TARRANT COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT NUMBER ONE

TEXAS WATER DEVELOPMENT BOARD

Upper West Fork and Clear Fork Trinity River Basin Water Quality and Regional Facility Planning Study

FINAL REPORT

August 1988

Alan Plummer and Associates, Inc.
CIVIL/ENVIRONMENTAL ENGINEERS • ARLINGTON–FORT WORTH, TEXAS

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307-0520/2

August 31, 1988

Mr. James M. Oliver
Tarrant County Water Control and
Improvement District No. 1
800 East Northside Drive
Fort Worth, Texas 76106

Re: Upper West Fork and Clear Fork Trinity River Basin Water Quality Regional Facility Planning Study - Final Report

Dear Mr. Oliver:

Transmitted herewith is the Final Report for the Upper West Fork and Clear Fork Trinity River Basin Water Quality and Regional Facility Planning Study. This report includes the following bound documents.

- Upper West Fork and Clear Fork Trinity River Basin Water Quality and Regional Facility Planning Study - Final Report
- Appendix A Clear Fork - Weatherford Facility Planning Region
- Appendix B Eagle Mountain Lake Facility Planning Region
- Appendix C Individual Communities Outside of Designated Facility Planning Regions
- Appendix D Methodologies
- Appendix E Water Quality Data

The final report incorporates comments transmitted by the Texas Water Development Board by letter of August 8, 1988, and editorial changes by our staff.

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We feel that this study will provide a valuable water quality management tool to Tarrant County Water Control and Improvement District No. 1, the Texas Water Development Board, the Texas Water Commission, and the various communities in the upper Trinity River Basin and have appreciated your support in performing the study.

Sincerely,

ALAN PLUMMER AND ASSOCIATES, INC.

Richard H. Smith

Richard H. Smith, P.E.

RHS/mm

Enclosure

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CHAPTER I

EXECUTIVE SUMMARY

GENERAL

The objective of this study was to determine the wastewater facilities needed to accommodate future population growth and to protect water quality in the 2,725-square-mile planning area that includes all of the Upper West Fork and Clear Fork of the Trinity River Basin. The study area included the watersheds of six reservoirs: Lake Arlington, Benbrook Lake, Lake Weatherford, Lake Worth, Lake Bridgeport, and Eagle Mountain Lake. These reservoirs are existing and projected sources of water supply for the region.

PROCEDURES

Meeting the above objective required the acquisition or development of information on lake use, population, pollutant loads, existing water quality, and water quality standards. This information was used in conjunction with water quality models of streams and lakes to determine the requirements for wastewater treatment plant effluents through a planning period that extends from the present through the year 2005. Facility plans were then developed to determine the most cost-effective alternatives for providing sewage service to the areas needing such service and to meet the various effluent requirements.

In developing wastewater facility plans, opportunities to provide treatment on a regional basis were examined. This examination resulted in the identification of regions in which population growth is sufficient to justify consideration of regional wastewater treatment. These regions are identified in this report as the Clear Fork-Weatherford Facility Planning Region and the Eagle Mountain Lake Facility Planning Region. The evaluations of these areas are summarized in Chapter IV. Detailed information on facility planning for communities in the Clear Fork-Weatherford Region and Eagle Mountain Lake Region is included in Appendices A and B, respectively. Facility planning information for communities within the study area, but outside these two regions, is presented in Appendix C. Appendix D provides a detailed description of methodologies used in the study, and Appendix E is a compilation and summary of existing water quality data for various water bodies in the study area.

RESULTS

Existing Water Quality

Water quality in the Upper Trinity River Basin is typically very good. The water quality criteria are met at most of the monitoring stations. The most frequently violated parameter was dissolved oxygen (DO). Violations occurred most frequently in the tributaries to the lakes and in the bay and cove areas of the lakes during low-flow summer conditions. Occasional violations in sulfates, total dissolved solids, and chlorides were also observed in the tributaries.

The acute toxicity numerical criteria for metals and pesticides in water were generally met. Chronic toxicity levels for cadmium, chromium, and copper were frequently violated. There were several violations of the methoxychlor chronic toxicity criterion. However, the small data base available for toxics precludes making general trend observations and conclusions. Special studies by the Texas Fish and Wildlife Department and the Tarrant County Water Control and Improvement District No. 1 showed PCBs and chlordane in the tissues of some aquatic species taken from the Clear Fork. The PCB and chlordane levels exceeded the Fish and Wildlife Department's alert level, but not the U.S. Food and Drug Administration's (FDA) action level.

Pollutant Loads

Information on pollutant loads was developed and used in conjunction with water quality models to assess wastewater treatment plant effluent requirements. A summary of the point and nonpoint source loads for each of the six lake watersheds in the study area is shown in Figures I-1 through I-3.

Wastewater Treatment Plant Effluent Requirements

To meet water quality objectives for the study area, effluent requirements were determined using procedures summarized in Chapter III and described in detail in Appendix D. The projected effluent requirements for wastewater treatment plants discharging into the streams in the study area, summarized in Table I-1, do not include the level of nutrient removal necessary for protection of the area's lakes. The District had anticipated using the results of water quality modeling done by the Texas Water Commission (TWC) at Eagle Mountain Lake while assessing future effluent requirements for the City of Azle; however, at the time of this writing, the results of this modeling were not yet available.

RECOMMENDATIONS AND CONCLUSIONS

Clear Fork-Weatherford Region

A regional wastewater system is recommended to provide treatment service to the Weatherford, Lake Weatherford, and Hudson Oaks Facility Planning Areas. Such a system could be designed, constructed, and operated by the Trinity River Authority of Texas, which could serve as the designated management agency for providing wastewater treatment to these areas. Weatherford could also serve as the designated management agency for providing wastewater treatment to the region. Regardless of which entity serves as the

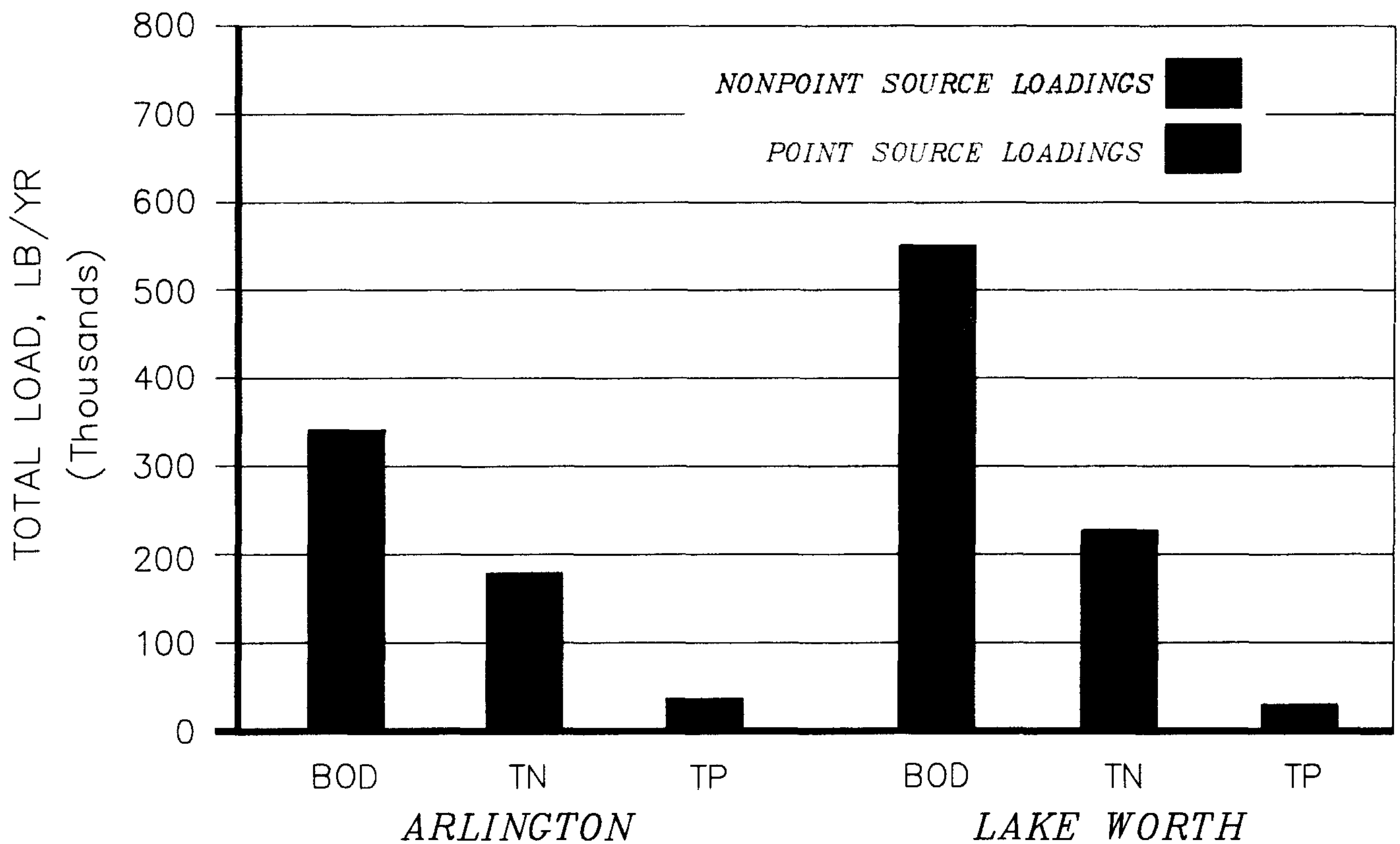


FIGURE I-1
PROJECTED POLLUTION LOADINGS
LAKE ARLINGTON AND LAKE WORTH

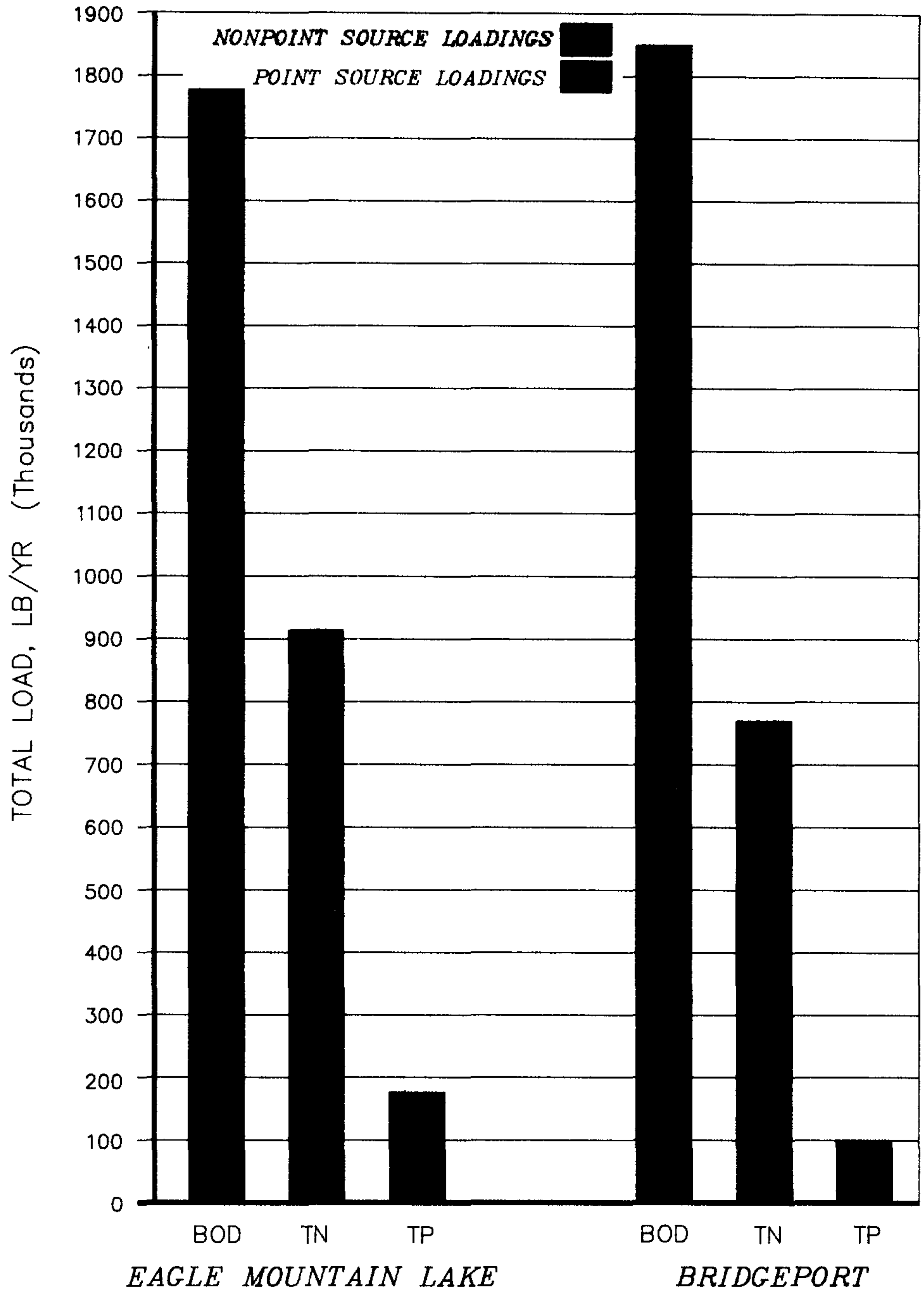


FIGURE I-2
PROJECTED POLLUTION LOADINGS
EAGLE MOUNTAIN LAKE AND LAKE BRIDGEPORT

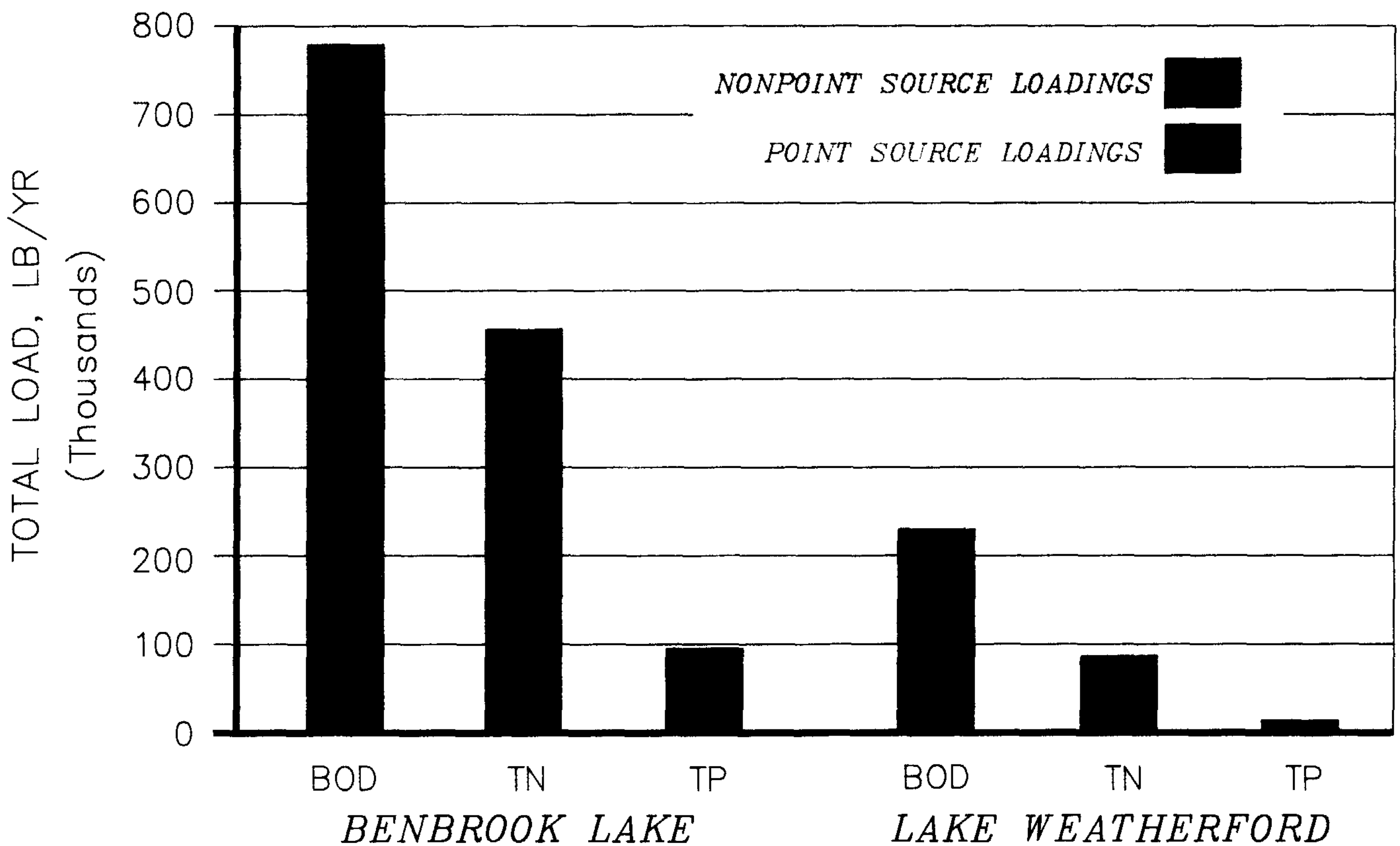


FIGURE I-3
PROJECTED POLLUTION LOADINGS
BENBROOK LAKE AND LAKE WEATHERFORD

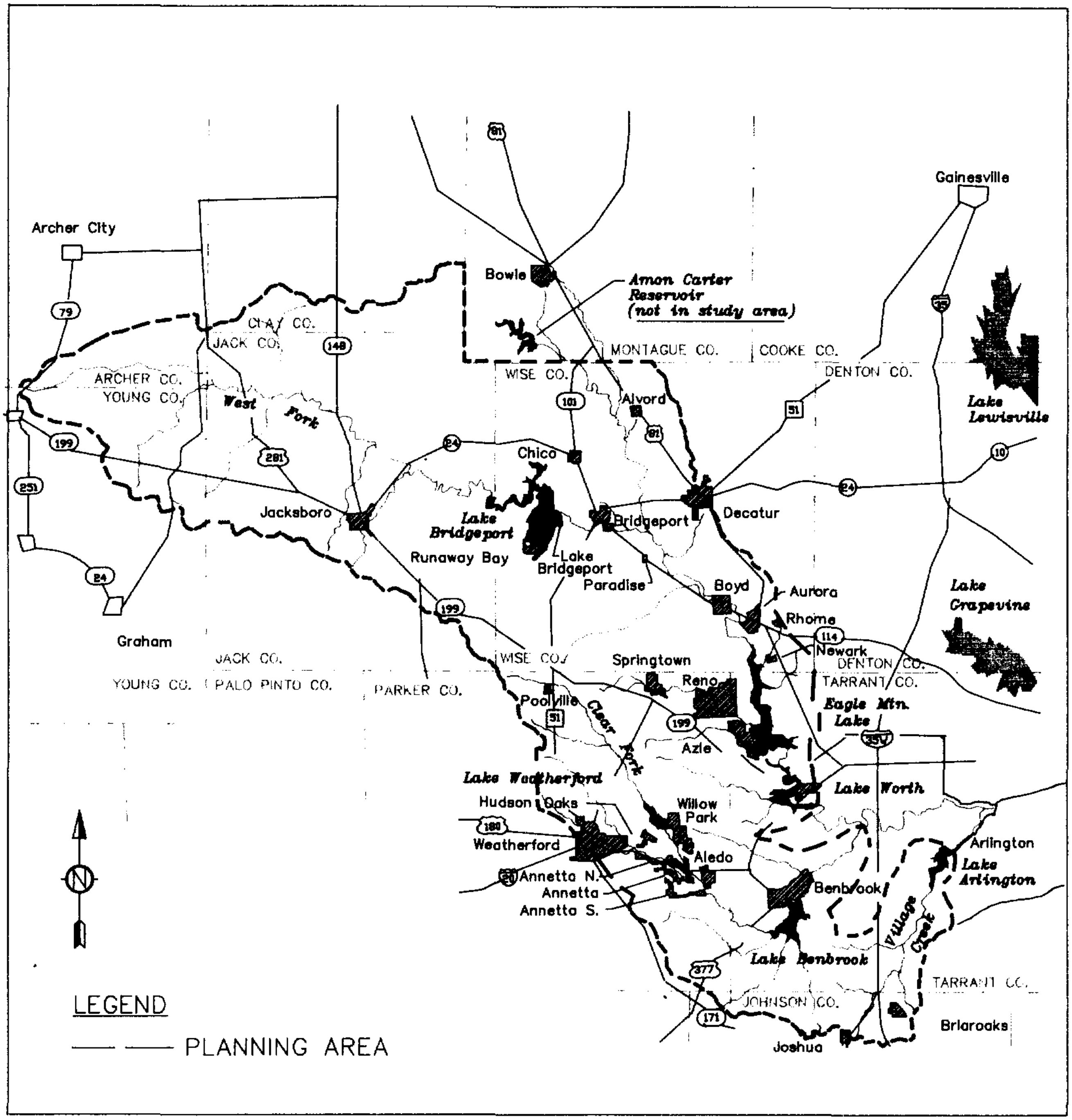


FIGURE II-1
UPPER TRINITY RIVER BASIN
WATER QUALITY MANAGEMENT PLAN STUDY AREA

TABLE I-1

SUMMARY OF RESULTS

Water Body[1]	Effluent Requirements[2] Conventional Reaeration[3]	Reaeration Restriction[4]	Method of Analysis
West Fork Trinity	20/15/5	10/3/5	Streeter-Phelps[5]
Martins Branch	20/15/5	10/3/5	Streeter Phelps[5]
Big Sandy Creek	20/15/5	10/3/5	Streeter Phelps[5]
Dry Creek	20/15/5	10/3/5	Streeter Phelps[5]
Village Creek	20/15/5	10/3/5	Streeter Phelps[5]
Town Creek, South Fork, Clear Fork	10/3/5	5/2/5	Streeter Phelps[7]
Walnut Creek	20/15/5	10/3/5	Streeter Phelps[7]
Ash Creek	20/15/5	10/3/5	Streeter Phelps[6]
Town Creek and South Fork	10/2/5	---	Qual-Tx[7]
Clear Fork	5/2/6	---	Qual-Tx[7]

Notes:
1. Projections for the municipal discharges at 2005 flows.
2. $CBOD_5/NH_3$-N/DO.
3. Texas reaeration formula used.
4. Reaeration coefficient restricted to ka $\leq$ 2/day in an attempt to account for pools in the stream.
5. No data of calibration.
6. Some limited water quality data available.
7. One usable data set for calibration.

designated management agency for wastewater treatment, each of the individual cities would serve as the designated management agency for collection of wastewater within its service area.

The following conclusions have been made concerning other communities in this region.

1. Construction of organized wastewater collection and treatment systems to serve existing households in Willow Park is not feasible at this time without grant assistance. Because such assistance is unlikely and because local soil conditions are generally unsuitable for on-site wastewater disposal, Willow Park should require developers to construct such systems to serve all new development. As the population of Willow Park increases, it may become feasible to extend sewer service to the northern portion of Willow Park from the aforementioned regional system. The southern portion of Willow Park will probably be served by a wastewater treatment plant planned for the Clear Fork Canyon Estates subdivision.

2. A recommendation cannot be made to construct organized wastewater collection and treatment facilities within the Annetta North, Annetta, or Annetta South Facility Planning Areas. The sparse development of these facility planning areas would result in high per-household sewerage costs that would make implementation of organized wastewater collection and treatment systems unaffordable during the planning period of this study.

   All households within the Annetta North, Annetta, and Annetta South Facility Planning Areas are currently served by individual on-site wastewater disposal systems. Discussions with Parker County Health Department personnel indicate that maximum-size conventional systems or evapotranspiration systems are required throughout these facility planning areas (FPAs) for new installations due to poor soil conditions. U.S. Soil Conservation Service maps confirm this and indicate that the most soils within these FPAs are unsuitable for individual on-site wastewater disposal systems due to slow percolation rates, rock, and/or flooding hazards. In view of this, these communities should consider requiring developers to construct wastewater collection and treatment systems to serve new development. The cities of Annetta North, Annetta, and Annetta South should also monitor population densities within their respective facility planning areas to determine when it may become cost-effective to implement organized wastewater systems.

3. Currently, the City of Aledo Water and Sewer Development serves most of the heavily populated developments within the corporate limits of City of Aledo with an organized wastewater collection and treatment system. The City of Aledo is aware of the current planning efforts underway by the City of Weatherford and the Trinity River Authority of Texas to implement a regional wastewater system. The city should continue to operate its existing wastewater treatment facility, but be aware of possible future advantages of becoming a member of a regional wastewater system.

Eagle Mountain Lake Region

The following conclusions from Appendix B are presented as a result of water quality and wastewater facility planning studies performed for the Eagle Mountain Lake (EML) Region.

1. Organized wastewater systems are probably not cost-effective in the immediate future for any areas that are presently unsewered. However, increased development and/or problems with on-site systems could alter this assessment.

2. Increasingly stringent effluent requirements, which are necessary to protect water supply resources, may require communities such as Azle with existing organized systems to seriously consider the diversion of sewage flows out of the EML watershed.

3. Expansion of the existing Azle wastewater treatment plants should be in a manner that facilitates ultimate inclusion of phosphorous removal and nitrification at all facilities.

4. Gradual extension of sewerage service into outlying areas could be achieved by requiring new housing or commercial developments to provide sewage collection systems with cluster on-site treatment facilities with either surface or subsurface land disposal of effluent. Surface land disposal systems must have permits from the TWC; whereas, subsurface disposal systems are licensed by either the District or county depending on proximity to the lake.

5. An agency should be identified that can guide local interests in properly operating and maintaining existing on-site systems and/or new cluster-type systems. Such an agency could possibly provide operating and maintenance services such as the pump-out of holding tanks and could possibly operate sewage treatment plants until a public sewer system becomes available.

Individual Communities Outside of Designated Facility Planning Regions

Twelve individual communities outside of the designated facility planning regions were evaluated for treatment needs. Most of these communities were found to be involved already in facility planning. These efforts and recommendations are described in Appendix C.

Recommended Ongoing Water Quality Management

It is recommended that Tarrant County Water Control and Improvement District No. 1 continue its role in water quality management for the study area by implementing an ongoing water quality management program. Such a program would enable the District and other local agencies with water supply responsibilities in the area to accomplish the following:

1. Develop and implement lake and stream water quality monitoring program to supplement state and federal water quality data collection.
2. Review monitoring data as they are received to detect immediate problems.
3. Respond to immediate problems.
4. Perform annual review of water quality data to determine long-term trends.
5. Perform periodic review of water quality standards and provide comments to TWC.
6. Perform annual assessment of monitoring programs and modify as needed.
7. Perform annual assessment of any special studies needed.
8. Review and comment on applications for new and renewed wastewater treatment plant permits. Present testimony at hearings, if necessary.
9. Monitor various proposed activities such as construction, agricultural operations, and landfills, and comment on the impact of such activities on water quality. Present testimony at hearings if necessary.
10. Prepare annual reports describing reservoir water quality conditions and watershed activities.
11. Update watershed plans as required in Section 208 of the Clean Water Act, and review and update long-term water quality goals.
12. Update intensive lake surveys and lake models every 5 to 10 years.

The District is currently developing a detailed work plan for accomplishing the above goals in not only the Clear Fork and West Fork watersheds, but also in the watersheds of Cedar Creek Reservoir and Richland Chambers Reservoir in East Texas. Water quality management in these two reservoirs is intimately linked to water quality in Lake Arlington, because water from Cedar Creek Reservoir is pumped to Lake Arlington and the Fort Worth Rolling Hills Water Treatment Plant and a pipeline is being constructed from Richland Chambers Reservoir to these locations. Extensions of these water supply lines to Benbrook Lake and possibly Lake Weatherford are planned for the future.

CHAPTER II

INTRODUCTION

STUDY OBJECTIVES

The Texas Water Development Board and the Tarrant County Water Control and Improvement District No. 1 are jointly sponsoring the development of a regional wastewater plan for a 2,725-square-mile area bounded by the drainage areas of Lake Arlington, the Upper West Fork of the Trinity River, and the Clear Fork of the Trinity River. The project has produced a feasibility plan for regional wastewater collection, treatment, and disposal facilities for the planning area. The planning effort consisted of two phases.

The first phase focused on collecting and evaluating data on the study area to develop mathematical models for determining the wastewater treatment needed to protect existing water quality and intended uses. The first phase also included a feasibility analysis of various treatment plant alternatives available to meet the treatment objectives. The second phase focused on summarizing and presenting information developed in Phase I and presenting recommendations with regard to point source and nonpoint source control measures consistent with area-wide water quality goals.

GENERAL METHODOLOGY

The Upper Trinity River Basin Water Quality Management Plan was prepared in two different phases as indicated above. The primary focus of the study was to determine the water uses for the area lakes and the actions required to protect those intended uses.

The study includes an assessment of current and projected study area populations and land use patterns and an identification of existing and projected point and nonpoint source pollutant loads. The information was used with historical water quality data, water quality criteria, and mathematical simulation models to evaluate wastewater management alternatives.

Facility planning alternatives for the study area were developed based on projected population trends. Regional wastewater treatment facility alternatives were evaluated for those areas most likely to benefit from regionalization of the treatment facilities, based on projected water use classifications, water quality simulation, and cost analysis.

More detailed descriptions of methodologies utilized during the course of the planning studies required for this project are included in Appendix D.

STUDY AREA

The study area boundaries, shown in Figure II-1, represent the drainage areas of Lake Arlington, the Upper West Fork of the Trinity River, and the Clear Fork of the Trinity River. The study area includes portions of Archer, Clay, Hood, Jack, Johnson, Montague, Parker, Tarrant, Wise, and Young counties. Table II-1 shows the many political subdivisions included in the study area. The size of the total planning area is 2,725 square miles and includes the following lakes and/or reservoirs:

- Lake Arlington
- Lake Weatherford
- Benbrook Lake
- Lake Bridgeport
- Amon Carter Reservoir (affects, but not included in, study area)
- Eagle Mountain Lake
- Lake Worth

FIGURE II-1

TABLE II-1

POLITICAL SUBDIVISIONS WITHIN PROJECT PLANNING AREA

Counties:

Archer	Montague
Clay	Parker
Hood	Tarrant
Jack	Wise
Johnson	Young

Cities:

Aledo	Fort Worth
Alvord	Hudson oaks
Annetta	Joshua
Annetta North	Lakeside
Annetta South	Lake Bridgeport
Arlington	Lake Worth
Aurora	Newark
Azle	Pelican Bay
Boyd	Reno
Bowie	Runaway Bay
Briar	Samson Park
Bridgeport	Springtown
Chico	Weatherford
Decatur	Willow Park

Special Districts:

Bay Landing
Benbrook Water and Sewer Authority
Central Texas Utilities
Community Water Supply Corporation
Fort Worth ISD
Johnson County FWSD No. 1
NORTEX Regional Planning Commission
North Central Texas Council of Governments
Parker County Utility District
Tarrant County MUD No. 1
Tarrant County WCID No. 1
Trinity River Authority
Saint Francis Village, Inc.
West Wise Rural Water Supply District
Wise County Water Supply District

Most of these lakes are existing or proposed water supply reservoirs for the region. Figure II-2 is a one-line diagram of the study area showing the relative location of the lakes to each other, dischargers into the system, water treatment plants, and existing sampling/monitoring stations. The major lakes and reservoirs are shown in Figure II-3.

STUDY AREA CHARACTERISTICS

The paragraphs that follow describe the existing and projected characteristics of the study area. The information was used to evaluate the potential impacts of the facility planning alternatives, to develop criteria for discharges into the system, and to determine what if any controls should be established for nonpoint sources and on-site disposal systems in the watersheds.

The data presented were developed from two different perspectives. The first perspective addresses the watersheds for the major lakes/reservoirs in the study area. The second perspective addresses the facility planning regions identified within the study area. The facility planning regions in the Upper Trinity River Basin are identified below and shown in Figure II-4.

- Clear Fork-Weatherford Facility Planning Region
- Eagle Mountain Lake Facility Planning Region
- North Lake Worth Facility Planning Region
- South Benbrook Lake Facility Planning Region
- Individual Communities Outside of Facility Planning Region

Areas within the Fort Worth city limits, but also part of North Lake Worth and South Benbrook Lake Facility Planning areas, were addressed in the Fort Worth Master Plan (in preparation) and are not included in the facility planning efforts documented in this report.

