DRAFT

ENVIRONMENTAL IMPACT STATEMENT

FOR

CONSTRUCTION OF WASTEWATER FACILITIES

WPC-Tex-992/1094
IMPACT STATEMENT NUMBER 7308

OFFICE OF GRANTS COORDINATION, REGION VI
ENVIRONMENTAL PROTECTION AGENCY
DALLAS, TEXAS

APPROVED BY:

for Arthur W. Busch
Regional Administrator
September 6, 1973

ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1600 PATTERSON, SUITE 1100
DALLAS, TEXAS 75201

September 17, 1973

OFFICE OF THE
REGIONAL ADMINISTRATOR

To All Interested Agencies and Public Groups

To comply with the provisions of the National Environmental Policy Act of 1969, we have prepared a draft environmental impact statement for the Trinity River Authority's proposed expansion of its Central Regional Treatment Facility.

In accordance with Section 102(2)(c) of the National Environmental Policy Act, we are requesting comments of various federal, state and local agencies on the draft of our environmental statement. When comments of the agencies concerned are received, we will prepare the final environmental impact statement to be forwarded to the Council on Environmental Quality. Any comments that you make will be included as an attachment to the statement when it is placed on file with the Council.

We would appreciate receiving your comments by October 19, 1973, to allow the statements to be given early review by the Council.

This Agency will hold a public hearing on the draft environmental impact statement. A copy of the notice of the public hearing is enclosed.

If you should require additional information, please contact Mr. Jim De La Plaine, Office of Grants Coordination, at telephone number (214) 749-1101.

Arthur W. Busch
Regional Administrator

3 Enclosures
Draft EIS for TRA
Notice of Public Hearing
Public Hearing Agenda

ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1600 PATTERSON, SUITE 1100
DALLAS, TEXAS 75201

OFFICE OF THE
REGIONAL ADMINISTRATOR

NOTICE OF PUBLIC HEARING

The Environmental Protection Agency will hold a public hearing in Dallas, Texas, beginning at 1:00 p.m. on October 9, 1973. The hearing will be held in Conference Room A and B, Environmental Protection Agency, 1600 Patterson Street. This hearing will be convened to present the Draft Environmental Impact Statement on the Trinity River Authority Wastewater Facilities.

The Trinity River Authority has submitted an application for federal financial assistance for the construction of additional wastewater treatment facilities at its Central Regional Wastewater Treatment Facility. The application has been designated WPC-Tex-992/1094.

The purpose of the hearing is to assure that public participation is an integral part of the agency planning and decision-making process by informing the interested citizens about the status and progress of studies and findings, and by actively soliciting comments from all concerned groups and individuals.

In order to permit maximum public participation, the Hearing Officer may, at his discretion, reconvene the hearing on Wednesday, October 10. In addition, a session will be held on Tuesday evening, October 9, beginning at 6:00 p.m.

Persons wishing to participate in the hearing are requested to notify Mr. Ancil Jones, Grants Coordinator, Office of Grants Coordination, Environmental Protection Agency, 1600 Patterson Street, Suite 1100, Dallas, Texas, 75201. While advance notice is requested, persons wishing to present testimony may indicate so at the hearing registration. Those persons who will be unable to attend but desire to submit written comments to be entered in the record should send those comments to the same address before October 5, 1973.

Copies of the impact statement to be presented at the hearing are available from the Environmental Protection Agency office at the above address.

HEARING AGENDA

October 9, 1973

1. Call to Order by Hearing Examiner 1:00 p.m.

2. Statement of Purpose of Hearing

3. Comments by State Agencies

4. Presentation of Draft Environmental Impact Statement

   Question and Answer Session regarding Draft Environmental Impact Statement

   Response by Environmental Protection Agency, State and/or City, as appropriate.

   Recess

5. Testimony

6. Statement by Hearing Examiner

7. Adjourn

TABLE OF CONTENTS

SUMMARY

(X) Draft Environmental Statement
( ) Final Environmental Statement

Environmental Protection Agency
Region VI, Office of Grants Coordination
Dallas, Texas

1. Name of Action
   Administrative Action (X)
   Legislative Action ( )

2. The proposed action consists of federal grant assistance as authorized by the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

The Trinity River Authority of Texas (TRA) has applied for federal funds to aid in the construction of additional wastewater treatment facilities at its Central Regional Wastewater Treatment Facility site. The expanded facility, located in Grand Prairie, is expected to treat the wastewater generated in the following areas through the year 1985.

Arlington (part)
Bedford
Carrollton
Coppell
Dallas (part)
Dallas/Fort Worth Airport
Euless
Farmers Branch
Addison
Grand Prairie
Irving

The proposed project involves the construction of a 70 Million Gallons per Day (MGD) activated sludge treatment facility to be operated in parallel with the existing 30 MGD trickling filter facility located at the TRA's Central Regional Treatment Site. The combined discharge (100 MGD) from these two systems will receive additional treatment by chemical precipitation, carbon absorption, and disinfection prior to discharge to the Trinity River approximately 8 stream miles upstream from downtown Dallas.

Sludge from the facility will be dewatered and incinerated at the plant and the ash produced will be disposed of by land filling on the plant site.

In addition to the treatment plant expansion, this project will include construction of a new 3 million gallon reservoir at the site of the existing Elm Fork Detention Reservoir and 31,700 feet of relief sewers parallel to the existing West Fork Interceptor, the Mountain Creek Interceptor, and the Cottonwood Creek Trunk Interceptor. The total estimated cost of the project is approximately 41 million dollars.

3. Summary of Environmental Impact and Adverse Environmental Effects.

The proposed facilities are expected to reduce health hazards in the service area, enhance water quality in the Trinity River, and aid in orderly physical development in the member communities, assuming adherance to existing land use plans.

The minor adverse effects which cannot be avoided are those normally associated with the existence and operation of wastewater treatment facilities. The increased noise levels and possible odors emanating from the facility will be minimized by modern design techniques and efficient operation.

Disruption of the environment and inconveniences to citizens during construction are unavoidable but will be reduced in severity by proper construction scheduling and techniques.

No serious adverse effects are anticipated due to the construction and operation of the proposed facility, unless a significant change occurs in the character of anticipated future development. The minor adverse effects expected appear to be acceptable when compared to the beneficial effects to be derived from the proposed project.

4. <u>Alternatives Considered</u>.

Several alternatives have been considered given due considerations to both economic and environmental factors. In addition, numerous system and subsystem alternatives have been evaluated in arriving at the alternative selected.

5. <u>List all Federal, State, and Local Agencies from which Comments have been Requested</u>.

<u>Federal Agencies</u>

U. S. Department of Agriculture
Environmental Planning and Management
U. S. Forest Service
Regional Office
1720 Peachtree Road, N.W.
Atlanta, Georgia 30309

Department of Health, Education & Welfare
1114 Commerce Street, Room 904
Dallas, Texas 75202

U. S. Department of the Interior
Assistant Secretary - Program Policy
Attn: Office of Environmental Projects Review
Department of the Interior
Washington, D. C. 20240

Bureau of Sport Fisheries and Wildlife
Southwest Region
Federal Building
Albuquerque, New Mexico 87103

National Park Service
P. O. Box 728
Santa Fe, New Mexico 87501

U. S. Geological Survey
Water Resources Division
630 Federal Building
300 East 8th Street
Austin, Texas 78701

Bureau of Outdoor Recreation
Building 41
Denver Federal Center
Denver, Colorado 80225

Bureau of Reclamation
P. O. Box 1609
Amarillo, Texas 79105

Bureau of Land Management
P. O. Box 1449
Santa Fe, New Mexico 87501

Office of Economic Opportunity
1100 Commerce
Dallas, Texas 75202

Federal Highway Administration
Director Highway Programs Office
819 Taylor Street
Fort Worth, Texas 76102

Economic Development Agency
702 Colorado
Austin, Texas 78701

Army Corps of Engineers
1114 Commerce Street
Dallas, Texas 75202

Department of Housing & Urban Development
819 Taylor
Fort Worth, Texas 76102

Department of Commerce
Attn: Dr. Sidney Galler
Deputy Assistant Secretary of
Environmental Affairs
Washington, D. C. 20235

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Federal Building
144 First Avenue South
St. Petersburg, Florida 33701

Council on Environmental Quality
HQs - Environmental Protection Agency
722 Jackson Place, N.W.
Washington, D. C. 20506

Division of Municipal Wastewater Programs
Attn: Ralph Fuhrman
Environmental Protection Agency
Washington, D. C. 20460

Dr. Carl Shuster, Jr., Director
Water Programs Impact Statement Office
Environmental Protection Agency
Washington, D. C. 20460

Office of Federal Activities
Environmental Protection Agency
Attn: Peter Cook
Washington, D. C. 20460

Management & Budget, Organization &
Management Systems Division
Attn: Mr. Charles Nelson
17th and Pennsylvania, Room 9026
Washington, D. C. 20503

State Agencies

Office of the Governor
Division of Planning Coordination
Capitol Station
P. O. Box 12428
Austin, Texas 78711

Texas Air Control Board
820 East 53rd Street
Austin, Texas 78751

State Department of Health
1100 West 49th Street
Austin, Texas 78756

Texas Industrial Commission
10th Floor, State Finance Building
Austin, Texas 78701

Texas Parks & Wildlife Department
John H. Reagan Building
Austin, Texas 78701

Texas Water Quality Board
P. O. Box 13246
Capitol Station
Austin, Texas 78711

Texas Highway Department
11th and Brazos
Austin, Texas 78711

Railroad Commission of Texas
910 Colorado
Austin, Texas 78701

Texas Water Rights Commission
722 Sam Houston Office Building
Austin, Texas 78701

Texas State Historical Survey Committee
P. O. Box 12276, Capitol Station
Austin, Texas 78711

Department of Agriculture
P. O. Drawer B.B.
Capitol Station
Austin, Texas 78711

General Land Office
Library & Archives Building
Austin, Texas 78701

Texas Animal Health Commission
1020 Sam Houston Office Building
Austin, Texas 78711

Forest Station
c/o Texas A&M University
College Station, Texas 77843

State Soil & Water Conservation Board
1018 First National Building
Temple, Texas 76501

Texas Tourist Development Agency
Room 500
John H. Reagan Building
Austin, Texas 78701

Texas Water Development Board
P. O. Box 13087
Capitol Station
Austin, Texas 78711

Association of Texas Soil & Water
Conservation Districts
306 West 14th Street
Friona, Texas 79035

Texas Conversation Council, Inc.
730 East Friar Tuck Lane
Houston, Texas 77024

Bureau of Economic Geology
University of Texas
University Station, Box X
Austin, Texas 78712

Texas Council for Wildlife Protection
3132 Lovers Lane
Dallas, Texas 75225

Texas Forestry Association
P. O. Box 1488
Lufkin, Texas 75901

Local Agencies and Individuals

Trinity River Authority of Texas
P. O. Box 5768
Arlington, Texas 76011

Forrest and Cotton, Inc.
Consulting Engineers
Suite 201, Bruton Park
8700 Stemmons Freeway
Dallas, Texas 75247

Mr. John L. Spinks, Jr.
Southwest Regional Representative
National Hudubon Society
P. O. Box 9585
Austin, Texas 78757

INTRODUCTION

Historically, the evolution of the water carrier system of waste removal reflects the most economical solution to a critical public health problem, the removal of pathogenic organic waste from areas of human habitation. The present level of treatment required reflects the additional necessity of reclaiming the water used to carry the waste. The method of ultimate disposal of the solids removed from the water is primarily determined by the continued need to protect the public from the adverse effects of pathogenic organic waste. Thus, the overall objective of this project and indeed the entire wastewater collection and treatment system is to benefit the public health.

It is intended that the proposed project will yield a long-term solution to the problem of the removal of pathogenic organic waste from areas of human habitation, e.g., interceptors, treatment area, detention basin, etc. With the present concentration of effort in the wastewater treatment field, it is anticipated that unit processes will continue to improve and that the need for reclaimed water will demand their use. It is anticipated that with these same developments, it will become increasingly necessary and feasible to tighten restrictions on the acceptance of industrial waste until the problems associated with them are eliminated completely. The prime objective of this project is the continued protection of public health through the provision of sanitary sewer treatment service to areas where the population concentration could produce a health problem without this service.

I. BACKGROUND

A. General

1. The Trinity River Authority of Texas. The Trinity River Authority of Texas is a political subdivision of the State of Texas created in 1955 by the 54th Legislature under Article XVI, Section 59 of the Texas Constitution. The Authority's jurisdictional boundaries comprises all of the territory contained within Tarrant, Dallas, Ellis, Navarro, and Chambers Counties, and generally that portion of the following Counties that lie within the watershed of the Trinity River: Kaufman, Henderson, Anderson, Freestone, Leon, Houston, Trinity, Madison, Walker, San Jacinto, Polk and Liberty. The Trinity River Authority is governed by a 24-member Board of Directors appointed by the Governor with the advice and consent of the Senate of the State of Texas. Representing the 17 counties which lie within the Authority's jurisdiction are four directors from Dallas County, 3 directors from Tarrant County, and 1 director from each of the remaining counties. There are also 2 directors at large.

   The Trinity River Authority is vested with all the powers of the State under Article XVI, Section 59 of the Constitution to effectuate flood control and the conservation and use, for all beneficial purposes, of storm and flood waters in the Trinity River Watershed, subject only to:

   (1) Declarations of policies by the Legislature as to the use of water;

(2) Continuing supervision and control by the State Board of Water Engineers;

(3) The provisions of Article 7471 prescribing the priorities of uses for water; and

(4) The rights heretofore and hereafter acquired in water by municipalities and others.

Regarding water quality, the act creating the Trinity River Authority states:

> "It shall be the duty of the Authority to exercise with the greatest practical measure of the conservation of beneficial utilization of storm, flood and unappropriated flow waters of the Trinity River Watershed in the manner and for the particular purposes specified hereinafter in this section and elsewhere in this act, powers, including those: . . .
>
> > (K) As a necessary aid to the conservation, control, preservation and distribution of such water for beneficial use, the Authority shall have the power to construct, own and operate sewage gathering, transmission and disposal services, to charge for such services, and to make contracts in reference thereto with municipalities and others."

The Trinity River Authority is authorized to make contracts for service under Article 8280-188 and Article 1109i, Vernon's Annotated Civil Statutes, and the Regional Waste Disposal Act, (compiled as Chapter 25, Water Code of Texas).

2. The Trinity River. The Trinity River rises in four North Central Texas counties, Grayson, Montague, Archer and Parker Counties, in what are called forks, namely, the East Fork, the Elm Fork, the West Fork and the Clear Fork. The mainstream begins with the junction of the Elm and West Forks at Dallas. From its headwaters it snakes 548 miles to Trinity Bay or the upper end of Galveston Bay. Its watershed, or drainage area, covers 17,845 square miles, and its width varies from a few feet at the north to a substantial girth at its mouth. The river begins in a section known as the Cross Timbers. It drains portions of the Grand Prairie and the Black Land Prairie, flows across the Post Oak Belt, the Piney Woods Region, and finally the Gulf Coast Plain. Over a substantial period of time its flow has gathered sufficient soils to have established a true delta with distributaries of sufficient size to cut off at least partially that part of the Bay known as Turtle Bay. Viewed culturally, the Trinity River has been a traditional division line between East Texas and Central Texas. Not far from its western bank, the Pine and Hardwood growth in red soils which characterize the eastern area give way to rolling, virtually treeless plains with a much darker, even black, soil which supports a different immigrant group who generally follow different occupational callings.

Water pollution has been a serious problem in the Upper Trinity River Basin's metropolitan area for many years, and there is a simple general reason. Except when the area lakes are spilling over following heavy rains, the entire basin above the metropolitan area is virtually 100% dammed off and consumed by people and their activities in the metropolitan area. Most of the water is released to the river, but only as effluents from wastewater treatment plants. Ninety-plus percent of the river flow in and below the metropolitan area consists of such effluents, except during and right after rains. Wastewater treatment plants in the metropolitan area appear to be better than the average for this country, but few, if any, other areas create such a sizable river with its effluents only, without any dilution water from upstream.

The consequent problems in the river are predictable: low Dissolved Oxygen (D. O.), high Biochemical Oxygen Demand (BOD), high coliform count, few fish, sludge banks on the river bottom, high ammonia concentrations, occasional odors, blooms of suspended algae, etc. The Trinity River Authority is studying ways to reduce these problems in the river, and to do it in such a way that the reduction of one problem will not increase another. Our main effort for the low flow conditions is the development of a mathematical model of the stream, indicating how each of the problems in the river would respond to various possible changes in wastewater treatment.

When it rains, other water quality problems occur in the river. It is known that with a moderate rise in the river following a period of low flow, the water quality in the river actually decreases. For example, the D. O. becomes lower, the BOD higher, coliforms higher, and fish die. Apparently, something other than

PAGE NOT

AVAILABLE

DIGITALLY

pure rainwater is entering the river along with the usual effluents. Possible sources are: leaves, oil, trash, and such from city streets and storm sewers; trash, natural debris, fertilizers or pesticides from rural land; poorer treatment of regular effluents because of rainwater infiltration into the system; bypassing of industrial effluents; and the resuspension of organic sludges which collect on the river bottom during long periods of low flow. These possible sources are actually being measured during rises in the river and will be analyzed in a way analogous to that for low flow conditions, that is, to recommend changes which will reduce the problems the most for the money spent.

3. Present Treatment Process. The first regional wastewater treatment system conceived and constructed in the southwest was the Trinity River Authority's Central Sewage System. Originally, this system provided service to the Cities of Dallas, Irving, Farmers Branch and Grand Prairie.

The Central Wastewater Treatment Facility is located on a 450 acre site immediately north of the Dallas-Fort Worth Turnpike and immediately west of Loop 12 in Grand Prairie.

The treatment plant is a two-stage trickling filter plant with the following major features: raw sewage lift station; primary clarifier; sludge thickeners; sludge digesters and drying beds; chlorination facilities; and oxidation ponds. Office and laboratory facilities are also provided. The plant was constructed to treat 30 million gallons a day (MGD) to a quality of 20 milligrams per liter (Mg/L) BOD and 50 Mg/L suspended Solids (SS).

Construction on the original project began in 1958, and the Central Sewage System became operational in 1959 serving an estimated population of 70,000 in the original four customer cities. The original system consisted of (1) the treatment plant facilities; (2) Elm Fork Interceptor and lift stations 1 and 2; (3) West Fork Interceptor; (4) Mountain Creek Interceptor; and (5) Jefferson Avenue Interceptor, lift station 3 and force main. The total initial construction cost of all projects initiated in 1958 amounted to $5,822,000 which represents the cost of a treatment plant with a 30 MGD capacity and 25.5 miles of interceptor ranging in size from 27 to 72 inches in diameter.

Since 1959, the Central System is now receiving flows from Arlington, Bedford, Euless, Carrollton, Coppell, Addison, and soon the Dallas-Fort Worth Regional Airport, in addition to the flows generated by the four original customer cities. During the first few years of operation, the daily flows treated averaged 7.0 MGD. As the population of the various cities served by the Central System increased, the need of additional interceptor facilities became apparent.

Since the opening of the plant in 1959, the population growth of the cities served by the Central Sewage Facility has increased at a phenomenal rate. The City of Euless experienced over a 350%

growth rate between the years 1960 and 1970 while the Cities of Bedford and Carrollton experienced a 271% and 226% growth respectively, and the Cities of Arlington, Farmers Branch, and Irving experienced over a 100% growth rate. Present population forecasts project 950,000 people to be served by the Central System by 1990. This growth rate has had its effect on using up the present capacity of the Central Sewage Facility. Flow rates are estimated to be 50.6 MGD for 1975 and 78.1 MGD for 1980. The need for expansion is clearly evident.

As a designated regional wastewater treatment operator, the Trinity River Authority's Central System expansion will also be necessary to meet the service needs of the area designated in the North Central Texas Council of Governments Upper Trinity Basin Sewage Treatment Plan.

Today the Central System is comprised of 72.5 miles of interceptor, 4 lift stations and a treatment plant. The average daily flow has increased to approximately 32 MGD with a connected load of approximately 300,000 people representing service to eleven customer cities in the Mid-Cities area between Dallas and Fort Worth.

B. Proposed Action

1. Project Description. From the history and descriptions, three primary problem areas may be identified relating to the existing Central Sewerage System Wastewater Treatment Plant. These are:

(A) Capacity. Based on information previously discussed, it is clear that the present capacity of the plant is no longer adequate to meet the projected needs of the existing and anticipated customers. The Trinity River Authority's Central Sewerage System is commited to providing additional capacity up to 100 million gallons per day. Commitment to a regional system has created a situation where a cycle has developed and, at least for the foreseeable future, will probably continue. This may be summarized as "request for service -- extension of interceptor -- expansion of plant." Such a cycle is difficult to break without a prior decision as to the limits of the service area to be served by a single plant. The decision becomes particularly difficult when the initial expense for a new regional treatment system is considered. For this report, the ultimate service area envisaged for the Central Sewerage System by the NCTCOG Upper Trinity River Basin Comprehensive Sewage Treatment Plan has been assumed. This is sufficient to consider the presently proposed plant expansion as a reasonable alternative for increased capacity because this expansion is concurrent with presently accepted and approved planning for the provision of sewage service in the Upper Trinity Basin.

(B) Degree of Treatment. It is clear that the existing method of treatment is no longer sufficient by itself, to insure compliance with existing water quality criteria. The reason is simply that since the plant was built, the standards have changed. Where primary and secondary treatment was adequate, tertiary treatment is now required.

(C) Odor. The primary cause of odor can be identified as the pond used for the disposal of partially digested sludge. The remaining pond, however, is also suspect since experience has shown that such ponds tend to become anaerobic during the colder months and "turn over" in the spring as temperatures increase. "Turn over is usually accompanied by odor. In addition to the seasonal odor, a background odor is noticeable at the plant site. Some of this may be due to the sludge pond and possibly the digesters.

From the above, it can be concluded:

(1) That additional capacity must be provided to meet future wastewater disposal needs up to 100 million gallons per day.

(2) That the degree of treatment presently being given to existing wastewater flows is inadequate to meet current requirements and must be increased to a degree requiring tertiary treatment.

(3) That the following is required at the existing plant to eliminate odor.

   a. The sludge pond needs to be eliminated and an alternative method of solids disposal provided.

   b. The polishing pond needs to be eliminated and an alternative method of treatment provided.

   c. The sludge digesters need to be rendered reliable or eliminated and replaced with a reliable solids handling system.

d. Sludge must be removed from primary clarifiers before it becomes anaerobic, or as quickly as possible if already anaerobic.

From the above discussion, the Trinity River Authority proposes to implement the following plan. The principal features of this plan are identified as:

(1) Modify the existing process to eliminate known sources of odor.

(2) Modify the existing process to include the required degree of treatment.

(3) Expand the existing facilities to the required 100 MGD capacity.

A discussion of the specific actions proposed to implement these objectives follows:

(1) <u>Odor Elimination</u> The following features of the proposed design are specifically intended to eliminate odor:

   a. Alternate Sludge Facilities. It is proposed to provide alternate sludge handling facilities including a sludge holding tank, dewatering, and incineration facilities.

   b. Elimination of Sludge Pond. Because of the partially undigested nature of the solids in the sludge pond, it is recognized that discharge of either the solids or the supernatant directly to the river could represent a significant public health hazard. Because of the less than optimum digestion conditions existing in the sludge pond and the absence of a method of controlling these conditions, the likelihood of digestion being completed in the pond appears remote. Without complete digestion, odorless air drying cannot be expected.

Therefore, following completion of alternate sludge handling facilities, to include dewatering and incineration, the following method of eliminating the sludge pond is proposed:

(1) The solids will be withdrawn first so that odors may be kept to a minimum by the existing liquid cover and the algae population therein.

(2) Solids will be degritted to protect subsequent equipment.

(3) Solids will then be dewatered to reduce heat required in incineration.

(4) Dewatering pressate or filtrate will be sent to the head of the plant for treatment.

(5) Solids will then be incinerated for deodorizing and sterilization.

(6) Incineration residue will be removed for burial on site or in a sanitary landfill.

(7) Following removal of the solids, the remaining water in the pond will be sent to the head of the plant for treatment.

c. Elimination of Polishing Pond. Since its construction, the polishing pond has served the partial function of a final clarifier for the settlement of trickling filter sludge as well as the function of an oxidation pond. Therefore, it is proposed to use the same method for the elimination of the polishing pond as was proposed for the elimination of the sludge pond.

d. Elimination of Sludge Digesters. Prior to dismantling of the existing digesters, sludge will be removed and processed through the proposed sludge handling system.

e. Prevention of Odor in Proposed Sludge Holding Tank. Gases coming from the proposed sludge holding tank will be treated with ozone to remove odor.

f. Equalization Pond Odor Prevention. To prevent the occurrence of odor in the proposed equalization pond, the equalization pond will be preceeded by primary clarification and will be aerated.

g. Toxic Waste Control. To prevent plant upset by toxic waste, which would result in odor, a monitoring system will be provided on the interceptors to indicate the presence of toxic levels of waste in the interceptors. The equalization basin will be divided into several sections to allow isolation of the waste upon receipt at the plant. Thereafter, it may be gradually blended with the remaining wastewater in non-toxic concentrations and treated.

h. Ultimate Disposal. Incinerator residue will be disposed of in a sanitary landfill on site.

(2) Features to Provide Required Degree of Treatment. The following features of the proposed design are specifically intended to provide the required degree of treatment.

a. Treatment Process. The existing facilities will be modified to provide secondary treatment to the first 30 millions gallons per day of flow. An additional biological process will be provided for the remaining anticipated flow. Both processes will be followed by tertiary physical treatment including carbon absorption, filtration, aeration, and chlorination.

b. Reliability. An equalization basin will be provided to reduce the flow and quality fluctuations in the incoming waste, thus allowing less opportunity for upset. Compartmentalizing the equalization basin and an interceptor toxic monitoring system will allow toxic concentrations to be identified and isolated. A revision of the power supply will provide back-up service in the event of blackout.

c. Wet Weather Flows. The primary clarifiers, filter chlorination, and aeration equipment will be sized to provide minimum treatment to increased flows resulting from infiltration during wet weather.

(3) Features Associated with Capacity Increase. The following additional work is required with the increase of capacity:

a. A railroad spur will be required into the plant to allow bulk purchase of chemicals. In the case of chlorine, the need for storage facilities will thus be eliminated. It is proposed to widen a plant levee to carry the spur. The spur will connect to an existing railroad line adjacent to the existing plant site.

b. It will be required to install new interceptors into the plant site to deliver the increased flows. This means that the existing plant levee must be crossed.

c. A new bridge will be required to allow passage of heavy equipment and to provide all-weather access. It is proposed to relocate the bridge northward and increase the span.

2. Financial Information. Table 1-1 shows the total cost for all projects contemplated under grant application WPC-TEX-992/1094, the amount eligible for grant and local shares for cost. The Trinity River Authority will have funds available to finance the local share of the project.

C. Social and Environmental Setting

1. Physical Characteristics of the Upper Trinity River Basin.

(A) Topography. Generally, the topography of the area affected by the Central Sewerage System is flat to gently rolling, which is typical of the Coastal Plain. Towards the northernmost and westernmost ends of the service area, one may encounter the more rugged features marking the beginning of the Central Lowland areas.

(B) Geology. The geology of the service area of the Central Sewerage System appears to be dominated by the upper cretaceous

TABLE 1-1
TRINITY RIVER AUTHORITY OF TEXAS
REGIONAL WASTEWATER SYSTEM
ESTIMATED COST OF IMPROVEMENTS
WPC-TEX-992/1094
March 7, 1973

Projects	Construction Cost	Engineering and Contingencies	Right-of-Way Costs	Project Cost	Grant Amount	Project Cost After Grants
Cottonwood Creek; Project 1	$ 165,000	$ 24,750	$ 11,500	$ 201,250	$ 142,312	$ 58,938
Parallel West Fork Interceptor	1,200,000	180,000	64,000	1,444,000	1,035,000	409,000
Parallel Mountain Creek Interceptor 1	250,000	37,500	12,000	299,500	215,625	83,875
Elm Fork Detention System	450,000	67,500	-0-	517,500	388,125	129,375
Lift Station Enlargements	500,000	75,000	-0-	575,000	431,250	143,750
Regional Plant Expansion	31,598,000	6,319,600	-0-	37,917,600	28,438,200	9,479,400
Subtotals	$ 34,163,000	$ 6,704,350	$ 87,500	$ 40,954,850	$ 30,650,512	$ 10,304,338
TOTAL PROJECT						$ 10,304,338

formations, particularly the Woodbine and Eagle Ford Formations. The Austin formation, being white chalky limestone and limy marl with layers of shelly marl on top, outcrops along the eastern edge of the service area. Because it is a hard resistant formation, its resistance to erosion has caused practically all the drainage lying west of its outcrop to concentrate in the main gorge of the Trinity River at Dallas. This includes Mountain Creek and Elm Fork. The larger stream valleys contain deposits of alluvium belonging to the Quaternary period.

(C) Soils. The soil types found in the service area are primarily East Cross Timbers, which is practically coextensive with the outcrop of Woodbine Sands and Black Land Prairie to the east of the East Cross Timbers. In the East Cross Timbers, soils vary in color from gray to light brown, reddish brown and red. They are generally well drained and erode easily on the slopes. The native vegetation consists principally of small oaks, hickory, and other hardwoods. Native grasses are scarce and not very nutritious. The principal alluvial soils are the Trinity Clay, the Catalpa Clay, the Frio Clay, the Frio fine sand loam, and the Ocklockonee fine sandy loam.

The Black Land Prairie is a treeless plain somewhat dissected by streams. Its topography varies from flat and undulating to gently rolling and rolling. The stream valleys are generally broad and shallow and contain large areas of alluvial soils which in the absence of levees would be subject to overflow. The native vegetation consists mainly of prairie grasses, with a few elm and hackberry trees located along the water-courses. The principal upland soils are dark waxy clays, some of which are calcareous and other noncalcareous. The calcareous clays are friable when dry, but the noncalcareous clays are generally tight even when dry. The principal alluvial soils found in the broad stream bottoms in the region are the Trinity Clay, the Catalpa Clay, and various members of the Ocklockonee series.

The Trinity Clay is the predominating soil type along the main streams. It is a dark calcareous clay, derived by the deposit of silt from the region of the Black Land Prairies. It exists in generally flat topography where the drainage is poor. In its natural condition, the Trinity Clay supports a growth of hardwood timber including the following species and varieties: Pin Oak, Burr Oak, Pecan, Ash, Elm, Gum, Locust, and Haw. When wet, the Trinity Clay is very waxy and gummy.

(D) Hydromorphic. The principal aquifer in the region of the Central Sewerage System is the Basal Trinity Sands. The principal water bearing beds in Dallas County are, in descending order, the Sands of the Woodbine, the Paluxy and the Basal Trinity Sands. The yield of these aquifers is low and area reliance is primarily placed on surface reservoirs. The aquifer recharge areas which might be affected are, from west to east, the Basal-Trinity-Paluxy Sands and the Woodbine Sands. All of these recharge areas are upstream of the existing plant discharge.

(E) Paleontology. There have been no major paleontological finds in the area except for the recent discovery of pre-historic animal bones at the site of the Dallas-Fort Worth Regional Airport presently under construction. It is felt generally that the massive urbanization of the study area has resulted in the obliteration of many potential sites for exploration. A more detailed discussion of studies on this subject is found in Appendix I.

2. Hydrology.

(A) Surface Water.

1. Relevant Bodies of Water. In the study area the major means of water supply is surface water. There are a number of reservoirs in the area including Grapevine Lake, Garza-Little Elm Lake, Lake Lavon, Lake Arlington, Lake Ray Hubbard and Lake Benbrook. There are no natural lakes in the study area. The Trinity River has been discussed previously, as was water quality in the river, Aquifer recharge is upstream from the proposed plant discharge.

2. Trinity River Water Quality Problems. The Trinity River from Fort Worth to below Dallas is of very poor quality. As previously discussed the sewage effluent comprises 95%

to 98% of the flow in the river during low flow periods.

Since the river flows through a massive urban complex the pollution from non-point sources is considerable. The ability of the stream to support other than a few rough fish is non-existent. During high flow the re-suspension of organic sludge depletes the D. O. to zero in some stretches of the stream.

The tertiary treatment proposed should play a significant role in helping to return the river to a more productive resource.

3. Information on Stream Flow. Rainfall information has been presented elsewhere in this report. Seasonal variations in stream flow at the Trinity River gauging station at Dallas are shown on the accompanying Tables 1-2 & 1-2a and 1-3 & 1-3a.

4. Areas Subject to Inundation and Flooding. All elements of the proposed improvements including the treatment plant outfall will be located above the flood contour.;

(B) Groundwater. There are no potential water quality problems associated with groundwaters which would result from the proposed project.

3. <u>Climate</u>. The climate in the study area is moist to dry. Spring and autumn months are mild, with warm days and cool nights, and summers are long and usually hot. Winters are usually mild; however, there are brief periods of extreme cold.

TABLE 1-2

8-0570. Trinity River at Dallas, Tex.

LOCATION.--Lat 32°46'30", long 96°49'10", Dallas County, on left bank on downstream side of left pier of Commerce Street viaduct in Dallas, 5.2 miles downstream from confluence of West and Elm Forks, and at mile 500.3.

DRAINAGE AREA.--6,106 sq mi.

PERIOD OF RECORD.--October 1898 to December 1899 (gage heights only published in WSP 28 and 37), July 1903 to current year.

GAGE.--Water-stage recorder. Datum of gage is 368.02 ft above mean sea level. Oct. 1, 1898, to Dec. 31, 1899, nonrecording gage at site 2 miles upstream at different datum. July 1, 1903, to July 20, 1930, nonrecording gage at present site and datum. July 21, 1930, to Sept. 30, 1932, nonrecording gage at site 6 miles downstream at datum 3.08 ft lower.

AVERAGE DISCHARGE.--66 years, 1,486 cfs (1,077,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 67,000 cfs May 8 (gage height, 40.68 ft); minimum, 120 cfs Oct. 29
Period of record: Maximum discharge, 184,000 cfs May 25, 1908 (gage height, 52.6 ft), from rating curve defined by current-meter measurements below 109,000 cfs; minimum observed for periods 1903-6, 1920-69, 1.2 cfs July 4, 1953, result of storage behind temporary dam 4 miles upstream.
Maximum stage since at least 1840, that of May 25, 1908. Flood in 1866 reached about the same stage.

REMARKS.--Records good. Flow is largely regulated by 10 major upstream reservoirs having a total combined capacity of 2,334,000 acre-ft of which 994,900 acre-ft is for flood control. The city of Dallas reported the diversion for municipal use during the year of 129,200 acre-ft of water from the Elm Fork, 41,400 acre-ft from Lake Tawakoni (on Sabine River), the purchase of 9,380 acre-ft from North Texas Municipal Water District (from the East Fork), and the return of 130,400 acre-ft of sewage effluent to river 4 miles downstream from station. For other diversions and effluent returns above station see records for stations 8-0480 and 8-0492.

REVISIONS (WATER YEARS).--WSP 850: 1903-6 (monthly and annual means). WSP 1922: Drainage area.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1968 TO SEPTEMBER 1969

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	233	169	1,040	240	829	3,060	5,370	2,100	5,390	1,430	323	214
2	233	283	735	233	475	3,260	5,300	1,820	5,000	1,430	291	200
3	226	743	841	240	375	3,460	5,350	1,730	5,100	1,310	276	550
4	261	499	357	247	307	3,460	5,350	1,730	5,150	1,220	268	940
5	220	276	332	240	291	3,580	5,400	8,790	4,900	1,400	778	447
6	220	240	299	233	247	3,790	5,350	10,700	4,850	1,490	605	348
7	240	226	291	240	276	3,700	5,300	41,000	4,800	1,490	429	307
8	233	291	276	261	261	3,740	4,860	53,600	4,750	1,430	332	268
9	1,370	384	268	254	268	3,740	3,550	25,000	4,650	1,340	261	340
10	2,790	299	247	233	226	3,960	3,260	10,600	4,600	1,310	247	307
11	896	220	254	233	233	3,610	3,220	6,610	4,560	1,140	233	291
12	291	200	261	226	307	3,420	3,050	5,880	4,510	645	233	366
13	261	207	240	214	323	2,210	4,550	5,200	4,460	420	247	315
14	233	226	247	214	569	1,160	3,930	6,940	4,510	291	240	276
15	220	299	233	226	1,600	3,940	3,180	11,200	4,560	307	379	261
16	214	348	220	240	938	8,720	2,660	6,430	4,560	332	625	254
17	220	261	233	254	429	3,680	7,490	11,800	4,510	366	411	268
18	194	214	261	220	357	6,920	8,730	12,900	4,460	384	323	254
19	181	194	438	220	307	3,430	5,370	8,640	4,380	357	284	254
20	169	200	307	247	357	2,120	4,510	7,560	4,330	332	247	220
21	188	214	447	247	942	1,490	4,120	7,540	4,280	366	240	226
22	207	226	402	214	3,120	2,540	4,020	8,260	4,240	438	254	291
23	188	220	299	226	1,650	4,610	4,450	10,300	4,240	429	315	2,990
24	181	214	268	226	1,150	4,900	4,030	9,840	3,550	366	348	2,620
25	181	214	261	233	1,000	4,110	3,500	8,730	2,280	323	323	605
26	181	341	247	207	2,160	4,190	2,900	8,500	1,610	299	560	410
27	175	2,040	276	200	2,480	4,780	3,370	10,300	1,550	268	599	350
28	163	2,630	307	194	2,760	5,520	3,770	9,140	1,520	299	411	307
29	169	1,020	291	567	------	6,080	2,550	8,900	1,490	307	348	276
30	175	465	261	2,470	------	6,160	2,240	7,800	1,460	315	375	250
31	169	------	240	3,100	------	5,920	------	5,780	------	307	307	------
TOTAL	10,882	13,363	10,679	12,599	24,237	125,260	130,730	335,320	120,250	22,141	11,112	15,005
MEAN	351	445	344	406	866	4,041	4,358	10,820	4,008	714	358	500
MAX	2,790	2,630	1,040	3,100	3,120	8,720	8,730	53,600	5,390	1,490	778	2,990
MIN	163	169	220	194	226	1,160	2,240	1,730	1,460	268	233	200
AC-FT	21,580	26,510	21,180	24,990	48,070	248,400	259,300	665,100	238,500	43,920	22,040	29,760

CAL YR 1968 TOTAL 706,966 MEAN 1,932 MAX 23,400 MIN 163 AC-FT 1,402,000
WTR YR 1969 TOTAL 831,578 MEAN 2,278- MAX 53,600 MIN 163 AC-FT 1,649,000

TABLE 1-2a

08057000 Trinity River at Dallas, Tex.

LOCATION.--Lat 32°46'30", long 96°49'10", Dallas County, on left bank on downstream side of left pier of Commerce Street viaduct in Dallas, 5.2 miles downstream from confluence of West and Elm Forks, and at mile 500.3.

DRAINAGE AREA.--6,106 sq mi.

PERIOD OF RECORD.--October 1898 to December 1899 (gage heights only published in WSP 28 and 37), July 1903 to current year.

GAGE.--Water-stage recorder. Datum of gage is 368.02 ft above mean sea level. Oct. 1, 1898, to Dec. 31, 1899, nonrecording gage at site 2 miles upstream at different datum. July 1, 1903, to July 20, 1930, nonrecording gage at present site and datum. July 21, 1930, to Sept. 30, 1932, nonrecording gage at site 6 miles downstream at datum 3.08 ft lower.

AVERAGE DISCHARGE.--67 years, 1,494 cfs (1,082,000 acre-ft per year).

EXTREMES.--Current year: Maximum discharge, 20,200 cfs Apr. 26 (gage height, 34.66 ft) maximum gage height, 34.88 ft Apr. 26; minimum discharge, 188 cfs Sept. 11
Period of record: Maximum discharge, 184,000 cfs May 25, 1908 (gage height, 52.6 ft), from rating curve extended above 109,000 cfs; minimum observed for periods 1903-6, 1920-70, 1.2 cfs July 4, 1953, result of storage behind temporary dam 4 miles upstream.
Maximum stage since at least 1840, that of May 25, 1908. Flood in 1866 reached about the same stage.

REMARKS.--Records good. Flow is largely regulated by 11 major upstream reservoirs having a total combined capacity of 2,205,000 acre-ft of which 648,600 acre-ft is for flood control. The city of Dallas reported the diversion for municipal use during the year of 134,800 acre-ft of water from the Elm Fork, 43,300 acre-ft from Lake Tawakoni (on Sabine River), the purchase of 8,800 acre-ft from North Texas Municipal Water District (from the East Fork), and the return of 137,800 acre-ft of sewage effluent to river 4 miles downstream from station. For other diversions and effluent returns above station see records for stations 08048000 and 08049200.

REVISIONS (WATER YEARS).--WSP 850: 1903-6 (monthly and annual means). WSP 1732: 1937 (M). WSP 1922: Drainage area.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	276	645	291	666	1,670	7,550	5,000	9,640	7,750	291	402	2,160
2	284	525	284	1,420	3,010	3,760	5,000	5,890	4,470	268	393	4,140
3	284	485	284	1,230	810	5,460	4,580	6,800	3,730	261	393	2,060
4	284	585	284	968	525	5,170	4,150	7,520	3,680	261	411	559
5	276	475	344	1,190	438	3,890	3,790	8,180	4,230	254	375	393
6	268	402	1,030	2,060	525	4,480	3,700	8,700	4,510	268	411	357
7	268	375	1,510	1,420	465	6,180	2,630	8,900	4,560	254	332	315
8	268	402	764	1,190	402	5,620	1,410	8,430	4,600	284	357	233
9	254	340	542	1,670	366	5,440	760	7,780	3,990	247	384	207
10	254	307	420	2,060	451	4,960	645	6,850	1,960	323	456	200
11	240	323	357	1,460	377	6,070	640	5,650	846	348	438	200
12	2,470	315	323	605	307	7,170	630	5,230	585	384	291	200
13	4,810	291	307	545	340	6,840	625	5,100	525	456	233	351
14	1,900	299	291	505	340	6,840	605	5,000	495	323	233	438
15	645	307	261	438	674	6,910	710	4,950	438	307	247	307
16	485	307	284	438	747	7,280	910	4,950	402	284	284	596
17	402	619	299	411	438	10,600	1,010	4,800	375	284	291	5,090
18	366	475	315	393	402	9,950	1,070	4,750	284	291	226	2,840
19	323	340	323	402	626	7,420	2,530	4,700	261	276	951	691
20	315	284	307	375	460	8,100	1,980	4,380	268	254	464	357
21	323	276	307	332	315	12,000	2,570	4,120	307	393	240	307
22	299	276	291	323	323	12,100	2,580	3,920	375	348	299	291
23	299	276	291	323	525	9,840	2,690	3,710	495	254	1,530	1,790
24	291	276	299	307	4,070	7,900	2,690	1,430	332	323	651	1,640
25	291	307	332	315	13,500	7,030	5,950	2,000	233	375	348	525
26	307	284	332	307	6,980	6,000	18,400	3,210	284	323	307	1,770
27	551	332	307	323	3,040	5,680	12,600	4,040	357	299	240	1,090
28	1,070	366	475	299	7,240	5,550	5,690	4,750	291	299	200	1,180
29	745	348	3,470	291	------	5,500	4,700	4,220	261	284	228	2,460
30	2,480	315	3,980	299	------	5,140	7,070	5,490	299	348	456	4,040
31	1,500	------	1,270	307	------	5,100	------	10,400	------	402	383	------
TOTAL	22,828	11,157	20,174	22,872	49,366	211,720	107,315	175,530	51,093	9,566	12,454	36,787
MEAN	736	372	651	738	1,763	6,830	3,577	5,662	1,703	309	402	1,226
MAX	4,810	645	3,980	2,060	13,500	12,100	18,400	10,400	7,750	456	1,530	5,090
MIN	240	276	261	291	307	3,760	605	1,430	233	247	200	200
AC-FT	45,280	22,130	40,020	45,370	97,920	419,900	212,900	348,200	101,300	18,970	24,700	72,970

CAL YR 1969 TOTAL 850,813 MEAN 2,331 MAX 53,600 MIN 194 ACFT 1,688,000
WAT YR 1970 TOTAL 730,962 MEAN 2,002 MAX 18,400 MIN 200 ACFT 1,450,000

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Trinity River at Dallas
1972
TABLE 1-3

File Number { Washington 08 0570 00 / District ....

Used rating table ~~dated~~ No. 9

...ge Read to hundredths Once ~~Twice~~ a Day by NWS

Gage heights used to half tenths between 9.5 and 11.8 feet; hundredths below and tenths above these limits.

April Gage height	April Discharge	May Gage height	May Discharge	June Gage height	June Discharge	July Gage height	July Discharge	August Gage height	August Discharge	September Gage height	September Discharge	Day
6	168	12.89	878	9.48	179	9.47	178	9.29	153	9.63	200	1
4	165	12.20	712	9.51	183	9.41	169	9.41	169	9.90	242	2
0	160	11.30	504	9.44	174	9.39	167	9.34	160	9.66	204	3
4	165	10.55	352	9.42	171	9.64	202	9.38	165	9.72	213	4
9	224	9.99	256	9.41	169	9.54	188	9.37	164	10.81	404	5
4	231	S	440	9.45	175	9.44	174	9.29	153	10.40	324	6
6	335	S	1,830	9.52	185	9.49	174	9.31	155	9.75	218	7
1	276	774J S	4,440	9.54	188	9.33	158	9.42	171	9.60	196	8
4	280	S	925	9.54	188	9.52	185	S	608	9.75	218	9
8	287	10.55	352	9.55	189	9.46	176	S	456	9.94	248	10
4	313	10.28	302	9.77	221	9.44	174	9.72	213	9.54	188	11
9	288	11.50	548	775J 9.93	247	S	237	9.58	193	9.56	190	12
2	213	11.10	462	10.05	266	S	1,190	9.60	196	9.59	195	13
9	208	10.13	279	10.93	428	10.58	362	10.65	372	9.40	168	14
	465	10.18	287	11.15	472	10.02	261	10.02	261	9.40	168	15
0	324	S	377	S	792	9.53	186	9.63	200	9.85	234	16
1	344	12.70	832	10.49	340	776J 9.43	172	9.56	189	10.05	266	17
0	422	11.70	592	9.81	228	9.50	182	9.60	196	9.53	186	18
6	519	11.00	442	9.61	197	9.85	234	9.51	183	9.45	175	19
7	497	9.85	234	9.50	182	9.58	193	9.52	185	9.48	179	20
	557	9.71	212	S	687	9.49	181	777J 9.45	175	10.15	282	21
6	539	9.66	204	S	684	9.49	181	9.52	185	10.78	398	22
4	331	9.63	200	10.11	276	9.49	181	9.71	212	11.00	442	23
8	338	9.62	199	9.68	207	9.56	190	9.54	188	10.72	386	24
0	290	9.63	200	9.76	220	9.40	168	10.15	282	10.09	272	25
2	245	9.56	189	9.57	192	9.53	186	10.28	303	9.80	226	26
	2,240	9.52	185	9.43	172	9.79	224	11.08	458	9.98	255	27
	3,030	9.48	179	9.48	179	9.48	179	9.92	245	11.16	474	28
	1,800	9.56	189	9.66	204	9.55	189	9.67	206	10.13	279	29
	1,710	9.50	182	9.96	252	9.54	188	9.51	183	9.96	252	30
		9.56	189			9.32	157	9.47	178			31
	16,967		17,172		8,247		6,986		7,157		7,682	
	566		654		275		225		231		256	

Period Year 1971-72: 579,511 / 1,583

Quarter	Computed	Checked	Date
First–Fourth	EHO	DZT	1-9-73

Quarter	Computed	Checked	Date
First–Fourth	SDP	DKM	1-5-73

Quarter	Disch. applied	Disch. checked	Date

Quarter	G. H. copied	G. H. checked	Date
First–Fourth	FAP	SDP	

TABLE 1-3a

July 1937

Daily Gage Height, in Feet, and Discharge, in Second-Feet, of Trinity River

Near Dallas, Tex. for the Year Ending September 30, 1972.

Drainage Area 6,106 Square Miles. Water-Stage Recorder continuous Ratio 1 : 6

Flow largely regulated by 11 major upstream reservoirs, combined capacity, 2,205,000 acre-ft, of which 898,800 acre-ft is for flood control.

Day	October		November		December 1971		January 1972		February		March		Day
	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	Gage height	Discharge	
1	9.43	172	S	2,340	15.03	1,410	27.85	6,850	10.55	352	10.15	282	1
2	9.46	176	S	1,190	S	2,110	27.86	6,860	10.57	356	9.90	242	2
3	S	2970	10.85	412	S	7,210	27.66	6,710	10.48	338	9.86	236	3
4	S	7,920	10.74	390	S	5,490	27.80	6,810	10.60	362	9.86	236	4
5	S	3,350	10.62	366	S	4,030	S	6,750	10.57	356	9.88	239	5
6	S	848	10.54	350	S	10,500	S	7,640	10.35	315	9.83	231	6
7	10.65	372	10.49	340	S	8,790	S	6,120	10.30	306	9.84	232	7
8	10.57	356	10.49	340	S	5,080	25.93	5,720	10.27	302	9.85	234	8
9	10.73	388	10.00	258	S	14,200	25.62	5,560	10.30	306	9.84	232	9
10	10.33	311	9.94	248	S	30,200	25.53	5,520	10.15	282	9.82	229	10
11	10.00	258	9.92	245	S	23,500	25.45	5,480	10.64	370	9.82	229	11
12	9.97	253	9.83	231	S	11,300	25.38	5,440	10.85	412	9.84	232	12
13	9.91	244	10.50	342	S	6,110	25.30	5,400	10.68	378	9.82	229	13
14	9.86	236	10.45	333	S	4,930	25.21	5,360	10.44	331	9.80	226	14
15	9.84	232	9.84	234	S	6,910	25.13	5,320	10.26	300	9.81	228	15
16	9.77	221	9.76	218	28.70	7,440	25.11	5,300	10.19	288	9.76	219	16
17	S	375	S	345	28.58	7,360	25.06	5,280	10.23	296	9.79	224	17
18	S	1,380	769 S	1,870	28.20	7,090	25.08	5,290	S	645	9.69	209	18
19	765 S	999	S	1,270	27.47	6,580	25.10	5,300	10.10	274	9.65	203	19
20	766 S	19,600	11.34	511	26.85	6,210	S	5,320	9.89	240	9.74	216	20
21	S	20,400	10.99	440	770 26.45	5,980	S	4,450	9.90	242	9.95	250	21
22	767, 768 S	10,700	S	497	S	6,170	S	3,520	10.15	282	10.38	320	22
23	S	3,370	S	1,240	S	6,620	17.32	2,120	10.13	279	10.03	263	23
24	S	1,010	14.23	1,200	26.56	6,040	771 S	2,060	10.12	277	9.99	256	24
25	S	522	14.50	1,270	26.36	5,930	S	1,140	10.08	271	10.18	287	25
26	S	478	14.71	1,330	26.25	5,880	12.48	779	10.18	286	S	296	26
27	S	1,280	14.53	1,280	26.25	5,880	12.44	768	9.97	250	S	356	27
28	S	1,030	14.44	1,260	26.63	6,080	11.35	515	772 9.80	226	10.05	.05 258	28
29	S	2,020	14.12	1,180	S	6,390	10.89	420	9.89	242	9.76	.16 196	29
30	S	2,320	14.55	1,290	S	2,770	10.70	382			9.79	.18 197	30
31	S	2,280			S	7,050	10.56	354			9.75	.20 189	31
Total		95,062		22,820		246,240		134,538		9,164		7,476	
Mean		3,067		761		7,943		4,340		316		241	
Second-feet per square mile													
Run-off in inches													
Run-off in acre-feet													

The average dates of occurrence for various temperature values are shown in Tables 1-4 and 1-5.

Tables 1-6 and 1-7 show other climatological data germane to the study area.

The average prevailing direction of the wind by month since 1898 is reflected below.

