prepared by Turner Collie & Braden Inc. in 1981 (job number 7188-002) and supplemental data obtained from the TCRWSS. A summary of the pipe sizes and Pressure Regulating Valve (PRV) settings is presented in Table 3.

Table 3 – Current Line Sizes and PRV Settings

Customer	Pipe Diameter (in)	PRV Settings (psi)
Riverside	6	81
City of Trinity	16	N/A
Glendale	12	94
City of Groveton	12	N/A
Chita (Trinity Rural)	6	N/A
Oakridge I (Lake Livingston WSSC)	3	80
Westwood Shores MUD	8	84
Lake L Acres (Trinity Rural)	6	N/A
Trinity Water Treatment Plant	16	158

The Current Condition flows to each customer are presented in Table 2. Based on the current high service pumps (HSP) #1 (three stages) and HSP #2 (six stages) operating and the system PRV settings, the resultant pressures at the customer facilities are presented in Table 4 and shown on the attached system schematic drawing. The pressures are at the top of the tank and generally represent the pressures experienced by TCRWSS confirming the accuracy of the model.

Table 4 – Current Condition Model Results

Customer	Pressure Results (psi)
Riverside	32.9
City of Trinity	64.5
Glendale	52.3
City of Groveton	52.3
Chita (Trinity Rural)	27.4
Oakridge I (Lake Livingston WSSC)	70.8
Westwood Shores MUD	78.5
Lake L Acres (Trinity Rural)	35.5
Trinity Water Treatment Plant	179.4

Summary of Alternative 1 – Surface Water Plant Addition at Trinity Plant

Alternative 1 addresses the 2010 demands shown in Table 2. The 2010 total demand is 2744 gpm for the six existing customers. Lake Livingston WSSC (Oakridge) is not included as a customer of the City of Trinity in this alternative. Since the total pumping capacity at the existing Trinity Plant is 1750 gpm, an additional pumping unit is required to meet demands. The model includes two HSP #1 (three stages) and three HSP #2 (six stages), for a total capacity of 2800 gpm. To supply water at an adequate pressure at Chita, an upgrade of the pump operating head was required as follows:

HSP #1: three stages, operating point: 350 gpm @ 407 ft.
HSP #2: six stages, operating point: 700 gpm @ 438 ft.

In order to achieve a pressure of at least 10 psi at each customer, some increases in the transmission line sizes were required. The upgraded line sizes and the revised pressure regulator settings, as well as the resultant system pressure readings at each customer are presented in Table 5 and shown on the attached system schematic drawing.

Table 5 – Alternative 1 Model Results

Customer	PRV Settings (psi)	Pressure Results (psi)
Riverside	134	9.4
City of Trinity	N/A	53.9
Glendale	63	18.9
City of Groveton	N/A	10.4
Chita (Trinity Rural)	N/A	15.9
Oakridge II (LLWSSC)	Included in 1A	Included in 1A
Westwood Shores MUD	35	9.5
Lake L Acres (Trinity Rural)	N/A	15.2
Trinity Water Treatment Plant	185	185.9

Summary of Alternative 1A – Surface Water Plant Addition at Trinity Plant

Alternative 1A addresses the 2010 demands shown in Table 2 for the six existing customers and Lake Livingston WSSC. The 2010 total demand is 2744 gpm for the six existing customers and 316 gpm for Lake Livingston WSSC (Oakridge). For the 2010 condition, Lake Livingston WSSC plans to replace Oakridge I with a centralized facility herein called Oakridge II. Since the total pumping capacity at the existing Trinity Plant is 1750 gpm, an additional pumping unit is required to meet demands. The model includes one HSP #1 (three stages) and four HSP #2 (six stages), for a total capacity of 3150 gpm. To supply water at an adequate pressure at Chita, an upgrade of the pump operating head was required as follows:

HSP #1: three stages, operating point: 350 gpm @ 407 ft.
HSP #2: six stages, operating point: 700 gpm @ 438 ft.

In order to achieve a pressure of at least 10 psi at each customer some increases in the transmission line sizes were required. The upgraded line sizes, the revised pressure regulator settings, as well as the resultant system pressure readings at each customer are presented in Table 6 and shown on the attached system schematic drawing.

Table 6 – Alternative 1A Model Results

Customer	PRV Settings (psi)	Pressure Results (psi)
Riverside	134	9.4
City of Trinity	N/A	42.9
Glendale	63	18.9
City of Groveton	N/A	10.4
Chita (Trinity Rural)	N/A	9
Oakridge II (LLWSSC)	N/A	92.8
Westwood Shores MUD	35	9.5
Lake L Acres (Trinity Rural)	N/A	12.4
Trinity Water Treatment Plant	185	186.7

Summary of Alternative 2 – New Centralized Surface Water Plant at Sebastopol

Alternative 2 addresses the 2010 demands shown in Table 2. The 2010 total demand is 2744 gpm for the six existing customers. Lake Livingston WSSC (Oakridge) is not included as a customer of the City of Trinity in this alternative. Alternative 2 considers both the construction of a new centralized plant in the vicinity of Sebastopol and the decrease in capacity of the existing Trinity Plant to 400 gpm. For this alternative the Trinity Plant was modeled with only one pump HSP #1 (three stages). During peak demand periods the Trinity Plant will supply Riverside with its demand of 359 gpm with a minimal contribution to the rest of the system. The operating point of HSP #1 at Trinity Plant is 350 gpm @ 378 ft. The 2010 total demand is 2744 gpm, of which 359 gpm (Riverside demand) is supplied from the Trinity Plant. The remaining demand will be provided by the new centralized plant (referred to as the Sebastopol Water Plant). The Sebastopol pumping capacity is provided by one HSP# 1 (three stages) and three HSP #2 (six stages).

In order to achieve a pressure of at least 10 psi at each customer's tank, certain line sizes were increased and some PRV settings were revised. Additionally, since there is a pressure gradient between the Trinity Plant and the City of Trinity, a flow control valve was added to the model to limit the flow from the Trinity Plant to 400 gpm. The sizes of the lines, the PRV settings, as well as the resultant system pressure readings at each customer are presented in Table 7 and shown on the attached system schematic drawing.