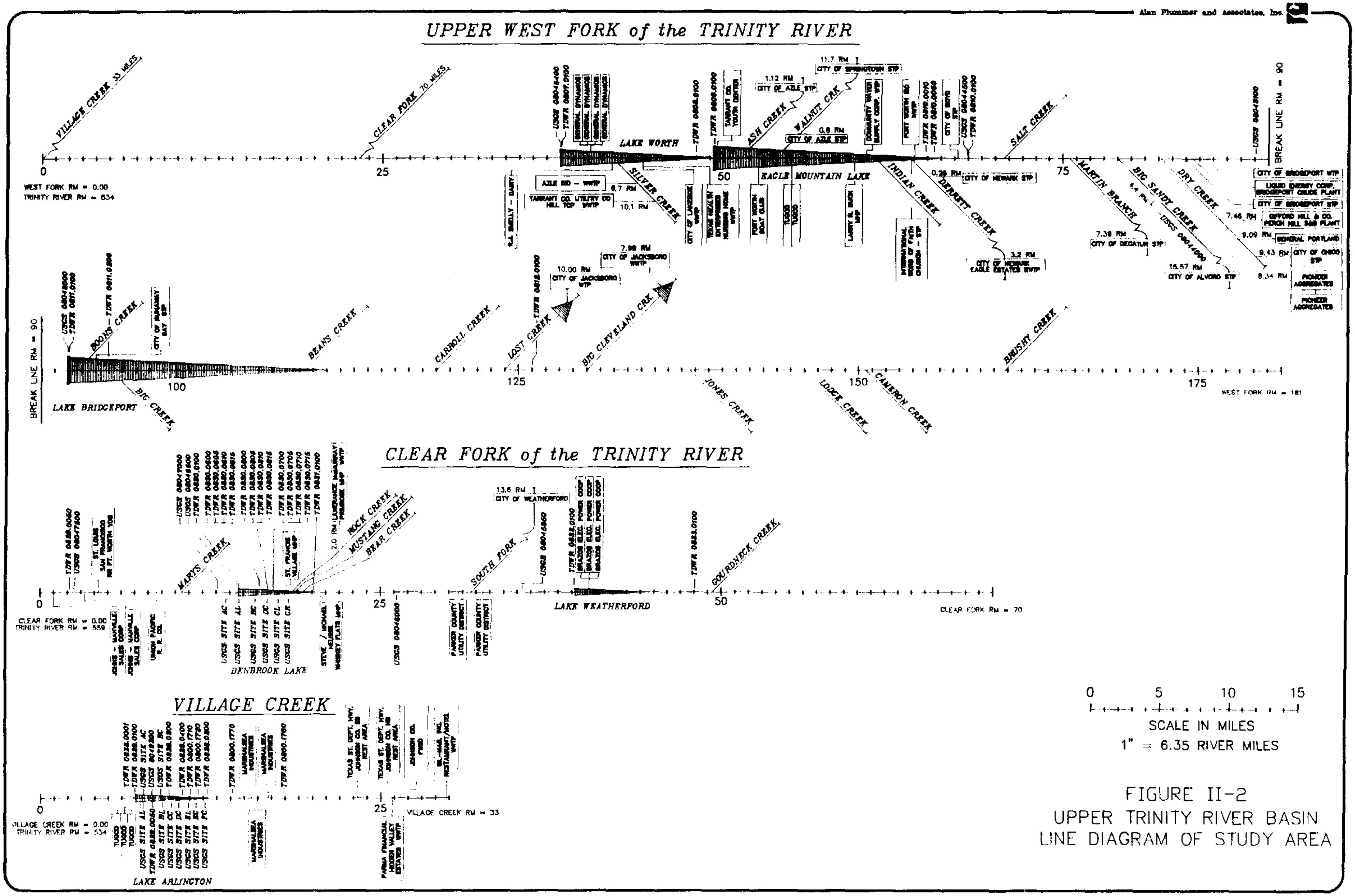


FIGURE II-2
UPPER TRINITY RIVER BASIN
LINE DIAGRAM OF STUDY AREA

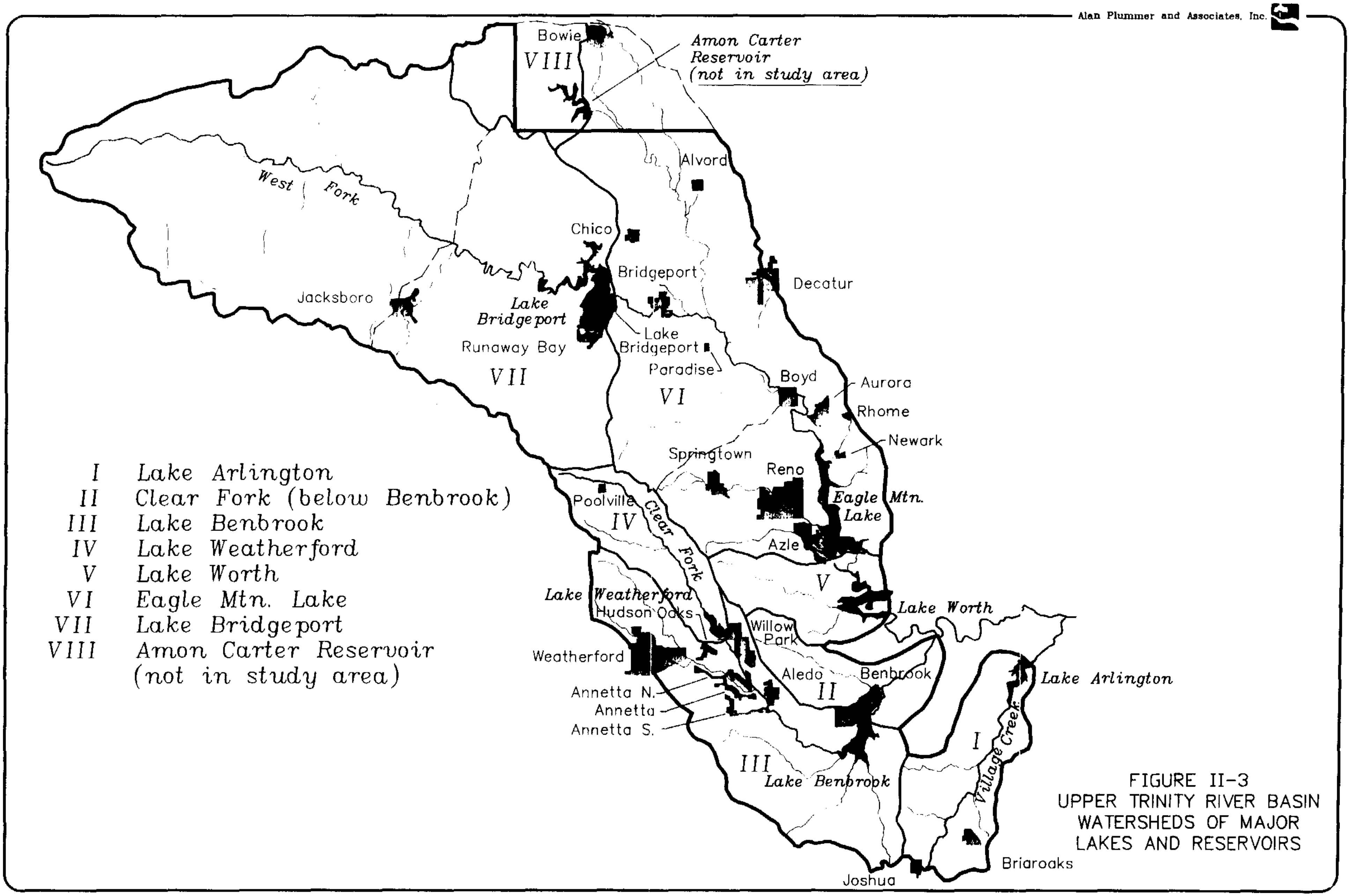


FIGURE II-3
UPPER TRINITY RIVER BASIN
WATERSHEDS OF MAJOR
LAKES AND RESERVOIRS

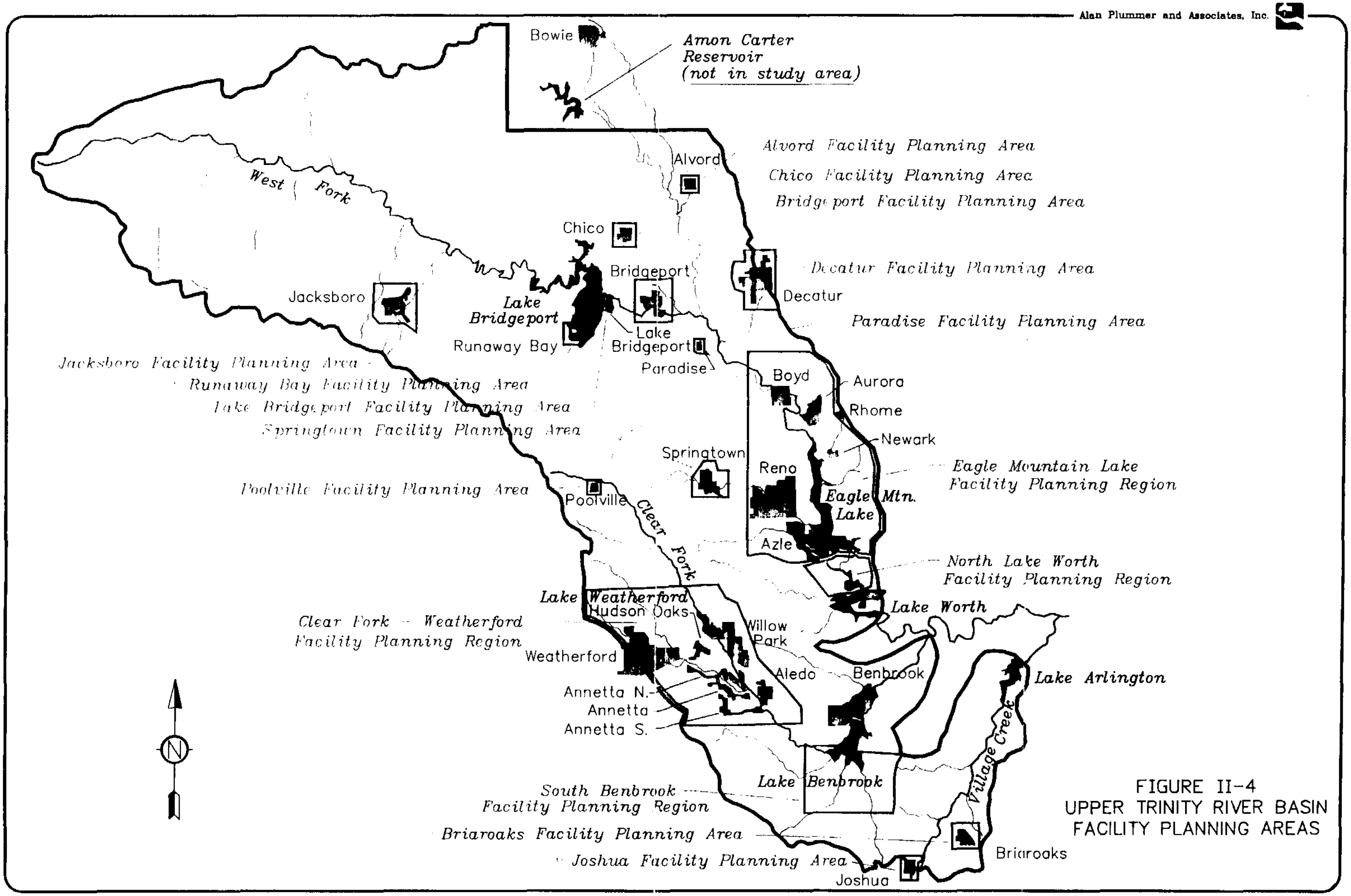


FIGURE II-4
UPPER TRINITY RIVER BASIN
FACILITY PLANNING AREAS

LAND USE AND POPULATION ESTIMATES

Water quality in any natural system is affected by both nonpoint source pollution and direct discharges into the river, stream, or lake. Nonpoint source pollution is a function of land use and precipitation patterns, while point source discharges are a function of population trends and activities.

Land Use Within the Study Area

The study area is predominantly rural. Only about 3.2% of the area is currently developed. Land use was divided into the following major categories:

- Urban
- Agriculture
- Pasture
- Forest

Table II-2 summarizes land use within the major watersheds. The land use percentages were determined by superimposing the watershed boundaries onto the land use remote sensing data compiled by North Texas State University in 1987, based on August 1985 satellite data.

The land use information was incorporated into the water quality projections and waste load allocations and methodologies. The recent significant increase in urbanization (particularly since 1977, when the last land use patterns were developed by the Texas Department of Water Resources) has resulted in increased runoff and increased nonpoint source loadings. The projected land use for 2005 conditions, based on 2005 population and 1980 population densities, is presented in Table II-3.

TABLE II-2

UPPER TRINITY RIVER BASIN WATERSHEDS
LAND USE SUMMARY
1985 CONDITIONS

Watershed No.	Watershed Name	Stream System	Land Use (Sq. Mi.) Urban	Agriculture	Pasture	Forest	Water	Total
I	Lake Arlington	Village Creek	16.1	30.6	65.7	27.0	3.6	143
II	Clear Fork	Clear Fork	17.5	13.4	43.2	13.3	1.6	89
III	Benbrook Lake	Clear Fork	7.8	67.4	194.1	42.8	7.9	320
IV	Lake Weatherford	Clear Fork	2.0	20.1	51.9	32.3	2.7	109
V	Lake Worth	West Fork	4.9	12.3	42.3	29.5	5.0	94
VI	Eagle Mountain Lake	West Fork	23.7	132.2	369.1	215.0	19.0	759
VII	Lake Bridgeport	West Fork	24.2	107.1	558.6	400.2	20.9	1111
VIII	Amon Carter Reservoir[3]	Big Sandy into West Fork	1.2	12.6	51.2	31.2	3.8	100

1. Based on August 1985 Thematic Mapper Satellite Data compiled by North Texas State University, 1987
2. Total area includes intervening drainage area only.
3. Not in study area, but loads impact study area

TABLE II-3

UPPER TRINITY RIVER BASIN WATERSHEDS
LAND USE SUMMARY
2005 CONDITIONS

Watershed No.	Watershed Name	Stream System	Land Use (Sq. Mi.) Urban	Agriculture	Pasture	Forest	Water	Total
I	Lake Arlington	Village Creek	30.7	29.2	56.9	22.6	3.6	143
II	Clear Fork	Clear Fork	18.2	13.4	42.8	13.1	1.5	89
III	Benbrook Lake	Clear Fork	22.4	65.9	185.3	38.4	8.0	320
IV	Lake Weatherford	Clear Fork	3.8	19.9	50.9	31.8	2.6	109
V	Lake Worth	West Fork	13.5	11.4	37.1	26.9	5.1	94
VI	Eagle Mountain Lake	West Fork	44.1	130.2	356.9	208.8	19.0	759
VII	Lake Bridgeport	West Fork	30.2	106.5	555.0	398.4	20.9	1111
VIII	Amon Carter Reservoir(3)	Big Sandy into West Fork	1.4	12.6	51.1	31.1	3.8	100

1. Projected land use based on extrapolation of existing land uses (Table II-2) utilizing 2005 populations and exitsing population density to project urban area increase and reducing other land uses by incremental increase distributing 10% to agriculture, 60% to pasture, and 30% to forest.
2. Total area includes intervening drainage area only.
3. Not in study area, but loads impact study area

Population Estimates and Projections

Population estimates and projections within the study area were based primarily on North Central Texas Council of Governments' (NCTCOG) 1987 population estimates and the 1980 census figures published by the U.S. Department of Commerce Bureau of the Census. These estimates were refined by information available from the planning regions and cities. Population estimates are presented for the watersheds in Table II-4 and for the facility planning regions in Table II-5. Population estimates were used to project future wastewater flows.

For the purpose of estimating potential on-site disposal system loads into the major lakes, the current population within the individual lake watersheds was further divided into sewered and unsewered populations. Table II-6 presents the sewered and unsewered population estimates as well as the percentage distribution for each of the study area watersheds. The sewered population was estimated by adding the populations of all incorporated towns served by organized systems, areas served by special sanitation districts, and areas around specific permitted wastewater treatment facilities. The unsewered population was estimated using the CDM/Rady Fort Worth 201 Facility Plan to identify the unsewered parts of the City of Fort Worth and by counting houses on the U.S. Geologic Survey's (USGS) 7.5-degree topographic maps and on recent aerial photographs. The number of houses was multiplied by NCTCOG's 1986 2.54-person-per-household estimate. The 2.54-persons-per-household is a general estimate for the entire area. Area-specific numbers were used to estimate populations in the individual facility planning regions.

The percent distribution of sewered and unsewered populations varies from a low of 0% to a high of 94% for sewered population and from a low of 6% to a high of 100% for unsewered population. The overall average indicates that 27% of the population in the study area is unsewered.

TABLE II-4

ESTIMATED AND PROJECTED WATERSHED POPULATIONS

Watershed	1980	1987	1990	2000	2005
Lake Arlington	90,500	113,000	123,000	154,000	172,000
Lower Clear Fork	140,000	166,000	176,000	190,000	195,000
Lake Benbrook	27,000	40,000	44,500	66,000	78,000
Lake Weatherford	3,000	3,800	4,200	5,200	5,500
Lake Worth	15,500	29,000	32,000	41,000	43,000
Eagle Mountain Lake	44,000	56,000	60,000	74,000	82,000
Lake Bridgeport	8,800	9,800	10,000	10,900	11,000
Amon Carter Reservoir	2,800	2,950	3,000	3,270	3,400
Total	331,600	420,550	452,700	544,370	589,900

TABLE II-5

UPPER TRINITY RIVER BASIN
WATER QUALITY MANAGEMENT PLAN
FACILITY PLANNING AREAS
POPULATION ESTIMATES AND PROJECTIONS

Facility Planning Area	1980	1987	1990	2000	2005
Clear Fork/Weatherford	17,104	22,180	24,350	31,600	35,230
Eagle Mountain Lake	17,173	25,090	28,150	38,335	43,440
Small Sewerage Planning Areas[(1)]					
Alvord	887	1,065	1,141	1,394	1,521
Briaroaks	962	1,376	1,553	2,145	2,446
Bridgeport	4,008	4,173	4,245	4,479	4,597
Chico	945	1,066	1,121	1,296	1,383
Decatur	4,230	4,738	4,885	5,634	6,052
Jacksboro	4,164	4,178	4,184	4,203	4,213
Joshua	1,757	5,214	5,846	7,965	9.544
Lake Bridgeport	325	415	455	580	642
Paradise	388	462	494	599	651
Poolville	318	431	475	639	716
Runaway Bay	504	800	930	1,350	1,560
Springtown	1,866	2,372	2,590	3,312	3,678

1. Includes both town and rural populations.

TABLE II-6

SEWERED AND UNSEWERED
1987 WATERSHED POPULATIONS[1]

Watershed	Sewered Population	Unsewered Population	Percent Distribution Sewered	Percent Distribution Unsewered
Lake Arlington	88,100	24,900	78%	22%
Lower Clear Fork	155,500	10,500	94%	6%
Lake Benbrook	16,100	23,900	40%	60%
Lake Weatherford	-0-	3,800	0	100%
Lake Worth	12,500	16,500	43%	57%
Eagle Mountain Lake[2]	29,600	26,400	53%	47%
Lake Bridgeport	4,800	5,000	49%	51%
Lake Amon Carter[2]	1,560	1,390	53%	47%
Total:	308,160	112,390	73%	27%
Total Population:	420,550			
Non Study Area				
- Population:	9,085			
Total Study Area				
Population:	411,465			

1. Estimates are based upon 1987 populations of cities and towns, house counts, and figures from City of Fort Worth 201 Facilities Plan.
2. These watersheds include nonstudy area populations.

EXISTING AND PROJECTED WATER USE

Surface Water

The lakes in the Upper Trinity River Basin are all major water supply sources for the study area and downstream populations. Table II-7 lists the lakes with their wholesale water suppliers. The consumptive water use from each of the lakes for 1980 and projections for 1990 and 2000 are presented in Table II-8. A brief description of each of the lakes and water uses is presented below.

Lake Arlington. Lake Arlington is located in Tarrant County on State Stream Segment No. 0828. Segment 0828 extends from Arlington Dam in Tarrant County up to the normal pool elevation of 550 feet that impounds Village Creek. It is currently used for contact recreation, public water supply, a high-quality aquatic habitat, power plant cooling, and terminal storage of water pumped from Cedar Creek Reservoir by Tarrant County Water Control and Improvement District No. 1. Future uses include a continuation of the existing uses, as well as terminal storage for water from Richland Chambers Reservoir in East Texas. Although Lake Arlington is owned by the City of Arlington, most of the water in the lake is owned by the District. The District supplies most of Arlington's water. Water supplied to Lake Arlington by the District is brought by pipeline from Cedar Creek. Part of the lake's water is taken by the Trinity River Authority to provide other customers in the mid-cities area. Other water customers include the cities of Mansfield and Dalworthington Gardens.

The watershed for Lake Arlington is 143 square miles and covers portions of Johnson and Tarrant counties. The incorporated cities within the watershed are Arlington, Burleson, Everman, Fort Worth, Kennedale, Briar Oaks, Crowley, Forest Hill, and Joshua.

TABLE II-7

UPPER TRINITY RIVER BASIN LAKES
WHOLESALE SURFACE WATER SUPPLIERS

Lake	Wholesale Water Suppliers
Lake Arlington	City of Arlington City of Bedford City of Dalworthington Gardens City of Mansfield Trinity River Authority Tarrant County Water Project
Lake Benbrook	Benbrook Water and Sewer Authority City of Fort Worth
Lake Bridgeport	City of Fort Worth TCWCID No. 1 City of Chico City of Decatur City of Runaway Bay Sid Richardson Scout Ranch West Wise Rural WSC
Eagle Mountain Lake	City of Azle City of Fort Worth TCWCID No. 1 City of Reno City of Springtown Walnut Creek WSC Community WSC Slay Estates Texas Electric Service Company
Lake Weatherford	City of Weatherford
Lake Worth	City of Fort Worth City of River Oaks City of Lake Worth

TABLE II-8

UPPER TRINITY RIVER BASIN LAKES
EXISTING AND PROJECTED CONSUMPTIVE WATER USE

Use	Arlington	Benbrook	Bridgeport	Eagle Mountain	Weatherford	Worth
1) 1980 CONSUMPTIVE USES (AC-FT)						
Total Municipal	19,345	5,771	1,881	9,405	641	3,313
Total Other	4,680	1,396	455	2,275	155	802
Total Use	24,025	7,168	2,336	11,681	796	4,115
2) 1990 CONSUMPTIVE USES (AC-FT)						
Total Municipal	28,930	10,467	2,352	14,112	988	7,527
Total Other	7,868	2,846	640	3,838	269	2,047
Total Use	36,798	13,313	2,992	17,950	1,257	9,573
3) 2000 CONSUMPTIVE USES (AC-FT)						
Total Municipal	36,655	15,709	2,594	17,614	1,238	9,759
Total Other	11,098	4,756	785	5,333	375	2,955
Total Use	47,753	20,465	3,380	22,946	1,612	12,713

<u>**Benbrook Lake**</u>. Benbrook Lake is located in Tarrant County and is State Stream Segment No. 0830. Segment 0830 extends from Benbrook Dam in Tarrant County to a point 220 yards downstream of U.S. 377 in Tarrant County, up to the normal pool elevation of 694 feet that impounds the Clear Fork of the Trinity River. The lake is currently used for flood control, conservation storage, navigation, contact recreation, municipal water supply, and as a high-quality aquatic habitat. Future uses include continuation of the existing uses mentioned above, as well as terminal storage for water diverted from Cedar Creek and Richland Chambers Reservoirs.

The lake is owned by the U.S. Government, and is under the jurisdiction of the U.S. Army Corps of Engineers. The major water supply systems for this watershed are the City of Fort Worth and the Benbrook Water and Sewer Authority.

The total drainage area upstream of Benbrook Lake is 429 square miles and covers portions of Johnson, Parker, Hood (minimal), and Tarrant counties. The incorporated cities included in this drainage area are Aledo, Annetta, Annetta North, Annetta South, Benbrook, Hudson Oaks, Weatherford, and Willow Park.

<u>**Lake Bridgeport**</u>. Lake Bridgeport is located on the West Fork of the Trinity River (State Stream Segment No. 0811). Segment 0811 extends from Bridgeport Dam in Wise County to a point immediately upstream of the confluence of Bear Hollow in Jack County, up to the normal pool elevation of 836 feet that impounds the West Fork of the Trinity River. Lake Bridgeport is currently used for contact recreation, public water supply, mining and other industrial uses, irrigation, storage, and a high-quality aquatic habitat. The lake is owned by the District and covers portions of Wise and Jack counties. Major municipal water rights holders are the District and the cities of Bridgeport, Runaway Bay, and Bay Landing. The watershed for Lake Bridgeport covers 1,111 square miles.

Eagle Mountain Lake. Eagle Mountain Lake is located in portions of Tarrant and Wise counties on State Stream Segment No. 0809. Segment 0809 extends from Eagle Mountain Dam in Tarrant County to a point 0.6 mile downstream of the confluence of Oates Branch in Wise County, up to the normal pool elevation of 649.1 feet that impounds the West Fork of the Trinity River. Eagle Mountain Lake is currently used for public water supply, contact recreation, power plant cooling, and a high-quality aquatic habitat. The reservoir and dam are owned by the District, and major municipal water customers include the cities of Fort Worth, Azle, Reno, and Springtown. The total drainage area upstream of Eagle Mountain Lake is 1,970 square miles.

Lake Weatherford. Lake Weatherford is located on the Clear Fork of the Trinity River (State Stream Segment No. 0832) in Parker County. Segment 0832 extends from Weatherford Dam in Parker County to a point 1.9 miles upstream of FM 1707 in Parker County, up to the normal pool elevation of 896 feet that impounds the Clear Fork of the Trinity River. Lake Weatherford is currently used for public water supply, contact recreation, power plant cooling, and a high-quality aquatic habitat. The City of Weatherford owns the lake and is currently its only major municipal user. The watershed area is 109 square miles.

Lake Worth. Lake Worth (State Stream Segment No. 0807) is located in Tarrant County on the West Fork of the Trinity River south of Eagle Mountain Lake. Segment 0807 extends from Lake Worth Dam in Tarrant County to a point 2.5 miles downstream of Eagle Mountain Dam in Tarrant County, up to the normal pool elevation of 594.3 feet that impounds the West Fork of the Trinity River. Lake Worth is currently used for public water supply, contact recreation, and a high-quality aquatic habitat. The lake is owned by the City of Fort Worth, and its major municipal users are the cities of Fort Worth and River Oaks. The total drainage area upstream of Lake Worth is 2,064 square miles.

TABLE II-9

GROUNDWATER SOURCES FOR MAJOR WATER PRODUCTION FACILITIES

Watershed	Groundwater Source
Arlington	Trinity Group used by City of Arlington.
Benbrook Lake	Trinity Group used by Benbrook Water and Sewer Authority and City of Fort Worth. Paluxy Formation used by Benbrook Water and Sewer Authority.
Lake Bridgeport	Trinity Group used by City of Fort Worth.
Eagle Mountain Lake	Trinity Group used by City of Fort Worth.
Lake Weatherford	Not Applicable.
Lake Worth	Trinity Group Used by City of Fort Worth.

Groundwater

While the bulk of the water supplied to the Upper Trinity River Basin users is surface water, there are groundwater resources available and used. Table II-9 lists the groundwater sources used in the Upper Trinity River Basin.

WATER QUALITY STANDARDS

This section discusses the Texas Water Commission's (TWC) Surface Water Quality Standards that apply to the waters in the Upper Trinity River Basin. The state of Texas develops the standards with the intent to:

> Maintain the quality of water in the state consistent with public health and enjoyment, propagation and protection of terrestrial and aquatic life, operation of existing industries, and economic development of the state; to encourage and promote development and use of regional and area wide wastewater collection treatment, and disposal systems to serve the wastewater disposal needs of the citizens of the state; and to require the use of all reasonable methods to implement this policy.

The Texas Surface Water Quality Standards are defined in detail in the Texas Administrative Code (TAC) Chapter 307. The standards applicable to the study are briefly summarized below.

Classification of Surface Waters

The major surface waters of the state are classified as segments for purposes of water quality management and designation of site-specific standards. Classified segments are aggregated by basins. The Trinity River

Basin is Segment 0800. The Upper Trinity River Basin consists of 13 hydrologic units or classified stream segments and one unclassified segment (denoted 0800). Each stream segment included in the study area is listed below with a brief description.

Stream Segment	Description
0800	Village Creek - This is an unclassified segment, but for the purposes of this study the segment includes Village Creek from the Town of Joshua to the point where the creek is impounded by Lake Arlington.
0807	Lake Worth - This segment includes Lake Worth from Lake Worth Dam to a point 2.5 miles downstream of Eagle Mountain Dam.
0808	West Fork Trinity River Below Eagle Mountain Reservoir - This segment includes the West Fork from a point 2.5 miles downstream of Eagle Mountain Dam to Eagle Mountain Dam.
0809	Eagle Mountain Reservoir - This segment includes Eagle Mountain Reservoir and its tributaries from Eagle Mountain Dam to a point 0.6 mile downstream of the confluence of Oates Branch with the West Fork of the Trinity River.
0810	West Fork Trinity River Below Bridgeport Reservoir - This segment includes the West Fork from a point 0.4 mile downstream of the confluence of Oates Branch to Bridgeport Dam.
0811	Bridgeport Reservoir - This segment includes Bridgeport Reservoir from Bridgeport Dam upstream to the confluence of Bear Hollow.

0812 West Fork Trinity River Above Bridgeport Reservoir - This segment includes the West Fork from the confluence of Bear Hollow to SH 79 in Archer County.

0828 Lake Arlington - This segment includes Lake Arlington from Lake Arlington Dam to the point where Village Creek becomes impounded.

0829 Clear Fork Trinity River Below Benbrook Lake - This segment includes the Clear Fork from the confluence with the West Fork to Benbrook Lake Dam.

0830 Benbrook Lake - This segment includes Benbrook Lake from Benbrook Lake Dam to a point 220 yards downstream of U.S. 377.

0831 Clear Fork Trinity River Below Lake Weatherford - This segment includes the Clear Fork from a point 220 yards downstream of U.S. 377 to Lake Weatherford Dam.

0832 Lake Weatherford - This segment includes Lake Weatherford from Lake Weatherford Dam to the location where the Clear Fork becomes impounded by the lake.

0833 Clear Fork Trinity River Above Lake Weatherford - This segment includes the Clear Fork from where the Clear Fork becomes impounded by Lake Weatherford to FM 3107 in Parker County.

General Water Quality Criteria

The State establishes general water quality criteria that apply to all waters of the state and specifically apply to substances attributed to waste discharges or the activities of man. The general criteria do not apply to those occasions when surface waters exhibit characteristics beyond the limits established by these criteria as a result of natural phenomena. The general criteria are paraphrased below.

Aesthetic Parameters.

1. Concentrations of taste- and odor-producing substances shall not interfere with the production of potable water by reasonable water treatment methods, impart unpalatable flavor to food fish including shellfish, result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the water in the state.

2. Surface water shall be essentially free of floating debris and suspended solids that are conducive to producing adverse responses in aquatic organisms or of putrescible sludge deposits or sediment layers that adversely affect benthic biota or any lawful uses.

3. Surface waters shall be essentially free of settleable solids conducive to changes in flow characteristics of stream channels or the untimely filling of reservoirs, lakes, and bays.

4. Surface waters shall be maintained in an aesthetically attractive condition.

5. Waste discharges shall not cause substantial and persistent changes from ambient conditions of turbidity or color.

6. There shall be no foaming or frothing of a persistent nature.

7. Surface waters shall be maintained so that oil, grease, or related residue will not produce a visible film of oil or globules of grease on the surface or coat the banks or bottoms of the watercourse.

Radiological Parameters. Radioactive materials shall not be discharged in excess of the amount regulated by Texas Regulations for Control of Radiation.

Toxic Parameters. Surface waters shall not be toxic to man, or to terrestrial or aquatic life. Additional standards requirements for toxic materials are specified in a later section of this report.

Nutrient Parameters. Generally applicable criteria for nitrogen, phosphorous, carbon, and trace elements cannot be established because sufficient information on nutrient cycling in Texas waters and cause-effect relationships between nutrient concentrations and water quality is not presently available. Site-specific nutrient criteria and/or permit limitations, where appropriate, will be established as information becomes available and after public participation and proper hearing. Nutrients from permitted discharges or other controllable sources shall not cause excessive growth of aquatic vegetation that impairs an existing or designated use.

Temperature. Temperature in industrial cooling lake impoundments and all other surface water in the state shall be maintained so as not to interfere with the reasonable use of such waters. Numerical temperature criteria have not been specifically established for industrial cooling lake impoundments, which in most areas of the state contribute to water conservation and water quality objectives. With the exception of industrial cooling impoundments, temperature elevations due to discharges of treated domestic (sanitary) effluent, and designated mixing a maximum temperature differential (rise over ambient) are established: fresh water streams - 5°F; fresh water lakes and impoundments - 3°F; tidal river reaches, bays, and gulf waters - 4°F in fall, winter, and spring and 1.5°F in summer (June, July, and August). Additional temperature criteria (expressed as maximum temperatures) for the classified segments in the study are specified in the numerical criteria section.

Dissolved Oxygen for Unclassified Waters. Unclassified waters that are perennial or support perennial aquatic life are designated for the specific uses that are existing or characteristic of those waters. In instances where little or no information is available to assess those uses, the waters will be preliminarily assumed to have a limited aquatic life use and associated criteria, as defined in TAC §307.7 (relating to site-specific uses and criteria). Upon administrative or regulatory action by the Commission that affects a particular unclassified water body, the characteristics of the affected water body will be reviewed to determine which aquatic life uses are appropriate. Additional uses so determined will be indicated in public notices for discharge applications. Uses that are not applicable throughout the year in a particular unclassified water body will be assigned and protected for the seasons in which such uses occur. Initial determinations of use will be considered preliminary, and in no way preclude redetermination of use in public hearings conducted by the Commission under the provisions of the Texas Water Code.