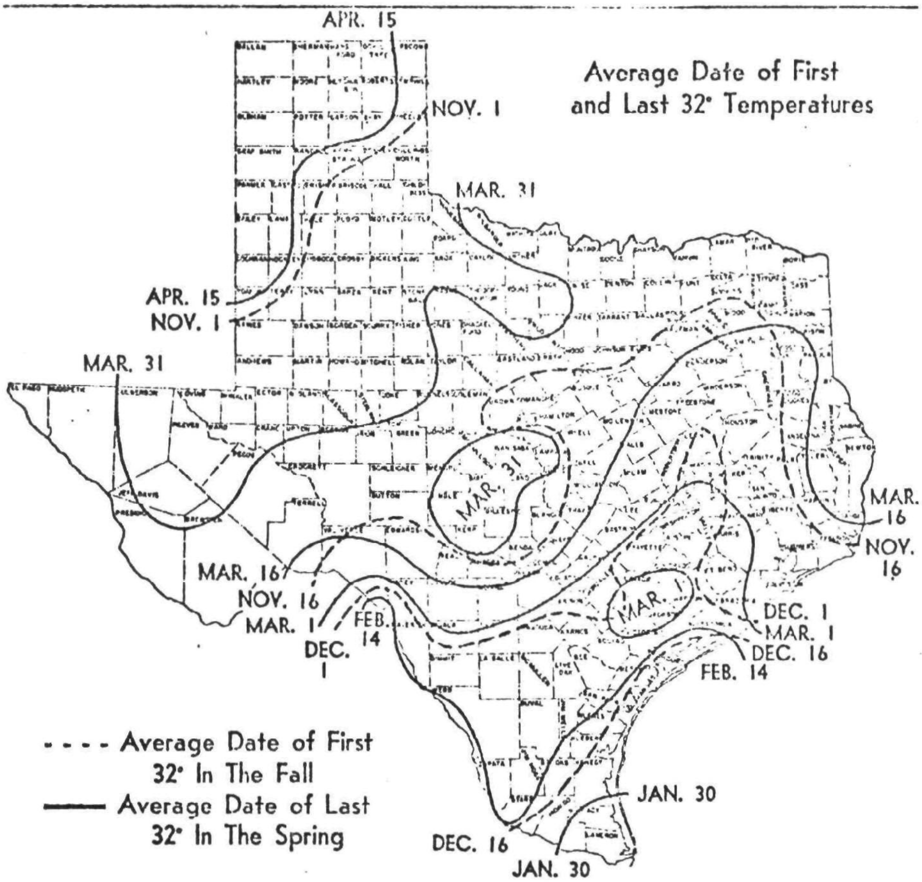
Month	Velocity (Knots)	Prevailing Direction (8 pts. of compass)
January	10.3	NW
February	11.1	NW
March	12.1	S
April	12.2	S
May	10.9	S
June	10.2	S
July	9.3	S
August	9.2	S
September	8.9	S
October	9.4	S
November	9.8	S
December	9.8	SW

PREVAILING WIND DIRECTION

JUNE 1971 - MAY 1972

Month	Resultant Direction in Degrees
June, 1971	180
July	180
August	140
September	130
October	180
November	170
December	220
January, 1972	250
February	210
March	190
April	170
May	130

TABLE 1-4


Average Date of First
and Last 32° Temperatures
APR. 15
NOV. 1
MAR. 31
APR. 15
NOV. 1
MAR. 31
MAR. 31
MAR. 16
NOV. 16
MAR. 1
FEB. 14
DEC. 1
MAR. 1
MAR. 16
NOV. 16
DEC. 1
MAR. 1
DEC. 16
FEB. 14
JAN. 30
DEC. 16
JAN. 30
- - - - Average Date of First
32° In The Fall
—— Average Date of Last
32° In The Spring

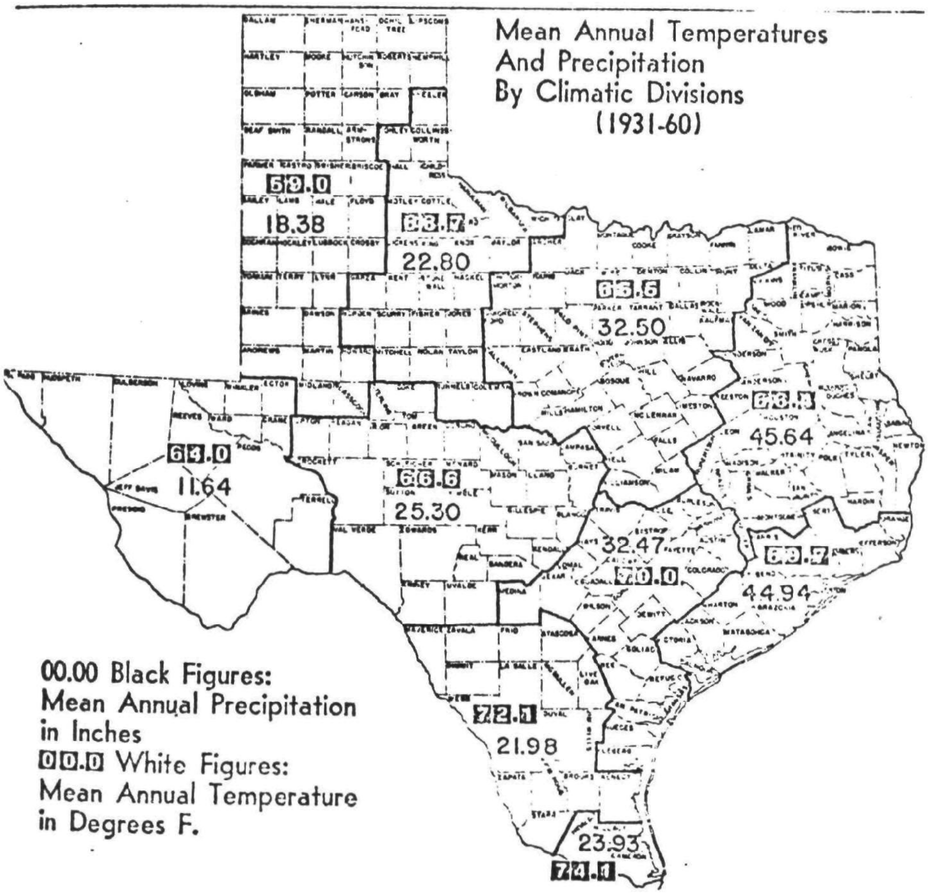

Mean Annual Temperatures
And Precipitation
By Climatic Divisions
(1931-60)
59.0
18.38
63.7
22.80
65.5
32.50
65.3
45.64
64.0
11.64
66.6
25.30
32.47
70.0
69.7
44.94
72.1
21.98
23.93
74.1
00.00 Black Figures:
Mean Annual Precipitation
in Inches
00.0 White Figures:
Mean Annual Temperature
in Degrees F.

TABLE 1-5

METEOROLOGICAL DATA

Source: NOAA, Environmental Data Service, Local Climatological Data.

Additional data for these locations are listed in the table of Texas temperature, freeze, growing season, and precipitation records, by counties

	Temperature						Precipitation					Relative Humidity		Wind			
	Record Highest	Month and Yr	Record Lowest	Month and Yr	No Days Max. 90 and Above	No Days Min 32 and Below	Maximum in 24 Hours	Month and Year	Snowfall Mean Annual	Max Snowfall in 24 Hours	Month and Year	6:30 A M CST	Noon CST	Speed, MPH Mean Annual	Highest Miles Per Hour	Month and Year	Per Cent Possible Sunshine
Abilene	111	8 43	-9	1-47	95	54	6 78	5 00	4 3	8 0	1 19	72	50	12 2	109	6 51	71
Amarillo	108	6-53	—16	2 99	71	107	6 75	5-51	13 9	20 6	3 34	72	44	13 6	84	5-49	73
Austin	109	7 54	—2	1 49	105	24	19 03	9-21	1 2	9 7	11 37	83	55	9 4	57	7-47	62
Brownsville	104	9 47	12	2-97	107	1	12 19	9 67	§	§	1-67	87	60	11 9	109	9 67	61
Corpus Christi	105	7-34	11	2-99	87	7	8 76	9 67	0 1	.5 0	1 97	90	64	11 9	161	8 70	64
Dallas	111	7-54	—3	1-30	94	37	9 18	9 47	2 1	7 4	1 64	79	55	10 9	77	7 36	65
Del Rio	111	7-60	11	2 51	122	18	8 28	6 35	0 8	4 7	1 25	78	54	9 7	89	8 70	70
El Paso	109	7-60	—8	1-62	104	61	6 50	7 81	4 4	8 4	11 05	57	35	9 8	70	5 50	83
Fort Worth	112	8-36	—8	2-99	87	44	9 57	9 32	3 0	12 1	1-64	83	57	11 4	73	8 59	65
Galveston	101	7 32	8	2 99	12	4	14 35	7-00	0 2	15 4	2 95	83	72	11 0	*100	9 00	64
Houston	108	8 09	5	1 40	95	13	15 65	8-45	0 4	20 0	2 95	87	60	10 8	‡	3 76	67
Lubbock	107	7 40	—17	2 33	83	101	8 85	8 65	8 8	12 1	2 61	74	16	13 3	89	5-70	73
Midland-Odessa	107	6 51	—11	2 33	98	70	5 99	7-61	3 4	5 9	1 55	73	42	10 4	67	2 60	73
Port Arthur-Beaumont	107	8-62	11	1 30	89	18	17 76	7 43	0 5	20 0	2-95	90	63	10 3	91	8 40	59
San Angelo	111	7 63	1	2 51	120	54	11 75	9 36	3 0	5 8	11-68	76	48	10 4	75	4-49	70
San Antonio	107	8 09	0	1-49	116	21	7 08	10 13	0 5	5 0	1-40	84	55	9 3	74	8 42	67
Victoria	110	7 39	9	1 30	103	12	8 57	4-69	§			88	59	10 2	††150	9-61	67
Waco	112	8 69	—5	1 49	104	31	7 18	5 53	1 5	7 0	1-49	80	57	11 8	69	6-61	63
Wichita Falls	113	8-64	—12	1-47	105	69	5 61	10 59	5 7	5 9	1-66	81	51	11 4	92	6-45	68
**Lake Charles, La.	104	8 51	12	1-48	73	14	16 01	6 47	§	5.0	2-60	90	62	8 6	58	1-62	61
**Shreveport, La	110	8 09	—5	2 99	97	34	7 17	4-53	1 3	4 0	3-65	86	57	9 3	44	9-65	65

§Trace, an amount too small to measure
†Also recorded on earlier dates, months or years
‡Anemometer damaged
*100 mph recorded at 6 15 p m Sept 8 just before anemometer blew away Maximum velocity estimated 120 MPH from NE between 7 30 p m and 8 30 p m
††Measured at Orange, Texas, near Port Arthur
‖Highest sustained wind estimated 110 mph Highest gust estimated 150 mph at 5 55 p m, Sept 11, 1961
**These stations are included because they are near the boundary line and their data can be considered representative of the eastern border of Texas

TABLE 1-6

TEXAS ANNUAL AVERAGE PRECIPITATION, 1892-1970

Source: NOAA Climatologist for Texas

The table below shows annual average precipitation over all of Texas for 1892-1970, inclusive, as measured by NOAA National Weather Service Stations Rainfall measurements now are taken at more than 900 locations throughout the state Figures given are an average of the precipitation in the 10 climatic subdivisions of the state Wide variation of rainfall in Texas makes an average figure for this large area of limited significance (Note. This table is a revision of figures used in previous Texas Almanacs)

Year—	Inches	Year—	Inches
1892	26 32	1932	32 76
1893	18 50	1933	26 15
1894	25 61	1934	25 59
1895	29 83	1935	35 80
1896	25 15	1936	30 32
1897	24 21	1937	25 89
1898	24 56	1938	25 45
1899	27 57	1939	23 52
1900	36 87	1940	32 70
1901	20 13	1941	42 62
1902	28 28	1942	30 68
1903	29 64	1943	24 28
1904	26 78	1944	34 08
1905	35 98	1945	30 06
1906	29.19	1946	35 16
1907	28 51	1947	24 75
1908	29 06	1948	21 79
1909	21 58	1949	35 08
1910	19 52	1950	24 48
1911	26 83	1951	21 99
1912	24 92	1952	23 27
1913	33 25	1953	24 76
1914	35 19	1954	19 93
1915	28 79	1955	23 [illegible]
1916	23 05	1956	16 1[illegible]
1917	14 30	1957	[illegible]
1918	26 03	1958	[illegible]
1919	42 15	1959	[illegible]
1920	29 93	1960	33 73
1921	25 18	1961	30 20
1922	29 83	1962	24 05
1923	37 24	1963	20 95
1924	22 32	1964	24 11
1925	25 37	1965	27 55
1926	32 97	1966	28 68
1927	24 32	1967	28 44
1928	27 56	1968	34 54
1929	29 47	1969	29 85
1930	28 44	1970	26 36
1931	28 37		

TEXAS DROUTHS, 1892-1970

The following table shows the duration and extent of Texas drouths by major areas 1892-1970 For this purpose, drouths are arbitrarily defined as when the division has less than 75 per cent of the 1931-1960 normal precipitation The 1931-60 normal precipitation is shown at the bottom of the table for each area in inches A short table which follows shows the frequency of drouths in each area and the total years of drouth in the area No climatic subdivision had less than 75 per cent of normal rainfall in 1955, 1956, 1957, 1958 or 1959

Year	High Plains	Low Rolling Plains	North Central	East Texas	Trans-Pecos	Edwards Plateau	South Central	Upper Coast	Southern	Lower Valley
1892	.	...	.	...	68	...	.	73	.	.
1893	.	...	67	70	..	49	56	64	53	55
1894		..	...	...	68	...	..	..	.	...
1897	.	...	...	...	...	...	73	...	72	...
1898	.	...	..	...	...	..	..	..	69	51
1901	.	71	70	..	...	60	62	70	44	..
1902		...	...	...	..	...	...	..	65	73
1907	.	...	...	...	..	...	...	...	..	65
1909		.	72	65	67	74	70	.	.	..
1910	59	59	61	69	43	65	69	74	59	..
1911			...	..	.	.	..	.	..	70
1916		73	..	74	70	...	73	69	.	
1917	53	50	63	59	44	46	42	50	32	45
1920	.	...	...	...	...	...	...	...	...	71
1921		...	...	..	72	...	...	...	..	73
1922	.	...	...	.	68	..	...	.	...	..
1924	.	...	73	73	...	71	..	72	..	.
1925	.	...	72	...	...	...	72	..	..	.
1927		...	...	...	..	..	..	74	..	71
1933	72	...	...	...	62	69	...	...	...	...
1934	66	...	...	...	46	69	...	...	.	...
1937	.	...	...	...	...	...	..	..	72	.
1939	.	...	..	...	..	..	69	..	..	72
1943	..	...	72	..	..	...	..	..	...	..
1948		..	73	74	62	...	73	67	..	
1950	.	...	...	...	..	...	68	...	74	61
1951		.	...	...	61	53	...	..	.	.
1952	58	66	...	...	73	..	...	...	56	70
1953	53	.	..	..	49	73	.		..	..
1954	70	71	68	73	..	50	50	57	71	
1956	51	57	61	68	44	43	55	62	53	53
1962	.	...	..	..	.	68	.	.	67	65
1963		..	63	68	.	65	61	73	..	
1964	74	...	...	...	69	...	..	...	...	63
1970	65	63		..	..	72		.	.	

1931 1960 Normal (Inches) — 18 51 22 99, 32 93 45 96 12 03 25 91, 33 21 4[illegible] 22 33 24 27

DROUTH FREQUENCY

This table shows the number of years of drouth and the number of separate drouths For example the High Plains has had 10 drouth years, consisting of five 1-year drouths one 2-year drouth and one 3-year drouth, for a total of seven drouths

Years										
1	5	6	8	6	5	7	10	8	9	13
2	1	1	2	2	4	4	2	2	2	1
3	1		.	.	1	...		.		
Total Drouths	7	7	10	8	10	11	12	10	11	14
Drouth Years	10	8	12	10	16	15	14	12	13	15

TABLE 1-7

TEXAS TEMPERATURE, FREEZE, GROWING SEASON, AND PRECIPITATION RECORDS, BY COUNTIES

Data in the table below are from the office of the NOAA State Climatologist, Austin. Because of the small change in averages, data are revised only at intervals of several years. Data below were the latest compilations by NOAA Environmental Data Service as of Jan. 1, 1971.

Table shows temperature, freeze, growing season and precipitation for each county in Texas. Data for counties where an NOAA National Weather Service has not been maintained long enough to establish a reliable mean are interpolated from isoline charts prepared from mean values from stations with long established records. Mean maximum temperature for July is computed from the sum of the daily maxima. Mean minimum for January is computed from the sum of the daily minima. Mean monthly temperature for July is the sum of mean maximum and mean minimum (for July) divided by 2. Precipitation data are based on the 30 year normal period 1931-1960.

County and Station—	Temperature: †Length of Record (Yr)	Temperature: Mean Max. July (°F)	Temperature: Mean Min. January (°F)	Temperature: Record Highest (°F)	Temperature: Record Lowest (°F)	Average Freeze Dates: Last in Spring	Average Freeze Dates: First in Fall	*Growing Season (Days)	Normal Total Precipitation: †Length of Record (Yr)	January (In)	February (In)	March (In)	April (In)	May (In)	June (In)	July (In)	August (In)	September (In)	October (In)	November (In)	December (In)	Annual (In)
Anderson, Palestine	77	94	37	114	−6	Mar. 8	Nov. 27	264	79	3.52	3.21	3.50	3.61	4.79	2.83	2.04	2.41	2.96	2.96	3.93	4.10	40.65
Andrews, Andrews	9	95	28	106	0	Apr 6	Nov 5	213	9	.70	.49	.42	.59	2.15	1.40	1.60	1.50	1.82	2.05	.41	.61	13.37
Angelina, Lufkin	60	94	39	110	−2	Mar 14	Nov 13	244	61	4.50	4.13	3.60	4.55	5.16	3.56	3.65	2.75	2.93	3.20	4.70	[illegible]	47.73
Aransas, Rockport	12	92	44	100	10	Feb. 7	Dec. 16	312	12	2.10	2.12	1.51	2.50	3.20	2.61	3.02	3.50	4.69	2.90	1.83	2.13	33.19
Archer, Archer City	7	58	25	105	−5	Mar 31	Nov. 6	220	27	1.21	1.43	1.56	2.12	4.15	2.57	1.51	1.55	2.79	2.43	1.47	1.41	[illegible]
Armstrong, Claude	6	95	28	105	−6	Apr. 6	Nov 5	213	6	[illegible]	.64	.63	1.45	3.50	2.97	2.10	2.45	1.51	1.53	.66	.53	19.93
Atascosa, Poteet	29	97	42	110	−1	Feb 24	Dec. 3	282	23	1.75	1.78	1.51	2.62	3.40	2.43	2.10	2.12	4.00	2.60	1.50	1.79	27.13
Austin, Sealy	49	95	41	110	2	Feb 26	Dec 6	282	55	3.34	3.12	2.80	3.87	4.40	3.56	3.77	3.21	3.71	3.35	3.42	3.20	42.61
Bailey, Muleshoe	43	92	23	110	−21	Apr. 22	Oct 20	181	43	.65	.45	.62	1.12	2.50	2.45	2.37	2.21	1.99	1.62	.53	.65	17.44
Bandera, Medina	6	95	38	105	9	Mar. 26	Nov. 16	235	6	1.63	1.77	1.05	2.65	4.20	3.02	2.35	2.00	3.70	2.00	1.28	1.58	28.52
Bastrop, Smithville	49	96	40	111	−1	Mar 6	Nov 29	268	51	2.53	2.76	2.32	3.53	3.04	3.87	2.03	2.44	3.29	2.40	2.97	2.83	36.22
Baylor, Seymour	15	95	25	120	−14	Apr 3	Nov 3	214	57	1.11	1.40	1.33	2.13	3.94	3.07	2.31	1.31	2.56	2.66	1.33	1.31	24.95
Bee, Beeville	73	95	45	111	5	Feb 22	Dec 4	285	75	2.05	1.76	1.78	2.44	2.24	2.93	2.57	2.20	3.64	2.45	1.90	2.21	28.61
Bell, Temple	79	96	37	112	−4	Mar 11	Nov 24	258	67	2.44	2.65	2.24	3.81	4.63	3.10	1.94	2.03	2.53	2.70	2.40	2.73	33.94
Bexar, San Antonio	56	94	42	107	0	Mar 6	Nov 26	265	97	1.76	1.63	1.67	2.82	3.45	2.95	[illegible]	2.36	3.43	2.50	1.37	1.73	27.54
Blanco, Blanco	69	96	35	110	−6	Mar. 26	Nov. 15	234	71	2.36	2.54	2.19	3.52	3.71	2.34	2.74	2.25	4.00	3.15	2.16	2.61	31.26
Borden, Gail	8	95	29	106	7	Apr. 6	Nov. 6	214	35	[illegible]	.75	.67	1.35	2.55	2.60	2.49	1.60	2.15	2.05	.55	.82	15.79
Bosque, Lake Whitney	21	96	36	111	−3	Mar 23	Nov. 21	243	21	2.43	2.57	2.29	4.05	4.43	3.02	2.20	1.70	2.95	2.51	2.51	2.71	33.20
Bowie, Texarkana Dam	15	95	35	107	2	Mar 21	Nov 11	235	23	4.50	4.04	4.50	5.20	5.00	3.45	3.55	3.05	2.50	3.07	4.30	4.54	47.59
Brazoria, Angleton	56	91	46	105	10	Mar. 5	Nov. 28	268	57	3.63	3.54	3.15	3.20	3.90	3.51	5.53	4.52	5.41	3.50	3.70	4.61	49.16
Brazos, College Station	19	95	42	110	−3	Mar 1	Nov 30	274	19	2.86	2.93	2.67	3.75	4.44	3.72	2.55	2.56	3.30	2.81	3.31	3.50	38.76
Brewster, Alpine	40	59	32	106	−2	Mar. 31	Nov 9	223	45	.61	.45	.25	.51	1.45	2.33	2.76	2.79	2.25	1.21	.42	.67	15.42
Briscoe, Silverton	6	94	26	104	−9	Apr. 6	Nov 6	214	22	.78	.65	.78	1.63	3.45	2.55	2.35	2.16	2.03	1.80	.55	.57	19.55
Brooks, Falfurrias	63	98	48	112	9	Feb 10	Dec. 10	303	63	1.52	1.23	1.02	1.93	2.79	2.43	1.47	2.63	4.51	2.03	1.00	1.46	24.13
Brown, Brownwood	77	96	33	113	−2	Mar. 22	Nov 19	242	78	1.83	1.73	1.75	2.95	4.50	3.03	1.82	1.71	2.77	2.49	1.41	1.75	27.74
Burleson, Somerville	3	96	42	105	16	Mar 1	Dec 1	275	3	3.60	3.05	2.62	3.55	4.70	3.25	2.75	2.60	2.80	2.50	3.30	3.50	37.45
Burnet, Burnet	76	56	37	114	−4	Mar 29	Nov 14	230	76	1.90	2.25	1.50	3.25	4.15	2.55	2.03	2.05	3.33	2.55	2.05	2.25	30.40
Caldwell, Luling	83	96	41	110	−3	Feb 27	Nov 29	275	86	2.26	2.41	1.96	3.55	3.75	3.10	2.57	1.93	3.43	2.50	2.35	2.33	32.63
Calhoun, Port Lavaca	30	92	47	107	3	Feb 19	Dec 16	300	30	2.50	2.65	2.25	3.20	3.45	2.75	3.60	3.30	4.50	3.35	2.35	2.50	36.83
Callahan, Putnam	5	96	32	110	6	Mar 25	Nov 11	228	56	1.06	1.05	1.19	2.63	4.32	2.45	2.04	1.57	2.35	2.73	1.25	1.45	24.29
Cameron, Harlingen	55	95	51	108	21	Feb 4	Dec 12	341	56	1.48	1.22	1.03	1.66	3.14	2.55	1.59	3.08	4.57	2.65	1.25	1.51	[illegible]
Camp, Pittsburg (near)		95	36			Mar 21	Nov 14	238	21	4.00	3.70	4.03	4.85	5.46	3.22	3.25	2.55	2.60	3.10	4.15	4.43	45.25
Carson, Panhandle	9	93	23	109	−10	Apr. 17	Oct 25	191	47	.66	.64	.85	1.40	3.45	2.92	2.45	2.55	1.80	1.80	.65	.53	20.00
Cass, Linden	11	94	36	103	10	Mar 19	Nov 11	237	33	4.40	4.00	4.40	5.60	5.25	3.25	3.25	2.95	2.50	3.00	4.30	4.60	46.90
Castro, Dimmitt	9	93	22	104	−6	Apr 16	Oct 26	193	11	.53	.42	.58	1.03	2.81	2.50	2.40	1.95	1.94	1.67	.54	.65	17.36
Chambers, Anahuac (near)	33	91	44	110	11	Mar 5	Nov 21	261	57	4.33	4.00	3.20	3.90	4.60	3.90	5.93	4.65	4.80	3.51	4.07	4.50	51.55
Cherokee, Rusk	25	94	38	107	1	Mar. 8	Nov. 21	258	25	4.00	3.79	3.62	4.30	5.00	3.00	2.50	2.50	2.95	3.10	4.10	4.70	44.23
Childress, Childress	55	95	26	115	−13	Apr. 3	Nov. 6	217	71	.82	.85	1.01	2.14	4.11	3.10	1.90	2.05	2.05	2.04	.65	1.02	21.81
Clay, Henrietta	73	95	30	116	−6	Mar. 27	Nov. 14	232	79	1.45	1.65	1.96	2.80	4.65	3.20	2.00	1.80	2.35	2.90	1.60	1.75	28.03
Cochran, Morton	6	92	22	105	−12	Apr. 15	Oct. 24	183	24	.60	.33	.40	.83	2.45	1.90	2.37	2.00	2.10	1.65	.30	.37	15.02
Coke, Robert Lee	9	56	33	109	3	Mar 31	Nov 12	226	36	.91	.92	1.05	1.72	3.45	2.10	2.00	1.35	2.60	2.10	.59	1.12	20.43
Coleman, Coleman	79	96	34	114	−6	Mar. 26	Nov 16	235	86	1.56	1.29	1.25	2.90	4.43	2.73	2.39	1.94	3.04	2.43	1.31	1.44	27.52
Collin, McKinney	54	96	34	118	−7	Mar. 26	Nov 11	230	65	2.21	2.53	2.78	3.97	5.29	3.22	2.42	1.78	2.82	2.95	2.61	2.17	34.50
Collingsworth, Wellington	8	99	26	110	−4	Apr 5	Nov. 3	212	23	.77	.84	1.05	2.03	4.30	3.03	2.10	2.05	2.10	2.15	.63	[illegible]	22.03
Colorado, Columbus	9	95	44	106	15	Mar 1	Dec 6	250	66	3.01	3.41	2.78	4.23	4.35	3.34	2.33	3.01	3.77	3.11	3.23	3.65	40.93
Comal, New Braunfels	34	96	40	110	2	Mar 6	Nov 26	265	81	2.41	2.42	2.17	3.15	3.82	3.41	2.23	2.05	3.45	3.05	2.05	2.27	32.51
Comanche, Proctor Reservoir	8	95	33	108	9	Mar. 27	Nov. 20	235	8	1.90	1.83	1.68	3.12	4.45	2.93	2.07	1.44	2.74	2.73	1.74	1.52	25.45
Concho, Paint Rock	5	96	35	109	7	Mar. 29	Nov 12	228	45	1.27	1.04	1.07	2.35	3.73	[illegible]	1.53	1.74	3.01	2.20	1.10	1.12	22.46
Cooke, Gainesville	77	96	32	114	−12	Mar 27	Nov 8	226	77	2.07	2.51	2.64	3.75	5.03	3.79	2.35	2.45	2.63	2.91	2.09	2.23	34.51
Coryell, Gatesville	54	96	36	112	−6	Mar 25	Nov 21	241	54	2.12	2.45	2.00	3.75	4.50	2.90	2.05	1.70	2.50	2.53	2.23	2.45	31.47
Cottle, Paducah	16	97	27	111	−4	Apr. 2	Nov 7	219	56	.50	.91	1.00	1.95	3.55	2.70	1.90	2.05	2.50	2.22	.89	1.04	21.43
Crane, Crane	[illegible]	96	32	112	−1	Mar 31	Nov 11	225	9	.65	.55	.36	.80	1.53	1.59	1.70	1.20	1.65	1.50	.35	.65	12.77
Crockett, Ozona	[illegible]	95	39	109	−8	Mar 26	Nov 14	233	30	.82	.80	.46	1.12	2.50	2.03	1.55	1.10	1.60	1.67	.56	.72	14.90
Crosby, Crosbyton	59	94	26	110	−14	Apr 10	Nov. 2	206	83	.92	.76	.72	1.62	3.43	2.47	2.52	2.14	2.22	2.72	.84	.96	21.32
Culberson, Van Horn	25	95	30	112	−7	Apr 1	Nov 11	224	32	.62	.26	.19	.36	.62	.61	1.93	1.54	1.45	1.09	.35	.41	9.51
Dallam, Dalhart	20	92	18	107	−21	Apr 23	Oct 18	173	20	.44	.40	.66	1.29	2.78	2.01	2.53	2.33	1.46	1.30	.45	.46	16.33
Dallas, Dallas	90	95	36	111	−3	Mar. 23	Nov 13	235	90	2.32	2.55	2.85	4.00	4.83	3.24	1.94	1.93	2.82	2.70	2.70	2.67	34.55
Dawson, Lamesa	43	94	28	111	−12	Apr. 8	Nov 6	212	60	.75	.61	.61	1.04	2.33	1.75	2.35	1.44	2.43	2.01	.74	.75	16.93
Deaf Smith, Hereford	39	93	22	111	−17	Apr 20	Oct 22	185	39	.58	.50	.64	1.15	2.32	2.50	2.73	2.12	1.67	2.15	.43	.69	15.04
Delta, Cooper	1	91	34	.		Mar 25	Nov 13	233	26	3.20	3.40	3.70	4.80	5.40	4.10	3.30	2.55	3.05	3.22	3.55	3.40	43.67
Denton, Denton	56	96	34	113	−3	Mar 27	Nov 8	226	56	1.50	2.42	2.51	3.69	5.03	3.10	2.05	1.73	2.37	2.45	2.05	2.13	31.56
De Witt, Cuero	17	96	44	103	2	Mar. 3	Nov. 29	270	26	2.27	2.37	2.00	3.60	4.10	3.25	2.50	2.60	3.50	2.55	2.35	2.62	34.13
Dickens, Dickens	7	96	27	107	6	Apr 4	Nov 7	217	7	.69	.85	.71	1.52	3.03	2.60	2.22	2.12	2.53	2.22	.84	[illegible]	20.24
Dimmit, Carrizo Springs	17	99	42	114	13	Feb 19	Dec 6	290	48	1.05	1.19	.92	1.91	3.11	2.43	1.55	1.82	2.91	2.19	.92	1.25	21.22
Donley, Clarendon	5	96	26	117	−11	Apr 9	Nov 1	206	19	.72	.70	.56	1.63	3.85	3.60	2.30	2.30	1.95	1.95	.55	.90	20.74
Duval, Freer	9	95	46	109	12	Feb 16	Dec 11	298	30	1.40	1.35	1.09	1.55	3.05	2.44	1.62	2.10	3.65	2.20	.99	1.50	23.15
Eastland, Eastland	61	96	32	115	−5	Mar. 27	Nov 11	229	63	1.50	1.55	1.50	2.50	4.45	2.70	2.05	1.80	2.62	2.50	1.47	1.60	25.54
Ector, Penwell	5	96	31	103	3	Apr 3	Nov 6	217	27	.80	.55	.34	.83	2.00	1.55	1.85	1.45	1.75	1.60	.40	[illegible]	13.77
Edwards, Rocksprings	32	94	38	105	3	Mar 16	Nov 21	250	35	.93	1.12	1.00	1.55	3.13	2.50	1.55	1.80	2.62	2.15	.80	1.05	21.19
Ellis, Waxahachie	16	96	35	115	−9	Mar 20	Nov 21	246	73	2.56	3.00	2.51	4.11	5.00	3.34	2.30	1.76	2.59	2.82	2.37	2.82	35.45
El Paso, El Paso	93	94	32	109	−8	Mar 9	Nov. 12	248	91	.46	.41	.35	.23	.40	.69	1.29	1.19	1.14	.85	.33	.43	[illegible]
Erath, Dublin	59	96	34	114	−9	Mar. 27	Nov 19	233	73	2.06	2.21	1.79	3.49	5.40	2.88	2.09	1.62	3.13	2.71	2.03	2.27	31.67
Falls, Marlin	26	96	38	112	−7	Mar. 13	Nov 25	257	41	2.55	2.75	2.45	4.10	4.09	3.10	2.10	2.05	2.90	2.50	2.75	3.03	34.83
Fannin, Bonham	56	94	33	115	−5	Mar 27	Nov 10	225	66	3.34	3.41	3.69	4.54	5.24	4.25	3.19	2.53	3.47	3.52	3.32	3.15	44.00
Fayette, Flatonia	62	96	42	111	4	Mar 2	Dec 4	277	62	2.36	2.78	2.19	4.05	4.26	3.64	2.54	2.39	3.82	2.50	2.57	2.53	36.52
Fisher, Rotan	6	96	28	111	3	Apr 2	Nov 6	218	41	.87	.93	.97	1.50	3.77	2.32	2.02	1.63	1.92	2.15	1.04	.95	20.43
Floyd, Floydada	31	91	26	109	−9	Apr. 7	Nov 6	213	23	.85	.71	.76	1.60	3.35	2.63	2.50	2.10	2.25	1.95	.60	.58	20.18
Foard, Crowell	1	98	28	.	.	Apr 2	Nov. 7	219	53	.96	1.11	1.16	2.03	4.97	2.60	1.56	1.85	2.50	2.51	1.22	1.11	23.99
Fort Bend, Sugar Land	65	94	44	108	6	Feb 14	Dec. 7	296	71	3.56	3.55	2.55	3.67	4.53	3.75	4.23	3.77	3.51	3.82	4.16	4.14	45.11
Franklin, Mount Vernon	5	94	35	105	10	Mar 23	Nov 12	234	5	3.70	3.58	3.90	4.90	5.25	3.45	3.50	2.60	2.90	3.20	3.90	3.90	44.79
Freestone, Fairfield	9	95	37	109	8	Mar 11	Nov 29	263	29	3.20	3.13	3.05	3.80	4.90	3.10	2.20	2.25	3.10	2.75	3.35	3.06	38.53
Frio, Dilley	53	95	12	111	9	Feb 23	Dec 2	281	60	1.33	1.47	.93	2.10	3.21	[illegible]	2.13	1.77	2.65	2.09	1.22	1.50	23.34
Gaines, Seminole	46	[illegible]	26	113	−23	Apr 5	Nov 4	210	47	.53	[illegible]	.59	1.03	[illegible]	1.62	1.61	1.50	2.04	2.00	.54	[illegible]	[illegible]
Galveston, Galveston	93	87	[illegible]	101	8	Jan 24	Dec 25	335	93	3.43	2.53	2.55	2.53	[illegible]	[illegible]	4.71	4.37	5.91	2.56	3.55	3.53	41.51
Garza, Post	9	95	27	107	0	Apr 5	Nov 7	216	60	.77	.85	.58	1.51	[illegible]	2.17	2.22	1.56	2.23	2.64	.74	.59	19.60
Gillespie, Fredericksburg	62	[illegible]	36	109	−5	Apr 1	Nov 6	219	65	1.65	2.00	1.70	2.92	3.70	3.05	2.25	2.15	3.90	2.85	1.63	1.95	29.96

Texas Temperature, Frost, Growing Season and Precipitation Records, by Counties —(continued.)

County and Station—	Temperature: Length of Record	Temperature: Mean Max July	Temperature: Mean Min. January	Temperature: Record Highest	Temperature: Record Lowest	Average Freeze Dates: Last in Spring	Average Freeze Dates: First in Fall	Growing Season	Normal Total Precipitation: Length of Record	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	Yr	°F	°F	°F	°F.			Days	Yr	In	In	In	In	In	In	In	In	In	In	In	In.	In
Glasscock, Garden City	4	95	33	110	1	Apr. 2	Nov 10	222	51	.74	.63	.56	1.27	2.34	1.76	2.14	1.65	1.87	1.67	.71	.57	16.27
Goliad, Goliad	32	94	46	112	7	Feb 24	Dec. 6	285	57	2.24	2.43	2.07	2.69	4.07	3.23	2.97	[illegible]	3.67	3.25	2.01	2.43	33.63
Gonzales, Gonzales	6	96	42	106	18	Feb 28	Dec 1	276	63	2.15	2.32	1.56	3.55	3.71	2.91	1.79	2.43	3.54	2.42	2.42	2.53	32.73
Gray, Pampa	35	94	23	100	—12	Apr 15	Oct. 27	195	45	.53	.69	.79	1.50	3.62	3.09	2.45	2.33	1.93	1.53	.61	.81	20.16
Grayson, Sherman	82	96	32	113	—2	Mar 27	Nov 9	227	83	2.47	3.37	2.99	4.38	5.21	3.75	2.75	2.61	2.89	3.23	2.79	2.84	39.05
Gregg, Longview	82	96	35	113	—7	Mar 14	Nov. 16	247	85	4.27	3.76	3.84	4.79	5.67	3.35	3.52	2.55	2.62	3.07	4.12	[illegible]	46.16
Grimes, Anderson	8	95	42	108	14	Mar 1	Dec. 4	278	56	3.73	3.27	2.77	4.27	4.43	3.26	3.01	2.91	[illegible]	2.55	3.45	3.70	40.76
Guadalupe, Seguin	46	96	42	110	0	Mar 6	Nov 28	267	47	2.03	2.24	1.93	3.17	3.55	3.18	2.20	2.02	3.61	3.05	1.71	2.17	31.55
Hale, Plainview	72	93	26	103	—8	Apr 10	Nov 6	211	78	.80	.62	.65	1.53	3.16	2.55	2.47	2.05	2.63	1.64	.59	.52	18.95
Hall, Memphis	63	98	26	117	—11	Apr 4	Nov 4	213	61	.76	.77	.83	1.76	4.23	2.78	1.84	1.62	2.07	2.01	.50	.63	19.91
Hamilton, Hamilton	9	96	31	109	6	Mar 27	Nov. 21	237	55	2.00	2.25	1.90	3.50	4.50	2.90	2.09	1.63	2.97	2.60	2.09	2.35	30.64
Hansford, Spearman	58	91	20	111	—22	Apr 22	Oct 25	186	49	.75	.80	1.19	1.09	3.61	3.24	2.72	2.71	1.74	1.71	.79	.60	21.86
Hardeman, Quanah (near)	60	93	28	119	—9	Mar 31	Nov. 7	221	67	.86	1.00	1.28	2.70	4.13	3.02	1.54	2.07	2.71	2.61	1.14	1.2[illegible]	24.70
Hardin, Kountze		93	42			Mar 13	Nov 14	246		4.75	4.45	3.45	4.50	5.20	4.25	5.32	4.25	3.75	3.20	4.50	5.45	53.00
Harris, Houston	16	93	45	108	5	Feb 14	Dec 11	300	55	3.78	3.44	2.67	3.24	4.32	3.09	4.22	4.27	4.23	3.77	3.86	4.36	45.95
Harrison, Marshall	66	95	37	112	—9	Mar. 16	Nov 17	245	60	4.75	4.01	4.40	4.43	5.25	3.18	3.23	2.53	2.73	3.01	4.41	5.01	46.95
Hartley, Channing	4	92	20	105	2	Apr 22	Oct 19	160	4	.58	.50	.68	1.35	2.58	2.30	2.55	2.75	1.53	1.00	.62	.66	18.00
Haskell, Haskell	16	97	30	115	—3	Mar 28	Nov. 15	232	16	.91	1.34	.92	1.93	3.99	2.54	2.38	1.92	2.04	2.27	1.33	1.33	23.20
Hays, San Marcos	77	96	40	111	—2	Mar 14	Nov 23	254	71	2.39	2.72	2.14	3.31	3.57	3.53	2.53	2.13	3.93	3.25	2.07	2.23	33.58
Hemphill, Canadian	60	95	23	112	—14	Apr 9	Oct 30	204	62	.62	.70	.99	1.57	4.00	3.05	2.44	2.17	1.84	1.78	.53	.75	20.50
Henderson, Athens	17	95	37	110	2	Mar 11	Nov. 26	260	22	3.10	3.30	[illegible]	4.40	5.25	3.20	2.25	2.40	2.85	3.10	3.50	[illegible]	40.40
Hidalgo, Mission	53	97	49	110	18	Feb 7	Dec 8	327	54	1.35	1.00	.85	1.61	2.22	1.94	1.55	1.65	3.24	2.65	.74	1.02	21.23
Hill, Hillsboro	66	96	36	113	—1	Mar 19	Nov 21	247	66	2.55	2.76	2.51	4.73	4.77	4.34	1.53	1.55	3.01	3.05	2.92	2.54	37.04
Hockley, Levelland	30	93	24	107	—16	Apr 15	Oct 28	196	30	.61	.47	.52	1.00	2.70	2.10	2.22	1.70	2.23	2.00	.50	.50	16.60
Hood, Granbury	27	96	34	110	—6	Mar 26	Nov 13	232	27	2.10	2.37	2.10	3.55	5.20	2.90	2.05	1.75	2.73	2.75	1.93	2.30	31.75
Hopkins, Sulphur Springs	42	94	34	114	—10	Mar. 23	Nov 16	234	66	3.30	3.45	3.70	4.75	5.53	3.50	3.25	2.69	2.87	3.25	3.75	3.65	43.57
Houston, Crockett	16	95	35	114	0	Mar. 6	Nov. 26	265	58	3.85	3.62	3.35	4.25	4.80	3.30	2.00	2.70	3.00	2.89	4.00	4.30	42.87
Howard, Big Spring	65	95	30	117	—7	Apr 4	Nov 7	217	72	.63	.49	.65	1.01	2.45	1.58	2.16	1.62	1.74	1.65	.70	.77	15.51
Hudspeth, Sierra Blanca	9	97	29	102	4	Mar. 26	Nov 12	231	9	.46	.26	.26	.30	.53	.60	1.25	1.30	1.25	.97	.33	.41	7.65
Hunt, Greenville	69	94	34	116	—4	Mar 21	Nov 13	237	70	2.89	3.31	3.56	4.75	5.72	4.20	3.18	2.27	2.92	3.21	3.56	3.20	42.51
Hutchinson, Borger	19	93	22	107	—12	Apr 20	Oct. 24	187	19	.64	.62	.90	1.40	3.35	2.57	2.55	2.62	1.75	1.75	.65	.61	19.91
Irion, Mertzon	5	95	36	107	9	Mar 27	Nov 14	232	26	.90	.86	.80	1.66	2.95	1.32	1.50	1.25	2.65	1.75	.70	.55	17.09
Jack, Jacksboro	29	97	32	112	—3	Apr 1	Nov 5	216	43	1.53	1.53	1.95	2.95	4.45	2.95	1.87	1.70	2.53	2.55	1.70	[illegible]	25.13
Jackson, Edna	3	93	46	105	20	Feb 19	Dec. 6	290	58	2.65	2.79	2.41	3.15	3.85	3.35	3.45	3.18	4.10	3.49	2.65	2.72	37.58
Jasper, Jasper	17	93	40	107	2	Mar 23	Nov 6	229	30	5.25	4.50	3.00	4.75	5.55	3.90	4.50	3.60	3.10	3.05	4.70	5.09	[illegible]
Jeff Davis, Mount Locke	35	82	31	97	—10				35	.96	.43	.33	.45	1.80	2.52	3.60	3.06	2.63	1.71	.31	.61	18.72
Jefferson, Port Arthur	26	91	44	107	11	Mar 11	Nov. 16	250	26	4.23	4.45	3.44	3.94	4.94	4.29	6.00	5.49	4.55	2.89	3.46	5.09	53.09
Jim Hogg, Hebbronville	12	99	47	109	12	Feb. 15	Dec 15	303	63	1.35	1.15	.90	1.70	2.55	2.29	1.40	1.83	3.45	1.30	.92	1.30	20.78
Jim Wells, Alice	17	97	47	111	12	Feb 15	Dec 4	289	17	1.53	1.37	1.30	2.03	2.56	2.93	1.86	2.33	4.49	2.69	1.46	1.61	26.70
Johnson, Cleburne	63	96	35	114	—3	Mar 25	Nov 14	233	67	2.04	2.64	2.35	3.79	4.45	2.92	2.17	2.25	2.75	2.94	2.25	2.55	33.20
Jones, Anson	13	97	30	103	4	Mar 31	Nov 9	223	13	.96	1.28	.92	1.67	4.15	2.96	1.97	1.53	2.55	2.54	1.34	1.32	23.37
Karnes, Kenedy	21	96	44	112	7	Feb 24	Dec 2	281	23	2.65	1.83	1.58	2.50	4.07	2.59	2.30	3.11	4.32	2.82	2.01	2.29	31.93
Kaufman, Kaufman	71	95	35	113	—3	Mar 18	Nov. 21	248	68	2.94	3.07	2.96	4.47	5.36	3.67	2.20	2.01	2.83	3.15	[illegible]	3.32	39.78
Kendall, Boerne	78	94	38	112	—4	Mar. 25	Nov. 11	231	74	2.22	2.35	1.83	2.72	4.19	2.90	2.50	2.31	4.04	2.75	1.85	2.23	31.67
Kenedy, Armstrong	12	95	48	109	18	Feb 2	Dec. 18	319	12	1.91	1.62	1.42	1.68	3.21	2.19	2.01	2.50	5.16	2.31	1.12	1.43	25.61
Kent, Jayton	6	97	25	110	—2	Apr 4	Nov. 6	216	6	.84	.93	.79	1.75	3.50	2.38	2.10	2.10	2.25	2.20	.83	.55	20.75
Kerr, Kerrville	74	94	34	110	—7	Apr 5	Nov 7	216	84	1.86	2.07	2.02	3.07	4.13	2.99	2.32	1.63	4.22	3.14	1.52	2.23	31.70
Kimble, Junction		94	34	110	—11	Apr 3	Nov 3	213		1.41	1.29	1.19	2.13	3.37	2.71	2.23	2.14	2.79	2.05	1.15	1.13	23.81
King, Guthrie	4	97	25	114	5	Apr 3	Nov 8	219	24	.89	.95	.90	1.83	3.55	2.60	1.95	2.12	2.53	2.25	.55	1.00	21.60
Kinney, Brackettville	13	94	39	109	8	Mar 1	Nov 26	270	93	.92	1.07	.89	1.72	3.03	3.34	1.57	1.90	2.62	2.04	.72	.52	[illegible]
Kleberg, Kingsville	21	96	48	103	11	Feb 5	Dec 16	314	21	1.65	1.50	1.20	2.05	3.00	2.30	2.00	2.50	4.75	2.45	1.35	1.62	26.50
Knox, Munday	32	98	26	116	—9	Apr 3	Nov 6	217	57	.96	1.34	1.13	2.35	3.62	2.08	2.23	1.73	2.42	2.46	1.35	1.41	23.91
Lamar, Paris	82	94	34	115	—13	Mar 25	Nov 14	235	87	3.03	3.45	3.47	5.19	5.43	4.25	3.05	2.73	3.52	3.22	3.75	[illegible]	45.11
Lamb, Littlefield	17	93	24	110	—14	Apr 16	Oct 27	194	42	.65	.45	.55	1.10	2.85	2.20	2.30	1.90	2.13	1.55	.53	.54	17.27
Lampasas, Lampasas	78	96	36	112	—12	Apr 1	Nov 10	223	75	1.90	2.20	1.59	3.36	4.59	2.99	1.90	2.00	3.15	2.52	2.17	2.37	31.01
La Salle, Cotulla		99	43	116	7	Feb 20	Dec 6	255	57	1.26	1.35	1.07	1.92	3.15	2.35	1.35	1.80	2.74	2.03	.50	1.43	21.43
Lavaca, Hallettsville	78	95	44	111	5	Mar 1	Dec 6	280	78	2.50	2.75	2.25	3.55	4.39	3.40	2.99	2.75	3.75	3.00	2.75	2.95	[illegible]
Lee, Lexington	9	96	40	107	12	Mar 1	Nov 29	273	9	2.75	2.90	2.40	3.75	4.00	3.65	2.50	2.33	3.03	2.55	3.00	[illegible]	[illegible]
Leon, Centerville	31	95	38	111	—3	Mar 6	Dec 1	270	31	3.50	3.25	3.10	4.10	4.70	3.25	2.70	2.40	3.25	2.65	3.60	3.93	40.30
Liberty, Liberty	67	93	43	108	8	Mar. 3	Nov. 19	261	66	4.78	4.21	3.13	4.33	4.49	4.18	5.05	4.01	4.00	3.74	4.08	5.16	51.16
Limestone, Mexia	55	96	37	112	—2	Mar 15	Nov 26	255	67	[illegible]	3.14	2.90	3.97	4.99	3.25	2.13	1.57	3.23	2.72	3.17	3.27	37.63
Lipscomb, Follett	35	95	23	110	—12	Apr 10	Oct 29	202	40	.63	.80	1.10	1.89	3.50	3.00	2.39	2.33	1.65	1.80	.75	.65	20.53
Live Oak, George West		97	45			Feb 20	Dec 6	289	54	1.59	1.53	1.45	2.15	3.13	2.60	2.01	2.33	3.51	2.59	1.46	2.10	25.77
Llano, Llano	78	98	34	115	—7	Mar. 29	Nov 13	229	78	1.62	1.91	1.45	2.95	3.93	2.25	2.02	1.72	3.41	2.35	1.73	1.90	27.59
Loving, Mentone	5	96	29	111	2	Apr 3	Nov 8	222	24	.50	.25	.24	.65	1.03	1.10	1.50	1.51	1.27	1.50	.33	.38	10.31
Lubbock, Lubbock	56	92	25	109	—17	Apr 9	Nov 3	208	53	.63	.57	.73	1.15	3.15	2.53	2.01	1.65	2.30	2.00	.54	.65	18.08
Lynn, Tahoka	12	94	27	103	—15	Apr 4	Nov 7	217	44	.70	.63	.66	1.20	2.55	2.20	2.20	1.60	2.35	2.04	.70	.70	[illegible]
McCulloch, Brady	42	96	34	108	0	Mar 31	Nov 12	226	43	1.50	1.33	1.25	2.85	3.70	2.59	2.00	1.55	3.25	2.15	1.35	1.40	25.01
McLennan, Waco	89	96	38	112	—5	Mar 16	Nov 24	253	89	2.27	2.42	2.35	3.85	4.57	2.67	1.99	1.69	2.77	2.55	2.19	2.74	32.38
McMullen, Tilden	12	95	44	109	9	Feb 19	Dec 7	291	12	1.50	1.54	1.15	2.15	3.25	2.75	1.93	2.10	3.09	2.27	1.33	1.83	25.27
Madison, Madisonville	26	94	40	110	—2	Mar 5	Dec 2	272	39	3.50	3.35	3.10	4.30	4.00	3.50	2.93	2.60	3.25	2.50	3.70	3.90	41.50
Marion, Jefferson		94	36	.	.	Mar 18	Nov 9	236	57	4.20	4.03	3.93	4.07	5.23	3.02	3.26	2.67	3.03	2.75	4.39	4.74	46.00
Martin, Lenorah		95	30			Apr 5	Nov 6	215	29	.75	.64	.57	1.05	2.35	1.70	2.05	1.50	1.95	1.70	.70	.76	15.72
Mason, Mason	14	95	34	109	7	Apr 3	Nov 6	217	39	1.50	1.50	1.30	2.58	3.50	2.62	2.23	1.95	3.40	2.20	1.40	1.53	25.65
Matagorda, Matagorda	43	90	48	103	11	Feb 17	Dec 10	296	60	3.03	3.06	2.37	3.22	3.29	2.70	3.73	4.24	5.03	3.51	2.95	[illegible]	[illegible]
Maverick, Eagle Pass	77	100	40	115	7	Feb 21	Dec 3	285	93	1.09	.92	.70	1.87	3.26	2.43	2.01	2.34	2.50	1.73	.66	1.00	20.34
Medina, Hondo	67	96	42	112	4	Mar 6	Nov 24	263	75	1.93	1.85	1.59	2.56	4.27	3.03	2.36	2.22	3.66	2.59	1.44	1.70	29.20
Menard, Menard	9	95	34	106	3	Mar 31	Nov 6	220	60	1.18	1.17	.95	2.25	3.29	2.20	2.22	1.92	3.30	1.99	1.01	1.13	22.64
Midland, Midland	56	95	31	109	—11	Apr 3	Nov 6	218	63	.80	.60	.36	.83	2.05	1.63	1.88	1.48	1.79	1.65	.47	.65	14.24
Milam, Cameron	59	96	39	114	—7	Mar. 13	Nov 24	236	61	2.90	2.71	2.45	3.91	3.75	2.89	1.62	1.59	2.85	2.62	2.84	3.01	33.55
Mills, Goldthwaite	10	96	34	110	4	Mar 31	Nov 16	230	37	1.87	1.88	1.80	3.20	4.25	3.05	1.90	1.70	2.97	2.50	1.75	2.00	23.57
Mitchell, Colorado City	50	96	30	115	—7	Apr 3	Nov 6	217	66	.85	.74	.84	1.63	3.19	2.04	2.51	1.61	2.14	2.10	.92	1.05	19.73
Montague, Bowie	15	96	32	112	—3	Mar 27	Nov 11	229	15	1.63	1.88	2.13	3.03	4.70	3.20	2.05	1.75	2.37	2.85	1.75	2.03	[illegible]
Montgomery, Conroe	50	94	40	109	2	Mar 1	Nov 26	270	50	4.01	3.62	[illegible]	4.72	[illegible]	[illegible]	[illegible]	[illegible]	3.77	3.19	[illegible]	4.51	47.44
Moore, Dumas	31	93	[illegible]	109	—15	Apr 20	Oct 22	[illegible]	33	[illegible]	[illegible]	.75	1.35	[illegible]	2.45	[illegible]	2.62	1.55	1.00	.61	[illegible]	15.33
Morris, Daingerfield (near)	11	[illegible]	[illegible]	103	4	Mar [illegible]	Nov 12	[illegible]	[illegible]	4.23	3.50	4.20	4.05	[illegible]	[illegible]	3.25	2.67	2.63	3.15	4.25	4.55	47.12
Motley, Matador	23	[illegible]	[illegible]	112	—4	Apr 3	Nov 7	[illegible]	[illegible]	.85	.72	.94	1.72	[illegible]	2.73	2.20	2.10	2.30	[illegible]	.71	[illegible]	20.31
Nacogdoches, Nacogdoches	70	[illegible]	[illegible]	110	—4	Mar 15	Nov 13	[illegible]	71	4.45	4.21	3.73	4.65	5.31	3.31	3.57	2.04	2.95	3.15	4.71	[illegible]	45.04
Navarro, Corsicana	91	[illegible]	[illegible]	113	—7	Mar 13	Nov 27	[illegible]	94	[illegible]	3.00	2.88	4.32	[illegible]	3.12	1.93	2.15	2.67	2.96	2.97	3.21	37.06
Newton, Newton	6	92	41	101	13	Mar 23	Nov 6	[illegible]	6	4.57	4.65	4.44	5.44	5.82	4.52	5.31	4.23	3.42	2.50	4.92	5.97	55.82
Nolan, Roscoe	33	96	30	110	—11	Apr 2	Nov. 9	221	35	.85	.94	.88	1.75	3.60	2.25	2.50	1.55	2.10	2.15	.93	1.05	20.60

Texas Temperature, Frost, Growing Season and Precipitation Records, by Counties.—(continued.)