Table 7 – Alternative 2 Model Results

Customer	Pressure Settings (psi)	Pressure Results (psi)
Riverside	135	10.4
City of Trinity	N/A	39.2
Glendale	62	17.9
City of Groveton	N/A	9.4
Chita (Trinity Rural)	N/A	26.6
Oakridge II (LLWSSC)	Included in 2A	Included in 2A
Westwood Shores MUD	35	9.5
Lake L Acres (Trinity Rural)	N/A	25.9
Trinity Water Treatment Plant	158	161.9
Sebastopol Water Treatment Plant	N/A	169.7

Summary of Alternative 2A – New Centralized Surface Water Plant at Sebastopol

Alternative 2A addresses the 2010 demands shown in Table 2 for the six existing customers (2744 gpm) and Lake Livingston WSSC (Oakridge – 316 gpm). For the 2010 condition, Lake Livingston WSSC plans to replace Oakridge I with a centralized facility herein called Oakridge II. Alternative 2A considers both the construction of a new centralized plant in the vicinity of Sebastopol and the decrease in capacity of the existing Trinity Plant to 400 gpm. For this alternative the Trinity Plant was modeled with only one pump HSP #1 (three stages). During peak demand periods the Trinity Plant will supply Riverside with its demand of 359 gpm with a minimal contribution to the rest of the system. The operating point of HSP #1 at Trinity Plant is 350 gpm @ 378 ft. The 2010 total demand is 2744 gpm, of which 359 gpm (Riverside demand) is supplied from the Trinity Plant. The remaining demand will be provided by the new centralized plant (Sebastopol Water Plant). The Sebastopol pumping capacity is provided by one HSP# 1 (three stages) and four HSP #2 (six stages).

In order to achieve a pressure of at least 10 psi at each customer's tank, certain line sizes were increased and some PRV settings were revised. Additionally, since there is a pressure gradient between the Trinity Plant and the City of Trinity, a flow control valve was added to the model to limit the flow from the Trinity Plant to 400 gpm. The sizes of the lines, the PRV settings, as well as the resultant system pressure readings at each customer are presented in Table 8 and shown on the attached system schematic drawing.

Table 8 – Alternative 2A Model Results

Customer	PRV Settings (psi)	Pressure Results (psi)
Riverside	135	10.4
City of Trinity	N/A	40
Glendale	62	17.9
City of Groveton	N/A	9.4
Chita (Trinity Rural)	N/A	11.9
Oakridge II (LLWSSC)	N/A	133.6
Westwood Shores MUD	35	9.5
Lake L Acres (Trinity Rural)	N/A	35.4
Trinity Water Treatment Plant	158	161.9
Sebastopol Water Treatment Plant	N/A	170.2

Turner Collie & Braden Inc.

A summary of the probable construction costs for the transmission line improvements is presented on the attached cost summary sheet. The costs are based on installation of new lines rather than the addition of a second parallel line. The value of adding new lines to loop the system will be evaluated during the preliminary engineering phase of the project.

If there are any questions concerning the above analysis results, please give me a call.

