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COMPREHENSIVE SURVEY REPORT ON TRINITY RIVER AND TRIBUTARIES, T--ETC(U)
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COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES
TEXAS

VOLUME 5

APPENDIX V - RECREATION AND FISH AND WILDLIFE
APPENDIX VII - ECONOMIC BASE STUDY
APPENDIX VIII - COMMENTS OF OTHER AGENCIES
APPENDIX IX - RESOLUTIONS, PUBLIC HEARINGS, PRIOR REPORTS

U.S. ARMY ENGINEER DISTRICTS
FORT WORTH AND GALVESTON, TEXAS
JUNE 1962

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COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

Volume 5

This volume comprises Appendix V - Recreation and Fish and Wildlife, Appendix VII - Economic Base Study, Appendix VIII - Comments of Other Agencies, and Appendix IX - Resolutions, Public Hearings, Prior Reports. The complete report consists of the following volumes:

11 Jun 62
12 254p.

Volume 1 - Main Report

Volume 2 - Appendix I - Project Formulation
Attachment - Information Required by Senate Resolution No. 148
Appendix III - Navigation and Navigation Economics
Appendix IV - Flood Control Economics

Volume 3 - Appendix II - Hydrology, Hydraulic Design, and Water Resources

Volume 4 - Appendix VI - Cost Estimates, Geology, and Design Information

Volume 5 - Appendix V - RECREATION AND FISH AND WILDLIFE
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COMPREHENSIVE SURVEY REPORT

ON

TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX V

RECREATION AND FISH AND WILDLIFE

U. S. ARMY ENGINEER DISTRICTS
FORT WORTH AND GALVESTON
CORPS OF ENGINEERS
FORT WORTH AND GALVESTON, TEXAS

JUNE 1962

COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX V

RECREATION AND FISH AND WILDLIFE

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APPENDIX V

RECREATION AND FISH AND WILDLIFE

INTRODUCTION

1. SCOPE.- Described here are the methods and techniques employed in this report to meet the requirements placed upon recreation and fish and wildlife as equal physical and economic purposes served by the multiple-purpose plan of development for the water resources of the Trinity River Basin. These studies have been concluded through use and projection of data compiled at existing Corps of Engineers projects, together with data obtained from reports prepared by others, especially the Outdoor Recreation Resources Review Commission (ORRRC) and through special studies made specifically to determine the effects, needs, and economics of the recreation and fish and wildlife aspects of this project. The studies were coordinated with the U. S. Fish and Wildlife Service and the National Park Service and reports prepared by these agencies are included in this appendix as exhibits 1 and 2, respectively.

2. The conclusions reached in this appendix have been used to support the analysis of the recreation and fish and wildlife purposes that entered into all steps of the planning included in the formulation of the recommended plan of development.

EXISTING AND PROPOSED IMPROVEMENTS

3. GENERAL.- Improvements in the interest of water conservation and flood control have been accomplished in the Trinity River Basin on and adjacent to the main stem and tributaries by the Federal Government, State and local governmental agencies, private concerns, and individuals. These improvements include channel rectification, levees, and reservoir projects. Additional improvements are also proposed in the interest of water conservation and flood control in the Trinity River Basin by various agencies. The locations of existing, authorized, and proposed improvements are shown on plate 1. Corps of Engineers projects in the Trinity River Basin which will have an effect on the basin's recreation and fish and wildlife resources are as follows:

a. Reservoir projects.

(1) Existing - Benbrook, Grapevine, Garza-Little Elm, and Lavon.

(2) Under construction - Navarro Mills.

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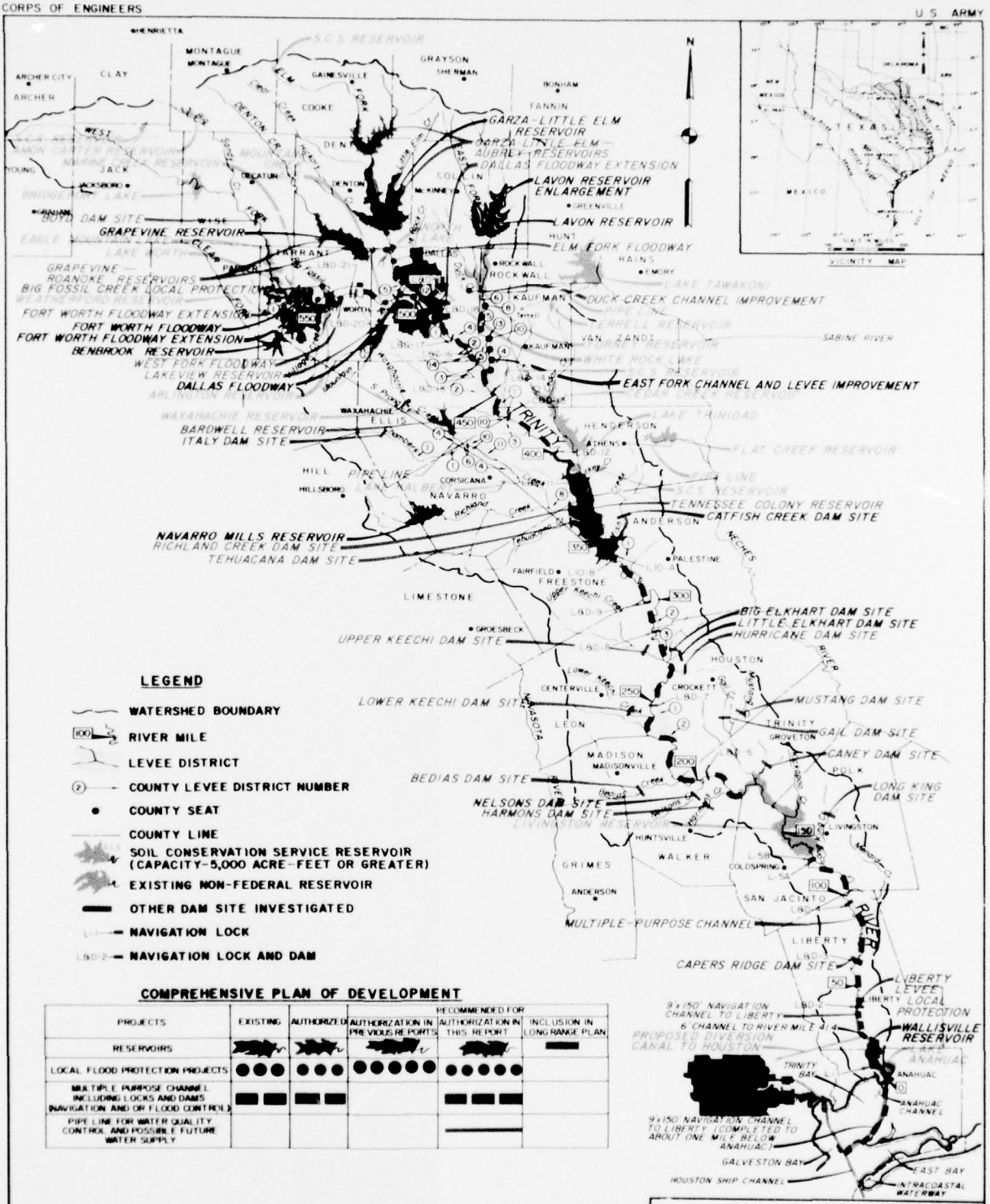


COMPREHENSIVE PLAN OF DEVELOPMENT

PROJECTS	EXISTING	AUTHORIZED	RECOMMENDED FOR AUTHORIZATION IN PREVIOUS REPORTS	RECOMMENDED FOR AUTHORIZATION IN THIS REPORT	INCLUSION IN LONG RANGE PLAN
RESERVOIRS	■	■	■	■	■
LOCAL FLOOD PROTECTION PROJECTS	●●●	●●●	●●●●●	●●●●●	
MULTIPLE PURPOSE CHANNEL INCLUDING LOCKS AND DAMS (NAVIGATION AND OR FLOOD CONTROL)	■■	■■		■■■	
PIPE LINE FOR WATER QUALITY CONTROL AND POSSIBLE FUTURE WATER SUPPLY				▬	

TRINITY RIVER AND TRIBUTARIES, TEXAS
TRINITY RIVER

COMPREHENSIVE PLAN OF DEVELOPMENT

U.S. ARMY ENGINEER DISTRICTS, FORT WORTH AND GALVESTON

(3) Authorized - Bardwell.

(4) Previously recommended - Wallisville and enlargement of Lavon.

(5) Recommended in this report - Lakeview, Tennessee Colony, Aubrey, Roanoke, and increasing the volume of conservation storage and the water surface area in Grapevine and Garza-Little Elm Reservoirs.

b. Channel project.- Proposed multiple-purpose channel for navigation and flood control, Houston ship channel to Fort Worth, Texas.

c. The recreation and fish and wildlife aspects of Navarro Mills, Bardwell, Wallisville and the enlargement of Lavon are discussed in previously submitted reports.

4. EXISTING AND PROPOSED RECREATION AREAS.- Recreation areas and facilities are developed or proposed at all of the Corps' multiple purpose projects cited above and will be open to free public use. Some of the projects under the jurisdiction of other agencies also have recreation areas and facilities developed or proposed. However, public use at these projects varies in accordance with the policies adopted by the respective agency responsible for the development and operation of the project. The principal impoundments in the basin, other than the Corps projects are Bridgeport, Eagle Mountain, Lake Worth, Arlington, Mountain Creek, Forney, Cedar Creek, and Livingston reservoirs. The latter three are currently under construction. The five existing reservoirs have practically no lands or facilities available for public recreation, with the exception of Lake Worth, which has approximately 2,000 acres of undeveloped lands in the upper reaches and downstream from Eagle Mountain. Much of the shoreline lands have been sold or leased for homesites, and public access to the lakes is largely through privately-owned commercial developments. Recreation development by local interests at the three reservoirs under construction is uncertain at this time. It is not known whether substantial acreage will be acquired for public use by the sponsoring agency. While it is expected that the waters will be open to public use, the principal access will of necessity be through privately-owned lands or commercial establishments. As of January 1961, there were 288 completed and 912 planned flood detention reservoirs in the basin. These projects were planned and constructed by the Soil Conservation Service. At the top of conservation pool levels they range in size from about five to about 100 surface acres. These reservoirs are not generally open to free public use since they are located on privately-owned land. However the projects do afford some water-related recreation potentialities

as some owners invite or permit relatives, friends, and associates to participate in the recreational activities available. In addition to the existing and proposed water development projects in the basin, there are two State parks, Huntsville and Fort Parker, operated by the Texas State Parks Board. Commercial recreation services and facilities are available in the areas adjacent to the Gulf Coast and bays. While these developments meet some of the recreation needs of the area, the principal public outdoor recreation opportunities are, or will be, afforded by existing and proposed Corps projects.