County and Station—	Temperature: †Length of Record	Temperature: Mean Max. July	Temperature: Mean Min. January	Temperature: Record Highest	Temperature: Record Lowest	Average Freeze Dates: Last in Spring	Average Freeze Dates: First in Fall	*Growing Season	Normal Total Precipitation: †Length of Record	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	Yr	°F.	°F	°F.	°F.			Days	Yr	In	In.	In	In	In	In	In	In	In	In	In	In	In.
Ochiltree, Perryton	4	95	22	105	—6	Apr. 18	Oct. 26	191	59	.61	.61	1.05	1.53	3.40	2.61	3.21	2.58	1.67	1.62	.73	[illegible]	[illegible]
Oldham, Vega	47	92	22	108	—17	Apr. 19	Oct. 21	186	47	.67	.59	.83	1.37	2.95	2.43	2.56	2.79	1.73	1.52	.69	[illegible]	15.96
Orange, Orange	9	91	44	105	17	Mar. 16	Nov. 11	240	68	4.40	4.50	3.40	4.40	5.00	4.50	6.75	5.10	4.60	3.10	4.10	5.40	55.75
Palo Pinto, Mineral Wells	16	96	33	112	3	Mar. 31	Nov. 7	221	16	1.50	2.05	2.00	3.20	5.15	3.00	1.88	1.70	2.75	2.75	1.80	2.05	29.13
Panola, Carthage	19	95	35	105	6	Mar 16	Nov 11	240	19	4.50	4.15	4.25	4.60	5.45	3.40	3.30	2.75	2.75	3.15	4.45	5.10	48.05
Parker, Weatherford	31	96	31	113	—11	Mar. 29	Nov 9	225	86	2.14	2.40	2.16	3.58	5.31	3.60	1.89	1.67	2.70	3.01	1.82	2.12	31.87
Parmer, Friona	6	92	21	103	—15	Apr 20	Oct. 20	183	40	.61	.45	.56	1.10	2.80	2.38	2.55	2.70	1.85	1.83	.52	.66	17.50
Pecos, Fort Stockton	16	94	33	114	—7	Mar. 31	Nov 10	224	16	.85	.56	.45	.76	1.88	1.51	1.57	1.34	1.55	1.23	.58	.74	13.07
Polk, Livingston	33	93	39	111	4	Mar. 11	Nov. 16	250	33	4.60	4.12	3.30	4.50	4.85	4.00	4.10	2.90	3.20	3.25	4.00	4.80	48.22
Potter, Amarillo	68	92	24	108	—16	Apr. 17	Oct 21	190	78	.65	.62	.82	1.32	3.37	2.49	2.34	[illegible]	[illegible]	1.76	[illegible]	.77	19.67
Presidio, Presidio	43	100	33	117	4	Mar 20	Nov 13	238	43	.43	.23	.16	.34	.74	.97	1.75	1.71	1.27	.81	.34	[illegible]	[illegible]
Rains, Emory	8	94	35	110	3	Mar. 21	Nov 18	242	24	3.10	3.40	3.60	4.70	5.50	3.60	3.10	2.50	2.87	3.75	[illegible]	3.65	[illegible]
Randall, Canyon	16	93	23	107	—14	Apr 15	Oct 27	195	47	.58	.51	.70	1.39	3.19	2.91	2.89	2.22	1.75	1.55	.53	.60	19.53
Reagan, Big Lake	5	96	26	107	10	Mar. 28	Nov 12	229	5	.85	.70	.50	1.05	2.30	1.80	1.65	1.13	1.75	1.62	.56	.75	14.72
Real, Prade Ranch	15	94	35	105	5	Mar 26	Nov 17	236	15	1.25	1.30	1.30	2.20	3.50	2.87	2.00	1.85	2.65	2.35	1.60	1.35	25.58
Red River, Clarksville	67	93	34	115	—7	Mar. 23	Nov 12	234	76	3.90	3.63	4.60	5.00	5.45	3.45	3.05	2.70	3.05	3.17	3.90	[illegible]	45.67
Reeves, Balmorhea	47	94	32	112	—9	Apr. 1	Nov 12	226	47	.75	.58	.36	.71	1.41	1.47	1.55	1.34	1.93	1.42	.51	.62	12.53
Refugio, Refugio	13	93	46	106	8	Feb 14	Dec. 15	304	23	2.03	2.00	1.79	2.97	3.77	2.75	2.05	3.59	4.83	2.91	1.83	2.37	33.76
Roberts, Miami	67	94	23	114	—15	Apr. 16	Oct 25	192	66	.70	.67	.97	1.61	3.50	3.03	2.38	2.45	2.09	1.89	.67	.83	21.15
Robertson, Franklin	9	96	40	110	11	Mar. 6	Nov. 29	268	9	2.83	2.94	2.45	3.88	3.95	3.02	2.51	2.16	2.62	3.63	3.16	2.19	[illegible]
Rockwall, Rockwall (near)	1	96	34	[illegible]	[illegible]	Mar. 23	Nov 14	236	20	2.55	2.90	2.95	4.30	5.25	3.50	2.49	2.10	2.43	3.05	3.60	2.57	37.79
Runnels, Ballinger	73	96	31	116	—9	Mar 30	Nov. 13	228	75	1.30	1.06	1.03	2.45	4.07	2.15	1.43	1.85	3.00	2.22	1.05	1.11	[illegible]
Rusk, Henderson	20	94	35	108	2	Mar. 11	Nov 16	250	61	4.24	4.01	4.01	4.42	5.44	3.41	3.02	2.55	3.11	3.31	4.02	4.58	46.75
Sabine, Hemphill	4	94	38	104	8	Mar. 21	Nov. 12	236	4	5.50	4.60	4.50	4.53	5.60	3.70	4.10	3.02	2.90	3.24	4.95	[illegible]	51.91
San Augustine, Jackson Hill	9	94	39	106	9	Mar 19	Nov 12	235	25	5.20	4.40	3.75	4.80	5.40	3.65	4.03	[illegible]	2.90	3.70	4.30	5.25	53.33
San Jacinto, Coldspring (near)	8	93	40	103	12	Mar. 5	Nov. 21	261	10	4.40	4.05	3.20	4.40	4.70	4.25	4.15	3.00	3.45	3.45	[illegible]	4.70	[illegible]
San Patricio, Sinton	13	94	47	103	11	Feb. 14	Dec. 14	303	47	1.85	1.60	1.60	2.50	3.25	2.60	2.50	3.00	4.65	2.85	1.86	2.22	30.60
San Saba, San Saba	8	96	33	103	5	Apr. 1	Nov 14	227	30	1.75	1.73	1.25	3.05	4.10	2.75	1.90	1.80	3.20	2.38	1.70	1.58	27.54
Schleicher, Eldorado (near)	5	95	38	105	8	Mar. 28	Nov 12	229	27	.91	.93	.70	1.65	2.95	2.10	1.67	1.35	1.75	1.55	[illegible]	.73	17.33
Scurry, Snyder	35	96	25	115	—10	Apr. 4	Nov 4	214	60	.71	.83	.76	1.39	3.57	2.16	2.46	1.70	1.55	2.14	.92	.59	19.51
Shackelford, Albany	57	97	31	114	—8	Mar 30	Nov. 9	224	89	1.07	1.54	1.23	2.40	4.60	2.41	2.00	2.14	[illegible]	2.65	[illegible]	[illegible]	25.95
Shelby, Center	30	94	38	110	0	Mar. 17	Nov. 12	240	30	5.00	4.50	4.10	4.70	5.70	3.40	3.70	2.77	2.50	3.19	4.60	5.30	49.95
Sherman, Stratford	30	93	19	103	—20	Apr 23	Oct 22	182	50	.46	.49	.75	1.25	2.90	2.15	2.70	2.35	1.40	1.45	[illegible]	[illegible]	17.03
Smith, Tyler	16	94	37	105	—5	Mar. 7	Nov 21	258	16	3.89	3.67	3.91	4.59	5.43	3.27	[illegible]	2.91	2.74	3.23	4.21	4.77	46.19
Somervell, Glen Rose	9	96	35	110	3	Mar 25	Nov 16	236	8	2.15	2.40	2.13	3.75	5.00	2.90	2.12	2.03	3.00	2.75	2.05	2.40	32.65
Starr, Rio Grande City	7	98	45	115	7	Feb 16	Dec. 7	314	102	.94	.79	.85	1.26	2.10	2.01	1.37	1.09	3.13	1.84	.61	[illegible]	17.27
Stephens, Breckenridge	16	95	31	114	—9	Mar. 31	Nov. 8	222	47	1.20	1.43	1.35	2.45	4.11	2.65	2.26	1.79	[illegible]	2.44	1.43	[illegible]	[illegible]
Sterling, Sterling City	5	95	33	111	5	Apr. 1	Nov. 11	224	45	.87	.94	1.02	1.66	2.77	2.03	2.26	1.77	2.32	2.03	.77	1.16	19.52
Stonewall, Aspermont	9	97	28	112	2	Mar. 31	Nov. 10	220	55	.75	1.11	.83	2.05	3.72	2.26	2.03	2.19	2.24	2.45	1.10	.79	21.73
Sutton, Sonora	11	94	35	107	0	Mar. 26	Nov 16	235	41	.90	.95	.61	1.54	2.50	2.35	1.73	1.43	1.75	1.95	.67	.78	17.59
Swisher, Tulia	6	93	24	109	—23	Apr. 10	Nov. 1	205	16	.70	.61	.63	1.50	3.12	2.75	2.40	2.10	1.95	1.75	[illegible]	[illegible]	[illegible]
Tarrant, Fort Worth	5	96	35	112	—5	Mar. 26	Nov. 11	230	53	2.64	2.24	2.51	3.62	4.52	2.98	1.75	1.63	2.54	2.59	2.60	2.35	31.33
Taylor, Abilene	4	94	33	109	—9	Mar. 31	Nov. 11	225	84	.83	1.03	1.04	2.27	4.33	2.67	2.15	1.47	2.07	2.65	1.11	1.23	23.32
Terrell, Sanderson	6	95	36	110	2	Mar. 21	Nov. 13	237	20	.62	.44	.27	.73	1.63	1.25	1.10	1.12	.95	1.96	.35	.51	11.21
Terry, Brownfield	7	93	26	111	—8	Apr 10	Nov. 2	206	17	.59	.70	.59	1.50	2.50	2.24	2.11	1.65	2.37	2.03	.43	.53	18.61
Throckmorton, Throckmorton	45	98	29	119	—9	Mar. 31	Nov. 6	220	45	1.10	1.32	1.27	2.44	4.22	3.17	1.55	1.59	2.21	2.73	1.42	1.37	24.83
Titus, Mount Pleasant	54	95	35	118	—5	Mar 23	Nov 12	233	54	4.03	3.65	4.00	4.99	5.23	3.35	3.25	2.73	[illegible]	[illegible]	[illegible]	[illegible]	45.47
Tom Green, San Angelo	60	95	34	111	1	Mar. 25	Nov 15	235	61	.97	.90	.93	2.01	3.20	1.61	1.41	1.27	2.50	1.83	[illegible]	[illegible]	[illegible]
Travis, Austin	74	95	41	109	—2	Mar. 3	Nov 28	270	115	2.35	2.58	2.13	3.55	3.71	3.22	2.15	1.94	3.44	2.83	2.12	2.53	32.53
Trinity, Groveton	1	94	39	108	20	Mar. 6	Nov. 21	260	27	4.20	4.00	3.40	4.50	4.50	3.75	3.50	2.90	3.00	3.00	4.10	4.50	45.95
Tyler, Rockland	8	94	35	106	7	Mar 16	Nov 12	241	66	5.39	4.25	3.45	4.59	5.40	3.64	4.10	2.81	2.97	3.24	4.63	5.64	[illegible]
Upshur, Gilmer	54	93	37	114	—4	Mar 16	Nov 16	245	51	4.25	3.93	4.00	4.75	5.50	3.25	3.30	2.60	2.87	3.15	4.15	[illegible]	[illegible]
Upton, McCamey	35	96	33	113	—2	Mar 26	Nov. 12	232	33	.85	.69	.31	.80	1.90	1.69	1.05	1.05	1.49	[illegible]	.35	.64	12.62
Uvalde, Uvalde	67	96	40	114	7	Mar 10	Nov. 21	255	76	1.25	1.25	1.00	2.00	3.40	2.87	1.57	1.50	2.87	2.15	.90	1.37	22.33
Val Verde, Del Rio	19	94	40	111	12	Feb 12	Dec. 9	300	19	.50	.53	.32	1.36	2.73	2.22	1.31	1.52	2.61	1.59	.62	[illegible]	17.83
Van Zandt, Wills Point	47	94	35	115	—1	Mar 16	Nov 21	250	48	2.93	3.25	3.25	4.50	5.40	3.75	2.60	2.35	2.79	3.20	3.50	[illegible]	[illegible]
Victoria, Victoria	9	92	46	110	9	Feb. 19	Dec 6	290	9	2.34	2.31	2.32	2.62	4.12	3.01	3.61	3.13	4.73	3.43	2.36	[illegible]	[illegible]
Walker, Huntsville	86	94	41	107	—2	Mar 7	Nov 27	265	89	3.90	3.97	3.23	4.43	4.71	4.26	2.51	3.62	3.25	3.27	4.31	[illegible]	45.15
Waller, Hempstead	5	95	43	103	13	Feb 24	Dec. 4	283	63	3.53	3.30	2.57	3.85	4.30	3.50	3.45	2.95	3.40	3.10	3.45	[illegible]	[illegible]
Ward, Monahans	11	96	30	106	—9	Apr 1	Nov. 10	223	11	.50	.40	.33	.76	1.60	1.20	1.75	1.40	1.35	1.50	.35	[illegible]	[illegible]
Washington, Brenham	56	95	43	111	—2	Mar 3	Dec 4	277	85	3.22	3.11	2.74	3.58	4.18	3.30	2.81	2.50	2.53	2.86	3.61	[illegible]	[illegible]
Webb, Laredo	104	99	47	115	5	Feb 7	Dec 26	322	59	1.13	.83	.62	1.65	2.79	1.36	1.35	1.70	2.56	1.63	[illegible]	[illegible]	[illegible]
Wharton, Pierce	63	93	44	108	4	Mar 5	Nov 26	266	63	3.17	3.16	2.61	2.84	3.93	3.51	3.50	3.66	3.57	3.93	3.31	3.33	[illegible]
Wheeler, Shamrock	1	98	24	112	—8	Apr. 7	Nov. 1	208	38	.72	.91	1.03	2.20	3.35	3.01	2.13	2.26	2.13	2.08	.80	[illegible]	[illegible]
Wichita, Wichita Falls	52	97	31	113	—12	Mar. 27	Nov. 11	229	74	1.12	1.39	1.54	2.53	4.60	3.20	1.97	1.79	2.31	2.87	1.42	[illegible]	25.20
Wilbarger, Vernon	37	95	29	119	—7	Mar. 31	Nov 7	221	35	1.05	1.25	1.50	2.10	4.50	3.20	1.90	1.75	2.60	2.60	1.25	1.25	[illegible]
Willacy, Raymondville	55	96	50	109	14	Feb 6	Dec. 11	331	59	1.83	1.15	1.30	1.45	3.43	2.46	1.94	3.00	4.65	2.57	1.37	1.33	[illegible]
Williamson, Taylor	65	96	39	112	—5	Mar. 11	Nov 24	258	74	2.56	2.81	2.20	3.52	3.69	3.52	1.53	2.30	3.31	2.72	2.60	2.53	[illegible]
Wilson, Floresville	9	96	42	106	14	Feb 24	Dec 1	280	54	2.60	1.90	1.62	2.55	3.45	3.10	2.25	2.35	4.09	2.65	1.90	[illegible]	[illegible]
Winkler, Wink	30	96	35	114	—14	Apr. 3	Nov. 8	219	30	.66	.32	.31	.75	1.47	1.16	1.78	1.51	1.07	1.54	.33	.41	11.21
Wise, Bridgeport	35	96	33	115	—1	Mar 31	Nov 6	220	61	1.71	1.91	2.10	3.22	4.51	2.88	2.04	1.61	2.33	2.03	1.67	2.15	29.32
Wood, Mineola	5	94	36	107	9	Mar. 17	Nov 18	246	5	3.50	3.55	3.75	4.75	5.40	3.35	3.20	2.70	2.75	3.25	4.00	4.10	44.39
Yoakum, Plains		92	24	105	—12	Apr 15	Oct. 31	199	30	.55	.33	.40	.80	2.30	1.81	2.25	1.75	2.13	2.03	.23	.30	14.99
Young, Graham	64	98	31	117	—8	Apr. 2	Nov. 4	216	84	1.31	1.62	1.79	2.84	4.22	3.23	1.87	1.67	2.55	2.61	1.65	1.51	27.81
Zapata, Zapata	9	99	47	112	22	Feb 14	Dec 15	304	9	.94	.80	.65	1.50	2.25	1.95	1.30	1.65	2.93	1.60	.76	[illegible]	17.23
Zavala, Crystal City	16	99	41	109	11	Feb 24	Dec 1	280	29	1.05	1.13	.90	1.85	3.20	2.65	1.80	2.25	2.50	2.20	.84	1.20	21.87

*Average interval between the last 32° F temperature in spring and the first 32° F temperature in the fall.

†Significant moves of location of Weather Bureau stations may cause records at a town not to be comparable. This accounts for short records listed at some points; e.g., Victoria has many years of weather records but a short-time record is used because of changes in locations that make comparisons inaccurate.

Weather Reduces Pollution

Urbanization, industrialization and agribusiness practices are increasing air pollution problems in Texas, as in other states. But frequent changes in air mass and regional-scale weather disturbances in Texas do not favor objectionable concentrations of air pollutants much of the time.

Detailed studies of meteorological conditions as related to air pollution are available from the NOAA Climatologist, Austin. Among other things, these show:

There are significant seasonal and geographical variations. Statewide, most serious pollution is likely to occur in December and [illegible] (also in November in the Northeast). Conditions in summer months are less conducive to pollution.

On a yearly basis, West Texas has less potential for air pollution than East Texas.

The frequency of light winds and temperature inversions at night tend to create pollution problems.

Few high-pressure systems stagnate over Texas for any length of time; therefore, the meteorological situation most favorable for serious air-pollution episodes rarely is present. In Texas stagnation is more likely to occur over the East Texas Pine Belt and in the El Paso area than elsewhere.

4. Botanical Elements. The West Fork of the Trinity River extends from Fort Worth, Texas to Dallas, Texas. This flat to gently rolling area has been greatly exploited leaving only small patches of forest generally less than 200 acres in size.

Cedar elm, green ash (*Fraxinus pensylvanica*), soap berry (*Sapindus saponaria*), American elm (*Ulmus americana*) and Texas sugarberry were dominant in this section of the river. Black willow (*Salix nigra*) and cottonwood (*Populus deltoides*) were locally frequent and dominated some gravel pit areas. Existing sloughs were generally surrounded by swamp privet (*Forestiera acuminata*). The more prevalent understory woody species were coral berry (*Symphoricarpos orbiculatus*), poison ivy (*Rhus toxicodendron*) and greenbriar (*Smilax* spp.).

There were no evident unique sites in this area of the Trinity River, although some large trees were present. Large trees of American elm, Texas sugarberry, pecan (*Carva illinoinensis*), cottonwood, green ash and bur oak (*Quercus macrocarpa*) were noticeable and were usually found close to the river. A wooded hilly area with openings and a spring present and located within the Post and Paddock Riding Club was somewhat unique due to a greater species and habitat diversity. Forested areas are generally confined to the banks of the river, and as a result, estimates of abundance are restricted to riverside sites. The area has been greatly modified due to urban development.

For further detailed discussion of this subject refer to Appendix II.

5. <u>Zoological Elements</u>. The Trinity River lies on the western edge of the Austroriparian biotic province and its avian and mammalian faunas are, in general, typical of those of the whole southwestern United States. Refer to Appendix III for a more detailed discussion.

6. <u>Historical, Archeological and Cultural Considerations</u>. A research of resources concerned with the historical and archeological developments of the Upper Trinity River Basin reveal that the Upper Trinity River Basin historically has developed substantially in the way as described by Professors Mertes, Glick, Sweazy and Check from Texas Tech University in a report entitled THE TRINITY RIVER GREENWAY -- A PROTOTYPE, A STUDY OF THE WEST FORK OF THE TRINITY RIVER submitted to the U. S. Army Corps of Engineers, Fort Worth District Office, Fort Worth, Texas in June 1972. Their findings and opinions read as follows from pages 47-49 of the report:

> "<u>History</u> - Prior to the arrival of the Europeans in the early 1500's, the Caddo Indian tribes inhabited much of Texas. Of this tribe, the Wichita group lived in the lands of the Trinity River headwaters.
>
> A long period of conquest and colonization of Texas was initiated with the coming of the Spanish conquistadores and missionaries. Throughout this period Texas was claimed and fought over by many nations. In 1690 Captain Alonso de Leon, Governor of Coahuila, came to Texas to eradicate traces of French occupation. He named a major river La Santisima Trinidad (Most Holy Trinity), and it became known as the Three Forks of the Trinity by early Anglo settlers (it actually has four forks: Clear, East, Elm, and West).
>
> Mexico gained her independence from Spain, and under her rule, Texas was colonized by Anglo-American settlers from 1821 to 1835. In the years 1835-1836 the Texas Revolution was fought, and the independent Republic

of Texas came to exist from 1836 to 1845. During this period most texans had settled on the coast or in the south-central regions of the Republic. Indians and great herds of buffalo occupied most of the remainder of the state.

In the 1840's, the Republic began to allow settlements in the Upper Trinity River Basin area under the empresario system. Heads of household were allowed 640 acres, and single men could claim 320 acres. For each section taken, one was reserved for the land settlement company and another for the Republic. In this way, most of what are now Tarrant and Dallas Counties was settled by colonists of the Peters Company. In 1845 the Republic applied for and was granted statehood.

Although Dallas and Fort Worth came to grow in close proximity, their development patterns of land use were quite different. Because of distinct physiographic differences, the rancher became predominant to the west and the farmer settled to the east.

In 1841, John Neely Bryan claimed a parcel of land under the Peters grant and promoted a townsite that was later incorporated as Dallas. Dallas County was named for a Vice-President of the United States and was organized in 1846.

The La Reunion Colony had been formed by French settlers in 1854 near the bluffs on the West Fork of the Trinity. But it failed, and many of its highly skilled and cosmopolitan members moved to Dallas and contributed greatly to the city's early development.

In 1868 a steamboat actually navigated the Trinity River as far as Dallas rekindling hopes that the city was in fact at the head of a navigable river. But similar later efforts met with less success. The coming of the railroads in the 1870's greatly increased Dallas' growth. Since then, as Texas' second largest city, it has become a center of economic activity.

A U. S. Army post was built in 1849 and was named Fort Worth for General William J. Worth, commander of troops in Texas at that time. The post was abandoned in 1853, but a village had grown around it. Tarrant County was also established in 1849 and named for General Edward H. Tarrant. He was so honored for his attack on an Indian village along Village Creek (a tributary of the West Fork and the present boundary between Fort Worth and Arlington) where he and his 70 men dispersed the Indians and "recovered many stolen horses and much stolen plunder". Thus, did the Battle of Village Creek in 1841 make the area safe for settlement.

Fort Worth developed in a colorful western tradition that still remains imbedded in its culture. After the Civil War, it became a major point of origin for the great cattle drives northward on the Chisolm Trail. In the 1870's, the advent of the railroads and building of the stockyards led to Fort Worth's fame as "Cowtown". The mansions of many wealthy cattlemen such as Burk Burnett, W. L. Waggoner, and Winfield Scott still stand within the City. Fort Worth continued to develop through meat packing and aircraft industries. It exists today as one of Texas' major metropolitan centers.

Important historic sites in and near the study area are listed below:

(1) Bird's Fort site. An inscribed granite marker stands on the site seven miles north of Arlington. In 1840, seven miles north of Arlington, Jonathan Bird established the fort on the military road from the Red River to Austin. An important Indian treaty was signed near the site on September 29, 1843. Remnants of the Snively Expedition sought refuge there on August 6, 1843.

(2) Cedar Springs. An inscribed granite marker stands in Dallas on the earliest known historic site in Dallas County. The area was visited in 1840 by Colonel W. G. Cooke's exploration party. A community established in 1848 was annexed to Dallas in 1929.

(3) Battle of Village Creek. An inscribed granite marker stands three miles east of handley on Highway 80. On May 24, 1841 General Tarrant and 70 men attacked an Indian village situated along Village Creek.

(4) La Reunion. A granite marker and a park are located near the Trinity Portland Cement Plant in Dallas on Highway 80. This is the site of the old French colony of the same name.

There are no known historical or archeological sites within this area that would be adversely affected by the development of a multiple-purpose channel.

No discussion of the history of the study area would be complete without at least a brief look at the flood history of the Trinity River. Most of the forks of the Trinity that pass through Fort Worth have been modified by channelization and leveed to contain flood waters. However, the Fort Worth levee system ends just upstream from the study area on the West Fork. From there to the beginnings of the levee system in Dallas County, the West Fork and some of its major tributaries continue to periodically flood the lowlands. Fairly recent and notable examples are the great flood of 1494 and the floods of the late 1950's when Big Fossil Creek inundated large residential sections in Richland Hills. The creek system has since been modified to minimize flood hazards.

Downtown Dallas also developed very close to the river's flood plain, and in 1908, a large portion of the downtown area was flooded. In 1926, the City and County of Dallas Levee Improvement District was created to build the Dallas Floodway. By 1930, the Trinity River through Dallas was substantially channelized and leveed to form the floodway. Major supplemental improvements were accomplished by the Corps of Engineers in 1953."

Further substantiation to the claim that no historical, archeological or cultural values will be disturbed by the construction and expansion of the Regional Wastewater Treatment Facility of the Trinity River Authority is substantiated in the work entitled ENVIRONMENTAL AND CULTURAL RESOURCES WITHIN THE TRINITY RIVER BASIN by James V. Sciscenti, et. al. of Southern Methodist University of Dallas, Texas submitted to the Corps of Engineers, Fort Worth District, Fort Worth, Texas.

The summary of this report on the historical and ethnohistorical significance of the Upper Trinity River Basin reflects the following on pages 194 and 195:

Summary and Recommendations

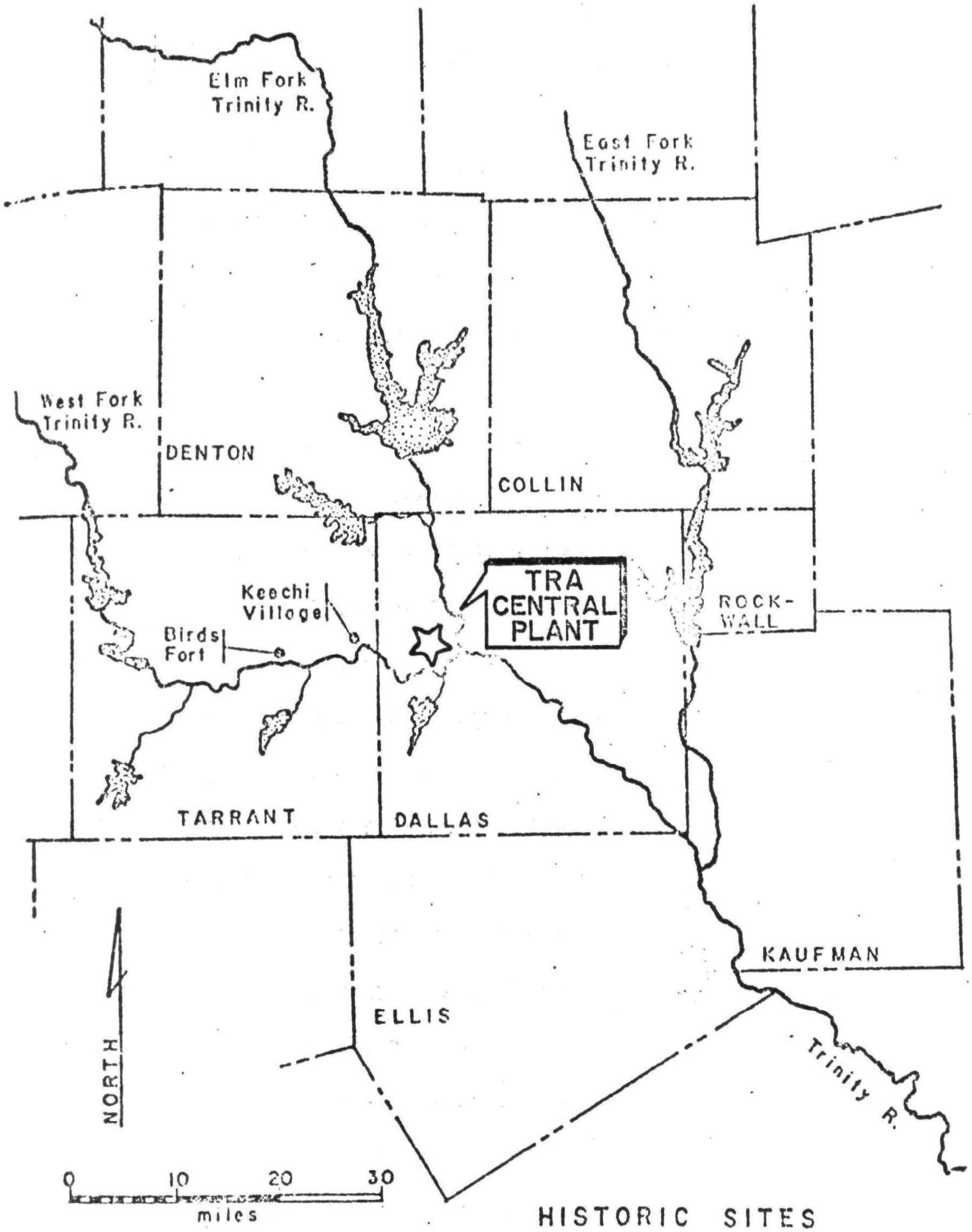
"After the initial settlement of the Upper Trinity Basin beginning about 1840, river navigation and rail transport provided the incentive for rapid population of the area after 1872. Few forts were built for the protection of the early settlers, and those that were in operation were short-lived. This area was an unknown wilderness during the Spanish missionizing and colonizing period, and no missions were established this far up the Trinity River. The historical resources of the area consist primarily of the remains of early settlements dating after 1840, most of which have been obliterated by urban growth.

The ethnohistorical data for the area is very scarce and imprecise. Sites of protohistoric occupation may be expected to exist in some numbers in the area, but great difficulty will be encountered in attempting to correlate these with specific referenced in the historical literature."

Other studies on the historical, archeological and cultural values associated with the Upper Trinity River Basin have been listed in the attached bibliography. These reports lead to the conclusion that no historical, archeological or cultural values will be affected by the project.

7. Social and Economic Conditions.

(A) Character of Communities -- Economic and Growth. Currently, cities located in the Mid-Cities region of the Dallas-Fort Worth metroplex are experiencing a period of rapid urban growth. As in most cities with a rapid residential, commercial and industrial development, physical development within the approximate Mid-Cities area is greatly dependent on the provision of utilities. To estimate future sewage needs, the present development of the Mid-Cities area was studied to



HISTORIC SITES
UPPER TRINITY RIVER BASIN

determine the type and intensity of land use. Land use patterns developed by the various city planning departments were converted to a density coefficient which coefficient was converted further to represent wastewater discharge from various areas in varying quantities. Land uses tabulated for use in estimating wastewater flows included shopping centers, shopping districts, commercial uses, manufacturing, central business districts, public and semi-public, and recreation and open areas. There are a number of trends that are associated with the various cities that comprise the Mid-Cities region of the Dallas-Fort Worth metroplex:

1. Irving. Completion of U. S. Highway 77, which provided essential connections between the City of Irving and job markets in Dallas, began a spectacular period of residential development in Irving in the early 1950's. Some industrial properties have been developed in Irving. Others are still available. Therefore, continued industrial expansion can be anticipated; however, most of the residents of this City will commute to jobs outside the City. Therefore, its considered unlikely that the character of Irving as a place of commuter residence will be significantly altered in the near future. Most of the commercial interests in Irving are concentrated in a strip developed along S. H. 356, and S. H. 183.
2. Grand Prairie. Beginning with the initial impetus provided by WWII, much of the land in the City of Grand

Prairie has been occupied by industry. Mostly the commercial interests in the City are presently concentrated in the strip along U. S. Highway 80. However, substantial residential expansion is being experienced in Grand Prairie and with it will grow some shopping centers in those areas. Future growth is expected to be primarily residential; however, it should take the form of multiple-family dwellings.

3. Farmers Branch. The City of Farmers Branch is predominately a residential area as a result of the wave of residential development which spread northward from Dallas. Completion of the Dallas North Tollway has stimulated further residential growth in Farmers Branch. Officials of the City and land planners feel that the City of Farmers Branch has reached a point to where the growth is leveling off because of the lack of available land for expansion. This community will remain predominately residential in the future.

4. Dallas. The portion of Dallas that is served by the Trinity River Authority's Central Sewage Plant is predominately residential in character and with some industrial land areas included. Future growth in this area will be predominately residential along the Fish Creek drainage area with light commercial and multiple-family dwellings mixed in a pleasing, kind of workable arrangement in that area.

5. Carrollton. The City of Carrollton received a portion of the outward residential growth from Dallas but received a much larger share of the industrial expansion. Adding a number of major manufacturers to its already respectable industrial base of the 1960's, Carrollton has become a significant center of employment. This trend, however, is expected to become more residential in nature with the industries being of the dry or domestic discharge kind.
6. Arlington. The City of Arlington, untouched by the industrialization of adjacent areas during WWII, maintained a suburban character and still offers appealing residential qualities. However, recent development of the Great Southwest Industrial District in Arlington has resulted in much heavier industrial land use in Arlington than had previously been experienced; however, this industrial land use is of the warehouse storage character and discharge of sewage effluent from this area is of domestic quality. It appears that Arlington will experience further significant residential and industrial growth.
7. Euless and Bedford. The Cities of Euless and Bedford are primarily residential with no large industry, but a number of small manufacturers of unstandardized products have become established in Euless. Potential for residential development of both cities is tremendous and

continued rapid increase in the industrial development can be expected due to the effect of the Dallas-Fort Worth Regional Airport.

8. Coppell and Addison. The City of Coppell consists of mostly scattered residential areas. The City of Addison is more concentrated with some land being used for residences and some for industrial purposes. Heavy residential and moderate to light industrial growth can be expected from these areas.

9. Dallas-Fort Worth Regional Airport. An additional factor widely expected to stimulate growth in the mid-cities region is the Dallas-Fort Worth Regional Airport now under construction. Sewerage and wastewater runoff generated by the Regional Airport will be pretreated prior to entering the Trinity River Authority's Central Sewage System.

The character of the remaining area in the Mid-Cities region is largely undeveloped farm land. However, it is expected that ultimately this too will develop, primarily residentially, thus, making a massive urban complex along the axis of the Dallas-Fort Worth dipole.

(B) <u>Population Trends and Projections</u>. Projections of future population and its distribution are necessary to permit estimates of future sewage flow in each portion of the project area to be made. Distribution of present and projected population in the project area has been formed utilizing available information such as census data, current development policies, current population projections by the Governor's Office, previous planning studies and transportation studies.

Many projections of population and resulting flow have been made by the Authority, area cities and other agencies as a part of necessary planning for water and wastewater facilities. Only those contracting parties now being served by the Trinity River Authority's system are included.

The tabulations include actual figures for 1970, a reasonably close approximation for those to be experienced in 1971 and 1972, and estimates for future years through 1990, the design year of the A Plan report for major interceptors. In that several improvements to the System requiring considerable expenditure are proposed for construction by 1976, projections are shown yearly through 1976, then in 5-year increments through 1990.

It is expected that all of the population within the project area will be provided with sewage facilities during the project period. Population projections developed are based upon consideration of current and anticipated development trends. These trends could be modified in the future if development is controlled because of water supply, sewage, drainage, transportation, or other factors. At this time, specific development controls such as staged development are not considered necessary by most area communities; however, as a result of the proposed project, the anticipated rate of growth may greatly increase and staged or regulated development may become necessary to safeguard environmental quality from uncontrolled development. Under strictly controlled conditions, the population distribution projected herein could be adjusted as necessary to reflect new development.

8. Miscellaneous Elements. There are no national parks or forests, or wildlife refuges in the study area. Contemporary human features throughout the watershed consist of single and multi-family dwellings. Areas along Fish Creek watershed is predominately undeveloped lands although intense development is taking place in close proximity to already developed cores of Arlington and Grand Prairie. The attraction of the entertainment center in Arlington and Grand Prairie, coupled with the expected impact of the Dallas-Fort Worth Regional Airport, is causing a great development to take place in the Mid-Cities area. With few exceptions, roads in the study area are open and all weather surfaced. Most are maintained in excellent condition. The main transportation arteries in the Mid-Cities area are in the Dallas-Fort Worth Turnpike, S. H. 183, S. H. 114, and I. H. 20 soon to be opened. Parks and recreation areas are numerous in the area as shown on the land use map (Figure I-1).

9. Needs of the Project Area. When growth in an area has taken place as fast as it has in the project area, the most pressing need is usually evident in the provision of services, i.e. sewer, water, streets, fire and police protection, etc. In the case of this project area,

there is a critical need to provide an adequate waste treatment system. Through planning and cooperative effort, the needs for solid waste disposal, neighborhood street systems, utilities

PAGE NOT

AVAILABLE

DIGITALLY

TABLE I-8

TRINITY RIVER AUTHORITY OF TEXAS

REGIONAL WASTEWATER SYSTEM

ESTIMATED POPULATION SERVED BY FISCAL YEAR

City or Agency	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
Arlington	16,600	17,700	19,000	43,300	54,300	68,900	135,600	172,600	242,000	298,000
Bedford	0	0	0	12,550	13,500	14,300	17,600	28,100	46,000	55,600
Carrollton (including Coppell)	800	18,150	21,900	25,700	29,500	33,200	36,300	47,800	57,000	67,000
Dallas	6,840	13,900	16,300	37,800	39,000	40,000	41,000	45,000	50,000	55,000
Dallas/Fort Worth Airport	0	0	0	8,900	19,300	22,600	24,100	31,700	40,000	47,700
Euless	3,000	8,000	14,400	29,200	32,600	36,000	39,300	50,000	62,000	74,000
Farmers Branch (including Addison)	28,100	28,800	30,000	32,200	35,400	39,000	40,600	46,700	50,000	52,300
Grand Prairie	46,000	47,400	48,800	55,700	58,700	66,000	69,900	86,300	102,000	110,000
Irving	90,140	94,500	96,000	104,300	115,200	120,000	127,000	160,000	195,000	220,000
TOTALS	191,480	228,450	246,400	349,650	397,500	440,000	531,400	668,200	844,000	979,600

TABLE I-9

TRINITY RIVER AUTHORITY OF TEXAS

REGIONAL WASTEWATER SYSTEM

ESTIMATED AVERAGE DAILY FLOWS - MGD - BY FISCAL YEAR

City or Agency	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
Arlington	1.76	1.91	2.09	4.85	6.19	7.93	15.73	20.71	30.25	38.74
Bedford	0	0	0	1.41	1.54	1.64	2.04	3.37	5.75	7.23
Carrollton (including Coppell)	0.09	1.92	2.36	2.88	3.36	3.82	4.21	5.74	7.12	8.71
Dallas	0.72	1.50	1.80	4.23	4.45	4.60	4.76	5.40	6.25	7.15
Dallas/Fort Worth Airport	0	0	0	1.00	2.20	2.60	2.79	3.80	5.00	6.20
Euless	0.30	0.54	1.03	3.27	3.72	4.14	4.56	6.00	7.75	9.62
Farmers Branch (including Addison)	3.13	2.91	3.22	3.61	4.04	4.49	4.71	5.60	6.25	6.80
Grand Prairie	4.49	5.63	5.20	6.24	6.69	7.59	8.11	10.36	12.75	14.30
Irving	9.55	8.23	9.15	11.68	13.13	13.80	14.73	19.20	24.38	28.60
TOTALS	20.04	22.64	24.85	39.17	45.32	50.61	61.64	80.18	105.50	127.35

TABLE I-10

TRINITY RIVER AUTHORITY OF TEXAS

REGIONAL WASTEWATER SYSTEM

ESTIMATED ANNUAL VOLUME FLOW - IN THOUSAND GALLONS

City or Agency	1970	1971	1972	1973	1974	1975	1976	1980	1985	1990
Arlington	642,400	697,150	762,850	1,770,250	2,259,450	2,894,450	5,471,450	7,559,150	11,041,250	14,140,100
Bedford	0	0	0	514,650	562,100	598,600	744,600	1,230,050	2,098,750	2,638,950
Carrollton (including Coppell)	32,850	700,800	861,400	1,051,200	1,225,400	1,394,300	1,536,650	2,095,100	2,598,800	3,179,150
Dallas	262,800	547,500	657,000	1,543,950	1,624,250	1,679,000	1,737,400	1,971,000	2,281,250	2,609,750
D/FW Airport	0	0	0	365,000	803,000	949,000	1,018,350	1,387,000	1,825,000	2,263,000
Euless	109,500	197,100	375,950	1,193,550	1,357,800	1,511,100	1,664,400	2,190,000	2,828,750	3,511,300
Farmers Branch (including Addison)	1,142,450	1,062,150	1,175,300	1,317,650	1,474,600	1,638,850	1,719,150	2,044,000	2,281,250	2,482,000
Grand Prairie	1,638,850	2,054,950	1,898,000	2,277,600	2,441,850	2,770,350	2,960,150	3,781,400	4,653,750	5,219,500
Irving	3,485,750	3,003,950	3,339,750	4,623,200	4,792,450	5,037,000	5,276,450	7,008,000	8,898,700	10,439,000
TOTALS	7,314,600	8,263,600	9,070,250	14,297,050	16,541,800	18,472,650	22,498,600	29,265,700	38,507,500	46,482,750

TABLE I-11

TRINITY RIVER AUTHORITY OF TEXAS

AVERAGE DAILY FLOW - MGD

PARTICIPANT PERCENTAGES

City or Agency	1973 Flow	1973 %	1975 Flow	1975 %	1976 Flow	1976 %	1985 Flow	1985 %
Arlington	4.85	12.36	7.93	15.67	15.73	25.52	30.25	28.67
Bedford	1.41	3.60	1.64	3.24	2.04	3.31	5.75	5.45
Carrollton (including Coppell)	2.88	7.35	3.82	7.55	4.21	6.83	7.12	6.75
Dallas	4.23	10.80	4.60	9.09	4.76	7.72	6.25	5.92
Dallas/Fort Worth Airport	1.00	2.55	2.60	5.14	2.79	4.52	5.00	4.74
Euless	3.27	8.35	4.14	8.18	4.56	7.40	7.75	7.35
Farmers Branch (including Addison)	3.61	9.22	4.49	8.87	4.71	7.64	6.25	5.92
Grand Prairie	6.24	15.93	7.59	15.00	8.11	13.16	12.75	12.09
Irving	11.68	29.82	13.80	27.26	14.73	24.90	24.38	23.11
TOTALS	39.17	100.00	50.61	100.00	61.64	100.00	105.50	100.00

and parks are being met through the intelligent application of zoning ordinances, building codes and land use plans. All cities in the study area have highly advanced systems of ordinance and code control to regulate orderly growth in their respective city. The need for this project is evident. When one realizes that this is an area that is subject to tremendous growth then it is obvious that the provision of adequate treatment of sewage is mandatory in order to avoid critical health problems in an urban area.

10. Programs of Others. The most notable project in the area is the construction of the Dallas-Fort Worth Regional Airport. This airport is on an 18,000 acre tract between Dallas and Fort Worth. It is forecast that by 1985 there will be enplanements and deplanements of approximately 20,000,000 persons per year. This project has spawned a number of highway improvement programs in order to meet the expected demand on area roadways. The Dallas-Fort Worth Regional Airport will be served by the Central Regional Wastewater Treatment System.

    Implementation of various wastewater treatment projects is currently being accomplished in the Upper Trinity River Basin which will result in beneficial effects on the receiving streams. A list of projects underway in the Dallas-Fort Worth Metroplex area are briefly described below.

    (A) City of Dallas. Dallas has a ten-year master plan to insure sufficient sewerage treatment facilities to meet growing needs.

Dallas has a research facility said to be unequaled in the country that is utilized for obtaining wastewater treatment plant design parameters. Dallas is planning to expand the capacity of its White Rock Plant to 125 MGD using an advanced treatment process. Anticipated completion date of construction is 1975.

(B) City of Fort Worth. Fort Worth has scheduled an expansion of its Village Creek Plant to 96 MGD advanced treatment facility. Anticipated completion date of construction is 1975.

(C) City of Garland. Construction plans and specifications are being completed for expansion of existing facilities to provide a 30 MGD advanced treatment utilizing the physical/chemical process. Anticipated completion date of construction is 1974.

(D) City of Lewisville. City has plans to expand its present plant to 3.0 MGD capacity and to build a new second plant with 3.0 MGD capacity. Each of the plants will have advanced treatment. Completion is scheduled for late 1974.

(E) City of Wylie. Construction of a new plant having a 1.0 MGD capacity is scheduled for completion in late 1973.

(F) City of Plano. Construction is scheduled to expand Plano's 1.85 MGD plant to a 4.0 MGD advanced treatment facility by late 1973.

(G) City of Flower Mound. Construction of a new 0.7 MGD advanced treatment facility is scheduled by late 1973.

(H) Trinity River Authority. Plans are being made to expand the Trinity River Authority's Central Plant from 30 MGD to 100 MGD capacity by 1976 and to eliminate the oxidation pond in favor of a more stable and dependable advanced treatment process.

(I) City of Euless. Presently in the process of phasing out two (2) overloaded wastewater treatment plants and discharging to the Trinity River Authority's Central Plant.

(J) Trinity River Authority. TRA completed construction in late 1970 of the 7 MGD capacity wastewater treatment plant which provides treatment for wastewater generated by the municipalities of Cedar Hill, Ferris, Duncanville, De Soto and Lancaster.

(K) Corps of Engineers. The Trinity River Multiple-purpose Channel Project for the comprehensive improvement of the Trinity River was authorized by the 89th Congress of the United States in the Omnibous Rivers and Harbors Act of 1965, in accordance with plans formulated by the Galveston and Fort Worth Districts and the Southwestern division of the U. S. Army Corps of Engineers and recommended by the Secretary of the Army.

The authorized project will develop the River Basin's water resources for navigation, flood control, water supply, recreation and related purposes. The plan provides for a multiple-purpose channel extending from the Houston Ship Channel in Galveston Bay to Fort Worth, Texas; a system of locks and dams, the dams to provide slack water pools for navigation and the locks to lift and lower vessel traffic between the pools; four multiple-purpose reservoirs, including one on the main stem of the river and three on tributary streams; and five local flood protection projects, including four in the Fort Worth-Dallas area and one at Liberty, Texas; and facilities for water quality improvement.

The 1965 act of Congress specifically authorized navigation as one of the project's purposes, with the provision that prior to expenditures of any funds for construction of those features designed exclusively for navigation, the Chief of Engineers shall submit to Congress a reevaluation based upon current criteria. The reevaluation of navigation followed criteria set forth in the Department of Transportation Act, Public Law 89-670, approved October 15, 1966. Several changes in navigation features of the authorized Trinity River Plan were proposed as a result of the restudy of navigation economics. These included adjustments in lock sizes, an increase in channel width, an elimination of three locks and dams that were included in the original plan.

A proposed channel alignment provides for numerous cutoffs across natural bends of the river, and for many reaches, it channel would be about 355 miles, compared with the natural river distance of about 552 miles. Additional length of the channel from the river's mouth to the Houston Ship Channel is approximately 28 miles.

The only relationship that the expansion of the Central Regional Wastewater Treatment Facility has to the Trinity River Multiple-purpose Channel is that the Trinity River will be the receiving waters of the effluent discharged by the Central Wastewater Treatment Facility. The Trinity River itself will receive benefits from the increased quality of the discharge from the Central Wastewater Treatment Facility.

Several studies have been made of the treatment requirements for sewage treatment plants discharging into the Trinity River with the following conclusions:

1. The Corps of Engineers report indicated that the plan for maintaining the water quality of the Basin could be developed through efficient use of available dilution water and utilization of advanced waste treatment technology to provide greater removals of BOD.
2. The Texas Water Plan indicates that low flow augmentation may help to bring water quality to levels that will satisfy water uses of the stream on an interim basis, but the highest technically and economically feasible treatment of waste would still be needed.

3. The North Central Texas Council of Governments Upper Trinity River Basin Comprehensive Sewage Plan concludes that with the anticipated continued growth of the Dallas-Fort Worth area, and with the extremely limited water quality control facilities planned by the Corps of Engineers, reuse of water must be practiced and the treatment of wastewaters to the highest practical degree will be necessary.

Under present plans and conditions, the improvement of wastewater treatment facilities that discharge into the Trinity River is necessary whether the Trinity Multiple-purpose Channel Project is constructed or not. The construction of this project is in keeping with the declared goals and objectives of the "Federal Water Pollution Control Act Amendments of 1972" Public Law 92-500, 92nd Congress, S.2770 October 18, 1972 which states in part that "it is the national goal that the discharge of pollutants into the navigable waters be eliminated by 1985."

The impact that the Trinity River Authority's Regional Wastewater Treatment Facility expansion has on the whole regional effort to abate pollution of the Trinity River is significant. The Authority is attempting to follow through with plans to implement a sewage treatment operation that will minimize to the greatest extent possible the emission of pollutants into the receiving waters of the Trinity River. As has been demonstrated, people in the Upper Trinity River Basin's metropolitan areas are committed to this goal.

11. Future Activities on the Watershed.

(A) General Information. Much of the information presented under paragraph 7 preceding is pertinent to expected future activities in the watershed served by the Central Sewage System. The matter of population trends, past and future, is discussed under that section, and Tables 1-8 - 1-11 show the population forecasts and flow projections for the cities on the system through the year 1990.

(B) Extent of Land Use Planning. In order to adequately assess the impact of the expansion of the Regional Wastewater Treatment Facility on land in the system service area, one must first determine (1) what is meant by "land use"; and (2) what different classifications of "land uses" there are.

Based upon the findings of the Committee on Land Use Statistics as reflected in the publication Land Use Information, A Critical Survey of U. S. Statistics Including Possibilities for Greater Uniformity compiled by Marion Clawson with Charles L. Stewart, the term "land use" is multi-faceted. The Committee generally agreed that the "only practical answer now, in our judgement, is to use additional and more specialized terms, so as to make as clear as possible exactly which concept is in mind, "Activities using land" is less appealing, perhaps somewhat awkward, but conveys in some contexts a clearer meaning than "land use", as the latter is commonly used." (p. 29) Therefore, for the purposes of assessing the impact, both beneficial and adverse, that the Regional Wastewater Treatment Facility expansion might have on "land use", we interpret "land use" as "activities using land."

As for what types of activities use land, we have concluded that in the Dallas-Fort Worth Mid-Cities metroplex the use of land is generally along the order of single family residential, multi-family residential, group quarters, mobile homes and others, manufacturing, institutional, open space and retail trade. Accepting that these are the generalized activities on land in the Mid-Cities service area, we now will be able to assess more definitively the impact that the Central Wastewater Treatment expansion can be expected to have on the service area.

The Commission on Land Use Statistics has concluded that ". . . water, sewer, telephone, electric power, and other lines are typically below ground surface in many cities; these create great values in the land which they serve, and certainly are one form of man's activities that make use of land." (p. 15)

The accompanying land use map, Figure I-1 indicates that there has been a great deal of residential activity in the Dallas-Fort Worth Mid-Cities area. The color codes reflect the various land uses as determined by in-depth analysis of cities master plans, city zoning ordinances, and other land use data. The map indicates the present situation as it concerns land use. The areas not color coded are considered to be rural unzoned areas. Land use projections in those areas that are presently unzoned are unreliable due to two factors:

1. In most cases, master plan development is not complete or projections past the year 1985 are unavailable.
2. Those areas existing as flood plains, etc. have been zoned residential, not because they will be used as residential areas, but because residential zoning is highly restrictive which gives the zoning commission and the city council the greatest amount of control over the future development of these areas.