Antidegradation. Nothing in the general criteria shall be construed or otherwise utilized to supersede the requirements relating to antidegradation.

Dissolved Oxygen for Unclassified Waters. Intermittent streams, unclassified streams, and unclassified dead-end barge and ship canals will maintain a 24-hour mean dissolved oxygen concentration of 3.0 mg/l, unless this level of protection is not technologically achievable with advanced treatment, as defined in the current TWC Continuing Planning Process Document, or unless no uses for the waters are expected that would require this concentration. A 24-hour mean of 2.0 mg/l dissolved oxygen will be required except in extraordinary circumstances. Absolute minimum dissolved oxygen concentrations at any time shall be 1.5 mg/l. Existing uses, including significant aquatic life uses created by perennial pools, will be maintained in conformance with the provisions relating to antidegradation. Seasonal uses or protection of downstream uses may require a higher dissolved oxygen concentration. In these cases, the higher dissolved oxygen level will be maintained in the seasons in which the use occurs, if the higher level can be achieved with advanced treatment, no discharge, or other approved control measure. Uses for intermittent streams may include such seasonal uses as contact and noncontact recreation, navigation, agricultural and industrial raw water supply, and aquatic life uses. Uses for unclassified dead-end barge and ship canals may include navigation, contact (where not prohibited) and noncontact recreation, industrial water supply, and aquatic life uses.

Bacteria. A fecal coliform criterion of not more than 200 bacteria per 100 ml shall apply to all water bodies not specifically listed for numerical criteria. Application of this criterion shall be in accordance with site-specific uses and criteria.

Antidegradation

Existing uses will be maintained and protected. No activities subject to regulatory action that would cause significant degradation of waters exceeding fishable/swimmable quality will be allowed unless it can be shown to the Commission's satisfaction that the lowering of water quality is necessary for important economic or social development. For details on the antidegradation policy and implementation of the policy, refer to TAC §307.6.

Toxic Materials

Water in the state shall not be acutely toxic to aquatic life except in small zones of initial dilution at discharge points. Water in the state with designated or existing aquatic life uses shall not be chronically toxic to aquatic life except in mixing zones and below critical low-flow conditions. Water in the state shall be maintained to preclude adverse toxic effects on human health resulting from contact recreation, consumption of aquatic organisms, or consumption of drinking water after reasonable treatment.

Permitted discharges or other controllable sources shall not cause maximum contaminant levels for public drinking water supplies, as established in the Federal Safe Drinking Water Act, to be exceeded after reasonable treatment by a water supply plant. Table II-10 presents the finished water standards from the EPA, Texas Department of Health, and the City of Fort Worth. Numerical criteria have been established for those specific toxic substances for which adequate toxicity information is available and that have the potential for exerting adverse impacts on the waters of the state. Numerical criteria applicable to toxic substances in the study area are presented in Table II-11. Additional details of the toxic material criteria and implementation of the criteria are presented in TAC §307.6.

Site-Specific Uses and Numerical Criteria

Uses and numerical criteria are established on a site-specific basis for classified segments and may also be applied to some unclassified waters.

TABLE II-10

DRINKING WATER STANDARDS

	EPA and Texas Department of Health Standards (mg/l)	City of Fort Worth Standards: Holly Water Treatment Plant (mg/l)	City of Fort Worth Standards: Rolling Hills Water Treatment Plant (mg/l)
PRIMARY STANDARDS			
Heavy Metals			
Arsenic	0.05	<0.02	<0.02
Barium	1.0	0.06	0.03
Cadmium	0.01	<0.01	<0.01
Chromium	0.05	0.02	0.02
Lead	0.05	0.01	0.01
Mercury	0.002	<0.0002	<0.0002
Selenium	0.01	<0.01	<0.01
Silver	0.05	<0.01	<0.01
Organics			
Endrin	0.0002	ND	ND
Lindane	0.004	ND	ND
Methoxychlor	0.1	ND	ND
Toxaphene	0.005	ND	ND
2,4-D	0.1	ND	ND
2,4,5-TP Silvex	0.01	ND	ND
Bacteriological			
Coliform Organisms	1.0(a)	0(a)	0(a)
SECONDARY STANDARDS			
Heavy Metals			
Copper	1.0	0.02*	0.01*
Iron	0.3	0.14*	0.20*
Manganese	0.05	0.02*	0.02*
Zinc	5.0	0.01*	0.01*
Other			
Chloride	300	44	26
Sulfate	300	29	36
Total Dissolved Solids	1000	248	157

Source: City of Fort Worth Water Department

ND - Not found at the minimum amount of the substance that can be detected by the EPA-approved method used

* - Four-quarter average

(a) - Organisms per 100 milliliters

TABLE II-11

CRITERIA FOR SPECIFIC TOXIC MATERIALS

Parameter	Fresh Water Acute Criteria (ug/l)	Fresh Water Chronic Criteria (ug/l)
Aldrin	3.0	----
Arsenic	360	190
Cadmium	32.2	1.1
Chlordane	2.4	0.0043
Chlorpyrifas	0.083	0.041
Chromium (Tri)	1679	200
Chromium (Hex)	16	11
Copper	18.5	12.36
Cyanide	45.78	10.69
DDT	1.1	0.0010
Demeton	---	0.1
Dieldrin	2.5	0.0019
Endosulfan	0.22	0.056
Endrin	0.18	0.0023
Guthion	---	0.01
Heptachlor	0.52	0.0038
Lindane	2.0	0.08
Lead	77.5	3.02
Malathion	---	0.01
Mercury	2.4	0.012
Methoxychlor	---	0.03
Mirex	---	0.001
Nickel	1370	152.3
PCBs (total)	2.0	0.014
Parathion	0.065	0.013
Pentachlorophenol	12.26	7.74
Selenium	260	35
Silver	3.78	0.49
Toxaphene	0.78	0.0002
Zinc	113	102.4

Note: Acute toxicity exerts short-term lethal impacts. Chronic toxicity exerts sublethal detrimental effects over an extended period such as growth impairment and reduced reproduction.

Parameters for which numerical standards have been developed include chlorides, sulfates, total dissolved solids, dissolved oxygen, pH, fecal coliform bacteria, and temperature.

Numerical standards and water use classification in the present Texas Surface Water Quality Standards, as well as the 1985 and 1987 Standards, are shown in Tables II-12, II-13, and II-14, respectively. It is apparent that very little change has occurred in the numerical standards and water uses for the stream segments in the Upper Trinity River Basin over the 7-year period being evaluated.

The existing water quality in the Upper Trinity River Basin segments is good, and each segment is classified for contact recreation, high-quality aquatic habitat, and public water supply. The state's definitions of these classifications are provided below.

<u>Contact Recreation</u>. Contact recreation activities are those that involve significant risk of ingestion of water, including wading by children, swimming, water skiing, diving, and surfing.

<u>Public Water Supply</u>. Segments designated for public water supply are those known to be used, or exhibiting characteristics that would allow them to be used, as the supply source for community and noncommunity water supply systems, as defined by regulations promulgated pursuant to the Safe Drinking Water Act (42 USC 300f, et seg.).

<u>Aquatic Life Subcategories</u>. The establishment of numerical criteria for aquatic life is highly dependent on desired use, sensitivities of usual aquatic communities, and local physical and chemical characteristics. Four subcategories of use are established. They include limited-quality, intermediate-quality, high-quality, and exceptional-quality aquatic habitat. The aquatic life categories attempt to recognize the natural variability of

TABLE II-12

CURRENT TEXAS SURFACE WATER QUALITY STANDARDS
UPPER TRINITY RIVER BASIN

Segment Number	Segment Name	Water Uses[1] A	B	C	D	CL^2 (mg/l)	SO_4[3] (mg/l)	TDS[4] (mg/l)	DO[5] (mg/l)	pH (S.U.)	Fecal[6] Coliform	Temp[7] (°F)
0807	Lake Worth	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0808	West Fork Trinity River Below Eagle Mountain Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0809	Eagle Mountain Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	94
0810	West Fork Trinity River Below Bridgeport Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0811	Bridgeport Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	90
0812	West Fork Trinity River Above Lake Bridgeport	CR	H	PS		100	100	500	5.0	6.5-9.0	200	88
0828	Lake Arlington	CR	H	PS		100	100	300	5.0	6.5-9.0	200	95
0829	Clear Fork Trinity River Below Benbrook Lake	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0830	Benbrook Lake	CR	H	PS		75	75	300	5.0	6.5-9.0	200	93
0831	Clear Fork Trinity River Below Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0832	Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0833	Clear Fork Trinity River Above Lake Weatherford	CR	H	PS		125	125	750	5.0	6.5-9.0	200	95

Source: Texas Water Commission SURFACE WATER QUALITY STANDARDS

[1]Class A: Recreation (CR - Contact Recreation)
Class B: Aquatic Life (H - High Quality)
Class C: Domestic Water Supply (PS - Public Water Supply)
Class D: Other

[2]Chlorides: Annual average not to exceed this value.

[3]Sulfate: Annual average not to exceed this value.

[4]Total Dissolved Solids: Annual average not to exceed this value.

[5]Dissolved Oxygen:

[6]Fecal Coliform: For contact recreation, fecal coliform content shall not exceed 200 colonies per 100 ml as a geometric mean based on a representative sampling of not less than five samples collected over not more than thirty days.

[7]Temperature: Not to exeed this value.

TABLE II-13

1985 TEXAS SURFACE WATER QUALITY STANDARDS
UPPER TRINITY RIVER BASIN

Segment Number	Segment Name	Water Uses[1] A	B	C	D	CL^2 (mg/l)	SO_4[3] (mg/l)	TDS[4] (mg/l)	DO[5] (mg/l)	pH (S.U.)	Fecal[6] Coliform	Temp[7] (^oF)
0807	Lake Worth	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0808	West Fork Trinity River Below Eagle Mountain Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0809	Eagle Mountain Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	94
0810	West Fork Trinity River Below Bridgeport Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0811	Bridgeport Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	90
0812	West Fork Trinity River Above Lake Bridgeport	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0828	Lake Arlington	CR	H	PS		100	100	300	5.0	6.5-9.0	200	95
0829	Clear Fork Trinity River Below Benbrook Lake	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0830	Benbrook Lake	CR	H	PS		75	75	300	5.0	6.5-9.0	200	93
0831	Clear Fork Trinity River Below Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0832	Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0833	Clear Fork Trinity River Above Lake Weatherford	CR	H	PS		125	125	750	5.0	6.5-9.0	200	95

Source: Texas Water Commission SURFACE WATER QUALITY STANDARDS
[1]Class A: Recreation (CR - Contact Recreation)
Class B: Aquatic Life (H - High Quality)
Class C: Domestic Water Supply (PS - Public Water Supply)
Class D: Other
[2]Chlorides: Annual average not to exceed this value.
[3]Sulfate: Annual average not to exceed this value.
[4]Total Dissolved Solids: Annual average not to exceed this value.
[5]Dissolved Oxygen:
[6]Fecal Coliform: For contact recreation, fecal coliform content shall not exceed 200 colonies per 100 ml as a geometric mean based on a representative sampling of not less than five samples collected over not more than thirty days.
[7]Temperature: Not to exeed this value.

TABLE II-14

1981 TEXAS SURFACE WATER QUALITY STANDARDS
UPPER TRINITY RIVER BASIN

Segment Number	Segment Name	Water Uses[1] A	B	C	D	CL[2] (mg/l)	SO_4[3] (mg/l)	TDS[4] (mg/l)	DO[5] (mg/l)	pH (S.U.)	Fecal[6] Coliform	Temp[7] (°F)
0807	Lake Worth	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0808	West Fork Trinity River Below Eagle Mountain Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	91
0809	Eagle Mountain Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	94
0810	West Fork Trinity River Below Bridgeport Reservoir	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0811	Bridgeport Reservoir	CR	H	PS		75	75	300	5.0	6.5-9.0	200	90
0812	West Fork Trinity River Above Lake Bridgeport	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0828	Lake Arlington	CR	H	PS		100	100	300	5.0	6.5-9.0	200	95
0829	Clear Fork Trinity River Below Benbrook Lake	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0830	Benbrook Lake	CR	H	PS		75	75	300	5.0	6.5-9.0	200	93
0831	Clear Fork Trinity River Below Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	90
0832	Lake Weatherford	CR	H	PS		100	100	500	5.0	6.5-9.0	200	93
0833	Clear Fork Trinity River Above Lake Weatherford	CR	H	PS		125	125	750	5.0	6.5-9.0	200	95

Source: Texas Water Commission SURFACE WATER QUALITY STANDARDS

[1]Class A: Recreation (CR - Contact Recreation)
Class B: Aquatic Life (H - High Quality)
Class C: Domestic Water Supply (PS - Public Water Supply)
Class D: Other

[2]Chlorides: Annual average not to exceed this value.

[3]Sulfate: Annual average not to exceed this value.

[4]Total Dissolved Solids: Annual average not to exceed this value.

[5]Dissolved Oxygen:

[6]Fecal Coliform: For contact recreation, fecal coliform content shall not exceed 200 colonies per 100 ml as a geometric mean based on a representative sampling of not less than five samples collected over not more than thirty days.

[7]Temperature: Not to exeed this value.

natural variability of aquatic community requirements and local environmental conditions. Table II-15 lists dissolved oxygen criteria for the aquatic life subcategories for fresh water.

SUMMARY

The project described in this document focused on development of a feasibility plan for regional wastewater collection, treatment, and disposal facilities for the Upper Trinity River Basin planning areas. The land use and population estimates presented in this chapter are used in the next chapter to develop nonpoint and point source load estimates and projections. The surface water quality standards establish water quality goals and objectives to be protected by appropriate water use and wastewater treatment and disposal and against which to compare the potential impact of the various wastewater treatment and disposal alternatives.

TABLE II-15

DISSOLVED OXYGEN CRITERIA
AQUATIC LIFE SUBCATEGORIES

Aquatic Life Use Subcategory	Dissolved Oxygen Criteria, mg/l		Aquatic Life Attributes		
	Freshwater mean/minimum	Freshwater in Spring mean/minimum	Habitat Characteristics	Sensitive Species	Diversity
Exceptional	6.0/4.0	6.0/5.0	Outstanding Natural Variability	Abundant	Exceptionally High
High	5.0/3.0	5.5/4.5	Highly diverse	Present	High
Intermediate	4.0/3.0	5.0/4.0	Moderately diverse	Very low abundance	Moderate
Limited	3.0/2.0	4.0/3.0	Uniform	Rare	Low

Source: 1988 Texas Surface Water Quality Standards, Texas Water Commission, April 1988.

Note: Dissolved oxygen means are applied as an average over a 24-hour period.

Daily minimum are not to extend beyond 8 hours per 24-hour day. Lower dissolved oxygen minimum may apply on a site-specific basis.

Spring criteria to protect fish spawning periods are applied during that portion of the first half of the year when water temperatures are 63.0^{o}F to 73.0^{o}F.

CHAPTER III

WATER QUALITY ASSESSMENT

INTRODUCTION

This chapter addresses the existing and projected water quality in the Upper Trinity River planning area. The water quality assessment consists of a review of historical water quality and development of models to project water quality in the planning area lakes and streams. Each of the elements of the water quality assessment is discussed and summarized below. Detailed historical water quality data are presented in Appendix E. The methodologies used in developing the lake and stream models are presented in Appendix D.

HISTORICAL WATER QUALITY

Water Quality Monitoring Stations

Water quality monitoring of the streams and lakes in the Upper Trinity River Basin has been conducted for many years by various federal, state, and local agencies. Data collected from 1980 through 1987 were used to assess historical water quality for this study. Agencies that have performed water quality monitoring or studies in this area include: the U.S. Geological Survey, the Texas Water Commission, the Fort Worth Water Department, the Texas Parks and Wildlife Department, the Texas Department of Health, and the Tarrant County Water Control and Improvement District No. 1. Data collected by other agencies (e.g., cities at their water treatment plant intakes), private firms, or state universities exist, but have not been included in this study.

Intensive water quality surveys were performed for this study by Alan Plummer and Associates, Inc., in association with Tarrant County Water Control and Improvement District No. 1, the City of Arlington's Pierce-Burch

Water Treatment Plant laboratory, and the Trinity River Authority's Central Regional Wastewater Treatment Plant laboratory. The intensive surveys were performed on Lake Worth (7/14/87), Walnut Creek (7/28/87), Lake Bridgeport (7/31/87 and 8/11/87), Benbrook Lake (7/15/87 and 8/12/87), Clear Fork below Lake Weatherford (7/8/87), Town Creek in Weatherford, Texas, (7/8/87), South Fork (7/8/87), and Lake Weatherford (8/3/87 and 8/17/87). The stream surveys measured dissolved oxygen, temperature, specific conductance, and pH through the course of one day at one site above any point source dischargers, the point source discharge, and several sites downstream of the dischargers. Samples were collected at each site and analyzed for nutrients and biochemical oxygen demand. The lake surveys involved sampling the lake at three to five locations on the lake where measurements of dissolved oxygen, temperature, specific conductance, and pH were taken at five foot verticle intervals. If a thermocline was noted, measurements were taken at one foot intervals in the region of greatest change. Samples were collected just below the surface and near the bottom and analyzed for a wide range of chemical parameters. The intensive surveys are explained in detail in Appendix D.

A listing of the water quality monitoring stations used in the historical water quality assessment is presented in Table III-1. The table shows the stream segment in which the station is located (see Chapter II for a description of stream segments), the agency responsible for the station, the station number and location, and the data reporting period. The stations are located on Figures III-1 through III-6.

Some of the sampling stations were monitored continuously over the 7-year period evaluated, while other stations were sampled only periodically or discontinued during the study period. Some stations were used as intensive surveys sites and samples were collected over a period of only a few days. The parameters analyzed at the stations varied. However, most sampling stations did include the basic physical and chemical water quality Table

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
<u>0800</u>				
Village Creek	1	0800.1710	At IH-20 in Arlington	1/8/80 - 6/21/85
	2	0800.1720	At U.S. 287 southwest of Arlington	1/21/80 - 6/14/85
	3	0800.1760	Oak Grove-Rendon Road northwest of Rendon (FM 1187)	1/21/80 - 6/14/85
	4	0800.1770	At Rendon Road southwest of Arlington	1/21/80 - 6/14/85
<u>0807</u>				
Lake Worth	5	0807.0100	Mid lake near dam	2/28/80 - 8/28/87
	18	0804.5400	Lake Worth above Fort Worth, Texas	9/8/80 - 5/10/84

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0807 (continued)	6	A-6	Lake Worth	7/14/87
	7	A-7	Lake Worth	7/14/87
	8	A-8	Lake Worth	7/14/87
	9	A-9	Lake Worth	7/14/87
	10	A-10	Lake Worth	7/14/87
	17	F-17	Lake Worth	1/2/80 - 12/24/87
	19	F-19	Casino Beach at Lake Worth	1/20/80 - 12/24/87
0808				
West Fork of Trinity River-Lake Worth to Eagle Mountain Dam	6	0808.0100	At Ten Mile Bridge	4/8/80 - 8/4/87
	18	F-18	At Ten Mile Bridge	1/2/80 - 12/24/87
0809				
Eagle Mountain Reservoir	7	0809.0010	At right end of dam	7/29/86 - 8/4/87
	8	0809.0100	Mid lake near dam	5/14/80 - 8/28/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0809 (continued)	9	0809.0200	Outer Dozier Slough Cove	7/29/86 - 8/4/87
	10	0809.0220	Mid Dozier Slough Cove	7/29/86 - 8/4/87
	11	0809.0230	Inner Dozier Slough Cove	7/29/86 - 8/4/87
	12	0809.0240	Outer Ash Creek Cove	7/29/86 - 8/4/87
	13	0809.0250	Mid Ash Creek Cove	7/29/86 - 8/4/87
	14	0809.0260	Inner Ash Creek Cove	7/29/86 - 8/4/87
	15	0809.0300	Near Texas Electric	7/29/86 - 8/4/87
	16	0809.0310	Outer Walnut Creek Cove	7/29/86 - 8/4/87
	17	0809.0320	Mid Walnut Creek Cove	7/29/86 - 8/4/87
	18	0809.0330	Inner Walnut Creek Cove	7/29/86 - 8/4/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0809 (continued)	19	0809.0400	Near Cole Subdivision	7/29/86 - 8/4/87
	20	0809.0410	Near Scotty's Camp	7/29/86 - 8/4/87
	21	0809.0420	Outer Old Ranch Cove	1/27/87 - 8/4/87
	22	0809.0430	Inner Old Ranch Cove	1/27/87 - 8/4/87
	23	0809.0500	Near Indian Creek Cove	7/29/86 - 8/4/87
	24	0809.0510	Outer Indian Creek Cove	7/29/86 - 8/4/87
	25	0809.0520	Mid Indian Creek Cove	7/29/86 - 8/4/87
	26	0809.0530	Inner Indian Creek Cove	7/29/86 - 8/4/87
	27	0809.0600	Near Newark Beach	7/29/86 - 8/4/87
	28	0809.0610	Mid Darrett Creek Cove	7/29/86 - 8/4/87
	20	F-20	Near dam	1/2/80 - 12/24/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0809 (continued)	29	0809.0700	Near Fort Worth ISD Outdoor Learning Center	7/29/86 - 8/4/87
Tributaries of Eagle Mountain Reservoir	30	0800.505	Briar Creek at FM 730	2/24/87 - 7/1/87
	31	0800.510	Walnut Creek at FM 1542	2/24/87 - 8/4/87
	32	0800.515	Ash Creek at SH 199	2/24/87 - 8/4/87
	33	0800.520	Dozier Creek at FM 1220	2/24/87 - 7/1/87
	34	0800.525	Indian Creek at FM 718	2/24/87 - 7/1/87
	35	0800.530	Darrett Creek at unnamed road in city	2/24/87 - 7/1/87
	36	0800.5225	Gilmore Branch at FM 1220	2/24/87 - 4/2/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0809 (continued)	32	A-32	Walnut Creek at bridge southwest of Springtown WWTP	7/28/87
	33	A-33	Walnut Creek at bridge northeast, of Springtown WWTP	7/28/87
	34	A-34	Walnut Creek at FM 2257	7/28/87
	35	A-35	Walnut Creek at FM 1540	7/28/87
	36	A-36	Walnut Creek at FM 730	7/28/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0810				
West Fork Trinity - Eagle Mountain Lake Headwater to Bridgeport Dam	37	0810.0010	West Fork Trinity River at Van Meter Bridge	7/30/86 - 8/4/87
	38	0810.0050	At SH 114 east of Boyd	(NO DATA)
	39	0810.0100	At FM 730 northeast of Boyd	4/8/80 - 1/14/87
0811				
Lake Bridgeport Dam	40	0811.0001	At left end of dam	(NO DATA)
	41	0811.0100	Mid lake near dam	5/14/80 - 8/28/87
	42	0811.0200	At confluence with West Fork Arm	5/14/80 - 9/4/80
	17	0804.3000	Near dam	1/9/80 - 5/7/84
	1	A-1	Lake Bridgeport	7/13/87 - 8/11/87
	2	A-2	Lake Bridgeport	7/13/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0811 (continued)	3	A-3	Lake Bridgeport	7/11/87 - 8/11/87
	4	A-4	Lake Bridgeport	7/13/87 - 8/11/87
	5	A-5	Lake Bridgeport	7/13/87
0812				
West Fork Trinity River above Lake Bridgeport	43	0812.0100	At SH 59 northeast of Jacksboro	12/12/80 - 1/14/87
0828				
Lake Arlington	44	0828.0001	In pump house at right end of dam	7/9/84 - 12/30/87
	45	0828.0050	Near TESCO Outfall	9/11/84 - 9/8/86
	46	0828.0100	Mid lake near dam	5/16/80 - 5/12/83
	47	0828.0200	In Henderson's Cove	NO DATA ****
	48	0828.0300	At mid lake	4/10/84 - 2/24/86

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0828 (continued)	49	0828.0400	Near center of lake, off end of Bowman Springs Road	7/10/84 - 9/8/86
		0804.9200		
	8		AC	2/5/80 - 8/28/87
	9		AL	2/5/80 - 8/28/87
	10		BC	2/5/80 - 8/28/87
	11		BL	2/5/80 - 8/28/87
	12		CC	2/5/80 - 8/28/87
	13		DC	2/5/80 - 8/28/87
	14		EC	2/5/80 - 8/28/87
	15		EL	2/5/80 - 8/28/87
	16		FC	2/5/80 - 8/28/87

[1]Reporting Agencies:

- ◯ Texas Water Commission
- △ United States Geological Survey
- ◇ Fort Worth Water Department
- □ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0829				
Clear Fork Trinity River-West Fork Trinity River Confluence in Benbrook Dam	50	0829.0050	At Rogers Road in Fort Worth	(NO DATA)
	51	0829.0100	At Bryant-Irvin Road in Fort Worth	4/8/80 - 2/28/86
	10	F-10	General Dynamics Recreation Area	1/16/80 - 12/24/87
	11	F-11	Overton Park	1/16/80 - 12/24/87
	12	F-12	Como Drainage	1/16/80 - 12/24/87
	13	F-13	Colonial Golf Course	1/16/80 - 12/24/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0829 (continued)	14	F-14	Colonial Cafeteria	1/16/80 - 12/24/87
	15	F-15	Fort Worth Zoo	1/16/80 - 12/24/87
	16	F-16	Forest Lake	1/16/80 - 12/24/87
	7	0804.7000	Clear Fork Near Benbrook, Texas	1/13/81 - 7/26/82
0830				
Benbrook Reservoir	52	0830.0001	In intake structure of dam	(NO DATA)
	53	0830.0100	Mid lake near dam	2/28/80 - 9/17/86

[1]Reporting Agencies:

Texas Water Commission

United States Geological Survey

Fort Worth Water Department

Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0830 (continued)	54	0830.0600	At Pipeline Cove 18 feet deep	4/16/85 - 6/3/85
	55	0830.0605	At Pipeline Cove 16 feet deep	4/16/85 - 6/3/85
	56	0830.0610	At Pipeline Cove 9 feet deep	4/15/85 - 6/5/85
	57	0830.0615	At Pipeline Cove 2 feet deep	4/16/85 - 6/3/85
	58	0830.0700	In Boat Ramp Cove 9 feet deep	4/23/85 - 6/3/85
	59	0830.0705	In Boat Ramp Cove 6 feet deep	4/16/85 - 6/3/85
	60	0830.0710	In Boat Ramp Cove 5 feet deep	4/15/85 - 6/5/85
	61	0830.0715	In Boat Ramp Cove 1 feet deep	4/16/85 - 6/3/85

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
<u>0830</u> (continued)	62	0830.0800	In Rotenone Cove 13 feet deep	4/16/85 - 6/3/85
	63	0830.0805	In Rotenone Cove 10 feet deep	4/16/85 - 6/3/85
	64	0830.0810	In Rotenone Cove 6 feet deep	4/15/85 - 6/5/85
	65	0830.0815	In Rotenone Cove 2 feet deep	4/16/85 - 6/3/85
		0804.6500		
	1		AC	2/5/80 - 7/26/82
	2		AL	2/5/80 - 7/26/82
	3		BC	2/5/80 - 7/26/82
	4		CR	2/5/80 - 7/26/82
	5			CL2/5/80 - 7/26/82
	6		DC	2/5/80 - 7/26/82

[1]Reporting Agencies:

Texas Water Commission

United States Geological Survey

Fort Worth Water Department

Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0830 (continued)	16	A-16	Benbrook Reservoir	7/15/87 - 8/12/87
	17	A-17	Benbrook Reservoir	7/15/87 - 8/12/87
	18	A-18	Benbrook Reservoir	7/15/87
	19	A-19	Benbrook Reservoir	7/15/87 - 8/12/87
	7	F-7	Benbrook Reservoir near dam	8/4/86 - 11/15/87
	8	F-8	Benbrook Reservoir	8/4/86 - 12/15/87
	9	F-9	Benbrook Reservoir near dam	1/16/80 - 12/24/87
Tributaries of Benbrook Reservoir	1	F-1	Longhorn Park	8/4/86 - 12/15/86
	2	F-2	Rocky Creek	8/4/86 - 8/11/87
	3	F-3	Mustang Creek	8/4/86 - 12/15/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLEI III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0830 (continued)	4	F-4	Bear Creek	8/4/86 - 12/15/87
	5	F-5	Clear Fork	8/4/86 - 11/15/87
	6	F-6	Dutch Branch	8/4/86 - 8/11/87
0831				
Clear Fork Trinity River-Benbrook Reservoir Headwater to Weatherford	66	0831.0100	At U.S. 377 southeast of Aledo	4/8/80 - 3/13/85
	19	0804.5850	Clear Fork near Weatherford, Texas	10/20/80 - 8/23/82

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLEI III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0831 (continued)	26	A-26	Clear Fork below Lake Weatherford	7/8/87
	27	A-27	Clear Fork below IH-20	7/8/87
	28	A-28	Clear Fork above confluence with South Fork	7/8/87
	29	A-29	Clear Fork 1.5 miles west of Aledo	7/8/87
	30	A-30	Clear Fork at FM 5	7/8/87
	31	A-31	Clear Fork downstream of Turkey Creek	7/8/87
Tributaries of the Clear Fork	20	A-20	Town Creek in Weatherford, Texas	7/8/87
	21	A-21	Town Creek upstream of the Weatherford WWTP	7/8/87
	22	A-22	Town Creek at IH-20	7/8/87
	23	A-23	Town Creek at Center Point	7/8/87

[1]Reporting Agencies:

Texas Water Commission

United States Geological Survey

Fort Worth Water Department

Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0831 (continued)	24	A-24	Underwood Branch at Center Point	7/8/87
	25	A-25	South Fork at FM 5	7/8/87
0832				
Lake Weatherford	67	0832.0010	In pump house upstream from end of dam	(NO DATA)
	68	0832.0100	Mid lake near dam	12/16/81 - 9/11/82
	11	A-11	Lake Weatherford	8/3/87 - 8/17/87
	12	A-12	Lake Weatherford	8/3/87
	13	A-13	Lake Weatherford	8/3/87 - 8/17/87
	14	A-14	Lake Weatherford	8/3/87
	15	A-15	Lake Weatherford	8/3/87 - 8/17/87

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

TABLE III-1

WATER QUALITY SAMPLING AND MONITORING STATIONS
IN THE UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Station location symbol[1,2]	Station	Location	Data reporting period
0833				
Clear Fork Trinity River above Lake Weatherford	69	0833.0100	At FM 41 northeast of Weatherford	4/8/80 - 3/13/86

[1]Reporting Agencies:

○ Texas Water Commission

△ United States Geological Survey

◇ Fort Worth Water Department

□ Alan Plummer and Associates, Inc.

[2]Station location symbols refer to Figures III-1 through III-6.