RECREATION RESOURCE DEVELOPED BY PROJECT

5. The Trinity River rises in its four principal forks lying to the west, north, and east of the Fort Worth-Dallas area in the West Cross Timbers, Grand Prairies and Blackland Prairies of Texas and flows slowly down an alluvial valley through the East Texas Timber Country and across the wooded Coastal Prairie and into Trinity Bay. Topography generally is rolling to gently undulating. The area, while not of great scenic beauty, is pleasant and attractive, particularly where wooded. The Benbrook and Lakeview reservoir sites are generally devoid of timber, other than along valleys or draws, but will support tree growth where planted. The alluvial valley is heavily timbered, as is most of the basin south of Kaufman County, except where cleared for agricultural purposes. Soils range from the heavy, black clays of the Grand, Blackland, and Coastal Prairies to the reddish, sandy soils of East Texas.

6. Proposed improvements would result in the addition of three reservoirs in the upper reaches of the Trinity River (Aubrey, Lakeview, and Roanoke), an increase in pool size of two existing reservoirs (Garza-Little Elm and Grapevine) addition of a major reservoir in the central portion of the basin (Tennessee Colony) and canalization of the river from the Houston Ship Channel 370 miles upstream to Fort Worth by construction of a multiple-purpose channel with depths ranging from 12 to 45 feet and having a bottom width of 150 feet to 300 feet. Navigation of the channel and intervening reservoir projects would be afforded by a series of 23 locks and 18 navigation dams. Canalization would result in numerous sizeable cut-offs, particularly in the central and lower portions of the basin. Altogether, the proposed improvements included in this report would result in an increase in impounded water surface at top of conservation or normal operating pools of approximately 135,600 acres. Reservoir waters would be relatively clear and of good quality while waters of the channel would be somewhat turbid and of varying quality.

7. Experience at completed multi-purpose projects in the Fort Worth District indicates that the principal recreational use of projects in the proposed plan of improvement, with the exception of

Tennessee Colony Reservoir, would fall in the day-use category, i.e., the principal use would be by individuals residing within a distance that will permit driving to the project, participating in recreational activities and returning the same day. However, the projects, because of their number and total surface acres, will attract visitors from longer distances as well and will even attract some visitation from outside the State. Tennessee Colony Reservoir, in particular, due to its size, quality of resource, and accessibility, would attract visitors from considerable distances who in turn would spend two or more days at the project. Much of this visitation will be from the upstream and downstream portions of the basin, or adjoining areas, both of which are heavily populated. The multiple purpose channel, in effect, would tend to tie the entire recreation resource together, resulting in heavy recreational use of the basin development from one end to the other.

8. POPULATION OF MARKET AREA.- On the basis of the above analysis, it is considered that the principal area of influence would be comprised of the 36 counties which are wholly or partially within the basin, plus three counties adjoining the downstream portion of the basin (Harris, Galveston, and Jefferson Counties), a total of 39 counties. The actual and projected populations, indicated in millions for these 39 counties, are as follows:

Year	1960	1970	2020	2070
Populations	3.886	4.672	11.765	22.136

9. DEMAND FOR OUTDOOR RECREATION.- Conclusions reached by the Outdoor Recreation Resources Review Commission and others interested in the field of recreation indicate that past actions taken to provide for outdoor recreation has not been adequate for present needs and will not be adequate for the future. The population is increasing rapidly, and individually the people are seeking the outdoors at a growing rate which is expected to increase over the coming decades. The major factors which underlie this large and sustained increase in outdoor recreation demand are as follows:

a. Rapid and steady growth in population with a marked trend toward a more urbanized population;

b. Larger than average increase in numbers of older people, retired or otherwise, with time for outdoor recreation;

c. Larger than average increase in young people not yet in the labor force;

d. Steady growth in per capita real incomes;

e. Improved travel facilities which bring more distant recreation areas within usable range;

f. Increase in leisure time due to paid vacations and shortened work weeks.

Outdoor Recreation Resources Review Commission studies further indicate that the greatest need for recreational activities is generated by the concentrated population in the metropolitan areas and to a slightly lesser degree by the adjacent urban areas. In addition, there is an apparent trend for a higher percentage of participation in outdoor recreation activities as compared to the past.

10. DEMAND FOR WATER-BASED RECREATION.- The demand for water-based recreation is evidenced by the increase in visitation to existing reservoirs under the jurisdiction of the Corps of Engineers, as well as by the increase in the number of hunting and fishing licenses being issued; and increases in sales of boats, motors, and equipment used for camping, fishing, and hunting, and other recreation activities. Visitation to all Corps projects located in the Trinity River Basin, as well as others outside the basin is increasing each year. Visitation to reservoir projects under the jurisdiction of the Southwestern Division is shown in figure 1. Visitation to projects under the jurisdiction of the Fort Worth District is shown in figure 2. It will be noted that visitation to projects in the Southwestern Division almost quadrupled during the past 10-year period and that visitation to Fort Worth District projects has increased at approximately the same rate. While a substantial part of this increase has resulted from filling or completion of additional reservoirs, with a resultant increase in opportunities, it is indicative of the surging demand for water-based recreation and the fact that this demand is far from being satisfied. Experience indicates that attendance at an individual project tends to level off a few years after completion and then increase at a slower rate. However, the addition of a new reservoir in the area of influence seldom actually depresses attendance at the existing reservoir. Attendance may become nearly static for a few years but eventually begins to increase, along with that of the new reservoir. This would indicate that there is a latent demand in every area for water-based recreation and all that is needed to translate this demand into actual attendance is to develop and provide the recreation opportunities associated with water resource projects.

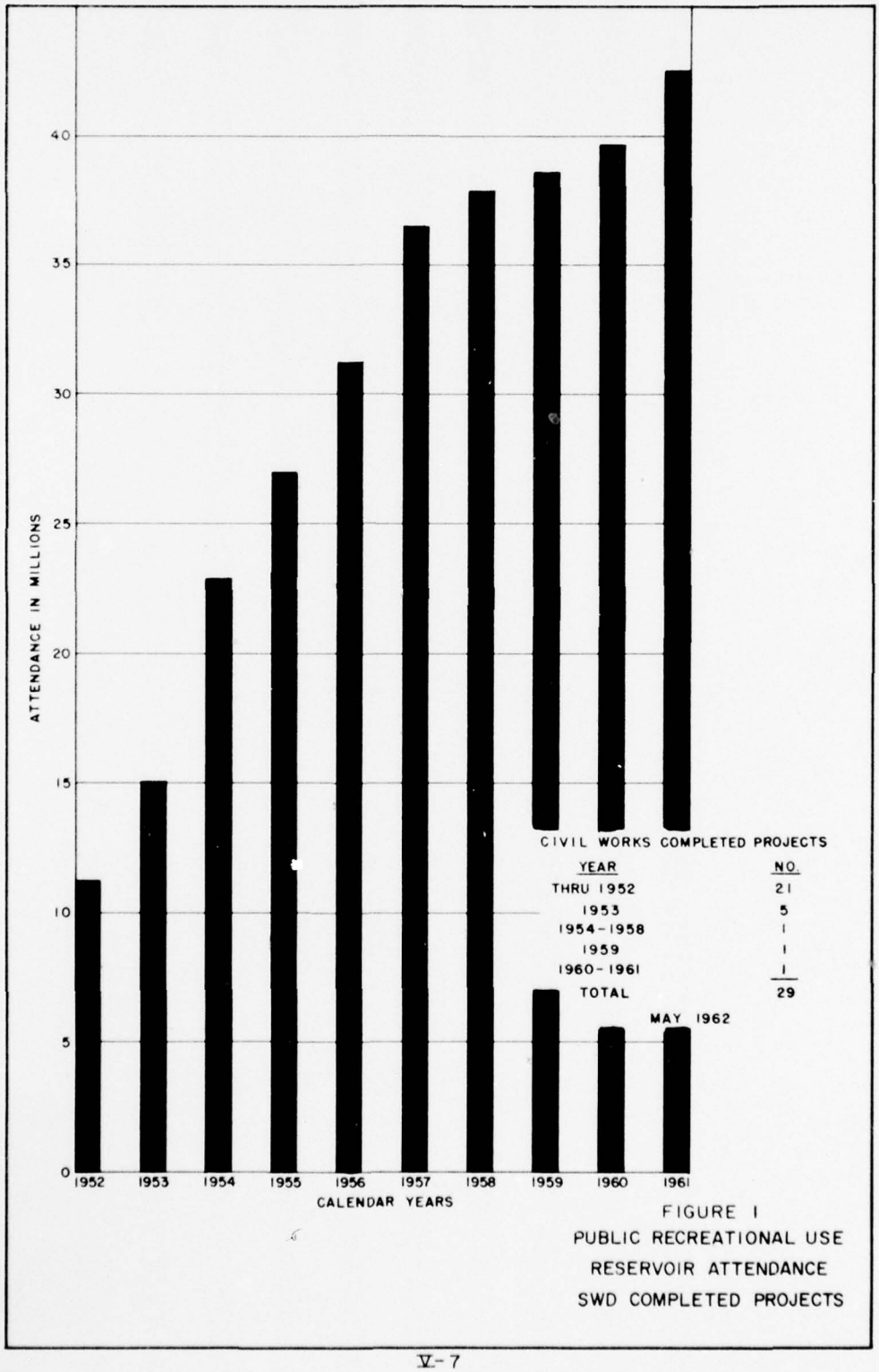
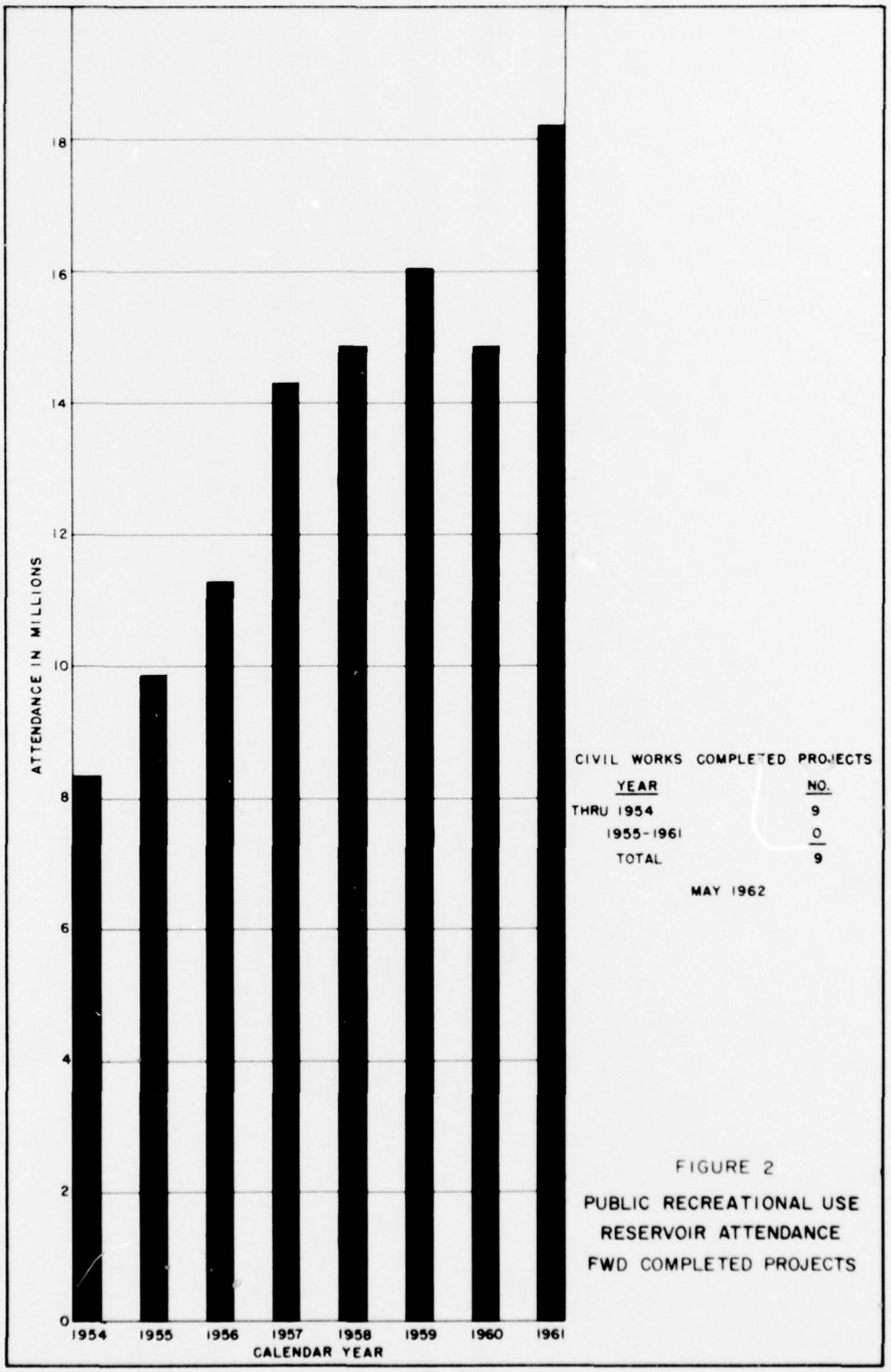