Based on present indicies and information, it is expected that the expansion of the Central Wastewater Treatment Facility will not have an adverse effect on the various activities that land in the service area could accommodate. It is fully expected that the expansion of the capacity of the treatment plant and the installation of major interceptors to serve new areas will have a beneficial effect on the orderly growth of the Mid-Cities area. The expansion of this plant will allow for the elimination of three sewage treatment plants that are presently unable to treat wastewater to acceptable standards. It will also allow for the acceptance of sewage from areas that are utilizing septic tanks or other means of disposal of wastewater because this service is not available. By centralizing the discharge into the main stem of the Trinity, the elimination of the dispersion of sewage effluent in the main tributaries to the Trinity will result in a beneficial effect on the water quality in those areas. The increased water quality will benefit land use by making it acceptable for use in its highest and best capacity.

(C) Available Plans. The North Central Texas Council of Governments Upper Trinity Basin Comprehensive Sewage Plan represents a well-developed plan for the orderly expansion of sewage service in order to protect area streams from pollution by inadequately treated or raw domestic sewage. Publications of and planning work accomplished by the North Central Texas Council of Governments may be seen at their offices at 1201 North Watson Road, Suite 270, Arlington, Texas.

(D) Impact of Possible Land Use Changes. Land use policies now in effect are expected to be followed in the future. The impact upon the proposed project by the possible changes in land use controls within the service area is not thought to be significant. No change in future land use can alter the fact that pollution problems now exist. It is extremely doubtful that the existing momentum of growth in the watershed can be slowed any significant degree without the adoption of strict land use controls by the area communities. It is obvious that if an adequate sewage treatment system is to be constructed to serve the watershed, a reasonable allowance for future growth must be provided, especially in those areas where present land use policies and controls are expected to continue indefinitely.

II. ALTERNATIVES TO THE PROPOSED ACTION

A. General. This section includes consideration and comparison of alternatives and selection of the optimum system.

The following subsections discuss in detail the alternatives in order that the logic of the decision-making process can be easily followed.

B. Major Objectives. The major objectives of this project are listed below in order of importance.

1. Provide maximum health and safety protection for the area residents. The transportation, treatment and safe disposal of domestic, commercial and industrial wastes are among the most important problems of environmental health today.
2. Reduce the pollution level in bodies of water which are receiving the treated effluent and prevent violation of water quality standards. The size of this metroplex, with respect to population and industries, is causing an ever increasing level of pollution. Treatment plants must keep pace with these increases, which means wastes should be properly treated. Therefore, man-made pollution may result in minimum adverse environmental and ecological effects.
3. Alleviate aesthetic problems. The proper treatment of wastes can alleviate the putrescibility of organic materials and nuisances from obnoxious odor. Aesthetic problems should also be minimized in a healthy environment.

C. Constraints or Conditions.

1. TWQB Waste Control Order. The preliminary approval granted by the TWQB to the Authority's Ammended Waste Control Order on August 23,

1972, set forth the following conditions: (1) 10 mg/L of BOD; (2) 10 mg/L of TSS; (3) a chlorine residual of 1.0 mg/L after a contact period of 20 minutes (based on peak dry weather flow).

2. Scope of Project. The existing plant was built in 1959 with a capacity of 30 MGD. All facilities are in good condition. All these facilities will be operated continuously as a part of the future treatment system. No modification of the existing plant will be included in the expansion (except the change of trickling water seals from mercury to mechanical as required by regulatory agencies and associated pump and piping changes which will allow full utilization of the existing treatment units.)

3. Physical. The plant is located in the Mid-City area of the Dallas-Fort Worth Metroplex (see Figure 2-1 location map). The areas nearby are residential, commercial and light-industrial areas. The growth of this adjacent area makes utilizing land outside the existing plant site economically infeasible.

4. Economical and Financial. The total cost of this project must be within the financial capability of government sponsoring agency or agencies, as the case may be. Transportation and treatment facilities must be of efficient design in order to minimize capital cost and subsequent operation and maintenance cost.

D. Structural and Non-Structural Alternatives. The Trinity River Authority of Texas has investigated the aspects of structural and non-structural alternatives in regard to the problem of wastewater acceptance into the system. The Authority is, however, a Regional Agency serving,

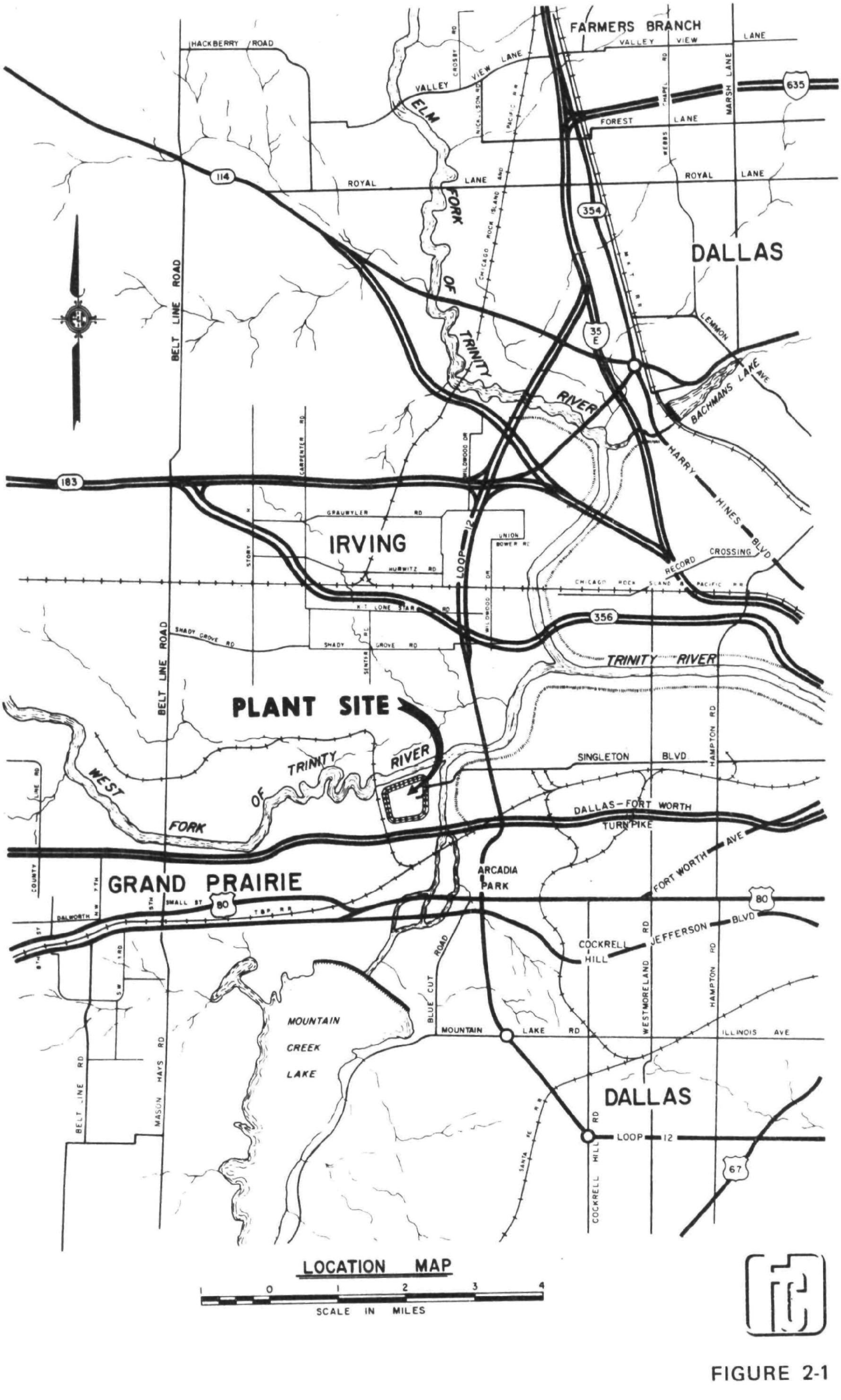

FARMERS BRANCH
DALLAS
IRVING
PLANT SITE
GRAND PRAIRIE
ARCADIA PARK
DALLAS
MOUNTAIN CREEK LAKE
ELM FORK OF TRINITY RIVER
WEST FORK OF TRINITY RIVER
TRINITY RIVER
BACHMANS LAKE
DALLAS-FORT WORTH TURNPIKE
HARRY HINES BLVD
BELT LINE ROAD
ROYAL LANE
FOREST LANE
VALLEY VIEW LANE
HACKBERRY ROAD
SINGLETON BLVD
FORT WORTH AVE
JEFFERSON BLVD
MOUNTAIN LAKE RD
ILLINOIS AVE
LOOP 12
LOCATION MAP
SCALE IN MILES

FIGURE 2-1

by contract provisions, a number of governmental agencies, therefore creating conditions perhaps not as conducive to enactment of non-structural alternatives. After careful consideration of both alternatives, the Authority has determined the following non-structural alternatives to be those which are feasible.

Contract provisions with System customers and governmental agencies being served, which impose the following major non-structural alternatives, are listed below.

1. Limitation of total wastewater quantity discharged into the System.
2. Limitation of wastewater quality discharged into the System.
3. Limitation of wastewater quantity discharged into designated points of entry into the System.
4. Imposition of rates charged as a function of quantity.
5. Imposition of rates charged as a function of quality.
6. Restriction on prohibitive discharges into the System.
7. Restriction on excessive discharges caused by storm or process water entry into the System.

The Authority has proceeded to investigate those structural alternatives which are required to transport and treat all wastewater discharged into the System within the parameters of the non-structural alternatives elements. For the design of the wastewater treatment facilities, process selection and unit component sizing will reflect the implementation of the above non-structural alternatives.

It appears that the structural and non-structural alternatives must exist in a state of economical balance and that this will be best achieved by the implementation of those non-structural alternatives listed herein, combined with such structural alternatives as are consequently necessary.

E. Centralized vs. Decentralized Systems. A July 1970 North Central Texas Council of Governments (NCTCOG) report entitled "Upper Trinity River Basin Comprehensive Sewerage Plan" addresses the question of centralization. The report summarized the study of an area covering roughly 11,000 square miles which included all of the Upper Trinity River Basin Watershed north of Henderson and Navarro Counties. Based on this study, the report recommended a comprehensive sewerage system and expansion program of interceptors, trunk sewers, and sewage treatment facilities located primarily in Dallas and Tarrant Counties. The recommendation is centered around six plants either already in existence or under construction. Among these is the Trinity River Authority's Central Sewerage System Plant. The present and proposed development of the Central Sewerage System is consistent with the development recommended in the report, which is now the official interim regional metroplex plan for the sewage interceptor systems and regional treatment facilities within the NCTCOG area.

Results of the NCTCOG report demonstrate that a trend toward regional wastewater collection and treatment systems has developed. The Authority's Central Sewerage System started this trend. Built to serve only four member cities, the Authority's Central System has grown to serve a much larger area as shown in Plates 1 & 2. To reverse that trend in the case of the Central System service area, and attempt to develop decentralized systems, would be economically unfeasible due to the large quantities of resources already invested in the Central System. Additionally, decentralization to a system of smaller plants requiring new interceptor systems and consequently new rights-of way would <u>appear</u> to be more environmentally disruptive than expansion of existing facilities on existing properties and rights-of-way. The same quantity and quality of effluent would probably (control might affect results somewhat) be discharged to the same river with no economic or environmental advantage gained.

It has been demonstrated that, at this time, the existing centralized system appears to be the most feasible and economical solution to the wastewater problem of the area served, but consideration to location alternatives for a centralized system has not been fully discussed.

Any consideration of new centralized facilities to be located at another site other than the existing, must recognize that the major method to transport the wastewater is by gravity flow. To obtain gravity flow, the pipeline must be installed with a slope. In level terrain, each successive joint of pipe must be placed deeper and deeper to maintain the slope. Since the cost of building the line is largely dependent on the depth of the excavation required, a practical limit exists at which a pump or "lift" station becomes more economical. Lift stations require power and that represents a use of a limited resource.

PAGE NOT

AVAILABLE

DIGITALLY

The site of the existing treatment plant was selected from several considerations, including how advantage may best be taken of existing drainage patterns, i.e., sloping ground, to economize the installation of gravity lines. Thus, the existing plant is located at the confluence of two major streams and near the confluence of a third. Existing interceptors serve portions of the drainage basins of all three streams, Mountain Creek, West Fork, and Elm Fork. It is unlikely that a better location can be found that will provide the same service to this area without increasing the number of lift stations required.

If the existing facilities were abandoned and new facilities were provided at a new site to treat full capacity, the existing lines would have to be abandoned and replaced, or a very large interceptor and pump station provided to move the wastewater to the new site for treatment. Similarly, if new facilities were provided at a new site to treat the capacity increase, rights-of-way would be required to transfer the flow to the new facility. A new plant site and new line work along new right-of-way represents considerably more disruptive to the environment than expansion of existing facilities. Since the same quantity of effluent, treated to the same degree, will still be discharged to the same river, no environmental advantage is gained by the additional expense incurred of an alternate location. When it is considered that space is available at the existing site, within the existing levee, for the required plant expansion, expanding the existing facilities to treat the required capacity becomes the least environmentally disruptive location alternative and has been selected as the alternate chosen for development.

In a study of centralization versus decentralization, some consideration should be given to residential, commercial, and industrial development that might be induced by centralized facilities. Many other stimuli for additional urban growth and development exist within the present and proposed service area of the Central Sewerage System. In this area, provision for sewerage service to developing areas is taken for granted. There is no question that sewage service will be provided where needed, because, not to do so would create a public health hazard in many cases; however, services traditionally lag behind demand and in the case of the Authority's expansion, this tradition is continued.

F. Treatment Subsystem and System Alternatives. (see Figure 2-2)

1. Subsystem Alternatives. Treatment systems can be broken down into their constituent parts or subsystems. The four major subsystem categories and some of the major alternatives available within each category follow. A number of these subsystem alternatives were not included in the comparison-selection process shown on Figure 2-2 due to overriding reasons (refer to EPA's Preliminary Draft for MANUAL FOR PREPARATION OF IMPACT STATEMENTS FOR WASTEWATER TREATMENT WORKS, March 1973) which are given in the following discussion.

(A) Effluent Disposal.

1. Ocean Outfall. Ocean outfall is not feasible because the closest ocean body, the Gulf of Mexico, is 300 miles away.

The long-distance piping construction makes this disposal method impractical.

2. Disposal in Inland Surface Waters. This is the recommended effluent disposal. Trinity River is the receiving water body. Discharge effluent in inland surface waters is the most economical effluent disposal method for this project.
3. Well Injection. Due to the wastewater quantity and the potential of causing underground water pollution, this method is not recommended.
4. Land Disposal. Because of the following reasons the land disposal of effluent is not practical.
   a. Plant is located in a populated residential and industrial area; crop irrigation area is not available.
   b. The quantity of water and the distance to the closest irrigation fields (West Texas, one hundred miles away) make this method economically infeasible.

(B) Treatment. Treatment process alternatives are usually governed by the effluent quality requirements, and the required effluent standards in this case minimize the alternative treatments for plant design.

1. Septic Tank. Septic tank treatment is impractical and impossible in this metroplex area due to the density of population and lack of available land for soil absorption.

Usually, septic tanks are considered more practical in small communities.

2. Primary treatment. Primary treatment could not achieve the required degree of treatment. The receiving water body, the Trinity River, has very low flow most of the year and a major portion of the river flow is sewage treatment plant effluents. At least secondary treatment is necessary.

3. Secondary Treatment.

   a. Technical Alternatives.

      1. Activated Sludge. The Authority's Central Sewage System treatability study indicated this process could successfully treat the Central Sewerage wastewater. Though the secondary treatment process is higher in cost, it will produce a more stable effluent quality and provide better controls.

      2. Trickling Filter. In general, the trickling filter cannot produce the required effluent quality or one as good as activated sludge process. Also, the new trickling filters will need a larger area; therefore, the existing pond treatment must be terminated for a new trickling filter construction site.

      3. Oxidation Pond and Lagoon. The land area requirements for ponds makes this alternative impractical. There is just not enough land for pond and lagoon treatment.

b. The activated sludge process is the optimum secondary treatment. The plant will be designed to treat a flow of 100 MGD which is the estimated 1985 flow.

4. Advanced Waste Treatment.

a. Technical Alternatives.

1. Final Polishing of Secondary Effluent. To use the activated sludge process alone would not be sufficient to meet the effluent quality requirements. High rate filtration and carbon absorption are necessary for removing the residual organic matters and suspended materials from secondary effluent.

2. Direct Chemical/physical Treatment. Chemical/physical treatment can be applied to raw wastewater. It is basically a sedimentation process with required chemicals being fed into the sedimentation tank. Following in the treatment, more solids are removed by filtration, and organic matter is removed by carbon absorption.

b. The advanced treatment design capacity is also based on the flow of year 1985. However, the design of treatment facilities, loadings, contact time, operating and maintenance costs of the above two Alternatives of advance waste treatment are significantly different.

(C) Sewer (Primarily Interceptors).

1. Area to be served. Exhibit 1 shows a map of the regional wastewater system.

PAGE NOT

AVAILABLE

DIGITALLY

2. Capacity and Phase of Construction. The capacity and phases of construction are shown in Exhibit 4. However, construction under the Federal grant currently being applied for includes only three of the interceptors. They are listed below:

   a. West-Fork Interceptor Parallel

   b. Mountain Creek Interceptor Parallel

   c. Cottonwood Creek Trunk Parallel

   These interceptor capacities are designed for flows of year 1990 and they will be built immediately after reception of the grant.

(D) Sludge Disposal.

1. Stabilization. Stabilization becomes unnecessary if the sludge will be incinerated. Stabilization always reduces the heat value in sludge. Therefore, if ultimate sludge disposal is incineration, stabilization will not be required or desirable.

2. Thickening, Conditioning and Dewatering. Sludge thickening and dewatering reduce the incinerator size and fuel cost. It is recommended that the sludge should be thickened, conditioned and mechanically dewatered, so that minimum energy will be required or desirable.

3. Final Disposal. Actually, final disposal should be discussed prior to the above two subsections because the decision regarding the final disposal

PAGE NOT

AVAILABLE

DIGITALLY

method will affect decisions regarding sludge stabilization and dewatering process.

a. Land Spreading. Land spreading sludge is not applicable because of the location of the plant and the lack of available land.

b. Ocean and Surface Water Disposal. Barge facilities are not available for ocean disposal. Surface water disposal will cause odor and water quality problems.

c. Well Disposal. This is not applicable due to the possibility of polluting the underground water.

d. Pyrolysis. This is an expensive process and it releases nutrients back to the treatment system, which is not preferred due to a future nutrient removal requirement.

e. Incineration. This is the recommended disposal method for the TRA Central Plant due to plant location and constraints. The ash can be landfilled on site.

2. <u>System Alternatives</u>. Optimum subsystem alternatives are combined into system alternatives. Alternatives of the TRA Sewerage System are extremely limited due to the constraints or conditions. Rejection of impractical alternatives was based on obvious and overriding reasons which were stated in the previous discussions. Also eliminated from further consideration due to overriding reasons were

location alternatives other than the existing centralized location as discussed in section E of this chapter.

(A) System Alternative A. One possible solution available to TRA is to build a regional sewer system, to use activated sludge process and advanced treatment process to treat the wastewater, to discharge effluent to the Trinity River, and dispose of sludge by thickening, dewatering, incineration and landfill. The estimated cost of construction of this system is $37,908,000 (excluding interceptor system). The estimated total treatment cost is 10.4 to 14.5¢/1000 gal.

1. Impacts of Alternative A.

    a. This alternative would be beneficial in that it eliminates the health hazard caused by untreated wastewater and the nuisance caused by objectionable odors.

    b. The treatment system will produce an effluent which can meet effluent quality standards. However, the system is not defined for phosphorus and nitrogen removal. The system can be altered, with additional facilities, to adequately remove nutrients.

    c. To incinerate sludge usually requires auxiliary fuel. Incineration requires a large amount of energy, however, energy through incineration should be a pratical operation in the future.

    d. Any incinerator is potentially a source of air pollution. Requirements of the State and other regulatory agencies having jurisdiction will be met and provision of future, stricter standards will be considered in design.

(B) System Alternative B. Another possible solution for TRA is to build a regional sewer system to use physical/chemical process to treat the wastewater, to discharge effluent to the Trinity River, and to dispose of sludge by thickening, dewatering, and incineration. The estimated cost of construction of this system is $44,780,000 (excluding interceptor system). The estimated total treatment cost is 16.1 to 21.7¢/1000 gallons.

1. Impact of Alternative B.

   a. This alternative would also eliminate the health hazard caused by untreated wastewater and the nuisance caused by obnoxious odors.

   b. The treatment system can achieve the required effluent quality and receive a bonus of higher phosphorus removal incidental to the process. However, more sludge will be generated with this treatment system. This sludge is more readily dewatered but the quantity of sludge offsets this advantage. Nitrogen removal in this system is difficult. The present nitrogen removal methods will result either in excess ammonia in the atmosphere by stripping, or in high chloride in the effluent by chlorination.

   c. More sludge will need to be disposed. Low sludge heat value requires more sludge dewatering facilities and a larger incinerator. However, if chemicals and materials can be successfully recycled in the processes, this system should be a feasible alternative.

d. There are a number of advantages inherent in the chemical/physical process, such as less land area requirements more control over treatment plant performance, etc.

3. Comparisons of System Alternatives. The biological/physical process (Alternative A) is recommended for treatment of the wastewater at the Central Plant. The reasons are as follows:

   a. Cost. A comparison of the construction cost and the operating and maintenance costs for the biological/physical and the chemical/physical processes are presented in Table 2-1. The two processes will have several common unit operations: influent collection structure, pretreatment, equalization, re-lift, disinfection and post aeration. The principle cost difference is in the method selected for biological stabilization and the resulting solid production for ultimate disposal. The costs favor the biological/physical process (Alternative A).

   b. Effluent Water Quality. The activated sludge process is proven to be capable of providing the required results. The Treatability Study field data obtained

PAGE NOT

AVAILABLE

DIGITALLY

from pilot plant tests indicate that the activated sludge, with additional advance waste treatment can reduce the BOD_5 and SS to levels less than 10 mg/L and even to 5/5 standards. The chemical/physical carbon absorption data demonstrated the lower standards could not be accomplished.

c. Solids Production. The biological/physical process results in lower quantities of sludge than the physical/ chemical process. This has a considerable effect on costs, as well as an advantage from ultimate disposal.

4. "No Action" Alternative.

   a. Impact of this Alternative.

      1. It fails to provide adequate health and safety protection for area residents by allowing the untreated and partially treated wastewater to be discharged into the Trinity River. The existing plant capacity is 30 MGD. By 1977 the projected wastewater flow will be 60 MGD and by 1985, the estimated flow will be 100 MGD.

      2. It fails to provide adequate public services in the area of need and development.

      3. It fails to protect the quality of the natural environment by the elimination of pollutants. The discharges into watercourses of untreated and partially treated wastewater will affect the downstream water quality, threaten the well-being of

wildlife, and also cause severe eutrophication problems.

4. It will seriously impede the orderly growth in the Upper Trinity metropolitan area, because of impairment to the general sewer service.
5. It generates aesthetic problems. The living conditions and standards of area residents and others downstream would be affected by the unfavorable sight and odor of untreated wastewater.

III. DESCRIPTION OF PROPOSED ACTION

A. Description of Proposed Treatment Facility.

1. Proposed Plant Rating. The expansion of the Trinity River Authority's Central Sewerage Plant will allow treatment of the average projected wastewater flow from the System through the design year 1985. The plant ratings initially, upon completion of construction, 1977, and at design year are presented in Table 3-1.

TABLE 3-1

PLANT RATING, MGD

Flow	1977	1985
Average Daily	60	100
Diurnal	36-96	60-160
Peak	150	250

2. Proposed Method of Treatment. The proposed method of wastewater treatment utilizes the biological/physical approach. The existing plant will be utilized at its design capacity of 30 MGD to accomplish "roughing operations" and thereby decrease the total organic loading to the proposed enlargements.

   A general description of the proposed wastewater treatment unit operations and processes is presented in Table 3-2 and illustrated in Figure No. 3-1.

PAGE NOT

AVAILABLE

DIGITALLY

TABLE 3-2

PROPOSED TREATMENT PROCESSES

Operation	Description
Screening	Mechanically cleaned, vertically inclined bar screen, with one inch bar openings. Screenings will be disposed in landfill.
Raw Wastewater Pump Station	The raw wastewater pumping station will provide an initial lift of 74 feet of the influent wastewater to the grit removal basins, then flow by gravity to existing plant, as well as to the proposed primary clarifiers, equalization basins, and activated sludge processes, including the final clarifiers. Odor control will be provided of the wet well exhaust through the use of ozone.
Grit Removal	Eight aerated grit removal basins, sized for 250 MGD peak flow at 5 minute detention time. The flow will be divided with a maximum of 30 MGD to be treated in existing plant and the remaining flow in the proposed facilities. The grit will be disposed of by landfill methods at the existing site.
Primary Clarification	Six circular basins to provide removal of settleable solids and floatable material,

sized for 220 MGD peak flow with the additional 30 MGD channeled to the existing plant clarifiers. At average design flow of 70 MGD, plus an additional 10 MGD intraplant flow, the overflow rate through the proposed primary clarifiers is 865 gal/ft^2/day and the detention time is 2.1 hours.

Equalization	Holding capacity of 11 MG to provide a constant flow to the aeration basins for minimizing daily fluctuations. Mixing capability to prevent sedimentation of solids. The effluent from the existing plant will be combined with the proposed plant flow in this equalization basin. The excess treated storm water will overflow the equalization basin and be pumped to the disinfection basin for further treatment.
Aeration Basin	Eight basins, complete mix design having a 5.2 hour detention time at 110 MGD average flow. Oxygen transfer into the wastewater will be accomplished by diffused air, with facilities of sufficient capacity to remove carbonaceous waste to 10 mg/L soluble BOD_5.
Final Clarification	Eight circular basins to provide a detention time of 2.1 hours and an overflow rate of

760 gal/ft^2/day at 110 MGD average flow for the separation of the solids and the liquid.

Relift Pump Station	The wastewater will be relifted to the pressure filters, with flow by gravity to carbon absorption, disinfection and post aeration basins. Sufficient head will be provided to discharge the treated wastewater at river flood stage.
Filtration	Pressure type, down flow design, service rate will be 6 gpm/ft^2. The design flow rate is 110 MGD.
Carbon Absorption	Expanded bed, granular activated carbon, upflow design with a service rate of 8 gpm/ft^2, 10 minute contact time. Carbon regeneration facilities will be provided. The carbon absorbers are sized for a 102 MGD flow rate.
Disinfection	Chlorination contact basins to allow 20 minute contact time and chlorination facilities sufficient to obtain 1.0 mg/L chlorine residual at peak flow af 250 MGD flow. The excess, treated storm water (150 MGD) will be combined with the proposed plant effluent flow for disinfection.

Post Aeration	Surface aerators will be provided, to raise the dissolved oxygen of the plant effluent to a minimum of 2 mg/L prior to discharge.
Sludge Handling	The primary and waste activated sludges will be concentrated, chemically conditioned, mechanically dewatered, and incinerated. The resulting inert ash will be disposed of by landfill at the existing site.

3. Wastewater Treatment Expected. The expected degree of treatment using the proposed biological/physical process is shown in Table 3-3. These are based on the average design flow rate of 100 MGD.

TABLE 3-3

WASTEWATER QUALITY

PROPOSED TREATMENT FACILITY

Parameter	Influent (mg/L)	Effluent (mg/L)	Removal (%)
Total BOD_5	263	10	96
Total COD	620	25	95
Suspended Solids	253	10	96
Dissolved Oxygen	0	2	NA
Fecal, log avg. not to exceed	NA	200/100 ml.	NA
Chlorine Residual	NA	1.0	NA

No provisions for nutrient removal are currently provided.

4. Special Units. Advanced waste treatment unit operations will be required to meet the stringent wastewater effluent standards specified in the proposed Discharge Permit. The effluent from the proposed biological process will require filtration in order to meet the suspended solids requirement of 10 mg/L, carbon absorption to maintain the BOD_5 value of 10 mg/L, disinfection, and post aeration to assure a minimum dissolved oxygen level of 2.0 mg/L.

   Ozone generation equipment will be provided for control of odors through its injection into the exhaust air at specified processing areas.

   The dewatered biological solids will be incinerated to produce a sterile, inert ash which is readily suitable for on-site landfill. The necessary air pollution control equipment will be installed to assure compliance with the Texas Air Control Board requirements and those of other regulatory agencies having jurisdiction.

5. Land Requirement. The proposed wastewater treatment plant will be constructed on the existing Authority's site. This site consists of 450 acres, completely surrounded by a levee. The existing lagoons, 159 acres, will be drained and utilized for solids disposal following established Texas Department of Health guidelines.

B. Description of Existing Treatment Facility.

1. Existing Plant Rating. The construction of the existing treatment plant was completed in 1959. The average daily flow during the

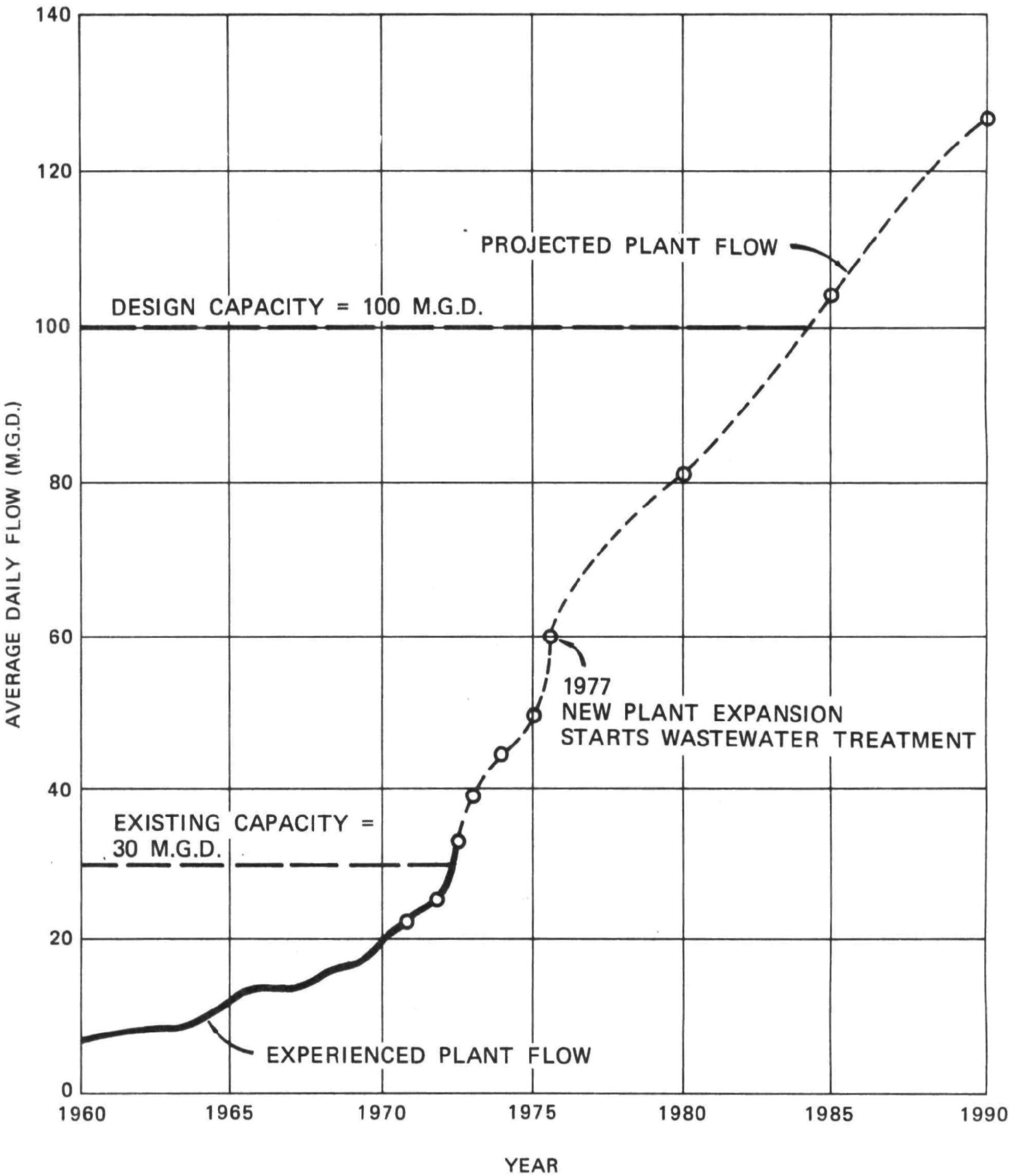
first year of operation was 6.6 MGD. The quantity of wastewater treated increased to 24 MGD in 1972. With the growth of the existing cities served by the Authority and the addition of Arlington to the Central System, the flow rates have averaged 32 MGD the first four months of 1973. Figure No. 3-2 shows the experienced flows, along with the projected quantities to design year.

2. Existing Method of Treatment. The wastewater is treated biologically using trickling filters, with the resulting sludge produced anaerobically digested and ultimate disposal by ponding. The principle wastewater treatment unit operations and processes existing at the Authority's Central Plant are presented in Table 3-4.

TABLE 3-4

EXISTING TREATMENT PROCESSES

Operation	Description
Pretreatment	This consists of screening, pumping and flow measurement.
Primary Clarification	Two circular basins, 220 ft. diameter, are provided to remove settleable solids and floating material. The recirculation flow from the primary trickling filter is returned to the primary clarifiers for further treatment.



TRINITY RIVER AUTHORITY OF TEXAS
CENTRAL SEWERAGE SYSTEM

AVERAGE DAILY FLOW PROJECTION

FIGURE NO. 3-2

Primary Trickling Filter	Two primary trickling filters having a total surface area of 69,300 sq. ft., a total volume of 8.6 acre-feet, and a hydraulic capacity of 22.5 MGD, each are used to biologically stabilize the organic waste. The primary filters have mercury type seals.
Secondary Trickling Filter	Two secondary trickling filters having a total area of 69,300 sq. ft., a total volume of 7.2 acre-feet, and a hydraulic capacity of 30 MGD each, are used to provide additional biological treatment. The secondary filters have mercury type seals.
Relift and Recirculation Pumping	The recirculation pumps provide the return flow back to the primary clarifiers. The relift pumps provide the lift necessary to transfer the treated wastewater to the oxidation pond and/or to the West Fork of the Trinity River as well as recirculation to the secondary filters.
Oxidation Pond	The east pond covers 85 acres, approximately 4 to 5 feet deep, having a total volume of 140 MG.

Sludge Handling — The primary sludge is degritted, gravity thickened and anaerobically digested. Ultimate disposal of the digested sludge is by ponding in the west lagoon.

3. Existing Wastewater Treatment. The existing Central Plant effluent quality is shown in Table 3-5.

TABLE 3-5

WASTEWATER QUALITY

EXISTING TREATMENT FACILITY

Parameter	Influent (mg/L)	Effluent* (mg/L)	Removal (%)
Flow 24 MGD Year 1972			
Total BOD_5	252	34.5	86
Suspended Solids	249	55.7	77
Flow 32 MGD Year Jan.-April 1973			
Total BOD_5	256	46.5	81
Suspended Solids	294	30.5	89
Discharge Permit			
Total BOD_5	NA	20.0	NA
Suspended Solids	NA	50.0	NA

* The suspended solids value for 1973 does not reflect the high summer values resulting from presence of algae.

4. Future Plans for Existing Plant. The existing plant will be loaded at a constant flow rate not to exceed 30 MGD. It will be utilized to remove settleable solids and to reduce the organic load. The effluent from the existing plant will be further treated in the

proposed plant biologically by the activated sludge process and by the advanced waste treatment operations.

To correct certain deficiencies in the existing plants, the following improvements are planned:

(A) The trickling filter mercury seals will be replaced with mechanical type seals.

(B) The existing anaerobic digestors will be shut down. The thickened sludge will be blended with the proposed plant sludge and mechanically dewatered and incinerated.

(C) The oxidation pond and the sludge disposal pond will not be used. They will be drained and the area utilized as on-site disposal of the proposed plants screenings, grit, and ash resulting from incineration.

C. Modification to Existing Plant. No modification to the existing plant will be included in the project except the change of trickling water seals from mercury to mechanical as required by regulatory agencies and associated pump and piping changes which will allow full utilization of the existing treatment units.

D. Proposed Line Work. Proposed line work includes the three interceptors below with their tentative sizes and lengths.

1.	West Fork Interceptor Parallel	21,200 ft. of 60 in. and 66 in. Running west from its point of connection to the Mountain Creek Interceptor
2.	Mountain Creek Interceptor Parallel	4,000 ft. of 60 in. running from the plant to its point of connection to the West Fork Interceptor

3.	Cottonwood Creek Trunk Parallel	6,500 ft. of 24 in. and 27 in. Running west from Lift Station No. 3

Also included in the proposed project is a detention reservoir of 3,000,000 gallons to be constructed adjacent to the existing detention reservoir, identified on Exhibit I.

E. <u>Total Area to be Affected by this Project</u>. In general, the Authority's System serves the Elm Fork and the Lower West Fork of the Trinity River. Exhibit 1 (following page 52) shows existing and proposed facilities, and a part of the natural drainage area being presently planned. The Central Plant is located north of the Dallas-Fort Worth Toll Road, in the northeast corner of the City of Grand Prairie, Dallas County. The plant location is shown in Figure No. 3-3.

The Central Regional Wastewater Treatment Plant will serve the metropolitan areas of Bedford, Carrollton, Coppell, Dallas-Fort Worth Regional Airport, Euless, Farmers Branch, Grand Prairie, Irving, and portions of Addison, Arlington, and Dallas, Exhibit 8 shows the areas served.

F. <u>Relationship of this Project with other Trinity River Basin Studies</u>. The North Central Texas Council of Governments (NCTCOG) prepared the COMPREHENSIVE SEWERAGE PLAN, which includes the Central Plant and System as one of six regional sewerage systems. The Plan proposed that the Central Plant be enlarged to a capacity of approximately 200 MGD by the year 2020. The Central Plant will serve the metropolitan areas of Bedford, Carrollton, Coppell, Dallas-Fort Worth Regional Airport, Euless, Farmers Branch, Grand Prairie, Irving and portions of Addison, Arlington and Dallas.

Previous reports and studies prepared for the Authority recommended that planning be initiated in 1972 for the enlargement of the Central System's treatment and transportation facilities. The increased capacity of the System will be necessary to provide service as the

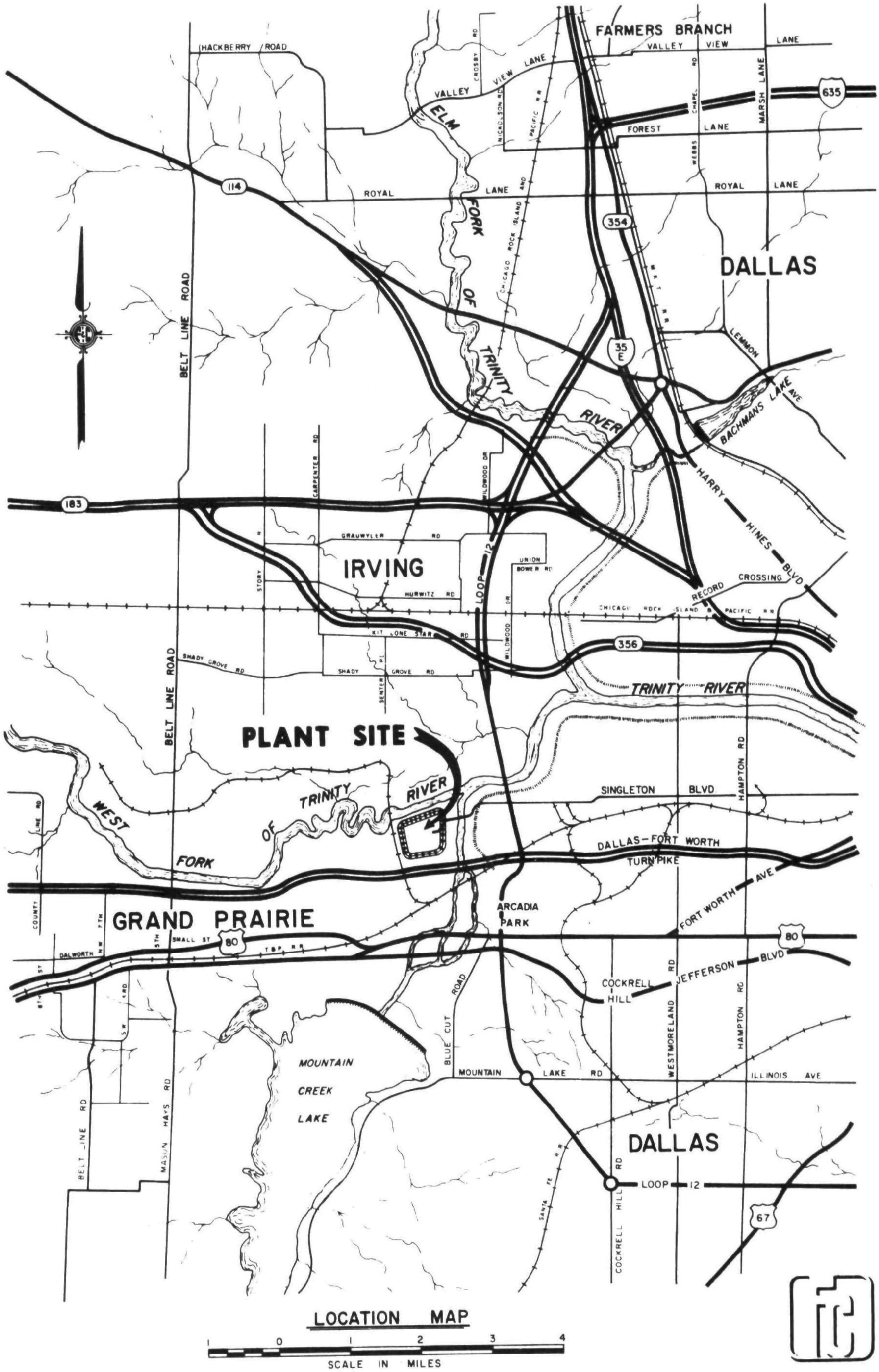

FARMERS BRANCH
DALLAS
IRVING
PLANT SITE
GRAND PRAIRIE
DALLAS
MOUNTAIN CREEK LAKE
ARCADIA PARK
ELM FORK OF TRINITY RIVER
WEST FORK OF TRINITY RIVER
TRINITY RIVER
BACHMANS LAKE
DALLAS-FORT WORTH TURNPIKE
HARRY HINES BLVD
SINGLETON BLVD
FORT WORTH AVE
JEFFERSON BLVD
BELT LINE ROAD
ROYAL LANE
FOREST LANE
VALLEY VIEW LANE
HACKBERRY ROAD
LOOP 12
LOCATION MAP
SCALE IN MILES

FIGURE NO. 3-3

PAGE NOT

AVAILABLE

DIGITALLY

area increases in population. In December 1971, it was recommended that additions to the treatment plant be implemented in order to treat 100 MGD which is the anticipated average daily flow to the System by 1985. Acceptance of this recommendation by the Authority led to the development of the Treatability Study which investigated the various treatment methods and reported the design values of each method studied. The data developed during the Treatability Study has been used to determine which treatment process or combination of processes proved to be the more feasible with respect to initial capital cost, operation and maintenance cost, discharge parameters, flexibility for expansion to a higher degree of treatment and increased flows, and impact of the selected processes on the environment.

The Design Analysis Report has been completed on this project which specifies in detail the proposed wastewater treatment unit operations and processes.

The proposed action conforms to agency planning in detail.

G. Status of Project, June 1973.

1. Treatability Study. This report presents the results and data developed during field studies conducted to determine the treatment parameters of various wastewater treatment unit operations and processes which can be utilized in the enlargement of the Central Plant. The report was completed in June, 1972.

2. Design Analysis Report. This report, completed March 1973, presents the design criteria for the biological/physical wastewater

treatment unit operations and processes recommended for enlargement of the Central Plant.

3. Plans and Specifications. Following approval of the Design Analysis Report by the Authority, and other regulatory and funding agencies, the information and recommendations presented herein will be used to prepare detailed plans and specifications for construction of plant enlargements and improvements.

   The time required for development of plans and specifications on the plant enlargements is estimated to be a minimum of ten (10) to a maximum of fourteen (14) months. Further, construction of the improvements will require approximately thirty-three (33) months following award of construction contracts. Preparation of detailed plans cannot begin, however, until all contract and funding negotiations are finalized.

4. Funding of the Project. A summary of the estimated costs for the principle elements of the proposed plant enlargement is given in Table 3-6.

   A request, WPC-TEX-992/1094 for Federal funding, has been made with approval for a portion of the funds obtained.

5. Timing. So far as known, timing of the proposed project is unrelated to any other Federal, state or local programs.

TRINITY RIVER AUTHORITY OF TEXAS
CENTRAL SEWERAGE SYSTEM

SUMMARY OF ESTIMATED COST

Pretreatment		
Plant entrance piping	$ 85,000	
Raw wastewater Lift Station	1,470,000	
Grit removal basins	840,000	$ 2,395,000
Primary Clarification		1,577,000
Equalization		1,458,000
Activated Sludge Process		
Aeration	$3,300,000	
Final Clarification	2,291,000	
Recirculation Station	420,000	6,011,000
Advanced Waste Treatment		
Relift Station	$ 625,000	
Filtration	3,000,000	
Carbon Adsorption	3,150,000	
Disinfection	370,000	
Post Aeration	185,000	7,330,000
Sludge Handling		
Sludge Concentration	$1,103,000	
Sludge Dewatering	1,059,000	
Sludge Incineration	3,825,000	5,987,000
Appurtenances		
Yard Piping	$1,300,000	
Buildings and Roads	700,000	
HVAC	350,000	
Yard Drainage	250,000	
Railroad and Embankment	300,000	
Electrical Service and Distribution	2,350,000	
Instrumentation	1,590,000	6,840,000
Sub-Total Estimated Plant Construction Costs		$31,598,000
Construction Contengencies and Engineering		6,320,000
Total Estimated Plant Costs		$37,918,000

TABLE 3-6

IV. ENVIRONMENTAL EFFECTS OF PROPOSED ACTION

A. Environmental Conditions Should the Proposed Action be Implemented.

1. Construction Impact (Short Term Impact)

(A). Alterations to Land Forms, Streams and Natural Drainage Patterns. There will be no permanent alterations to land forms, streams or natural drainage patterns outside of the existing levees due to construction. Any temporary alterations during the course of construction will be rectified prior to completion of construction.

(B). Erosion Control Measures. Because of the flat character of the flood plain area in which most work is expected to occur, it is not anticipated that erosion will present a significant problem.

In those areas where erosion may occur, it will be required that erosion be controlled by the use of temporary settling pits, dikes, berms and area cover material. Temporary dams will be required for those portions of line work which cross existing levees. Following such work, the construction sites will be graded, seeded and restored to their original condition.

(C). Affect of Siltation and Sedimentation on Area Watercourses. It is possible that some sedimentation and turbidity will occur in the receiving waters during construction even with erosion control. It is known that bridge work will be required to gain access to the plant site for heavy equipment. Every precaution will be taken during construction to minimize the amount of sedimentation and turbidity occurring in the receiving waters.

(D). Protection for Cover Vegetation and Trees. Where possible, cover vegetation including trees will be protected by means of fences and wooden slats attached to trees. Where necessary for construction of line work, vegetation and trees will be removed. Only such growth within the right-of-way as is necessary to construction and subsequent operation and maintenance will be removed.

(E). Clearing with Herbicides, Etc. Clearing involving the use of herbicides, defoliants, blasting, cutting or burning is not anticipated, but should any of these methods of clearing be required, it will be accomplished under supervised conditions and monitored.

(F). Disposal of Soil and Vegetation Spoil. Top soil will be stockpiled and subsequently placed on stripped areas and fill areas. Excess soil will be deposited in the lagoon area. Vegetation spoil will be disposed of by burial, at at site(s) obtained by the contractor.

(G). Relocation. The project will require no relocations.

(H). Method of Land Acquisition. No lands are to be acquired for this project.

(I). Adjacent Land Values. Adjacent land values are not expected to change significantly due to the nature of the area.

(J). Dredging, Tunneling and Trenching. Construction will not require dredging or tunneling. Trenching will consist of crossing intermittent watercourses. These crossings will be made at times of little or no flow. In most cases, the line will be encased in concrete where there would otherwise be a chance of scouring or washout. Construction will require no significant change in the cross-section of watercourses.

(K). Bypassing. Construction will require no bypassing of sewage at any time.

(M). Minimizing the Impact of Bypassing. Minimizing the impact of bypassing will be unnecessary as there will be none.

(N). Dust Control Measures. Dust control measures, if necessary, will consist of frequent sprinkling with water.

(O). Areas Affected by Construction Noise. The proposed plant and detention reservoir construction will take place at the existing plant site and the existing detention reservoir site. For the most part, construction will be sufficiently removed from residences so that construction noise will not be heard. Some portions of interceptor work may be sufficiently close to residences so that some noise may be heard.

(P). Precautions Against Noise. Construction of the proposed facility will require the use of machinery and equipment which increases ambient noise levels and produces temporary high noise levels. Equipment to be used will include backhoes, power shovels, heavy trucks, and compressors and pumps.

These pieces of equipment have an average noise level ranging from 70 to 85 dBA. The contractor will be required to minimize the impact of noise as much as possible. For instance, if pneumatic hammers are used, the contractor will be required to use new hammers which operate at 90 to 100 dBA, or, if old hammers are used, to furnish a protective enclosure to muffle the sound. In general, the contractor will be required to limit his work to daylight hours. It is expected that noise impact on wildlife will be limited to temporary displacement of birds and small mammals.

(Q). Areas Affected by Blasting. It is not anticipated that any blasting will be required during construction of the proposed project.

(R). Precautions Against Effects of Blasting. Blasting is not anticipated to be required. Should it be, however, the shots will be light and will be accomplished under supervised conditions and monitored. The contractor will be required to take all necessary precautions to protect area residents and wildlife from any possible effects.

TABLE 4-1

MAXIMUM RECOMMENDED OCCUPATIONAL NOISE EXPOSURE

Sound Level dBA	Daily Exposure Time hr
90	8
92	6
95	4
97	3
100	2
102	1-1/2
105	1
110	1/2
115	1/4 or less

TABLE 4-2

MAXIMUM SUGGESTED NON-OCCUPATIONAL EXPOSURE

Sound Level dBA	Daily Exposure Time
70	16-24 hours
75	8
80	4
85	2
90	1
95	30 minutes
100	15
105	8
110	4
115	2

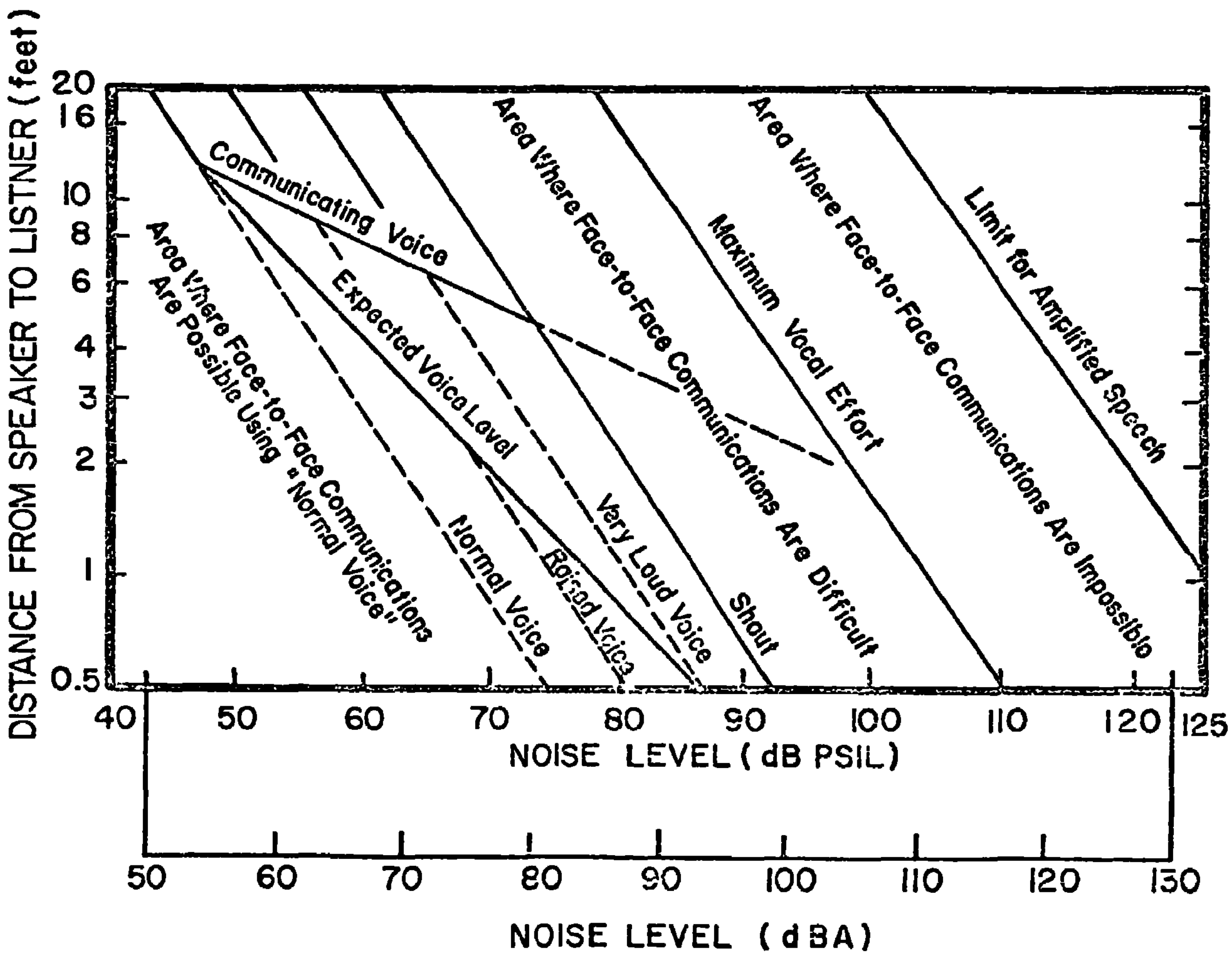

DISTANCE FROM SPEAKER TO LISTNER (feet)
20
16
10
8
6
4
3
2
1
0.5
Communicating Voice
Expected Voice Level
Area Where Face-to-Face Communications Are Possible Using "Normal Voice"
Normal Voice
Raised Voice
Very Loud Voice
Shout
Area Where Face-to-Face Communications Are Difficult
Maximum Vocal Effort
Area Where Face-to-Face Communications Are Impossible
Limit for Amplified Speech
40
50
60
70
80
90
100
110
120
125
NOISE LEVEL (dB PSIL)
50
60
70
80
90
100
110
120
130
NOISE LEVEL (dBA)

TABLE 4-3

(S). <u>Measures to Minimize Vehicular and Pedestrian Traffic Disruption</u>. The contractor is required by state law to provide and maintain detours and the necessary number of barricades, signs, flags, flagmen, and traffic cones to adequately direct traffic. The contractor will be directed to follow these requirements in the contract specifications. Vehicular and pedestrian traffic disruption will be minimized further by other provisions of the contract specifications. The contractor will be required to submit for approval by the Engineer, before beginning work on the project, a plan of construction operations, outlining in detail a sequence of work to be followed and setting out the method of handling traffic during construction; to keep traveled surfaces clean and free of dirt or other materials used in his hauling operations; and to not cross moving traffic with hauling equipment by weaving with the flow, protected by flagmen or other protective measures deemed necessary by the Engineer.