Very truly yours,

Jim Johnson, P.E.
Project Manager

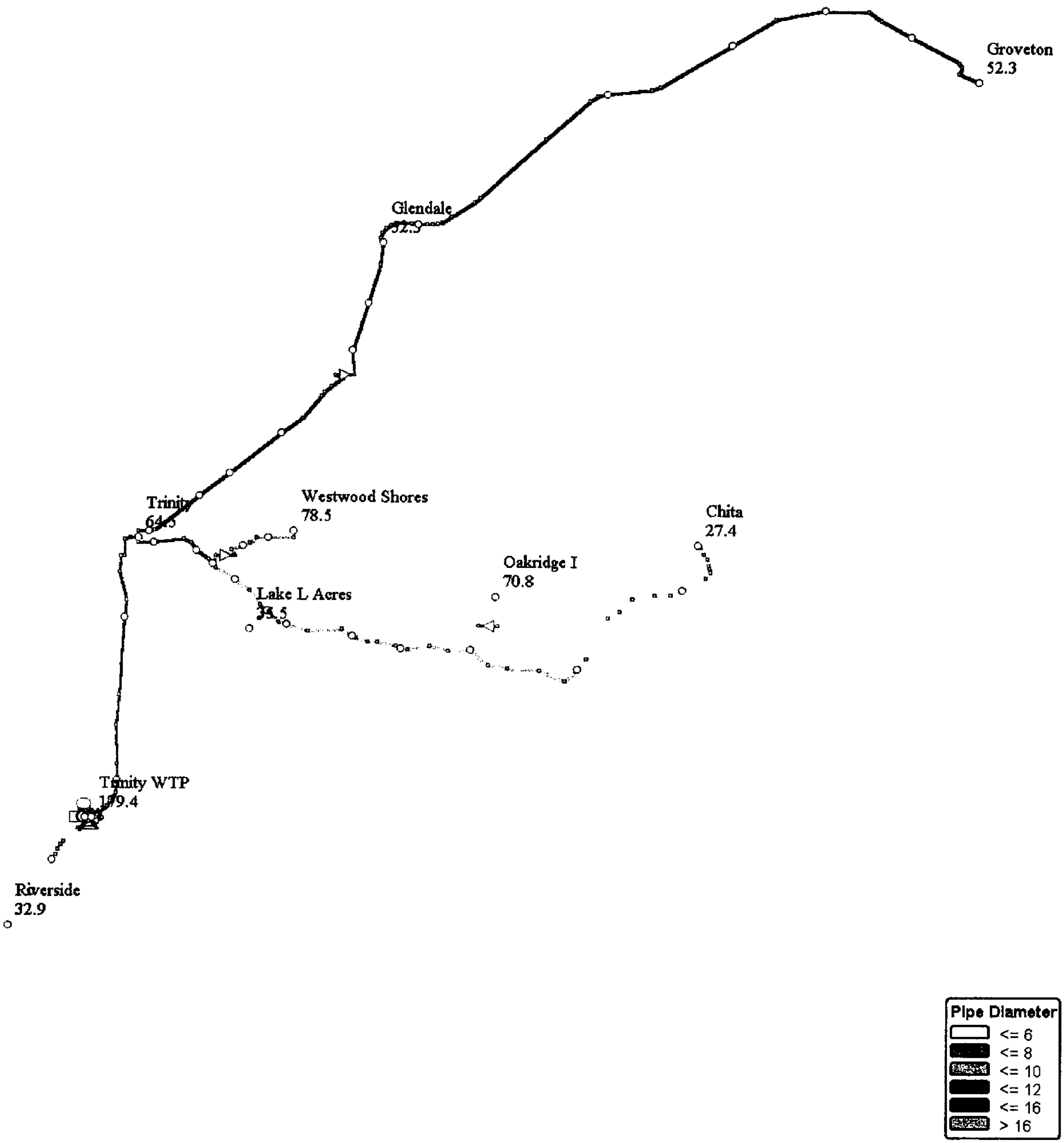
JJ:dm

Attachments

P:\15-46100\TWDB Final File\Report Files\Appendix C\sims21.doc

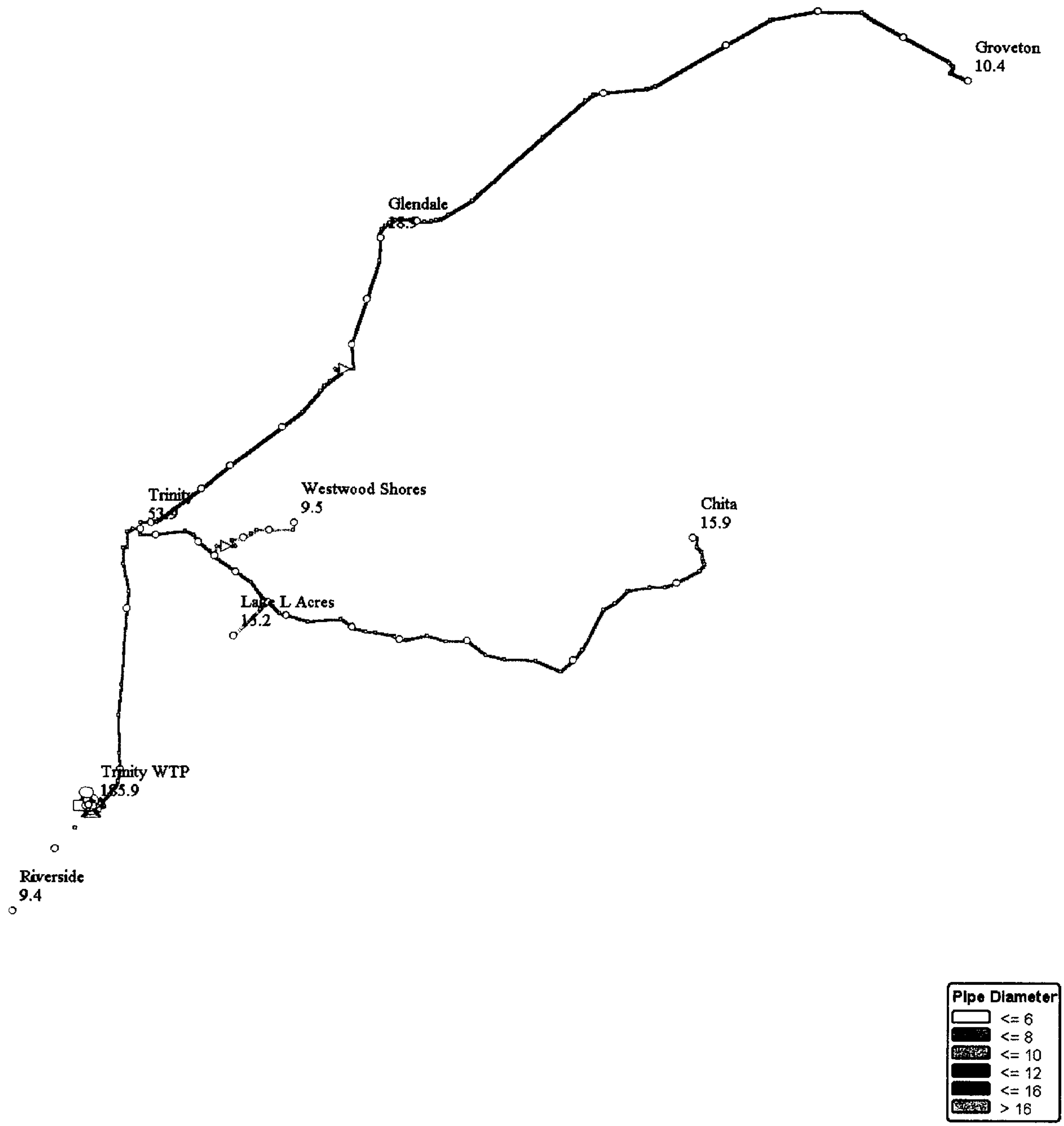
January 28, 2000

Trinity County Regional Water Supply System
Current Condition

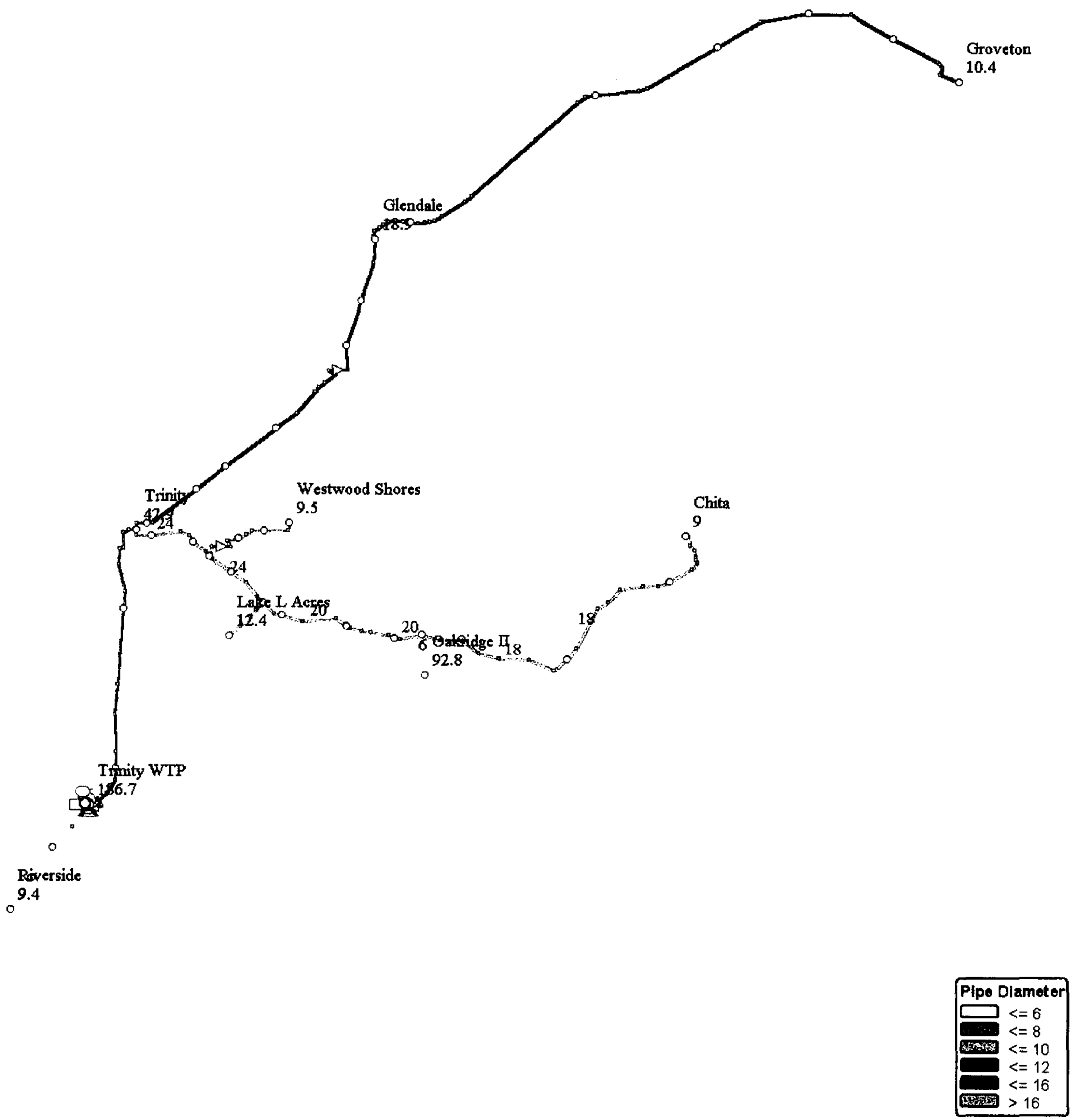


January 31, 2000

Trinity County Regional Water Supply System
Alternative 1 – Surface Water Plant Addition at Trinity Plant