FIGURE 1
PUBLIC RECREATIONAL USE
RESERVOIR ATTENDANCE
SWD COMPLETED PROJECTS



CIVIL WORKS COMPLETED PROJECTS

YEAR	NO.
THRU 1954	9
1955-1961	0
TOTAL	9

MAY 1962

FIGURE 2

PUBLIC RECREATIONAL USE
RESERVOIR ATTENDANCE
FWD COMPLETED PROJECTS

11. RECREATION PROJECTIONS FOR AREA OF INFLUENCE.- In projecting the demand for water-based recreation in the Trinity River Basin, several factors were considered, including those cited in paragraphs 8 and 9. Cognizance was taken of the report published by Resources for the Future entitled "The Crisis in Outdoor Recreation" and the report entitled, "Water Recreation Needs in the United States, 1960-2000" contained in Committee Print No. 17, 86th Congress, 2nd Session, both of which indicate increases in outdoor recreation visitation of tenfold or more by the year 2000, of which 75% is estimated to be water-oriented. It immediately became apparent that projections based on a rate of increase in recreation demand greatly exceeding the rate of population growth, as projected in these reports, would result in a recreation demand far beyond the capability of the project to satisfy. While experience records at multiple purpose projects in the Fort Worth District and the Southwestern Division would tend to confirm the validity of the higher rates of projections, their use in this report would only further amplify the inability of the project to satisfy the demand. Accordingly, it was decided to indicate a projection rate based on the present number of visits per person in the principal area of influence and generally in line with the projection contained in the report of the ORRRC that the demand for outdoor recreation as a whole would triple by the year 2000. In arriving at this conclusion, attendance at four completed reservoirs in the upper portion of the basin (Benbrook, Grapevine, Garza-Little Elm and Lavon) was compared to the population in the area of influence. Results of these studies and the projected demand for the basin are outlined below.

12. UPSTREAM AREA.- The four existing Corps projects in the Fort Worth-Dallas area of the basin attracted 7,000,000 visitors during the year 1960. The population of this area for 1960 was 1,700,000, which indicates an average ratio of four visits per person. When this rate of visitation is projected for the upstream portion of the basin, a total of 42,000,000 visits by the year 2070 is indicated. The ORRRC predicts that the demand for outdoor recreation will triple by the year 2000. When this rate of increase is projected to the year 2070, the potential visitation is 45,000,000, a reasonably close correlation. Projected population in the upper Trinity basin as compared to potential recreation demand is illustrated by figure 3.

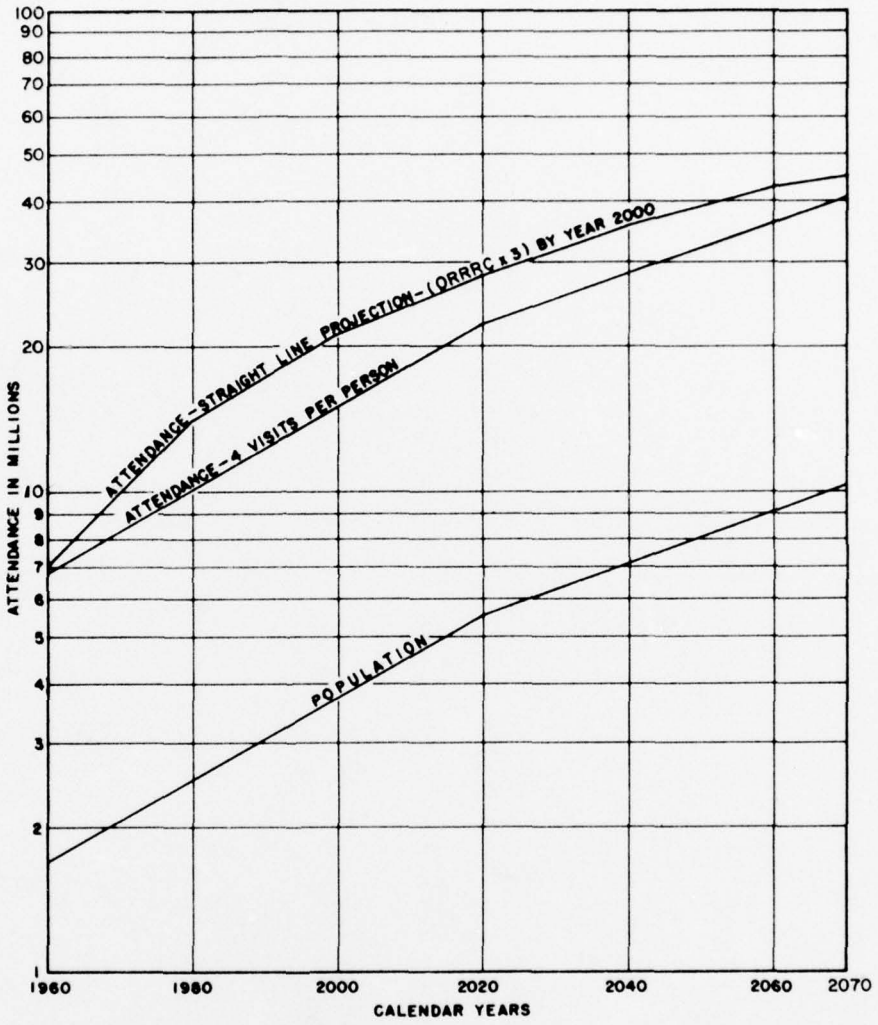


FIGURE 3

UPSTREAM AREA OF
TRINITY RIVER BASIN
PROJECTED POPULATION
AND
RECREATION DEMAND

13. INTERMEDIATE AREA.- The Tennessee Colony Reservoir and the multiple-purpose channel are located in this area which contains a combination of urban and rural population of approximately 550,000. Other reservoir projects are planned for this area by the Corps of Engineers and local interests. Visitation records for this area are not available, but it is considered that the rate of visitation would be medium to heavy due to the quality of recreation afforded and accessibility from major population centers. The reservoir and channel areas would provide resources for both recreation and fish and wildlife development. The cutoffs along the channel would enhance the development of recreational areas and related facilities. For these reasons it is estimated that the potential visitation in this area would be in the order of 15,000,000, by the year 2070, of which about one-half would be the result of demand within the area itself.

14. DOWNSTREAM AREA.- The downstream area of the multiple-purpose channel would be adjacent to the heavily populated Galveston, Harris, and Jefferson Counties which had a total population of about 1,629,000 in year 1960. The principal existing water-based recreation areas within these counties are located on the Gulf or bays which contain salty water. Wallisville Reservoir and the proposed channel above Wallisville Reservoir would provide fresh water and related recreation facilities which should attract a considerable number of visitors from the counties adjoining this area. Visitation records for this section are not available, but assuming the visitation rate for water-based recreation to be essentially the same as for the upstream portion, the potential demand for this type of activity in the area, in terms of visits, would also be in the order of 42,000,000 by the year 2070. If this demand is split 50-50 between fresh and salt water, there would then remain a potential demand for fresh water-based recreation of 21,000,000.

15. CAPACITY OF PROJECT TO MEET RECREATION DEMAND.- Experience indicates that there is a degree of visitation or usage which, if regularly exceeded, makes the recreational aspects of a project less attractive and results in deterioration may be termed the optimum visitation capacity or design capacity of the project. In effect, it becomes a visitation design load, which should not be regularly exceeded. This may be expressed in terms of annual visitation or peak-day (normal summer weekend) visitation. For purposes of this report the design capacity of each project is expressed in terms of optimum annual visitation.

16. There are a number of factors which affect the optimum capacity of a water-resource project. Major factors to be considered include:

a. Principal types of recreational use.

b. Area of usable lands and waters.

c. Nature and length of shoreline.

d. Nature of recreation resources.

17. On the basis of experience at existing reservoirs in the Fort Worth District and taking the above factors into consideration, it is estimated that the optimum capacity of projects in the plan of improvement, together with other Corps projects cited in paragraph 3, will be as follows:

Project	Optimum annual visitation
Aubrey	6,000,000
Bardwell	1,500,000
Benbrook	2,500,000
Grapevine	3,500,000
Garza-Little Elm	7,500,000
Lakeview	3,500,000
Lavon	5,000,000
Navarro Mills	2,500,000
Tennessee Colony	8,000,000
Wallisville	2,000,000
Multiple Channel	6,000,000
Total	48,000,000

18. As previously stated, the recreation demand for the Basin by the year 2070 is estimated to be 78,000,000 visits, whereas total project capacity is estimated to be 48,000,000. Thus, it may be seen that even with the proposed plan of improvement, the recreation demand for the basin would not be met by Corps projects alone. Requirements over and above the capabilities of these projects should be met by additional projects or developments by the State or other agencies. In this connection, a statewide master plan for the State

Parks System is now in the process of preparation by the Horticulture and Parks Management Department of the Texas Technological College. When this study has progressed to the point that State Park requirements are more definitely known, the proposed plan of improvement for the basin will be coordinated in more detail with representatives of the State Parks Board in order that the development proposed would be fully considered and cooperative actions taken where feasible.

19. PROJECT VISITATION.- In estimating the number of annual recreation visits that would be made to the project, it has been assumed that the project would be physically complete by 1970. On this basis, taking into account experienced visitation at existing reservoirs, together with project capacities and other considerations involved, it is estimated that the initial and average annual visitation to the projects included in the plan of improvement would be as follows:

Project	Initial 1970	Average Annual	Optimum annual Visitation
Lakeview	1,500,000	3,000,000	3,500,000
Aubrey	2,000,000	4,000,000	6,000,000
Grapevine	2,500,000	3,000,000	3,500,000
Garza-Little Elm	3,000,000	5,000,000	7,500,000
Tennessee Colony	2,500,000	6,000,000	8,000,000
Multiple-Purpose Chan'l	1,350,000	5,000,000	6,000,000
Totals	12,850,000	26,000,000	34,500,000

20. The above visitation figures include sightseers, presently estimated at approximately 25% of the total. As population increases in the area surrounding a project the percentage of sightseers may increase, with a resultant increase over the estimated visitation shown. However, this would not affect materially the amount of lands or facilities actually required.