(T). <u>Effects of Night Work</u>. The contractor will generally be required to limit his activity to daylight hours. Night work will be permitted only under unusual circumstances and when conditions dictate that an item of work be done at night. For example, line tie-ins may need to be done at night in order to take advantage of low flow conditions characteristic of early morning hours. In such cases, only areas required will be flood-lighted and no harm to wildlife or serious disturbance to area residents is anticipated.

(U). Protection Against Construction Hazards. Most construction will be isolated from the public. That construction near the public will be line work across raods. The public will be protected in such cases by protective measures required of the contractor such as signs, detours, barricades, flagmen, and warning lights. In all cases, the contractor will be required to take all necessary precautions to protect the public and his employees from construction hazards. Safety provisions for such protection will be included in the contract specifications.

2. Long Term Impact

(A). Land Affected by the Construction. The proposed plant expansion and additional detention reservoir will be constructed at the site of the existing plant and the existing detention reservoir. No additional land purchase will be necessary. The wastewater treatment site was originally chosen out of geographic necessity as a location near the confluence of three major water courses: the Elm Fork of the Trinity River, the West Fork of the Trinity River and Mountain Creek. The project site is located in a flood plain and reclaimed from an area that was previously utilized as a gravel pit. The area around the plant is open and there are no parks or other areas of recognized aesthetic value within the immediate vicinity. The physical location of the plant site is ideal for the operation of a regional sewage treatment facility. Line work will be accomplished within existing right-of-way.

The effect of line work would be on approximately 6 miles of right-of-way 50 ft wide and the plant expansion will affect approximately 100 acres of the present 450 acre site owned by the Authority.

(B). Beneficial Uses of Land. The use that is intended is the same that is presently employed so there is no beneficial use of the land eliminated.

(C). Change in the Natural or Present Character of the Area. There will be no change in the area due to this project.

(D). Interference with Natural Views. Proposed structures will not interfere with or obstruct natural views to any significant degree. Interceptor lines will be underground and most other facilities will be constructed at or near grade. Only the filter standpipe and incinerator stack will extend upwards to any degree and these structures will be located at the proposed plant expansion site, which is relatively isolated, surrounded by levees on three sides and a toll road, which will be at a distance from the structures, on the fourth side.

(E). Architectural Techniques. Plant facilities will be constructed into functional units and design of the component units will consider the aspect of aesthetics in making every effort towards realizing that goal. Measures anticipated which should minimize the effect of the project on natural or aesthetic values are architectural techniques for rendering above-ground structures compatible with surrounding environment and specifications for construction, environment control and clean up. Architectural techniques which will be employed to minimize the impact of surface structures on the environment will be the use of earth-tone materials and compatible pastel colors.

(F). Landscaping. A number of techniques will be employed in an effort to provide the type of landscaping that will make the plant site blend with the surrounding area. Trees and shrubs will be planted, fences will be erected where necessary, grading and grass planting will be implemented and full time grounds maintenance measures will be employed.

(G). The Relationship Between Residences and Business, the Project, and Prevailing Wind Patterns. The prevailing wind is southerly; the nearest business is approximately one mile from the plant site. One and one-half miles immediately north of the site there are numerous residences. The nearest group of these is approximately one mile northwest of the site and the next nearest group is approximately the same distance to the west southwest. The third such residence group is approximately three-fourths of a mile due east of the site.

(H). Possible Odor Sources and Their Effects. Possible odor sources and their effects were considered very carefully in the selection of a treatment process. Since the plant will utilize activated sludge processes throughout, including elimination of existing oxidation ponds, odors emanating from the treatment facility are expected to be infrequent and only during abnormal conditions. If, during some rare circumstance, odors do develop, it is probable that only those residences discussed above would be subjected to odor nuisance.

(I). Incineration: The proposed features aimed at the control of odor will result in the elimination of the present conditions which are causing periodic odor problems. Since incineration of solid wastes is proposed, a minimal level of emissions and particulate matter will issue from the proposed plant where previously there was no such discharge. Present Texas legislation requires that both a permit to construct and a permit to operate any facility which may emit air contaminates must be obtained from the Texas Air Control Board. Incineration equipment will be designed to meet standards set forth by the Texas Air Control Board.

(J). Assessment of potential odor problems: The following features of the proposed design are specifically intended to eliminate odor:

1. Alternate Sludge Facilities. It is proposed to provide alternate sludge handling facilities including a sludge holding tank, dewatering, and incineration facilities.
2. Elimination of Sludge Pond. Because of the partially undigested nature of the solids in the existing sludge pond, it is recognized that discharge of either the solids or the supernatant directly to the river could represent a significant public health hazard. Because of the less than optimum digestion

conditions existing in the sludge pond and the absence of a method of controlling these conditions, the likelihood of digestion being completed in the pond appears remote. Without complete digestion, odorless air drying cannot be expected. Therefore, following completion of alternate sludge handling facilities, to include dewatering and incineration, the following method of eliminating the sludge pond is proposed:

a. The solids will be withdrawn first so that odors may be kept to a minimum by the existing liquid cover and the algae population therein.
b. Solids will be degritted to protect subsequent equipment.
c. Solids will then be dewatered to reduce heat required in incineration.
d. Dewatering pressate or filtrate will be sent to the head of the plant for treatment.
e. Solids will then be incinerated for deodorizing and sterilization.
f. Incineration residue will be removed for burial on site or in a sanitary landfill.
g. Following removal of the solids, the remaining water in the pond will be sent to the head of the plant for treatment.

3. Elimination of Polishing Pond. Since its construction, the existing polishing pond has served the partial function of a final clarifier for the settlement of trickling filter sludge as well

as the function of an oxidation pond. Therefore, it is proposed to use the same method for the elimination of the polishing pond as was proposed for the elimination of the sludge pond.

4. Elimination of Sludge Digesters. Prior to dismantling of the existing digesters, sludge will be removed and processed through the sludge handling system.
5. Prevention of Odor in Proposed Sludge Holding Tank. Gases coming from the proposed sludge holding tank will be treated with ozone to remove odor.
6. Equalization Pond Odor Prevention. To prevent the occurrence of odor in the proposed equalization pond, the equalization pond will be preceded by primary clarification and will be aerated.
7. Toxic Waste Control. To prevent plant upset by toxic waste, which would result in odor, a monitoring system will be provided on the interceptors to indicate the presence of toxic levels of waste in the interceptors. The equalization basin will be divided into several sections to allow isolation of the waste upon receipt at the plant. Thereafter, it may be gradually blended with the remaining wastewater in non-toxic concentrations and treated.
8. Ultimate Disposal. Incinerator residue will be disposed of in a sanitary landfill on site.

The proposed features aimed at the control of odor will result in the elimination of the present conditions which are causing periodic odor problems. Since incineration of solid wastes is proposed, a minimal level of emissions and particulate matter will issue from the proposed plant where previously there was no such discharge. Present Texas legislation requires that both a permit to operate any facility which may emit air contaminates must be obtained from the Texas Air Control Board. Incineration equipment will be designed to meet standards set forth by the Texas Air Control Board.

(K). Water Quality Standards: This project is designed to conform to the North Central Texas Council of Governments' area wide plan for the provision of sewer service to meet water quality standards as set forth by the Texas Water Quality Board.

(L). Effects on Present Water Quality. Algal concentrations below the outfall will be significantly reduced. During clear, dry weather such as exists much of the time, chlorophyll concentrations in the present pond effluent are around 500 ppb, and in the river just above the plant around 25 ppb. The proposed action would greatly reduce the algae in the effluent, and thereby in the river. This will probably be the most visually obvious effect on water quality, and would be apparent through the immediate Dallas area.

Associated with the lower algal concentrations and lower total suspended solids in the effluent would be a lowered prepensity for anaerobic organic sludge to deposit in the river during low flow. Therewith odors and total suspended solids in the river would be lowered. Dissolved oxygen in the river would be higher due to lower effluent BOD though it cannot be said precisely how much at particular points downstream. Since BOD requires a certain amount of time to be assimilated, some of the effects will be manifest in the immediate area below the plant and some will occur only after the river has received additional effluents from the City of Dallas plant, the East Fork, and other sources.

The reduction of eutrophication is not a prime goal of the proposed actions, because there is not firm basis for achieving that end at this time. Processes designed primarily for nutrient removal are not in the proposed action. However, the proposed use of ferric chloride for sludge treatment will reduce the phosphates in the water extract from the sludge. Moreover, the nutrient concentrations in the effluent may be reduced as a consequence of the improved biological and physical treatments called for in the proposed action. Particularly, improved solids removal by the physical treatments may reduce phosphates, which commonly adhere to certain solids. The net effects on algal growth and other phenomena of eutrophication downstream cannot be predicted at this time; it may or may not be noticeable. In any case they are harmonious and synergistic with all known anti-eutrophication measures. When the most effective anti-eutrophication measures for the Trinity Basin are identified, the proposed action will not foreseeably hinder their application or effectiveness in this plant.

(M). Effects on Aquatic Biota: Through increased dissolved oxygen and reduced solids and toxins such as ammonia, a more vigorous and diverse aquatic biota will develop, particularly among benthic and necktonic animals. This project alone is not expected, however, to raise the dissolved oxygen or reduce other problems to the point that an unlimited oxygen-requiring, cool-water, and otherwise sensitive fishery will result. Rather, more likely, there will be some movement in that direction by possibly permitting very rough fish as carp and gar to survive in the immediate metropolitan area, where presently only the surface breathing mosquitofish is continually present. Present indications (Texas Parks and Wildlife Department, personal communication, 1973; Browning unpublished notes) are that scaly game fish do not persist above SH7 near Crockett because of occasional severe oxygen depressions (the "black rise") plus an old lock and dam obstruction at that point; catfish may be found above that point, up to the vicinity of Corsicana; carp and gar flourish up to the southern edge of Dallas; and only mosquitofish are found from there to the farthest upstream (Riverside) STP on the West Fork. This pattern has exceptions as various fish enter the River in flood releases or runoff from upstream reservoirs or tributaries, or certain favorable conditions persistent long enough to permit upstreamward migrations. However, dry weather and low flow are the limiting conditions, and when they occur they reduce the populations to those indicated above.

Fewer solids will permit cleaner substrates for benthic organisms. Effects on algae have been discussed above, under 1. Suspended algae will be significantly reduced directly below the outfall, and possibly, though less predictably, reduced farther downstream. The resulting clearer water in the river may permit somewhat greater growth of rooted/attached plants, but it is not expected to be problematic because the natural clay-sand-gravel substrate of the river and steep banks discourage bottom growths.

(N). Effects of Chlorine residuals on aquatic life: The effects of chlorine residuals on aquatic life in general is an open question. Even so, there is one specific study related to the situation at hand (Silvey, 1970). It and subsequent work (Davis, 1973) indicates that chlorination inhibits or kills stream-purifying, assimilative bacteria as well as target harmful bacteria, that chlorinated hydrocarbons are formed in the process, and that even the harmful bacteria rebound to sizable populations downstream.

On the other hand, we know of no kills of fish or other aquatic macro-organisms which have been attributed to routine effluent chlorination. Moreover, desirable species of fish are known to flourish in certain waters receiving chlorinated effluents in northeastern Texas (Lake Lewisville near Denton discharges; Lake Lavon near McKinney discharges).

On balance, however, we believe it to be a quite open question. There may be undesirable effects on the aquatic biota, but they haven't been thoroughly documented yet.

(O). De-Chlorination: The possibility of de-chlorination exists through the addition of reducing agents or retention facilities. Reducing agents (Na_2SO_3, $Na_2S_2O_3$) constitute an oxygen demand and are undesirable for that reason, besides cost. Retention facilities would still leave the question of how much retention is necessary to avoid harm. Since harm is not yet known, de-chlorination is not indicated.

(P). Effect on municipal and industrial water supplies, irrigation, recreation and other uses: The effect on subsequent use of the receiving water would be generally desirable. The above-named effects on water quality (l) and aquatic biota (m) would make it more desirable for industrial or domestic water supplies, recreation, including aesthetics, and most other uses. Fresh water fishing is expected to improve only by allowing first rough fish, then catfish, and then scaly game fish to move farther upstream in or toward the metropolitan area from the south than at present.

Small, possible decreases in nutrient concentrations resulting from the project might mean less fertilizer value when used for irrigation, but it is not expected to affect the demand for such use, if it is detectable at all.

(Q) Wastewater Re-Use. Water supplies in project area are adequate at the present time. Re-use is not presently contemplated.

(R) Effects of Re-Use on Receiving Waters Quality. There is not sufficient data to draw any conclusion.

(S) Groundwater Recharge. There is no groundwater depletion problem.

(T) Spray Irrigation is not proposed.

(U) Present and Potential Market for Reclaimed Water in the Area. is currently unknown. As the quality of the treated wastewater improves, the possibility of future uses will probably present themselves.

(V) Diversion of Flows Between Basins will not occur.

(W) Ultimate Disposal Methods for Grit, Ash, and Sludge. Sludge will be incinerated. The incinerator residue, along with grit, will be buried in a sanitary landfill as defined by the Texas State Health Department. As required by the Texas State Department of Health, selection of disposal sites will be based on consideration of topography and drainage systems, location of flood plains and water wells, direction of prevailing winds, proximity of residences and structures, existing zoning, subsurface conditions, existing roads and bridges, haul distance, availability of cover, and expected life of the fill. Every effort will be taken to insure that the Public Health is protected.

(X) Solids Re-Use. There will be no solids reuse. After incineration, ash will be used for land fill.

(Y) Effects on Historic Sites, Recreation Areas or Natural Preserves. No element of the proposed project will be located near any such sites, areas or preserves.

(Z) Local Areas Designated for Use as Recreational Areas or Natural Preserves. The map (Figure 1) shows the areas that are designated open space, natural preserve or recreational area. The area immediately east of the plant site is open space flood plain.

(AA) Potential Noise Levels. Normal operation and maintenance of the completed facilities will generate very little noise, except that generated by large mechanical systems such as pump motors, compressors, blowers, and fans. In all cases, mechanical systems will be designed to conform to Occupational Safety and Health Act of 1970 and Walsh-Healy Act specifications regarding the limitation of sound pressure acting upon exposed persons' eardrums. In all cases, the sound pressure levels generated will be limited to 81 dBA. This will limit the total noise level, from two adjacent noise sources, to a maximum of 85 dBA.

(BB) Measures to Eliminate Noise. The general approach to noise reduction that will be employed can be divided into two major parts.

1. Reduction of noise at its source.
2. Reduction of noise level at the listeners' ears by changes in the path from the source.

Reduction at the source will be accomplished by selection of equipment with low vibration amplitude and low sound radiation levels. It will involve proper bearing alignment, proper lubrication, and use of vibration isolators. In the case of blowers and compressors, intake and discharge silencers will be provided.

Reduction of noise level at the listeners' ear will be provided by changing the relative position of the source and the listener, by changing the accoustical environment, and by introducing attenuating structures, such as walls, barriers, or total enclosures, between the source and the listener.

(CC) Control of Access to Facilities. The proposed plant construction site is surrounded by a toll road on one side and by levees on the other three sides, providing single access to the plant through which coming and going will be monitored.

(DD) Effect on Insect Populations. The proposed project should have no effect whatever on insect populations.

(EE) Insect Control Programs will not be required.

(FF) Insecticides will not be required by the proposed project.

(GG) Effect on Wildlife, Birdlife and Aquatic Habitats. Wildlife on the watershed consists of small mammals and birds. There are no resident populations of fishes or amphibians since the watercourses are low D. O. and intermittent in flow. Although the construction impact will necessitate a temporary impairment of the normal habitat for some of these animals and birds, the long-term impact will not be great. It should be noted that the population density for the smaller mammals which now inhabit the watershed grows smaller each year as urbanization proceeds.

Clearing of vegetation will temporarily dislocate the mammals and birds along proposed alignments. After completion of all line work, the cleared areas will again be available for growth of vegetation and areas cleared for construction will again be available for wildlife habitat. With regard to the treatment plant, no large-scale clearing will be necessary; however, there may be some permanent displacement of mammals and birds in the oxidation ponds. Since, in the recent past, there has been human activity in the plant area, it is doubtful that displacement caused by either construction or operation of the treatment facilities will be significant to any degree. With regard to aquatic habitats, the effect upon the aquatic habitat will not be significant. In-stream dissolved oxygen concentrations will still be at levels entirely inadequate for propogation of fish life. The diluted in-stream values of nutrients added by the wastewater stream will not be sufficient to impair the quality of the river water nor to have any long-term impact upon aquatic habitats in the river.

(HH) Project Relation to Flood Plains. As discussed previously, the site for the Central Sewerage Facility is located in the flood plain of the West Fork of the Trinity River. The treatment plant site also has, at present, and will continue to have, protective floodway levees around its perimeter, kept in an aesthetically pleasing condition by proper ground maintenance. The levees are designed to protect the facility from the Standard Project Flood as estimated by the Fort Worth District Corps of Engineers. This project will not hamper the flow of flood waters.

3. Secondary Impacts of the Proposed Action.

(A) The Degree to Which this Project Will Ultimately Affect Residential or Industrial Development is not quantifiable. Many factors determine the degree to which development will occur in the project area. development primarily depends upon a market for the sale of houses. Where that market is likely to occur, as in the Mid-Cities area stimulated by the Regional Airport, Six Flags, Seven Seas, etc., and where there is available land for development, the development of residential areas will be significant. The same theory applies in industrial development. Industry develops because of the potential to make a profit. The profit potential depends on the availability of raw materials at a reasonable price, availability of transportation, and location in a viable market place and, very important, the availability of labor. Therefore, should any of these ingredients be missing, then potential for development is decreased, this is without regard to whether sewage service is available or not. Since the Mid-Cities area has an economic and labor base conducive to industrial development, it is expected that there will be a significant amount of industrial development. Where adequate sewer and water services are present, the secondary impact is to create a more favorable climate in which residential and industrial development will be able to proceed in an orderly fashion.

(B) Ultimate Effect of the Project on the Character of the Area. Land use plans and trends indicate that the character of the area will develop in primarily a residential fashion because of the need for housing for people who work in the major core centers of Dallas and Fort Worth. Because of many reasons the Mid-Cities area has developed a primarily residential character, however, it is expected that needed services to the Regional Airport will spawn the growth of service and warehousing type industries in the future around the Airport. In any event, the proposed project is essential to the orderly development of the area which is expected to take place.

Concurrent with the long-range planning for sewerage service, there are a number of studies presently underway that will provide a guide to the provision of basic services such as water supply, solid waste disposal, transportation, etc., to meet the area needs through 1990 and beyond.

Presently the NCTCOG is engaged in a study to determine the best method for disposal of solid waste and to select sanitary landfill sites that will serve area needs through the year 1990. This study is being carried out under the sponsorship of the EPA under Grant No. G05-EC-00080-01. A synopsis of the study's purpose can be found in Appendix V - COPERATIVE REGIONAL SOLID WASTE PROGRAM SUMMARY REPORT. Preliminary information cóncerning present solid waste loads and projected future solid waste loads can be obtained from the NCTCOG. Sufficient data on conclusions regarding this aspect of the environmental assessment is currently not available. However, the detailed design is due to be completed by January, 1974.

(C) Extent to Which Undeveloped Areas Will Ultimately be Sewered. Where development has occurred in the watershed and where that area is designated to be served by the Central Sewage System as outlined in the NCTCOG UPPER TRINITY BASIN SEWAGE TREATMENT PLAN, sewage service will be provided. Service to undeveloped areas will be done in a manner that complies with the "reserve capacity" requirements of the Federal Water Pollution Control Act Amendments of 1972, Section 204 (a) (5). In undeveloped areas, it will be necessary to construct sub-systems which will collect and deliver sanitary sewage to the system proposed herein. It is the current policy of all the local governing agencies to require land developers to construct sub-systems of this type to City Standards and Specifications. It is probable that all currently undeveloped areas on the watershed will ultimately be sewered as a result of growth in the area; however, only a portion will be as a result of the proposed project and those undertaken by land developers and other privately financed entities within the design life of the facilities. This project is designed to serve a drainage area of approximagely 183,000 acres. Table 4-4 demonstrates how much development is expected to occur in each member city by design year 1985 and how much of this development is expected to be residential. Exhibit 8 delineates the project service area of each City or Agency served.

(D) Relationship Between the Project's Effect on Growth and the Type of Growth Desired by the Area Residents. Based on current land use policies and implementation by current zoning codes developed with public participation, there is no reason to believe that the growth stimulated by the project will be other than the type desired by the area residents. It is possible that the rate of growth may exceed that desired by area residents, and in such a case a new plan calling for staged development may have to be prepared by the appropriate communities.

(E) How This Project is Being Used to Implement Land Use Planning. By being able to provide a dependable service for sewage treatment, thus allowing the elimination of all plants in the service area, land use planning may be implemented where basic services, such as sewer and water, will be able to serve where the plan calls for such service. Where designations of land use categories may change the consideration of the availability of basic services is a primary consideration in reaching new determinations. Any such changes would be reviewed by the public as required by most zoning codes.

TABLE 4-4

TRINITY RIVER AUTHORITY OF TEXAS REGIONAL WASTEWATER SYSTEM

Existing and Projected Residential Development

City or Agency	Service Area (Acres)	1973 Developed Area (Acres)	1973 Residential Usage of Developed Area %	1973 Residential Usage of Developed Area Acres	1973 Population Served	1985 Estimates Developed Area (Acres)	1985 Estimates Residential Usage of Developed Area %	1985 Estimates Residential Usage of Developed Area Acres	1985 Estimates Population Served
Arlington	31,600	12,000	50	6,000	43,300	30,000	70	21,000	242,000
Bedford	6,500	3,000	60	1,800	12,550	6,000	70	4,200	46,000
Carrollton, Incl. Coppell	21,400	8,000	50	4,000	25,700	16,000	50	8,000	57,000
Dallas	18,400	8,000	50	4,000	37,800	14,000	50	7,000	50,000
D/FW Airport	17,600	10,000	0	0	8,900	15,000	0	0	40,000
Euless	7,000	5,000	60	3,000	29,200	6,000	70	4,200	62,000
Farmers Branch, Incl. Addison	10,200	8,000	50	4,000	32,200	10,000	50	5,000	50,000
Grand Prairie	33,300	15,000	60	9,000	55,700	28,000	60	16,800	102,000
Irving	36,800	20,000	60	12,000	104,300	32,000	60	19,200	195,000
TOTALS	182,800	89,000		43,800	349,650	157,000		85,400	844,000

V. ADVERSE IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED.

A. General. Careful planning, design and construction scheduling can minimize adverse effects on the environment. In spite of the best efforts in this direction, however, construction and operation of the proposed facilities will result in minor adverse effects on the human environment, and these effects cannot be avoided. Fortunately, most adverse effects will occur during the construction period and in a comparatively small area.

The proposed project by itself is the outgrowth of a prior commitment to a regional system. With each expansion, the reasons for abandonment of this system must be correspondingly more compelling. At this time, this system still appears to be the most feasible and economical solution to the wastewater problem of the area served and is consistent with the Regional Plan for Sewage Treatment.

1. Summary of Adverse Impacts. Unavoidable impacts to the environment as a consequence of the proposed project are listed as follows:

   (A) Unavoidable appearance of man-made structure in remote unpopulated areas.

   (B) Occasional unavoidable odor associated with wastewater treatment plant.

   (C) Unavoidable minimal levels of machine and motor noise detectable by operating personnel.

   (D) Unavoidable construction noises.

   (E) Unavoidable limited disruption of traffic during construction.

   (F) Unavoidable minimal levels of air contaminants and particulate matter in the air.

(G) Unavoidable removal of trees and disruption of ground along right-of-way.

2. Disruption and Inconvenience During Construction. The construction of projects such as the one proposed disrupts the neighborhood and temporarily impacts inhabitants of the immediate area. Disruption of vehicular and pedestrian traffic will result in obvious inconveniences, such as blocked driveways, closed roads, reduced speeds in the construction area and soft road or shoulder surfaces following installation of sewer lines. These inconveniences can be significantly reduced or eliminated by proper scheduling, close coordination with local officials, adequate early notification of the public, and proper control and protection of traffic by control signals, signs and barriers. Construction methods which will minimize impacts and maintain environmental protection will be achieved through the requirements of contract documents and plans and specifications. In residential areas, open ditches and excavation for sewers will be in such lengths as to minimize inconvenience and nuisance. Ground surfaces will be restored as nearly as possible to their original condition without delay upon completion of construction. Stockpiles and machinery parking will be required to be so located as to reduce nuisance and temporary blight and to minimize disruption of flow of traffic. Route selection will respect and protect vegetation to the maximum extent practical.

3. Noise. Construction of the proposed facilities will require the use of machinery and equipment which may increase ambient noise

levels and produce a temporary nuisance condition. Equipment to be used will include backhoes, power shovels, heavy trucks, compressors and pumps. These machines have an average noise level ranging from 70 to 85 dBA. The contractor will be required to minimize the impact of noise insofar as possible. His work hours will be limited to daylight hours. Noise impact on wildlife is expected to be limited to temporary displacement of birds and small mammals. If the use of pneumatic hammers becomes necessary, the contractor will be required to use new hammers which operate at 90 to 100 dBA, and if old hammers are used, he will be required to furnish a protective enclosure to muffle the sound.

Normal operation and maintenance of the completed project will generate very little noise. The sound levels generated will be extremely low and far below nuisance sound levels. Location of the site far removed from dwellings eliminates any opportunity for a nuisance impact.

4. Loss of Habitat. Construction activities and clearing will result in a temporary loss of habitat for small mammals and birds. After completion of the line work and the lift station, however, the cleared areas will again be available for growth of vegetation and areas cleared for construction will again be available for wildlife habitat. At the treatment plant, there may result some permanent displacement of small mammals and birds because of the drainage and filling of the oxidation ponds.

5. Air Pollution. Construction activities may result in small temporary increases in particulate matter concentrations due to dust. This will be kept to a minimum by requiring the sprinkling of dusty areas. Construction equipment will generate some hydrocarbons, carbon monoxide and other pollutants typical of those produced by internal combustion engines. There will be no large-scale concentration of such discharges to the atmosphere and contaminants will not reach dangerous concentrations. At the treatment facility, abnormal operating conditions may occasionally result in some odors being generated. Every precaution will be taken in the design of the facilities to reduce the risk of odor generation.

6. Aesthetic Considerations. Even the best designed and most efficiently operated wastewater treatment plant is not viewed by the majority of householders as being an aesthetically desirable or compatible neighborhood resident. While most people understand that such treatment facilities are essential to the public health, they are considered a necessary evil to be located in an area as remote from habitation as possible. The population densities of areas in close proximity to the proposed treatment facilities is extremely low. While everything possible will be done to make the plant unobtrusive and architecturally pleasing, it must be recognized that most people would consider it aesthetically undesirable as an integral part of a residential neighborhood.

VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

If this project is not built and pollution continues, then, in a comparatively short term, the usefulness of the immediate environment with respect to water resources will have been used up. If this project is built and pollution is eliminated, quality of the environment will be improved immediately and there will be an opportunity for the maintenance and enhancement of long-term productivity of the environment which would not otherwise be possible. This productivity would result from increased, higher order land usage than would be the case if the projects were not built.

So long as this project is delayed, or in the event that it is not constructed, then the present, or then existing, generation must continue to pay an "environmental cost" without gaining any benefits whatsoever. This environmental cost is manifested in restriction of growth and prosperity, limiting land usage to lower orders than would otherwise be possible, and eventual gross pollution of the environment. In this event, neither the present, existing or future generations will gain any benefits even though the "environmental cost" will have been paid.

Construction of the proposed project is justified now. It is justified now in order to provide maximum protection of health and safety to area residents, to provide adequate and efficient levels of public services, including sanitary sewers, at a reasonable cost, and to protect the quality of the natural environment by the elimination of pollutants. To delay these projects in order to reserve a long-term option for other alternatives, including continuing as at present, would be stewardship of the poorest kind in the short-term usage of man's environment.

The belief that this project will have a net beneficial effect is based on present land use practices and available future land use projections and rates. Should the character of development significantly change or the rate of growth rapidly increase, serious environmental degradation may result. For this reason, close coordination of land use plans and controls among the member communities of this system will be critical.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION, SHOULD IT BE IMPLEMENTED

The energy and materials required to construct, operate and maintain the proposed project represent irreversible and irretrievable commitments of resources. While these resources are essentially non-renewable resources, e.g., concrete, steel, automotive fuels, etc., the goals which will be met by the proposed project cannot be met in any other way without similar commitments. The benefits to be realized by commitment of these resources are worth far more than the depletion costs of their commitment and the early consumption of these resources in this way is well justified.

A. Resources which will be irretrievably committed to the project are identified as follows:

1. Energy. It is estimated that energy will be required at the rate of approximately 18,340,000 BTU per million gallons when the proposed plant reaches capacity. Of this, it is estimated that 10,000,000 BTU per million gallons will be required in the form of natural gas to serve the treatment process. The remaining 8,340,000 BTU, equivalent to approximately 2,400 kilowatt-hours per million gallons, will be supplied as electricity. It is conservatively estimated that the total energy cost at full plant capacity will be $44.70 per million gallons at today's prices. The cost of both energy forms is expected to increase markedly in the future. Although some economizing measures are possible which may become increasingly more attractive as the present energy crisis worsens, the energy committed will not be retrievable.

Presently, electric power is obtained from Fort Worth. It is anticipated that a second power source from Dallas will be provided. The method of providing natural gas is being studied.

2. Chemicals. The chemicals proposed for use in the proposed project are:

1. Chlorine	-	disinfection
2. Lime	-	sludge dewatering
3. Ferric Chloride	-	sludge dewatering, clarification, phosphorus removal
4. Organic Polymer	-	sludge dewatering, clarification, filtration, phosphorus removal
5. Ozone	-	odor control

(A) Chlorine. Chlorine is the least expensive disinfection agent available. It is conventional and provides a residual for prolonged disinfection. However, chlorine will contribute to the chloride concentration in the effluent. If it reacts with ammonia, a taste or odor problem will result if the water is drawn downstream for domestic use.

It is estimated that 8,400 pounds per day of chlorine will be required at an average flow of 100 millions gallons per day. A dosage of 10 milligrams per liter is assumed. The capital cost of the chlorination equipment is estimated to be approximately-$55,000. At current unit costs, it is estimated that the total annual operation cost of chlorination will be approximately $134,000.

Chlorine is a commonly used chemical and is readily available. It is expected that this will continue to be the case.

(B) Lime. Lime is one of the most economical coagulants available which fits the needs of the proposed process. Lime is readily available and has a history of effectiveness and past success. However the use of lime can increase the alkalinity and hardness in the water removed from the sludge. In addition, the used lime will decrease the heat value of sludge. Therefore, more fuel is required in the incineration process.

At an average flow of 100 million gallons per day, it is estimated that 115 tons of sludge will be produced per day. Based on planned usage of chemicals for sludge conditioning and current unit costs, it is estimated that the total annual costs for lime will be approximately $67,000.

(C) Ferric Chloride. Ferric chloride is another of most economical coagulants available which fits the needs of the proposed process. Ferric chloride is also readily available and also has a history of effectiveness and past success.

For the 115 tons per day of sludge, estimated to occur at the average design flow of 100 million gallons per day, it is estimated that the total annual costs for ferric chloride will be approximately $101,000. This is based on the planned usage of chemicals for sludge conditioning.

Ferric Chloride and lime may be used to do the same job. However, different equipment may be required. Maximum use may be obtained from ferric chloride by recirculation.

(D) Organic Polymers. Polymers are flexible and do not increase sludge volume and weight significantly. They increase the efficiency of settling. They agglomerate a wide variety of inorganic and organic solids, including colloids, which are present in wastewaters. They operate efficiently in waters of widely varying pH or chemical content. They can eliminate the need for inorganic chemicals, permit reductions in chemical storage and metering facilities, minimize maintenance of equipment, and make chemical handling safer and cleaner. Polymers have a low order of toxicity and present no unusual health hazards in ordinary handling and use. However, since they are manufactured rather than naturally occurring, they are proprietary, more expensive and available in limited quantities. Their continued availability is subject to the availability of the market. The total annual cost of polymers for dewatering is estimated to be approximately $18,000, assuming their use as a filtration aid is continual.

Fortunately, the quantity of polymers required is small. Many sources are reportedly available at the present time. In the event of their unavailability, their job can be performed by lime or ferric chloride. Additional equipment would be required. Polymers can not be recovered for reuse.

(E) Ozone. Ozone is a powerful and effective oxidizing agent. It is quite effective in treating odorous gases already in the atmosphere. But ozone is toxic to humans in excessive concentrations. Thus, caution in application is critical. For reasons of safety and efficiency, the odorous gases are often drawn into a confined space for ozone treatment.

3. Manpower. It is estimated that when the plant reaches its design capacity, it will require a commitment of 3.78 manhours per million gallons treated at an estimated cost of $16.77. The design will include features to render the work areas safe, pleasing, and sanitary. However, the manhours once committed are irretrievable.
4. Money. Money is a method of measuring man's efforts. Therefore, it must be considered a resource of finite limitations similar to manhours. Because of the mechanism of bonds, service charges, and interest, it may be said that the money committed to this project will be retrieved through customer service charges. However, the opportunity to commit the same money to some alternate endeavor during the lifetime of the bonded indebtedness must be described as irretrievable. Compensation for this irretrievability is reflected in the interest rendered. The estimated capital cost of this proposed project is $40,954,850.
5. Land. During the lifetime of these facilities, land designated for their use will be effectively unavailable for other use. It is not anticipated that these facilities will be abandoned.

However, should they be, the land may be returned to its former condition and made available for other use. The exception to this statement may be the land used for landfill. The subsequent use of a landfill is dependent on the nature of the solids which will be deposited therein. No additional right-of-way is required for this project.

B. Alternatives. The alternatives have been considered from both economical and environmental viewpoints at more general levels and more detailed levels of decision making. The proposed project is considered to be the most feasible and economical consistent with the stated objectives and with present and anticipated levels of impact on the environment.

VIII. COMMENTS, PUBLIC PARTICIPATION AND INFORMATION DISSEMINATION

THE STATE OF TEXAS X

COUNTY OF TRAVIS X

As official custodian of the records of the Texas Water Quality Board, I certify that the attached and foregoing is a true and correct copy of Page 1 of the Minutes of the Texas Water Quality Board Meeting of August 23, 1972 reflecting the action of the Board concerning the application of the Trinity River Authority of Texas to amend Waste Control Order No. 10303, as it appears in the official records in the office of the Board.

Witness my hand and the seal of the Texas Water Quality Board this 26th day of January, 1973.

(Seal)

Hugh C. Yantis, Jr., Executive Director
Texas Water Quality Board

TEXAS WATER QUALITY BOARD
MINUTES
OF THE MEETING OF
AUGUST 23, 1972

The Regular Business Meeting of the Texas Water Quality Board was called to order by Mr. Gordon Fulcher, Chairman, at 9:00 a.m. in the Madrid Room of the Sheraton Crest Inn, 111 East 1st Street, Austin, Texas with the following members present:

Mr. Gordon Fulcher, Chairman
Mr. J. Doug Toole
Mr. Roy D. Payne, Alternate for Mr. Byron Tunnell
Mr. G. R. Herzik, Jr., Alternate for J. E. Peavy, M.D.
Mr. Clayton T. Garrison
Mr. Seth Burnitt, Alternate for Mr. Harry P. Burleigh

Staff members present were Messrs. Hugh C. Yantis, Jr., Executive Director; Dick Whittington, Deputy Director; and Josiah Wheat, Legal Counsel. Other staff members and interested parties present are shown on the Attendance List attached (Attachment No. 1).

Mr. Roland Allen, Assistant Attorney General, administered the oath to all persons who planned to appear as witnesses at the meeting.

3700.

Mr. Art Busch, Regional Administrator of the Environmental Protection Agency, joined the Board in recognition of the City of Gatesville for filing Application No. 1,000 for grants to build wastewater treatment facilities.

3701.

The following applications for waste control orders received preliminary approval on motion by Mr. Payne, seconded by Mr. Herzik, and passed unanimously.

El Paso County Water Authority, Amend WCO No. 10795
Harris County Municipal Utility District No. 13
Jack Ray (Feed Lot Restaurant)
Spicewood in Balcones Village
Trinity River Authority of Texas Amend WCO No. 10303

TEXAS WATER QUALITY BOARD

PH 475-2651
AC 512

314 WEST 11TH STREET 78701
P O BOX 13246 CAPITOL STATION 78711
AUSTIN, TEXAS

August 15, 1972

TO: Parties interested in the application of TRINITY RIVER AUTHORITY OF TEXAS, AMEND WASTE CONTROL ORDER NO. 1030.

Gentlemen:

The enclosed Hearing Commission Report will be presented to the Texas Water Quality Board at 9:00 a.m. on August 23, 1972 at the Sheraton Crest Inn, Madrid-Granada Rooms, 1st Floor, 111 East 1st Street, Austin, Texas.

In order that the Board may render a final decision that takes into account review and research by the Board's staff, the Board will generally receive only testimony concerning matters that were presented at the hearing conducted by the Board's staff. Testimony will be admissible to point out deficiencies or omissions in the hearing report, statements made in clarification of the report findings, or changes which have occurred since the original hearing. The Board may, in its discretion, also permit oral arguments on issues not raised at the previous hearing, but persons who make requests to present new material should be prepared to show that the delay in bringing forward the new information was not their fault.

We request that written exceptions and written requests to be heard at the Board Meeting be transmitted to the Board's staff at least three (3) days prior to the Board Meeting. If the request to speak or the written exceptions are in the nature of protest to the issuance of a waste control order, out of fairness to the applicant, the person making the protest should furnish a copy of it to the applicant at least three (3) days prior to the Board Meeting.

Very truly yours,

James Showen

James Showen, Director
Hearings and Enforcement

EDR:tt

cc. Office of the Attorney General
State Health Department
Air Control Board
Texas Water Development Board
Parks and Wildlife Department
TWQB District No. 4

HEARING COMMISSION REPORT

SYNOPSIS

I. Applicant
  A. Name: Trinity River Authority of Texas
  B. Address: P.O. Box 5768
  Arlington, Texas 76011

II. Discharge
  A. Volume: Not to exceed an average of 100,000,000 gallons per day.
  B. Type: Treated domestic sewage effluent
  C. Course: Directly into the West Fork of the Trinity River in Dallas County, Texas, thence into the Trinity River.

III. Hearing
  A. Date: July 13, 1972
  B. Location: Duncanville, Texas
  C. Hearing Commission: J. Randel Hill, Presiding Officer
  Gary D. Schroeder, Industrial Services
  Don Eubank, TWQB District No. 4
  Jack Morris, TWQB District No. 4
  D. Appearances:
    1) Proponents: Mr. William B. London, Consultant
    Mr. Alan H. Plummer, Project Director
    Mr. J.T. Rankin, Engineer
    Mr. James L. Strawn, Development Manager
    2) Opponents: None
    3) Observers: Mr. Morris Howard, City Manager, City of Irving
    Mr. Chris Pledger, Health Dept., City of Irving
    4) Comments by letter: Texas Water Development Board
    Texas Parks and Wildlife Department

IV. Findings
  A. An effluent quality in conformance with the terms and conditions of the Proposed Waste Control Order will have no adverse effects upon the uses of the receiving waters.
  B. The substantially improved quality parameters proposed in the attached order will be in conformance with quality requirements for like discharges into the Trinity River.
  C. The Texas Parks and Wildlife Department and the Texas Water Development Board have endorsed the application.

V. Recommendations
  A. Waste Control Order Granted: Yes
  B. Effective Date of Board Action: August 23, 1972
  C. Status: Preliminary approval

SUMMARY OF THE EVIDENCE

Trinity River Authority of Texas (Central Treatment Plant) has applied to the Texas Water Quality Board for an amendment to its existing waste control order to authorize a discharge not to exceed an average flow of 100,000,000 gallons per day of treated domestic sewage from its proposed improved regional sewage treatment plant. Improvements to the existing facility, located approximately nine miles west of Dallas, Texas, adjacent to West Fork of the Trinity River, are scheduled for completion in mid-1975. The Authority's existing waste control order authorizes an average daily discharge of 30,000,000 gallons, with the treated effluent being discharged into West Fork of the Trinity River. By 1975 the quality parameters required by the attached Proposed Waste Control Order will be in conformance with quality requirements for like discharges into the Trinity River.

A public hearing concerning this application was held on July 13, 1972 in Duncanville, Texas. The proposal is to retain the existing trickling filter process sewage treatment plant. The proposed additional facilities will allow an increase in discharge volume and will serve to improve the current effluent quality.

In commenting on the application by letter dated July 6, 1972, the Texas Parks and Wildlife Department stated that, "since the effluent objectives are excellent and adequate facilities to prevent by-pass of sewage are planned, the Department would offer no objection." The Texas Water Development Board, in a letter dated June 20, 1972, stated that the proposals described in the application present no significant hazard to the quality of groundwater in the area. The application has been unopposed.

In view of the evidence, the Hearing Commission recommends that the Texas Water Quality Board grant preliminary approval to the application of Trinity River Authority of Texas (Central Treatment Plant).

EDR:tt

J. Randel Hill, Presiding Officer

Gary D. Schroeder, Industrial Services

August 8, 1972

Page 1. Except as specified in the Special Provisions herein, this amendment supersedes and replaces Page 1 (issued January 23, 1963) of Waste Control Order No. 10303.

NAME: Trinity River Authority of Texas
ADDRESS: P. O. Box 5768
CITY: Arlington, Texas 76011

TYPE OF WASTE CONTROL ORDER: Amendment to Waste Control Order No. 10303

NATURE OF BUSINESS PRODUCING WASTE: Regional Sewage Treatment Plant

GENERAL DESCRIPTION AND LOCATION OF WASTE DISPOSAL SYSTEM:

Description: The existing trickling filter process sewage treatment plant is to be retained as a functional part of the expanded treatment facility. The new facility will serve to improve the current effluent quality being discharged along with the proposed increase. Preliminary studies are being made considering two possible treatment processes: (1) Activated sludge and (2) Chemical/Physical.

Location: Approximately 9 miles due west from downtown Dallas on the Dallas-Ft. Worth Turnpike near the confluence of the West Fork of the Trinity River, the Elm Fork of the Trinity River and Mountain Creek in Dallas County, Texas.

CONDITIONS OF THE WASTE CONTROL ORDER:

Character: Treated Domestic Sewage Effluent

Volume: Not to exceed an average of 100,000,000 gallons per day
Not to exceed a maximum of 250,000,000 gallons per day
Not to exceed a maximum of 17,400 gallons per minute

Quality:

Item	NOT TO EXCEED Monthly Average	24-Hr. Daily Composite	Individual Sample
BOD	10 mg/l	15 mg/l	20 mg/l
Total Suspended Solids	10 mg/l	15 mg/l	20 mg/l

A chlorine residual of not less than 1.0 mg/l shall be maintained after at least a 20-minute detention time (based on peak flow).

Point of Discharge: Directly into the West Fork of the Trinity River in Dallas County, Texas, thence into the Trinity River in the Trinity River Basin.

SPECIAL PROVISIONS:

This order is granted subject to the policy of the Board to encourage the development of area-wide waste collection, treatment and disposal systems. The Board reserves the right to amend this order in accordance with applicable procedural requirements to require the system covered by this order to be integrated into an area-wide system, should such be developed; to require the delivery of the wastes authorized to be collected in, treated by or discharged from said system, to such area-wide system; or to amend this order in any other particular to effectuate the Board's policy. Such amendments may be made when, in the judgment of the Board, the changes required thereby are advisable for water quality control purposes and are feasible on the basis of waste treatment technology, engineering, financial, and related considerations existing at the time the changes are required, exclusive of the loss of investment in or revenues from any then existing or proposed waste collection, treatment or disposal system.

These public sewerage facilities shall be operated and maintained by a sewage plant operator holding a valid certificate of competency issued under the direction of the Texas State Health Department as required by Section 20 (a) of Article 4477-1, Vernon's Texas Civil Statutes.

Operation and maintenance of the facilities described by this waste control order shall be in accordance with accepted practices for this type of waste treatment facility and shall include related maintenance such as painting, proper disposal of solid waste, and weed and grass cutting.

SPECIAL PROVISIONS: (Cont'd.)

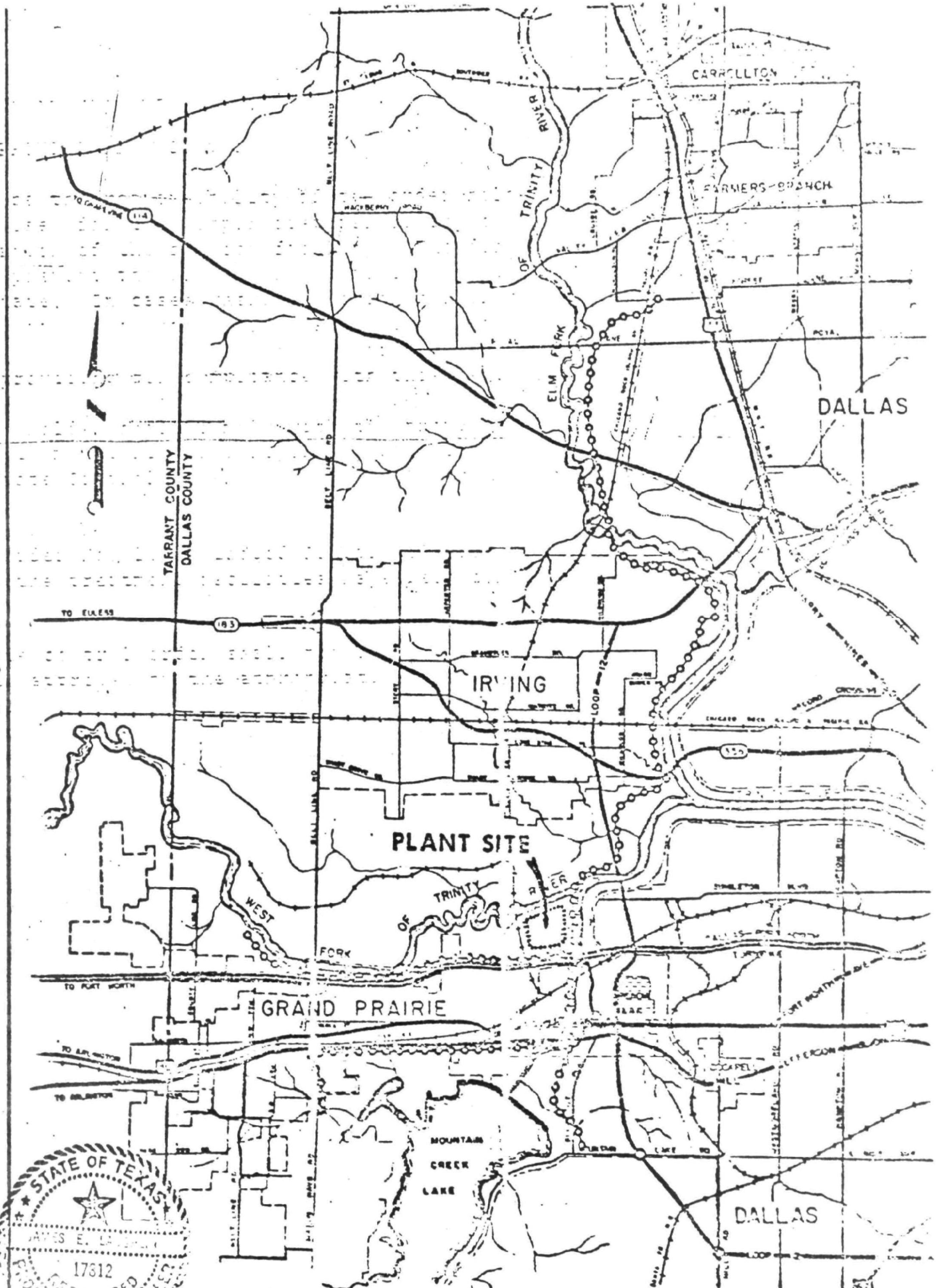
It shall be the responsibility of the order holder to provide by contract or otherwise, for the proper disposal of any excess sludge resulting from the operation of the subject facility. The disposal shall be accomplished so as to prevent the sludge from entering or otherwise affecting the waters of the State. In cases where the order holder contracts for the disposal of the sludge, the order holder shall inform the contractor of the requirement concerning the proper disposal of the sludge and shall exercise prudent care in providing for compliance with this requirement.

The order holder shall comply with the provisions of Board Order No. 69-1219-_ relative to monitoring and reporting data on effluent described in "Conditions of the Waste Control Order".

The waste control order holder shall comply with the conditions of Waste Control Order No.. 10303 issued January 23, 1963 until the proposed improvements to the treatment facilities have been completed. The estimated completion date for making these improvements is July 15, 1975.

This waste control order shall not issue until after plans and specifications have been approved by the appropriate State agency and further ratification by the Board.

GDS:el



VICINITY MAP

Cedar Hill, Texas
CHRONICLE

APR 27 1972

TRA To Begin Central Sewage System West Of Dallas

Trinity River Authority expects to begin construction by June 1973 on a $43 million modernization of its Central Sewage system facilities west of Dallas.

The project, said James L. Strawn, TRA development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

TRA's board of directors, meeting in Huntsville April 21, authorized the Authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 percent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area. Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

Strawn said the forecast of a construction start by June 1973 was based on an estimated 10 to 12 months for detailed engineering plus an estimated three months for review and approval of final plans and specifications by the EPA and the Texas Water Quality Board. Target date for completion is early 1975.

TRA is now negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing TRA revenue bonds covering 15 percent of the project costs.

Under study are the two-stage sludge method and the chemical physical process. A decision will be made after careful analyses of tests and cost factors.

"We are trying to keep a tight rope on the project in order that we may move immediately from the engineering to the construction stage," said Strawn. "The facts are that the Central plant is already crowding its 30 million-gallons-per day capacity, and we must move forward with all possible speed."

During the summer, when Trinity streamflow through Dallas is extremely low, discharges of treated wastewater from Fort Worth, Dallas and Mid-Cities treatment plants comprise virtually 100 percent of the river's flow.

"As we get better sewage treatment in this area, we are contributing greatly to pollution control of the river all the way to the Gulf," said Strawn. "Pollution control is one of the main objectives of the Trinity Master Plan, and our basin-wide water quality management study now getting underway will help us achieve that goal."

Houston, Texas
CHRONICLE
(Cir. D. 274,512 - S. 310,000)

MAY 1 4 1972

On Trinity

$43 Million New Sewage System Plan

Arlington (AP)—The Trinity River Authority expects to begin construction by June, 1973, of a $43 million modernization of its central sewage system facilities west of Dallas.

The project will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate lagoons and discharge an effluent of higher oxygen content into the Trinity River.

The authority will apply to the Environmental Protection Agency for a federal grant to finance 55 percent of the costs of the plant and interceptor lines.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing revenue bonds covering 45 percent of the project costs.