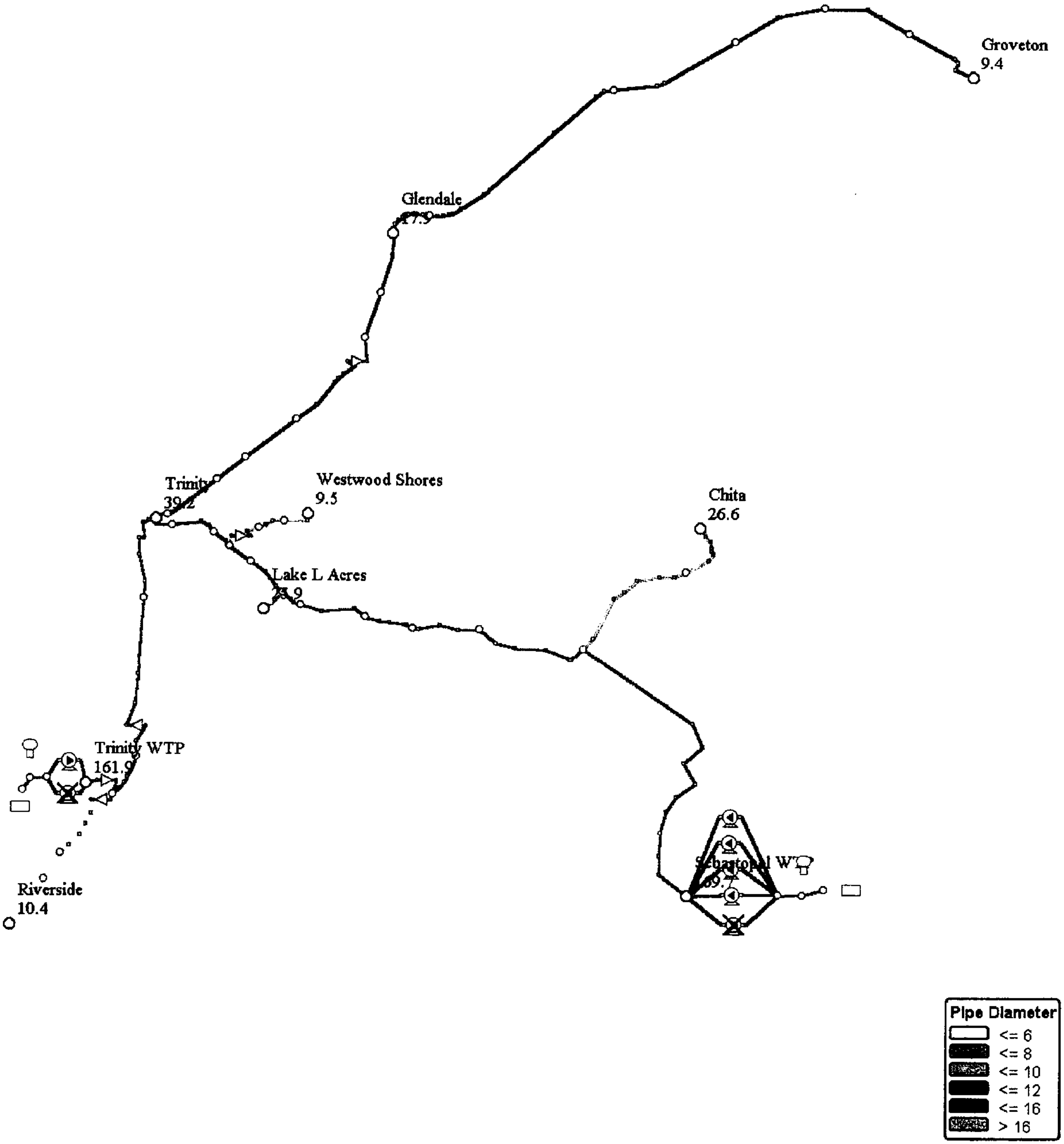


Trinity County Regional Water Supply System
Alternative 1A – Surface Water Plant Addition at Trinity Plant