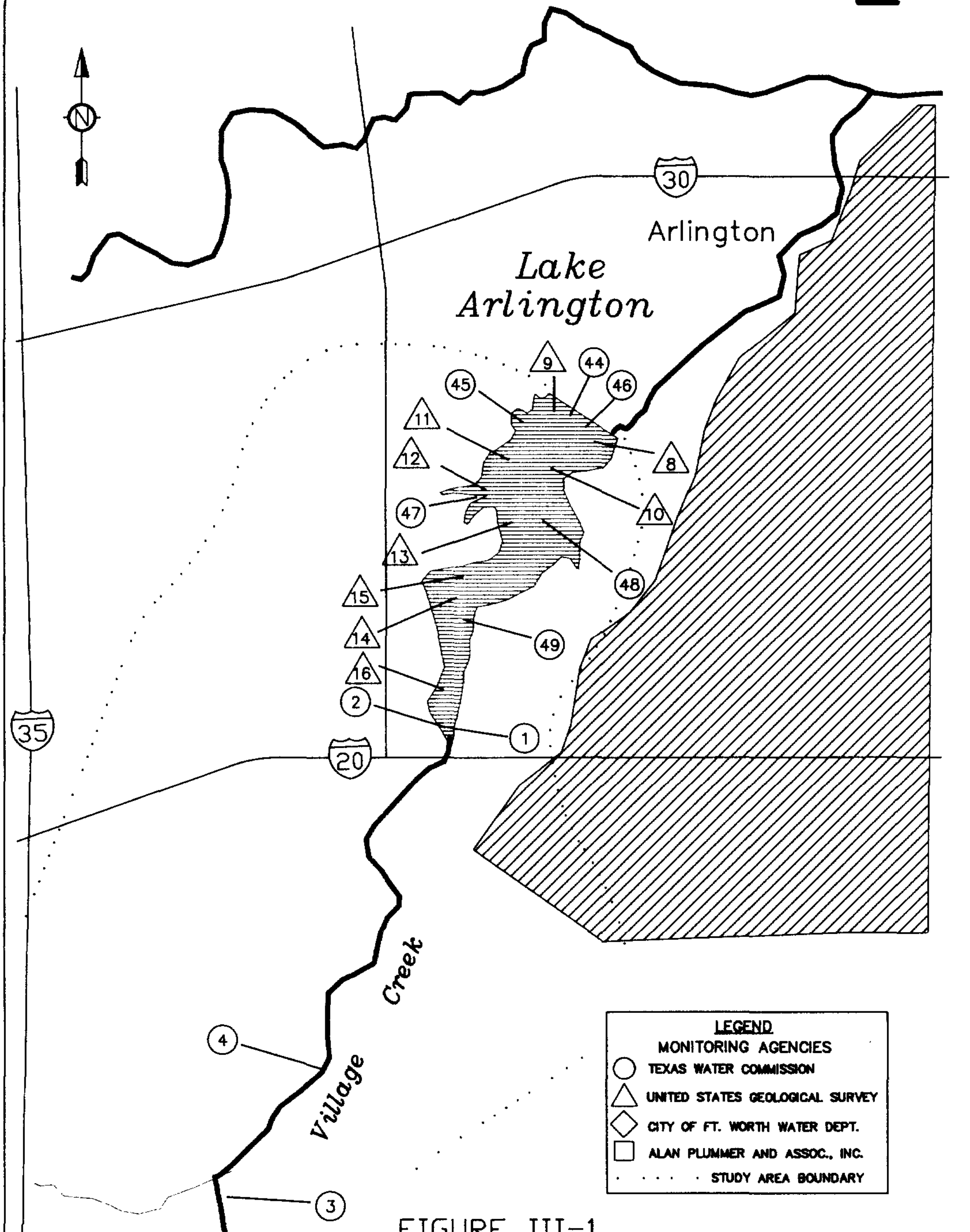


FIGURE III-1
UPPER TRINITY RIVER BASIN
WATER QUALITY MONITORING STATIONS
FOR LAKE ARLINGTON AND VILLAGE CREEK

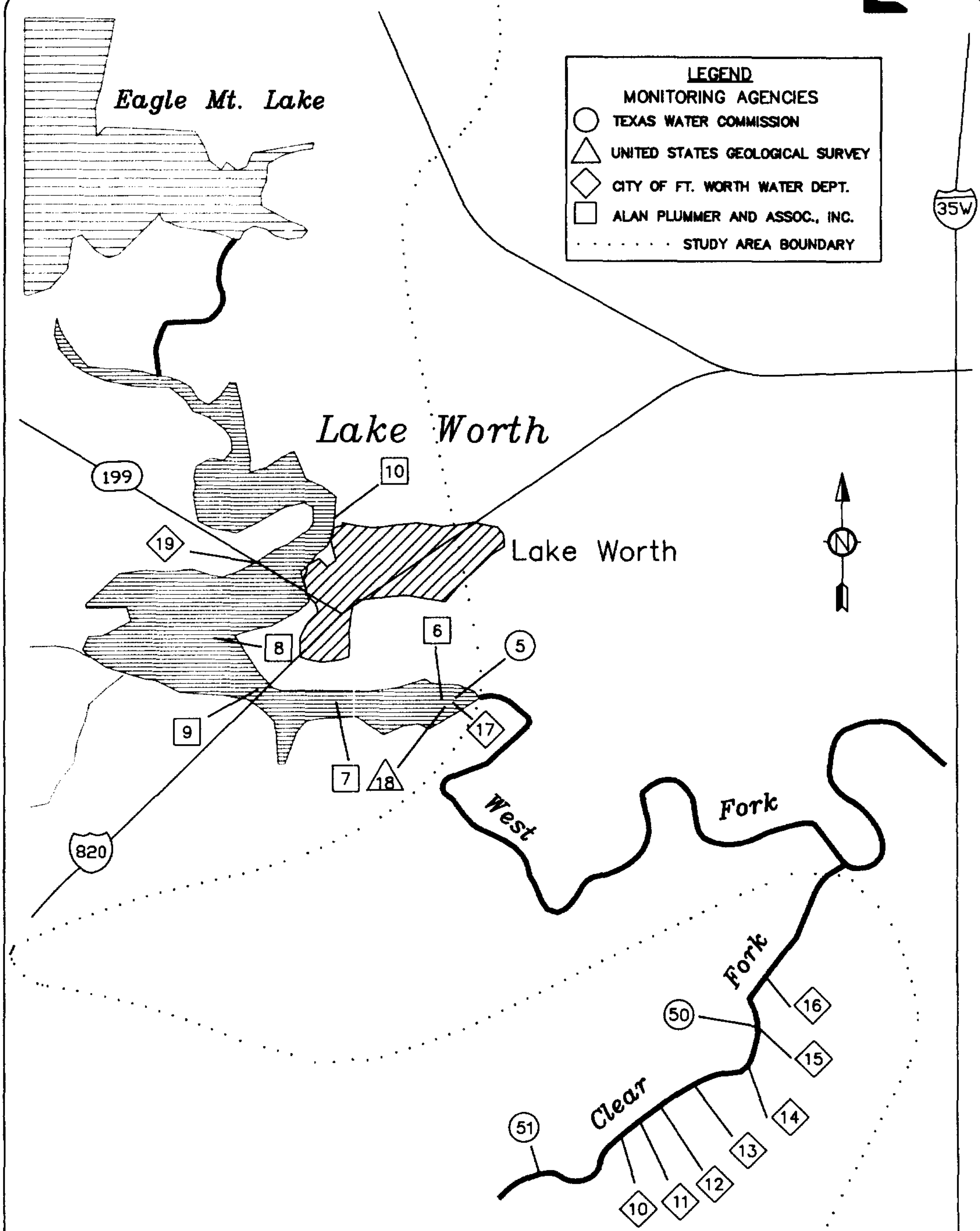


FIGURE III-2
UPPER TRINITY RIVER BASIN WATER QUALITY MONITORING STATIONS FOR LAKE WORTH AND THE CLEAR FORK OF THE TRINITY RIVER

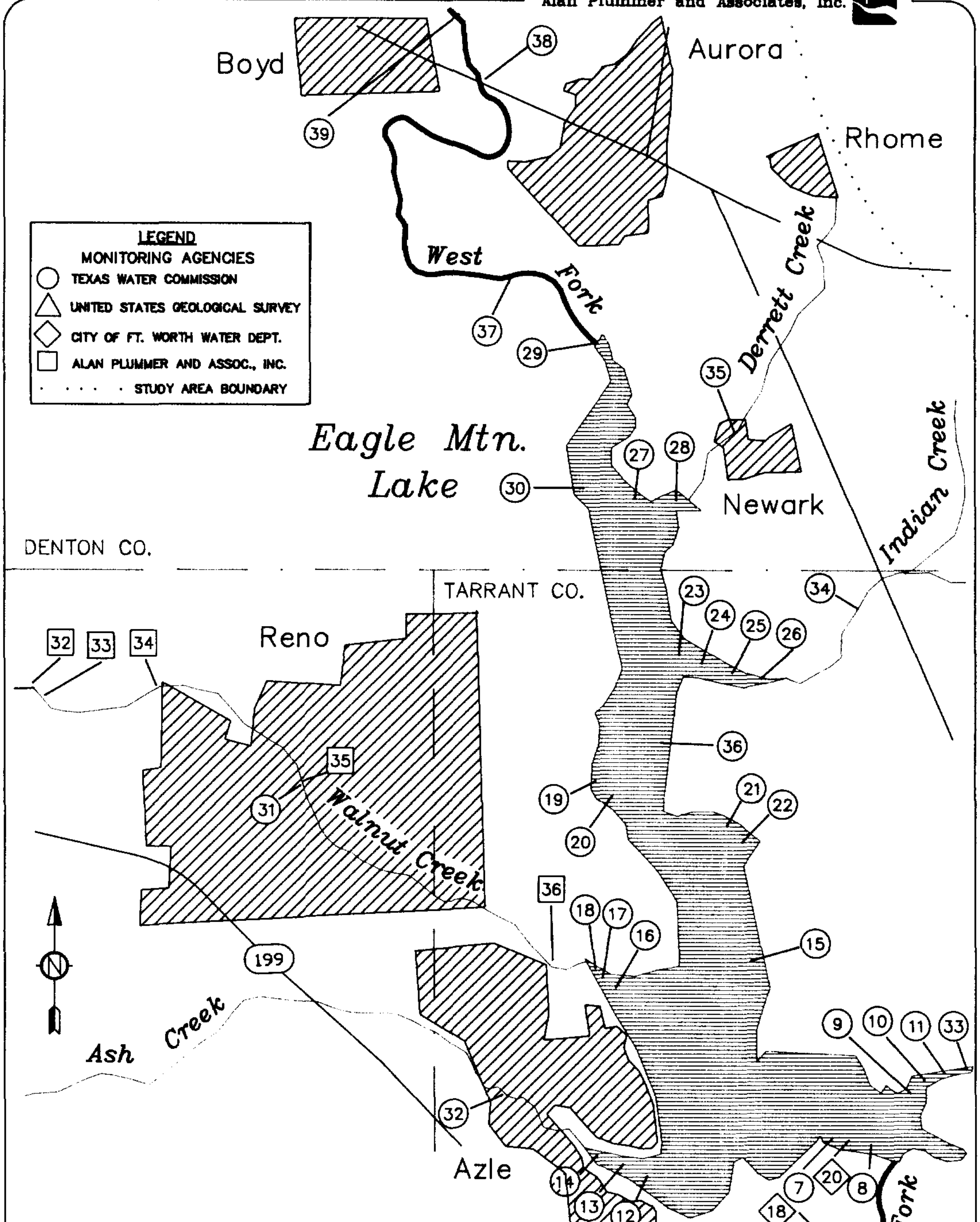


FIGURE III-3
UPPER TRINITY RIVER BASIN WATER QUALITY
MONITORING STATIONS FOR EAGLE MT. RESERVOIR
AND THE WEST FORK OF THE TRINITY RIVER

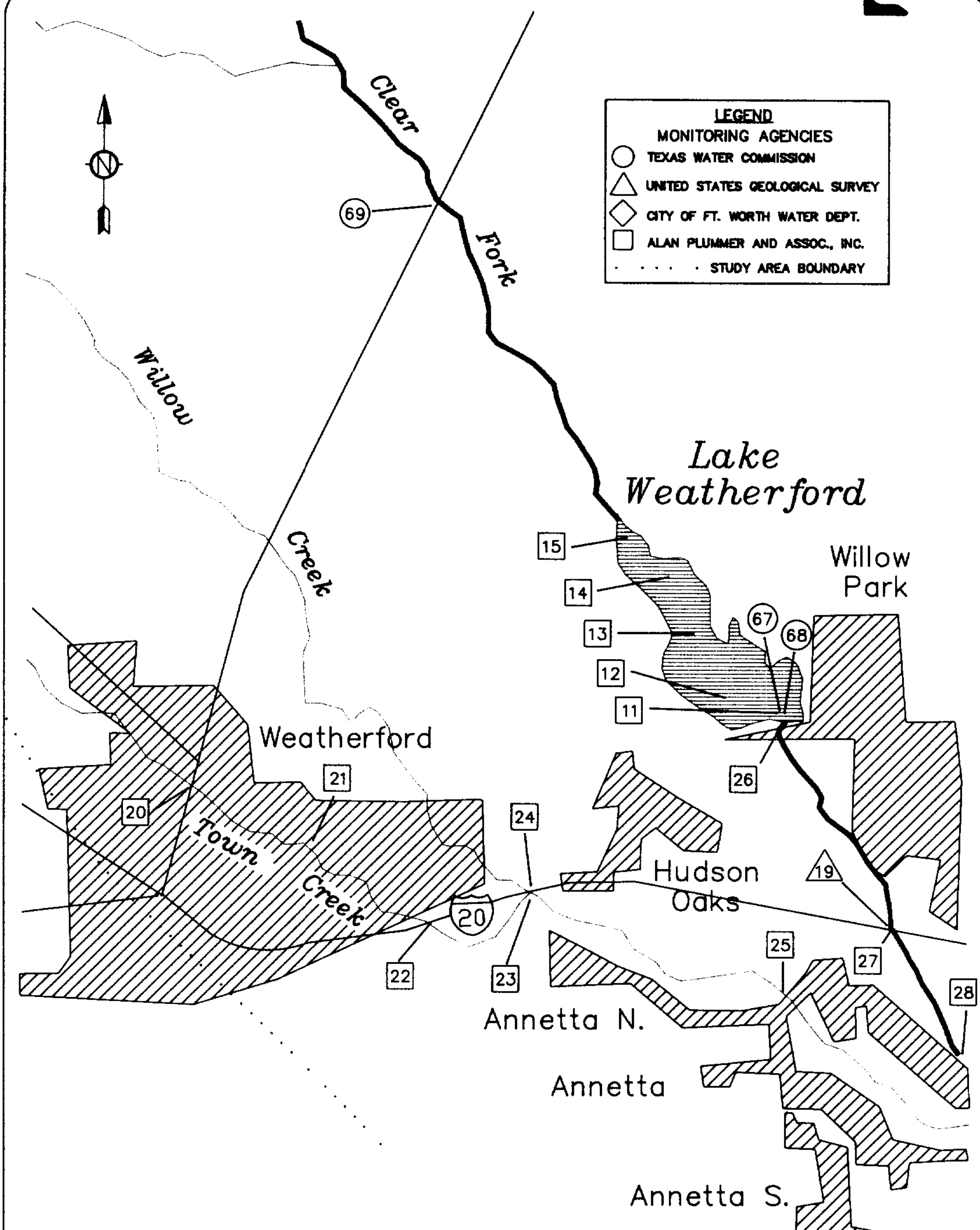


FIGURE III-4
UPPER TRINITY RIVER BASIN WATER QUALITY MONITORING STATIONS FOR LAKE WEATHERFORD AND THE CLEAR FORK OF THE TRINITY RIVER

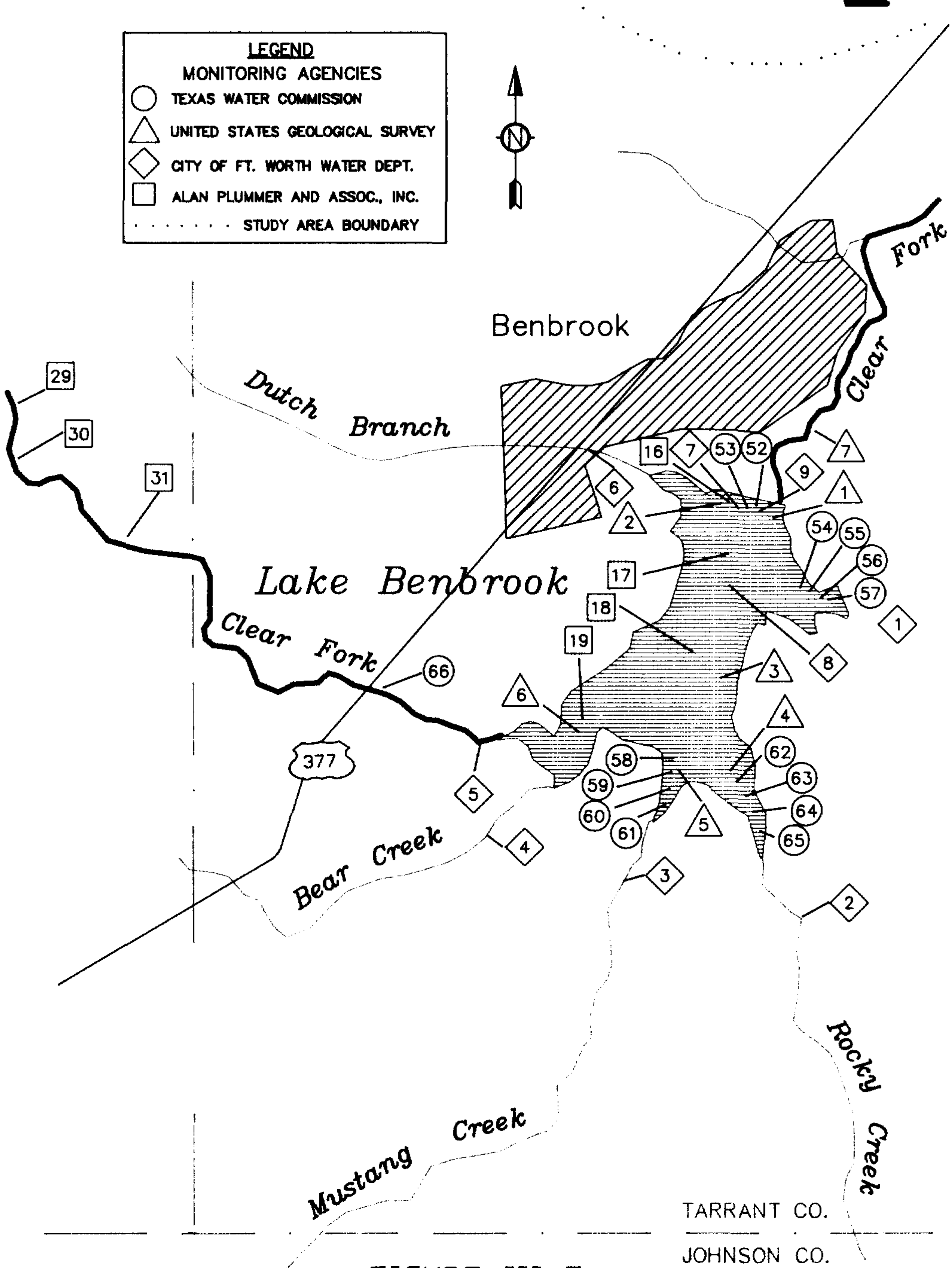


FIGURE III-5
UPPER TRINITY RIVER BASIN WATER QUALITY MONITORING STATIONS FOR LAKE BENBROOK AND THE CLEAR FORK OF THE TRINITY RIVER

Alan Plummer and Associates, Inc.

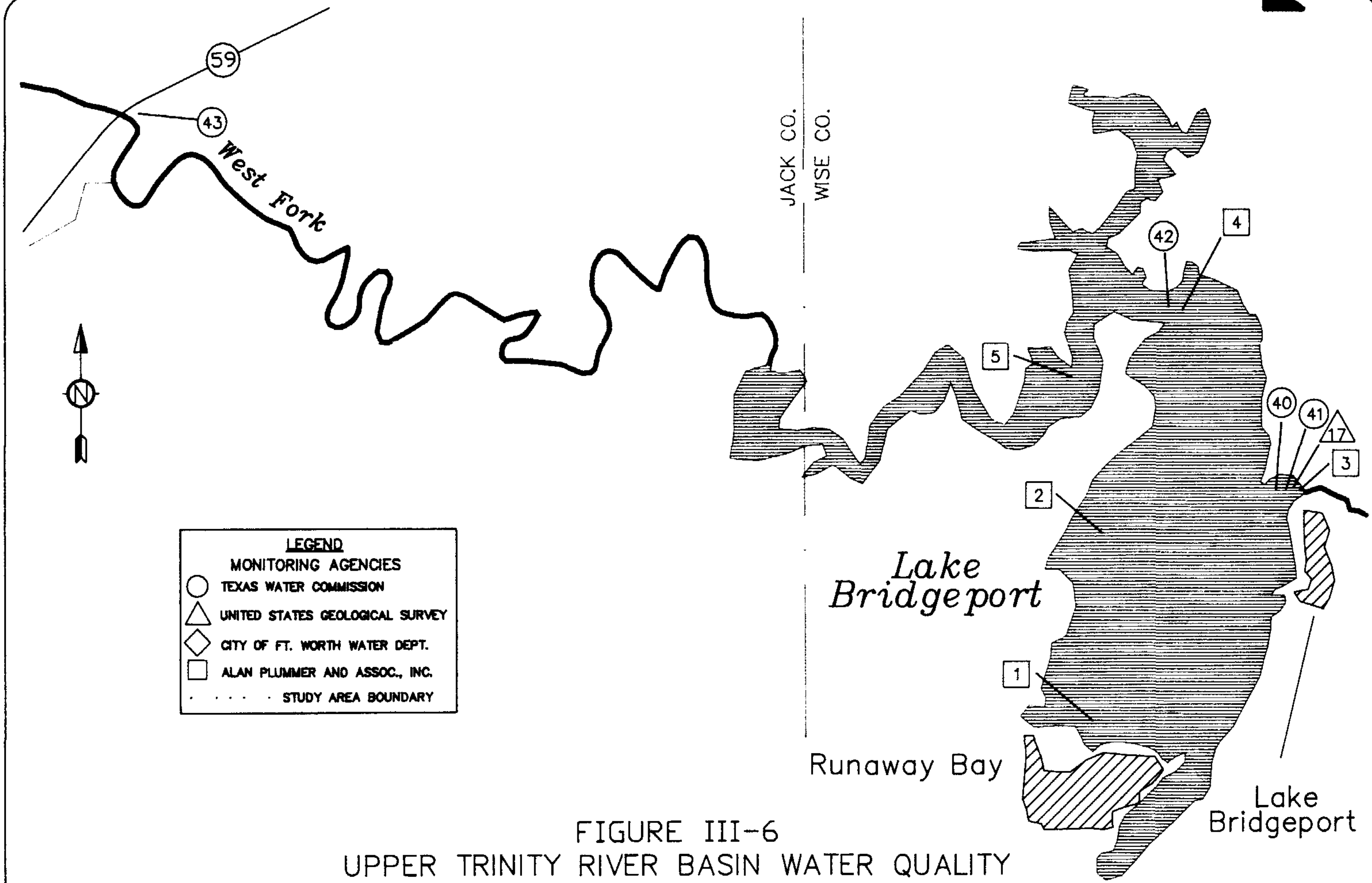


FIGURE III-6
UPPER TRINITY RIVER BASIN WATER QUALITY MONITORING STATIONS FOR LAKE BRIDGEPORT AND THE WEST FORK OF THE TRINITY RIVER

parameters: DO, pH, temperature, fecal coliform, and nitrogen and phosphorous series.

Numerical Criteria for Nontoxic Materials

The State of Texas has established numerical water quality criteria for chlorides, sulfates, total dissolved solids, dissolved oxygen, pH, fecal coliforms, and temperature for the waters of the state. Numerical criteria are developed based on the intended use of the stream or water body and historical water quality. The current numerical criteria for each of the stream segments in the study area presented in Table II-12.

Water quality data were summarized for each monitoring station and by segment over the reporting period of 1980 through 1987. The water quality data summary for each segment was then compared with the numerical criteria of the current Texas Surface Water Quality Standards.

A summary of the water quality data for each segment is presented in Table III-2 for the following parameters: temperature, dissolved oxygen, pH, chlorides, sulfates, fecal coliform, and total dissolved solids. An overall geometric mean for fecal coliform for each segment was not determined, but by examining the water quality data summary for each monitoring station and segment and by referring to the 1986 State of Texas Water Quality Inventory, the segments that were in violation of the numerical criteria for fecal coliforms could be determined. The Texas Water Quality Inventory for 1986 was also referred to when no data were available for total dissolved solids.

Water quality data for each monitoring station are presented in Appendix E. The water quality for each segment is briefly summarized in the following.

TABLE III-2

SUMMARY OF STANDARD WATER QUALITY PARAMETERS BY SEGMENT
UPPER TRINITY RIVER BASIN

Stream segment	Sample measurement	Temp (oC)	DO (mg/l)	pH (mg/l)	C1 (mg/l)	SO_4 (mg/l)	Fecal coliform (#/100 ml)	TDS (mg/l)
<u>0807</u>								
Lake Worth	Number of samples	175	15	178	180	14	65	5
	Minimum	6.0	4.5	7.3	8.0	10.0	1.0	170.0
	Maximum	32.2	11.8	8.7	46.0	22.7	600.0	384.0
	Average	20.2	7.9	8.3	44.8	23.7	-	217.0
<u>0808</u>								
West Fork of Trinity River -Lake Worth to Eagle Mountain Dam	Number of samples	93	31	95	100	32	79	13
	Minimum	5.0	1.8	7.1	15.0	3.9	1.0	210.0
	Maximum	31.1	12.9	9.7	71.9	60.0	800.0	384.0
	Average	19.2	8.7	8.1	42.2	24.1	-	277.2
<u>0809</u>								
Eagle Mountain Reservoir	Number of samples	434	343	436	288	193	187	179
	Minimum	4.4	1.9	6.5	12.0	3.9	1.0	124.0
	Maximum	35.8	14.6	9.7	207.0	145.0	3200.0	1424.0
	Average	22.3	9.0	8.2	43.3	27.0	-	318.6

TABLE III-2

SUMMARY OF STANDARD WATER QUALITY PARAMETERS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	Temp (oC)	DO (mg/l)	pH (mg/l)	C1 (mg/l)	SO_4 (mg/l)	Fecal coliform (#/100 ml)	TDS (mg/l)
<u>0810</u>								
West Fork Trinity River	Number of samples	37	37	34	37	37	33	11
-Eagle Mountain Lake	Minimum	6.6	5.6	6.9	14.5	6.6	10.0	252.0
Headwater to Bridgeport Dam	Maximum	29.2	13.5	8.2	230.0	230.0	41000.0	764.0
	Average	17.7	8.5	7.7	83.2	58.7	-	577.1
<u>0811</u>								
Lake Bridgeport Dam	Number of samples	22	16	15	14	14	6	5
	Minimum	8.5	5.7	7.4	18.0	3.0	1.0	134.0
	Maximum	34.0	11.3	8.6	36.0	23.0	40.0	216.0
	Average	25.1	7.6	8.2	26.8	14.8	-	172.6
<u>0812</u>								
West Fork Trinity River	Number of samples	20	19	19	20	20	17	-
above Lake Bridgeport	Minimum	5.2	2.5	5.8	14.0	4.0	10.0	-
	Maximum	30.4	11.7	8.2	1080.0	710.0	92000.0	-
	Average	16.9	7.4	7.3	174.9	152.8	-	-

TABLE III-2

SUMMARY OF STANDARD WATER QUALITY PARAMETERS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	Temp (oC)	DO (mg/l)	pH (mg/l)	C1 (mg/l)	SO_4 (mg/l)	Fecal coliform (#/100 ml)	TDS (mg/l)
0828								
Lake Arlington	Number of samples	386	377	358	145	145	164	201
	Minimum	0.0	4.3	7.1	14.5	10.7	1.0	3.0
	Maximum	37.5	13.1	9.3	31.0	39.0	316.0	309.0
	Average	22.2	8.2	8.2	20.2	26.9	-	193.0
0829								
Clear Fork Trinity River Confluence in Benbrook Dam	Number of samples	516	29	539	543	29	422	6
	Minimum	0.6	4.7	6.9	14.0	4.3	1.0	174.0
	Maximum	34.4	16.2	9.0	93.0	100.0	21000.0	236.0
	Average	21.1	9.7	8.0	37.7	31.2	-	197.2
0830								
Benbrook Reservoir	Number of samples	270	161	171	151	77	94	27
	Minimum	5.6	5.7	7.1	17.0	12.0	1.0	167.0
	Maximum	36.7	11.8	8.8	58.0	37.5	250.0	231.0
	Average	21.6	8.8	8.2	32.5	24.4	-	191.0

TABLE III-2

SUMMARY OF STANDARD WATER QUALITY PARAMETERS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	Temp (oC)	DO (mg/l)	pH (mg/l)	C1 (mg/l)	SO_4 (mg/l)	Fecal coliform (#/100 ml)	TDS (mg/l)
<u>0831</u>								
Clear Fork Trinity River	Number of samples	44	43	41	32	32	19	12
-Benbrook Reservoir	Minimum	5.5	2.8	6.9	10.0	5.0	11.0	132.0
Headwater to Weatherford	Maximum	33.0	12.0	9.4	78.0	104.0	7000.0	430.0
	Average	20.2	7.3	7.7	39.4	37.9	-	311.3
<u>0832</u>								
Lake Weatherford	Number of samples	12	12	12	4	4	4	-
	Minimum	10.9	6.8	7.2	17.0	18.0	14.0	-
	Maximum	31.0	11.9	8.5	48.0	37.0	136.0	-
	Average	26.7	7.9	8.1	32.8	27.3	-	-
<u>0833</u>								
Clear Fork Trinity River	Number of samples	19	19	16	19	19	16	-
above Lake Weatherford	Minimum	5.7	4.7	7.2	19.0	5.0	20.0	-
	Maximum	31.0	11.7	8.5	158.0	168.0	35000.0	-
	Average	17.6	8.4	7.7	109.0	78.6	769.0	-

Segment 0807 - Lake Worth. Several violations of the dissolved oxygen criteria occurred in this segment, but no other violations occurred in any of the other water quality parameters. The dissolved oxygen violations were primarily found in Lake Worth near the dam.

Segment 0808 - West Fork of Trinity River, Lake Worth to Eagle Mountain Dam. Occasional dissolved oxygen, pH, and fecal coliform criteria were violated near the Ten Mile Bridge within the segment.

Segment 0809 - Eagle Mountain Reservoir. Occasional violations of the total dissolved solids criteria were measured at many of the monitoring stations within this segment. Dissolved oxygen, chloride, and temperature criteria were also frequently violated at several monitoring stations. Monitoring stations in shallow bays or coves where water has a tendency to become stagnant appeared to be the locations where a majority of the violations occurred. In addition, typical concentrations in the areas where the violations occurred were often elevated above typical values found in the rest of the segment.

Segment 0810 - West Fork of Trinity River, Eagle Mountain Lake Headwater to Bridgeport Dam. Numerical criteria for chlorides, sulfates, total dissolved solids, and fecal coliforms were violated on occasion. The violations usually occurred near the Van Meter Bridge and along FM 730.

Segment 0811 - Lake Bridgeport Dam. The water quality within this segment is very good. Only isolated occurrences of temperature criteria violations have been seen near the reservoir dam.

Segment 0812 - West Fork Trinity River Above Lake Bridgeport. Dissolved oxygen, pH, chloride, sulfate, fecal coliform, and total dissolved solids criteria were occasionally violated within this segment. The violations were observed at the monitoring stations near SH 59. Poor water quality, especially low dissolved oxygen levels and high levels of total dissolved solids, chlorides, and sulfates, is not uncommon in this segment in the hot summer months when the river flow is low and sluggish.

<u>Segment 0828 - Lake Arlington</u>. Occasional violations occurred within this segment when numerical criteria for temperature, dissolved oxygen, pH, fecal coliform, and total dissolved solids were exceeded by the measured values at several monitoring stations. Violations typically took place at stations near the dam and in coves or bays in the lake.

<u>Segment 0829 - Clear Fork of Trinity River, West Fork Trinity River Confluence in Benbrook Dam</u>. Violations of temperature, dissolved oxygen, and fecal coliform criteria occasionally occurred within this segment. Also, elevated levels of these parameters that were in excess of typical values found in this segment were occasionally measured. Typically, violations took place in reaches of the Clear Fork of the Trinity River near the City of Fort Worth.

<u>Segment 0830 - Benbrook Reservoir</u>. The water quality in this segment was generally very good. Infrequent violations of the temperature criteria were observed in the reservoir near the dam.

<u>Segment 0831 - Clear Fork of Trinity River, Benbrook Reservoir Headwater to Lake Weatherford</u>. Occasional violations of temperature, dissolved oxygen, pH, sulfate, fecal coliform, and total dissolved solids criteria took place within this segment. Typically, the violations occurred in the reach along U.S. 377 or near IH 20. Most of the violations were the result of poor water quality during the summer months when the river flow was low and sluggish.

Segment 0832 - Lake Weatherford. The water quality is characteristically very good within this segment. No violations of the numerical criteria were recorded at any of the monitoring stations within this segment.

Segment 0833 - Clear Fork Trinity River Above Lake Weatherford. Dissolved oxygen, chloride, sulfate, fecal coliform, and total dissolved solids criteria were occasionally violated within this segment. The violations typically occurred on the Clear Fork near FM 51.

Conclusions

The water quality within the Upper Trinity River Basin is generally very good. Only a small percentage of violations occurred based on the total number of samples collected. In some segments, there were no violations, and sometimes there were as few as one or two violations. Temperature, dissolved oxygen, fecal coliforms, and total dissolved solids were the most frequently violated parameters within the segments.

Violations, when observed, typically occurred in rivers or tributaries of lakes and in coves or bays of lakes. Violations occurring in rivers and tributaries of lakes frequently were the result of low-flow conditions during the warm summer months. This low-flow condition contributed primarily to low dissolved oxygen concentrations and higher concentrations of chlorides, sulfates, and total dissolved solids. Violations occurring in lakes typically took place in coves or shallow bays sheltered from the wind. In these areas, there is a minimal amount of mixing by the wind, there is essentially no flow, and the water becomes stagnant.

Segments 0811 (Lake Bridgeport Dam), 0830 (Benbrook Reservoir), 0832 (Lake Weatherford) had the fewest number of violations within the basin. Segment 0832 had no violations, while segments 0811 and 0830 had very infrequent violations of the temperature criteria. It should again be noted that the water quality was summarized over the period of 1980 through 1987. Violations of the state criteria within the Upper Trinity River Basin are not necessarily indicative of the existing water quality. Some water quality problems that resulted in violations in the early portion of the reporting period may have already been resolved. Other areas, such as rivers and streams, where the water quality is basically a function of flow, may continually be in violation of the state criteria during the summer months.

Nutrients

The nutrients of primary concern in the water quality assessment include nitrogen and phosphorus. The nitrogen series consists of total Kjeldahl nitrogen (organic plus ammonia), ammonia, nitrites, and nitrates. The phosphorous series includes total phosphorous and dissolved orthophosphorous.

Nutrients are necessary for the growth and reproduction of algae. They can be related to the eutrophication level in a lake. To assess the potential environmental ramifications of various wastewater treatment alternatives, nutrient levels were used as input to the water quality models developed. Background nutrient levels and nutrient input from point and nonpoint sources relate to the existing and projected chlorophyll "a" levels.