Snyder, Texas
NEWS
(Cir. D. 6,273)

MAY 1 4 1972

Construction Set On Sewage Facilities

ARLINGTON, Tex. (AP) — The Trinity River Authority expects to begin construction by June next year of a $43 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, develop manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

System updating expected

Trinity River Authority expects to begin construction by June 1973 on a $43 million modernization of its Central Sewage system facilities west of Dallas.

The project, said James L. Strawn, TRA development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

TRA's board of directors, meeting in Huntsville in April, authorized the Authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the Dallas-Fort Worth-Mid Cities area. Also, the board authority authorized an application to the Texas Quality Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

Strawn said the forcast of a construction start by June 1973 was based on an estimated 10-to-12 months for detailed engineering plus an estimated three months for review and approval of final plans and specifications by the EPA and the Texas Water Quality Board. Target date for completion is early 1975.

TRA is now negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton Euless, and the Dallas-Fort Worth Regional Airport for amortizing TRA revenue bonds covering 45 per cent of the project costs.

Under study are the two-stage sludge method and the chemical-physical process. A decision will be made after careful analyses of tests and cost fcactors.

"We are trying to keep a tight rope on the project in order that we may move immediately from the engineering to the construction stage," said Strawn. "The facts are that the central plant is already crowding its 30 milliongallonsper-day capacity, and we must move forward with all possible speed."

During the summer, when Trinity streamflow through Dallas is extremely low, discharges of treated wstewater from Fort Worth, Dallas and Mid- treatment plants comprise virtually 100 per cent of the river's flow.

Hurst, Texas
MID CITY NEWS
(Cir. D. 6,379)

JUL 12 1972

TRA Okays Expansion Of Area Sewage System

By C. L. RICHHART
Star-Telegram Writer

HUNTSVILLE — The Trinity River Basin now is the setting "for the most active environmentalists in the state," John Scott of Fort Worth said here Friday.

That was how Scott, president of the Trinity River Authority, sized up the meaning of action taken by TRA directors and reports given by the agency's officials and staff specialists.

Scott referred to the second largest construction project undertaken by TRA, the $13.5 million expansion of the Central Sewage System in the Fort Worth-Dallas area.

• • •

THE TREATMENT capacity of the plant will be expanded from 30 million to 100 million gallons per day during 1973. The plant is or soon will be serving Arlington, Grand Prairie, East Dallas, Irving, Farmers Branch, Carrollton, Coppell, Euless, Addison, Bedford and the Dallas-Fort Worth Regional Airport.

O. P. Leonard of Fort Worth, TRA president when the first $7 million in bonds was issued for the Central Sewage System, observed that "it is hard to believe what a big job the system is doing."

Leonard admitted he was a little doubtful about the potential of the project when the first bonds were issued but now cities are eager to be included in the system, he said.

• • •

THE QUARTERLY board meeting included reports from David Brune of Arlington, TRA general manager; Alan H. Plummer Jr., project director for TRA's basinwide water quality management study; Dr. Richard M. Browning, planning biologist for the study, and William R. Brown Jr., development manager.

The TRA board also authorized a contract between TRA and the City of Fort Worth under which Fort Worth will seek financial assistance for six waste-water transportation and treatment construction projects under the Texas Water Pollution Control Compact.

The board authorized issuance of $170,000 in revenue bonds for the TRA-Fort Worth project.

Arlington, Texas
ARLINGTON NEWS

AUG 2 / 1972

Water board awards permit for new plant

124

Daily News Austin Bureau

AUSTIN—The Texas Water Quality Board has given the Trinity River Authority preliminary approval of a permit to operate a 100,000,000 gallon per day sewage treatment plant.

The plant is to be located on the Dallas-Fort Worth Turnpike near the confluence of the West Fork of the Trinity, the Elm Fork of the Trinity and Mountian Creek.

Final approval awaits approval of engineering design specifications by the WQB.

The plant is to discharge the highly treated effluent into the West Fork of the Trinity.

It is to be a "tertiary," or advanced, waste treatment plant. The biochemical oxygen demand is to be 10 milligrams per litre, compared to the normal WQB permit requirement of 20 mg-l.

There were no opponents at the WQB meeting or at a staff-[illegible]

Arlington, Texas
CITIZEN-JOURNAL
(Cir. W. 15,865)

AUG 31 1972

Sewer Interceptor Plant for TRA Is Awarded $795,000

124

Environmental Protection Agency authorities have come through with a $795,000 payment to the Trinity River Authority toward a sewage interceptor system to serve the area surrounding the new regional airport.

Total cost of the project, which is now 96 per cent complete, is $2,804,000. The EPA stated the system will greatly improve the quality of water being discharged into the Trinity River.

The system is designed primarily to handle a peakload from the airport which will serve an estimated 36 million passengers yearly. The waste will be moved through the TRA's Bear Creek interceptor for treatment at its central sewage plant in West Dallas.

The EPA has indicated it may award more than $3 million in grants for wastewater transmission and treatment facilities serving and future owners of the new airport.

Dallas, Texas
OAK CLIFF TRIBUNE
(Cir. 2xW 15,700)

MAY 10 1972

TRA To Modernize Key Sewage Plant

Trinity River Authority expects to begin construction by June 1973 on a $13 million modernization of its Central Sewage system facilities west of Dallas.

The project, said James L. Strawn, TRA development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

TRA's board of directors, meeting recently in Huntsville, authorized the Authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 percent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area. Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

Strawn said the forecast of a construction start by June 1973 was based on an estimated 10-to-12 months for detailed engineering plus an estimated three months for review and approval of final plans and specifications by the EPA and the Texas Water Quality Board. Target date for completion is early 1975.

TRA is now negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing TRA revenue bonds covering 45 percent of the project costs.

Under study are the two-stage sludge method and the chemical-physical process. A decision will be made after careful analyses of tests and cost factors.

"We are trying to keep a tight

See TRINITY on Page 10

Continued from Page 1

rope on the project in order that we may move immediately from the engineering to the construction stage," said Strawn. "The facts are that the Central plant is already crowding its 30 million-gallons-per-day capacity, and we must move forward with all possible speed."

During the summer, when Trinity streamflow through Dallas is extremely low, discharges of treated wastewater from Fort Worth, Dallas and Mid-Cities treatment plants comprise virtually 100 percent of the river's flow.

"As we get better sewage treatment in this area, we are contributing greatly to pollution control of the river all the way to the Gulf," said Strawn. "Pollution control is one of the main objectives of the Trinity Master Plan, and our basin-wide water quality management study now getting underway will help us achieve that goal."

Officials trying to freshen air

12 ?

By DON RUTHERFORD
Daily News
Tarrant County Bureau

Have you ever traveled along the Dallas-Fort Worth Turnpike and gotten a whiff of something that smells awful just west of Loop 12 ?

That's the Trinity River Authority's central sewage plant, located just north of the turnpike, and things are apoppin' in North Texas to freshen the air in that neck of the woods.

Jim Goff, who is director of water quality planning for the North Central Texas Council of Governments, said the foul smell in recent months has been caused by operational problems at the plant and by the fact that the plant uses oxidation ponds as its means of treating sewage

Goff explained "Oxidation ponds for secondary treatment don't work too well in this particular locality with plants that large These ponds are based on sunlight shining into the water and causing algae to grow — photosynthesis. Algae gives off oxygen

"The problem in operating this type of plant is that it is very sensitive to the elements When you get long periods of time without sunlight you have a plant that is approaching a critical stage.

"These ponds approach a point where there isn't sufficient oxygen being generated to satisfy the demand for oxygen

"The recent odor problem had some operational problems within the plant Because it was necessary to empty some of their 'digesters' into one pond, there was a heavy demand for oxygen and the pond went to the condition without oxygen and smelled."

The Trinity River Authority plan calls for expanding the plant and eliminating the oxidation ponds and replacing that section of the plant with treatment processes that are not dependent on the unreliable elements of sunlight and wind action, Goff said.

He said the plant will be expanded and in operation by 1975 and that this expansion will increase its capacity three-fold.

Goff pointed out that the additional plant expansion will be more expensive and will take more qualified people to operate it. He said the possibility exists that the plant will even by using chemicals and "all these costs add up."

Goff said the Garland and possibly Lewisville and Flower Mound sewage plants will go to the pondless type plant in the future

He emphasized that the expansion TRA central plant is in keeping with the overall water quality plan as outlined for the North Texas region by the North Central Texas Council of Governments — both in type of facility and in the time frame for expansion

He pointed out that COG's plan is based on two things

(1) obtaining water quality conditions in the river for a quality environment, and

(2) providing a regional system which would be the least cost to all those participating

It may [illegible] citizens of North Texas who have smelled the smell along the Dallas-Fort Worth Turnpike will insist on a third ingredient — no more whiffs for the whiffers.

Irving, Texas
DAILY NEWS
(Cir. D. 8,343)

MAY 26 1972

Lufkin, Texas
NEWS
(Cir. D. 9,106 - S. 9,501)

MAY 2 1 1972

TRINITY RIVER AUTHORITY PLANS SEWAGE SYSTEM — The TRA, in a Dallas press release, announced plans to start construction not later than June, 1963, of a $43 million modernization program for its sewage system west of Dallas.

At the same time the board authorized an application to the Texas Water Quality Board for an amended waste control order

discharge of increased volume of waste water.

The Authority is negotiating contracts with Dallas, the Dallas - Fort Worth Regional Airport and several adjacent communities for amortizing revenue bonds covering 45 per cent of the project costs.

The TRA project will increase the plant's capacity from 30 million to 100 million gallons daily, eliminate smelly sludge, and will discharge an effluent of a higher oxygen content into the Trinity River.

MAY 2 4 1972

Irving area has problem of bad odor

By DAVE MONTGOMERY
Urban Affairs Writer

The scientific name is hydrogen sulphide, but to more than 20,000 South Irving residents, that spells Phew—with a capital P.

Nearly everytime the wind kicks up, or when the weather gets sunny and summery, two giant sewage treatment lagoons release a noxious odor that wafts across the Trinity River and engulfs a wide swath of the Dallas suburb.

The gas carrying the offensive odor is hydrogen sulphide, the same gas which makes rotten eggs rotten. But whether it be eggs or sewage, the human response is very much the same.

"We've had any number of complaints," says Irving Assistant City Mgr. Darwin McGill. "I don't know if anyone has moved out because of it, but it does get pretty bad at times."

The two lagoons, one 70 acres in size and the other 150 acres, are operated by the Trinity River Authority just across the river west of Irving and just north of the Dallas-Fort Worth Turnpike.

Although an expansion project eventually will eliminate the lagoons—and the odor—TRA officials foresee relief no earlier than spring of 1974.

"We know we've got a problem and we're not trying to duck it," says James Strawn, development manager for TRA. "We're doing everything to minimize the problem and solve it as quickly as we can."

The smell, caused by inadequate oxygenation in the huge treatment ponds, particularly plagues a large part of Southern Irving, frequently occurring on a day-to-day basis during the spring and summer months.

Passing motorists on the turnpike also [illegible]

[illegible]

See IRVING on Page 24

IRVING GAS ODOR

Continued From Page 1

[illegible] of year, in March and April, by two factors," Strawn explains. "The weather begins to warm up and that stirs up the biological process in the ponds. Then, there are the 30- and 40-mile-per-hour winds that blow into South Irving. That surely doesn't help the problem any."

The TRA already has taken steps to try to reduce the odor, but only with minimal success. One approach was to inject $10,000 worth of "masking chemical" — a glorified perfume—into the ponds through a 1,400-foot-long line.

Helicopter crews also have frequently dumped chemicals into the lagoons by air. But as any South Irving resident woefully laments, the odor still exists.

According to Strawn, the only sure solution is elimination of the ponds, a goal the TRA eventually will accomplish with a $31 million plant expansion project which will rely on more up-to-date methods of sewage treatment.

Presently, the project is still in the planning stage. [illegible] completion date is at [illegible] three years away [illegible] Strawn, however, said the construction schedule may be altered to eliminate the lagoons by early 1974.

The odor is caused by what Strawn defines as an "anaerobic" condition, in which organisms have overloaded the ponds, consuming all of the oxygen and releasing the odorous hydrogen sulphide.

The condition was accelerated about a year ago, Strawn said, when the TRA was forced to put solid waste in one of the lagoons to make repairs on the solid waste system.

"But we've had an odor problem with our lagoons for some time, ever since we started getting an appreciable amount of flow," Strawn observed. "The only solution now is to enlarge the plant."

Waxahachie, Texas
LIGHT
(Cir. D. 3,932)

APR 26 1972

TRA Plans To Start Work On Sewer System In 1973

124

Trinity River Authority expects to begin construction by June 1973 on a $43 million modernization of its Central Sewage system facilities west of Dallas.

The project, said James L. Strawn, TRA development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

TRA's board of directors, meeting in Huntsville April 21, authorized the Authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 percent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area. Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

Strawn said the forecast of a construction start by June 1973 was based on an estimated 10-to-12 months for detailed engineering plus an estimated three months for review and approval of final plans and specifications by the EPA and the Texas Water Quality Board. Target date for completion is early 1975.

TRA is now negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing TRA revenue bonds covering 45 per cent of the project costs.

Under study are the two-stage sludge method and the chemical-physical process. A decision will be made after careful analyses of tests and cost factors.

"We are trying to keep a tight rope on the project in order that we may move immediately from the engineering to the construction stage," said Strawn. "The facts are that the Central plant is already crowding its 30 million-gallons-per-day capacity, and we must move forward with all possible speed."

During the summer, when Trinity streamflow through Dallas is extremely low, discharges of treated wastewater from Fort Worth, Dallas and Mid-Cities treatment plants comprise virtually 100 per cent of the river's flow.

"As we get better sewage treatment in this area, we are contributing greatly to pollution control of the river all the way to the Gulf," said Strawn. "Pollution control is one of the main objectives of the Trinity Master plan, and our basin-wide water quality management study now getting underway will help us achieve that goal."

$43 MILLION FOR MODERNIZATION

TRA Bid for Sewage Grant Is OK'd

By C. L. RICHHART
Star-Telegram Writer

HUNTSVILLE — Trinity River Authority directory meeting here today authorized the TRA management to apply for a federal grant to help finance a $43 million modernization of TRA's Central Sewage system facilities.

TRA now is negotiating contracts with Irving, Grand Prairie, Arlington, Dallas, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing TRA revenue bonds covering 45 per cent of the Central Sewage project costs. The other 55 per cent, it is hoped, will come from the Environmental Protection Agency.

JAMES L. Strawn of Arlington, TRA development manager, said the project will increase the plant's sewer treatment capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge a cleaner effluent into the Trinity River.

Strawn estimated that construction could begin in June 1973 on the modernization project, with completion expected early in 1975.

"We are trying to keep a tight rope on the project in order that we may move immediately from the engineering to the construction stage," Strawn said. "The facts are that the Central plant already is crowding its 30-million-gallons-per-day capacity, and we must move forward with all possible speed."

* * *

DISCHARGES of treated wastewater from Fort Worth, Dallas and the Mid-Cities area treatment plants make up virtually 100 per cent of the river's flow during the summer when Trinity streamflow through Dallas is extremely low, Strawn told the board.

"As we get better sewage treatment in this area we are contributing greatly to pollution control of the river all the way to the Gulf, which is one of the main objectives of the Trinity master plan of development," Strawn said

MAY 19 1972

Trinity Construction Is Planned

ARLINGTON, Tex. (AP) — The Trinity River Authority expects to begin construction by June next year of a $43 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, developmanager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth midcities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth [illegible] for amortizing revenue bonds covering [illegible] per cent of the project costs.

BAYTOWN, TEX.
SUN

MAY 1 6 1972

TRA Is Due To Start Work On Sewage Job

ARLINGTON, Tex. (AP) — The Trinity River Authority expects to begin construction by June next year of a $43 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, developmanager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth midcities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with [illegible] Grand Pr[illegible] Farmers Branch, Carrollton, Euless and [illegible] Worth Regional Airport for amortizing revenue bonds covering 45 per cent of the project costs.

Stephenville, Texas
EMPIRE -
(Cir. D. 3,890-S. 3,890)
Tribune
MAY 17 1972

Trinity River Authority To Begin Construction

ARLINGTON, Tex (AP) - The Trinity River Authority expects to begin construction by June next year of a $13 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 percent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing revenue bonds covering 45 percent of the project costs.

Tyler, Texas
MORNING TELEGRAM
(Cir. D. 14,776)

MAY 18 1972

Trinity River Authority To Modernize

ARLINGTON, Tex. (AP) — The Trinity River Authority expects to begin construction by June next year of a $43 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, developmanager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort [illegible]

[illegible] per cent of the project costs.

GAINESVILLE, TEXAS
REGISTER

MAY 1 8 1972

Trinity River Plant Under Construction

ARLINGTON, Tex. (AP) — The Trinity River Authority expects to begin construction by June next year of a $13 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, developmanager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing revenue bonds covering 45 per cent of the project costs.

Corpus Christi, Texas
CALLER
(Cir. D. 66,242)

MAY 1 8 1972

Wastewater project is slated

ARLINGTON (AP) — The Trinity River Authority expects to begin construction by June next year of a $43-million modernization of its central sewage system facilities west of Dallas

The project, said James L. Strawn, development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth midcities area

Also, the board authorized an application to the Texas Water Quality Board for an [illegible] waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth [illegible] for [illegible] project costs.

Amarillo, Texas
NEWS GLOBE
(Cir. D. 47,276)

MAY 1 4 1972

$43 Million Work On Trinity River System Slated

ARLINGTON, Tex (AP) — The Trinity River Authority expects to begin construction by June next year of a $13 million modernization of its central sewage system facilities west of Dallas.

The project, said James L. Strawn, development manager, will increase the plant's capacity from 30 million to 100 million gallons a day, eliminate smelly lagoons, and discharge an effluent of higher oxygen content into the Trinity River.

The authority's directors have authorized the authority to apply to the Environmental Protection Agency (EPA) for a federal grant to finance 55 per cent of the costs of the plant and interceptor lines that will be needed to serve the burgeoning Dallas-Fort Worth mid-cities area.

Also, the board authorized an application to the Texas Water Quality Board for an amended waste control order to discharge an increased volume of wastewater.

The authority is negotiating contracts with Dallas, Irving, Grand Prairie, Arlington, Farmers Branch, Carrollton, Euless and the Dallas-Fort Worth Regional Airport for amortizing revenue bonds covering 45 per cent of the project costs.

BIBLIOGRAPHY

IX.

BIBLIOGRAPHY

Marion Clawson, with Charles L. Stewart. Land Use Information, A Critical Survey of U. S. Statistics Including Possibilities for Greater Uniformity.

Jack E. Coster, et. al. A Survey of the Environmental and Cultural Resources of the Trinity River. Stephen F. Austin State University.

Dr. Thomas R. Hayes, et. al. Environmental Impact Study of the Elm Fork of the Trinity River.

J. D. Mertes, et. al. Trinity River Greenway - A Prototype. Texas Tech University

James V. Sciscenti, et. al. Environmental and Cultural Resources within the Trinity River Basin. Southern Methodist University through the Institute for the Study of Earth and Man.

REPORTS

A Plan for A Regional Wastewater System; Arlington, Carrollton, Dallas, Dallas/Fort Worth Regional Airport, Euless, Farmers Branch, Grand Prairie, Irving. Trinity River Authority of Texas; January 1962.

Dallas-Fort Worth Regional Transportation Study; Vol. 2, Plan Report. Study Office Staff, Texas Highway Department; July 1967.

Joe H. Jones. Dallas-Fort Worth, Regional Growth Influencing Transportation Planning; Area Economic Survey No. 24. Bureau of Business Research, The University of Texas at Austin, 1965.

Grant Application to Environmental Protection Agency, Water Quality Office, for Comprehensive Water Quality Management Planning for Trinity River Basin, Texas. Trinity River Authority of Texas; March 1971.

Progress Report, Covering Period January 1, 1966 through December 31, 1967. Trinity River Authority of Texas.

Report on Proposed Central Sewage Treatment Plant to Serve Areas of the Elm Fork and the West Fork of the Trinity River. Trinity River Authority of Texas; November 1956.

Report on Master Plan of the Trinity River and Tributaries, Texas; Prepared for the Trinity River Authority of Texas. Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas; April 18, 1958.

Supplemental Report on Master Plan of the Trinity River and Tributaries, Texas; Prepared for the Trinity River Authority of Texas. Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas; December 1960.

Upper Trinity River Basin Comprehensive Sewerage Plan; Vol. 1. Report to the North Central Texas Council of Governments. Camp, Dresser, and McKee; Forrest and Cotton, Inc.; Freese, Nichols and Endress.

Upper Trinity River Basin, Comprehensive Sewerage Plan; Vol. 4, Environmental Assessment. North Central Council of Governments, Arlington, Texas; May 1972.

Upper Trinity River Basin; Water Quality Monitoring Plan. Trinity River Authority of Texas; July 1970.

APPENDIX I

Archeological and Palentological Considerations

Resource Data By

Sciscenti, J. V., J. E. Ubelaker, W. F. Mahler, R. D. Hyatt, M. L. Scott, S. A. Skinner, D. Gillette, J. T. Thurmond. 1972. Environmental and Cultural Resources Within the Trinity River Basin. Southern Methodist University, Dallas, Texas under contract with the Corps of Engineers, Fort Worth District. 306 pp.

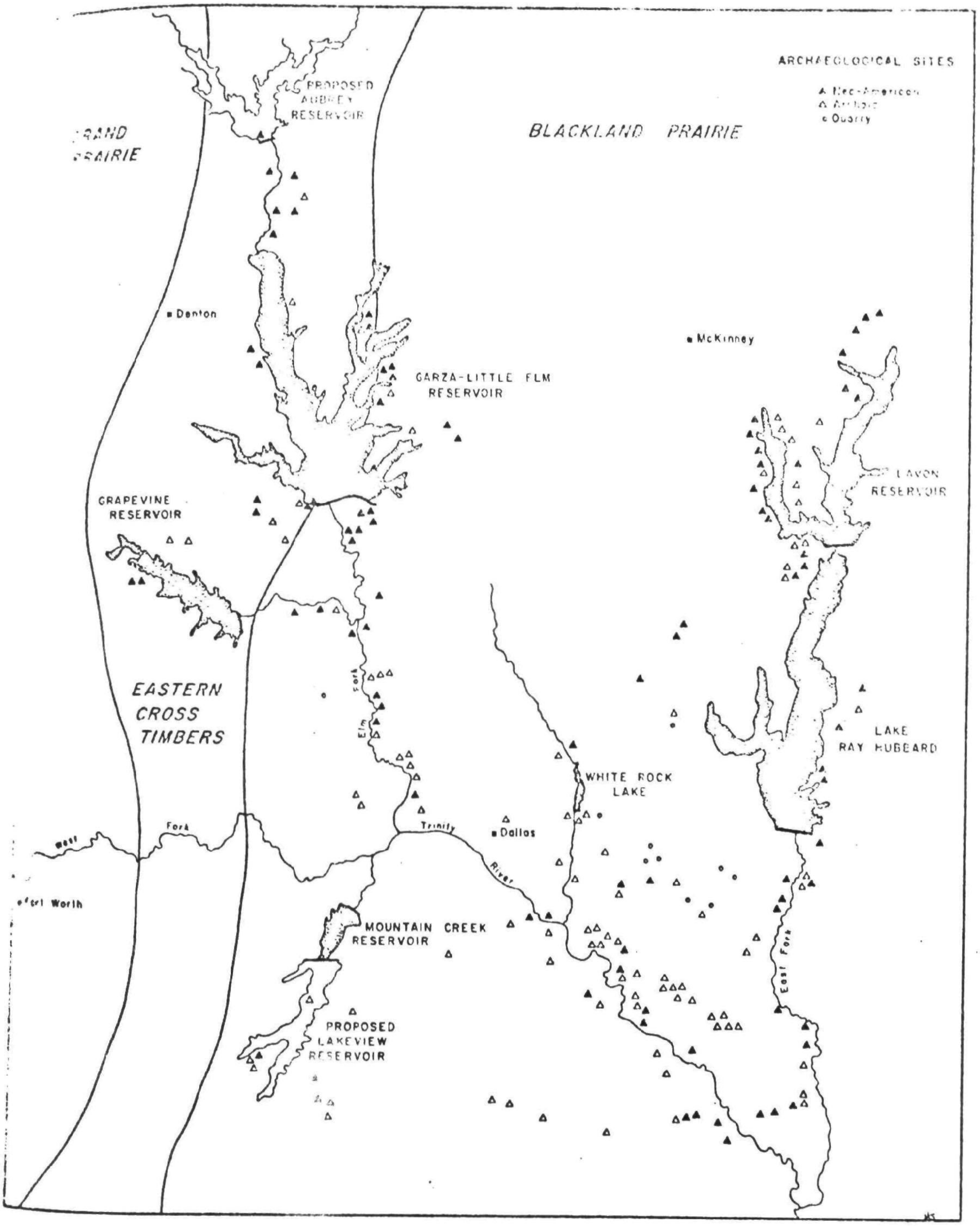


Figure 12. Location of recorded sites in the Upper Trinity Basin.

Upper Trinity River

Archaeological research in the Upper Trinity River basin ... been dominated by members of the Dallas Archeological ...iety. Salvage excavations have been conducted at Lake Lavon, ...a-Little Elm Reservoir and Forney Reservoir but not at ...te Rock Lake, Grapevine Reservoir, Eagle Mountain Lake, ...untain Creek Lake or Eagle Mountain Lake.

Open village and camp sites are common throughout the ...ea, occurring particularly along the major and minor drain...es. These sites range in size from small single occupation ...nting camps to deep stratified camp sites which were occupied ...termittently for a number of years. Very few of these sites ...ve been adequately excavated and the majority of studies are ...mply artifact descriptions.

The majority of recorded sites occur at the edge of the Trinity River floodplain or on low rises located within the river floodplain. Many unreported sites may occur under the river silt where they have been buried by repeated overbank flooding.

A review of the pertinent literature presented below shows that there is a long sequence of prehistoric occupation and that considerable work has been done in the Upper Trinity in the area around Dallas. Of particular interest is the Paleo-Indian occupation of the area, the Trinity Aspect (Archaic) occupation and the Neo-American period Wylie Focus which has been described for East Fork.

Three separable physiographic/vegetation zones cut across the Upper Trinity Basin in such a way as to make their definition and general delimitation simple. The basis for the zones is the underlying geological formation which affects the vegetation, soils, water runoff, fauna and the topography. Each zone is described below in order that they can serve as a backdrop for the testing of man's response to their respective resources during the prehistoric period. We expect that the Indians were aware of these differences and knew the various food and other resources that occurred throughout the area. If this is true we can expect that the archaeological remains will reflect this environmental variation. This will be seen in site location and in the different maintenance activities carried out by the prehistoric inhabitants.

The Blackland Prairie is a broad zone which sweeps from northeastern Texas, crosses the Trinity River between Kerens on the east and Grand Prairie on the west and continues southwestward toward San Antonio. Smooth to gently rolling surfaces characterize the upland and the valleys are broad and shallow. Upper Cretaceous limestone/marl formations form the bedrock from which clay soils of the Houston-Wilson and Wilson-Crockett series are derived. Elevation ranges from 400-800' but is nowhere pronounced.

Some small bodies of timber occur on the otherwise "treeless" prairies which are covered by bunch grass. Trees do occur in the alluvial soils along the drainages and these include elm, hackberry, oak, ash, pecan and others. Drainage is rapid due to the clay soils and the many small tributary streams radiating from the major drainages. Rapid runoff results in frequent overbank flooding and deposition of soil on the floodplain.

The Eastern Cross Timbers is a narrow band of oak forest which crosses the Elm Fork of the Trinity in the area of the proposed Aubrey Reservoir and sweeps down Elm Fork through the lower end of Garza-Little Elm Reservoir and then runs west of Elm Fork until it corsses the West Fork of the Trinity River between Grand Prairie and Fort Worth. The Woodbine fm. sand is the bedrock and a fine sandy loam soil, the Kirvin-Norfolk group, is on top of the Woodbine. Elevation ranges from 300-600' and there is no great physiographic relief.

Low, rounded hills typify the area and these are covered with the cover of a thick oak timberland. In some areas the area is savannah like with a broken, patchy woodland. The area is well watered and water penetrates well into the ground rather than running off.

The Grand Prairie adjoins the Eastern Cross Timbers on the east and is in part bounded by the Western Cross Timbers on the west. Lower Cretaceous rocks form the bedrock foundation for the Grand Prairie and the dominant soils are the Denton-San Saba group which are clay and stoney clay. Elevation ranges from 800-1200' and large parts of this range are visible since

There are many steep-sided valleys in the otherwise level plain. The plain is smooth to rolling and is deeply dissected by drainages which have narrow bottomlands.

Grass covers (or covered) the prairie but in those areas where shallow stony soils occur, a heavy but small tree and shrub growth occurs. Bison and antelope inhabited the prairie in the historic period. Water is available year-round in free flowing springs and in the major streams. However ground water runoff is rapid due to the nature of the surface cover.

It is proposed that the three areas of the Upper Trinity River Basin were occupied by prehistoric peoples whose economy was linked to the seasonal variation of natural resources and that this is expressed in a central based wandering community pattern. If this is true we would expect:

1) sites located in the river floodplain were occupied on a seasonal basis to collect limited types of specific food resources;
2) floodplain sites will have been repeatedly reoccupied and this will be seen by stratified living floors which have been sealed over by silt deposits;
3) base camps will be located at the edge of the river floodplain but above the regular overflow level of the river;
4) hunting camps and quarry camps will be found in the upland in locations where the respective resources were available.

It is proposed that this model has widespread applicability to the entire area but that specific intra-area responses to the environment will be reflected by:

1) use of area-restricted raw materials, particularly stone and clay;
2) variation in the seasonal foods used due to the nature of the specific zones, for example, more nuts may have been used in the Eastern Cross Timbers, more buffalo may have been eaten by Grand Prairie people since the buffalo was more readily available there;
3) distinct architectural features such as the large pits which occur in Wylie Focus sites along East Fork;
4) differences in intra-site settlement patterns as they reflect the seasonal maintenance cycle and/or the composition of the task groups at each site.

Literature Abstracts

GENERAL

Smith, C. A., Jr.
1969 Archeology of the Upper Trinity Watershed. The Record 26:1:1-14.

This article represents the most recent synthesis of the archaeology of the Upper Trinity Watershed. Smith uses the specific site excavation data and site distribution studies to reconstruct the culture history of the area and to explain the variation in the prehistoric occupation of the natural terrain.

Evidence of early man has been found throughout the Upper Trinity in association with the Pleistocene terrace known as the Upper Shuler. This is the second terrace of the river and in situ archaeological remains have been recorded at Lewisville, near White Rock Creek and Hickory Creek near Denton. Radiocarbon dates are available only from the Lewisville site and these do not agree with dates from early man sites elsewhere in the country. Association of Paleo sites with the second terrace suggests that contemporaneous use of the first terrace and floodplain may have occurred and has since been silted over.

Archaic occupation is known best from Elm Fork and has been described as the Trinity Aspect. This Aspect spans the period and is subdivided into the Carrollton (early) and Elam Focus (later). In contrast to the big game hunters of the Paleo-Indian period, the Archaic people have a diversified economy based on hunting and gathering of seasonally available food resources. Archaic sites are found in place within the first terrace of the river. The nature of floodplain and upland use is as yet unknown.

Large sedentary villages, the use of bow and arrow and pottery, and agriculture are the features which mark the Neo-American period. Two cultural manifestations, the Wylie Focus and the Henrietta Focus, have been reported but understanding of the period throughout the area and the relationship of the peoples is as yet unexplored. An intrusive site is known from Mountain Creek in Dallas County. The site is reported to be a pure Alto Focus site representative of the early Gibson Aspect of the Neches River in East Texas.

Henrietta Focus sites occur along Elm Fork but they are known primarily only through artifact typology. A few burials have been reported but there is no data on houses. The supposedly diagnostic feature of the Henrietta Focus is the presence of a pottery type known as Nocona Plain. No site from this period has been adequately excavated along the Elm Fork of the Trinity. Henrietta Focus is dated to the prehistoric period.

The Wylie Focus is a manifestation that has been recorded on the East Fork of the Trinity. Its geographic boundaries are unknown. Large circular subterranean pits are diagnostic of the focus and are dated to the early Neo-American period on the basis of trade pottery from East Texas. Large villages occur in the river floodplain but very little is known of the villages except for burials and the large pits. Moreover the small seasonal sites are unreported and this results in a biased understanding of the way-of-life of the Wylie Focus peoples.

Evidence of historic Indian occupation of the area is unknown although documentary evidence suggests that the historic Wichita traveled and lived in the area.

In summary, Smith points out that the Upper Trinity has been occupied from the Paleo-Indian period through the early Historic period. Little is known about the Paleo-Indian and Archaic occupation and this needs to be better studied. Additional study of the Neo-American sites will be required in order to determine the importance of pottery making and the way-of-life of the prehistoric peoples.

..zenbuehler, Robert C.
1942 Some Interesting Indian Workshops in Dallas County. The Record. 3:5:28-31.

This brief article concentrates on the description of a ..mber prehistoric workshop sites located in the Mesquite-.agoville area. A map showing the location of workshop .tes and of camp or village sites is included. (Workshop ..tes are spots where chippable stone, usually in the form of .obbles, was gathered or quarried by the Indians.) There are .2 prehistoric campsites shown as located along the Trinity .etween the mouth of Prairie Creek and White Rock Creek. Al-.hough this does not include all the sites in the area it .oes suggest that workshop sites occur on the upland away from the river and along the drainage creeks.

Kirkland, Forrest
1942 A Series of NonPottery Sites in Dallas County, Texas. The Record 3:6:32-38

In this article Kirkland describes the then known archaeological resources on both sides of the Trinity from a mile southeast of Seagoville to 2 miles northwest of Kleberg. The locations of non-pottery and pottery are shown on a sketch map. Pottery sites (Neo-American) are found to be located on sandy soil which is found west of the river on the leading edge of the river terrace (6 sites) or in the river bottom (4 sites). Non-pottery sites (Archaic) occur on the yellow clay hills at the edge of the terrace and both sides of the river (19 sites are shown).

Hanna, Henry, Jr.
1940 A Most Interesting Dallas County Indian Campsite. The Record 2:2:8-11.

This site is located on Honey Creek south of the Trinity. The creek is fed by a small spring and in this area a grooved stone axe, six whole pottery vessels and three pottery effigy heads (figurines) were recovered. The site probably represents late Neo-American occupation.

..ok, Wilson W., Jr. and R. K. Harris
1955 Scottsbluff Points in the Obshner Site near Dallas, Texas. Bulletin of the Texas Archeological Society 26:75-100.

..ner, Joel L.
1970 Activity Analysis of a Prehistoric Site. Bulletin of the Texas Archeological Society 41:25-35.

The Obshner site is an early Archaic site located on the first terrace east of the Trinity near Kleberg. The archaeological deposit is thin and excavation revealed that this represents a campsite repeatedly visited by hunting parties. Occupation is primarily during the early Archaic period, sometime before 4000 B.C.

General Dallas References:

Gwin, Thomas B.
1941 An Interesting Type of Indian Artifact from Dallas and Ellis County. The Record 2:9:41-43.

Harris, R. K.
1936 Indian Campsites in the Upper Trinity Basin. Bulletin of the Texas Archeological Society, Vol. 8 TAS Annual Report.

1941 Additional Information about Dallas County Hand Axes. The Record 3:1:3.

Hatzenbuehler, Robert C.
1948 Disturbed Burial near Seagoville. The Record 6:8:33.

White Rock Creek

Harris, R. K.
1949 Burial 7, Site 27A5-19. The Record 7:7:24-25.

Hatzenbuehler, Robert and R. K. Harris
1949 Burial 5, Site 27A5-19. The Record 7:6:21-22.

Kirkland, Forrest and R. K. Harris
1941 Two Burials Below the White Rock Lake Spillway. The Record 2:10:49-54.

A prehistoric campsite located on the east bank of White Rock Creek was being slowly eroded away by overflow of the creek. Members of the Dallas Archeological Society salvaged a number of burials which were exposed by erosion. The site is probably late Archaic in age based on the projectile point styles and the absence of pottery.

Soilberger, J. B.
1953 The Humphrey Site. The Record 11:3:11-14.

The Humphrey site is a late prehistoric/early historic site located on the west side of White Rock Creek and was destroyed during construction of a housing development adjacent to the White Rock Creek Lake.

Harris, R. K. and Inus Marie Harris
1970 A Bison Kill on Dixon's Branch Site 27A2-5, Dallas County, Texas. The Record 27:1:1-2.

A bison kill site is reported from Dixon's Branch which is a tributary of White Rock Creek. The bison was associated with the gray-black silt geologic deposit and three Fresno arrow points were found in the rib cage. Therefore an inferred date of late prehistoric/early historic can be attributed to the bison kill. The authors note that they know of "many archeological sites located in and on the terraces of small creeks in the Dallas area, such as Ash Creek, Upper White Rock Creek, Duck Creek, Five Mile Creek, Ten Mile Creek, Bear Creek, and others..."

Lagow Discovery

Crook, Wilson W., Jr.
1961 A Revised Interpretation of the Lagow Discovery, Texas. American Antiquity 26:4:545-548.

Oakley, K. P. and W. W. Howells
1961 Age of the Skeleton from the Lagow Sand Pit, Texas. American Antiquity 26:4:543-545.

Shuler, Ellis W.
1932 Figurine From a Gravel Pit of Dallas, Texas. Bulletin of the Texas Archeological and Paleontological Society 4:7?-?0.

1934 Collecting Fossil Elephants at Dallas, Texas. Bulletin of the Texas Archeological and Paleontological Society 6:75-79.

Paleontological work in the twenties unearthed a human skeleton which was reportedly in association with Pleistocene ...ic fauna. Reevaluation of the geologic context and chemical ...alyses show that the skeleton is not as old as the associ...ted fauna. With the aid of recent radiocarbon dates Crook ...tributes the skeleton to the Early Archaic (greater than ...500 B.P.) and prior to the red clay veneer on the first ...errace of the Trinity.

Crook, Wilson, W., Jr. and R. K. Harris
1952 Trinity Aspect of the Archaic Horizon: The Carrollton and Elam Foci. Bulletin of the Texas Archeological and Paleontological Socity 23:7-38.

The Carrollton and Elam foci make up an Archaic manifestation which occurs throughout parts of the Blackland Prairie and may extend into the Eastern Cross Timbers. Sites assigned to this period are typically found on the first terrace of the Trinity at a spot where a small tributary cuts through the terrace to reach the floodplain. Trinity Aspect sites are generally in a buried condition and often later Neo-American sites overlie the Archaic site. Neo-American sites are also found in the river floodplain.

Kirkland, Forrest, R. K. Harris and Robert Hatzenbuehler
1949 Refuse Pits Excavated in Site 27A-1-2. The Record 7:5:17-19.

Hughes, Jack T. and R. K. Harris
1951 Refuse or Fire Pit Excavated in Site 27A1-2. The Record 10:2:7-8.

A non-pottery site is located on the west side of Elm Fork near the Carrollton dam.

Crook, Wilson W., Jr. and R. K. Harris
1953 Some Recent Finds at the Wheeler Site near Carrollton. The Record 11:5:21.

1954 Traits of the Trinity Aspect Archaic: Carrollton and Elam Foci. The Record 12:1:2-16.

1954 Another Distinctive Artifact: The Carrollton Axe. The Record 13:2:10-18.

1959 C-14 Date for Late Carrollton Focus Archaic Level: 6000 Years B.P. Oklahoma Anthropological Society Newsletter 8:3:1-2.

A summary of the archaeology and more recent work is provided by these articles. Of particular importance are radio-

...ion dates which show that the Elam focus represents the ...iod 6000-4000 B.P. and that Carrollton Focus is older.

...ain, Dessamae
1963 A Cache of Blades from Carrollton, Texas. The Record 18:1:2-7.

1966 A Site in Northwestern Dallas County. The Record 23:1:2-4.

A brief description of a Carrollton Focus site located on the first terrace of Elm Fork and known as the County Line site.

APPENDIX II

Botanical Considerations

Resource Data By

Coster, J. E., C. D. Fisher, D. D. Hall, H. L. Jones, J. D. McCullough, A. P. McDonald, E. S. Nixon, J. R. Singer. 1972 A Survey of the Environmental and Cultural Resources of the Trinity River. Stephen F. Austin University, Nacogdoches, Texas under contract with Corps of Engineers, Fort Worth District. 397 pp.

and

Sciscenti, J. V., J. E. Ubelaker, W. F. Mahler, R. D. Hyatt, M. L. Scott, S. A. Skinner, D. Gillette, J. T. Thurmond. 1972. Environmental and Cultural Resources Within the Trinity River Basin. Southern Methodist University, Dallas, Texas under contract with the Corps of Engineers, Fort Worth District. 306 pp.

Vegetational Areas of Texas

1. Pineywoods
2. Gulf Prairies and Marshes
3. Post Oak Savannah
4. Blackland Prairies
5. Cross Timbers and Prairies

Figure 20. Map positioning the Trinity River in relation to surrounding vegetational areas. Vegetational areas after Gould, 1969.

In order to depict the plant communities of the Trinity River bottom on a more localized basis, the river was divided into segments. Each segment or area was mapped and plant communities were located and discussed. Tables reflecting composition and abundance of species were prepared for each area.

RESULTS

Area 1

The West Fork of the Trinity River extends from Fort Worth, Texas, to Dallas, Texas. That portion between Fort Worth and the Tarrant-Dallas county line subsumes Area 1 (Figure 21). This flat to gently rolling area has been greatly exploited leaving only small patches of forest generally less than 200 acres in size.

Cedar elm, green ash (*Fraxinus pensylvanica*), soap berry (*Sapindus saponaria*), American elm (*Ulmus americana*) and Texas sugarberry were dominant in this section of the river (Table 14). Black willow (*Salix nigra*) and cottonwood (*Populus deltoides*) were locally frequent and dominated some gravel pit areas. Existing sloughs were generally surrounded by swamp privet (*Forestiera acuminata*). The more prevalent understory woody species were coral berry (*Symphoricarpos orbiculatus*), poison ivy (*Rhus toxicodendron*) and green-briar (*Smilax* spp.) (Table 14).

There were no evident unique sites in this area of the Trinity River, although some large trees were present. Large trees of American elm, Texas sugarberry, pecan (*Carya illinoinensis*), cottonwood, green ash and bur oak (*Quercus macrocarpa*) were noticeable and were usually found close to the river. A wooded hilly area with openings and a spring present and located within the Post and Paddock Riding Club (Site 1, Figure 21), was somewhat unique due to a greater species and habitat diversity.

Area 2

From its beginning at the Tarrant-Dallas county line, Area 2 extends along the Trinity River to Interstate Highway 45 in the center of the city of Dallas (Figure 22). Forested areas are generally confined to the banks of the river, and as a result, estimates of abundance are [illegible]. The area has been greatly modified due to urban development.

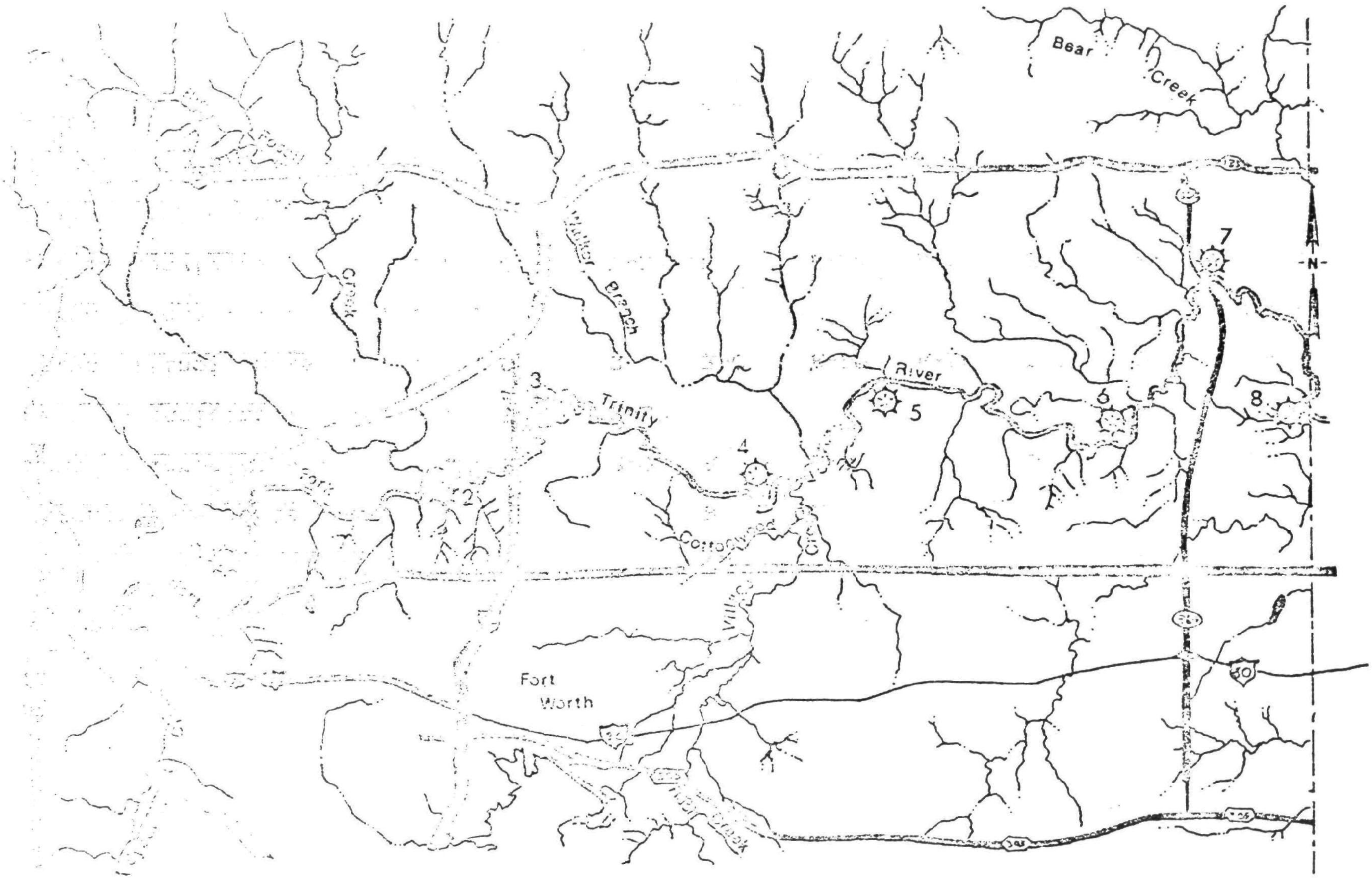


Figure 21. Trinity River Area 1 including Sites 1 through 8.

Table 14. Estimated abundance* of shrub, tree and woody vine species in Area 1 (See Figure 21).

Species	Sites Studied 1	2	3	4	5	6	7	8
Acer negundo	LO	LO	R-LO	R-LO	LO	R-LO	R-O	R-LO
Amorpha fruticosa							R	
Aristolochia tomentosa		R	VR		R		R	VR
Baccharis neglecta			R	R			R-LO	
Bumelia lanuginosa	R	R-O	R	R-O	O	O	O	R-O
Campsis radicans	R	R-LO					R	
Carya illinoinensis	O	R	R-O	R-LO	R-LO	R-O	O	R-O
Carya texana								O-LF
Celtis laevigata	O	F-LA	F	F-LA	A	F-A	F-A	F-LO
Celtis reticulata								R
Cercis canadensis		R		R		R	R	R-LO
Cissus incisa	R	R	R-O	R	R	R	R-O	R

Table 14. Continued

Species	Sites studied 1	2	3	4	5	6	7	8
Cissus trifoliata		R						
Cocculus carolinus.	R-O	R	R	R		R	R	R
Cornus drummondii		R-LO	R		R-LO	R	R-LO	O
Crataegus brazoria.						R		
Crataegus glabriuscula				O		R-LO		
Crataegus mollis.				O		R		
Crataegus sp.	R-O	R-O	O		O-LF		O-LF	R-O
Cucurbita foetidissima. . . .			R		R			
Diospyros virginiana.								R
Euonymus atropurpureus. . . .								R
Forestiera acuminata.	LA	R-O	LA	R-LO	LF	LF	LF	F-LF
Fraxinus americana.			R	R				
Fraxinus pennsylvanica	LO	LO	O-F	O	O	R-LO	O-LF	LO

Table 14. Continued

Species	Sites studied							
	1	2	3	4	5	6	7	8
Gleditsia triacanthos	R	R	R-O		R-LO	R-O	R-O	R-O
Ilex decidua	R	R-O	R	R	R-LO	R-LO	R	LO
Juniperus virginiana						VR	R	R-O
Ligustrum quihoui		R		R				
Ligustrum sp.	R	R	R				VR	
Maclura pomifera	R	R-LO	O	O	R	R		R-O
Matelea gonocarpa	R	R	R	R	R	R	R-O	R
Melia azedarach	R-O	R-O	R	R	R		R	
Melothria pendula	R	R	R		R	R		VR
Morus alba	R		R					
Morus rubra	O	O-LF	O	R-O	R-O	R-O	O	R-O
Parkinsonia aculeata		VR						
Parthenocissus quinquefolia . .	O	R-O	O	R	R-O	R-O	O	R-O

Table 14. Continued

Species	Sites studied 1	2	3	4	5	6	7	8
Passiflora incarnatum				R				
Phoradendron sp.				R		R		
Platanus occidentalis	R	R					R	R
Populus deltoides	LO	LO	LO	LO-LA	LO		LO-LF	LO
Prosopis glandulosa		R	R	R	VR	LO-LF	R-LO	LO
Prunus mexicana				VR			R-LO	R-LO
Prunus [illegible]			VR					
Ptelea trifoliata		R						
Quercus macrocarpa		O	O	R-O	O	O	R-O	R-O
Quercus marilandica						R		R-LO
Quercus muhlenbergii		R	R	R	R	R	R	R-LO
Quercus stellata						LO	LO	LF
Quercus [illegible]								R

Table 14. Continued

Species	Sites studied 1	2	3	4	5	6	7	8
Rhus aromatica							R-LO	
Rhus glabra.							R	R-LF
Rhus toxicodendron	R-O	R	R-O	R-O	R-O	R	O	O
Rubus sp..	R	R-LO		R-LO		R	R	
Salix nigra.	LO	LO	LO	LO	LO	LO	LO	LO
Sambucus canadensis.	LF	LF	LF	R	R		R	R-LF
Sapindus saponaria	O	O	F	R-LF	F	F	O-F	R-O
Smilax bona-nox.	O-F	F-A	O	F-LA	F	O-F	F	F
Smilax hispida								R
Smilax rotundifolia.	R	R-O	O	LO	R	R	R	R-O
Solanum triquetrum								R
Sophora affinis.	R-O	R	R-O	R-O	R-O	O-F	O	R-LO
Symphoricarpos orbiculatus . . .	O-LF	F	F	F	O	LF	O-LF	O

Table 14. Continued

Species	Sites studied 1	2	3	4	5	6	7	8
Tilia americana			R					
Ulmus alata								R-LF
Ulmus americana	O-LF	LO	O	R-LF	O	R-LO	O-F	O-F
Ulmus crassifolia	O-LA	F-LA	F	F-LA	F-A	F-A	F-A	F-LA
Viburnum rufidulum		R			R	R-LO	VR	LO
Vitex agnus-castus		R		VR				
Vitis aestivalis	LO						R-O	
Vitis mustangensis								R-O
Vitis rotundifolia			R	R	R			R-O
Zanthoxylum clava-herculis		VR		R	VR	R		O-LF

*Abundance is based upon the following scale:

D - Dominant　　F - Frequent　　R - Rare
A - Abundant　　O - Occasional　　VR - Very Rare
The letter "L" in front of any of the letters above indicates local abundance.