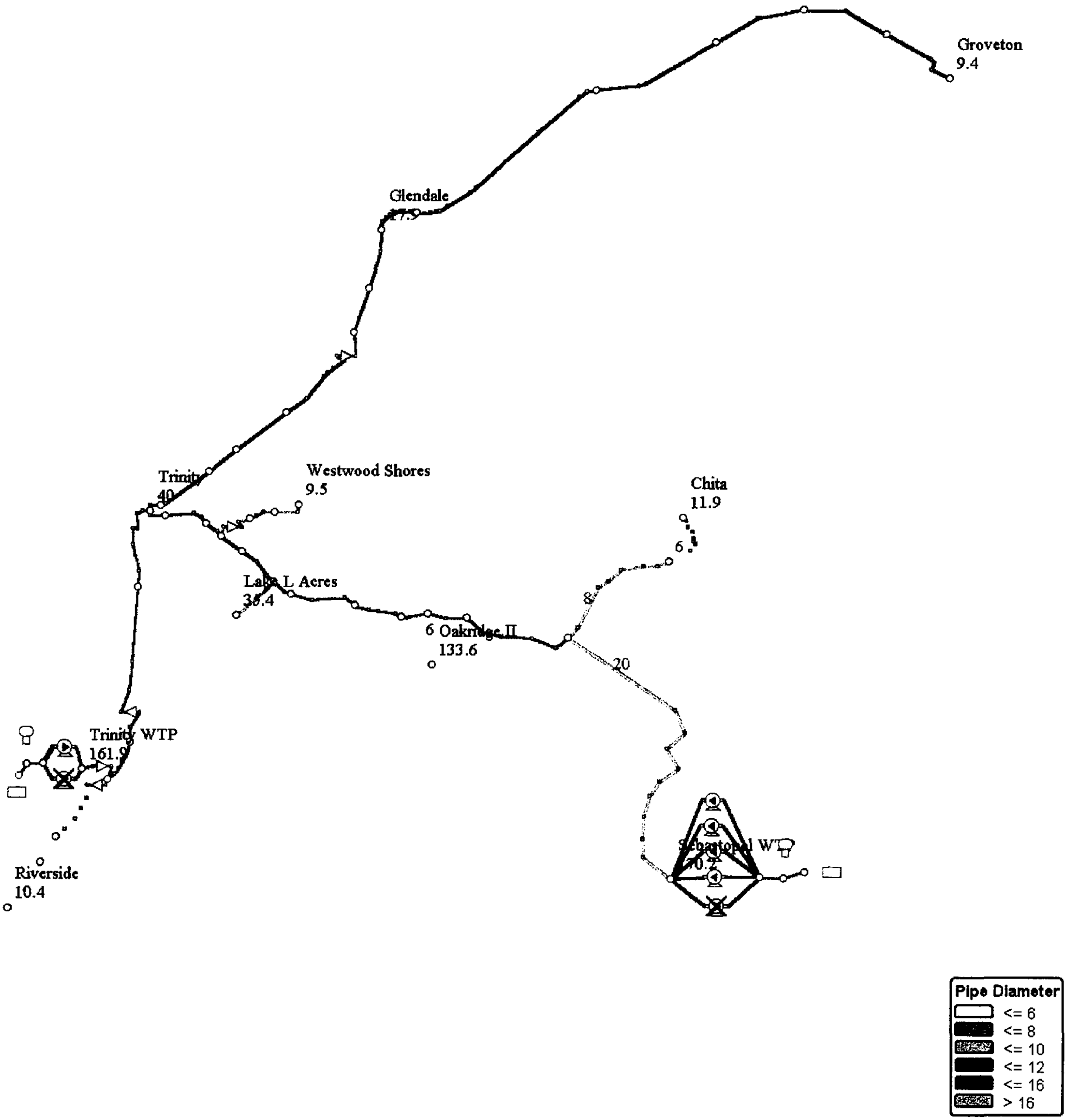


January 28, 2000

Trinity County Regional Water Supply System
Alternative 2 – New Centralized Surface Water Plant at Sebastopol



Trinity County Regional Water Supply System
Alternative 2A – New Centralized Surface Water Plant at Sebastopol



Summary of Probable Construction Costs for
TCRWSS Transmission System Improvements
TC&B Job No. 15-46100-002

Table 1 - Cost Summary for Expansion of Existing Trinity Plant

Pipeline Segment	Alternative 1 - Expand Trinity Plant for 6 Existing Customers				Alternative 1A - Expand Trinity Plant for 6 Existing Customers + LLWSSC			
	Size	LF	$/LF	Cost	Size	LF	$/LF	Cost
Hwy 356 from Trinity to Sebastopol	16	43800	55	$2,409,000	18	13200	80	$1,056,000
					20	15300	110	$1,683,000
					24	15300	140	$2,142,000
Sebastopol to Chita	16	18900	55	$1,039,500	18	18900	80	$1,512,000
Hwy 356 to Lake L Acres	8	3000	17	$51,000	10	3000	25	$75,000
Hwy 356 to Oakridge II				$0	6	500	11	$5,500
Total Probable Cost				$3,499,500				$6,473,500

Table 2 - Cost Summary for New Plant at Proposed Location Shown on Exhibit 6 (Chalk Bluff)

Pipeline Segment	Alternative 2 - Sabastopol Plant for 6 Existing Customers				Alternative 2A - Sabastopol Plant for 6 Existing Customers + LLWSSC			
	Size	LF	$/LF	Cost	Size	LF	$/LF	Cost
Hwy 356 from Trinity to Sebastopol	12	2500	32	$80,000	12	6400	32	$204,800
	16	32400	55	$1,782,000	16	28500	55	$1,567,500
Sebastopol to Chita	8	18900	17	$321,300	6	6500	11	$71,500
					8	12400	17	$210,800
Hwy 356 to Lake L Acres	8	3000	17	$51,000	8	3000	17	$51,000
Hwy 356 to Oakridge II				$0	6	500	11	$5,500
New Sebastopol Plant to Transmission System (plant located at Proposed location as shown on Exhibit 6)	16	18350	55	$1,009,250	20	18350	110	$2,018,500
Total Probable Cost Proposed Plant Location				$3,243,550				$4,129,600

Summary of Probable Construction Costs for
TCRWSS Transmission System Improvements
TC&B Job No. 15-46100-002

Table 3 - Cost Summary for New Plant at Alternate Location Shown on Exhibit 6 (White Rock Creek)								
Pipeline Segment	Alternative 2 - Sabastopol Plant for 6 Existing Customers				Alternative 2A - Sabastopol Plant for 6 Existing Customers + LLWSSC			
	Size	LF	$/LF	Cost	Size	LF	$/LF	Cost
Hwy 356 from Trinity to Sebastopol	12	2500	32	$80,000	12	6400	32	$204,800
	16	32400	55	$1,782,000	16	28500	55	$1,567,500
Sebastopol to Chita	8	18900	17	$321,300	6	6500	11	$71,500
					8	12400	17	$210,800
Hwy 356 to Lake L Acres	8	3000	17	$51,000	8	3000	17	$51,000
Hwy 356 to Oakridge II				$0	6	500	11	$5,500
New Sebastopol Plant to Transmission System (plant located at Alternate location as shown on Exhibit 6)	16	1000	55	$55,000	20	1000	110	$110,000
Total Probable Cost Alternate Plant Location**				$2,289,300				$2,221,100

**Remarks: The cost for the Alternate plant location would be applicable to either the White Rock Creek location shown on Exhibit 6 or to a plant located at the intersection of Hwy 356 and Hwy 355.
Factors such as raw water quality will be evaluated during the preliminary engineering phase