The summary for nutrient levels measured in each of the stream segments in the study area is presented in Table III-3. Nutrient levels at each of the monitoring stations in the Upper Trinity River Basin are included in Appendix E.

TABLE III-3

SUMMARY OF NUTRIENT LEVELS BY SEGMENT
UPPER TRINITY RIVER BASIN

Stream segment	Sample measurement	TKN (1)	Amm-N (1)	NO2-N (1)	NO3-N (1)	NO3-N and NO2-N (1)	Total Phosphorus (2)	Dissolved Ortho-Phosphorus (2)
0807								
Lake Worth	Number of samples	4	13	4	13	-	13	13
	Minimum	.85	0.01	.002	0.01	-	0.01	0.01
	Maximum	1.70	0.31	.003	0.19	-	0.10	0.03
	Average	1.14	0.145	.00225	0.041	-	0.035	0.01
0808								
West Fork of Trinity River -Lake Worth to Eagle Mountain Dam	Number of samples	13	32	13	32	-	32	32
	Minimum	1.10	0.01	0.001	0.01	-	0.01	0.01
	Maximum	7.70	0.92	0.05	1.71	-	8.80	0.29
	Average	3.28	0.12	0.01	0.19	-	0.35	0.03
0809								
Eagle Mountain Reservoir	Number of samples	186	194	182	63	-	193	192
	Minimum	0.1	0.01	.001	0.01	-	0.01	0.01
	Maximum	11.9	0.78	.21	1.2	-	0.90	0.5
	Average	2.8	0.09	.01	0.25	-	0.07	0.03

(1) Mg/l as N (2) Mg/l as P

TABLE III-3

SUMMARY OF NUTRIENT LEVELS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	TKN (1)	Amm-N (1)	NO2-N (1)	NO3-N (1)	NO3-N and NO2-N (1)	Total Phosphorus (2)	Dissolved Ortho-Phosphorus (2)
0810								
West Fork Trinity River -Eagle Mountain Lake Headwater to Bridgeport Dam	Number of samples	13	37	13	37	-	37	37
	Minimum	0.61	0.01	.001	0.01	-	0.04	0.01
	Maximum	16.8	1.00	.070	5.01	-	0.50	0.38
	Average	4.62	0.12	.020	0.37	-	0.20	0.07
0811								
Lake Bridgeport Dam	Number of samples	8	17	7	17	-	17	17
	Minimum	0.81	0.01	.002	0.02	-	.01	0.01
	Maximum	1.23	0.12	.002	0.20	-	0.04	0.02
	Average	0.95	0.06	.002	0.4	-	0.02	0.01
0812								
West Fork Trinity River above Lake Bridgeport	Number of samples	-	20	-	20	-	20	20
	Minimum	-	0.02	-	0.02	-	0.04	0.01
	Maximum	-	0.29	-	1.19	-	0.74	0.12
	Average	-	0.10	-	0.25	-	0.25	0.03

(1) Mg/l as N (2) Mg/l as P

TABLE III-3

SUMMARY OF NUTRIENT LEVELS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	TKN (1)	Amm-N (1)	NO2-N (1)	NO3-N (1)	NO3-N and NO2-N (1)	Total Phosphorus (2)	Dissolved Ortho-Phosphorus (2)
<u>0828</u>								
Lake Arlington	Number of samples	48	92	58	88	67	114	51
	Minimum	0.40	0.0	.01	0.0	.01	0.00	0.00
	Maximum	1.90	10.0	.05	0.8	.40	0.30	0.10
	Average	0.79	0.48	.01	0.1	.11	0.03	0.01
<u>0829</u>								
Clear Fork Trinity River Confluence in Benbrook Dam	Number of samples	6	29	5	26	-	29	23
	Minimum	0.07	0.02	.01	0.02	-	0.01	0.01
	Maximum	2.82	0.95	.02	0.49	-	0.32	0.05
	Average	1.16	0.15	.02	0.17	-	0.07	0.02
<u>0830</u>								
Benbrook Reservoir	Number of samples	59	59	37	41	23	84	54
	Minimum	0.02	0.001	.001	.002	.01	.003	.001
	Maximum	8.5	.56	.10	.79	.29	.54	.12
	Average	1.70	0.04	.02	0.08	.12	.08	.03

(1) Mg/l as N (2) Mg/l as P

TABLE III-3

SUMMARY OF NUTRIENT LEVELS BY SEGMENT
UPPER TRINITY RIVER BASIN
(continued)

Stream segment	Sample measurement	TKN (1)	Amm-N (1)	NO2-N (1)	NO3-N (1)	NO3-N and NO2-N (1)	Total Phosphorus (2)	Dissolved Ortho-Phosphorus (2)
<u>0831</u>								
Clear Fork Trinity River	Number of samples	18	44	20	38	-	43	33
-Benbrook Reservoir	Minimum	.50	.02	.01	.01	-	.01	.01
Headwater to Weatherford	Maximum	2.94	1.25	.45	1.67	-	3.01	2.91
	Average	1.20	0.21	.09	0.39	-	0.79	0.86
<u>0832</u>								
Lake Weatherford	Number of samples	8	12	8	12	-	12	12
	Minimum	0.63	0.02	.01	0.01	-	0.01	0.01
	Maximum	1.30	0.12	.02	0.80	-	0.13	0.03
	Average	0.90	0.04	.01	0.12	-	0.04	0.02
<u>0833</u>								
Clear Fork Trinity River	Number of samples	-	19	-	18	-	19	19
above Lake Weatherford	Minimum	-	0.02	-	0.01	-	0.02	0.01
	Maximum	-	0.36	-	1.34	-	0.37	0.16
	Average	-	0.09	-	0.13	-	0.12	0.03

(1) Mg/l as N   (2) Mg/l as P

Toxic Substances

Toxic substances were discussed under water quality criteria in Chapter II. All of the waters in the Upper Trinity River Basin are classified for contact recreation, public water supply, and high-quality aquatic life. They are, therefore, subject to the most stringent of the toxic material numerical criteria.

The frequency and list of toxic parameters tested varied tremendously throughout the study area. Metals were measured more frequently than organics. However, data were available only on Lake Arlington and Benbrook Lake. The data collected for metals and organics are presented by station in Appendix E and results are summarized below.

With regard to metals, the chronic toxicity levels for cadmium, chromium, and copper were frequently violated. Occasional violations for other metals and occasional violations of the acute toxicity levels were also observed. Given the limited data set, however, conclusions with regard to toxic metals should be further evaluated with more routine analyses.

Organic pesticides were measured in bottom sediments and whole water samples. The water samples were from Lake Arlington only. These data are included in Appendix E. Whole water pesticide concentrations were lower than the TWC chronic toxicity criteria with the exception of methoxychlor, which exceeded the chronic toxicity criteria level of 0.03 ug/l. There are no sediment criteria against which to compare the sediment concentrations.

Additional Water Quality Studies

Texas Parks and Wildlife Department. The Texas Parks and Wildlife Department has collected various species of fish and turtles at several locations along the Clear Fork of the Trinity River in the study area, as well as at other locations on the West Fork of the Trinity River outside the study area. The animals were then tested for pesticides, heavy metals, and PCBs, which accumulate in the fatty tissue of animals. The concentrations of these substances become magnified as they move up the food chain, and may reach extremely high levels by the time they reach man.

At each of the three sites along the Clear Fork, alert level concentrations for PCBs and chlordane were exceeded, and elevated levels of heavy metals were detected in many of the fish analyzed. Alert level concentrations are established by the U.S. Food and Drug Administration (FDA) for fish and also by the Texas Parks and Wildlife Department for consumption by other fish. The toxic substance concentration detected is a function of the size and fatty tissue content of the animal. Although concentrations for these substances have been gradually reduced over the years, these studies show that additional improvement in water quality as it pertains to these toxic substances is required.

Fort Worth Health Department Urban Storm Water Monitoring Program. Section 26.177 of the Texas Water Code requires that all cities within the state having populations greater than 5,000 inhabitants establish a program for pollution abatement from generalized sources such as storm sewers and urban rainfall runoff. As a result, the Fort Worth Health Department developed and implemented an Urban Storm Water Monitoring Program to maintain and improve the existing drainage water quality within the city.

Drainage outfall sites were selected, and each month the water quality of each was assessed by physical, chemical, and biological tests. The tests were performed on rainless days to develop a representative profile of the normal drainage water quality of the city. In addition, the water quality assessment of one raw water control site was used to compare the water quality of raw water to that of the drainage water.

By assessing the water quality of the drainage water, the substances that have a potential for causing serious water quality problems can be tracked and the situation remedied.

Urban storm water runoff from city streets, parking lots, etc., is also being evaluated for water quality and hydrological data and compared against a control site from newly developed areas that have no traffic or industry.

Investigations to locate sources of drainage pollution are followed by corrective action at the pollution source when possible. The prevention of future drainage water pollution by reviewing new industrial development plans, minimizing industrial runoff, issuing permits to industries that use or produce hazardous materials, and educating the public will be the most important phase initiated to ensure that the program is ultimately successful.

Water Quality Study by the Tarrant County Water Control and Improvement District No. 1. An intensive survey of 15 sites was performed by the District in November 1987 on the Clear Fork of the Trinity River near Fort Worth. A routine water quality analysis was performed as well as a bottom sediment and fish tissue analysis.

No unexpected results were observed from the routine water quality analysis and no PCB or chlordane concentrations exceeded FDA action levels from the fish tissue analysis. However, in bottom sediment samples collected from five of the sites, PCB and chlordane concentrations exceeded the EPA 85 percentile for sediments.

Summary

Water quality in the Upper Trinity River Basin is typically very good. The water quality criteria are met at most of the monitoring stations. The most frequently violated parameter was DO. Violations occurred most frequently in the tributaries to the lakes and in the bay and cove areas of the lakes during low-flow summer conditions. Occasional violations in sulfates, total dissolved solids, and chlorides were also experienced in the tributaries.

The acute toxicity numerical criteria for metals and pesticides in water were generally met. Chronic toxicity levels for cadmium, chromium, and copper were frequently violated. There were several violations of the methoxychlor chronic toxicity criterion. The small data base available for toxics precludes making general trend observations and conclusions. Special studies by the Texas Fish and Wildlife Department and the District showed PCBs and chlordane in the tissues of some aquatic species taken from the Clear Fork. Levels exceeded the Fish and Wildlife Departments alert level, but not the FDA's action level.

EXISTING AND PROJECTED POLLUTANT LOADS

There are two types of loads that affect water quality. These loads are point source loads and nonpoint source loads. Point source loads are those loads that originate from a specific source such as an industrial facility or a wastewater treatment plant. Point source loads typically enter the river or lake through a discharge pipe. Nonpoint source loads are more diffuse in their generation and entry into a receiving stream. Nonpoint source pollutant loads are typically associated with runoff during rainfall. For purposes of this study, pollutant loads from septic tanks around the lakes are considered nonpoint source loads.

Point Source Dischargers

The point source dischargers in the Upper Trinity River Basin were initially identified from self-reporting data supplied by the Texas Water Commission. These data were later updated by referring to NCTCOG's publication, Sewerline (draft 1987). Table III-4 summarizes the point source dischargers in the study area. The dischargers shown in Table III-4 include those that have been approved and are not yet operational in addition to existing dischargers. The dischargers' locations are shown on Figure III-7.

Nonpoint Source Pollutant Loads

Nonpoint source pollutant loads are primarily a function of land use and rainfall/runoff patterns in a watershed for a river, stream, or lake. In the study area, the annual rainfall averaged from 36 inches near Bridgeport to 33 inches near Benbrook Lake. The overall study area average was 34 inches.

To estimate the annual quantity of runoff, runoff coefficients were developed using the measured rainfall near stream gaging stations. The quantity of rainfall was estimated by distributing the inches of rainfall over the entire drainage area associated with a gaging station. Then the runoff was estimated by assuming that the annual stream flow represented total runoff from the drainage area. The runoff quantity was divided by the rainfall quantity to calculate a runoff coefficient (Rv) for each year during a 13-year period of record. (Fewer data points were available at Aledo and Weatherford.) An average Rv was then calculated for use in estimating nonpoint source pollutants. The Rv calculated in this manner was an overall basin average and was not specific to any particular land use.

The nonpoint source loads were calculated as a function of land uses defined in Tables II-2 and II-3 and runoff/precipitation patterns. Runoff coefficients vary for different land use types. The runoff coefficients were estimated based on the assumption that each of the nonurban land runoff coefficients was a percentage of the urban land use runoff coefficient.

TABLE III-4

UPPER TRINITY RIVER BASINS
WATER QUALITY MANAGEMENT PLAN
POINT SOURCE DISCHARGERS

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
Azle ISD-WWTP	807-Lake Worth	.009	20	20	Irrigation-------------------------------------					
General Dynamics Plt. 4	807-Lake Worth	30.00	0	0	19.696	19.202	--	--	--	--
General Dynamics Plt. 4	807-Lake Worth	0.00	0	0	--	--	--	--	--	--
General Dynamics Plt. 4	807-Lake Worth	2.00	0	0	.7657	.5069	--	--	--	--
General Dynamics Plt. 4	807-Lake Worth	2.00	0	0	.7127	1.0423	--	--	--	--
City of Lakeside WWTP	807-Lake Worth	.030	30	0	Irrigation-------------------------------------					
R.J. Smelley-Dairy	807-Lake Worth	0.00	?	?	No Discharge-----------------------------------					
Tarrant Co. Utility Co. Hilltop Park WWTP	807-Lake Worth	0.00	?	?	No Data--					
Texas Health Enterp. Nursing Home WWTP	807-Lake Worth	0.00	?	?	Irrigation-------------------------------------					
City of Azle Walnut Creek WWTP	809-Egl. Mnt. L.	.1250	20	20	.1421	.1564	52.96	78.92	24.75	99.26
City of Azle Ash Creek WWTP	809-Egl. Mnt. L.	.4500	10	15	.3656	.4433	6.50	5.00	6.46	25.16

TABLE III-4

POINT SOURCE DISCHARGERS
(continued)

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
City of Runaway Bay WWTP	811-L. Bridgeport	.2000	10	15	No Discharge-------------------------------------					
City of Jacksboro WTP	812-Upper W. Frk.	.0420	0	25	No Discharge-------------------------------------					
City of Jacksboro WWTP	812-Upper W. Frk.	.185	30	90	.2534	.3313	34.60	37.57	84.70	111.29
Johnson Co. FWSD#1 WWTP	828-Vill. Crk.	.450	20	20	.2782	.2641	4.08	3.83	7.71	6.67
BIL-MAG, Inc. Restaurant & Motel WWTP	828-Vill. Crk.	0.00	?	?	No Data---					
Marshalsea Industries Oak Grove Airport WWTP	828-Vill. Crk.	.0175	20	20	.0066	.0036	9.16	7.43	15.50	12.00
Parma Financial Hidden Valley Est. WWTP	828-Vill. Crk.	.031	?	?	No Data--					
T.U.G.C.O. Handly Plt.	828-Vill. Crk.	1.28016	0	0	.7748	.7384	Cooling Water-----------------			
T.U.G.C.O. Handly Plt.	828-Vill. Crk.	--	0	30	.1291	.1101	--	--	1.97	2.41
T.U.G.C.O. Handly Plt.	828-Vill. Crk.	--	0	30	10.83	10.83	--	--	15.78	19.94
Texas Dept. Highways Burleson Rest Stop WWTP	828-Vill. Crk.	.006	20	20	.0021	.0010	8.50	6.00	27.00	16.86
Texas Dept. Highways Burleson Rest Stop WWTP	828-Vill. Crk.	?	?	?	No Data--					

TABLE III-4

POINT SOURCE DISCHARGERS
(continued)

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
John Wasilchak Highland Village WWTP	828-Vill. Crk.	.170	10	15	No Data--					
John Wasilchak Oakdale Village WWTP	828-Vill. Crk.	.275	10	15	No Data--					
Johns Manville Sales Corp.	829-Clr. Frk.	.010	0	0	No Discharge-----------------------------------					
Johns Manville Sales Corp.	829-Clr. Frk.	.007	0	0	No Discharge-----------------------------------					
St. Louis San Francisco Railway-F.W. Yards	829-Clr. Frk.	0.00	?	?	No Data--					
Union Pacific R.R. F.W. Centenial Yd. WWTP	829-Clr. Frk.	.060	100 lb/day (COD)	10 lb/day	.1249	.1503	321.48 (COD)	133.88 (COD)	28.82	16.18
Lawrence McMurry Primrose MHP-WWTP	830-L. Benbrook	.037	10	15	No Data--					
Steve Neusse Whiskey Flats MHP-WWTP	830-L. Benbrook	.037	10	15	.0008	.0016	18.00	24.29	22.00	39.86
St. Francis Village, Inc. WWTP	830-L. Benbrook	.0490	10	15	.0305	.0449	22.92	12.00	39.78	17.75
Parker Co. Utility District Aledo WWTP	831-Clr. Frk.	.0910	20	20	.0462	.0417	88.83	38.14	86.36	62.96

TABLE III-4

POINT SOURCE DISCHARGERS
(continued)

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
Larry Buck Dido Retirent Cntr	809-Egl. Mnt. L.	.011	10	15	--	.0006	--	8.33	--	3.00
Community WSC WTP	809-Egl. Mnt. L.	.001	0	25	No Discharge--------------------------------------					
Fort Worth Boat Club WWTP	809-Egl. Mnt. L.	.015	10	15	.0138	.0142	6.25	9.0	8.17	14.2
Fort Worth ISD Learning Center WWTP	809-Egl. Mnt. L.	0.000	?	?	No Data---					
International Word of Faith Church STP	809-Egl. Mnt. L.	.010	?	?	No Discharge Irrigation------------------------					
City of Newark WWTP	809-Egl. Mnt. L.	.1500	10	15	.0526	.0436	3.25	2.69	4.67	5.19
City of Newark Eagle Estates	809-Egl. Mnt. L.	.336	10	15	Not in Operation---------------------------------					
City of Springtown WWTP	809-Egl. Mnt. L.	.1200	30	30	.1020	.1324	29.63	9.29	77.33	11.64
T.U.G.C.O. Generating Sta.	809-Egl. Mnt. L.	432.0	?	?	169.0488	143,574	Cooling Water---------------			
T.U.G.C.O. Generating Sta.	809-Egl. Mnt. L.	0.000	0	30	.0498	.0413	--	--	16.66	12.80
Tarrant Co. Youth Center	809-Egl. Mnt. L.	0.00	?	?	No Data--					
Tarrant Co. MUD # Dozier Slough	809-Egl. Mnt. L.	.2000	10	15	Closed in Early 1987-Flows diverted to Ft. Worth V.C.					

TABLE III-4

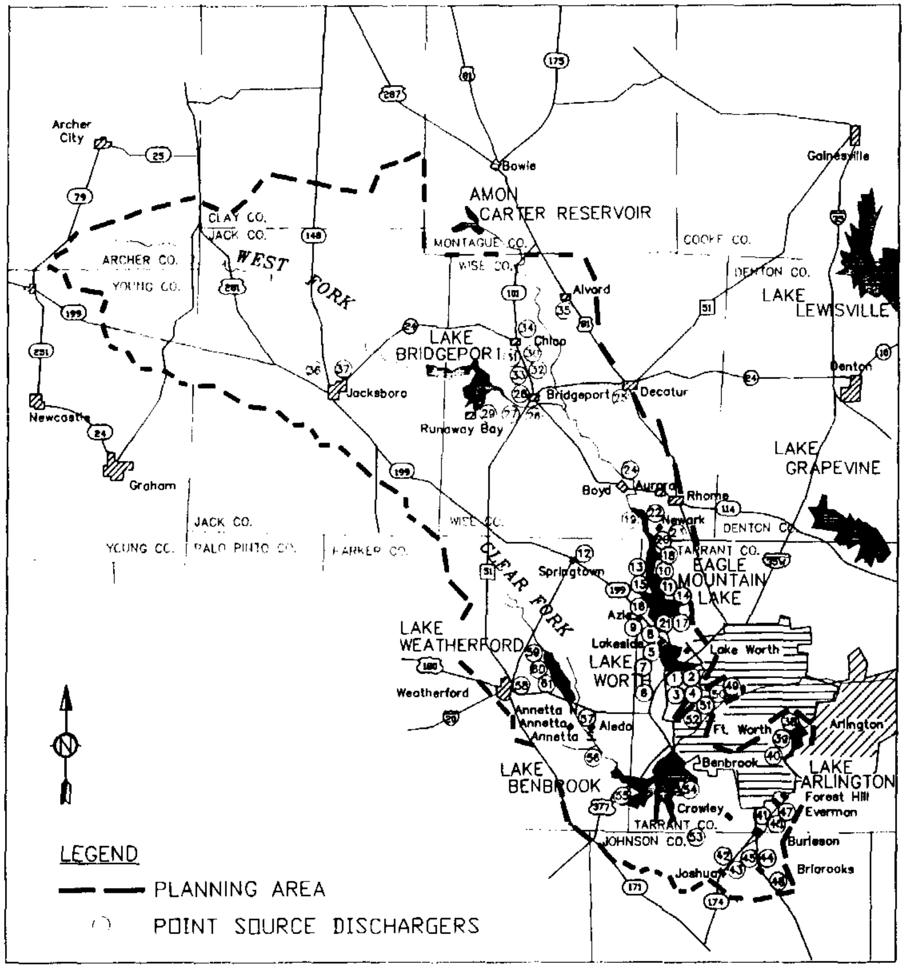
POINT SOURCE DISCHARGERS
(continued)

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
City of Alvord WWTP	810-W. Frk. Trin.	.1120	20	30	.0510	.0512	6.63	4.42	5.71	11.92
City of Boyd WWTP	810-W. Frk. Trin.	.0700	30	90	.0279	.0642	25.42	23.00	67.17	65.50
City of Bridgeport WTP	810-W. Frk. Trin.	.0170	0	25	.0200	.0154	--	--	41.64	18.82
City of Bridgeport WWTP	810-W. Frk. Trin.	.3900	30	90	.1536	.1709	28.83	27.43	56.96	58.43
City of Chico WWTP	810-W. Frk. Trin.	.0760	20	90	.0728	.0783	20.33	11.29	19.33	20.14
City of Decatur WWTP	810-W. Frk. Trin.	.4000	30	90	.5803	.3165	25.25	21.31	68.25	51.63
General Portland Chico Plt.	810-W. Frk. Trin.	0.00	0	20	.2171	.1091	3.64	--	5.00	10.43
Gifford Hill & Co. Perch Hill S&G Plant	810-W. Frk. Trin.	0.00	0	25	No Discharge-----------------------------------					
Liquid Energy Corp. Bridgeport Crude Plt.	810-W. Frk. Trin.	0.000	N/A	N/A	No Discharge-----------------------------------					
Pioneer Aggregates A Division Facility	810-W. Frk. Trin. 1985 1986	2.000 6.000	0	25	5.0167	4.3600	--	--	13.20	7.12
Pioneer Aggregates A Division Facility	810-W. Frk. Trin.	?	0	25	New Permit - No Information Available------------					

TABLE III-4

POINT SOURCE DISCHARGERS
(continued)

Name	Stream Segment	Permited Flow MGD	Permited BOD mg/l	Permited TSS mg/l	1985 Flow MGD	1986 Flow MGD	1985 BOD mg/l	1986 BOD mg/l	1985 TSS mg/l	1986 TSS mg/l
Parker Co. Utility District District WWTP	831-Clr. Frk	.2500	20	20	Not Built Yet------------------------------------					
City of Weatherford WWTP	831-Clr. Fr.	3.000	20	30	1.466	1.4635	5.54	2.64	10.16	4.65
Brazos Elect. Power Coop. N. Texas Ses.	832-L. Wrthfrd.	85.00	N/A	N/A	12.8642	6.08 Cooling Water-----------------------				
Brazos Elect. Power Coop. N. Texas Ses.	823-L. Wrthfrd.	--	0	30	.0010	No Discharge	--	No Discharge	12.25	No Discharge
Brazos Elect. Power Coop. N. Texas Ses.	832-L. Wrthfrd.	--	0	30	No Discharge--------------------------------------					



1. General Dynamics Fort Worth Air Force Plant #4
2. General Dynamics Fort Worth Air Force Plant #4
3. General Dynamics Fort Worth Air Force Plant #4
4. General Dynamics Fort Worth Air Force Plant #4
5. City of Lakeside WWTP
6. R.J. Smelley - Dairy
7. Tarrant County Utility Co. Hill Top WWTP
8. Texas Health Enterprises Lakeside Nursing Home - WWTP
9. Azle ISD - WWTP
10. Texas Utilities Generating Company
11. Texas Utilities Generating Company
12. City of Springtown
13. Community Water Supply Corporation Water Treatment Plant
14. Fort Worth Boat Club
15. City of Azle Walnut Creek - WWTP
16. City of Azle Ash Creek - WWTP
17. Tarrant County Municipal Utilities District #1 Dozier Slough Plant
18. Larry R. Buck Dido Area Retirement Center
19. Fort Worth ISD Learning Center - WWTP
20. International Word of Faith Church - STP
21. Tarrant Co. Youth Center
22. City of Newark - WWTP
23. City of Newark - Eagle Estates - WWTP
24. City of Boyd - WWTP
25. City of Decatur - WWTP
26. City of Bridgeport - WWTP
27. Liquid Energy Corporation Bridgeport Crude Plant
28. City of Bridgeport - WTP
29. City of Runaway Bay
30. General Portland Inc. Chico Plant
31. Gifford-Hill & Company, Inc. Perch Hill S&G Plant
32. Pioneer Aggregates
33. Pioneer Aggregates
34. City of Chico
35. City of Alvord
36. City of Jacksboro - WWTP
37. City of Jacksboro - WTP
38. Texas Utilities Generating Company
39. Texas Utilities Generating Company
40. Texas Utilities Generating Company
41. Marshalsea Industries, Inc. Oak Grove Airport
42. Parma Financial Hidden Valley Estates - WWTP
43. Johnson County FWSD #1
44. Texas State Department of Highways - Johnson County SB Rest Area
45. Texas State Department of Highways - Johnson County NB Rest Area
46. BIL-MAG, Inc. Restaurant/Motel WWTP
47. John Wasilchak Highland Village - WWTP
48. John Wasilchak Oakdale Village - WWTP
49. St. Louis/San Francisco RR Fort Worth Yards
50. Union Pacific Railroad Company Fort Worth Central Yard
51. Johns-Manville Sales Corporation
52. Johns-Mansville Sales Corporation
53. Lawerance McMurry Primrose MHP - WWTP
54. St. Francis Village, Inc.
55. Steve/Michael Neusse Whiskey Flats MHP
56. Parker County UD Aledo Plant
57. Parker County UD - Dist. WWTP
58. City of Weatherford WWTP
59. Brazos Electric Power Cooperative, Inc.
60. Brazos Electric Power Cooperative, Inc.
61. Brazos Electric Power Cooperative, Inc.

FIGURE III-7
UPPER TRINITY RIVER BASIN
POINT SOURCE DISCHARGERS

Land Use	Factor of Urban Rv
Urban	1.0
Agriculture	0.50
Pasture	0.25
Forest	0.10

The runoff coefficients associated with the different land uses were calculated based on the relationship:

$$Rv\ (avg)/Area = Rv(u)*A(u)+Rv(a)*A(a)+Rv(p)*A(p)+Rv(f)*A(f)$$

Where: Rv (avg) = Average Rv for watershed or drainage basin
Area = total area for watershed or drainage basin
Rv ( ) = runoff coefficient for specific land use
A ( ) = area associated with specific land use
(u) = urban land use
(a) = agriculture land use
(p) = pasture
(f) = forest

and:
$$Rv(a) = 0.5 * Rv(u)$$
$$Rv(p) = 0.25 * Rv(u)$$
$$Rv(f) = 0.10 * Rv(u)$$

The average annual rainfall and a summary of the runoff coefficients calculated for the various land uses within the watersheds are shown in Table III-5 for existing conditions and Table III-6 for projected conditions. The nonpoint source loads were calculated for the drainage area of each lake. Due to its size, the Eagle Mountain Lake watershed was divided into three drainage areas. Loads through upstream lakes into downstream watersheds were attenuated by 75% based on the Vollenweider equation. The annual existing and projected nonpoint source loads are shown in Table III-7 and Table III-8, respectively.

TABLE III-5

SUMMARY OF RAINFALL AND RUNOFF COEFFICIENTS
USED IN ESTIMATING NONPOINT SOURCES
FOR EXISTING CONDITIONS

Watershed	Rainfall (in.)	Runoff Coefficients				Total
		Urban	Agriculture	Pasture	Forest	
Arlington						
I	38	0.198	0.099	0.050	0.020	0.072
Benbrook						
IV	35	0.214	0.107	0.054	0.021	0.057
III	34	0.238	0.119	0.060	0.024	0.072
II	34	0.173	0.089	0.043	0.017	0.072
Eagle Mountain Lake and Lake Worth						
VIIA	34	0.241	0.121	0.060	0.024	0.057
VIII	34	0.234	0.117	0.059	0.023	0.057
VI	34	0.207	0.104	0.052	0.021	0.057
V	33	0.199	0.100	0.050	0.020	0.055

TABLE III-6

SUMMARY OF RAINFALL AND RUNOFF COEFFICIENTS
USED IN ESTIMATING NONPOINT SOURCES
FOR 2005 PROJECTED CONDITIONS

Watershed	Rainfall (in.)	Runoff Coefficients				
		Urban	Agriculture	Pasture	Forest	Total
Arlington						
I	38	0.163	0.081	0.041	0.016	0.072
Benbrook						
IV	35	0.205	0.102	0.051	0.020	0.057
III	34	0.213	0.116	0.053	0.021	0.072
II	34	0.171	0.185	0.143	0.017	0.072
Eagle Mountain Lake and Lake Worth						
VII	34	0.237	0.119	0.059	0.024	0.057
VIII	34	0.233	0.116	0.058	0.023	0.057
VI	34	0.192	0.096	0.048	0.019	0.057
V	33	0.157	0.078	0.039	0.016	0.055

TABLE III-7

SUMMARY OF NONPOINT SOURCE LOADS
TOTAL ANNUAL EXISTING NONPOINT SOURCE LOADS
(lb/year)

Basin	BOD	NH3	TKN	TP-P	OP-P
Lake Arlington	320,000	42,900	92,100	18,000	8,220
Lake Benbrook[1]	704,000	101,000	205,000	38,300	18,800
Lake Weatherford	226,000	32,200	65,400	12,000	5,920
Lake Worth[2]	551,000	73,500	157,000	28,700	12,500
Eagle Mountain Lake[3]	1,680,000	227,000	481,000	87,400	36,900
Lake Bridgeport	1,840,000	231,000	518,000	90,800	21,100
Amon Carter Reservoir (not included in study)	150,000	19,900	42,600	7,560	3,790

1. Loads to Lake Weatherford are attenuated 75 percent and included in the loads to Lake Benbrook.

2. Loads to Eagle Mountain Lake are attenuated 75 percent and included in the loads to Lake Worth.

3. Loads to Lake Bridgeport and Amon Carter Reservoir are attenuated 75 percent and included in the loads to Eagle Mountain Lake.

TABLE III-8

SUMMARY OF NONPOINT SOURCE LOADS
TOTAL ANNUAL 2005 NONPOINT SOURCE LOADS
(lb/year)

Basin	BOD	NH3	TKN	TP-P	OP-P
Lake Arlington	317,000	39,500	90,300	18,200	7,890
Lake Benbrook[1]	700,000	95,800	203,000	38,600	18,300
Lake Weatherford	226,000	31,600	65,100	12,100	5,860
Lake Worth[2]	550,000	70,700	156,000	29,200	12,300
Eagle Mountain Lake[3]	1,680,000	221,000	479,000	88,200	36,500
Lake Bridgeport	1,840,000	229,000	518,000	91,300	21,600
Amon Carter Reservoir (not included in study)	150,000	19,900	42,600	7,570	3,790

1. Loads to Lake Weatherford are attenuated 75 percent and included in the loads to Lake Benbrook.

2. Loads to Eagle Mountain Lake are attenuated 75 percent and included in the loads to Lake Worth.

3. Loads to Lake Bridgeport and Amon Carter Reservoir are attenuated 75 percent and included in the loads to Eagle Mountain Lake.

On-site disposal systems or septic tanks represent a potential source of pollutants to the lakes in the study area. As indicated in Table II-6, about 27% of the population in study area is currently unsewered. The significance and size of the pollutant load depends on the soil type and proximity and density of the systems in relation to the lake. Table III-9 shows the potential loads from septic systems within a 2,000-foot perimeter of each of the lakes. The loads shown range from an unattenuated load to a load reduced by 90%.

Comparison of Point Source Discharger Loads and Nonpoint Source Loads

The major point source dischargers are located in the Eagle Mountain Lake and Benbrook Lake watersheds. These watersheds are used for comparing nonpoint source and point source loads. Table III-10 compares the BOD loads from nonpoint sources and point sources for permit conditions and 1986 discharges based on TWC self-reporting Data.

In the Eagle Mountain Lake watershed, point source loads represent about 5% of the total BOD load under 1986 flow/quality conditions and about 7% under permit conditions. In the Benbrook Lake watershed, point source loads represent 2% of the 1986 BOD load into the watershed, but could represent as much as 16% under permit conditions. The percentage distribution of BOD loading in 1986 from each of the major wastewater treatment plants, as well as the nonpoint source loading in each watershed, is also indicated on Table III-10 for further information.