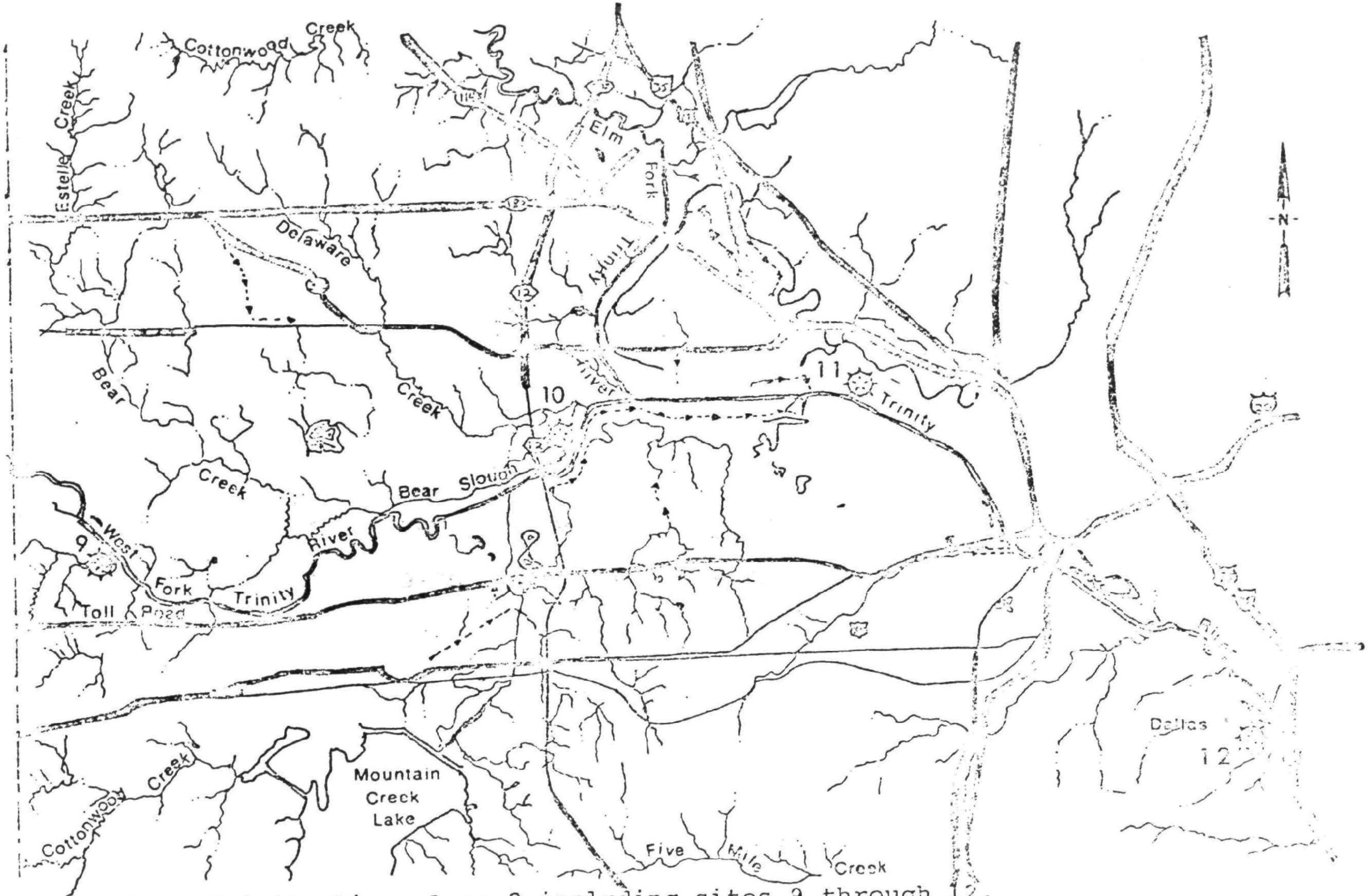


Figure 22. Trinity River Area 2 including sites 9 through 12.

Black willow and eastern cottonwood were generally frequent along the Trinity River and at times were abundant in wet, low-lying areas. Green ash, soapberry, Texas sugarberry and cedar elm were locally prevalent (Table 15).

Unique vegetational areas were absent. An area of about 50 acres near Interstate Highway 45, however, had an uncommon abundance of red mulberry (<u>Morus rubra</u>).

<u>Area 3</u>

Area 3 lies within Dallas County between Interstate Highway 45 and Mallow Bridge Road (Figure 23). Larger and somewhat less disturbed tracts of forest were present, but were generally situated between the flood control levees of the river.

Dominant tree species along this section of the river were Texas sugarberry, green ash and cedar elm (Table 16). Large trees were scarce, probably as a result of past selective cutting. Some sites, however, have more recently been protected by hunting and fishing clubs. The most unique area in this section of the river was that associated with the Fin and Feather hunting and fishing club because of species and habitat diversity (Site 14, Figure 23). This site included approximately 1000 acres of forest and contained several lakes and ponds which displayed a varied herbaceous flora. Woody plants of green ash, buttonbush (<u>Cephalanthus occidentalis</u>) and black willow frequented the margins of these lakes and ponds. Site 15 (Figure 23) is aesthetically pleasing due to the presence of a natural cut-off of about 30 acres in size, but vegetatively it is similar to other forests in this sector.

<u>Area 4</u>

Area 4 extends from the Mallow Bridge Road in Dallas County to just south of State Highway 34 in Ellis and Kaufman counties (Figure 24). Agriculture is the major land use along this sector of the river, and most of the land outside of the protective levees is cleared. Forests are confined to rather narrow bands between the levees except in the area around the junction of the East Fork of the Trinity River. Numerous sloughs are scattered throughout area 4. The trees were generally small to medium in size. Past selective logging was [illegible].

Table 15. Estimated abundance* of shrub, tree and woody vine species in Area 2 (See Figure 22).

Species	Sites studied 9	10	11	12
Acer negundo	R-O	R-LO	O-F	O-F
Amorpha fruticosa		R-LO	R-O	
Baccharis neglecta		R		
Berchemia scandens				R-O
Bumelia lanuginosa	R	O	R	R
Campsis radicans				R-O
Carya illinoinensis	R-O	O-LF	R	O-LF
Catalpa speciosa				VR
Celtis laevigata	A	F-A	O	F-A
Cephalanthus occidentalis		R		VR
Cercis canadensis			VR	R
Cissis incisa		R		
Cocculus carolinus				R-O
Cornus drummondii				VR
Crataegus sp.	O-F	R-O		
Diospyros virginiana				R
Forestiera acuminata	LA	F-LF	O	F-LF
Fraxinus pensylvanica	O	F	O-F	F
Gleditsia triacanthos	R-O	O-LF	R	R-O

Table 15. Continued

Species	Sites studied 9	10	11	12
Ilex decidua		R		
Juniperus virginiana		R	R	VR
Ligustrum sp.	R		R-O	
Ligustrum sp.			R	
Maclura pomifera	O	O	R-O	F
Matelea gonocarpa	R			
Melia azedarach	R	R-O	R	O
Morus alba		R	R-O	
Morus rubra	R-O	R-O	O	LA
Parthenocissis quinquefolia		R	R	
Platanus occidentalis				R
Populus deltoides	LO	LF-LA	A	F-A
Prosopis glandulosa	R-O	R-O	R	
Quercus macrocarpa	R	R		
Quercus shumardii				R
Rhus toxicodendron	O	O		F
Rubus trivialis		R-LO		
Rubus sp.			LO	O
Salix nigra	LF	LF-LA	A	F-A
Sapindus saponaria	O-LF	F	O-LF	F
Smilax bona-nox	F	O-LF	O	O
Smilax rotundifolia	F	O-F	R-O	

Table 15. Continued

Species	9	10	11	12
	Sites studied			
Sophora affinis.	R-O	O-F	R-LF	R-O
Symphoricarpus orbiculatus . .	LO	R-LO		R
Tamarix gallica.		R		
Ulmus americana.	O	O	R	O
Ulmus crassifolia.	A	F-A	O	R
Vitex agnus-castus			R	LO
Vitis mustangensis		R-O		
Vitis rotundifolia	R			
Vitis sp..				R-O
Zanthoxylum clava-herculis . .		R		

*Abundance is based upon the following scale:

D - Dominant
A - Abundant
F - Frequent
O - Occasional
R - Rare
VR - Very Rare

The letter "L" in front of any of the letters above indicates local abundance.

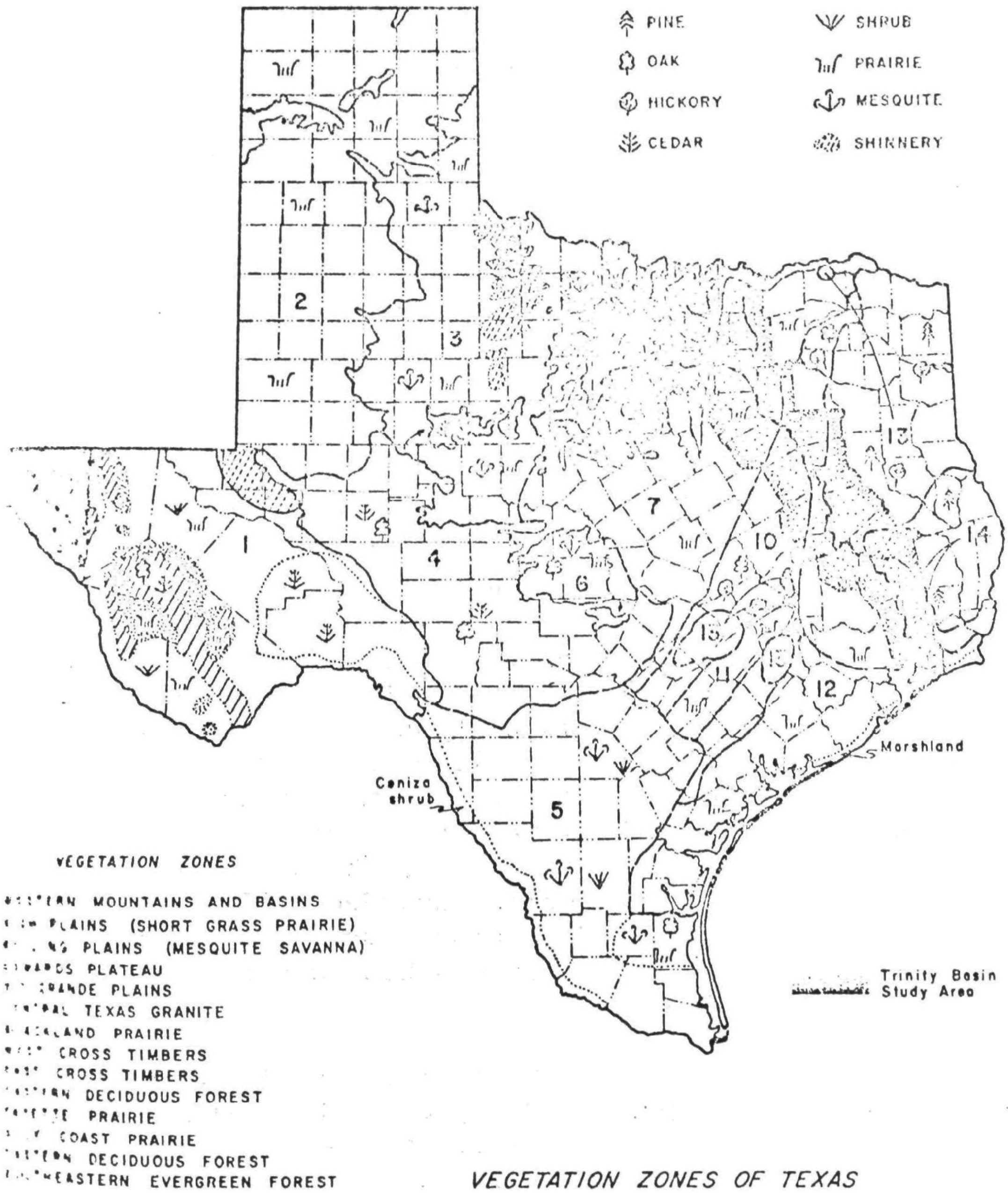


Figure 2. Vegetation zones of Texas.

..rubs, and small trees. Numerous running springs and streams .. a characteristic feature instead of the swamps and broad ..tomlands of the pine forest. The western edge of the ..ge of the shortleaf pine (P. echinata) and loblolly pine . taeda) is regarded as the western boundary of the oak-..kory-pine forest (Little, 1971).

Secondary succession. According to Tharp, the various ..ages of succession are dependent upon the prior history of .. particular area. The vegetation varies from pure pine ..ands to mixed to pure hardwood (oak-hickory). The same ..ncept expounded upon in the previous section of secondary ..ccession may be utilized within this vegetation zone.

Fields abandoned from cultivation are often covered ..th a dense stand of loblolly pine, commonly referred to .. "old field pine," in addition to sassafras, persimmon, ..d Andropogon virginicus.

A study of grazed and ungrazed plots on two forest ..pes within Sam Houston National Forest is summarized ..rner, 1942). An elm-oak bottomland forest study showed ..at switchcane and Carex provided good late fall and win-..er grazing when mature. It was protected during the spring ..d summer for growth and maturation. If not grazed during ..e fall and winter, a thicket-like understory developed. ..ral stages developed in the following sequence: 1) weeds, .. Carex, 3) switchcane, 4) palmetto, and 5) woody plants. .. the pine-oak upland forest sites, the ungrazed plots de-..creased the carpet grass (which retarded tall grass growth) ..d tall grasses increased causing a greater fire hazard. .. addition, pine reproduction was best under partial shade ..d a light grass density.

Hydrosere. Swamps are typically absent and Pontederia ..d Eichhornia decrease and disappear. Different taxa be-..e involved in the formation of the various vegetation ..nes up to the climax upland forest of oak-hickory.

..K-HICKORY FOREST

This forest is the westernmost extension of the Eastern ..ciduous Forest (provided one continues to follow the zone ..thward to the Red River and westward to include the East

(West Cross Timbers projecting southward). The hickories decrease in number westward until the oaks are the dominant taxa within the East and West Cross Timbers. The dominants are Quercus stellata - post oak, Q. marilandica - blackjack, and Carya texana - black hickory. Rolling sandhills with streams, valleys, and floodplains are characteristic.

Secondary succession. On burned-over land, the dominants possess the ability to resprout and form a dense thicket type of vegetation. On cut-over land, when the sprouts are grazed by livestock, grasses become a dominant seral stage. Old abandoned fields are invaded by forbs (coreopsis - 1 to 2 years), followed by grasses, and then shrubs (sassafras and persimmon), ultimately leading to a climax oak-hickory; however, Bilan and Stransky (1966) recommend the planting of pines within the zone on a field trial basis following their research even though pines are absent in secondary succession within this zone.

Hydrosere. The aquatics and marsh plants are similar to those in the oak-hickory-pine. The floodplain consists of different taxa (willow, cottonwood, elm, ash, pecan, walnut, hackberry) than found in the pine-oak forest. The vegetation of the Carrizo sands was studied by McBryde (1933) and by Kral (1955).

COASTAL PRAIRIE

The low, flat, marshy area of alluvium and sand is considered by Tharp to be a seral stage. The dominant plants are grasses, yet the area is invaded by woody vegetation characteristic of the vegetation types along its borders. Woodland does occur on sandy ridges and along the streams. In Texas, only the Trinity and the San Jacinto rivers flow into the Gulf through wooded bottoms. All of the other Texas streams enter the Gulf by way of marshlands. The invasion by woody taxa is apparently due: 1) to overgrazing, 2) to elimination of prairie fires, and 3) to accelerated seed dispersal of woody taxa.

BLACKLAND PRAIRIE

The Blackland Prairie received its name from the black, soils derived from the limestone parent material. The annual precipitation is from about 30 inches in the western to 40 inches in the easternmost section. Grasses repre- the dominant vegetation type even though the grasses may partially obscured by the spring, summer, and fall annual perennial forbs in their respective seasonal aspect. The tall grasses, such as bluestems (*Andropogon* spp.), are domi- where protected in the eastern part giving way to shorter grasses westward - buffalo grass (*Buchloe dactyloides*) and gramas (*Bouteloua* spp.). Most of the land is in cultivation with the rough, untillable land usually overgrazed.

The most intensive study of any section of the Blackland Prairie was conducted by Dyksterhuis (1946) on the Fort Worth Prairie. The research covered a 5 year period (1939 - 1944) and included a historical resume, areal description, vegetation, succession, seasonal development and yields of principal grasses. A brief outline on the factors influencing the vegetation of the Fort Worth Prairie (Dyksterhuis, 1946; Winkler, 1915) is presented with the documentation sources included in the bibliography. The chronology of events is as follows:

Pre-Caucasian - Caddoan cultural group; a density of one Indian per 5,000 acres.
1541 - Coronado and 29 horsemen traveled the length of the prairie.
1700 - Strong French and Spanish influence on the Caddoan Indians.
1750 - Wild horses became a factor.
1800 - 1850 - Plains Indians with horses modified pre-Caucasian culture.
1841 - Earliest diary of a traveler (Kendall, 1845).
1850 - 1860 - Settlement by white man.
1850 - Whiting (1850) describes Trinity River, the roads, vegetation, and the area settled by white man.
1852 - Capt. R. B. Marcy's expedition with plant collections from the headwaters of Trinity. Torrey (1853) wrote the report for the botanical part.
1854 - Pope expedition traversed north end of Fort Worth Prairie and did not distinguish between Cross Timbers and Prairie; described vegetation.
1854 - Parker (1856) described months of June and July.
1850 - 1880 - Greer (1935) recalls vegetation encountered as a boy.

1866 - 1885 - Cattle trails, Chisholm and Shawnee, ran the length.
1883 - Barbed wire, drought, and fence-cutting.
1800's - Severe overstocking of ranges, drought, and prairie fires.
1860 - 1930 - 1860: 20 acres per mature cow/yr.
1890: 7 acres per mature cow/yr.
1930: 11 acres per mature cow/yr.

The early reports of expeditions by white man indicated that the vegetation of the prairie was tall and luxurient with grasses and in the spring, wild flowers were bountiful. In the dry, hot summers, the vegetation turned brown and the wild flowers disappeared giving an opposite aspect. The wooded areas were restricted to creeks with game and wildlife abundant.

In the final analysis by Dyksterhuis (1946) following the detailed plot studies, 3 groups were compared: present condition (over the broad area studied), late subsere (7,000 acre ranch carefully managed), and climax (relict climax vegetational areas). The trends in the importance of the principal grass species are presented in charts showing annual grasses and forbs decreasing towards the climax with perennial grasses and forbs increasing. Stipa leucotricha represented the dominant species in the disclimax with Andropogon scoparius as dominant in the climax.

Relations between relief, soils, and vegetation, the seasonal development of vegetation, and monthly yields of principal grasses were also extensively studied and discussed.

Other papers treating the Blackland Prairie are Thomas (1962) and Hill (1901).

WESTERN CROSS TIMBERS

A study similar to that of the Grand Prairie was also conducted by Dyksterhuis (1948) on the vegetation of the Western Cross Timbers. This study is of the same high quality as that of the Grand Prairie and covered 10 years intermittently. A superficial summary is presented.

The Western Cross Timbers is divided into two areas,

...e Main Belt and the Fringe. The Main Belt is characterized ...y Red and Yellow Podzolic soils on Cretaceous strata with ...ndy soils and gentle relief while the Fringe is character-...ed by immature Reddish Prairie soils on Pennsylvanian ...rata with gravelly and rocky soils on rugged topography. ...e understory taxa differ from one belt to the other. The ...hief characteristic of the Western Cross Timbers vegetatively ...s the presence of post oak (*Quercus stella*) and blackjack ...Q. *marilandica*) but the other vegetation varies locally be-...ause of the soils and land use.

Climax vegetation. The climax or original vegetation consisted of grasses, the dominants being little bluestem (*Andropogon scoparius*), Indian grass (*Sorghastrum nutans*), and big bluestem (*Andropogon furcatus*). It was concluded that the climax vegetation was grassland and the oaks constituted a postclimax. The savanna was a result of the edaphic factors which prevented the vegetation from being a grassland under that particular climate (climatic climax - monoclimax concept). This area could be considered as an edaphic climax under the polyclimax concept. The vegetation consisted of tall grasses with well-spaced oaks forming a savanna upon settlement by white man.

Floristically, 4 types of vegetation based upon soil types were described: 1) *Quercus-Smilax* - podzolic soils, 2) *Quercus-Prosopis* - immature Reddish Prairie soils, 3) *Prosopis* - mature Reddish Prairie soils, and 4) old field - podzolic soils. The present understory vegetation is a grazing disclimax with oaks having increased to form a woodland or forest.

Secondary succession. Under certain conditions, the succession may reach the climax in 14 years through 4 seral stages: 1) weed stage, 2) annual threeawn stage, 3) splitbeard bluestem stage, and 4) the little bluestem stage. The threeawn stage may persist for years with unrestricted grazing or if seeds of advanced stages are absent.

Grazing coactions, autecological studies of 14 of the most important grasses, 4 typical points in range degeneration, seasonal vegetational data, methods of study, survey of historical literature, soils, geology, and topography were discussed and integrated.

Studies comparable to those of Dykstorhuis on the West ..ss Timbers and the Grand Prairie have not been conducted . the East Cross Timbers or as a matter of fact, anywhere ..e in Texas.

The early expeditions quite often did not differentiate .etween the East and West Cross Timbers, particularly if ..y were north of Red River where the mosaic of prairie and ..odland was not as massive in area. The wildlife common ..d abundant to the whole area (Cross Timbers and Blackland ..airie) included buffalo, bear, deer, antelope, wild boars, ..rtridges, turkeys, as well as Castilian cattle and herds . mustangs. Yet, the ranges evidently were not overgrazed ..cording to the accounts of the vegetation prior to actual ..ttlement by white man.

Endemics

An endemic plant is defined as indigenous or native to ..e area and not introduced from another geographic area. An endemic 1) is persistent over a small geographic area from a wider distribution in the past, or 2) has evolved in place and is slowly expanding its range. The nature or biology of closely related taxa may indicate the origin or relationship of some endemics upon detailed biosystematic studies. A study of the Californian endemics and their relationships (Stebbins and Major, 1965) illustrate the type of study which should be made in Texas, especially in regard to the study area. The principal problem is that the Texan species have not been studied in the depth that the Californian taxa have been studied. The basic research still needs to be done before that type of study can be meaningful. The approach is different from the one in this report and in future studies, both should be integrated for a better understanding of the role of endemics and their importance to man.

A brief, superficial summary of points that would be pertinent to Texas endemics is presented from the study by Stebbins and Major (1965). The study was an "approach to the problem of determining what floristic and ecological conditions promote 1) the persistence of relict species and 2) the origin of new species. The most satisfactory approach in the long run is to study in detail the ecological re-

APPENDIX III

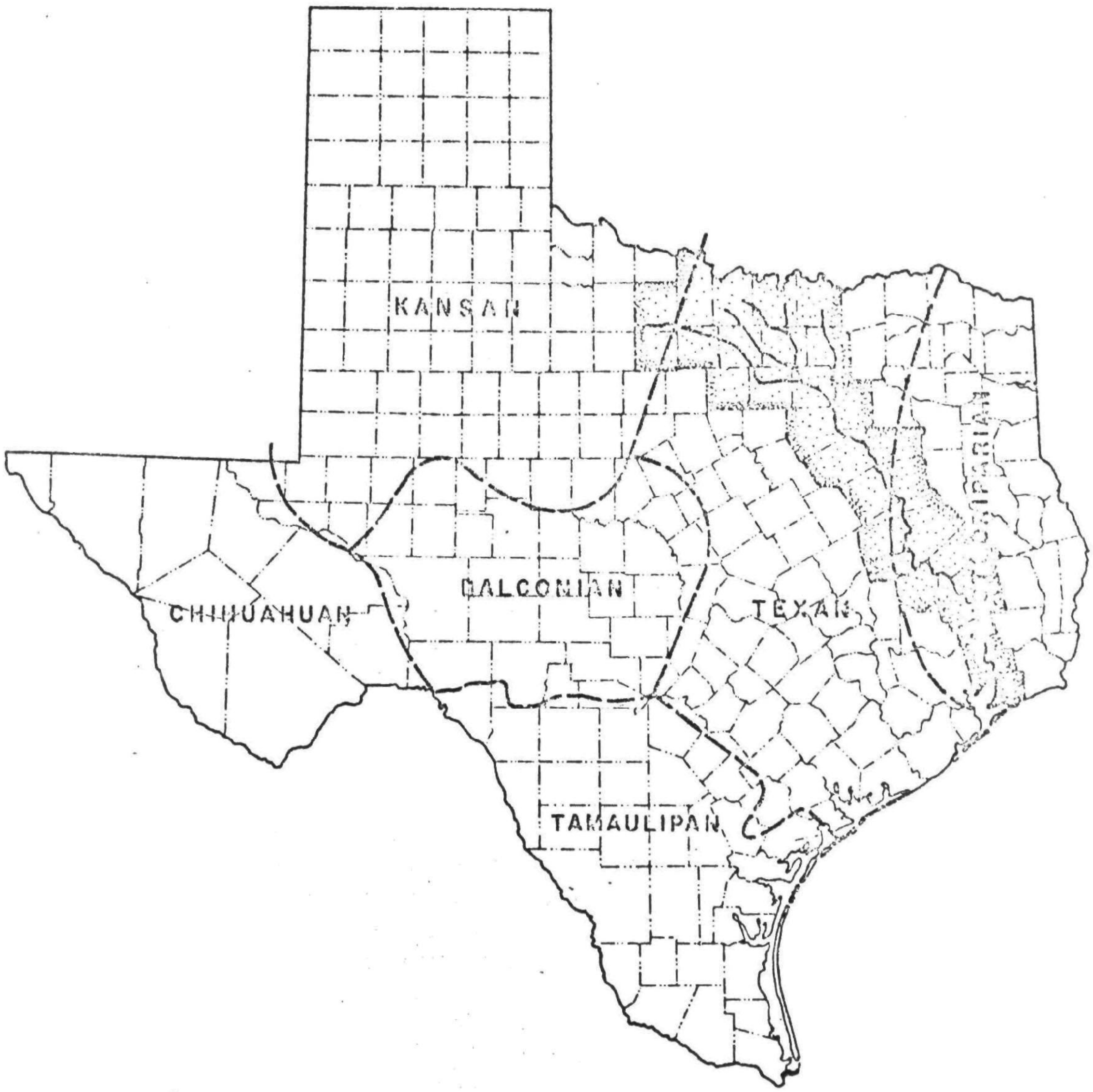
Zoological Considerations

Resource Data By

Coster, J. E., C. D. Fisher, D. D. Hall, H. L. Jones, J. D. McCullough, A. P. McDonald, E. S. Nixon, J. R. Singer. 1972. A Survey of the Environmental and Cultural Resources of the Trinity River. Stephen F. Austin University, Nacogdoches, Texas under contract with the Corps of Engineers, Fort Worth District. 397 pp.

and

Hayes, T. R., T. R. Hellier, T. E. Kennedy, Jr. 1972. Environmental Impact Study of the Elm Fork Region of the Trinity River. For the Corps of Engineers, Fort Worth District.



BIOTIC PROVINCES IN TEXAS

Figure 1. Biotic provinces in Texas

DISCUSSION

Rare, Endangered, and Endemic Species

black bear (Ursus americanus): this species was once wi spread in Texas, but now is found only in small numbers the western mountains (Davis, 1966). According to Baker (1956) bears persisted in East Texas at least until the 1930's, and there are a few later reports from Tyler, Polk, Angelina, and Nacogdoches Counties. In the current survey no evidence of bears was found and they were not reported to the investigators by any local resident. It is therefore very unlikely that this species now exists anywhere along the Trinity River.

river otter (Lutra canadensis): although no conclusive signs of river otters were found during this inventory, it was reported as occurring on the lower Trinity River in Liberty County by two residents who were interviewed, and Davis (1966) says that it still occurs locally in East Texas. A specimen from the Attoyac River in Nacogdoches County was brought to this investigator in 1970. This semi-aquatic carnivorous mammal must therefore be considered a rare inhabitant of at least the lower part of the river.

red wolf (Canis niger): the red wolf formerly ranged widely over East and Central Texas, as far north as the Red River (Davis, 1966), but recent specimens from Texas are all from the upper coastal region, centering in Chambers County. It is difficult to gather reliable information because this species is often confused with the coyote, with which it apparently readily interbreeds. Hybrid animals add to the problem of identification (see McCarley 1959). It is this investigators opinion that red wolves could and probably do occasionally wander northward along the lower part of the Trinity River in Liberty,County, but conclusive evidence is presently lacking. This species prefers open areas with adequate cover rather than extensive forests.

cougar or mountain lion (Felis concolor): cougars are known to occur with certainty in Texas today only in the more remote parts of South and West Texas, where their numbers are apparently dwindling. This species once occurred throughout the state, and there are still frequent unconfirmed reports from many parts of East Texas. Several persons who were interviewed in Liberty County and one in Anderson County insisted that they had seen mountain lions or their tracks recently. However, in the absence of any convincing evidence it is considered highly improbable that this species inhabits any area along the Trinity River today. Nevertheless, there are some habitats, such as the Tanner Bayou area, which could conceivably support a pair of these animals. According to Baker (1956) the last reliable report from East Texas was from Angelina County in 1927.

wood ibis (Mycteria americana): the present breeding range of this species in the United States is apparently restricted at least on a regular basis, to Florida (A.O.U., 1957). However, wood ibises wander widely in mid- and late summer, reaching coastal Texas by June and then continuing inland in many localities (Peterson, 1960; Wolfe, 1956). This investigator has found them to be of regular occurrence, in small numbers or groups of up to 20 individuals all along the Trinity River, first appearing in mid-June. Birds forage around the edges of marshes, swamps and lakes, but apparently only very rarely on the shore of the river itself.

roseate spoonbill (Ajaia ajaja): spoonbills nest very locally along the central and upper coast of Texas, including Chambers County, and at scattered locations elsewhere around the Gulf to Florida. It is possible that a few pairs nest in the Old River heronry (on the Trinity River just above the Liberty-Chambers county line, see Table 33). After the breeding season some individuals wander inland, and can be expected almost anywhere along the river, as far northward as Dallas. This investigator recorded a single individual along the river in northwestern Henderson County on June 27.

Mississippi kite (Ictinia misisippiensis): although this species is a locally common breeding bird in parts of the Texas Panhandle and North-central Texas, it was not known to occur as a summer resident anywhere in East Texas prior to the present investigation. A total of 13 individuals (7 adults, 5 sub-adults, and 1 bird of undetermined age) were recorded at 8 different sites along the lower Trinity River, all in Liberty County except for one site between Polk and San Jacinto Counties (approximately 2 miles below Lake Livingston dam, where 2 adults and 1 sub-adult were seen). Although sub-adults (i.e., about 1 year old) may not have been breeding, it is probable that adults were, but no nests were found. Mississippi kites prefer open wooded areas or scattered trees near water. They are known to breed locally from the sou[illegible] the southern [illegible] the [illegible] Atlantic coast.

osprey (Pandion haliaetus): this species is extremely widespread, breeding throughout much of North America and elsewhere in both the Old and New Worlds. However, it is nowhere common, and North American populations have declined sharply in the past 20 years. Wolfe (1956) states that no definite nesting records are known for Texas, although he cites a report by Simmons in 1925 which claimed the species was a permanent resident along the coast. It is suspected that most summer records of ospreys from Texas are of non-breeding birds, which is likely true of the two individuals observed during this study on the lower Trinity River in June. The species is known from the state primarily as a migrant and winter resident, occurring along the coast and on the larger lakes and rivers. The osprey is a fish-eating species, and it is thought that its recent decline is a result largely of chlorinated hydrocarbons (primarily DDT) in its body tissues.

red-cockaded woodpecker (*Dendrocopos borealis*): because of its dependence on mature pine stands (see Lay and Russell, 1970), this is a very local species in East Texas, and elsewhere throughout its range across the southeastern United States. Rarely are suitable habitats found very near the Trinity River, and the only population of which this investigator is aware in the general area of the present inventory is one on the north side of Lake Livingston in the Brushy Creek area of Trinity County (Dan Lay, pers. comm.).

ivory-billed woodpecker (*Campephilus principalis*): although Wolfe (1956) considered this species extinct in Texas, there have been numerous unconfirmed sightings in the Big Thicket area of East Texas during the last ten years (unpublished report by Fred Collins, Texas A&M University), the most publicized being those of John Dennis (Dennis, 1967). Owing to the lack of evidence, many orthinologists have been unwilling to accept any of the recent reports as authentic, and some such as Dr. Keith Arnold of Texas A&M University (pers. comm.) and Dr. J. T. Tanner at the University of Tennessee (Moser, 1972) are convinced the species does not inhabit any site in Texas today. The ivory-billed woodpecker, if not already extinct, must certainly be considered on the verge of extinction, not only in Texas but everywhere throughout its former range in the southeastern United States and Cuba (see Tanner, 1942; Dennis, 1948).

In the present investigation a large woodpecker was seen and sketched by Lin Risner on July 12 as it flew along the west bank of the river about 2 miles below Highway 162 in the Trinity Bayou area of Liberty County. There is no doubt that the sketch depicts an ivory-billed woodpecker, the upper wing pattern being unmistakable. If it is to be argued that Mr. Risner did not see an ivory-billed woodpecker, then it would have to be concluded that either: (1) he sketched something he did not see at all, or (2) his sketch is not an accurate representation of what he saw. My personal knowledge of Mr. Risner's character and integrity, and of his keen ability as a field observer, leads me to conclude that he did, in fact, see an ivory-billed woodpecker. The area is a relatively undisturbed bottomland forest of some 13,000 acres.

Species of Economic Importance

Game animals

The white-tailed deer is an extremely popular and important game species along most of the Trinity River, where it reaches its largest population densities in bottomland hardwood forests (see Collins, 1961; Lay, 1965; Segelquist and Green, 1968; Stransky and Halls, 1962). Many landowners lease their property for deer hunting in the fall and there are several large hunting clubs, such as the Arizona Creek Wildlife Club in Liberty County with approximately 100,000 acres and about 2,000 members (M. J. Cain, pers. comm.). Sportsmen interviewed often said that deer hunting along the middle regions of the river was among the best anywhere in the state, and this was also the opinion of Mr. Walt Daniel, the resident game biologist in Fairfield (pers. comm.). Other mammals which are extensively hunted for sport are the gray and fox squirrels, and to a lesser extent the swamp and cottontail rabbits. Raccoon and fox hunting are also very popular sports along the Trinity River. These animals, mostly inhabitants of forested areas, provide many hours of recreation and bring a considerable amount of revenue into the region.

The Trinity watershed is one of the most valuable areas in East Texas for breeding wood ducks. Although these birds were not very often seen on the river itself, they nest in moderate densities on the wooded swamps, sloughs, and oxbow lakes on the floodplain. Sixty-four wood ducks were counted flying over the river at dusk on July 13 from an observation point near Moss Bluff in Liberty County, and on July 12 at Gaylor Lake in the Tanner Bayou area of Liberty County a total of 31 birds were counted in the hour before dark. Several broods of half-grown young wood ducks were seen on the upper and middle sections of the river in early July, always accompanied [illegible] or both parents.

Although no data were gathered during this investigation during the winter months, this investigator was informed by numerous residents, and by Walt Daniel of Fairfield, that the same areas utilized for breeding by wood ducks are frequented by many hundreds of wintering waterfowl from October through March. These birds are extensively hunted and their popularity among hunters ranks with that of the white-tailed deer. The site of the Old River Refuge (Table) is a 1,700 acre duck hunting preserve. This very large swamp is located about one mile west of the river and two miles north of the Liberty-Chambers county line.

Fur-bearing animals

Beavers are more abundant in the Trinity River watershed (to the knowledge of this investigator) than they are anywhere else in the state of Texas. Dan L[illegible] (pers. comm.) stated that populations along the Trinity River were introduced there from West Texas populations in the late 1930's and early 1940's after native beavers had been virtually exterminated from East Texas in the early part of the century. Owing to protection given them by law this species made a remarkable comeback along the Trinity River, to the point where they are now sometimes considered a nuisance and a pest. Although they have valuable pelts, and trapping permits can be obtained from the Texas Parks and Wildlife Department, there appears to be little interest in commercial trapping of beavers along the river today. Likewise, there is an apparent lack of interest in exploiting the mink, another relatively common fur-bearing mammal inhabiting the Trinity River.

A third species, the introduced nutria from South America, also has a pelt of potential commercial value, but this investigator is not aware of any nutrias being trapped for their fur. Although not common on the river itself, the nutria was rather frequently encountered in marshes or lakes near the river, and on some of the larger slow-moving tributary streams such as Redmond Creek in lower Liberty County. At times nutria populations can build up in a marsh, lake, canal, or irrigation ditch to the point where the animals become a major pest by eating all of the aquatic vegetation, or even crops and pine seedlings (Evans, 1970; Atwood, 1950).

Sites of Particular Ecological Importance

From an ecological viewpoint there are many valuable areas along the Trinity River. The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] Nixon in the [illegible] [illegible] this overall project. All of these sites are very important for wildlife.

These include: (1) the forest area between the old and new channels of the East Fork of the Trinity River in Kaufman County, at their confluence with the Trinity River; (2) the Bruce Smith Ranch on the east side of the river in Henderson County, southwest of Tool (in the Sanders Creek general area); (3) the east side of the river in Anderson County in the general vicinity of Big Lake, several miles above Highway 84 crossing; (4) the south side of the river in Walker County in the Black Creek/White Oak Creek area; (5) the north side of the river in Walker County on the Earl Moore Ranch in the Horseshoe Lake area; (6) the south and west side of the river in San Jacinto County south of FM 1127 in the Davison Bayou/Coley Creek area; (7) most of the west side of the river in Liberty County between the New River Lakes Development and Sam Houston Lakes Development (approximately the middle region of the river between Highways 105 and 162); (8) the Tanner Bayou area on the west side of the river in Liberty County between Highway 162 and Capers Ridge; and (9) a large forested and swampy area on the west side of the river in Liberty County across from Moss Bluff, generally from about 1-1/2 miles north of the county line north to the Harrison and Timber Lake subdivisions.

Although the above sites are considered to be the best wildlife areas along the river at the present time, it should be emphasized that numerous other sites are also highly valuable, including all nesting colonies of herons and egrets (see Table 33). In Liberty County where most of the river is extensively forested on both sides it is difficult to single out specific sites as being more important than others. However, the present survey of the river indicates that the Tanner Bayou area is almost certainly the most significant and valuable ecological area situated anywhere along the Trinity River today. Every effort should be made to preserve it. Currently, most of the approximately 13,000 acres of forest in this area is owned by the Kirby Lumber Company, and the area is leased for both hunting and grazing. However, because of the inaccessibility by road to much of the area, it remains relatively little disturbed by man. It is possible that one or more ivory-billed woodpeckers may inhabit this area.

CONCLUSIONS

The Trinity River lies on the western edge of the Austroriparian biotic province (Dice, 1943; Blair, 1950), and its avian and mammalian faunas are, in general, typical of those of the whole southeastern United States.

TABLE I. Fishes Collected in Present Study.

Lepisosteus osseus (Linnaeus) - long-nosed gar

Dorosoma petenense (Gunther) - threadfin shad

Dorosoma cepedianum (LeSueur) - gizzard shad

Notemigonus crysoleucas (Mitchell) - golden shiner

Notropis venustus (Girard) - blacktail shiner

Notropis lutrensis (Baird and Girard) - red shiner

Notropis atrocaudalus Everman - blackspot shiner

Pimephales vigilax (Baird and Girard) - bullhead minnow

Ictalurus punctatus (Rafinesque) - channel catfish

Ictalurus melas (Rafinesque) - black bullhead

Noturus nocturnus (Jordan and Gilbert) - freckled madtom

Fundulus notatus (Rafinesque) - blackstripe topminnow

Gambusia affinis (Baird and Girard) - mosquitofish

Menidia audens Hay - Mississippi silverside

Roccus chrysops (Rafinesque) - white bass

Micropterus punctulatus (Rafinesque) - spotted bass

Micropterus salmoides (Lacepede) - largemouth bass

Chaenobryttus gulosus (Cuvier) - warmouth

Lepomis macrochirus Rafinesque - bluegill

Lepomis megalotis (Rafinesque) - longear sunfish

Pomoxis annularis Rafinesque - white crappie

Percina scierus Swain - dusky darter

Percina caprodes (Rafinesque) - logperch

Etheostoma spectabile (Agassiz) - orange throat darter

Aplodinotus grunniens Rafinesque - freshwater drum

TABLE II. Checklist of Species Found in Garza-Little Elm Reservoir and Elm Fork Trinity Drainage by Bonn (1956) and Lamb (1957).

Lepisosteus platostoma Rafinesque - shortnose gar

Lepisosteus productus (Winchell) - spotted gar

Lepisosteus osseus (Linnaeus) - longnose gar

Dorosoma cepedianum (LeSueur) - gizzard shad

Astyanas fasciatus (Cuvier) - banded tetra

Ictiobus bubalus (Rafinesque) - smallmouth buffalo

Carpiodes carpio (Rafinesque) - river carpsucker

Mineytrema melanops (Rafinesque) - spotted sucker

Cyprinus carpio Linnaeus - carp

Notemigonus crysoleucas (Mitchell) - golden shiner

Opsopoeodus emiliae Hay - pugnose minnow

Notropis atherinoides Rafinesque - emerald shiner

Notropis umbratilis (Girard) - redfin shiner

Notropis lutrensis (Baird and Girard) - red shiner

Notropis buchanani Meek - ghost shiner

Notropis venustus (Girard) - blacktail shiner

Notropis brazosensis Hubbs and Bonham - Brazos River shiner

Hybognathus nuchalis Agassiz - silvery minnow

Hybognathus placita Girard - plains minnow

Pimephales vigilax (Baird and Girard) - bullhead minnow

Campostoma anomalum (Rafinesque) stoneroller

Ictalurus punctatus (Rafinesque) - channel catfish

Ictalurus melas (Rafinesque) - black bullhead

TABLE II. Checklist of Species Found in Garza-Little Elm Reservoir and Elm Fork Trinity Drainage by Bonn (1956) and Lamb (1957). (continued)

Ictalurus natalis (LeSueur) - yellow bullhead

Noturus mollis (Mitchell) - tadpole madtom

Noturus nocturnus (Jordan and Gilbert) - freckled madtom

Fundulus notatus (Rafinesque) - blackstripe topminnow

Fundulus kansae Gorman - plains killifish

Gambusia affinis (Baird and Girard) - mosquitofish

Roccus chrysops (Rafinesque) - white bass

Micropterus punctulatus (Rafinesque) - spotted black bass

Micropterus salmoides (Lacepede) - largemouth black bass

Chaenobryttus gulosus (Cuvier) - warmouth

Lepomis cyanellus Rafinesque - green sunfish

Lepomis macrochirus Rafinesque - bluegill

Lepomis humilis (Girard) - orangespotted sunfish

Lepomis microlophus (Gunther) - redear sunfish

Lepomis megalotis (Rafinesque) - longear sunfish

Pomoxis annularis Rafinesque - white crappie

Percina caprodes (Rafinesque) - logperch

Etheostoma chlorosoma (Hay) - bluntnose darter

Etheostoma gracile (Girard) - slough darter

Etheostoma barratti Holbrook - scalyhead darter

Etheostoma spectabile (Agassiz) - orangethroat darter

Aplodinotus grunniens Rafinesque - drum

9

Euphorbia bicolor, Fleabane (*Erigeron* sp.), Tumblegrass (*Schedonnardus paniculatus*), Buffalobur (*Solanum rostratum*) and *Croton* sp.

5. MAMMALS - Trapping, utilizing mostly Sherman live traps and a few Museum-Special snap-traps, was accomplished in 5 different ecologic associations: (1) Mesophytic Forest, (2) Old-Field Grasses (eradicated forest and disturbed prairie grasses), (3) Blackland Prairie Grasslands, (4) Bare-soil (bull-dozed forest) and (5) cross-timber forest. Sampling comprised 745 trap-nights. Trapping yielded 49 specimens representing 5 genera. Collections were taken in the flood-plain to the terraces. Trapping distribution is presented below in tabular form.

NUMBER OF TRAP NIGHTS AND CATCHES IN DIFFERENT ENVIRONMENTS

	MESOPHYTIC	BARE SOIL (BULL-DOZED FOREST)	CROSS TIMBERS	OLD-FIELD GRASSES	BLACKLAND PRAIRIE
Trap-Nights	47 21 21 21 15	47 47 (1 *Peromyscus* near bull-dozed trees)	25 25 (19 *Sigmodon* 3 *Peromyscus* 2 *Mus* 2 *Rattus* 1 *Reithrodontomys*) 27 specimens	ERADICATED MESOPHYTIC FOREST 47 38 38 15 (6 *Sigmodon* 1 *Mus*) 7 specimens	DISTURBED 50 50 50 (No catch) SLIGHT STRESS 50 (5 *Sigmodon* 1 *Rattus* 2 *Mus* 1 *Peromyscus*) 9 specimens RELATIVELY UNDISTURBED 50 50 (2 *Sigmodon* 7 *Mus*) 9 specimens
TRAP NIGHTS	125	94	50	176	300
SPECIMENS	0	1	27	7	18

The cotton rat (Sigmodon) is highly adaptable and occurs in both disturbed as well as relatively undisturbed areas as long as grassy cover is available. The Norway Rat (Rattus) and the House Mouse (Mus) dwell near human habitations. The Harvest Mouse (Reithrolontomys) lives in both grassland and open forest especially savannahs. The Deer Mouse (Peromyscus maniculatus) is chiefly a dense forest inhabitant.

According to Blair (1950) and Burt and Grossenheider (1964) there are about 45 species of mammals in the Elm Fork region. However, many of the original habitats have been decimated or greatly modified by human activity and there are probably less than 40 mammalian species remaining. The signs of Beavers (Castor) are common along the Elm Fork. In addition the Muskrat (Ondatra), Armadillo (Dasypus), Raccoon (Procyon), Opossum (Didelphis), Swant Rabbit (Sylvilagus), Striped Skunk (Mephitis), two species of squirrels (Sciurus) and the Gray Fox (Urocyon) are typical inhabitants of the mesophytic forest.

6. AMPHIBIA - About 12 species of Amphibia are reported from the Elm Fork region (Conant, 1958). Two very interesting tree-frogs live in ponds and swamps adjacent to the Elm Fork, the Green Treefrog (Hyla cinerea) and the Gray Treefrog (Hyla versicolor). All amphibian species are dependent on rather high humidity micro-climates for completion of their life cycle.

7. REPTILES - About 44 species of reptiles are reported from the Elm Fork region (Conant, op. cit.). The Cottonmouth (Agkistrodon

piscivorus), Pigmy Rattlesnake (Sistrurus miliaris), Garter Snake (Thamnophis sirtalis), Diamond-Backed Water Snake (Natrix taxispilota), the Blotched Water Snake (N. erythrogaster), the Broad-Headed Skink (Eumeces laticeps), Five-Lined Skink (E. fasciatus) and the Ground Skink (Lygosoma laterale) are all high humidity water and forest species. The same is true for eight of nine species of turtles which occur in the Elm Fork region.

8. BIRDS - Pulich (1961) reports that about 320 species of birds occur in the study region. Texas leads all other states in varieties of birds, about 500. Some 43% of the Elm Fork avi-fauna are migratory species which 'stop-over' along the meso-phytic forest in particular during spring and fall. Many migratory and resident birds are spectacular: the gaudy Painted-Bunting, Promonothary Warbler, Red-Tail Hawk, Belted Kingfisher and the Great Blue Heron. The giant Pileated Woodpecker was exterminated by man several decades ago.

APPENDIX IV

Geological Considerations

Resource Data By

Sciscenti, J. V., J. E. Ubelaker, W. F. Mahler, R. D. Hyatt, M. L. Scott, S. A. Skinner, D. Gillette, J. T. Thurmond. 1972. Environmental and Cultural Resources Within the Trinity River Basin. Southern Methodist University, Dallas, Texas under contract with the Corps of Engineers, Fort Worth District. 306 pp.

Sciscenti, J.V.

Introduction

The northern portion of the Trinity River Basin includes bedrock of Paleozoic and Mesozoic age sediments. In the northwestern extreme of the basin, the older Permian sediments are overlain conformably by Pennsylvanian/Mississippian age carbonates and clastics. At the surface, these dip toward the northwest at a shallow angle, the outcrops trending roughly north-south. To the east and south, Cretaceous sediments lap unconformably onto the older Paleozoic rocks. These Cretaceous rocks are the oldest Texas remnants of the series of deposits accumulated during the retreat of the sea during the Mississippi Embayment. Beginning with Lower Cretaceous sediments in the north, the Trinity River passes over progressively younger Mesozoic and Cenozoic sediments to the south. All were deposited as sediments on the margin of the Gulf Coast Geosyncline. In the subsurface the formations generally thicken considerably toward the Gulf, approaching geosynclinal proportions at depth.

Paleozoic topography is variable, consisting largely of limstone-capped uplands standing as remnants of the once continuous veneer of the carbonate-shale-sandstone cover. From the Lower Cretaceous southward and eastward, topography consists of sets of gently rolling hills trending more-or-less perpendicular to the course of the Trinity River and forming long continuous cuestas on the up-dip sides of the exposures.

General Stratigraphy

Except for the Late Paleozoic sediments (Permian and Missippian-Pensylvanian) in the northwestern corner of the basin, surface exposures include a progression of Early Cretaceous formations in the north through a more-or-less complete representation of Tertiary formations to the south. Correlation is largely biostratigraphic rather than structural or lithologic.

A fair number of detailed stratigraphy papers have been published, although no single account has replaced the overall treatments of Dumble (1918) and Sellards, et al. (1932). Nearly all sedimentary rocks in the basin can be categorized as lowland terrestrial, shoreline, or near-shore deposits

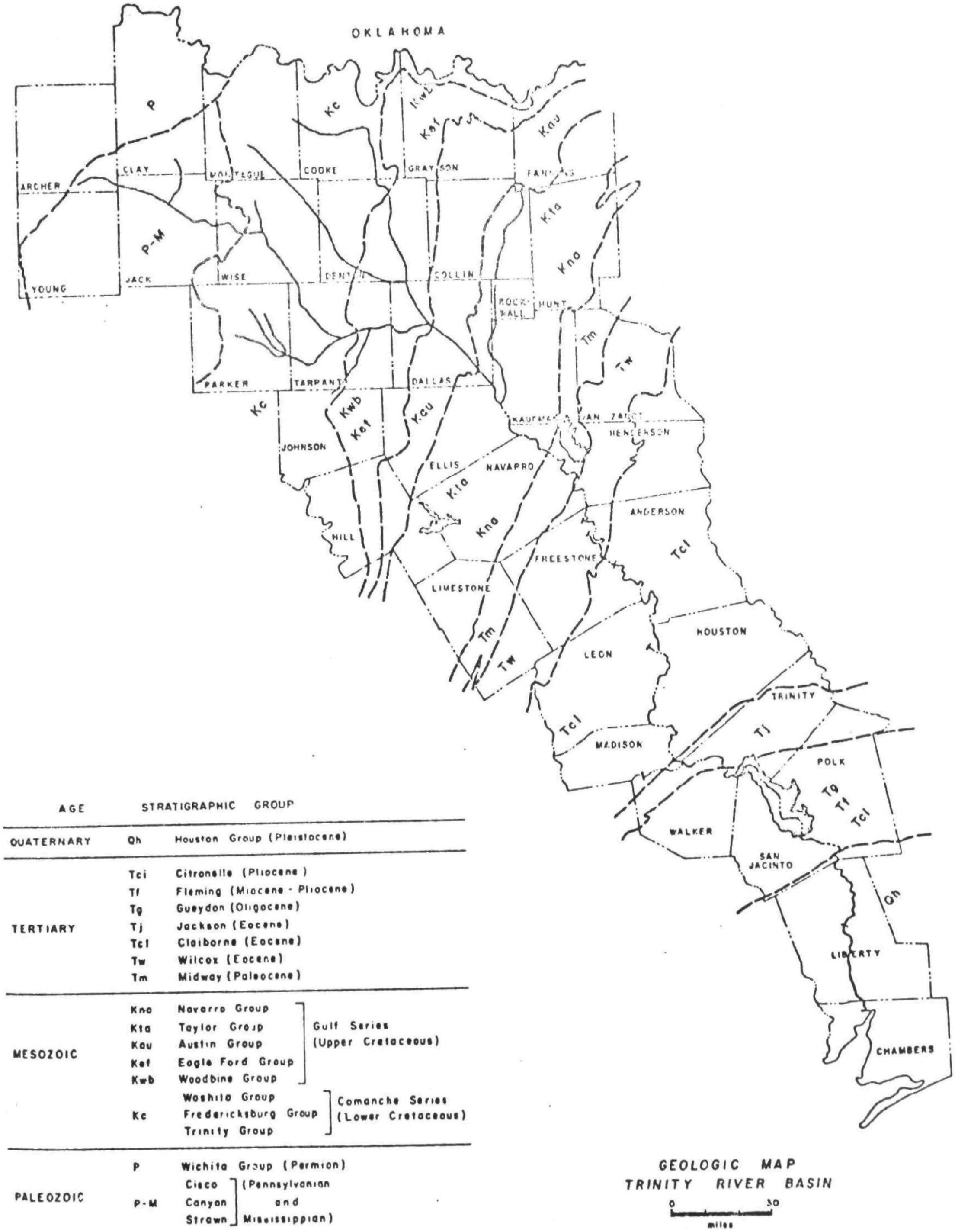


Figure 15. Geologic map of the Trinity River Basin.

where the formations crop out at the surface. For this reason, all formations are potentially important for their fossil content, since these environments are the most likely to accumulate organisms in abundance. Especially important to paleontologists and stratigraphers are the following: the Permian "red-beds" region in the northwestern section of the basin for their terrestrian Paleozoic amphibians and reptiles (only a couple localities elsewhere in the world have proven as productive and as important to vertebrate evolution); the Lower Cretaceous formations in the northern and western part of the basin for their occasional ancestral mammal content; the Upper Cretaceous formations which were deposited in a shallow sea, for their invertebrate content, and for their large marine reptiles; the Paleocene-Cretaceous formational contact for purposes of correlation with other regions of the world; the Eocene and Middle Tertiary sediments for their invertebrate and vertebrate fossils; and the Quaternary formations, especially of Dallas and surrounding counties for their abundant vertebrate faunas of Pleistocene age.

A detailed account of all the formations in the basin is not feasible for this report. However, a general description of the formations of each age group follows:

Quaternary: strandline and nearshore deposits of Pleistocene age; stratigraphy poorly understood, based on coastline terrace levels according to sea level fluctuations during the last 2 million years; outcrops few; the area has been poorly surveyed for fossils; paleontology includes a poor representation of typical Pleistocene vertebrates and snails.