APPENDIX D

PLANT OPERATING RECORDS

HUNTSVILLE REGIONAL WATER SUPPLY SYSTEM
Expenditure History - Unaudited

	Account	1993	1994	1995	1996	1997	5 YR AVG
4000	Salaries	$154,359	$152,244	$163,586	$172,104	$187,271	165,913
4010	Salaries - Part Time	5,978	5,178	3,409	4,596	6,200	5,072
4020	FICA	12,085	11,670	12,573	13,109	14,244	12,736
4030	Health/Life	14,570	9,989	11,538	13,149	14,640	12,777
4040	Pension	11,289	11,009	12,629	13,341	21,375	13,929
4060	Unemployment	491	947	0	0	0	288
4070	Recognition	62	453	60	571	0	229
4080	Education	0	0	0	0	1,335	267
4100	Office Supplies	1,112	795	896	1,137	721	932
4110	Dues & Subs.	720	336	581	302	580	504
4120	Fees O/T Dues & Subs.	446	465	915	3,387	5,292	2,101
4130	Maint. Supplies	8,744	8,535	10,517	9,463	9,932	9,438
4140	Lab Supplies	3,541	3,667	4,200	2,917	4,427	3,750
4150	Chemicals	185,799	177,861	227,420	232,690	273,196	219,393
4160	Petroleum Products	2,657	4,837	1,770	4,007	3,897	3,434
4170	Instrument Supp./Rep.	1,661	1,286	1,761	1,369	2,235	1,662
4200	Auditing	4,500	4,500	4,500	4,500	4,750	4,550
4210	Engineering	0	16,774	47,380	2,700	0	13,371
4220	Legal	0	0	0	0	0	0
4230	Outside Services	57,659	8,041	19,607	20,095	14,787	24,038
4240	Professional Serv.	1,556	2,231	3,526	3,079	4,365	2,951
4300	Telephone	4,423	4,366	4,049	4,199	4,520	4,311
4310	Postage	677	695	752	735	671	706
4320	Printing & Binding	333	3,610	2,286	1,717	291	1,647
4330	Insurance Payments	31,262	30,223	29,958	34,046	35,800	32,258
4360	Travel	564	396	162	328	365	363
4370	Laundry/Uniform Rental	4,688	3,741	4,022	3,552	3,359	3,872
4380	Training	1,945	1,294	1,871	1,962	2,726	1,960
4410	Water	67,890	67,890	86,140	86,140	86,140	78,840
4420	Power	208,062	216,023	214,123	224,212	243,575	221,199
4430	R&M-Imp. O/T Bldg.	1,666	3,839	0	18,338	0	4,769
4440	R&M-Equipment	1,158	2,688	1,735	1,889	1,240	1,742
4450	R&M-Plant	8,750	25,591	11,949	17,712	23,169	17,434
4460	R&M-Vehicles	1,064	712	1,011	184	443	683
4470	R&M-Emergency	0	0	0	0	0	0
4490	Off-Site Sludge Disposal			73,600	52,800	106,250	77,550
4510	Equip. Rental	669	1,318	474	794	620	775
4650	Operating Overhead	105,905	118,755	129,032	146,195	151,271	130,232
4660	Admin. Overhead	51,725	47,576	57,660	51,475	55,360	52,759
4700	Land	0	0	0	0	0	0
4720	Buildings	0	0	9,467	0	0	1,893
4740	Imp. O/T Bldg.	0	0	4,300	7,046	0	2,269
4760	Mach. & Equip.	25,435	13,233	24,012	24,713	25,264	22,531
4800	Bond Prin. Pay.	420,000	450,000	480,000	510,000	670,000	506,000
4810	Interest	358,838	340,247	320,172	298,571	450,013	353,568
4820	Paying Agent Fees	652	2,464	1,482	1,425	1,667	1,538
	TOTALS	$1,762,935	$1,755,479	$1,985,125	$1,990,549	$2,431,991	1,985,216

	1993	1994	1995	1996	1997	5 YR AVG
(#413 in '81 inc. chem.)						
Total Pumpage in 1,000 gal.	1,353,583	1,289,061	1,328,459	1,531,790	1,773,924	1,455,363
Max. Pumped (peak daily) (in 1,000 gal.)	7,779	6,721	7,507	7,763	8,038	7,562
Treated Water Cost (per 1,000 gal.)	$1.30	$1.36	$1.49	$1.30	$1.37	$ 1.37
O&M Cost (per 1,000 gal.)	$0.73	$0.75	$0.89	$0.77	$0.74	$ 0.77
Total Pumpage as MGD	3.71	3.53	3.64	4.20	4.86	3.99
Chemical Cost / MG	$ 137	$ 138	$ 171	$ 152	$ 154	$ 150
Power Cost / MG	$ 154	$ 168	$ 161	$ 146	$ 137	$ 153

LIVINGSTON REGIONAL WATER SUPPLY SYSTEM
Expenditure History - Unaudited

	Account	1993	1994	1995	1996	1997		**5 YR AVG**
4000	Salaries	$75,987	$80,895	$85,616	$86,612	$92,651		84,352
4020	FICA	5,609	5,985	6,302	6,338	6,685		6,184
4030	Health/Life	6,605	5,097	5,445	6,179	6,738		6,013
4040	Pension	5,330	5,598	5,855	6,011	9,346		6,428
4070	Recognition	167	168	145	0	0		96
4100	Office Supplies	774	1,067	900	792	865		880
4110	Dues & Subs.	276	123	196	199	120		183
4120	Fees O/T Dues & Subs.	361	445	470	544	439		452
4130	Maint. Supplies	4,501	5,568	5,276	4,589	5,017		4,990
4140	Lab Supplies	1,445	1,382	1,809	1,421	2,326		1,677
4150	Chemicals	34,696	32,862	46,288	47,720	42,162		40,746
4160	Petroleum Products	1,019	1,677	1,639	2,275	1,922		1,706
4170	Instrument Sup./Rep.	973	1,560	3,073	2,828	1,735		2,034
4200	Auditing	4,000	4,000	4,000	4,000	4,000		4,000
4210	Engineering	3,800	7,300	0	0	0		2,220
4220	Legal	0	0	0	0	0		0
4230	Outside Services	1,054	2,866	2,721	10,966	4,031		4,328
4240	Professional Serv.	1,091	1,823	2,813	2,443	3,174		2,269
4300	Telephone	1,886	1,691	1,740	1,712	1,628		1,731
4310	Postage	174	138	125	59	195		138
4320	Printing & Binding	425	207	285	1,691	385		599
4330	Insurance Payments	15,401	15,364	14,901	14,937	15,645		15,250
4360	Travel	190	196	194	164	153		179
4370	Laundry/Uniform Rental	1,738	1,430	1,626	1,595	1,616		1,601
4380	Training	639	597	942	1,320	839		867
4410	Water	37,230	37,230	48,180	48,180	48,180		43,800
4420	Power	71,457	82,153	82,160	84,415	82,223	77783	80,482
4430	R&M-Imp. O/T Bldg.	5,454	2,359	2,759	4,019	33,515		9,621
4440	R&M-Equipment	1,132	949	2,410	1,889	1,203		1,517
4450	R&M-Plant	13,274	13,771	10,932	18,856	19,383		15,243
4460	R&M-Vehicles	464	375	131	1,692	1,301		793
4470	R&M-Emergency	0	0	0	0	0		0
4490	Off-Site Sludge Disposal			20,000	0	0		6,667
4510	Equip. Rental	0	0	32	92	54		36
4650	Operating Overhead	35,880	48,925	48,303	52,590	50,332		47,206
4660	Admin. Overhead	23,665	24,998	21,880	25,615	26,805		24,593
4720	Buildings	0	1,702	0	0	0		340
4740	Imp. O/T Bldg.	0	0	2,786	0	0		557
4760	Mach. & Equip.	1,500	121,655	4,455	6,055	4,675		27,668
4800	Bond Prin. Pay.	210,000	220,000	235,000	250,000	265,000		236,000
4810	Interest	241,660	228,312	214,625	199,095	183,707		213,480
4820	Paying Agent Fees	925	2,315	1,057	1,316	1,386		1,400
	TOTALS	$810,782	$962,783	$887,071	$898,209	$919,436		895,656