Tables III-11 and III-12 show loadings from discharges for nitrogen and phosphorus. Permit load conditions were not readily available for nitrogen and phosphorus, but it can be seen from the tables that point source loads represent about 11% and 23% of the 1986 nitrogen load for the Eagle Mountain and Benbrook watersheds, respectively, and about 29% and 50% of the 1986 phosphorus load for Eagle Mountain Lake and Benbrook watersheds. The

TABLE III-9

POTENTIAL ANNUAL POLLUTANT LOADS
TO STUDY AREA LAKES FROM SEPTIC SYSTEMS

Lake	Estimated Unsewered Population	Pollutant	Unattenuated Load (LB/YR)	Load Remaining in Various Removal Percentages 10% (LB/YR)	50% (LB/YR)	90% (LB/YR)
Eagle Mountain	7,804	BOD5	190,809	171,728	95,404	19,081
		TN	55,281	49,753	27,641	5,528
		TP	35,665	32,099	17,833	3,567
Worth	1,496	BOD5	36,577	32,920	18,289	3,658
		TN	10,597	9,537	5,299	1,060
		TP	6,837	6,153	3,418	684
Weatherford	885	BOD5	21,638	19,475	10,819	2,164
		TN	6,269	5,642	3,135	627
		TP	4,045	3,640	2,022	404
Arlington	5	BOD5	122	110	61	12
		TN	35	32	18	4
		TP	23	21	11	2
Benbrook	254	BOD5	6,210	5,589	3,105	621
		TN	1,799	1,619	900	180
		TP	1,161	1,045	580	116
Bridgeport	1,397	BOD5	34,157	30,741	17,078	3,416
		TN	9,896	8,906	4,948	990
		TP	6,384	5,746	3,192	638

1. Number of Counted Houses x 2.54 (1986 NCTCOG Figure for Pop. Est.)
2. Equation:
   Unsewered Pop. x 75 gal/capita day x 3.7856 L/gal x conc. (mg/l) x 365 day/yr $\div 10^6$ x 2.205 = lb/yr.
3. Based on the following assumptions: 75 gal/capita day
   BOD_5 = 107 mg/l
   TN = 31 mg/l
   TP = 10 mg/l

TABLE III-10

NONPOINT SOURCE AND POINT SOURCE
BOD LOAD COMPARISONS
1986 CONDITIONS

	BOD Loading				
	Permit			1986	
Treatment Plant/Source	lb/yr	% of total	Avg. MGD	lb/yr	% of Total
Azle (W.C.)	7615	0.4	0.1564	37,596	2.1
Azle (A.C.)	13,706	0.7	0.4433	6,751	0.4
Dido Retire.	335	-	0.0006	15	-
Fort Worth B.C.	457	-	0.0142	389	-
Newark	4,569	0.2	0.0436	357	-
Springtown	10,965	0.6	0.1324	3,746	0.2
Alvord	6,823	0.4	0.0512	689	0.1
Boyd	6,396	0.4	0.0642	4,498	0.3
Bridgeport	35,616	2.0	0.1709	14,278	0.8
Chico	4,630	0.3	0.0783	2,693	0.1
Decatur	36,551	2.0	0.3165	20,544	1.1
Jacksboro	16,905	0.9	0.3313	37,912	2.1
Total Point Source	144,568	7.9		129,468	7.2
Total Nonpoint Source	1,680,000	92.1		1,680,000	92.8
Total BOD Load	1,824,568	100%		1,809,468	100%
Benbrook Lake Watershed					
Whiskey Flats	1,127	0.1	0.0016	118	-
St. Francis Village	1,493	0.1	0.0449	1,641	0.2
Parker Co. UD/Aledo	5,544	0.7	0.0417	4,844	0.7
Weatherford	129,147	15.4	1.4635	11,768	1.6
Total Point Source	137,311	16.3		18,371	2.5
Total Nonpoint Source	704,000	83.7		704,000	97.5
Total BOD Load	841,311	100%		722,371	100%

TABLE III-11

NONPOINT SOURCE AND POINT SOURCE
NITROGEN LOAD COMPARISONS
1986 CONDITIONS

Treatment Plant/Source	1986 Nitrogen Loading Average Plant MGD	lb/yr	% of Total
Eagle Mountain Lake Watershed			
Azle (W.C.)	0.1564	9,528	1.1
Azle (A.C.)	0.4433	27,005	3.3
Dido Retirement	0.0006	37	-
Fort Worth Boat Club	0.0142	865	0.1
Newark	0.0436	2,656	0.3
Springtown	0.1324	8,066	1.0
Alvord	0.0512	3,119	0.4
Boyd	0.0642	3,911	0.4
Bridgeport	0.1709	10,411	1.3
Chico	0.0783	4,770	0.6
Decatur	0.3165	19,281	2.4
Jacksboro	0.3313	20,182	2.5
Total Point Source		109,831	13.4
Total Nonpoint Source		708,000	86.6
Total Nitrogen Load		817,831	100%
Benbrook Lake Watershed			
Whiskey Flats	0.0016	97	-
St. Francis Village	0.0449	2,710	0.7
Parker Co., U.D./Aledo	0.0417	2,540	0.6
Weatherford	1.4635	89,154	22.3
Total Point Source		94,501	23.6
Total Nonpoint Source		306,000	76.4
Total Nitrogen Load		400,501	100%

TABLE III-12

NONPOINT SOURCE AND POINT SOURCE
PHOSPHORUS LOAD COMPARISONS
1986 CONDITIONS

Treatment Plant/Source	Average Plant MGP	1986 Phosphorous Loading lb/yr	% of Total
Eagle Mountain Lake Watershed			
Azle (W.C.)	0.1564	3,811	2.9
Azle (A.C.)	0.4433	10,802	8.2
Dido Retirement	0.0006	15	-
Fort Worth Boat Club	0.0142	346	0.3
Newark	0.0436	1,062	0.8
Springtown	0.1324	3,226	2.5
Alvord	0.0512	1,248	0.9
Boyd	0.0642	1,564	1.2
Bridgeport	0.1709	4,164	3.2
Chico	0.0783	1,920	1.5
Decatur	0.3165	7,712	5.9
Jacksboro	0.3313	8,073	6.1
Total Point Source		43,943	33.5
Total Nonpoint Source		87,400	66.5
Total Nitrogen Load		131,343	100%
Benbrook Lake Watershed			
Whiskey Flats	0.0016	39	0.1
St. Francis Village	0.0449	1,084	1.4
Parker Co., U.D./Aledo	0.0417	1,016	1.3
Weatherford	1.4635	35,662	46.9
Total Point Source		37,841	49.7
Total Nonpoint Source		38,300	50.3
Total Nitrogen Load		76,151	100%

self-reporting data did not record values of effluent concentration for nitrogen and phosphorous, and average condition values of 20 mg/l and 8 mg/l were used to determine loadings for these constituents.

Table III-13 shows the load comparisons for projected conditions for BOD, nitrogen, and phosphorous. Projected point source loads are based on existing plants only. For municipal plants, discharges were increased, relative to the 2005 population projections. Other discharges (e.g., industrial) were increased to permit level. Plants are assumed to attain a minimum effluent quality of 10 mg/l BOD_5 and 15 mg/l TSS. Point source loads represent about 6%, 27% and 54% for BOD, nitrogen, and phosphorous, respectively, for EML; and 10%, 34% and 61% for BOD, nitrogen, and phosphorous for Benbrook Lake.

Table III-14 is a summary table of load comparisons for existing and projected conditions and shows that percentage of the nitrogen load coming from point sources doubles from existing to projected conditions for EML, while the phosphorous percentage increases about 1.6 times and BOD stays about the same for point source loads. Nonpoint loading stays about the same for BOD and decreases from about 10% to 20% for nitrogen and phosphorous loadings for the EML watershed under existing and projected conditions. For the Benbrook watershed, the percentage BOD load increases about 4 times for point sources going from existing to projected conditions, and nitrogen and phosphorous percentages increase about 1.4 and 1.2 times, respectively. For nonpoint sources, BOD stays about same, decreasing slightly, and nitrogen and phosphorous decrease 15% and 30%, respectively, going from existing to projected conditions.

Tables III-15 through III-18 give local comparison data for Lake Bridgeport, Lake Worth, Lake Weatherford, and Lake Arlington. The Lake Worth and Lake Weatherford watersheds do not include any point source dischargers, and therefore nonpoint source loads are 100% of the pollutant

TABLE III-13

NONPOINT SOURCE AND POINT SOURCE LOAD COMPARISONS - PROJECTED CONDITIONS[1]

Treatment Plant/Source	Projected Plant Flow MGD	BOD lb/yr	BOD % of Total	Nitrogen lb/yr	Nitrogen % of Total	Phosphorous lb/yr	Phosphorous % of Total
Eagle Mountain Lake Watershed							
Azle (W.C.)	0.30	9,138	0.5	18,276	1.9	7,310	3.9
Azle (A.C.)	0.26	38,379	2.1	76,757	8.0	30,703	16.2
Dido Retirement	.011	335	-	670	0.1	268	0.1
Fort Worth Boat Club	.095	2,894	0.2	5,787	0.6	2,315	1.2
Newark	.186	5,665	0.3	11,331	1.2	4,532	2.4
Springtown	.389	11,849	0.7	23,697	2.5	9,479	5.0
Alvord	.112	3,411	0.2	6,823	0.7	2,729	1.4
Boyd	.133	4,051	0.2	8,102	0.8	3,241	1.7
Bridgeport	.497	15,138	0.8	30,276	3.2	12,111	6.4
Chico	.129	3,929	0.2	7,858	0.8	3,143	1.7
Decatur	.701	21,352	1.2	42,704	4.5	17,082	9.0
Jacksboro	.360	10,965	0.6	21,931	2.3	8,772	4.6
Total Point Source		127,106	7.0	254,212	26.6	101,685	53.5
Total Nonpoint Source		1,680,000	93.0	700,000	73.4	88,200	46.4
Total Load		1,807,106	100%	954,212	100%	189,885	100%
Benbrook Lake Watershed							
Whiskey Flats	.037	1,127	0.1	2,254	0.5	902	0.9
St. Francis Village	.049	1,493	0.2	2,985	0.7	1,194	1.2
Parker Co., U.D./Aledo	.262	7,980	1.0	15,961	3.5	6,384	6.4
Weatherford	2.154	65,609	8.5	131,218	29.1	52,487	52.7
Total Point Source		76,209	9.8	157,418	33.8	64,967	61.2
Total Nonpoint Source		700,000	90.2	298,800	66.2	38,600	38.8
Total Load		776,209	100%	451,218	100%	99,567	100%

1. Projected point source loads are based on the expansion of existing wastewater treatment plants.

TABLE III-14

SUMMARY TABLE OF NONPOINT SOURCE AND POINT SOURCE LOAD COMPARISON

	Percentage Distribution			
	Existing Conditions		Projected Conditions	
	Point Source	Nonpoint Source	Point Source	Nonpoint Source
Eagle Mountain Lake Watershed				
BOD	7.2	92.8	7.0	93.0
Nitrogen	13.4	86.6	26.6	73.4
Phosphorous	33.5	66.5	53.6	46.4
Benbrook Lake Watershed				
BOD	2.5	97.5	9.8	90.2
Nitrogen	23.6	76.4	33.8	66.2
Phosphorous	49.7	50.3	61.2	38.8

TABLE III-15

NONPOINT SOURCE AND POINT SOURCE
BOD LOAD COMPARISONS
1986 CONDITIONS

Treatment Plant/Source	Permit lb/yr	Permit % of Total	1986 AVG. MGD	1986 lb/yr	1986 % of Total
Lake Bridgeport Watershed					
Jacksboro	16,894	1.0	.3313	37,890	2.0
Total Point Source	16,895	1.0		37,890	2.0
Total Nonpoint Source	1,840,000	99.0		1,840,000	98.0
Total BOD Load	1,856,895	100.0		1,877,890	100.0
Lake Worth Watershed					
Total Point Source	0	0		0	0
Total Nonpoint Source	551,500	100%		551,000	100%
Total BOD Load	551,500	100%		551,000	100%
Lake Weatherford Watershed					
Total Point Source	0	0		0	0
Total Nonpoint Source	226,000	100%		226,000	100%
Total BOD Load	226,000	100%		226,000	100%
Lake Arlington Watershed					
Oak Grove Airport	1,065	0.3	.0036	81	--
SDHPT, Burleson Rest Stop	365	0.1	.001	18	--
Johnson Co. FWSD #1	27,397	7.9	.2641	3,079	1.0
Total Point Source	28,827	8.3		3,178	1.0
Total Nonpoint Source	320,000	92.7		310,000	99.0
Total BOD Load	348,827	100.0		323,178	100.0

TABLE III-16

NONPOINT SOURCE AND POINT SOURCE
NITROGEN AND PHOSPHOROUS LOAD COMPARISONS
1986 CONDITIONS

Treatment Plant/Source	1986 Avg. Plant MGD	Nitrogen lb/yr	Nitrogen % of Total	Phosphorous lb/yr	Phosphorous % of Total
Lake Bridgeport Watershed					
Jacksboro	.3313	20,170	3.0	8,068	8.0
Total Point Source		20,170	3.0	8,068	8.0
Total Nonpoint Source		749,000	97.0	90,800	92.0
Total BOD Load		769,170	100.0	98,868	100.0
Lake Worth Watershed					
Total Point Source		0	0	0	0
Total Nonpoint Source		230,500	100%	28,700	100%
Total BOD Load		230,500	100%	28,700	100%
Lake Weatherford Watershed					
Total Point Source		0	0	0	0
Total Nonpoint Source		97,600	100%	12,000	100%
Total BOD Load		97,600	100%	12,000	100%
Lake Arlington Watershed					
Oak Grove Airport	.0036	219	0.1	88	0.4
SDHPT, Burleson Rest Stop	.001	610	0.1	24	0.1
Johnson Co. FWSD #1	.2641	16,079	10.6	6,432	26.2
Total Point Source		16,359	10.8	6,544	26.7
Total Nonpoint Source		135,000	89.2	18,000	73.3
Total BOD Load		151,359	100.0	24,544	100.0

loadings for these watersheds. In the Lake Bridgeport watershed, point source loads represent about 2% of the total BOD load under 1986 flow/quality conditions and about 1% under permit conditions. In the Lake Arlington watershed, point source loads represent 1% of the 1986 BOD load into the watershed, but could represent as much as 8% under permit conditions. The percentage distribution of BOD loadings in 1986 from each of the major wastewater treatment plants, as well as the nonpoint source loadings in each watershed, is also shown in Table III-15. Table III-16 shows loadings from discharges for nitrogen and phosphorous. Permit load conditions were not readily available for nitrogen and phosphorous, but it can be seen from Table III-16 that point source loads represent about 3% and 11% of the 1986 nitrogen load for the Lake Bridgeport and Lake Arlington watersheds, respectively, and about 8% and 27% of the 1986 phosphorous load for the Lake Bridgeport and Lake Arlington watersheds.

Table III-17 shows the load comparisons for projected conditions for BOD, nitrogen, and phosphorous for the Lake Bridgeport, Lake Worth, Lake Weatherford, and Lake Arlington watersheds. Point source loads represent about 0.6%, 2.9% and 8.8% of the BOD, nitrogen, and phosphorous loads, respectively, into Lake Bridgeport and 7%, 26.8%, and 51.1% for BOD, nitrogen, and phosphorous loads into Lake Arlington.

Table III-18 is a summary table of load comparisons for existing and projected conditions for Lake Bridgeport, Lake Worth, Lake Weatherford, and Lake Arlington. It shows that the point source percentage of nitrogen loading stays about the same for existing and projected conditions for Lake Bridgeport, while the phosphorous percentage increases slightly, from about 8% to 9% and BOD decreases from 2% to 0.6% for point source loads. Nonpoint loading stays about the same for all constituents for Lake Bridgeport. For the Lake Arlington watershed, the percentage BOD increases about 6% for point source loads, going from existing to projected conditions, while nitrogen and phosphorous increase 2.5 and 1.9 times

TABLE III-17

NONPOINT SOURCE AND POINT SOURCE
LOAD COMPARISONS - PROJECTED CONDITIONS[1]

	Projected Plant Flow MGD	BOD lb/yr	BOD % of Total	Nitrogen lb/yr	Nitrogen % of Total	Phosphorous lb/yr	Phosphorous % of Total
Lake Bridgeport Watershed							
Jacksboro	.360	10,965	0.6	21,931	2.9	8,772	8.8
Total Point Source		10,965	0.6	21,931	2.9	8,772	8.8
Total Nonpoint Source		1,840,000	99.4	747,000	97.1	91,300	91.2
Total Load		1,850,965	100%	768.931	100%	100,072	100%
Lake Worth Watershed							
Total Point Source		0	0	0	0	0	0
Total Nonpoint Source		550,000	100%	226,700	100%	29,200	100%
Total Load		550,000	100%	226,700	100%	29,200	100%
Lake Weatherford Watershed							
Total Point Source		0	0	0	0	0	0
Total Nonpoint Source		226,000	100%	96,700	100%	12,100	100%
Total Load		226,000	100%	96,700	100%	12,100	100%
Lake Arlington Watershed							
Oak Grove Airport	.0175	533	0.2	1,066	0.6	426	1.1
SDHPT, Burleson Rest Stop	.006	183	--	366	0.2	146	0.4
Johnson Co. FWSD #1	0.757	23,058	6.8	46.115	26.0	18.446	49.6
Total Point Source		23,774	7.0	47,547	26.8	19,018	51.1
Total Nonpoint Source		317,000	93.0	129,800	73.2	18,200	48.9
Total Load		340,774	100%	177,347	100%	37,218	100%

1. Projected point source loads are based on the expansion of existing wastewater treatment plants.

TABLE III-18

SUMMARY TABLE OF NONPOINT SOURCE AND POINT SOURCE LOAD COMPARISON

	Percentage Distribution			
	Existing Conditions		Projected Conditions	
	Point Source	Nonpoint Source	Point Source	Nonpoint Source
Lake Bridgeport Watershed				
BOD	2.0	98.0	0.6	99.4
Nitrogen	3.0	97.0	2.9	97.1
Phosphorous	8.0	92.0	8.8	91.2
Lake Worth Watershed				
BOD	0	100	0	100
Nitrogen	0	100	0	100
Phosphorous	0	10	0	100
Lake Weatherford Watershed				
BOD	0	100	0	100
Nitrogen	0	100	0	100
Phosphorous	0	100	0	100
Lake Arlington Watershed				
BOD	1.0	99.0	7.0	93.0
Nitrogen	10.8	89.2	26.8	73.2
Phosphorous	26.7	73.3	51.1	48.9

respectively. For nonpoint sources, BOD decreases 6% and nitrogen and phosphorous decrease about 16% and 24% respectively, going from existing to projected conditions.

WATER QUALITY PROJECTIONS

A simplified lake analysis was developed to provide a basis for estimating the eutrophication related water quality impacts from treatment plants for existing and projected populations and possible regional sewage collection and treatment alternatives.

Procedures

Water quality data from Benbrook Lake, Eagle Mountain Lake, and Lake Worth were employed to calibrate a two-layered, summer average, steady-state eutrophication model for each of the lakes. The models had essentially the same framework and most, though not all, coefficients were the same in each model. The calculations used observed data on the concentration of total nutrients to compute the distribution of nitrogen and phosphorous chemical species and the concentration of chlorophyll "a". The calibrations emphasized the top-layer water quality and the inorganic nutrient concentrations. Tables III-19, through III-21 provide comparisons of the observed and calculated water quality for each of the lakes. Appendix D contains a listing of the kinetic subroutine used in the WASP model and the input data for each of the lake calibration runs.

A series of projections were developed for Eagle Mountain Lake and Benbrook Lake using the estimates of nonpoint source loads contained in Tables III-7 and III-8. The projections for both lakes were developed assuming that the total nutrient concentrations in plant effluents without nutrient removal were 5.6 mg/l total phosphorous and 17 mg/l total nitrogen. The total loadings for nitrogen and phosphorous were computed for growth and

TABLE III-19

COMPARISON OF OBSERVED AND CALCULATED VALUES FOR LAKE WORTH

Variable	Observed		Calculated	
	Top	Bottom	Top	Bottom
UP mg/l	.02	.02	.025	.025
OP mg/l	<.01	<.01	.001	.002
NO_3 mg/l	<.02	<.02	.002	.004
NH_3 mg/l	.29	.23	.04	.05
OH mg/l	.59	.63	.27	.27
Chl "a" ug/l	15.2	--	15.4	--

Legend: UP - Unavailable Phosphorous
OP - Ortho Phosphorous
NO_3 - Nitrates
NH_3 - Ammonia
ON - Organic Nitrogen
Chl "a" - Chlorophyll "a"

TABLE III-20

COMPARISON OF OBSERVED AND CALCULATED VALUES
FOR LAKE BENBROOK

	TOP				BOTTOM			
	Observed				Observed			
Variable	Min.[2]	Max.[2]	Avg.[2]	Calc.	Min.[2]	Max.[2]	Avg.[2]	Calc.
TP mg/l	.02	.07	.04	.056	.05	.09	.06	.058
UP mg/l	.06	0	.05	.03	.03	.08	.05	.05
OP mg/l	<.01	.02	.006	.01	<.01	.03	.008	.01
NO_3 mg/l	<.03	.1	.04	.04	<.03	.3	.05	.12
NH_3 mg/l	<.03	.1	.04	.04	<.03	.3	.05	.12
ON mg/l	1.03	1.20	1.	1.06	.86	1.6	1.	1.
DO mg/l	5.7	10	6.4	8.2	0	7.8	6.3	4.3
Chl 'a' ug/l	2.4	20	11	10.6	--	--	--	--

1. Legend: TP - Total Phosphorous
DO - Dissolved Oxygen
UP - Unavailable Phosphorous
OP - Ortho Phosphorous
NO_3 - Nitrates
NH_3 - Ammonia
ON - Organic Nitrogen
Chl "a" - Chlorophyll "a"
2. Intensive survey data 7-15-87

TABLE III-21

COMPARISON OF OBSERVED AND CALCULATED VALUES
FOR EAGLE MOUNTAIN LAKE

	TOP					BOTTOM				
	Observed					Observed				
Variable	Min.[1]	Max.[1]	Avg.[1]	Std.[1]	Calc.	Min.[1]	Max.[1]	Avg.[1]	Std.[1]	Calc.
TP mg/l	.15	.01	.05	.03	.044	.01	.22	.07	.05	.03
UP mg/l	--	--	.03	--	.03	--	--	.02	--	.01
OP mg/l	.01	.06	.02	.01	.014	.01	.22	.05	.14	.02
NO_3 mg/l	.01	.3	.1	.15	.3	.01	.6	.11	.17	.33
NH_3 mg/l	.01	.27	.08	.07	.06	.01	.43	.11	.12	.09
ON mg/l	.01	3.2	1.7	1.2	1.5	1.0	2.7	1.9	.46	1.5
DO mg/l	--	--	--	--	5.6	--	--	--	--	4.7
Chl'a' ug/l	2.7	25.6	17.5	8.6	17.3	2.7	18.8	12.1	9.0	12.7

1. Observed data from joint study by TWC/SEML/TWCID performed in summer 1986-1987.

treatment scenarios developed in the facility planning tasks of this project. (See Appendices A, B, and C.) The ratio of projected nutrient loads to the existing load for each of the nutrients was developed for the various scenarios. These ratios were employed to calculate new in-lake nutrient concentrations assuming that the concentrations changed in proportion to the change in loads.

Results

Eagle Mountain Lake Projections. The estimated plant flows upstream of Eagle Mountain Lake were approximately 1.8 MGD under current conditions and 5.1 MGD in the year 2005. The 2005 treatment plant flow contains flows from existing plants and septic tank systems as well as flows associated with the projected population growth.

Table III-22 presents the projected chlorophyll "a" concentrations in Eagle Mountain Lake for the conditions examined and for the calibration that represents the existing conditions. The existing chlorophyll "a" concentration is approximately 17 ug/l and is estimated to increase to approximately 20 ug/l if nutrient removal is not provided in the future. Nutrient removal for existing discharges is estimated to reduce concentrations to between 14 and 15 ug/l. The projected chlorophyll "a" concentrations change approximately ±3 ug/l. This magnitude of change has been considered to be significant in some situations. It is difficult to quantitatively relate this concentration change to modifications in water usage. In addition, the summer chlorophyll "a" data for Eagle Mountain Lake have a standard deviation in excess of 8 ug/l. The projected change of ±3 ug/l would be difficult if not impossible to measure in the lake during a summer season.

TABLE III-22

PROJECTED CHLOROPHYLL "a" FOR EAGLE MOUNTAIN LAKE

Conditions				
	Flow - MGD[1]		Nutrient	Chl 'a'
Year	Lake	Fort Worth	Removal	ug/l
Existing	1.8	-	None	17.3
Existing	1.8	-	P to 1 mg/l	14.8
Existing	1.8	-	N to 3.3 mg/l	15.6
2005	5.1	-	None	20.3
2005	5.1	-	P to 1 mg/l	16.2
2005	5.1	-	N to 5 mg/l	17.3
2005	3.85	1.26	None	19.5
2005	3.85	1.26	P to 1 mg/l	16.9
2005	3.85	1.26	N to 5 mg/l	16.0
2005	3.86	2.25	None	18.6
2005	2.86	2.25	P to 1 mg/l	14.9
2005	2.86	2.25	N to 5 mg/l	16.0

1. Projected wastewater flows were based on expansion of the existing treatment plants to treat the increased flow from higher populations and flows that are currently treated in septic systems.

The projections indicated a potentially significant trend associated with the increases in discharge of treated sewage without accompanying nutrient controls. The current analysis is a lake-wide analysis and smoothes out spatial effects. It can be anticipated that shallow near-shore areas, which are in coves where the treatment plant effluents enter the lake, will be subject to larger impacts. (It still may be difficult to measure changes in concentrations.)

Examination of the information presented in Table III-22 indicates that either nitrogen or phosphorous removal could be considered to control chlorophyll "a" concentrations. Under existing conditions, light is the factor that is limiting chlorophyll "a" concentrations and the influence of nutrients appears to be modest in terms of limiting growth. Control of either nutrient can induce a limitation associated with the nutrient that is controlled. The calculations indicate that phosphorous control is somewhat more effective then nitrogen control, and experience indicates that phosphorous control has the additional advantage of being more compatible with many nonpoint source control actions.

The current analysis can provide a basis for long-term planning, while the more complex Eagle Mountain Lake eutrophication analysis being developed by the state can ultimately provide the basis for detailed planning and implementation that could consider both point and nonpoint source controls.

Benbrook Lake Projections. Table III-23 presents estimates of chlorophyll "a" concentrations for Benbrook Lake. Existing conditions (calibration) and various nutrient control policies have been considered. Existing chlorophyll "a" concentrations are approximately 11 ug/l and are projected to increase to between 13 and 14 ug/l in the future without nutrient controls. Control of nutrients at existing discharges could reduce current chlorophyll "a" to approximately 8 ug/l. The data base for Benbrook Lake is not as extensive as the data base for Eagle Mountain Lake. Similar

TABLE III-23

PROJECTED CHLOROPHYLL "a" FOR LAKE BENBROOK

Condition			
Year	Flow-MGD[1]	Nutrient Removal	Chl "a" ug/l
Existing	2.4	None	11.3
Existing	2.4	P to 1 mg/l	7.3
Existing	2.4	N to 5 mg/l	7.9
2005	3.67	None	13.6
2005	3.67	P to 1 mg/l	7.3
2005	3.67	N to 5 mg/l	9.0

1. Projected wastewater flows were based on expansion of existing treatment plants to treat increased flows from higher populations and flows that are currently treated in septic systems.

variations of observed data and effects can be anticipated. Increases in chlorophyll "a" projected by the current analysis are for lake-wide conditions and increased impacts could be anticipated in shallow near-shore areas close to locations where loads enter the system. The difficulties of relating changes in chlorophyll "a" concentrations to modifications of water usage are also applicable to the Benbrook Lake situation. Variations in observed data could make it difficult or impossible to measure changes in water quality associated with anticipated loading increases or decreases.

Phosphorous controls appear to be somewhat more effective than nitrogen controls for future conditions. This assessment is, in part, related to the limited water quality data base for Benbrook Lake and to the initial estimates of point and nonpoint sources limitations in available data. It is suggested that the data base and associated analysis be strengthened. The current analysis suggests that nutrient removal could be required in the future; therefore, new or expanded facilities should be designed to accommodate later inclusion of phosphorous removal processes.

Other Water Quality Considerations for Lakes. A basic policy issue exists in terms of the desirability and affordability of nutrient control policies for Benbrook Lake and Eagle Mountain Lake. In both situations, there will be an increase in chlorophyll "a" concentrations with increases in nutrient loads associated with population growth. Tangible benefits or improvements from a nutrient control program will be difficult or impossible to measure and quantify.

If nutrient controls are identified as appropriate for either or both systems, then the current analysis indicates that phosphorous controls will be the most effective choice for summer conditions. Nonpoint source controls of phosphorous should be considered in the overall management of water quality if nutrient removal is considered appropriate.

The current analysis is for average summer conditions. It is possible that an analysis of data from other seasons could identify a need for nitrogen control. It is unlikely that the issues associated with the relationship of water usage to water quality or the difficulty of measuring changes in water quality will be affected by analysis of additional seasons.

Stream Analysis

The Streeter-Phelps simplified mathematical model was used to model all the streams in the Upper Trinity River Basin for determining projected wastewater effluent quality limits for the year 2005 in a scenario where all communities along the streams operated their own wastewater treatment plants (WWTP). Streams that were modeled in the Upper Trinity River Basin were: Village Creek, Ash Creek, Walnut Creek, the West Fork Trinity River system (including Martin's Branch, Big Sandy Creek, Dry Creek, and Town Creek), South Fork Trinity, and the Clear Fork Trinity River system. Qual-Tx was also used to model Town Creek, South Fork Trinity, and the Clear Fork Trinity River. Details of model development are presented in Appendix D.

Projected year 2005 populations of individual cities taken from this report were used to determine the projected flows to be utilized in the models. In addition, daily usage rates (gpcd) for each community were determined to evaluate projected flows, based on information from Federal WWTP design criteria data, Texas state WWTP design criteria, Texas state septic system design criteria, and Texas Water Commission self-reporting data collected from community wastewater treatment facility records in the Upper Trinity River Basin. In several communities, evaluated usage rates seemed to be uncharacteristically low. Some additional modeling check runs were performed using higher usage rates for the communities in question, and it was found that there was no change in effluent quality requirements.

The low usage rates could possibly be due to plant discharge flows taken from the TWC self-reporting data. If plant personnel in those communities recorded flows in periods of lower usage, the gpcd values may be low also. However, the anticipated growth in these communities is small, and since there were no additional stream impacts from the increased usage rates used in the model check runs, the difference in the usage rates does not appear to be an important issue. It is also important to note that the lower usage rates, as well as the other rates used to determine the projected flows, were within the recommended range of the federal and state design criteria.

Results of the simplified modeling are shown in Table III-24. A range of effluent quality requirements was determined by testing for two sets of stream conditions: 1) normal reaeration and 2) limited reaeration where the stream is influenced by low-flow and pooling effects. In addition, three different flows were considered for the Johnson County Freshwater Supply District No. 1 (FWSD No. 1) to determine the range of impacts possible on Village Creek. Discharge flows from major industries along the streams modeled in this study were consistent with current TWC self-reporting data. Industrial flows were assumed to remain relatively constant through the year 2005.

SUMMARY

Water quality in the Upper Trinity River Basin is typically good. Violations of surface water quality standards are occasionally observed in association with low stream flow conditions and shallow, stagnant water in bay and cove areas around the lakes. Low DO violations were occasionally observed in the lakes near the dams.

Nonpoint source and point source pollutant load estimates and projections were developed. It appears that nonpoint source loads represent the majority of the annual pollutant loads into the study area lakes and

TABLE III-24

**SIMPLIFIED MODELING RESULTS
PROJECTED EFFLUENT SETS
2005 PROJECTED FLOWS
UNDER NORMAL AND LIMITED AERATION**

Receiving Stream	Effluent Quality Normal Reaeration			Effluent Quality Limited Reaeration		
	BOD (mg/l)	NH_3 (mg/l)	DO (mg/l)	BOD (mg/l)	NH_3 (mg/l)	DO (mg/l)
Town Creek	10	3	5	5	2	5
South Fork	10	3	5	5	2	5
Clear Fork	10	3	5	5	2	5
<u>Village Creek</u>						
JCFSD No. 1 @ 0.5 mgd	20	15	5	10	3	5
JCFSD No. 1 @ 1.0 mgd	20	15	5	10	3	5
JCFSD No. 1 @ 2.0 mgd	20	15	5	10	3	5
Dry Creek	20	15	5	10	3	5
Big Sandy Creek	20	15	5	10	3	5
Martins Branch	20	15	5	10	3	5
Martins Branch	20	15	5	10	3	5
West Fork	20	15	5	10	3	5
Ash Creek	20	15	5	10	3	5
Walnut Creek	20	15	5	10	3	5

streams. Therefore, any water quality management plan should consider the potential impact of nonpoint source loads on the water quality.