Middle and Late Tertiary: Oligocene, Miocene, Pliocene sediments, including a variety of terrestrial, shoreline, and nearshore deposits; stratigraphy incompletely understood, based in large part on vertebrate fossil correlation with continental Tertiary deposits, especially in north Texas sediments and in Kansas/Nebraska Tertiary sediments; outcrops few; early paleontological literature reflects a serious competition for vertebrate fossils with deliberately poor descriptions of localities; the few definitely known localities have been largely covered by aggradation during historic times due to agricultural and lumbering practices; the area has produced a large number of Tertiary fossils, now housed in many major museums around the country, without locality data; a concentrated survey for old and new localities in this area is a must if previously recovered fossils are to retain any value.

Early Tertiary: Eocene and Paleocene near-shore and terrestrial deposits; abundance of invertebrate fossil information, especially important to stratigraphy; only a few reported known sites of vertebrate fossil recoveries; potentially extremely important for its vertebrate content; the fossils are known to exist, but few concentrated efforts aimed at finding the localities have been conducted; outcrops few and difficult to reach in many places because of thick vegetation cover.

Included in the area of early Tertiary sediments is the region of the proposed Tennessee Colony dam in Anderson and Freestone Counties (see figures 15 and 16 for references and geology). This area is potentially the most important region in the basin with proposed construction projects. Tehuacana Creek, just north of the proposed dam site, has produced an abundance of invertebrate fossils, with many important type localities in the creek's drainage, all very important to stratigraphy. Moreover, there is a possibility that Eocene or Paleocene vertebrates are likely to be uncovered. Any vertebrate remains should be excavated at all cost, for here lies a possible Eocene or Paleocene vertebrate locality unique to all the world; only 4 or 5 other areas in the world have produced Paleocene vertebrates in any abundance, a situation which accounts for a poor understanding of early mammalian evolution.

Upper Cretaceous: Largely near-shore and offshore deposits of sandstones and limestones; stratigraphy fairly well known owing to abundant fossil content, especially foraminifera; includes occasional recoveries of large Mesozoic marine reptiles, important as representatives in an intermediate geologic and geographic position compared to areas of more abundant vertebrate recoveries; numerous type localities for invertebrates.

Lower Cretaceous: Near-shore and terrestrial deposits of sandstones, shales and limestones; stratigraphy poorly known for general lack of study and paucity of fossil material collected; fossil content in recent years has proven exceedingly productive for important groups of vertebrates (see various papers by Slaughter and Thurmond); important especially for early mammal recoveries; probably the poorest known region in the basin for its fossils despite the potential importance of Early Cretaceous fossils to paleontologists and stratigraphers.

Pennsylvanian-Mississippian: Largely offshore carbonates (limestone reefs), shales and sands; in the basin, these are an extension of a massive reef-complex to the south; many important invertebrates have been described from the areas to the south, while a lesser amount of concentration in the formations within the basin have yielded a small number of fossils; potentially important as a major tie-in with other continental Pennsylvanian sediments to the north.

Permian: Extends barely into the basin; includes a dominant terrestrial "red-bed" facies which has produced abundant numerous important terrestrial vertebrates; early locality data for this region is particularly difficult to decipher, when published, owing to a past of jealousy and possessiveness for the extremely important amphibian and reptile material recovered in the area.

Pleistocene Terraces of the Trinity River

Although the remnant terrace system along the Trinity River has been well studied in places (notably in Dallas County) little information has been gathered concerning Pleistocene terrace geology and paleontology along the river's entire course. Three remnant terraces are generally recognized, each with consistent elevations above present floodplain (conventionally numbered at T-0), and with distinct vertebrate and invertebrate faunas (Fig. 16).

The terrace geology is poorly understood with respect to sources for alluvial material. The most consistent mapping of terraces on the Trinity River relies on elevations, as follows:

T-0 Trinity River modern floodplain, approximately 20 feet above normal water level.

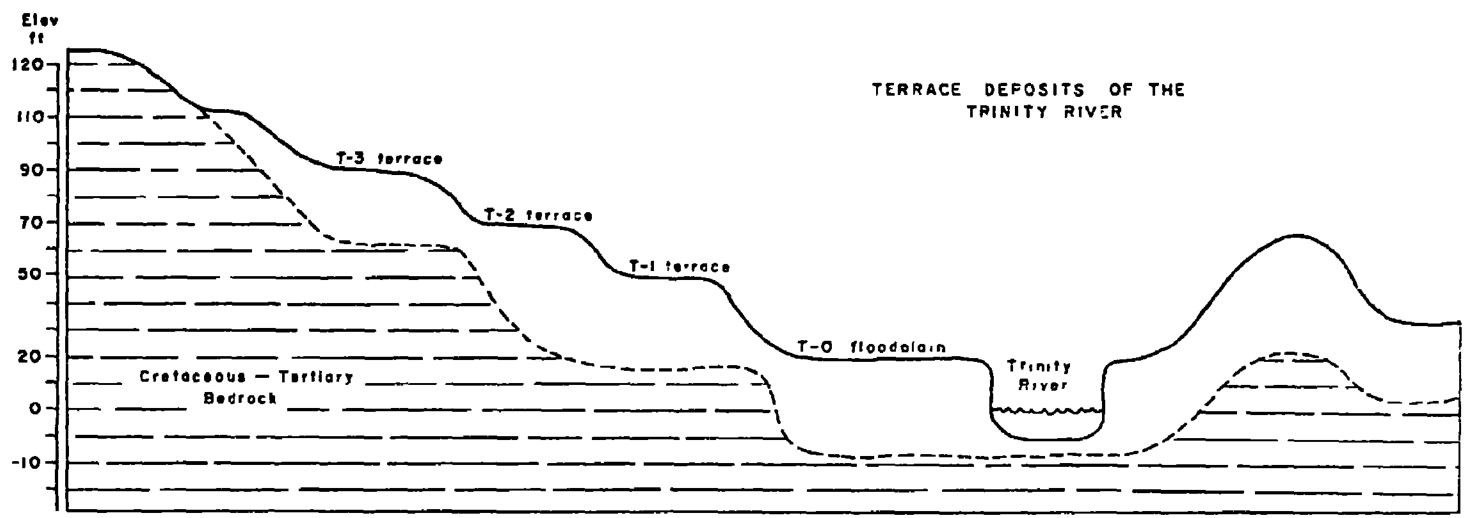


Figure 16. Terrace deposits of the Trinity River.

T-1 First terrace, often incompletely preserved owing to erosion; approximately 50 feet above river level.

T-2 Second terrace, generally present but not in full section; approximately 70 feet above river level.

T-3 Third terrace, never yet found in full section with associated fauna; often present as a cap on T-2 consisting of basal gravels and cobbles; difficult to recognize; minimum 90 feet above river level.

The ages of the terraces have been well established by faunal correlation and by radiocarbon dating:

T-0 5,000-2,000 B.P. (before present) to present; totally modern fauna.

T-1 10,000 B.P. to 4,000 B.P.; essentially modern vertebrate and snail faunas.

T-2 50,000 B.P. to 10,000 B.P.; early and middle Wisconsin age fauna; many extinct species; common mastodon, mammoth, bison, camel, horses, extinct deer, extinct giant land tortoise, extinct ground sloth.

T-3 In excess of 50,000 years before present; no associated fauna known.

These terraces have produced some of the best faunas for the late Pleistocene of North America. It is very likely that concentrated prospecting by experienced paleontologists will produce more (and hopefully better) terrace faunas south of Dallas County (Henderson County contains the only other well studied T-2 fauna in the south Trinity River drainage -- Stovall and McAnulty 1941). If the meagre, albeit important, information regarding the Trinity terrace is to retain any value, further exploration and mapping are essential, especially in areas to be excavated by construction or areas to be flooded.

TABLE 1 continued

County	Abstract Locality Number	Total Localities
Hunt	180	1
Parker	4, 74, 211, 347, 363	5
Tarrant	4, 11, 15-19, 24, 48-50, 70, 71, 74, 89-92, 94, 111, 112, 148, 151, 155, 161, 185-189, 191, 196, 203, 205-208, 211, 215, 216, 219, 221, 222, 230-233, 248, 249, 256-260, 266, 283-288, 292, 293, 324, 325, 327, 348, 351, 352, 359, 363, 380, 381, 383, 390-402	88
Dallas	10, 13, 84, 110, 150, 156, 162, 167, 171, 174-176, 212, 220, 226-229, 242, 243, 245-247, 261, 291, 294, 295, 298, 321, 333-335, 348, 362, 364, 367, 371-373, 387-389	42
Rockwall	21, 22, 78, 154, 166, 181, 322, 337, 353, 362, 366, 385	12
Kaufman	25, 58-60, 130, 131, 143, 144, 178, 225, 330, 362	12
Johnson	4, 74, 202, 217, 234, 352, 403	7
Ellis	7, 8, 73, 157, 163, 224, 236-238, 262, 302-304, 334, 339, 368-370	18
Hill	3, 352, 405	3

Cushman, J. A., 1932, *Textularia* and Related Forms from the Cretaceous, Cushman Laboratory Foraminifera Research Contributions, Vol. 8, Part 4, pp. 86-97, 1 pl. (Contribution 124).

Abstract: Clarification of a group of similar foraminifera and descriptions of new forms; important to stratigraphy; two type localities in basin.

Localities:
(78) Collin County, 5.1 miles from Josephine along the highway to Nevada.
(79) Navarro County, 6 miles east of Corsicana.

Cushman, J. A., 1940a, American Upper Cretaceous Foraminifera of the Genera *Dentalina* and *Nodosaria*, Cushman Laboratory Foraminifera Research Contributions, Vol. 16, Part 4, pp. 75-96, illus. (Contribution 223).

Abstract: Discussion of the foraminiferal population of these genera in the Upper Cretaceous sediments of North America; four type localities in basin.

Localities:
(80) Navarro County, clay pit 2 miles south of Corsicana Court House.
(81) Limestone County, Mexia highway at forks of Wortham Road, 2.8 miles east-southeast of Cooledge.
(82) Navarro County, road ditch 3.5 miles northwest of Union Seminary School, 4.3 miles south-southeast of Corbet.
(83) Grayson County, on road at north edge of Whiteright, north-facing slope of branch valley.

Cushman, J. A., 1940b, American Upper Cretaceous Foraminifera of the Family Anomalinidae, Cushman Laboratory Foraminifera Research Contributions, Vol. 16, Part 2, pp. 27-40, illus. (Contribution 218).

Abstract: Descriptions of representatives of this family, some of which are particularly useful as index fossils.

Localities:

(84) Roadcut, south side of U.S. highway 80, 2 feet above sidewalk, opposite Catholic school, 3.8 miles west of Union Station, Dallas, Dallas County.

(85) North of Sulphur Creek, 2.3 miles southeast of Gober, Fannin County.

(86) 2.6 miles east of Barry, on road to Corsicana, Navarro County.

Cushman, J. A., 1941, American Upper Cretaceous Foraminifera Belonging to Robulus and Related Genera, Cushman Laboratory Foraminifera Research Contributions, Vol. 17, Part 3, pp. 55-69, illus. (Contribution 230).

Abstract: Discussion of the Robulus group of foraminifera from the Coastal Plain Cretaceous; one definite locality in basin.

Localities:

(87) Limestone County, Mexia highway at forks of Wortham Road 2.8 miles east-southeast of Cooledge.

Cushman, J. A. and C. I. Alexander, 1930, Some Vaginulinas and Other Foraminifera from the Lower Cretaceous of Texas, Cushman Laboratory Foraminifera Research Contributions, Vol. 6, Part 1, pp. 1-10, 2 pls. (Contribution 87).

Abstract: Discussions of forams of this type, with descriptions of five new species.

Localities:

(88) Near the Fort Worth-Denton contact, 1.5 miles west of Krum, Denton County.

(89) In the Denton, 5 miles south of Fort Worth, Tarrant County.

(90) In the Weno, 5 miles south of Fort Worth, Tarrant County.

(91) At Cragins Knobs, 6 miles west of Fort Worth, Tarrant County.

(92) At Lake Worth Dam near Fort Worth, Tarrant County.

(93) West of Sanger, Denton County

Cushman, J. A. and E. R. Applin, 1946, Some Foraminifera of the Woodbine Age from Texas, Mississippi, Alabama and Georgia, Cushman Laboratory Foraminifera Research Contributions, Vol. 22, Part 3, pp. 71-76, illus. (Contribution 279).

Abstract: Clarification of several forms, and description of four new species.

Localities:
(94) "in a valley tributary to the Trinity River near the east edge of Tarrant County; a four foot exposure below ledge of fossiliferous "Tarrant" limestone in creek bank, 50 feet south of dike of earthen stock tank and about 800 feet north of Dorothy Switch."
(95) "from an eroded hillside along old highway approximately 2 miles east of Whitesboro, Grayson County."
(96) "exposed on a hillside above a small pond, 0.9 mile south 45° west of the center of Loy State Park Lake, 2 miles southwest of Denison, Grayson County."

Cushman, J. A. and E. R. Applin, 1947, Some New Foraminifera from the American Cretaceous, Cushman Laboratory Foraminifera Research Contributions, Vol. 23, Part 3, pp. 53-55, illus. (Contribution 293).

Abstract: Description of six new species.

Localities:
(97) 3 1/2 miles southeast of Gordonville, Grayson County.
(98) 2 miles east of Whitesboro, Grayson County.

Cushman, J. A. and N. L. Thomas, 1929, Abundant Foraminifera of the East Texas Greensands, Journal of Paleontology, Vol. 3, No. 2, pp. 176-194, 2 pls.

Abstract: Description of the East Texas Eocene foraminiferan fauna; one locality in basin.

Localities:
(99) Anderson County, one mile north of Elkhart near the railroad at Hopkins fault.

10)

Hay, O. P., 1924a, Description of Some Fossil Vertebrates from the Upper Miocene of Texas, Biological Society of Washington Proceedings, Vol. 37, pp. 1-19, 2 figs., 6 pls.

Abstract: Description of several new species of large Miocene vertebrates, all type localities outside of basin (mainly Grimes County); note on a collection from Cold Spring, San Jacinto County.

Hay, O. P., 1924b, The Pleistocene of the Middle Region of North America and Its Vertebrated Animals, Carnegie Institute of Washington Publication No. 322A, 385 pp., 5 figs., 29 maps.

Abstract: An exhaustive work giving a run-down of Pleistocene localities for each of 19 categories of large vertebrates, with discussion and analysis; a starting point for all work in Pleistocene vertebrate paleontology. Analysis of the Pleistocene in the Trinity River Valley; analysis of distribution maps for 29 categories of large Pleistocene vertebrates; localities for each animal.

Localities:

(149) Mastodon, Cooke County, in surficial deposits at Gainesville.

(150) Mastodon, Dallas County, in city limits of Dallas; Lagow gravel pit; gravel pit south of Dallas; near Wilmer under a bridge over a stream.

(151) Mastodon, Tarrant County, vicinity of Fort Worth, north side of Trinity River north of Fort Worth, a junction of Trinity River and Little Fossil Creek, 5 miles east of Fort Worth.

(152) Mastodon, Trinity County, near Clapps Ferry, 10 miles west of Trinity.

(153) Mastodon, San Jacinto County, one mile below Drews' Landing on the west bank of the Trinity.

(154) _Elephas columbi_, Collin County Panther Creek, 2 miles south of Rock Hill; gravel pit near McKinney.

(155) _Elephas columbi_, Tarrant County, no definite locale.

(156) Elephas columbi, Dallas County, various [illegible] localities, and 5 miles south of Dallas along Missouri, Kansas and Texas Railroad.

(157) Elephas columbi, Ellis County, no definite [illegible].

(158) Elephas columbi, Navarro County, near [illegible].

(159) Elephas columbi, Trinity County near Trinity.

(160) Elephas columbi, Polk County, in a gravel pit.

(161) Elephas [illegible], Tarrant County, near Fort Worth, in gravel pit 1.5 miles southwest of Fort Worth.

(162) Elephas imperator, Dallas County, in Dallas, [illegible] a gravel pit along Trinity River 4.5 miles [illegible] of Dallas; various along Trinity River.

(163) Elephas imperator, Ellis County, in the bed of a stream near Waxahachie.

(164) Elephas imperator, Polk County, in a gravel pit near Onalaska.

(165) Elephant, species indeterminant, Denton County, 5 miles from Denton.

(166) Elephant, species indeterminant, Collin County, in a gravel pit near McKinney.

(167) Elephant, species indeterminant, within city limits of Dallas.

(168) Elephant, species indeterminant, Navarro County, somewhere near Dawson.

(169) Elephant, species indeterminant, San Jacinto County, a mile below Drews' Landing on Trinity River.

(170) Equus, Denton County, 6 miles northeast of Denton.

(171) Equus, Dallas County, newly opened Lagow Pit one mile north of the old pit and in city limits.

(172) Equus, Anderson County, from Palestine.

(173) Equus, Trinity County, White Rock Shoals at the mouth of White Rock Creek.

(174) Camel, Dallas County, in Lagow Pit in Dallas.

(175) Deer, Dallas County, Lagow Pit.

(176) Extinct bison, Dallas County, Lagow Pit in Dallas, in the Vilbig sand pit east of Dallas near Rock Creek.

Heaslip, W. G., 1968, Cenozoic Evolution of the Alticostate Venericorids in Gulf and East Coastal North America, Palaeontographica Americana, Vol. 6, No. 34, pp. 52-135, 28 figs., 29 pls.

(215) A northwestward facing slope two miles north of Handley, Tarrant County.
(216) On a south facing slope 200 yards north of U.S. highway 80, on the Wadell Ranch, 1.5 miles east of Handley, Tarrant County.
(217) On a southwestward facing hill about 1 mile east of Burleson, Johnson County.

McNulty, C. L., 1963, Teeth of Petalodus alleghaniensis Leidy from the Pennsylvanian of North Texas, Texas Journal of Science, Vol. 15, pp. 351-353, illus.

Abstract: Note of the first formal recognition of these late Paleozoic shark teeth in the Texas area, with descriptions.

Localities:
(218) In the quarry of the Wesco Corporation, 4 1/2 miles northwest of the town of Bridgeport, Jack County (Wise ? County) Texas.

McNulty, C. L., 1964, Hypolophid Teeth from the Woodbine Formation, Tarrant County, Texas, Eclogae Geologiae Helvetiae, Vol. 57, Part 2, pp. 537-539, 1 pl.

Abstract: Descriptions of several rare fossil ray teeth of Late Cretaceous age.

Localities:
(219) In low cuts along road to Central Airlines Operations Hangar, Southwest International Airport, Tarrant County.

McNulty, C. L. and G. Kienzlen, 1970, An Enchodontid Mandible from the Eagle Ford Shale (Turonian), Dallas County, Texas, Texas Journal of Science, Vol. 21, pp. 447-451, illus.

Abstract: Discussion based on the recovery of a large Cretaceous fish, with comments regarding osteology, distribution and functional anatomy.

Localities:
(220) On the south bank of the Trinity River, at a point about 100 yards east of the Loop 12 bridge in west-central Dallas County.

from the abandoned Bachelor schoolhouse; in uppermost portion of several gullies which drain northwest into Little High Point Creek, north-central Kaufman County.

Meier, R. W., 1964, Geology of the Britton Quadrangle, Dallas, Ellis, Johnson, and Tarrant Counties, Texas, thesis. Department of Geological Sciences, Southern Methodist University, Dallas, Texas, viii + 24 pp., 3 text-figs., geological map.

Abstract: Includes several detailed measured sections.

Localities:
(226) 3.0 miles due west of Cedar Hill, 0.3 mile east of the quadrangle's limits, just north of Mansfield Road, Dallas County.
(227) 3.4 miles due west of Cedar Hill along Bagget Branch, 0.4 mile north of Mansfield Road, Dallas County.
(228) 4.3 miles south 80° west of Cedar Hill, 1/2 mile west of Anderson Road, just north of Mansfield Road, Dallas County.
(229) 0.9 mile south of Mansfield Road, just west of Boss Cope Road, Dallas County.
(230) 2.3 miles north of Britton, just east of Sutton Road along an unnamed tributary of Mountain Creek, Tarrant County.
(231) 0.9 mile south of Webb along Bowman Ranch on the Webb-Mansfield road, Tarrant County.
(232) Along an unnamed tributary of Walnut Creek, 1.9 miles north 30° east of Mansfield, Tarrant County.

Meyer, W. G., 1939, Stratigraphy and Historical Geology of Gulf Coastal Plain in Vicinity of Harris County, Texas, American Association of Petroleum Geologists Bulletins, Vol. 23, No. 2, pp. 145-211, 8 figs., including index and paleogeography maps.

Abstract: Comprehensive study of the sediments of late Tertiary age in the vicinity of Harris County, with extended discussion of paleogeography. No measured sections.

Michael, Fouad Yousry, 1971, Studies of Foraminifera from the Comanchean Series (Cretaceous) of Texas, Ph.D. thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, vii + 87 pp., 7 text-figs., 7 pls.

Abstract: Regional stratigraphic study with paleo-environmental interpretations based on foraminifera; 21 localities in basin in Denton, Tarrant, Cooke, Parker, Grayson, Johnson, Coryell, and McLennan Counties.

Moreman, W. L., 1942, Paleontology of the Eagle Ford of North and Central Texas, Journal of Paleontology, Vol. 16, No. 2, pp. 192-220, illus.

Abstract: Paleontological distribution and paleogeography of the common ammonites, clams, and oysters of the Eagle Ford Shale in north central Texas; mainly biostratigraphic.

Localities:

(233) 2.25 miles east of Tarrant, Texas, railway station (measured along railroad tracks) just north of the railroad trestle on a small tributary of the Trinity River, Tarrant County.

(234) 4 miles south of Alvarado, Texas on the east side of the Waco highway, Johnson County.

(235) 4 miles east of Whitesboro, Texas, 0.25 mile south of the Whitesboro-Sherman highway, Grayson County.

(236) 0.5 mile east of the Britton-Midlothian highway 2.7 miles south of the Britton, Texas railway station in small ravines cut in the westward facing slope, Ellis (?) County.

(237) 4 miles south of the Britton, Texas railway station on the Midlothian highway in a ravine east of the road, Ellis (?) County.

(238) 100 yards east of the bridge on the Britton-Midlothian highway at a point 4.4 miles south of the Britton railway station, Ellis (?) County.

(239) In a small ravine just south of the Lewisville-Hebron road 3.5 miles east of the Lewisville railroad station, Denton County.

(240) In bluffs on Indian Creek 5.5 miles east of the Lewisville railway station on the Hebron road; one bluff is near the road on the south side, the other is 0.5 mile south of the road, Denton County.

(241) In a small ravine 100 yards north of the Prosper-Denton road 3 miles west of Prosper, Texas, Denton County.

(242) 6 miles northwest of the central business block of Irving, Texas, or 3.2 miles north of Sowers, Texas, where a tributary of Hackberry Creek forms a low bluff on the east side of the road, Dallas County.

(243) 4.35 miles north of Sowers, Texas, where the Sowers-Coppell road turns right (east) one mile, and 0.5 mile north of the road on a tributary of Hackberry Creek, Dallas County.

(244) 3.4 miles southeast of Pottsboro, Texas on the Whitesboro road, Grayson County.

(245) 1.4 mile east of Carrollton, Texas in an exposure on the north side of the road on Rawhide Creek, Dallas County.

(246) In a tributary of Hackberry Creek about 0.25 mile west of the Hackberry-Irving road, 1 mile south of the intersection west of the Dallas-Rhome highway, Dallas County.

(247) On the south bank of the Elm Fork of the Trinity River at a point where the railroad north out of Irving, Texas crosses the river, Dallas County.

(248) One mile south of Arcadia Park, Texas, Tarrant County.

(249) Two miles west of Arcadia Park, Texas, Tarrant County.

Overmyer, D. O., 1953, Geology of the Pleasant Grove Area, Dallas County, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, iii + 11 pp., 3 text-figs., geological map.

Palmer, K. V. W., 1937, The Claibornian Scaphopoda, Gastropoda, and dibranchiate Cephalopoda of the Southern United States, Bulletins of American Paleontology, Vol. 7, No. 32, in 2 parts, 730 pp., 91 pls.

(259) Santa Fe railroad cuts, 8 miles southwest of Fort Worth, Tarrant County.
(260) Feltz Ranch Quarry on Rocky Creek approximately 6 miles southwest of Fort Worth, Tarrant County.

Pessagno, E. A., Jr., 1967, Upper Cretaceous Planktonic Foraminifera from the Western Gulf Coastal Plain, Palaeontographica Americana, Vol. 5, No. 37, pp. 245-445, 63 figs., 101 pls.

Abstract: Extensive monograph.

Localities:
(261) Scony Mobil Oil Co., Field Research Laboratory, Dallas Core of type Eagle Ford, 5.2 miles south of the old Eagle Ford station on the Texas Pacific Railroad; 3.5 miles south of Arcadia Park, 10 miles north northwest of Britton and 12.5 miles southeast of the old Tarrant Station on the St. Louis, San Francisco and Texas Railroad (Dallas County).
(262) Clay pit of Baron Brick Co. at Palmer, Ellis County.

Pitkin, J. A., 1959, The Geology of the Palmer Quadrangle, Ellis County, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, ii + 25 pp., 7 text-figs., geological map.

Plummer, H. J., 1926, Foraminifera of the Midway Formation in Texas, University of Texas Bulletin No. 2644, 206 pp., 15 pls., including map.

Abstract: Detailed account of the early Tertiary foraminifera of Texas; many new genera and species from a total of 41 type localities, including the following counties in the basin: Hunt, Van Zandt, Kaufman, Henderson, Navarro, Freestone, Anderson, Limestone Counties; this important reference should be consulted by any future workers planning to collect invertebrate fossils in the area.

Plummer, H. J., 1934, Epistominoides and Coleites, New Genera of Foraminifera, American Midland Naturalist, Vol. 15, No. 5. pp. 601-608, 1 pl.

written in a popular style "so that it may reach the largest audience possible". Includes many stratigraphic sections; necessary reading for anyone working in the area.

Shuler, E. W., 1923, Occurrence of Human Remains with Pleistocene Fossils, Lagow Sand Pit, Dallas, Texas, Science, Vol. 57, pp. 333-334.

Abstract: Association of human remains with a distinct Sangamon vertebrate fauna. Puzzling, unsolved problem. Shuler was convinced that the association was real, not a mixed occurrence.

Localities:
(294) Lagow Sand Pit, Dallas County.

Shuler, E. W., 1934, Collecting Fossil Elephants at Dallas, Texas, Field and Laboratory, Vol. 3, No. 1, pp. 24-29, 3 figs.

Abstract: General description of elephant remains in the Dallas area Trinity River terraces, and a short discussion of early man in North America; Dallas County.

Shuler, E. W., 1935, Terraces of the Trinity River, Dallas County, Texas, Field and Laboratory, Vol. 3, No. 2, pp. 44-53, 2 figs., maps.

Abstract: The first systematic description of Trinity River terraces, delimiting 4 levels: Union Terminal, Travis School, Love Field and Irving Terraces; Dallas County. Interpretations altered later by radiocarbon dating and more extensive analysis.

Shuler, E. W., 1950, A New Elasmosaur from the Eagle Ford Shale of Texas-the Elasmosaur and Its Environment, Fondren Science Series, No. 1, Part 2, 32 pp., illus.

Abstract: Description of a remarkably complete elasmosaur skeleton from Upper Cretaceous sediments. Technical description plus a popular account.

Localities:
(295) On the Andy Anderson plantation, west of Cedar Hill, Dallas County.

Slaughter, B. H., 1959, The First Noted Occurrence of *Dasypus bellus* in Texas, Field and Laboratory, Vol. 27, No. 2, pp. 77-80, illus.

Abstract: First Texas report of these Sangamon-age armadillos. Several other localities now known to include *D. bellus* also.

Localities:
(296) Hickory Creek, near its junction with the Trinity River in southern Denton County.

Slaughter, B. H., 1965a, A Therian from the Lower Cretaceous (Albian) of Texas, Yale University Peabody Museum of Natural History Postilla, Vol. 93, pp. 1-18, illus.

Abstract: Description of a phylogenetically important intermediate family of early modern-type mammals based on teeth recovered from Wise County.

Localities:
(297) In a shallow gully 250 yards northeast of U. S. highway 81, 3 miles northwest of Decatur, Wise County, on the farm of Mr. Lee Butler.

Slaughter, B. H., 1965b, Preliminary Report on the Paleontology of the Livingston Reservoir Basin, Texas, Fondren Science Series No. 10, 12 pp., 1 map.

Abstract: Appraisal of paleontological resources of the Lake Livingstone (then) proposed area to be flooded; extensive mapping and prospecting produced abundant Miocene and Quaternary vertebrate fossils; 22 localities shown on map, now all inundated; several of the localities collected prior to flooding.

Slaughter, B. H., 1966, The Moore Pit Local Fauna; Pleistocene of Texas, Journal of Paleontology, Vol. 40, pp. 78-91, illus.

(371) Dallas County, Hackberry Creek Eagle Ford Shale.
(372) Dallas County, 3 1/2 miles west of Cedar Hill.

Turner, W. L., 1950, Geology of the Eagle Ford Quadrangle, Dallas County, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, iv + 29 pp., 7 text-figs., geological map.

Udden, J. A., C. L. Baker and C. Bose, 1916, Review of the Geology of Texas, University of Texas Bulletin No. 1644, pp. 1-164, illus., map.

Abstract: General treatment. Updated by Sellards, et al., 1933 (University of Texas Bulletin No. 3232).

Uyeno, T. and R. R. Miller, 1962, Late Pleistocene Fishes from a Trinity River Terrace, Texas, Copeia 1962, pp. 338-345, illus.

Abstract: Fish fauna comprised of 6 or 7 species of freshwater fishes, assigned to the Sangamon Interglacial (Late Pleistocene). Extension of the several vertebrate faunas by Slaughter and collaborators then recovered from Trinity River terraces; this was one of the first good fish faunas from the Pleistocene.

Localities:
(373) From the T-2 terrace of the Trinity River at the southern city limit of Dallas, Dallas County.

Vaughan, T. W. and W. P. Popenoe, 1935, The Coral Fauna of the Midway Eocene of Texas, <u>in</u> The Midway Group of Texas, by Julia Gardner, University of Texas Bulletin No. 3301, pp. 325-343, pls. 3 and 4 in part.

Abstract: Descriptions of Eocene corals in the Midway of Texas, now considered Paleocene; two localities in basin.

Localities:
(374) Navarro County, 3 1/2 miles to 4 miles south of Wortham.
(375) Limestone County, Tehuacana member of the Kincaid Formation.

(382) Grayson Marl at Grayson Bluff, Grayson County.
(383) In the "Goodland" Formation at Cragin's Knobs, 5 miles west Fort Worth, Tarrant County.
(384) Navarro Formation near Terrell, Kaufman County.
(385) Wolfe City sand member of the Taylor Formation about 1 mile north 30° west of Farmersville, Collin County.
(386) Navarro formation in a creek 1/4 mile north of Corsicana, Navarro County.

Welles, S. P., 1949, A New Elasmosaur from the Eagle Ford Shale of Texas; Systematic Description, Fondren Science Series, No. 1, Part 1, 28 pp., illus.

Abstract: Description of an early find of an extinct large marine reptile from the Cretaceous. New species.

Localities:
(387) Andy Anderson farm near Cedar Hill, Dallas County.

Welles, S. P. and B. H. Slaughter, 1963, The First Record of the Plesiosaurian Genus, Polyptychodon (Pliosauridae) from the New World, Journal of Paleontology, Vol. 37, No. 1, pp. 131-133, illus.

Abstract: Description of the remains of a short-necked plesiosaur, a marine reptile of the Cretaceous, new species.

Localities:
(388) 100 yards west of Chalk Hill Road and 300 yards north of West Commerce, Dallas, Dallas County.

White, M. P., 1933, Some Texas Fusilnidae, University of Texas Bulletin No. 3211, 106 pp., 10 pls.

Abstract: Descriptions of a variety of Texas foraminifera; many new species; type localities, several in Jack, Young, and Parker Counties barely into basin.

Williams, T. E., 1957a, Remains of a Pleistocene Turtle from a Terrace Deposit near Seagoville, Dallas County, Texas, Field and Laboratory, Vol. 25, p. 34.

Abstract: Short note on the recovery of a large turtle.

Localities:
(389) Smith Gravel Company pit, 3 miles southeast of Seagoville, immediately southeast of the Bois d'Arc Road, and 0.7 mile southwest of its intersection with Combine Road, Dallas County.

Williams, T. E., 1957b, Correlation by Insoluble Residues in the Austin Chalk of Southern Dallas County, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, ii + 15 pp., 1 pl., geological map.

Willimon, E. L., 1970, Quaternary Gastropods and Paleoecology of the Trinity River Floodplain of Dallas County, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, ix + 89 pp., 2 tables, 11 text-figs.

Wilson, J. A., 1954, Miocene Carnivores, Texas Coastal Plain (abs.), Geological Society of America Bulletins, Vol. 65, p. 1326.

Abstract: Report on several carnivores from the Texas Miocene having a bearing on biostratigraphic relationships in the Texas Miocene.

Winn, V., 1953, Geology of the Carrollton Quadrangle, Dallas and Denton Counties, Texas, thesis, Department of Geological Sciences, Southern Methodist University, Dallas, Texas, i + 15 pp., 2 text-figs.

Winton, W. M., 1925, The Geology of Denton County, University of Texas Bulletin No. 2544, pp. 1-86, 8 figs., 21 pls., map.

Abstract: Includes several stratigraphic measured sections with fossil content. These should be reexamined for their fossil content, and re-described.

APPENDIX V

COOPERATIVE REGIONAL SOLID WASTE PROGRAM SUMMARY REPORT

North Central Texas Council of Governments

SUMMARY REPORT

STUDY DESIGN

SYSTEMS ANALYSIS STUDY AND REGIONAL PLAN FOR SOLID WASTE DISPOSAL FOR THE NORTH CENTRAL TEXAS REGION

JULY, 1972

PREPARED BY

NORTH CENTRAL TEXAS
COUNCIL OF GOVERNMENTS

RECYCLED PAPER

COOPERATIVE REGIONAL SOLID WASTE PROGRAM

A SUMMARY REPORT OF

THE STUDY DESIGN

FOR THE

SYSTEMS ANALYSIS STUDY

AND

REGIONAL PLAN FOR SOLID WASTE DISPOSAL

FOR THE

NORTH CENTRAL TEXAS REGION

ENVIRONMENTAL PROTECTION AGENCY

GRANT TO

NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS

In October, 1971, the Environmental Protection Agency Office of Solid Waste Management Programs announced the approval of an application by the North Central Texas Council of Governments for a grant for a regional solid waste systems analysis study and plan for North Central Texas. This report represents a summary of the study design for that study and the detailed procedure and work to be accomplished under the study.

Solid Waste Management Planning Grant
No. GC 5-EC-00080-01
Jan 1974 - Completion date

REGIONAL SOLID WASTE SYSTEMS ANALYSIS STUDY

The Regional Solid Waste Systems Analysis Study will have for its output the following objectives:

1. To develop for implementation an incremental regional plan for the disposal of solid waste from the present to a target year of 1990. Such a plan will designate the optimum system which will provide for an equitable cost distribution among the muncipalities and governmental entities within the study area (see attached map).

2. To provide interim solutions to existing transfer and disposal problems for those governmental entities within the study area which are currently at a decision point regarding existing facilities.

3. To provide a continuing system of evaluation to react to the dynamics of urban growth and the contingencies which will arise.

The Regional Solid Waste Systems Analysis Study involves the application of a computerized systems analysis approach to problem solving to the subject of regional solid waste disposal. The analysis techniques will be closely associated in data requirements and techniques with other functional planning for the region, particularly the transportation planning function.

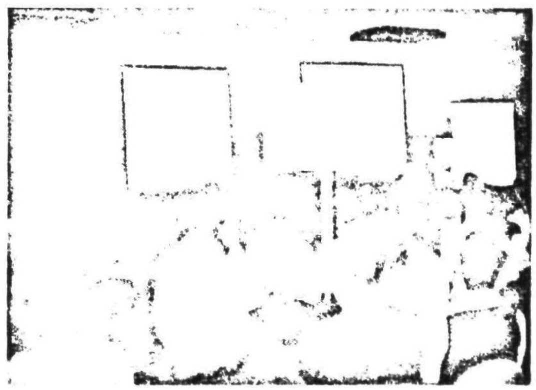
Given these guidelines, the consulting firm of Henningson, Durham and Richardson entered into a contract with the North Central Texas Council of Governments in March, 1972, to produce a study design for the Regional Solid Waste Systems Analysis Study which would designate the steps and tasks necessary to accomplish the stated objectives of the program. The study design delineates the work to be accomplished, relates each individual task specified to the overall work program, and designates responsibility for each task and the role of all parties involved in the study.

The various sequential and continuing steps as outlined in the study design will be concerned with: goals and objectives; public information and participation; basic population, employment and terrain data; inventory of existing solid waste transfer and disposal facilities; continuing solid waste monitoring program; determination of present and future solid waste generation rates; evaluation of abandoned motor vehicle problems; the development of an early action program; evaluation of current transfer, disposal and recycling hardware; the selection of potential facility locations; the selection of the apparent optimum transfer, processing and disposal systems; the development of facility design criteria; the development of alternative organizational plans; and the development of the proposed regional solid waste plan. This work will be accomplished in sixteen separate and distinct steps which are further subdivided into 74 tasks. As major decision points occur, summary reports will be prepared and reviewed by the Regional Solid Waste Policy Development Committee.

Project direction will be the responsibility of the North Central Texas Council of Governments. The Regional Solid Waste Policy Development Committee will be responsible for monitoring the project progress through periodic reports from the study staff. The committee will be charged with the responsibility of reviewing the study output at all major decision points and providing input into the study indicating local preference in certain areas of planning.

Step 1 - Develop Public Information, Education and Support Program

The general public is becoming increasingly more aware that there is a solid waste problem, but public knowledge about solid waste disposal is too meager to provide the basis for support of any new disposal arrangement which would require voter approval. It is therefore an important part of the planning process to inform the public during the planning process and prior to any recommendations regarding new disposal arrangements to insure voter support.



A program of communication on the Regional Solid Waste Systems Analysis Study will, therefore, be initiated at the beginning of the program. The general public will be kept informed by their elected officials and through the news media, periodic publication of a newsletter, and face-to-face contact between the staff and interested citizens.

News releases and visual aids will be developed for use in presenting the results of the study by the NCTCOG staff. This phase of the study will be coordinated by a member of the NCTCOG staff.

Step 2 - Prepare Study Base Maps

Maps and map materials will be assembled to provide suitable coverage and detail for relating solid waste, socioeconomic and transportation data to small geographic areas regionally.

Aerial photography is available for certain areas for use in visualizing existing land use and other physical conditions. Suitable regional base maps will be prepared and will cover the entire 11-county area.

Step 3 - Prepare Population, Land Use and Employment Data

Data on population, dwelling units, and employment, both existing and at the forecast dates, will be required by small geographic area to determine the rate of solid waste generation for the region. Much of this data, particularly in the areas of population and employment, are being generated for transportation planning purposes and will be utilized by the solid waste study staff. A further refinement of this data will be accomplished and organized on computer tapes for use in the calibration of solid waste generation equations. Future solid waste generation rates will then be determined on the basis of forecast year data.

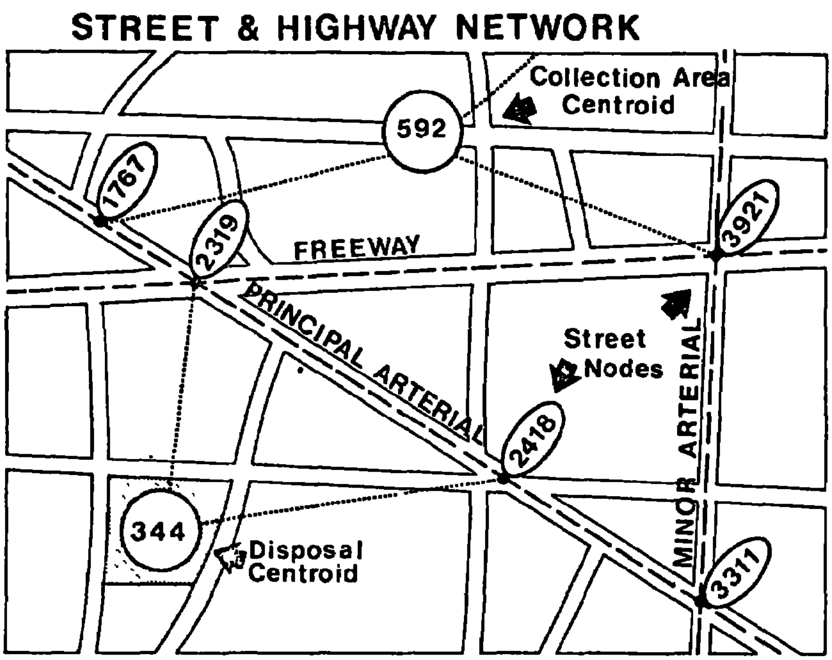
Step 4 - Summarize Terrain Characteristics

Data pertaining to topography and subsurface water and soil conditions will be assembled and organized for use in the evaluation of the suitability of areas for possible disposal facilities. This material will be organized and analyzed for use in selecting potential facility locations.

Step 5 - Assemble Data on Existing Solid Waste Transfer and Disposal Facilities

The present system of solid waste transfer/processing and disposal facilities will be inventoried and these facilities analyzed. Recent surveys conducted by the Texas State Department of Health and the Texas Water Quality Board will be utilized and updated where necessary to accomplish this task. Such updating will be accomplished through an in-depth review of currently maintained records and on-site field surveillance as it becomes necessary.

Step 6 - Assemble Solid Waste Transportation Network Data



Costs incurred in the movement of solid waste from collection or transfer point to disposal point are among the largest financial expenditures involved in the disposal of solid waste. It is, therefore, important to locate disposal facilities at points most convenient to where solid waste generation occurs to reduce these transportation costs. Accessibility to prospective disposal facilities depends heavily on existing and proposed street and highway systems. These systems must therefore be identified and pertinent link data, such as the link's distance, the type of facility, posted speed limits, and other factors, determined before a cost of transporting the solid waste can be determined.

A computerized street and highway transportation network will be utilized for purposes of determining transportation costs. The existing network of the intensive study area which was developed for the Regional Public Transportation Study will provide the basis for the required transportation network. A network similar in design and compatible with the existing transportation network will be developed for use in the contiguous study area. Points of solid waste generation and the location of solid waste disposal facilities, defined as collection and disposal centroids, respectively, will be referenced to the network and the time and distance between the two calculated. To these parameters, vehicle and man-hour costs will be added to yield cost factors of transportation of solid waste. Such cost factors will be used in the optimization model. Factors pertinent to rail haul will also be gathered and the potential applications of this mode determined.

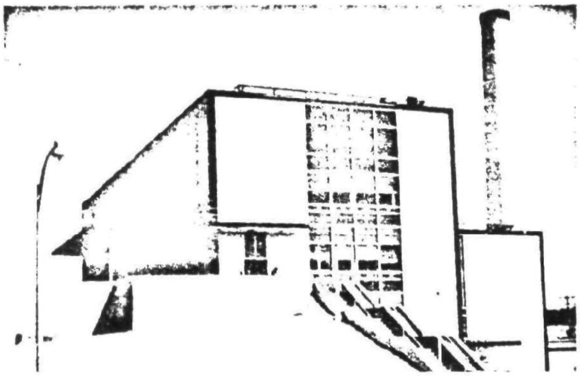
Step 9 - Evaluate Abandoned Motor Vehicle Problem

The magnitude and implications of motor vehicle abandonment will be reviewed in the North Central Texas Region. Guidelines developed in a national study on motor vehicle abandonment and recycling potentials recently completed by the Environmental Protection Agency will be adapted to this region. Local statistical information and legal data will be obtained and compared to the national data to insure positive identification of the local problem. Constraints on the local system will be determined and recommendations relative to removing those constraints will be made at the completion of this step.

Step 10 - Develop Early Action Program

Several of the governmental entities participating in the Regional Solid Waste Systems Analysis Study are currently at a decision point regarding existing facilities. Selection of new sites must be made immediately to meet current demands for disposal facilities. Paralleling this requirement for immediate action is the desire by those entities that new sites be as nearly optimized in location as possible and compatible with the forthcoming regional plan. This program, with the assistance of the Texas State Department of Health, will identify those areas, determine the extent of action required, then propose interim solutions for those areas based upon the best information immediately available.

Step 11 - Evaluate Processes for Transferring, Recycling, Processing and Disposing of Solid Waste



Current transfer, processing, and disposal techniques and related equipment will be identified, evaluated, and rated for use in the future solid waste disposal system for the region. Techniques currently available will be researched and evaluated for applicability to the North Central Texas Region. Those techniques which are rated "more desirable" will be further evaluated on the basis of capital and operating costs.

Step 12 - Select Potential Facility Locations

A preliminary selection of sites suitable for solid waste processing or disposal will be made and their existence simulated in the computerized optimization model. Any site selected for simulation must meet certain criteria involving zoning, surrounding land use, accessibility, size, and environmental factors such as soil and ground water conditions. Those sites selected for simulation will be evaluated on a weighted rating system indicating the most desirable sites. Those sites receiving the higher ratings will be identified for further investigation and the system for rating the sites detailed for the Regional Solid Waste Policy Development Committee. The RSWPDC members will review the selection process and provide input which might affect the acceptance of such sites. Following this review process, the sites receiving the higher ratings and found to be most acceptable by the Regional Solid Waste Policy Development Committee will be candidates for further testing in the optimization model.

Step 13 - Select Transfer, Processing, and Disposal Systems to be Utilized

Solid waste transfer, processing, and disposal sites being considered for inclusion in the time-staged growth plan will be analyzed in detail on the basis of economic desirability, zoning, surrounding land use, accessibility, size, and the affect on the environment, particularly in the areas of soil and water conservation. Mathematical equations will be written to represent intermediate facilities for use in the Environmental Protection Agency's Fixed Charge Model which simulates the system. Preliminary selection of locations for facilities will be performed by using a simplified fixed charge model of the 1980, 1985, and 1990 systems. Solution of these mathematical problems for the 1980, 1985, and 1990 system will identify facilities to be given more detailed considerations. Cost data for these facilities will be reviewed and updated. A facility configuration and operation cost table will be computed for each time span, and sensitivity analysis will be performed as necessary to identify parameters to which the solutions are sensitive. The results of this step will be a time-staged growth plan, tabulated cost data for operating facilities in each of the configurations in the plan, and sensitivity analysis data in tabular form.

Step 14 - Develop Facility Design Criteria and Cost Estimates

A general design criteria will be described for each type of facility selected. The design criteria will include the general treatment of such items as access, screening, utilities, fencing, site components, and maintenance. In addition, each selected facility will undergo a detailed evaluation for its effect on the environment and the resultant cost estimate will be refined and summarized.

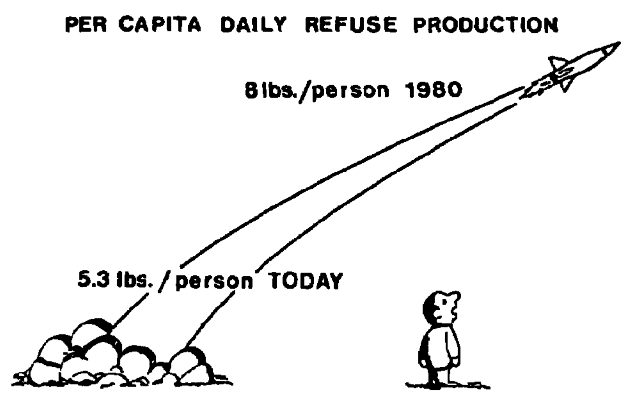
Step 15 - Develop Alternative Organizational and Financial Structures

The various alternative organizational and financial structures to implement the regional solid waste plan will be identified and described, then rated on a weighted rating system. This rating system will consider political realities and legal constraints, cost implications, financial participation potential, ability to meet implementation schedule, degree to which existing organizations may be utilized, and other elements. The Regional Solid Waste Policy Development Committee will be asked to review alternatives and make suggestions for possible modification.

Step 16 - Develop Proposed Regional Solid Waste Plan

Technical and organizational alternatives will be matched and tested to produce alternative plans which would provide municipalities and other governmental entities within the study area with a means of solid waste disposal. The alternative plans will be adequate through the forecast year, equitable in distribution of costs, and compatible with the environment. From these alternative plans, a regional management plan for solid waste disposal will be selected and developed in depth.

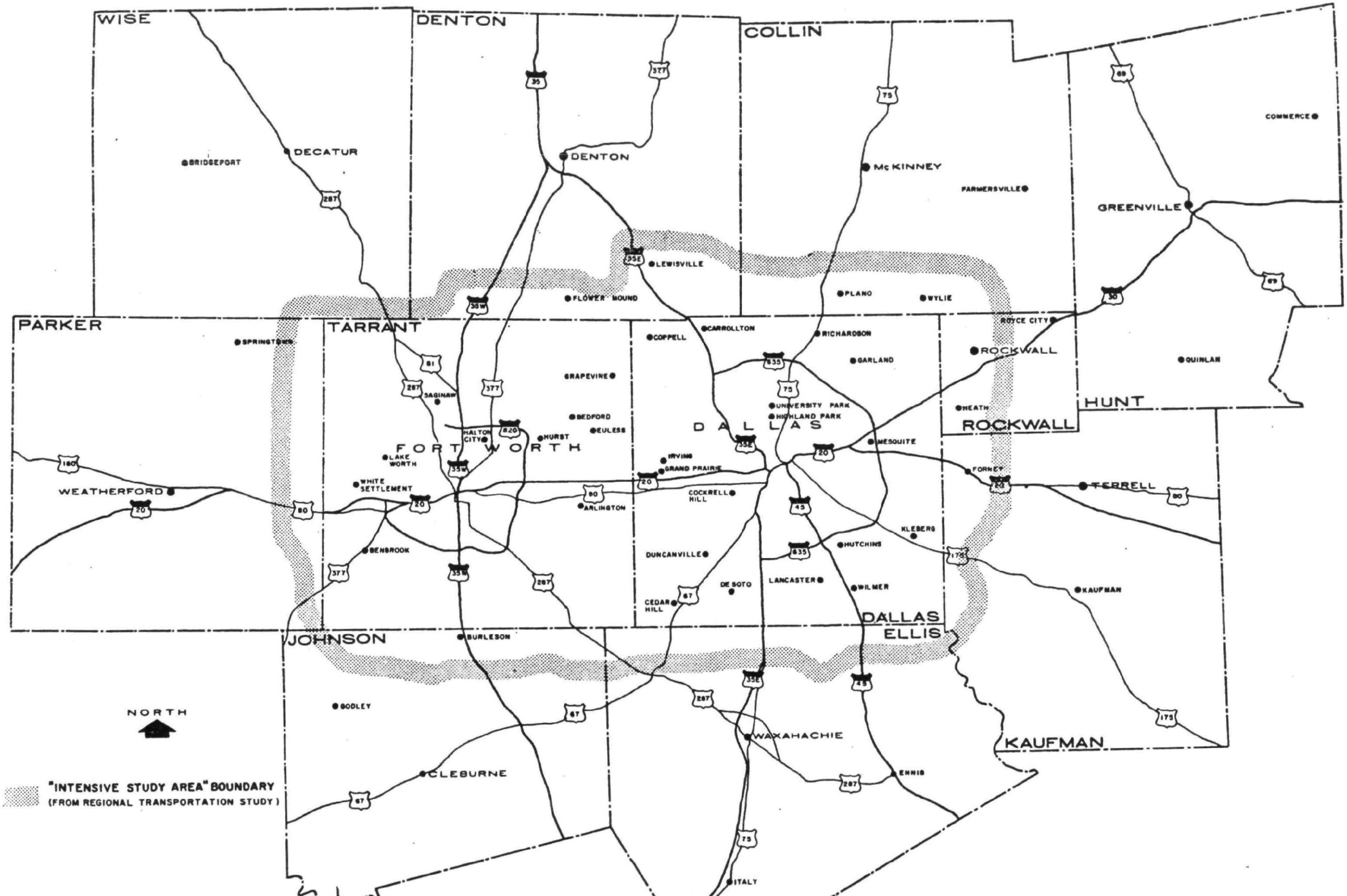
Step 17 - Develop Regional Continuing Planning Program



A voluntary solid waste data collection program employing techniques developed in the National Data Network, a sophisticated data acquisition and analysis system sponsored by the Environmental Protection Agency, will be initiated and used as a data base for developing regional solid waste generation rates for the forecast years. Commercial-industrial generation rates, by some 16 SIC classifications, will be developed through an in-depth review of existing records and studies, to include the industrial solid waste study conducted by the Texas Water Quality Board. This step will also be addressed to the dynamics of urban growth and other contingencies which will arise. A refined program for monitoring the entire system operation for all types of solid waste generation will be developed. Procedures will be prepared for the use of the computerized optimization model to update the plan at five-year intervals (1980, 1985, and 1990) or more frequently if the existing circumstances so dictate.

Step 18 - Prepare Final Reports

Final reports detailing work done on the study, providing supporting data for the selected regional plan, and clearly defining areas of responsibility in implementing the plan, will be prepared and submitted to the Regional Solid Waste Policy Development Committee for their review and consideration. The end result will be a report which encompasses all previous reports with a summary to be prepared of that final report.



SYSTEMS ANALYSIS STUDY AND REGIONAL PLAN
FOR SOLID WASTE DISPOSAL
FOR THE NORTH CENTRAL TEXAS REGION
EN 8 NT US UD EA