21. GENERAL RECREATION VS. FISH & WILDLIFE.- Visitor attendance statistics compiled at nine completed reservoirs in the Fort Worth District with a total water surface area of 88,550 acres and varying in size from 510 acres to 23,470 acres at the top of the conservation or power storage levels were as follows:

Year	Total recreation visitors (millions)	General recreation visitors (millions)	General recreation Per cent	Fish and Wildlife recreation visitors (millions)	Fish and Wildlife recreation Per cent
1957	14.4	9.8	68	4.6	32
1958	15.0	9.0	60	6.0	40
1959	16.0	9.5	60	6.5	40
1960	15.0	8.5	57	6.5	43
1961	18.3	12.0	65	6.3	35
Average			62		38

22. The location, size, and number of areas to be developed at each authorized project will be presented in a preliminary master plan. Details of the proposed development to provide for public recreation and the conservation and management of fish and wildlife will be presented in a master plan for each project. Basic recreational facilities to be provided would include access roads, parking areas, public camping and picnicking areas, water supply, sanitary facilities, boat launching ramps, signs, essential safety devices, etc. Group picnic shelters, beach improvements for public swimming, including simple change houses, and boat anchorage areas would also be provided where such facilities are warranted. Additional facilities and services necessary or desirable for full development of the recreation potential will normally be arranged for by concessions and permits to private organizations and individuals or by leases or licenses to other federal agencies or to state and local governmental agencies.

23. Data and information presented above for nine reservoir projects under the jurisdiction of the Fort Worth District indicate that 62 percent of the visitors participated in general recreation activities such as picnicking, camping, etc., and that 38 percent participated in fish and wildlife recreation activities such as sport fishing, hunting, etc. The Texas Game and Fish Commission issued a news item during 1960 which revealed that the percentage of Texans who fish and hunt is about 10 percent higher than the national average. It showed that 33.2 percent of the population which are 12 years old and over fish and hunt, whereas the national average is 23.0 percent. For the purpose of this report, it is assumed that 65 percent of the estimated visitors would participate in general recreation activities such as picnicking, camping, etc., and 35 percent would participate in fish and wildlife recreation activities such as sport fishing, hunting, etc.

PLAN OF IMPROVEMENT

24. STUDIES.- Preliminary studies indicate that the recreation resources are sufficient to justify recreation and fish and wildlife as primary purposes for the multiple-purpose channel and multiple-purpose reservoir projects. Pertinent information relative to size, land requirements, costs, and benefits of the recreational purposes in the proposed projects are shown in table 1 and described in the following paragraphs.

TABLE 1

PERTINENT DATA - RECREATION AND FISH AND WILDLIFE

Project	Water surface area (acres)	Lands required (Acres)									Benefits
		Recreation, incl sport fishing & hunting			Fish and wildlife						
		Project purposes	Public use & access	Total	Water area	Land area	Project purposes	Abv upperguide Natl. refuge	Mitigation losses	Total	
Lakeview	12,300	2,800	760	3,560	-	-	-	-	-	-	$2,025,000
Aubrey	24,340	4,800	1,300	6,100							
Garza-Little Elm	5,900[1]		2,900	2,900							
Subtotal	30,240	4,800	4,200	9,000	-	-	-	-	-	-	2,900,000
Roanoke											
Grapevine	4,360[2]		1,100	1,100	-	-	-	-	-	-	
Subtotal	4,360		1,100	1,100							150,000
Tennessee Colony	73,540										
P.U. & Access		6,400	1,907	8,307							4,050,000
F & WL Service					9,500	10,900	20,400	600		21,000	
T.G. & F.C.					1,000	1,950	2,950		8,050	11,000	
Subtotal	73,540	6,400	1,907	8,307	10,500	12,850	23,350	600	8,050	32,187	
Multiple purpose channel	15,200[3]	860	2,600	3,460	-	-	-	-	-	-	3,375,000
Grand Total	135,640	14,860	10,567	25,427	10,500	12,850	23,350	600	8,050	32,187	12,500,000

[1] 5,900 increase in water surface area plus existing 23,470 = 29,370 total.
[2] 4,360 increase in water surface area plus existing 7,380 = 11,740 total.
[3] 6,600 acres in river cutoffs below Tennessee Colony Dam.

25. LAKEVIEW PROJECT.- Lakeview Dam is located on Mountain Creek between Fort Worth and Dallas, Texas. The impounded water would cover 12,300 acres at the top of conservation storage level. Based on the existing and projected population for this area and the number of visitors the existing projects have attracted, it is conservatively estimated that the proposed Lakeview Reservoir project would attract an initial annual visitation of about 1,500,000 visitors after sufficient water is impounded, and would eventually attract about 3,500,000 visitors annually. The average annual visitation would be approximately 3,000,000. The total lands required for public use and access is estimated to be 3,560 acres. Of this amount 2,800 acres would be acquired under the 1962 joint land acquisition policy for project purposes. The remainder consists of 760 acres for public use and access. The estimated cost for lands, clearing, and facilities in the interest of public use are shown in table 2.

26. AUBREY PROJECT.- Aubrey Dam site is located at mile 60.0 on the Elm Fork of the Trinity River, 30 river miles upstream from Lewisville Dam (Garza-Little Elm Reservoir). The Aubrey reservoir would be classified as a multiple-purpose reservoir for flood control and water conservation and would be designed to provide, in combination with Garza-Little Elm Reservoir, the same degree of flood control protection as that provided by the existing Garza-Little Elm Reservoir. The flood control storage proposed for Aubrey Reservoir would permit a reallocation of storage in Garza-Little Elm Reservoir, and increase that storage presently allocated to water conservation. The impounded water in Aubrey Reservoir would cover 24,340 acres at the top of the conservation storage level. Based on the existing and projected population for this area and the number of visitors the existing projects have attracted, it is conservatively estimated that the proposed Aubrey Reservoir project would attract an initial annual visitation of about 2,000,000 visitors after sufficient water is impounded, and would eventually attract about 6,000,000 visitors annually. The average annual visitation will be 4,000,000. The total land required for public use and access is estimated to be 6,100 acres. Of this amount 4,800 acres would be acquired under the 1962 joint land acquisition policy for project purposes. The remainder consists of 1,300 acres for public use and access for the Aubrey Reservoir. In addition, about 2,900 acres of which about 2,800 would be acquired in fee title in lieu of existing flood flowage easements and 100 acres in fee title above the upper guide contour, to meet requirements for public use at the modified Garza-Little Elm Reservoir. Lands thus obtained should be blocked out in accordance with sound real estate practices, giving due consideration to specific recreation and public access needs in each area. The estimated costs for lands, clearing, and facilities in the interest of public use are shown in table 2.

TABLE 2

ESTIMATED COST OF LANDS, CLEARING, AND FACILITIES FOR PUBLIC USE AND ACCESS

Project	Lands(1) Public use and access		Clearing(1)		Facilities (2)			Grand Total
	Acres	Cost	Acres	Cost	Initial Dev. Cost	Future Dev. Cost	Optimum Dev. Cost	
Lakeview	760	$805,000	8,500	$372,000	$1,694,000	$1,750,000	$3,444,000	$4,621,000
Aubrey	1,300	350,000	3,000	813,000	2,310,000	3,750,000	6,060,000	7,223,000
Garza-L.E.	2,900	824,000	3,000	281,000	500,000	-	500,000	1,605,000
Subtotal	4,200	1,174,000			2,810,000	3,750,000	6,560,000	8,828,000
Roanoke Grapevine	1,100	871,000	2,300	215,000	375,000	-	375,000	1,461,000
Tennessee Colony	1,907	451,000	20,000	1,875,000	2,997,000	5,100,000	8,097,000	10,423,000
Multiple-purpose Channel	2,600	1,076,000	-	-	2,150,000	1,433,000	3,583,000	4,659,000
Grand Total	10,567	4,377,000	46,800	3,556,000	10,026,000	12,033,000	22,033,000	29,992,000

(1) Separable cost over and above project requirements.
(2) Does not include engineering and design or supervision and administrative costs.

27. GARZA-LITTLE ELM RESERVOIR.- When the storage is reallocated in the Garza-Little Elm Reservoir, the top of the conservation level would be raised seven feet. The impounded water level would then cover 29,370 surface acres, or an increase of 5,900 surface acres. Based on the results of studies made in connection with raising the conservation pool level at Lavon Reservoir and the number of additional visitors this reservoir would attract, it is estimated that the increased water surface area at the Garza-Little Elm Reservoir will initially attract an additional 400,000 visitors. Based on the existing and projected population for this area and the number of visitors the existing projects have attracted, it is conservatively estimated that the modified Garza-Little Elm Reservoir project would attract an annual visitation of about 3,000,000 visitors after the additional water is impounded, and would eventually attract about 7,500,000 visitors annually. The average annual visitation would be approximately 5,000,000. The estimated costs for lands, clearing, and facilities in the interest of public use are shown in table 2.

28. ROANOKE PROJECT.- Roanoke Dam is located at mile 32.0 on Denton Creek and 20.3 river miles upstream from Grapevine Dam. Roanoke would be classified as a single-purpose flood control reservoir, and would be designed to provide, in combination with Grapevine Reservoir, the same degree of flood control protection as that provided by the existing Grapevine Reservoir. The flood-control storage proposed for Roanoke Reservoir would permit a reallocation of storage in Grapevine Reservoir, and increase that storage presently allocated to water conservation. The Roanoke project was investigated as a dual-purpose project, flood control and water storage for recreation, and it was determined that this type project would reduce the dependable yield of Grapevine Reservoir by about 6.5 million gallons per day. By comparison of benefits realized from recreational uses and the reduction in water conservation yield, it was found that provision of storage of water for recreational purposes is not economically feasible. The total land required for public use and access is estimated to be 1,100 acres. This would involve the acquisition of fee title in lieu of existing flood flowage easements on 600 acres and the acquisition of additional 500 acres of privately owned lands above the upper guide contour to meet requirements for public use at the modified Grapevine Reservoir, since Roanoke will serve only as a flood control reservoir. Lands thus obtained should be blocked out in accordance with sound real estate practices, giving due consideration to specific recreation and public access needs in each area.

29. GRAPEVINE RESERVOIR.- When the storage is reallocated in the Grapevine Reservoir, the top of the conservation pool level will be raised 21 feet. The impounded water level would then cover 11,740 surface acres, or an increase of 4,360 surface acres. Based on the results of studies made in connection with raising the conservation

pool level at the Lavon Reservoir and the number of additional visitors this reservoir would attract, it is estimated that the increased water surface area at the Grapevine Reservoir would initially attract an additional 300,000 visitors. Based on the existing and projected population for this area and the number of visitors the existing projects have attracted, it is conservatively estimated that the modified Grapevine Reservoir project would attract an annual visitation of about 2,500,000 visitors after the additional water is impounded, and would eventually attract about 3,500,000 visitors annually. The average annual visitation would be approximately 3,000,000. The estimated costs for lands, clearing, and facilities in the interest of public use are shown in table 2.