The results of the dissolved oxygen water quality analysis are summarized in Table III-25. Information is presented for the two levels of reaeration coefficients examined in the current study and the two types of models used in the analysis. The restriction on the average reaeration coefficient attempts to make an allowance for the effects of pools in the water bodies. However, pools would also provide locations suitable for sources of dissolved oxygen and sinks of ammonia from phytoplankton, algae, and plant growth that are not included in the analysis. The data collected suggest that these sources of oxygen and sinks of ammonia may be quite significant. Thus, the analysis with the reaeration restriction appears very conservative and quite restrictive.

A basic policy issue exists in terms of the desirability and affordability of nutrient control policies for Benbrook Lake and Eagle Mountain Lake. In both situations, there will be an increase in chlorophyll "a" concentrations with increases in nutrient loads associated with population growth. The calculated increases in chlorophyll "a" can be eliminated by nutrient removal at point sources. Tangible benefits or improvements from a nutrient control program will be difficult or impossible to measure and quantify.

If nutrient controls are identified as appropriate for either or both systems, then the current analysis indicates that phosphorous controls will be the most effective choice for summer conditions. Nonpoint source controls of phosphorous should be considered in the overall management of water quality if nutrient removal is considered appropriate.

TABLE III-25

SUMMARY OF RESULTS

Water Body[1]	Effluent Requirements[2] Conventional Reaeration[3]	Reaeration Restriction[4]	Method of Analysis
West Fork Trinity	20/15/5	10/3/5	Streeter-Phelps[5]
Martins Branch	20/15/5	10/3/5	Streeter-Phelps[5]
Big Sandy Creek	20/15/5	10/3/5	Streeter-Phelps[5]
Dry Creek	20/15/5	10/3/5	Streeter-Phelps[5]
Village Creek	20/15/5	10/3/5	Streeter-Phelps[5]
Town Creek, South Fork, Clear Fork	10/3/5	5/2/5	Streeter-Phelps[7]
Walnut Creek	20/15/5	10/3/5	Streeter-Phelps[6]
Ash Creek	20/15/5	10/3/5	Streeter-Phelps[6]
Town Creek and South Fork	10/2/5	---	Qual-Tx[7]
Clear Fork	5/2/6	---	Qual-Tx[7]

Notes:
1. Projections for the municipal discharges at 2005 flows.
2. $CBOD_5/NH_3$-N/DO.
3. Texas reaeration formula used.
4. Reaeration coefficient restricted to ka $\leq$ 2/day in an attempt to account for pools in the stream.
5. No data of calibration.
6. Some limited water quality data available.
7. One usable data set for calibration.

The current analysis is for summer average conditions. It is possible that an analysis of data from other seasons could identify a need for nitrogen control. It is unlikely that the issues associated with the relationship of water usage to water quality or the difficulty of measuring changes in water quality will be affected by analysis of additional seasons.

CHAPTER IV

WASTEWATER FACILITY PLANS

INTRODUCTION

The objectives of this project are to develop, evaluate, and present to the involved and affected parties alternatives for wastewater treatment in the Upper Trinity River Basin based on water quality, political subdivisions, and cost. This chapter summarizes results of planning efforts for the Clear Fork-Lake Weatherford Facility Planning Region, the Eagle Mountain Lake Facility Planning Region, and for several isolated communities within the Upper Trinity River Basin. Details of data and assumptions used in developing the summary information presented here are contained in individual facility plan reports dedicated to each facility planning region and included as Appendices A, B, and C to this report.

The information and costs presented are intended to aid the communities, cities, planning agencies, and potential operators in evaluating wastewater treatment alternatives in their areas. Recommended alternatives are presented in the following sections based on comments from and discussions with the parties affected, refinement of costs, and completion of the receiving water quality impact analysis. However, recommendations on alternatives for the Eagle Mountain Lake Facility Planning Region cannot be refined until the Texas Water Commission concludes its present studies and permit hearings in that region.

Affordability guidelines published in EPA document CG-82, which state that the total annual charges to customers should not exceed 1.75% of the median annual household income when that income is over $17,000, were referenced when performing the facility plan costing standards. The 1979 median household income for Tarrant County was $18,642 per year, and therefore the guideline for affordability would be about $325 per household per year.

Likewise, the median household income for Parker County is $17,245, and the guideline for affordability for that county would be about $300 per year. The median household income for Wise County for 1979 was $16,381. For amounts between $10,500 and $17,000, the suggested limit of affordability is 1.5%; therefore, the affordability guideline for Wise County would be about $245.

METHODOLOGY

The facility planning work associated with this study developed data necessary to evaluate the feasibility of specific projects needed to protect water quality in the Upper West Fork and Clear Fork of the Trinity River Basin while providing efficient, cost-effective treatment. These data aid in identification of priorities, costs, and locations of necessary pollution abatement facilities. The identification of sound alternatives to maintain water quality and to provide cost-effective wastewater treatment was a primary objective of the study.

The rapidly growing population within parts of the study area has resulted in the need to provide cost-effective treatment to serve that growth while protecting the water quality of the reservoirs that are the predominant sources of water supply for the area and other downstream areas. The impacts of high population growth, increased nonpoint sources of pollution due to urbanization, and the need for additional water and wastewater facilities must be balanced with the need to protect the water quality of the lakes in the region.

The protection of the water quality of these lakes must begin before population growth circumvents the time for detailed evaluation of regional facilities to handle the wastewater that will be generated. Studies done by local Councils of Governments and other agencies show that the area population is growing and that, by the year 2000, approximately 51% more people may be residing in the area. Much of this growth is and will continue to occur in the vicinity of the major lakes of the region. Many streams and lakes are already feeling the impact of this increased growth. These facility planning efforts will determine the areas of greatest growth and will address the difficult problems of achieving water quality protection and economically feasible wastewater treatment and disposal.

The resources preserved by protecting water quality include more than just the water supply. People from a large part of Texas enjoy the region's lakes because of the excellent boating, fishing, hunting, swimming, camping, and other recreational activities. Protection of the water quality of the lakes is needed to maintain the tremendous recreational benefits.

The study area boundaries represent the drainage areas of Lake Arlington, the Upper West Fork, and the Clear Fork of the Trinity River. These boundaries are totally within the Trinity River Basin.

The wastewater facility planning concentrated on the three facility planning regions indicating a more critical need for organized systems. Most of these facility planning regions correspond to population clusters and watershed boundaries that could potentially benefit from construction of regional sewerage systems. These three facility planning regions are:

1. Clear Fork-Weatherford Facility Planning Region
2. Eagle Mountain Lake Facility Planning Region
3. Isolated individual communities outside of designated facility planning regions

Areas within the Fort Worth city limits, but also part of North Lake Worth and South Benbrook Lake Facility Planning Regions were addressed in the Fort Worth Master Plan (in preparation) and are, therefore, not included in the facility planning efforts described in this report.

Alternative treatment technologies for local, subregional, and regional sewerage systems serving each of the communities within these planning areas were also evaluated.

POTENTIAL MANAGEMENT AND FUNDING ALTERNATIVES

Potential management agencies and sources of funding must be considered for each system. City utility departments, utility districts, and private water supply companies are among the management options potentially available. Any management agency considered must have the legal authority to issue bonds, collect revenue, and meet other requirements such as may be imposed by federal or state law. Existing agencies that might be considered within each of the designated facility planning regions are listed in Table IV-1. To manage certain facilities, some of these agencies might be required to enact ordinances or amend their current operating guidelines.

Several sources of funding may be considered for each system. Revenue bonds represent a common, widely accepted method of financing public sewage facilities. General obligation bonds may be the preferred funding source for some municipalities. Recently enacted amendments to the Clean Water Act seek to replace federal grants with state-administered revolving loan funds by 1990.

The State Water Pollution Control Revolving Fund (State Revolving Fund, or SRF) is a perpetual fund through which the Texas Water Development Board (TWDB) provides low-interest loans to Texas communities for the construction of wastewater treatment works. The initial "seed" money for the SRF comes from federal capitalization grants and a 20% state match, as authorized by the 1987 Clean Water Act Amendments and state enabling legislation, S.B. 807. The SRF program replaces the old federal construction grants program and is managed by the state. Financial assistance from the SRF is available

TABLE IV-1

EXISTING MANAGEMENT AGENCIES CONSIDERED

Clear Fork-Weatherford Facility Planning Region	Eagle Mountain Lake Facility Planning Region	Other Areas Outside Designate Facility Planning Regions
Local	Local	Local
City of Weatherford City of Willow Park Town of Hudson Oaks City of Aledo City of Annetta City of Annetta North City of Annetta South Parker Co. Utility District	City of Azle City of Reno City of Pelican Bay City of Boyd City of Aurora City of Newark City of Rhome Tarrant Co. Water Municipal Utility District No. 1 City of Fort Worth Parker Co. Utility District Tarrant Co. Water Control and Improvement District No. 1	City of Decatur City of Briaroaks City of Bridgeport City of Jacksboro City of Joshua Johnson Co. Fresh Water Supply District No. 1 City of Springtown City of Chico Wise Co. Water Control Improvement District No. 1 City of Lake Bridgeport City of Alvord Parker Co. Utility District
Regional/Subregional	Regional/Subregional	Regional/Subregional
City of Weatherford Parker Co. Utility District City of Fort Worth Tarrant Co. Water Control and Improvement District No. 1 Trinity River Authority of Texas	City of Azle Tarrant Co. Municipal Utility District No.1 Parker Co. Utility District City of Fort Worth Trinity River Authority of Texas Tarrant Co. Water Control and Improvement District No. 1	N/A

in the form of low-interest loans for the construction of wastewater treatment works; the interest rate is currently set at 4%. For purposes of cost analysis for this study and on the basis of available SRF funds, an interest rate of 4-1/2% and payout period of 20 years were used.

A more detailed description of the facility planning methodology is included in Appendix D.

CLEAR FORK-WEATHERFORD FACILITY PLANNING REGION

Area Included in Facility Planning Region

This facility planning region, shown in Figure IV-1, encompasses the Clear Fork drainage basin upstream of Turkey Creek and includes the watersheds of the Clear Fork and South Fork of the Trinity River.

Communities selected for examination as facility planning areas (FPAs) are listed below:

- City of Weatherford
- City of Willow Park
- Town of Hudson Oaks
- City of Aledo
- Lake Weatherford Area
- City of Annetta North
- City of Annetta
- City of Annetta South

The boundaries of these individual facility planning areas were shown in Figure IV-1. It should be noted that the authority of the City of Aledo is limited to their corporate boundary only. As a general law city, Aledo

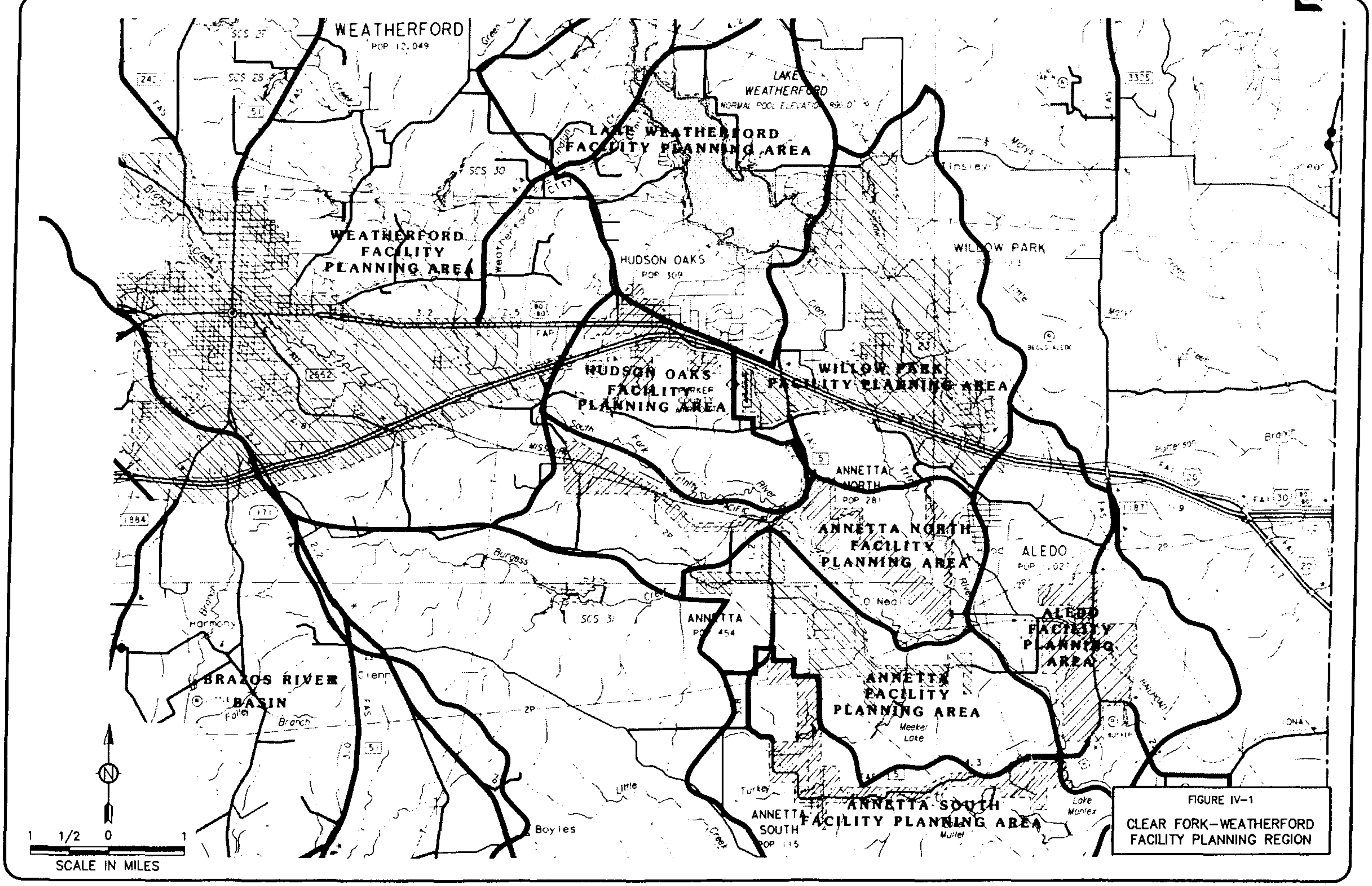


FIGURE IV-1
CLEAR FORK—WEATHERFORD FACILITY PLANNING REGION

would have a 1/2 mile ETJ, but control in this area is accessed by the City of Fort Worth which has a 5-mile ETJ that takes precedence since it is a home rule city.

All of these facility planning areas, except the Lake Weatherford area, lie within segment 0831 (Clear Fork Trinity River Below Lake Weatherford) of the Trinity River Basin. The Lake Weatherford Facility Planning Region encompasses segment 0832 and the lower portions of segment 0833.

The terrain surrounding these communities may generally be described as hilly, ranging from gently sloping to relatively steep cliffs adjacent to river channels in some areas. Most of the larger population clusters are in communities along IH 20 and U.S. 80.

Population Projections

Populations in each of the communities were projected through year 2005. The North Central Texas Council of Governments estimates for 1987 are available and were used for the cities of Weatherford, Willow Park, and Aledo. Population figures for 1987 in other communities were estimated from recent aerial photographs and from information provided by representatives of the individual communities.

Population projections for each of the community facility planning areas are presented in Table IV-2.

Summary of Alternatives

For each facility planning area, four basic wastewater disposal options were considered. The first of these alternatives involves continued on-site disposal for areas not currently served by an organized system. The remaining three alternatives involve implementation of an organized system

TABLE IV-2

CLEAR FORK-WEATHERFORD FACILITY PLANNING REGION
FACILITY PLANNING AREA POPULATION ESTIMATES AND PROJECTIONS

Community	Estimated 1987 Population	Estimated 2005 Population
City of Weatherford	14,660	17,950
City of Willow Park	2,100	4,640
Town of Hudson Oaks	900	2,410
City of Aledo[1]	1,350	2,180
Lake Weatherford Area	1,540	2,020
City of Annetta North	660	1,630
City of Annetta	410	940
City of Annetta South	330	890

1. Includes population outside corporate boundaries of City of Aledo which is in ETJ of Fort Worth.

at local, subregional, or regional levels. The estimated per-household annual costs for all organized system alternatives considered for the Clear Fork-Weatherford Facility Planning Region are presented in Table IV-3. Permit limitations for each area will depend on water quality and regulatory constraints discussed elsewhere in this report. Costs presented in Table IV-3 represent fully developed system costs based on 2005 population projections. Actual costs may vary somewhat depending on exact system layouts, areas served, financing, and other factors. Details of the calculations used in generating the figures in Table IV-3 are presented in Appendix A.

The cost of individual on-site disposal systems may vary considerably throughout the region. Conventional on-site systems, where suitable soils exist, may cost from $1,500 to $2,500. In areas where unsuitable soils are prevalent, however, initial costs of $5,000 to $10,000 may not be uncommon. If these initial costs are financed in a 30-year home mortgage at an 11% interest rate, the homeowner may incur an annual cost of $173 (based on a $1,500 initial cost) to $1,150 (based on a $10,000 initial cost).

Existing Organized Systems

Three organized sewerage systems currently have permits to operate within the Clear Fork-Weatherford Facility Planning Region. The largest plant is operated by and serves the City of Weatherford. This plant is located in the City of Weatherford and discharges to Town Creek, 1 mile above the IH 20 bridge. This plant essentially serves all citizens within the Weatherford city limits and is permitted for an average daily discharge of 2.12 million gallons per day (MGD). The plant currently discharges approximately 1.5 MGD under average conditions.

TABLE IV-3

CLEAR FORK-WEATHERFORD FACILITY PLANNING REGION
SUMMARY OF ESTIMATED COSTS FOR ORGANIZED SYSTEM

Facility Planning Area	2005 Total Flow (MGD)	System	Range of Estiamted Annual Costs per Household (Based on Projected 2005 Population)(1) 10/15/2	5/5/2
Willow Park	0.46	Local	367	427
		Sub-Regional		
		Regional	365	386
Hudson Oaks	0.24	Local	403	N/A
		Sub-Regional	385	N/A
		Regional	344	365
Lake Weatherford Area	0.20	Local	693(2)	729(2)
		Sub-Regional	667(2)	800(2)
		Regional	657(2)	678(2)
Annetta North	0.10	Local	407	N/A
		Sub-Regional	325	440
		Regional	296	316
Annetta	0.09	Local	565	N/A
		Sub-Regional	450	574
		Regional	432	453
Annetta South	0.09(3)	Local	613	N/A
		Sub-Regional	522	632
		Regional	488	510
Weatherford	2.15	Local	177(5)	225(5)
		Sub-Regional	200(5)	225(5)
		Regional		
Aledo	0.22	Local		
		Sub-Regional	200(5)	311(5)
		Regional	167(5)	188(5)

(1) Lower annual cost is for 10/15/2 permit conditions; higher annual cost is for 5/5/2 permit conditions.
(2) Includes costs of individual pumping units required at each waterfront home.
(3) Total from two independent local collection systems
(4) Existing system currently operating
(5) In addition to costs of operating, maintaining, and servicing debt on existing city collection system.

The City of Weatherford's long-range sewerage system master plan calls for a second wastewater treatment plant to be constructed near the community of Center Point in the future. It is not yet permitted.

The second permitted and the only other operating sewerage system within the Clear Fork-Weatherford Region is the City of Aledo wastewater system. The city now operates the wastewater collection and treatment system formerly owned and operated by the Parker County Utility District. This above-ground steel package plant serves about 60% of the current population within the Corporate Limits of the City of Aledo. It is currently permitted for an average discharge of 0.091 MGD, but an application for an amendment to increase the permitted flow to 0.130 MGD has been submitted to the Texas Water Commission. The plant discharges to an unnamed tributary of the Clear Fork near the southwest side of the City of Aledo.

The third permit is currently held by Mr. Doyle Hanley, the developer of Clear Fork Canyon Estates. The proposed WWTP will discharge up to 0.25 MGD from a site on the south end of the City of Willow Park. This facility is intended to serve a proposed high-density residential and commercial development in Willow Park. Mr. Hanley has entered into a Wastewater Treatment Facility Transfer Agreement with the City of Willow Park that establishes the terms and conditions for the construction and subsequent transfer of the WWTP to the City of Willow Park. Development of this system is not yet underway.

Existing On-Site Systems

All other developed areas within the Clear Fork-Weatherford Facility Planning Region are served by individual on-site disposal systems. The cities of Weatherford and Willow Park administer their own septic tank programs. Septic tank installations throughout the remainder of Parker

County are regulated by the Parker County Health Department in accordance with Texas State Health Department criteria.

Soils throughout a large portion of the region are unsuitable for septic tank drain fields. In general, soils in and adjacent to the Clear Fork and South Fork are classified as unsuitable due to flooding, and many soils at higher elevations are unsuitable because of relatively shallow depth of rock. Soils at middle elevations, flanking the floodplains of both the Clear Fork and the South Fork, vary in suitability from poor (due to slow percolation rates) to good. Soil suitability for this region is summarized in Table IV-4.

Detailed records regarding septic tank installations have not been maintained by the Parker County Health Department until recently. Conversations with local representatives indicate that there are problems with septic tank systems in Hudson Oaks, Willow Park, and in the surrounding area due to shallow rock and groundwater.

More detailed descriptions of each facility planning area in the Clear Fork-Weatherford Facility Planning Region, as well as further breakdown and detail of proposed facility plans and estimated costs, are included in Appendix A of this report.

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION

Area Included in Facility Planning Region

Eagle Mountain Lake (EML) is located in northwestern Tarrant and southeastern Wise counties about 12 miles northwest of downtown Fort Worth. The lake is on the West Fork of the Trinity River between Lake Worth and Lake Bridgeport. It is identified as river mile 49 to river mile 66 of the West Fork, which is segment 0809. EML was completed in 1932 for the

TABLE IV-4

CLEAR FORK-WEATHERFORD FACILITY PLANNING REGION
SUMMARY OF SOIL SUITABILITY
FOR ON-SITE DISPOSAL

Facility Planning Area	Percent Distribution for Soils			
	Slight Limitation	Moderage Limitation	Severe Limitation (slow perc)	Severe Limitation (rock; flooding)
Willow Park	5	10	5	80
Hudson Oaks	10	20	15	55
Annetta	5	25	5	65
Annetta North	20	10	45	25
Annetta South	3	1	1	95
Lake Weatherford Area	25	30	5	40

purposes of water supply and recreation, and it has approximately 200 miles of shoreline and a surface area of 9,000 acres. The lake is owned, operated, and maintained by the Tarrant County Water Control and Improvement District No. 1.

The planning region for Eagle Mountain Lake is shown in Figures IV-2 and IV-3, and the 16 individual FPAs included therein are listed as follows:

- Azle Facility Planning Area
- Ash Creek Facility Planning Area
- Pelican Bay Facility Planning Area
- Peden Facility Planning Area
- Swift Branch Facility Planning Area
- Reno Facility Planning Area
- Briar Creek Facility Planning Area
- Hog Branch Facility Planning Area
- Boyd Facility Planning Area
- Aurora Facility Planning Area
- Oates Branch Facility Planning Area
- Newark Facility Planning Area
- Avondale Facility Planning Area
- Gilmore Branch Facility Planning Area
- Boat Club Facility Planning Area
- Lake Country Estates Facility Planning Area

The individual planning areas in most cases are drainage basins for the creeks that flow into Eagle Mountain Lake. In some instances, however, the boundaries have been modified to account for political boundaries such as city limits. Table IV-5 summarizes the areas and also the population estimates for each individual planning area.

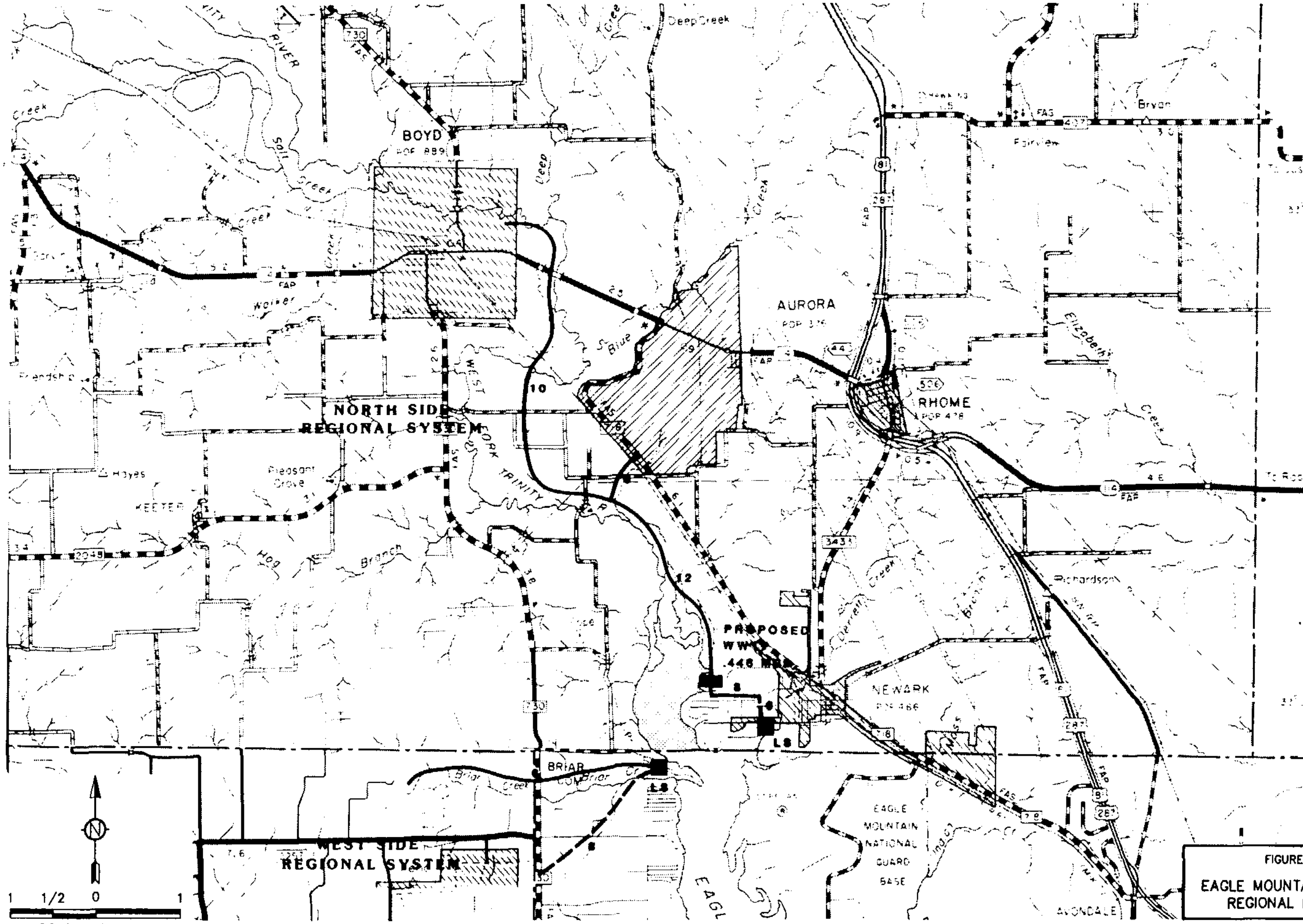


FIGURE IV–2
EAGLE MOUNTAIN LAKE (N)
REGIONAL FACILITIES

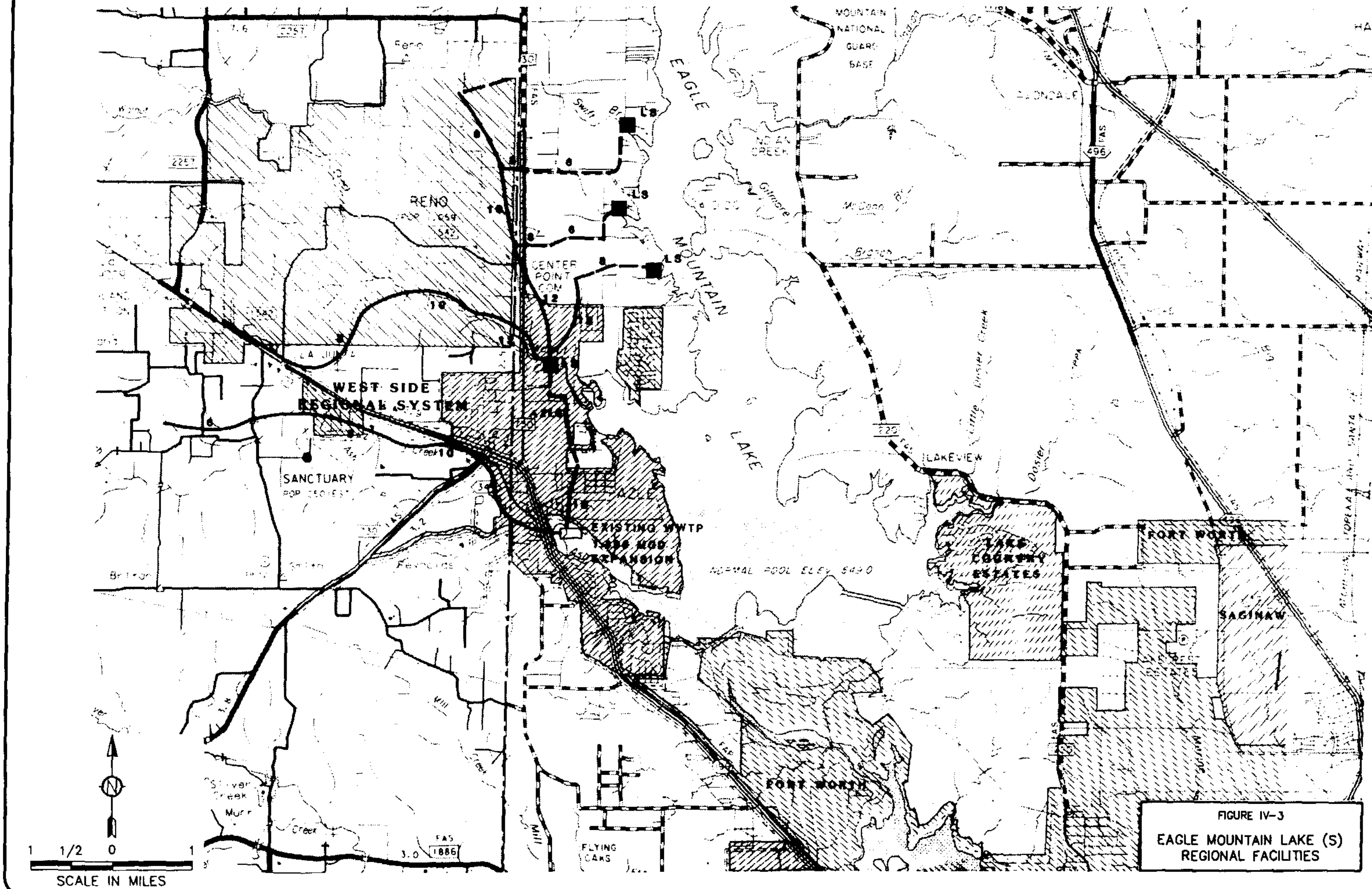


FIGURE IV-3
EAGLE MOUNTAIN LAKE (S) REGIONAL FACILITIES

TABLE IV-5

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
FACILITY PLANNING AREA POPULATION ESTIMATES AND PROJECTIONS

Facility Planning Area	Area (Acres)	Population 1987	Population 2005
Azle	8,320	8,682	14,250
Ash Creek	5,550	1,270	2,110
Reno	14,475	2,697	5,675
Pelican Bay	1,270	1,541	3,560
Peden	1,180	427	710
Swift Branch	1,370	561	935
Briar Creek	4,850	867	1,420
Hog Branch	10,180	521	740
Boyd	21,710	1,570	2,415
Aurora	8,315	509	740
Oates Branch	4,095	816	1,155
Newark	5,090	1,250	1,860
Avondale	11,465	406	655
Gilmore Branch	5,030	450	750
Boat Club	4,010	500	955
Lake Country Estates	5,510	2,450	4,680
Total Region	112,420	25,090	43,440

The topography around Eagle Mountain Lake is gently rolling with elevations ranging from 650 feet above sea level near the lake to over 980 feet above sea level in the hills just a few miles away from the lake. Normal water level in the lake is elevation 649.1 (crest of service spillway).

Population Projections

Population figures for 1987 were estimated from aerial photographs of the planning area, copies of subdivision plats, and windshield surveys for rural areas and some smaller towns; and from the North Central Texas Council of Governments' (NCTCOG) 1987 population estimates for cities. Year 2005 projections for cities were obtained by linear extrapolation of growth rates from 1980 through 1987. In rural areas, the 2005 projections were derived from extrapolating average growth rates from cities in the area. The 1987 population is estimated at 25,090, and the 2005 projection is 43,440, which is a 73% increase over 18 years. A density of 2.54 persons per household was used throughout the calculations for the region.