	1993	1994	1995	1996	1997		5 YR AVG
(#413 in '81 incl. chem.)							**5 YR AVG**
Total Pumpage in 1,000 gal.	377,528	428,338	473,106	573,137	583,683	610515	487,158
Max. Pumped (peak daily) (in 1,000 gal.)	1,757	2,172	2,110	2,504	2,932		2,295
Treated Water Cost (per 1,000 gal.)	$2.15	$2.25	$1.87	$1.57	$1.58		1.88
O&M Cost (per 1,000 gal.)	$0.95	$1.20	$0.92	$0.78	$0.80		0.93
Total Pumpage as MGD	1.03	1.17	1.30	1.57	1.60		1.33
Chemical Cost / MG	$ 92	$ 77	$ 98	$ 83	$ 72		$ 84
Power Cost / MG	$ 189	$ 192	$ 174	$ 147	$ 141	$ 127	$ 156

TRINITY COUNTY REGIONAL WATER SUPPLY SYSTEM
Expenditure History - Unaudited

Account		1993	1994	1995	1996	1997	5 YR AVG
4000	Salaries	$98,145	$106,351	$109,333	$105,201	$110,299	105,866
4010	Salaries - Part-Time	440	5,853	400	101	2,374	1,834
4020	FICA	7,442	8,316	8,520	7,874	8,210	8,072
4030	Health/Life	8,365	6,175	6,809	7,520	9,155	7,605
4040	Pension	5,960	7,273	7,269	6,921	9,152	7,315
4060	Unemployment Comp.	0	0	0	0	0	0
4070	Recognition	0	38	470	166	205	176
4100	Office Supplies	420	827	776	716	624	673
4110	Dues & Subs.	213	229	135	205	121	181
4120	Fees O/T Dues & Subs.	916	1,778	1,042	757	837	1,066
4130	Maint. Supplies	3,279	3,426	2,958	3,296	3,915	3,375
4140	Lab Supplies	1,087	1,224	1,179	1,090	1,014	1,119
4150	Chemicals	3,772	3,405	4,555	5,619	5,808	4,632
4160	Petroleum Products	1,860	1,871	2,048	2,695	2,738	2,242
4170	Instrument Sup./Rep.	1,958	6,758	4,554	5,493	2,899	4,332
4200	Auditing	4,500	4,500	4,500	4,500	4,500	4,500
4210	Engineering	3,800	1,770	31,400	0	0	7,394
4220	Legal	0	0	47	0	15	12
4230	Outside Services	13,220	8,183	22,705	10,939	15,528	14,115
4240	Professional Serv.	852	192	775	668	145	526
4300	Telephone	1,412	1,917	1,513	1,752	1,560	1,631
4310	Postage	127	211	48	59	166	122
4320	Printing & Binding	260	210	318	71	0	172
4330	Insurance Payments	15,511	16,854	16,932	16,123	17,470	16,578
4360	Travel	203	234	122	133	147	168
4370	Laundry/Uniform Rental	2,816	2,428	2,261	2,039	2,290	2,367
4380	Training	884	1,392	1,136	1,517	2,140	1,414
4410	Water	20,805	20,805	20,805	20,805	20,805	20,805
4420	Power	82,338	59,710	45,634	59,099	69,342	63,225
4430	R&M-Imp. O/T Bldg.	210	3,067	3,937	4,399	1,393	2,601
4440	R&M-Equipment	1,008	3,217	667	1,119	1,248	1,452
4450	R&M-Plant	14,505	22,762	36,552	19,936	26,781	24,107
4460	R&M-Vehicles	820	545	469	828	995	731
4510	Equip. Rental	529	344	138	604	1,045	532
4520	Rent - Other Property	9,614	8,510	9,280	9,086	10,356	9,369
4650	Operating Overhead	36,985	41,520	42,786	45,940	44,539	42,354
4660	Admin. Overhead	26,405	33,137	35,240	29,960	32,830	31,514
4720	Buildings	0	11,761	0	5,877	0	3,528
4740	Imp. O/T Bldg.	0	0	184,811	3,119	38,675	45,321
4760	Mach. & Equip.	10,588	63,661	6,239	8,490	2,509	18,297
4840	Contract Principal Pay.	24,734	0	0	0	0	4,947
4850	Contract Interest Pay.	1,298	0	0	0	0	260
4800	Bond Prin. Pay.	25,000	30,000	30,000	30,000	30,000	29,000
4810	Interest	99,229	97,875	96,375	94,688	93,375	96,308
4820	Paying Agent Fees	175	350	375	200	375	295
	TOTALS	$531,685	$588,679	$745,113	$519,605	$575,580	592,132

	1993	1994	1995	1996	1997	5 YR AVG
Total Pumpage in 1,000 gal.	320,462	283,680	309,337	302,866	345,204	312,310
Max. Pumped (peak daily as MGD)	1.368	1.373	1.360	1.312	1.415	1.366
Treated Water Cost (per 1,000 gal.)	$1.66	$2.08	$2.41	$1.72	$1.67	$1.91
O&M Cost (per 1,000 gal.)	$1.27	$1.62	$2.00	$1.30	$1.31	$1.50
Average Daily Pumpage as MGD	0.88	0.78	0.85	0.83	0.95	0.86
Power Cost / MG	$ 257	$ 210	$ 148	$ 195	$ 201	$202

APPENDIX E

TWDB REVIEW COMMENTS

TEXAS WATER DEVELOPMENT BOARD

NOV 1999
TRA OF TEXAS
SOUTHERN REGION

November 17, 1999

Mr. Danny F. Vance
General Manager
Trinity River Authority
P.O. Box 1554
Huntsville, Texas 77342-1554

Re: Regional Facility Planning Contract Between the Trinity River Authority (TRA) and the Texas Water Development Board (Board), TWDB Contract No. 99-483-311, Review Comments on Draft Final Report

Dear Mr. Vance:

Staff members of the Texas Water Development Board (Board) have completed a review of the draft report under TWDB Contract No. 99-483-311 and offer comments shown in Attachment 1.

However, certain items as identified in Attachment 1 were not included or addressed in the Draft Final Report and as submitted does not meet contractual requirements. Therefore, please submit these items for review prior to delivery of the Final Report.