30. TENNESSEE COLONY PROJECT.- Tennessee Colony Dam is located about river mile 340 on the main stem of the Trinity River. The impounded water would cover 73,540 acres at the top of the conservation storage level. The Fort Worth District is presently constructing one reservoir project and proposes to initiate construction on another reservoir project during 1963, both of which are located within a 50-mile radius of the proposed Tennessee Colony project. There are also other reservoir projects located within a 50-mile limit of this proposed reservoir which are operated by agencies other than the Corps of Engineers, as indicated on plate 1. Based on the existing and projected population for the Tennessee Colony area and the number of visitors attracted at comparable reservoirs, it is conservatively estimated that the proposed Tennessee Colony Reservoir would attract an initial annual visitation of about 2,500,000 visitors after sufficient water is impounded, and would eventually attract about 8,000,000 visitors annually. The average annual visitation would approximate 6,000,000. The total land required for public use and access is estimated to be 8,120 acres. Of this amount 6,400 acres would be acquired under the 1962 joint land acquisition policy for project purposes. The remainder consists of 1,720 acres for public use and access. It would also involve the acquisition of an additional 600 acres for a national refuge requested by the U. S. Fish and Wildlife Service, if approved by Congress. The estimated costs for lands, clearing, and facilities, in the interest of public use are shown in table 2.

31. MULTIPLE PURPOSE PROJECT.- The multiple-purpose channel would extend from the existing Houston Ship Channel in Galveston Bay to the city of Fort Worth, Texas, having an over-all length of about 370 miles. The bottom width of the channel would vary from 150 to 300 feet. There would be two principal turning basins, one at Dallas, Texas, and the other at Fort Worth, Texas. The channel with a minimum depth of 12 feet and a minimum width of 150 feet would pass through 3 reservoir projects; namely, Wallisville, Livingston, and Tennessee Colony, all on the main stem of the Trinity River. Twenty-three locks

and 18 navigation dams, exclusive of the Wallisville, Livingston, and Tennessee Colony Dams, would be constructed on the multiple-purpose channel. It is proposed to construct diversion dams at the upper end of each river cutoff where the course of the existing river would be changed due to the construction of the multiple-purpose channel. These diversion structures would preclude the river from reverting to its existing course and divert the flow into the multiple-purpose channel. Under normal operation conditions all or a portion of the cutoffs would be partially filled with water resulting from impoundments upstream from the proposed locks and dams. Many of these river cutoffs and some of the tributary streams would provide excellent areas for the development of facilities associated with both general and fish and wildlife recreation activities. The water impounded in many of the cutoffs and tributary streams would provide excellent areas for fishing and the storage of boats. About 8,600 acres of surface area would be provided, exclusive of the portion in the three reservoirs, when the water surface in the completed multiple-purpose channel is at the top of the normal operating pools for navigation purposes. Furthermore, about 6,600 additional acres would be inundated in the cutoffs between the locks and dams numbered one through 12 when the water in the completed multiple-purpose channel is at its normal operating level for navigation purposes. It is proposed to fill all the cutoffs upstream from lock and dam number 13 with spoil material resulting from excavation of the multiple-purpose channel, since this portion of the river is located in an existing or proposed leveed floodway. Due to its nature, width, and navigation in the channel the 15,200 surface acres of impounded water would not attract as many visitors for recreational activities as a similar size reservoir project. However, the channel would attract many visitors desiring to observe the passage of floating equipment through the locks, to navigate the channel for sport and pleasure, and to fish. Appropriate facilities must be developed along the channel to provide access, vehicle parking, picnicking, camping, boat launching, boat storage, etc. Facilities located on or adjacent to the channel for the storage and servicing of pleasure craft as well as providing the general public with their needs and demands such as food, drinks, etc., should be spaced at about 30-mile intervals. Since the Federal Government is acquiring fee title only to those lands within and adjacent to the channel where structures would be constructed and for the development for public use and access, private industry will, no doubt, develop these types of activities on privately-owned land. This condition will preclude the normal control exercised by the Corps of Engineers in regulation of spacing of such facilities to provide sufficient service and to prevent undue competition. Based on the existing and projected population for the entire basin area and the visitors attracted to the existing reservoirs previously discussed, it is conservatively estimated that the proposed multiple-purpose channel would attract an annual visitation of about 1,350,000 visitors during

its first three years of operation and eventually attract about 6,000,000 visitors annually. The average annual visitation would be approximately 5,000,000. A large percentage of these visitors would be sightseers only. The total land required for public use and access is estimated to be 2,600 acres. This is in addition to the lands to be acquired in fee title for project purposes. The estimated costs for lands and facilities in the interest of public use are shown in table 2.

ECONOMIC BENEFITS OF RECREATION

32. Economic benefits resulting from the development of the recreation resources associated with water resource projects can be evaluated and expressed in several different ways, including actual assignment of a monetary value for each project visit. The latter method has been used in benefits vs. cost considerations of this report, using a conservative unit value of 50¢ per visit for general recreation and $1.00 for sport fishing and hunting, the latter being in accordance with the schedule of value adopted by the Inter-Agency Committee on Water Resources at its 18 October 1960 meeting.

33. While values used indicate substantial benefits from recreational aspects of the project, they are considered most conservative and in many ways do not indicate fully the economic impact of recreation and related activities associated with large water resource projects. The fact is that recreation invariably improves the local economy, the degree depending primarily on the recreation demand of the area and the quality of recreation afforded.

34. Experience and actual studies at existing projects in the Southwestern Division show that counties in which large reservoirs are wholly or partially located have a notably better economic performance than non-reservoir counties in terms of broad indicators such as population, per capita income, wages, retail trade, and bank deposits. There are many reasons for this. Of basic importance is the fact that each large reservoir provides new opportunities for capital to be profitably used in the development of businesses associated with recreation, thereby putting capital to work in an economically productive manner.

35. Recreation associated with major water resource projects attracts outside dollars and investment in the area affected in a number of ways. Particularly significant are the following:

a. Recreation attracts visitors who in the aggregate spend large sums at lakeshore resorts and service establishments.

b. Recreational visitation induces private investors to finance or develop overnight accommodations, marinas, and many other recreation-related sales and service facilities. The Corps of Engineers encourages needed service facilities on Federal lands and waters by concession agreements and special use permits.

c. Recreational aspects of projects attract many newcomers to the reservoir area who construct homes and cabins for themselves as near the shorelines as possible.

d. Industry is attracted to the general area because of the recreation climate afforded its employees, even though the industry itself may not be a heavy water user.

36. In the case of the Trinity River Basin, it is not anticipated that the recreation resource will attract heavy visitation from outside the basin with the exception of the lower reaches which will undoubtedly attract many visitors from the adjoining coastal counties. However, there is a most substantial demand and need for water-based recreation opportunities, particularly in the upper Trinity Basin, and it is anticipated that industry and investment in many forms will be attracted to the area because of its recreation opportunities, in combination with the favorable opportunities for commerce, if the water and recreation resources are developed as proposed. Further, this demand and interest may be expected to continue and to increase for the life of the project. Assuming that each recreation spender, on the average, spends $2.50 per visit and that only 20 percent of this expenditure contributes directly to the local income (both estimates considered conservative) it is apparent that this in itself constitutes a steadily-growing multiple-million dollar industry. When the actual value of water-based recreation to the individual is added to this, together with the many corollary benefits resulting from productive capital investments in recreation-related services and in the development of new industries, it may be readily seen that recreation benefits accruing to this project are both tangible and substantial, and that the actual benefits assigned are conservative.

COORDINATION WITH OTHER FEDERAL AGENCIES

37. U. S. FISH AND WILDLIFE SERVICE.- The U. S. Fish and Wildlife Service was furnished data and information applicable to the proposed plan of improvement on the Trinity River and tributaries, prior to 1 December 1961. The Service was requested to prepare a report on the fish and wildlife aspects relative to the developments proposed by the Corps of Engineers. The Service's report, dated May 1962, applicable to the information furnished prior to 1 December 1961, is attached in this appendix as exhibit 1. However, additional facilities consisting of Aubrey Reservoir, Roanoke Reservoir, and

increase in water storage levels at the existing Grapevine, Garza-Little Elm Reservoirs and the proposed Lakeview and Tennessee Colony Reservoirs were included in the plan of improvement. The Service has been furnished additional data and information applicable to the additional facilities and requested to furnish a supplement to its report dated May 1962. Their report dated May 1962 received the concurrence of the Texas Game and Fish Commission. The Service's report contains several recommendations with regard to the development of the fish and wildlife resources of the Trinity River and Tributaries project. Their recommendations, together with the comments of the District Engineers, Corps of Engineers, Fort Worth and Galveston Districts, are as follows:

a. Recommendation No. 1.- That fish and wildlife be included among the purposes for which project authorization is sought.

b. Comment.- This recommendation is concurred in and fish and wildlife has been included among the recommended project purposes.

c. Recommendation No. 2.- That the Corps of Engineers provide access facilities for hunters and fishermen, as discussed in paragraphs 92 through 95 of the attached substantiating report, for Tennessee Colony Reservoir, Lakeview Reservoir, the multiple-purpose channel, and the Trinity River cutoffs.

d. Comment.- It is proposed to provide access and facilities for hunters and fishermen. The number, size, and location of areas selected for development for public facilities and types of facilities to be developed will depend on several factors, such as topographic features of the land below and above the normal water levels, tree cover, etc. The areas will be selected and a plan for developing each area will be accomplished during the detailed planning stage.

e. Recommendation No. 3.- That 6 seining areas totaling 1,200 acres in Tennessee Colony Reservoir and 3 seining areas totaling 600 acres in Lakeview Reservoir be cleared to ground level of all stumps and other obstructions. Specific locations and dimensions of seining areas will be determined by the Texas Game and Fish Commission during more advanced project planning stages.

f. Comment.- This recommendation is concurred in and consideration will be given to the site locations recommended by the Texas Game and Fish Commission.

g. Recommendation No. 4.- That timber and brush clearing in Lakeview Reservoir be restricted to that required for seining areas, maintaining public health, construction of the dam and spillway, and efficient operation of the project for the authorized purposes.

h. Comment.- It is the policy of the Corps of Engineers to limit clearing of timber and brush in reservoir areas to the minimum amount necessary in the interest of economy, giving full consideration to the purposes for which the project is authorized and constructed.

i. Recommendation No. 5.- That passage lanes be made through the densely timbered areas to the headwaters and upper reaches of coves in Tennessee Colony Reservoir to provide access for fishermen and hunters. Specific design of these passageways will be made by the Texas Game and Fish Commission during the more advanced project planning stages.

j. Comment.- It is the policy of the Corps of Engineers to clear passage lanes in densely timbered reservoir areas to provide access for boaters and navigators. Consideration will be given to locating such passage lanes at sites recommended by the Texas Game and Fish Commission.

k. Recommendation No. 6.- That Lakeview and Tennessee Colony Reservoirs be zoned to realize maximum fishing and hunting benefits and to reduce conflicts with other recreational uses.