Copies of recorded plats from county records and property maps from tax appraisal districts were obtained to aid in the determining population projections and location for areas not served by collection systems. Approximately 75 subdivisions were identified and located outside of cities with community sewerage systems. Table IV-6 summarizes the subdivisions by individual planning area. The west side of the lake (from Azle to Briar Creek) has 54 of the 75 subdivisions (not including the area within the sewered city limits) or over 70% of the development activity in the region. Another 17% is in the Lake Country/Boat Club area. There is also a substantial population in the Newark area, outside the city limits, although no specific subdivisions were identified.

TABLE IV-6

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
SUMMARY OF SUBDIVISIONS

Facility Planning Area	Number of Subdivisions Identified	Approximate Number of Lots
Azle	3	130
Ash Creek	12	770
Reno	9	415
Pelican Bay	8	1,685
Peden	8	350
Swift Branch	7	240
Briar Creek	7	890
Hog Branch	-	-
Boyd	-	-
Aurora	3	85
Oates Branch	-	-
Newark	-	-
Avondale	1	175
Gilmore Branch	5	95
Boat Club	9	370
Lake Country Estates	4	4,650
Total	76	9,855

The development activity on the west side of the lake varies in size, type of development, and proximity to the lake. The lakeshore itself is the only continuously developed zone. Subdivisions are scattered over the length of the lake and as far away from the lake as 7 miles. Sometimes the developments are in clusters of two or three, but usually not within 1/4 mile of each other. Lot sizes vary from less than 1/3 of an acre to 4 acres. Over 30% of the population of the EML region is considered to be rural and in unincorporated areas. Developed urban land covers only about 3% of the EML region.

The majority of the planning area east of EML is currently undeveloped and was not projected for development in the resource documents used for this study. Treatment alternatives have not been prepared for this area. However, several recent occurrences could affect the growth rates in these areas. Major developments are proposed in the area east of the planning region. This could result in residential growth for the areas north and east of the lake. In addition, the City of Fort Worth has proposed the construction of a new water treatment facility in the area east of EML. Both of these activities could substantially alter the expected growth rates and open new areas of development.

Summary of Alternatives - Phase I

The population figures and subdivision locations have been identified for each FPA. This information, along with the topographic data from USGS maps, was used to lay out proposed collection systems and determine the preliminary sizes, locations, and costs for gravity lines, pump stations, force mains, and treatment plants, according to the methodology described in Appendix D. Collection and treatment facilities were identified on an area-by-area basis for each FPA. After the systems had been defined individually for each FPA, subregional and regional systems were identified by combining the individual FPAs systems.

Two of the 16 facility planning areas (Hog Branch and Oates Branch) did not have developed areas with enough population to warrant facility design. The Azle FPA was addressed in a recently prepared master plan, and no additional new facilities were identified for this FPA. Also, no new facilities were identified for the Boyd FPA, as they are also currently served by an existing WWTP and the city has proposed expansion to meet future needs. Facilities were identified for the remaining 12 individual facility planning areas. Costs were determined for 15 individual systems, three subregional systems, and two regional systems. Detailed cost breakdowns for each of the FPAs are included in Appendix B. Table IV-7 summarizes the Phase I alternative system costs for each of the planning areas.

Several additional alternatives were evaluated during Phase II studies with respect to wastewater discharges from the City of Azle and the west side of Eagle Mountain Lake. However, no definite recommendations or conclusions were developed because the Texas Water Commission hearings with the City of Azle have not yet been completed and the modeling of Eagle Mountain Lake by the TWC to develop effluent limitation guidelines and future water quality criteria has not yet been completed.

Summary of Alternatives - Phase II

Additional alternatives evaluated during Phase II for wastewater discharges from the City of Azle and/or Pelican Bay and other FPAs on the west side of EML can be divided into three basic groupings or treatment scenarios based on point of treatment:

1. Ash Creek/Walnut Creek WWTP
   - 10/15/2
   - 10/15/2 with Phosphorous Removal
   - 10/15/2 with Nitrogen Removal

TABLE IV-7

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
SUMMARY OF COSTS FOR ORGANIZED SYSTEMS
PHASE I

Facility Planning Area	Type of Facility	Range of Annual Costs per Household (Based on 2005 Projected Populations)[1]
Azle[2]	Ash Creek Subregional #2	180 - 210
	Walnut Creek Subregional #2	165 - 195
	Westside Regional	195 - 210
Ash Creek	System #1	520 - 560
	System #2	710 - 760
	System #3	280 - 325
	Sub-regional #1	405 - 445
	Sub-regional #2	180 - 210
Pelican Bay	Individual	235 - 260
	Sub-regional	260 - 290
	Regional	280 - 335
Peden	Individual	610 - 640
	Sub-regional	490 - 540
Swift Branch	Individual	540 - 570
	Sub-regional	435 - 465
Reno	System #1	605 - 635
	System #2	455 - 485
	Sub-regional #1	545 - 575

1. Lowest cost is for 10/15 permit conditions; highest cost is for 10/15/2 conditions further detailed breakdown of all costs are shown in Appendix B.
2. Costs are applied only for population exceeding plant capacity and include cost for regional system only, no existing system costs are included.

TABLE IV-7

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
SUMMARY OF COSTS FOR ORGANIZED SYSTEMS
PHASE I
(continued)

Facility Planning Area	Type of Facility	Range of Annual Costs per Household (Based on 2005 Projected Populations)1
Briar Creek	System #1	470 - 500
	System #2	685 - 745
	Sub-regional	505 - 540
Boyd[3]	Regional	220 - 250
Aurora	Individual	635 - 665
Newark[4]	Individual	600 - 625
Newark[5]	Regional	220 - 250
Avondale	Individual	470 - 510
Gilmore Branch	Individual	560 - 585
Boat Club	Individual	950 - 980
	Sub-regional[6]	780
Lake Country	Individual	935 - 1015
	Sub-regional[6]	560

3. Costs do not include existing local collection system costs.

4. Portion outside of city limits only.

5. Portion in city limits only; costs do not include existing local collection system costs.

6. Cost of collection system plus treatment costs from Fort Worth.

2. Fort Worth Satellite WWTP
   2.04 MGD
   6.3 MGD
3. Fort Worth Village Creek WWTP

The first treatment scenario, which includes modification of existing plants, considered various treatment requirements because defined effluent requirements have not yet been established by TWC. The second treatment scenario considered a plant location west of Lake Worth per the 201 Facilities Plan for Village Creek WWTP. Two plant capacities were considered for this group. One alternative considered a 2.04 MGD plant to serve the population of the service area. The 2.04 MGD was based on 120 gallons per capita per day. The second alternative considered the Fort Worth Facilities Plan plant sized at 6.3 MGD with the outfall to Mary's Creek. The third treatment scenario considered discharge into the Fort Worth system with eventual treatment by their Village Creek WWTP in accordance with the city's current wastewater master plan, soon to be completed.

Various service area options were considered for each of the groupings and treatment categories, which resulted in the list of 11 alternatives shown in Table IV-8. The annual costs per household for each of the Phase II alternatives are also shown in the table. More detailed descriptions of the proposed systems, as well as further breakdown of the estimated costs and location maps, are also included in Appendix B for the above alternatives.

Existing Organized Systems

There are currently eight wastewater treatment plants permitted in the region, four of which are municipal WWTPs. One of the WWTPs (International Word of Faith Church WWTP) has a no-discharge permit, and another (operated by TCMUD No. 1) closed in March 1987 and diverted the wastewater to the

TABLE IV-8

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
PHASE II SYSTEMS

Alt. No.	Treatment Facility	Service Area	2005 Population	Cost Per Household
1	Ash Crk/Walnut Crk 10/15/2	Azle	10,500	230
2	Ash Crk/Walnut Crk 10/15/2	Azle, Pelican Bay	13,935	220/395
3	Ash Crk/Walnut Crk 10/15/2 with Phosphorous Removal	Azle	10,500	320
4	Ash Crk/Walnut Crk 10/15/2 with Phosphorous removal	Azle, Pelican Bay	13,935	275/395
5	Ash Crk/Walnut Crk 10/15/2 with Nitrogen Removal	Azle	10,500	340
6	Ash Crk/Walnut Crk 10/15/2 with Nitrogen Removal	Azle, Pelican Bay	13,935	290/420
7	Satellite WWTP - 2.04 MGD	Azle, Downstream Intervening	17,040	435
8	Satellite WWTP - 6.3 MGD	Azle, Downstream Intervening, FW Silver Crk/Live Oak Crk	19,377	530
9	Fort Worth Village Creek WWTP	Azle	10,500	285
10	Fort Worth Village Creek WWTP	Azle, Pelican Bay	13,935	265/360
11	Fort Worth Village Creek WWTP	Azle, West side EML	21,995	295(1)

1. For costs to other FPAs in west side of EML see costs for individual FPA and add to base cost.

Fort Worth system. The four municipal treatment plants serve the cities of Azle (two WWTPs), Boyd, and Newark. The two remaining private facilities are for Larry Buck (DIDO Retirement Center) and the Fort Worth Boat Club. The permit conditions and the average discharges for the previous two years are summarized in Table III-5.

Existing On-Site Systems

The Cities of Aurora, Pelican Bay, and Reno do not have organized collection and treatment systems. The City of Pelican Bay uses the state criteria and requires inspections for new on-site systems, the City of Reno contracts with an independent sanitarian to handle the permitting, and the City of Aurora currently does not have a permit process established. Both Tarrant and Parker counties have adopted regulations and established an inspection and permitting process for individual on-site systems in areas under their jurisdiction. Wise County is currently in the process of developing regulations and procedures for individual on-site systems.

Soils in the area are generally clays; however, the eastern side of the lake has a substantial amount of rock, and the western and northern areas have more loamy and sandy clay soils. The Soil Conservation Service (SCS) has rated the soils for their suitability for use as septic tank absorption fields. Table IV-9 summarizes the soil ratings for each of the individual planning areas into four general categories:

1. Slight limitations for use
2. Moderate limitations for use
3. Severe limitations for use due to slow percolation rates
4. Severe limitations for use due to shallow rock or flooding

TABLE IV-9

EAGLE MOUNTAIN LAKE FACILITY PLANNING REGION
SOIL SUITABILITY FOR ON-SITE DISPOSAL

Facility Planning Area	Percent Distribution for Soils			
	Slight Limitation	Moderate Limitation	Severe -slow perc	Severe rock; floods
Azle	10	5	65	20
Ash Creek	-	15	70	15
Reno	5	25	60	10
Pelican Bay	-	5	95	0
Peden	-	55	35	10
Swift Branch	5	15	75	5
Briar Creek	5	15	60	20
Hog Branch	-	45	45	10
Boyd	-	70	20	10
Aurora	-	60	10	30
Oates Branch	-	50	30	20
Newark	-	55	25	20
Avondale	-	5	20	75
Gilmore Branch	10	10	20	60
Boat Club	5	-	5	90
Lake Country Estates	5	-	15	80

More detailed descriptions of each facility planning area in the Eagle Mountain Lake Facility Planning Region, as well as further breakdown and detail of proposed facility plans and estimated costs, are included in Appendix B to this report.

INDIVIDUAL COMMUNITIES OUTSIDE OF DESIGNATED FACILITY PLANNING REGIONS

Areas Included as Individual Communities

There are 12 individual communities within the Upper Trinity River Basin that are outside the designated facility planning regions. The names, county locations, and stream segments of the communities selected for study as facility planning areas are listed below:

Community	County	Stream Segment
City of Decatur	Wise	0810
Community of Briaroaks	Johnson	0828
City of Bridgeport	Wise	0810
City of Jacksboro	Jack	0812
Town of Joshua	Johnson	0828
City of Runaway Bay	Wise	0811
City of Springtown	Parker	0809
City of Chico	Wise	0810
Community of Paradise	Wise	0810
Community of Poolville	Parker	0833
City of Lake Bridgeport	Wise	0810
City of Alvord	Wise	0810

Population Projections

Population projections through year 2005 for the 12 individual communities are presented in two separate formats. Table IV-10 lists population projections based on the area within current city limits; Table IV-11, lists

TABLE IV-10

INDIVIDUAL COMMUNITIES
FACILITY PLANNING AREA TOWN POPULATIONS[3]

Area	1987	2005
Alvord[1]	1,050	1,500
Briaroaks[1]	850	1,520
Bridgeport	3,850	4,140
Chico[1]	1,000	1,290
Decatur[2]	4,588	5,840
Jacksboro[1]	4,000	4,000
Joshua[2]	4,830	8,910
Lake Bridgeport[1]	350	550
Paradise[1]	462	651
Poolville[1]	390	650
Runaway Bay[1]	800	1,560
Springtown[1]	2,100	3,240

1. Linear extrapolation used to project populations to 2005.
2. From individual cities master plan projections.
3. Populations are for areas within the current city limits.

TABLE IV-11

SMALL FACILITY PLANNING AREA POPULATIONS(1)(2)

Area	1987	2005
Alvord	1,065	1,521
Briaroaks	1,376	2,446
Bridgeport	4,173	4,597
Chico	1,066	1,383
Decatur	4,738	6,052
Jacksboro	4,178	4,213
Joshua	5,214	9,544
Lake Bridgeport	415	642
Paradise	462	651
Poolville	431	716
Runaway Bay	800	1,560
Springtown	2,372	3,678

1. These numbers include both rural and town populations for each area delineated. The 1987 town figures come from the Texas Department of Health population Data System, "1980 Census of Population - Number of Inhabitatns, Texas," and "North Central Texas Council of Governments Current Population Estimates for 1987." The 1987 town numbers were checked with the local city officials to determine accuracy. The 1987 rural populations are based on actual house counts. All rural populations are based on actual house counts. All rural populations and 2005 town projections are based on linear extrapolation.

2. Town population portion of these numbers come from individual city master plan projections.

population projections based on the entire FPA, including both rural and town population projections.

Summary of Alternatives

Four of the 12 individual communities are currently served by septic tank systems. For each of these four FPAs, four basic wastewater treatment and disposal options were studied. The annual estimated per-household costs of the four alternatives for these communities are presented in Table IV-12. Permit limitations for each FPA will depend on water quality and regulatory constraints discussed elsewhere in this report. Actual costs may differ depending on exact collection system layouts, area served, financing costs, and other design- and construction-related factors.

Existing Organized Systems

Eight of the individual communities have organized wastewater treatment systems permitted to discharge effluent. All but one of the eight current permit holders are city governments, the exception being the Town of Joshua. The Johnson County Fresh Water Supply District No. 1 is the discharge permit holder for the Joshua FPA and operates the existing wastewater treatment plant. Table IV-13 lists the current discharge permit holders and the permitted and average daily flows for each.

More detailed descriptions of each facility planning area in the Individual Communities Facility Planning Region, as well as further breakdown and detail of proposed facility plans and estimated costs, are included in Appendix C to this report. Most of the individual communities are involved in some level of facility planning. These efforts are also described in Appendix C.

TABLE IV-12

SUMMARY OF ESTIMATED ANNUAL COSTS FOR ORGANIZED WASTEWATER TREATMENT SYSTEMS

Facility Planning Area	Total Flow (2005)	Annual estimated cost per-Household ($) Treatment Level 10/15[1]	10/15[2]
Briaroaks	0.152 MGD	300	336
Paradise	0.065 MGD	540	609
Poolville	0.072 MGD	451	514
Lake Bridgeport	0.064 MGD	834	905

1. Cost estimate based on 10/15 permit conditions without ammonia removal.
2. Cost estimate based on 10/15 permit conditions with ammonia removal.

TABLE IV-13

SUMMARY OF INDIVIDUAL COMMUNITIES
WITH POINT SOURCE DISCHARGE PERMITS

Facility Planning Area	Permitted Flow (MGD)	Average Daily Flow (MGD)
Decatur	0.400	0.316
Bridgeport	0.390	0.171
Jacksboro	0.185	
	(0.430)[1]	0.352
Joshua[2]	0.450	0.264
Runaway Bay	0.200	0.100
Springtown	0.260	0.132
Chico	0.076	0.078
Alvord	0.112	0.051

1. Amended discharge permit became effective October 1987.

2. Discharge permit of Joshua FPA held by Johnson County Fresh Water Supply District No. 1.

Four of the individual communities selected for study as facility planning areas are currently served by on-site disposal systems. The U.S. Soil Conservation Service surveys soil conditions to determine suitability for use as a septic system absorption field. Table IV-14 summarizes soil suitability for on-site disposal (septic tank) systems for the FPAs currently served by on-site disposal systems.

TABLE IV-14

SUMMARY OF SOIL SUITABILITY FOR ON-SITE DISPOSAL SYSTEMS

Facility Planning Area	Percent Distribution for Soils			
	Slight Limitation	Moderate Limitation	Severe Limitation[1]	Severe Limitation[2]
Briaroaks	25	10	50	15
Paradise	0	25	60	15
Poolville	10	10	75	5
Lake Bridgeport	0	0	80	20

1. Severe due to slow percolation rate.
2. Severe due to flooding or depth to rock.

CHAPTER V

LOCAL INVOLVEMENT

GENERAL

This project has included an extensive local involvement program to aid the Fort Worth Tarrant County Water Control and Improvement District No. 1 in identifying known water quality problems and wastewater facility needs. This program has included the formation and use of advisory committees, contact with local councils of government, meetings with local officials, and meetings with special interest groups. The following is a summary of these activities.

ADVISORY COMMITTEES

The District sought assistance from its own advisory committee, made up of District water customers, in forming an advisory committee for this study. The resulting committee is shown as Table V-1. As the study progressed, the large amount of planning work devoted to the Clear Fork-Weatherford area and the Eagle Mountain Lake area made it necessary to establish subcommittees for these areas. Tables V-2 and V-3 show the initial subcommittees for the Weatherford-Clear Fork and Eagle Mountain Lake subcommittees, respectively. Initial meetings were held in the Weatherford-Clear Fork area and Eagle Mountain Lake area on June 8, 1987, and July 2, 1987, respectively. Additional meetings were held in Weatherford, Texas, and in Azle, Texas, on October 14, 1987, and October 21, 1987. The following items were presented:

1. Status report
2. Preliminary results of facility planning
    a. Alternatives
    b. Costs
    c. Financing
    d. Institutional arrangements

TABLE V-1

INITIAL
ADVISORY COMMITTEE MEMBERS

Jim Scanlan
City of Fort Worth
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Bill Smith
Trinity River Authority of Texas
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James Dickason (Ken Reneau)
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Don Dickens
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Sam Renshaw, Jr.
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Jane Ojeda
NCTCOG
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TABLE V-2

INITIAL
SUB-COMMITTEE MEMBERS FOR THE WEATHERFORD CLEAR FORK

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Judith Kirchdorfor
Parker County Utility District
Aledo, Texas 76008

TABLE V-3

INITIAL
SUB-COMMITTEE MEMBERS FOR THE EAGLE MOUNTAIN LAKE AREA

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3. Questions and comments
4. Future meetings

Meetings to present the results of this study to the overall advisory committee, the two subcommittees, and other interested parties were held in Weatherford, Texas, on May 26, 1988, and in Azle, Texas, on June 2, 1988. A 30-day comment period was allowed, beginning June 2, 1988.

Finally, the District's own advisory committee has maintained an active interest in this study and has been briefed on study progress on a quarterly basis.

MEETINGS WITH COUNCILS OF GOVERNMENT

In an effort to inform all local governments with a possible interest in this study, the District has met with representatives of the North Central Texas Council of Governments in Arlington, Texas, and NORTEX Regional Planning Commission in Wichita Falls, Texas. Each of these agencies is a voluntary association of cities, counties, and special districts and was created to assist local governments in planning for common needs, cooperating for mutual benefit, and coordinating for sound regional development.

MEETINGS WITH LOCAL OFFICIALS

In developing information for this study, the District met at least once with officials from each of the following cities in the planning area:

Weatherford	Azle
Hudson Oaks	Decatur
Aledo	Chico
Willow Park	Bridgeport

Jacksboro
Joshua
Runaway Bay
Springtown
Alvord
Fort Worth
Lake Bridgeport

In developing recommendations for a possible regional wastewater system in the Clear Fork-Weatherford portion of the study area, additional meetings were held with the District, the Trinity River Authority, and the City of Weatherford and among the District, the Trinity River Authority and the Town of Hudson Oaks.

MEETINGS WITH SPECIAL INTEREST GROUPS

Because of its interest in improving and preserving the quality of Eagle Mountain lake, Save the Lake has maintained an active interest in this study. In fact, Save the Lake, the Texas Water Commission, the City of Fort Worth, and the District participated in a separate two-year study of Eagle Mountain Lake that involved intensive water quality monitoring, pollutant load determinations, and water quality modeling. On August 11, 1987, the District met with Save the Lake to discuss the following relative to the Upper Trinity Water Quality Study.

1. Background and objectives
2. Work plan
   a. Land use and population
   b. Water use
   c. Water quality criteria
   d. Data for water quality modeling
   e. Pollutant loads
   f. Pollutant load reductions
   g. Facility planning
   h. Interim report

    i. Final report
    j. Advisory committee
3. Questions and comments

CHAPTER VI

ONGOING AND FUTURE WATER QUALITY MANAGEMENT ACTIVITIES

GENERAL

The primary objective of an ongoing water quality management program is to provide information upon which to base decisions on how financial resources for water quality control should be allocated. In this regard, it is recommended that Tarrant County Water Control and Improvement District No. 1 implement an ongoing water quality management program for the Upper West Fork and Clear Fork Trinity River Basin. Such a program would involve the following activities by the District and other local agencies with water supply responsibilities in the area.

1. Develop and implement lake and stream water quality monitoring program to supplement state and federal water quality data collection.
2. Review monitoring data as they are received to detect immediate problems.
3. Respond to immediate problems.
4. Perform annual review of water quality data to determine long-term trends.
5. Perform periodic review of water quality standards and provide comments to TWC.
6. Perform annual assessment of monitoring programs and modify as needed.
7. Perform annual assessment of any special studies needed.
8. Review and comment on applications for new and renewed wastewater treatment plant permits. Present testimony at hearings, if necessary.
9. Monitor various proposed activities such as construction, agricultural operations, and landfills, and comment on the impact

of such activities on water quality. Present testimony at hearings if necessary.

10. Prepare annual reports describing reservoir water quality conditions and watershed activities.
11. Update watershed plans as required in Section 208 of the Clean Water Act, and review and update long-term water quality goals.
12. Update intensive lake surveys and lake models every 5 to 10 years.

It should be mentioned that the District is currently developing a detailed work plan for accomplishing the above goals in not only the Clear Fork and West Fork watersheds, but also in the watersheds of Cedar Creek Reservoir and Richland Chambers Reservoir in East Texas. Water quality management in these two reservoirs is intimately linked to water quality in Lake Arlington, because water from Cedar Creek Reservoir is pumped to Lake Arlington and the Fort Worth Rolling Hills Water Treatment Plant and a pipeline is being constructed from Richland Chambers Reservoir to these locations. Extensions of these water supply lines to Benbrook Lake and possibly Lake Weatherford are planned for the future.

LAKE WATER QUALITY MONITORING

There are six lakes in the study area, all of which are used for domestic water supply, and recreation and to maintain aquatic habitat.

The lakes are:

- Lake Arlington
- Benbrook Lake
- Lake Bridgeport
- Eagle Mountain Lake
- Lake Weatherford
- Lake Worth

The drainage areas of these lakes will experience increases in population, which can impact lake water quality through increases in point and/or nonpoint source loadings. As previously mentioned, it is probable that pressure to provide nutrient removal for both point and nonpoint sources will increase. Lake water quality measurements and quantitative analysis of the cause-and-effect relationships between inputs and lake water quality can provide useful information when deciding which nutrients to remove to control lake water quality, the timing of identified removals, and the water quality improvement to be obtained for different degrees of removal.

However, it should be recognized that lake water quality varies over a yearly cycle and from year to year. The underlying water quality trends, particularly year to year, are obscured by variations in water quality that are due to changes in loads (point and nonpoint), heat inputs, flows, dominant organisms, radiation inputs, light transmission, and other factors. It is not uncommon to observe year-to-year improvements in water quality when the underlying trend is toward poorer water quality.

Water quality management actions attempt to control year-to-year trends in water quality, but are virtually useless in controlling seasonal variations. Further, because of the diverse factors that determine the details of year-to-year water quality, controls are associated with modifications in water quality trends and directions rather than more rigorous control of water quality to specified limits.

Accordingly, it is recommended that ongoing and intensive monitoring of water quality be performed on these lakes. Routine monitoring normally involves three or four field trips per year, during which top and bottom water quality samples are collected for laboratory analysis and field measurements are made in a vertical profile at three or four stations. The routine monitoring program is directed toward providing data that will allow identification of year-to-year trends in water quality (i.e., how fast is water quality changing). An intensive survey involves more frequent sampling (e.g., monthly) of more stations as well as special studies of such things as algal respiration/photosynthesis and benthic oxygen demand. The intensive surveys are geared to providing data that can be used in lake water quality models to assess quantitatively which controls should be implemented (i.e., is nutrient control going to be effective, which nutrient should be controlled, and how is degree of control related to water quality changes) and the probable effectiveness of control actions on changes in the underlying water quality trends. An intensive survey has recently been completed by TWC for Eagle Mountain Lake, and another is soon to be underway by the City of Fort Worth on Lake Worth as part of the EPA's Clean Lake Program. It is recommended that additional intensive surveys be performed on Lakes Arlington, Benbrook, Bridgeport, and Weatherford in the near future and that ongoing routine monitoring be performed on all of these lakes. The District is currently considering implementing a routine monitoring program on Lakes Arlington, Benbrook, Bridgeport, and Eagle Mountain as well as both routine and intensive monitoring of its two East Texas reservoirs.

Routine Monitoring

If possible, quarterly sampling should be performed. However, where budget constraints exist, routine monitoring of lake water quality could be limited to the summer. Lake water quality can be expected to vary over the years, with the largest potential for conflicts between reduced water quality and increased water usage found in the period between mid-May and mid-October, perhaps concentrated in the June-to-August period. Because of financial constraints currently experienced by various agencies, it is desirable to consider combining and coordinating various local, state, and federal sampling and testing programs.

As a minimum, routine monitoring should include the following quality parameters:

1. Dissolved oxygen, temperature, and conductivity at 5-foot depth intervals
2. Surface secchi depth
3. Surface chlorophyll "a"
4. Surface fecal coliform
5. One surface and one bottom sample analyzed for:
   a. TKN-N
   b. NH_3-N
   c. NO_3-N
   d. NO_2-N
   e. Total nitrogen - N (calculated)
   f. Total phosphorus - P
   g. Orthophosphorus - P
   h. N - suppressed BOD_5
   i. N - suppressed BOD_{20}
   j. TSS

As these analyses are not done under the existing routine sampling programs, the District is considering implementation of routine monitoring of Eagle Mountain Lake and Lakes Bridgeport, Benbrook, and Arlington. It is recommended that the cities of Weatherford and Fort Worth consider similar monitoring programs for Lakes Weatherford and Worth, respectively.

Intensive Lake Surveys

Intensive lake surveys should be performed once each 6 to 12 years or prior to major water quality management decisions. Eagle Mountain Lake was surveyed by TWC in 1986 and 1987, and Lake Worth will be surveyed in 1988 and 1989 by the City of Fort Worth. Lake Arlington has an extensive data base from USGS, the Texas Department of Water Resources, and the City of Arlington. An analysis of the existing data indicates that intensive sampling of Lake Arlington is not presently warranted. This leaves Benbrook Lake, Lake Weatherford, and Lake Bridgeport as bodies of water that require development of intensive sampling data bases. As part of its ongoing water quality management program, the District is setting priorities for conducting intensive monitoring programs for Lakes Benbrook and Bridgeport as well as its two East Texas reservoirs. It is recommended that the City of Weatherford consider such a program for Lake Weatherford.

Basic Intensive Lake Sampling Program Contents

I. Stations

A. Three to five sampling stations should be used along the centerline of the lake and the centerlines of any major arms. (An initial reconnaissance survey with DO, temperature, and chlorophyll "a" measurements should be considered to help define sample locations.)

B. Sampling in coves that are of concern from a water quality perspective should consist of three stations down the cove to the main body of the lake. Cove stations should be associated with a lake centerline sampling station.

II. Sampling frequency

A. 13 samples per year per station

B. Sampling periods - January, March, April, May (2), June, July, August (2), September, October (2), and November

III. Analysis (minimum analysis)

A. Vertical - each 5 feet

1. DO, temperature, conductivity
2. At maximum gradient, reduce interval of sampling to each foot for the 5-foot interval

B. Sampling at each station
   1. Secchi depth (top sample only)
   2. Chlorophyll "a" (top sample only)
   3. TKN-N - one sample each top and bottom
   4. NH_3-N - one sample each top and bottom
   5. NO_3-N - one sample each top and bottom
   6. NO_2-N - one sample each top and bottom
   7. Total N - calculated
   8. Total P - one sample each top and bottom
   9. Ortho-P - one sample each top and bottom
   10. N - suppressed BOD_5 - one sample each top and bottom
   11. N - suppressed BOD_{20} - One sample each top and bottom
   12. TSS - one sample each top and bottom

C. Special studies to consider depending on lake and management decisions
   1. Light and dark bottle studies
   2. SOD and nutrient release studies
   3. AGP studies

Lake Data Analysis

Consideration should be given to combining the data from routine monitoring into a data base available throughout the District. Further, the routine monitoring data should be analyzed for trends in water quality over time with special emphasis on identifying the probable water quality limiting factors and yearly variations in the intensity and location of vertical stratification.

The intensive survey data can be analyzed using the nonlinear phytoplankton analysis currently being developed and used by the TWC staff on Eagle Mountain Lake.

It should be noted that the programs indicated above will provide information for lake water quality management decisions with respect to nutrient, phytoplankton, and dissolved oxygen. Rooted aquatic plants require collection of additional information and may also require substantial modification and/or development of analysis techniques.

STREAM WATER QUALITY MONITORING

As part of its ongoing water quality management program, the District is considering supplementing stream monitoring performed by the TWC. This would be done where necessary to calibrate stream water quality models used to evaluate waste discharge permit applications and where necessary to evaluate nonpoint source pollution.

ASSESSMENT OF PERMIT APPLICATIONS

One of the activities anticipated by Tarrant County Water Control and Improvement District No. 1 as part of its ongoing water quality management program is the review of waste discharge permit applications. Water quality models and calculation techniques developed as part of this study will be used and improved in the ongoing program.

ASSESSMENT OF NONPOINT POLLUTION

This study provides estimates of nonpoint source pollution loads to the various lakes in the study area, but does not provide recommendations for initial nonpoint source controls, because site-specific information is lacking in all but the Lake Weatherford and Lake Arlington watersheds. Remote sensing studies performed by Texas Christian University for the cities of Weatherford and Arlington may provide information that can be used to begin making preliminary recommendations of erosion controls and other nonpoint source control measures. A Clean Lakes Program study that began in May 1988 for the Lake Worth watershed will provide information required to make such recommendations for the Lake Worth watershed. Also of significance is the fact that the Texas Water Commission recently began work on a statewide nonpoint source management program. This program includes a statewide assessment of nonpoint source problems and the development of a management program that will, among other things, identify the effectiveness of site-specific best management practices (BMPs) to control nonpoint source pollution. It is hoped that this program will also include the development of wet-weather water quality criteria for use in nonpoint source pollution control. In any case, the District plans to obtain the results of the TWC's nonpoint source assessment and to coordinate with the TWC Nonpoint Source Management Program as part of ongoing water quality management in the Upper Trinity.

REGULATION OF PRIVATE SEWAGE FACILITIES

Another ongoing water quality management activity being undertaken by the District is the regulation of on-site sewage disposal at Lake Bridgeport, Eagle Mountain Lake, and its two East Texas reservoirs. Private sewage disposal in other parts of the study area is regulated by the various counties or cities that have jurisdiction. Regulation of such facilities, whether by the District, counties, or cities, must conform to the Texas Water Code and the Texas Department of Health's January 1, 1988, Construction Standards for On-Site Sewerage Facilities.

COORDINATION WITH OTHER AGENCIES

As part of its role in ongoing water quality management in the Upper Trinity, the District must coordinate with numerous agencies including:

- Various cities within the planning area

- Trinity River Authority
- Texas Water Commission
- Texas Water Development Board
- Texas State Department of Health
- Various counties within the planning area
- North Central Texas Council of Governments
- Nortex Planning Commission
- United States Geological Survey
- United States Army Corps of Engineerss
- United States Environmental Protection Agency
- United States Department of Agriculture
- Texas State Soil and Conservation Board

The District has already begun this coordination by taking steps to routinely receive information from the TWC regarding existing and proposed discharge permits and water quality data collected by the TWC for the Statewide Monitoring Network or for special studies. The District will be providing any data it collects to the Texas Water Commission and Texas Water Development Board for inclusion in the Texas Natural Resources Information System (TNRIS).

WATER QUALITY DATA MANAGEMENT

In that ongoing water quality management involves the handling of large amounts of data, the District is developing a computerized data management system for this purpose. This system will be used to handle not only water quality information, but also information on existing and proposed waste dischargers in the study area, information on various land use activities in the various watersheds, and information of a regulatory nature.

UPDATES OF THIS STUDY

It is anticipated that this study will be updated on a watershed-by-watershed basis every 3 to 5 years. For example, completion of a planned study of Cedar Creek and Richland Chambers Reservoirs in East Texas over the next 2 years will result in the need to further evaluate Lake Arlington, because Lake Arlington receives much of its flow from Cedar Creek and will receive future flows from both Cedar Creek and Richland Chambers Reservoirs.