After the Board transmits comments to the TRA regarding the above referenced items, TRA shall consider incorporating all comments from the EXECUTIVE ADMINISTRATOR and other commentors on the draft final report into the Final Report.

Please contact Mr. Ernest Rebuck, the Board's designated Contract Manager, at (512) 936-2317, if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles, Ph.D., P.E.
Deputy Executive Administrator
Office of Planning

cc: Jim R. Sims
Ernest Rebuck

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ATTACHMENT 1
TEXAS WATER DEVELOPMENT BOARD

DRAFT REPORT REVIEW COMMENTS
TWDB Contract No. 99-483-311
"Trinity County Regional Water Supply System Surface Water Conversion and Service Area Expansion"

SCOPE OF WORK COMMENTS

The following items from the scope of work (SOW) either are missing or are inadequately addressed in the draft report:

Task (1) Collect and evaluate background information related to the project such as water demand projections and service areas of the participating customers, especially the new potential customers, as well as topographic information needed for determination of a feasible raw water intake location.

Comment The report satisfactorily addresses water demand projections; however no information such as location, size, or existing facilities is provided for the service areas. Topographic information is not included. Although Exhibits 5 and 6 use USGS quadrangle maps as a base, the contour elevations are not legible. Pertinent topographic points could be marked and labeled on Exhibits 5 and 6, or the topographic information could be presented in a table.

TasK (2) Collect and evaluate existing site-specific facility information such as existing Trinity County Regional Water Supply System (TCRWSS) and Huntsville Regional Water Supply System (HRWSS) water treatment and transmission facilities and related operating records.

Comment The report provides a good description of the facilities for both the TCRWSS and HRWSS water treatment plants. However information on the location and size of the existing transmission facilities is not included, with the exception of the relatively small section from the TCRWSS plant to Riverside shown in Exhibit 5. Information on operating records, except for certain statistics on annual production and two O&M costs for the TCRWSS plant, is missing.

OTHER COMMENTS

The Executive Summary and pg. III-4 state that the capacity of the surface water plant facilities needed to provide water to the existing customers is 3.5 mgd and that for both existing and two potential customers is 4.1 mgd. Since the projected water demands exceed these amounts, the report should note in the Executive Summary and possible on pg. III-4, that the existing well field will continue to supply 400 gpm (0.576 mgd).

The report on pg. II-2 states that the O & M cost for the TCRWSS plant was $1.00/1000 gal prior to 1988 and $1.30/1000 gal after 1988, due to decreased production capacity. Additional explanation should be provided on why the cost increased so significantly.

Table III-2 on pg. III-3 contains a typo. The entry under "Supply Required to Meet TNRCC" requirements for "Existing Customers" should be 2744 gpm/3.95 mgd instead of 2744 gpm/23.95 mgd.

Overall the report contains a good discussion of membrane technology. However, the following points should be considered:

(a) The classification of the four membrane types, pgs. IV-6 and IV-7 should note that microfiltration and ultrafiltration generally operate at "line" pressure. Also pressure ranges for low and high pressure should be provided.

(b) The statement in the first complete paragraph on pg. IV-7 that low quality source water would require pretreatment prior to microfiltration is misleading, since it has not been established what level of pretreatment, if any, would be required for Lake Livingston or Trinity river water. There is a similar concern with respect to the first paragraph under "Potential Membrane Advantages" on pg. IV-8 which states that pre-filtration, pH adjustment, preoxidation and coagulation/sedimentation may be required.

(c) The reference to the disposal of concentrate waste streams under 'Pressure Membrane Disadvantages', should be more specific. Microfiltration and ultrafiltration, which are the membrane systems that would be applicable to the Trinity County Regional Water Supply System, are backwashed, and generally the backwash is circulated to the head of the plant in a similar manner as for conventional water treatment plants. In effect the disposal of concentrate waste streams is of concern only with nanofiltration and reverse osmosis systems, which may not be applicable in this case.

(d) The membrane system cost data on pg. VIII-2 is unclear as to what processes, such as pretreatment, are included.

The report recommends conventional treatment using pre-engineered units. This conclusion appears pre-mature in that the report also recommends further evaluation of membrane technology during the preliminary engineering phase of the project.

The report refers to at least two reports, i.e. a TC&B report in 1990 and one by R.W. Harden and Assoc. in 1986. The full reference for these reports should be provided, preferably in a "List of References".

TEXAS WATER DEVELOPMENT BOARD

February 28, 2000

Mr. Danny F. Vance
General Manager
Trinity River Authority
P.O. Box 1554
Huntsville, Texas 77342-1554

Re: Regional Facility Planning Contract Between the Trinity River Authority (TRA) and the Texas Water Development Board (Board), TWDB Contract No. 99-483-311, Review Comments on Draft Final Report

Dear Mr. Vance:

Staff members of the Texas Water Development Board have completed a review of the revised draft final report under TWDB Contract No. 96-483-189. Board staff offers the additional comments to the draft report as shown in Attachment 1. As stated in the above referenced contract, TRA will consider incorporating comments, as shown in the letter dated November 17, 1999, Attachment 1, from the EXECUTIVE ADMINISTRATOR and other commentors on the draft final report into a final report. TRA must include a copy of the EXECUTIVE ADMINISTRATOR's comments in the final report.

The Board looks forward to receiving one (1) unbound camera-ready original and nine (9) bound double-sided copies of the Final Report on this planning project. Please contact Mr. Ernest Rebuck, the Board's designated Contract Manager, at (512) 936-2317 if you have any questions about the Board's comments.

Sincerely,

Tommy Knowles, Ph.D., P.E.
Deputy Executive Administrator
Office of Planning

Enclosures
cc: Ernest Rebuck

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD

Review Comments to Revised Draft Final Report:
"Trinity County Regional Water Supply System Surface Water Conversion and Service Area Expansion"
Contract No. 99-483-311

1. The report should state that pre-engineered treatment plants, such as described on pg. VII-2, will require a minimum three-month pilot study to be consistent with the statement to that effect on pg. VIII-2 under Probably Membrane System Costs. This is based on a telephone conversation with Joe Strouse, who is the Team Leader of Plans Review for TNRCC.

2. The report on pg. VIII-2 states that two membrane manufacturers reviewed the Trinity River water. Please include the names of those manufacturers.

Trinity River Authority of Texas
Trinity County Regional
Water Supply System
Surface Water Conversion
And
Service Area Expansion
March 2000
Contract No. 99-483-311

The following map is not attached to this report. Due to its size, it could not be copied.
It is located in the official file and may be copied upon request.

TRA/TCRWSS- January 2000

Surface Water Conversion Feasibility Report
Job No. 15-46100-001 Exhibit: 1A

Please contact Research and Planning Fund Grants Management Divison at (512) 463-7926 for copies.