l. Comment.- Zoning of reservoirs to avoid conflicting uses by fishermen and general recreationists are reservoir management problems and will warrant consideration during detailed planning studies or when the projects are placed in operation. It is not the policy of the Corps of Engineers to seek law enforcement authority for personnel assigned to the projects. Therefore, enforcement of zoning and all other adopted regulations must be enforced by local law enforcement officers or game wardens.

m. Recommendation No. 7.- That 21,000 acres of lands, essentially as shown on plate II of the Service's report, be provided as an integral part of the project for a national wildlife refuge on a portion of Tennessee Colony Reservoir in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Specific boundaries of the refuge, as well as estimates of land acquisition and development facilities and costs, will be prepared by the Bureau of Sport Fisheries and Wildlife during the more advanced project planning stages.

n. Comment.- It is agreed that the Tennessee Colony Reservoir would create extensive waterfowl habitat and would offer considerable potential for the development of a national wildlife refuge. The refuge managed by the U. S. Fish and Wildlife Service, would offer considerable opportunity for waterfowl management and

would improve hunting for waterfowl in adjacent areas. The Service indicates that benefits attributable to establishment of a refuge would be an amount at least equal to its cost plus those occurring as a result of local waterfowl hunting and from visitation for scientific studies, nature observations, and allied uses made possible only by this refuge. The Service estimates that the benefits from hunting would amount to approximately $70,000 annually plus an estimated 100,000 man-days annually of general recreational and educational uses. Realization of benefits is recognized, but the applicable portion of these benefits is not credited to the Tennessee Colony Reservoir project, since the refuge is considered separately from the reservoir project. It is hoped that the Congress will give favorable consideration to the national wildlife refuge as an adjunct to the Tennessee Colony project.

o. Recommendation No. 8.- That, with the help of the Texas Game and Fish Commission, an area similar in size and development and otherwise equivalent to the present state-owned Gus Engeling Wildlife Management Area, be acquired and developed at project cost and its title vested in the Texas Game and Fish Commission.

p. Comment.- A specified amount of funds have been set up in the estimated project cost to provide for anticipated mitigation losses at this wildlife management area. The action and procedure taken will have to be developed between personnel in the Corps of Engineers and Texas Game and Fish Commission during the advance project planning stage.

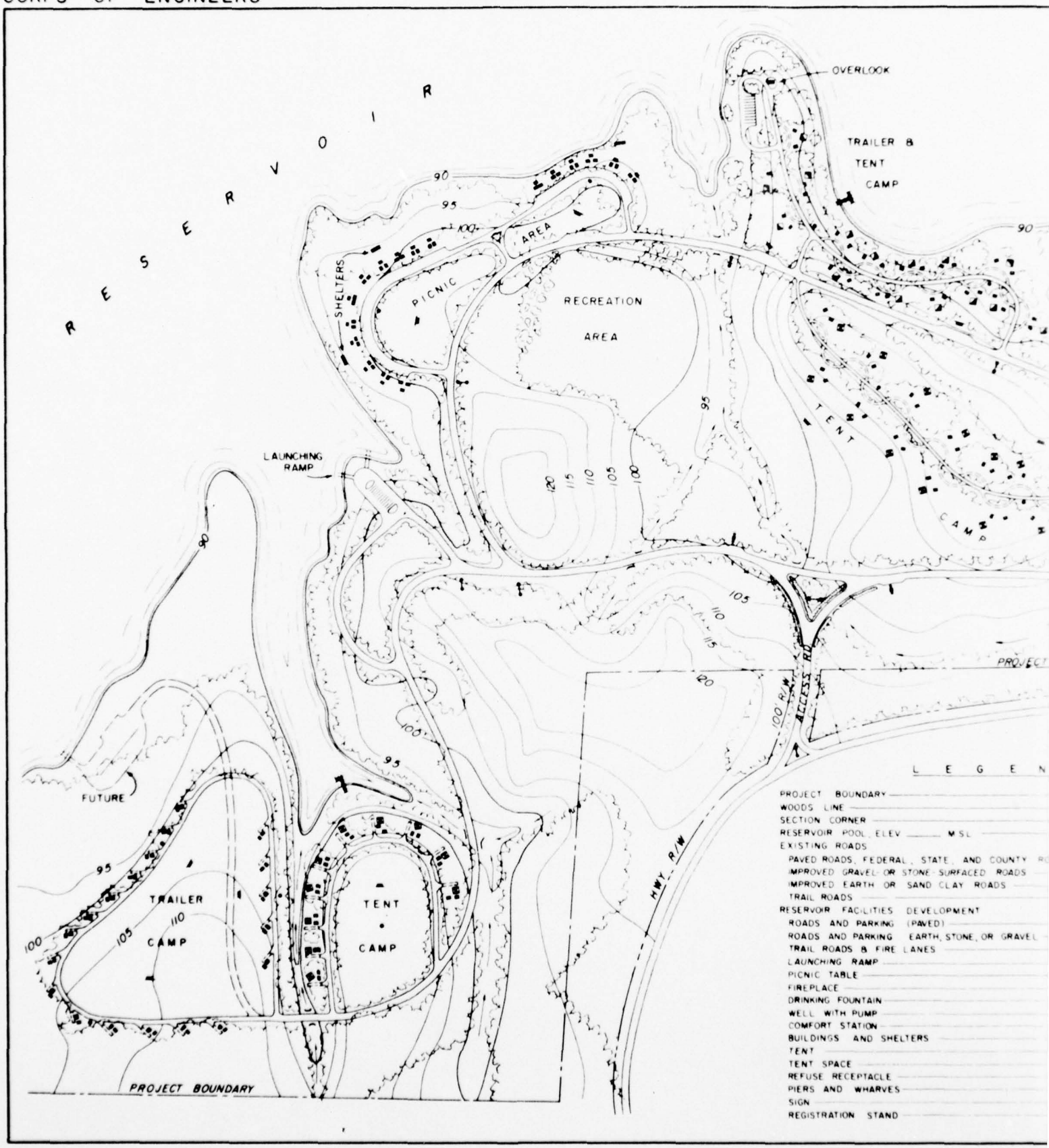
q. Recommendation No. 9.- That the regimen resulting from project operation provide for a mean monthly fresh-water discharge of 120,000 acre-feet, when available, into Trinity Bay during the period from March through October, to meet the requirements of estuarine fisheries.

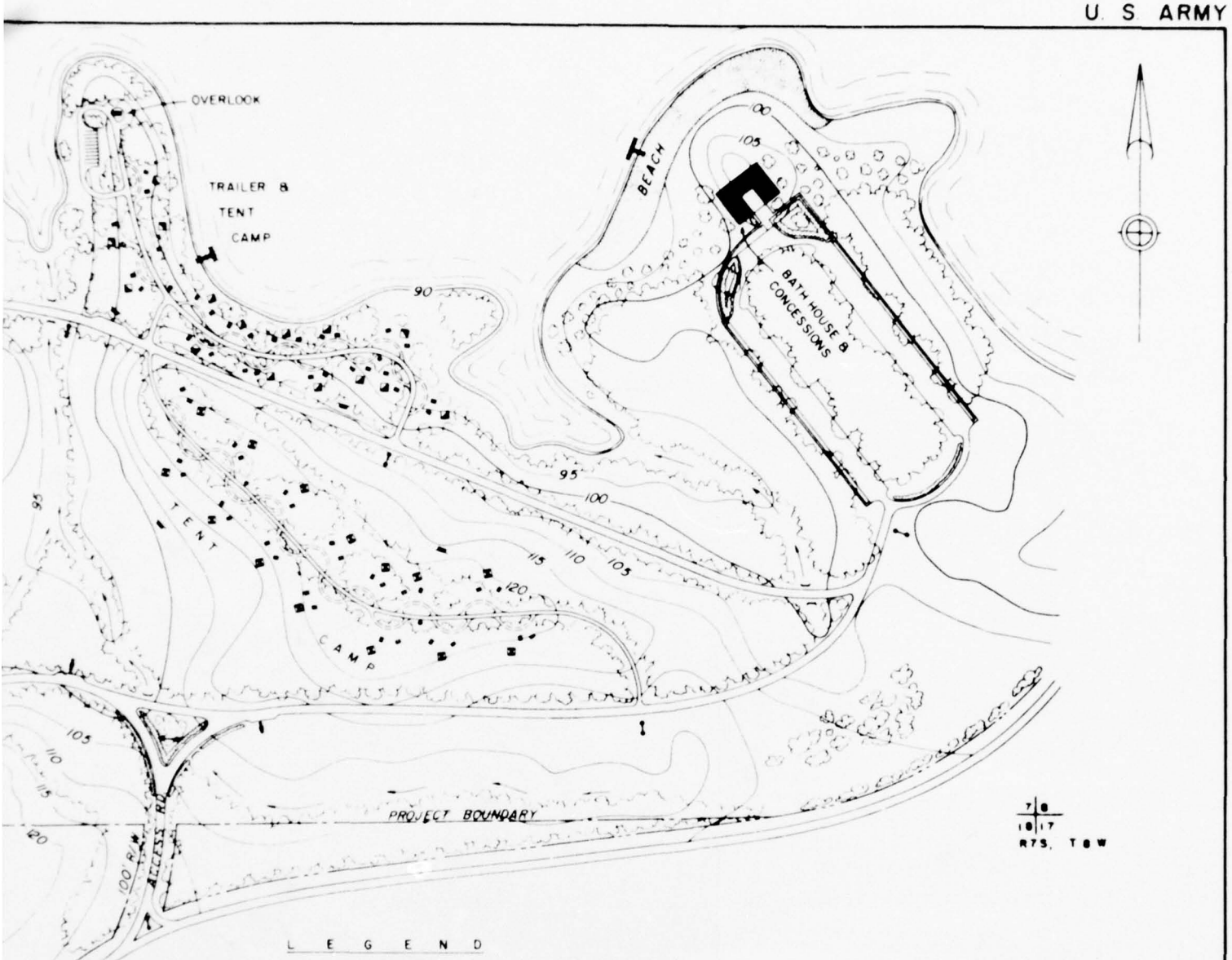
r. Comment.- Storage in the system of reservoirs considered in this report would be allocated primarily to the conservation of water for municipal, industrial, and quality of water control. The Corps of Engineers has no control over the yield from the conservation storage of these reservoirs. Requirements for navigation will be available from return flows, uncontrolled local flows, and the navigation storage in Benbrook and Grapevine Reservoirs. During droughts, water required for navigation purposes at the downstream locks would be available for estuarine purposes. During floods, regulated flows from Corps of Engineers reservoirs would also be available for estuarine purposes. The order and magnitude of these flows would depend on hydrologic conditions.

38. NATIONAL PARK SERVICE.- The National Park Service was consulted with respect to recreational aspects of the Trinity River Basin with particular attention focused on the Lakeview and Tennessee Colony Reservoirs and the multiple-purpose channel improvement. A reconnaissance of the area was made by a representative of the Region 3 Office, National Park Service, and a report of the findings was submitted, which is attached in this appendix as exhibit 2. The report contained an appraisal of the recreational potentials of the Lakeview and Tennessee Colony Reservoirs and the multiple-purpose channel project. Subsequent to receipt of the report prepared by the National Park Service additional facilities consisting of Aubrey Reservoir, Roanoke Reservoir, and increase in water storage levels at the existing Grapevine and Garza-Little Elm Reservoirs and the proposed Lakeview and Tennessee Colony Reservoirs were included in the plan of improvement. The National Park Service was not requested to supplement its original report to include the added facilities since they are situated in an area where the needs and potential are already known. Also, the estimated visitation and recreation benefits utilized in this appendix in the analyses of all investigated reservoirs and multiple-purpose channel plans were based on studies made by the Corps of Engineers as described herein.

39. TYPICAL LAYOUTS.- The preliminary studies were based on providing necessary facilities required for access and internal roads, picnicking, camping, sanitary facilities, potable water supplies, parking areas, boat launching ramps, play areas, etc. The recreation facilities would be generally as shown on the typical layout for reservoir projects, plate 2, and typical layout for lock and dam areas along the multiple-purpose channel, plate 3.

CORPS OF ENGINEERS





L E G E N D

	EXISTING	PROPOSED
PROJECT BOUNDARY		
WOODS LINE		
SECTION CORNER		
RESERVOIR POOL, ELEV ____ MSL		
EXISTING ROADS		
PAVED ROADS, FEDERAL, STATE, AND COUNTY ROUTE MARKERS		
IMPROVED GRAVEL OR STONE SURFACED ROADS		
IMPROVED EARTH OR SAND CLAY ROADS		
TRAIL ROADS		
RESERVOIR FACILITIES DEVELOPMENT		
ROADS AND PARKING (PAVED)		
ROADS AND PARKING EARTH, STONE, OR GRAVEL	E OR G	E OR G
TRAIL ROADS & FIRE LANES		
LAUNCHING RAMP		
PICNIC TABLE		
FIREPLACE		
DRINKING FOUNTAIN		
WELL WITH PUMP		
COMFORT STATION		
BUILDINGS AND SHELTERS		
TENT		
TENT SPACE		
REFUSE RECEPTACLE		
PIERS AND WHARVES		
SIGN		
REGISTRATION STAND		

200 0 200 400 600 800 1000

SCALE IN FEET

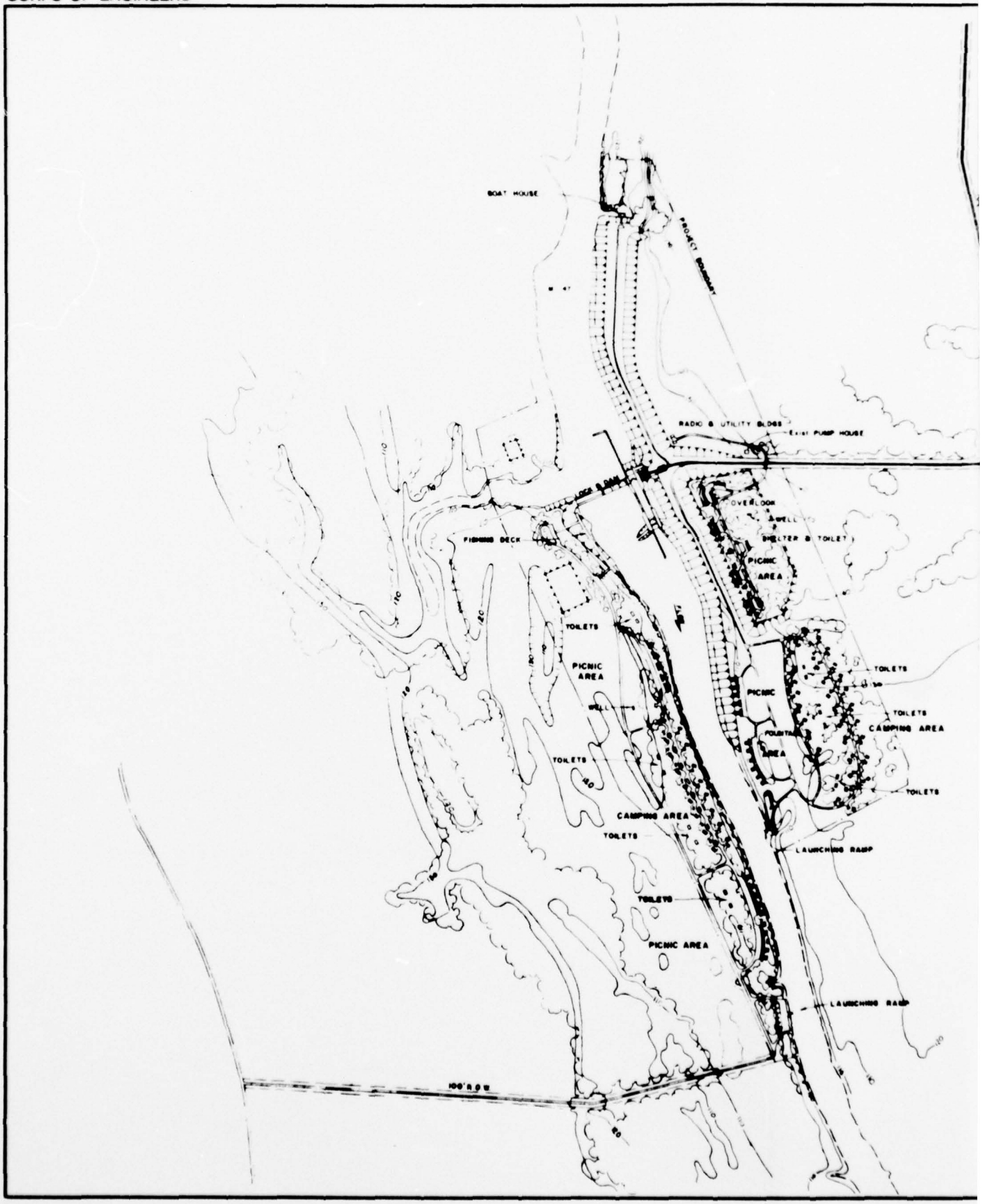
OFFICE OF THE CHIEF OF ENGINEERS
CIVIL WORKS
WASHINGTON, D. C.

STANDARD PLANS

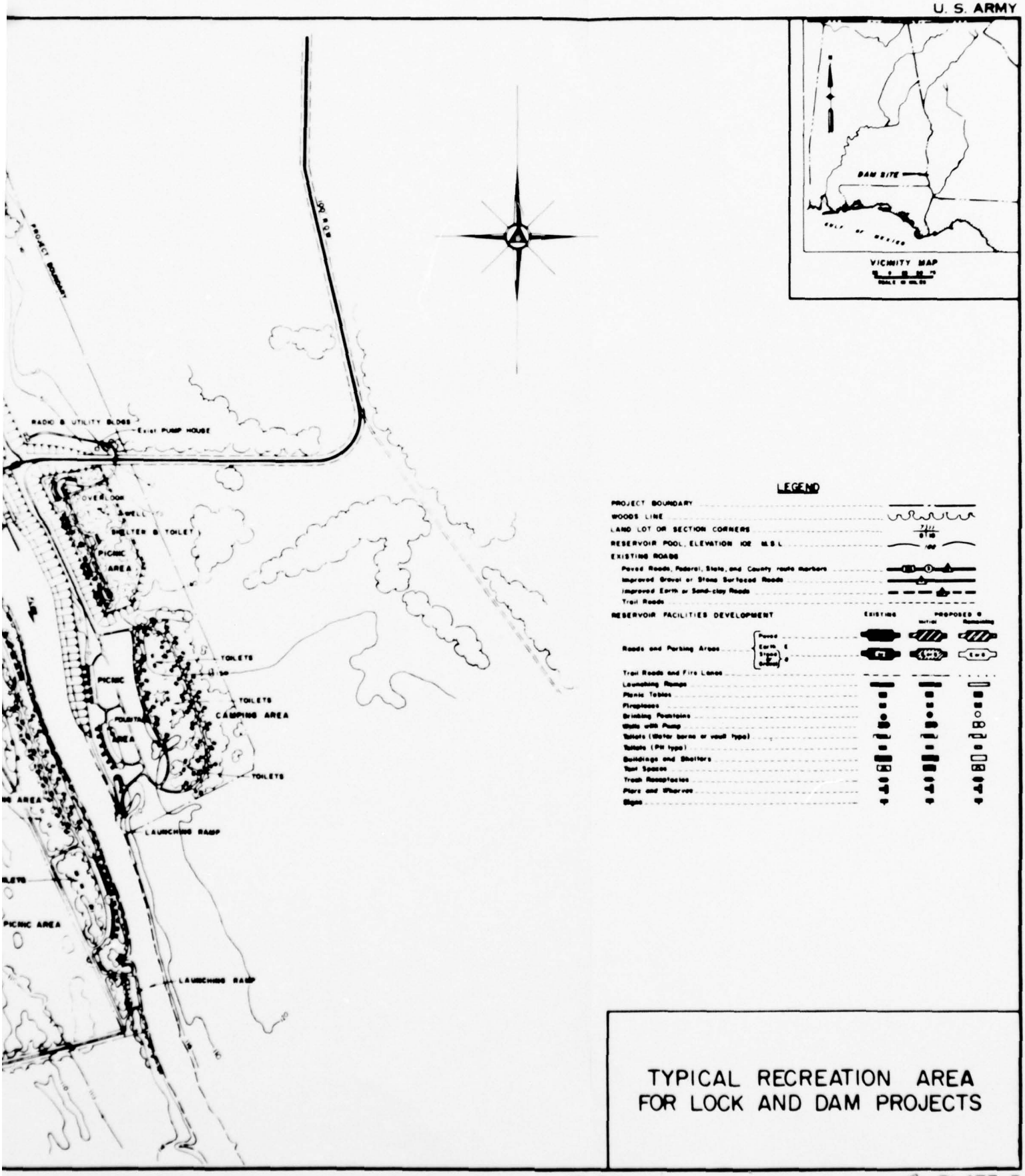
TYPICAL RECREATION AREA DEVELOPMENT - LAYOUT PLAN

DRAWING NO. LP-1

CORPS OF ENGINEERS



U. S. ARMY



TYPICAL RECREATION AREA FOR LOCK AND DAM PROJECTS

CONCLUSIONS

40. The existing and projected effective population and resulting recreation needs within the Trinity River Basin and surrounding the area of influence have been determined and the consideration has been given to these requirements in the development of the plan of improvement. Analysis of the proposed multiple-purpose projects, which include recreational facilities to meet requirements for the optimum annual visitation, indicate that they are fully justified from an economic standpoint. While these projects would provide an important source of outdoor recreation to complement existing facilities, they do not approach total satisfaction of such needs as determined in this study. The problem remaining is one of developing the water and land resources to provide for use by the greatest number of people within the basic capacity of the projects to support this use without adversely affecting the fundamental recreation and fish and wildlife values inherent in the projects.

41. Satisfaction of the ultimate outdoor recreation requirements in the subject basin would come from supplementary development of needed facilities by the State and local governmental agencies, by private enterprise, and possibly by construction of additional water resource projects.

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

Bureau of Sport Fisheries and Wildlife

Southwest Region

Albuquerque, New Mexico

TRINITY RIVER AND TRIBUTARIES

TEXAS

May 1962

APPENDIX V, Exhibit 1

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

ADDRESS ONLY THE
REGIONAL DIRECTOR

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
TEXAS
UTAH
WYOMING

May 25, 1962

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1600
Fort Worth 4, Texas

Dear Sir:

This letter is a synopsis of the Bureau of Sport Fisheries and Wildlife report on the fish and wildlife aspects relative to developments proposed by the Corps of Engineers in its comprehensive review report on the Trinity River and Tributaries, Texas. The attached substantiating report is designed to accompany the Corps of Engineers' survey report and was prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Our studies were conducted in cooperation with the Bureau of Commercial Fisheries and the Texas Game and Fish Commission. Concurrence in the report by the Texas Game and Fish Commission is indicated by the attached copy of a letter dated April 20, 1962, signed by Mr. Eugene A. Walker, Director of Program Planning.

We understand that the project involves construction of Tennessee Colony Reservoir on the main stem of the Trinity River in Freestone, Anderson, Navarro, and Henderson Counties, Texas; Lakeview Reservoir on Mountain Creek in Dallas and Tarrant Counties, Texas; floodways on the West Fork of the Trinity River between Dallas and Fort Worth, on the Elm Fork of the Trinity River between its mouth and Lewisville Dam (Garza-Little Elm Reservoir), and on portions of Denton Creek between Grapevine Dam and the Elm Fork; channel, levee, and interior drainage works on small tributary streams of the Elm Fork, the West Fork, and the main stem of the Trinity River; enlargement and extension of the existing Dallas Floodway; and construction of a multiple-purpose channel for flood control and navigation from the Houston Ship Channel in Galveston Bay via the Trinity River and the West Fork of the Trinity River to the Dallas-Fort Worth area. The channel will have 23 locks and 18 dams for navigation and will pass through Tennessee Colony, Livingston, and Wallisville Reservoirs.

Because the Corps of Engineers assumes that Livingston and Wallisville Reservoirs will be impounding water by the time the Trinity River and Tributaries Project gets under way, the Bureau of Sport Fisheries and Wildlife makes a comparable parallel assumption in its study of the project's effects on fish and wildlife resources. No attempt has been made in this report to evaluate the fish and wildlife resources of the proposed Livingston Reservoir which is to be constructed by local interests. Although Livingston and Wallisville Reservoirs will create important fish habitat, it is recognized that they will contribute to a reduction or curtailment of streamflows into Trinity Bay thereby affecting fish habitat in that Bay. During the period of analysis, about 1,250,000 acre-feet of water annually will be diverted from the lower reach of the Trinity River for municipal, industrial, and agricultural uses. These diversions will be made possible by impoundment of Livingston and Wallisville Reservoirs and other upstream locally sponsored reservoirs. Some of the water diverted will be returned to the Galveston Bay system as sewage, industrial, and agricultural effluents. Most of this return flow will enter the bay system by way of the Houston Ship Channel, bypassing Trinity Bay. The Trinity River and Tributaries Project will not affect significantly fish and wildlife at either Wallisville or Livingston Reservoirs.

An analysis for a 100-year period (1970-2070) has been given to fish and wildlife resources associated with streams, river-bottom lakes, reservoirs, estuaries associated with the Trinity River, and about 655,000 acres of land and water in the proposed reservoir basins and the Trinity River flood plain.

Construction and operation of the project will provide good-quality fishing in the proposed Lakeview and Tennessee Colony Reservoirs and will improve the quality of the fish habitat in the Trinity River and the West Fork of the Trinity River. Attractive fishing will be provided in numerous cutoffs and in the tailwater of Tennessee Colony Reservoir; this will compensate for river-bottom lake fishing lost because of the project. Freshwater diversions from the project will add to the adverse effects on marine fish habitat in estuaries associated with the Trinity River caused by existing and other proposed water-development projects in the basin. Nursery areas of particular importance for the sustenance of juvenile shrimp, menhaden, and anchovies in Trinity Bay will be reduced in quality. Smaller populations of these species will occur in the Bay and will be reflected in decreased catches in the Bay and in the Gulf of Mexico.

Big-game and upland-game habitat, populations, and hunting opportunities throughout the project area will be reduced by the project. The Texas Game and Fish Commission's Gus Engeling Wildlife Management Area, an 11,000-acre research unit, will be seriously impaired by the Tennessee Colony Reservoir. Compensatory measures will be required to relocate the area and to replace the developments.

In general, the project will cause extensive losses to fish and wildlife.

Waterfowl habitat will be lost or reduced in quality on seasonally flooded bottom lands and in river-bottom lakes. Construction of Lakeview and Tennessee Colony Reservoirs will not compensate for these losses although a limited amount of resting habitat for migrating waterfowl will be provided by these two reservoirs. A national wildlife refuge established on a portion of Tennessee Colony Reservoir would provide feeding as well as resting areas for waterfowl. Additionally, it could support a wildlife management program and provide hunting, fishing, and recreation. An estimated 20,400 acres of project lands and waters within the guide-taking line elevation 288 and about 600 acres of lands above elevation 288 would be required for the Federal refuge. The proposed refuge area would be located north of U. S. Highway No. 287 as shown on Plate II. It is assumed that the land required for the refuge would be purchased by the Corps of Engineers as an integral part of the project in accordance with the joint policies of the Departments of the Interior and of the Army relative to reservoir project lands approved February 16, 1962.

It is recognized that the proposed boundary for the refuge may be revised in detail as project plans are refined during advanced planning stages. It should be noted that the Bureau of Sport Fisheries and Wildlife may be interested in including certain additional project-purchased lands adjacent to the proposed boundary if their incorporation into the refuge would permit more efficient operation of the refuge or the project. A definite refuge plan would be prepared at such time as specific project plans are developed by the Corps of Engineers.

It is recommended:

1. That fish and wildlife be included among the purposes for which project authorization is sought.

2. That the Corps of Engineers provide access facilities for hunters and fishermen, as discussed in paragraphs 92 through 95 of the attached substantiating report, for Tennessee Colony Reservoir, Lakeview Reservoir, the multiple-purpose channel, and the Trinity River cutoffs.

3. That 6 seining areas totaling 1,200 acres in Tennessee Colony Reservoir and 3 seining areas totaling 600 acres in Lakeview Reservoir be cleared to ground level of all stumps and other obstructions. Specific locations and dimensions of seining areas will be determined by the Texas Game and Fish Commission during more advanced project planning stages.

4. That timber and brush clearing in Lakeview Reservoir be restricted to that required for seining areas, maintaining public health, construction of the dam and spillway, and efficient operation of the project for its authorized purposes.

5. That passage lanes be made through the densely timbered areas to the headwaters and upper reaches of coves in Tennessee Colony Reservoir to provide access for fishermen and hunters. Specific design of these passageways will be made by the Texas Game and Fish Commission during the more advanced project planning stages.

6. That Lakeview and Tennessee Colony Reservoirs be zoned to realize maximum fishing and hunting benefits and to reduce conflicts with other recreational uses.

7. That 21,000 acres of lands, essentially as shown on Plate II, be provided as an integral part of the project for a national wildlife refuge on a portion of Tennessee Colony Reservoir in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat.401, as amended; 16 U.S.C. 661 et seq.). Specific boundaries of the refuge, as well as estimates of land acquisition and development facilities and costs, will be prepared by the Bureau of Sport Fisheries and Wildlife during the more advanced project planning stages.

8. That, with the help of the Texas Game and Fish Commission, an area similar in size and development and otherwise equivalent to the present State-owned Gus Engeling Wildlife Management Area, be acquired and developed at project cost and its title vested in the Texas Game and Fish Commission.

9. That the regimen resulting from project operation provide for a mean monthly fresh-water discharge of 120,000 acre-feet, when available, into Trinity Bay during the period from March through October, to meet the requirements of estuarine fisheries.

As advocated in Recommendation No. 6, adequate zoning to reduce conflicts between competing forms of recreation on the proposed Tennessee Colony and Lakeview Reservoirs would result in significant fishing benefits. A national wildlife refuge established on Tennessee Colony Reservoir, as proposed in Recommendation No. 7, would contribute to the national waterfowl management program and would result in substantial waterfowl hunting benefits. Replacement of the State's Gus Engeling Area, as advanced in Recommendation No. 8, would compensate for the loss of a highly valuable wildlife research and management area. Provision for the maintenance of adequate fresh-water discharges into Trinity Bay, as urged in Recommendation No. 9, would prevent the reduction of marine fish habitat and the loss of valuable commercial fishing.

Adoption of all of the recommendations made in this report would provide benefits attributable to the Trinity River and Tributaries Project amounting to $1,236,000 annually.

This report is based upon the assumption that all project lands and waters will remain open to free use of hunting and fishing except for sections reserved for safety, efficient operation, protection of public property, or fish and wildlife management.

Our investigation was based upon information received from the Corps of Engineers, Fort Worth and Galveston Districts, prior to December 1, 1961, and any modification of plans should be brought to the attention of the Texas Game and Fish Commission and the Bureau of Sport Fisheries and Wildlife.

Sincerely yours,

John C. Gatlin

John C. Gatlin
Regional Director

Enclosure

Copies (10)

Distribution:

(2) Executive Secretary, Texas Game and Fish Commission, Austin, Texas
(2) Regional Director, Region IV, Texas Game and Fish Commission, Houston, Texas
(2) District Engineer, Corps of Engineers, U. S. Army, Galveston, Texas
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(1) Chairman, Southwest Field Committee, U. S. Department of the Interior, Muskogee, Oklahoma
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(2) Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
(2) Director, Biological Laboratory, Bureau of Commercial Fisheries, Galveston, Texas
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Substantiating Report

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PREFACE

This report presents fish and wildlife aspects relative to developments proposed by the Corps of Engineers on the Trinity River and Tributaries Project, Texas, and is intended to accompany the Corps of Engineers' survey report. Prepared in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), this report has been coordinated with the Bureau of Commercial Fisheries, which agency provided the analysis of the project's effects on marine fishery resources. The investigation and preparation of the report have been carried out in cooperation with the Texas Game and Fish Commission.

Comprehensive investigations of the project by the Corps of Engineers are based upon the following authorizations:

1. Resolutions by the Committee of Rivers and Harbors of the House of Representatives, adopted March 31, 1944, February 28, 1945, November 30, 1945, and August 6, 1948.

2. Resolution by the Committee on Public Works of the Senate, dated January 20, 1958.

3. The Act of July 3, 1958 (72 Stat. 297).

The proposed plan of development is designed to provide flood control, navigation, streamflow regulation, and water conservation for municipal and industrial uses and such allied uses as recreation and fish and wildlife. The plan is compatible with water-conservation projects proposed in the basin by the Trinity River Authority. It is compatible also with plans developed by the U. S. Study Commission - Texas.

This preliminary analysis of the project's effects on fish and wildlife resources is limited in detail to those works of improvement proposed by the Corps of Engineers. It is made with the full realization that local interests will develop numerous water-conservation reservoirs, many of which will exist by the time the Federal project reaches construction status. The period of analysis for this report is from the year 1970 to the year 2070.

For the purpose of fish and wildlife evaluation, the area of influence includes the Trinity River and its flood plain, lands in the proposed Lakeview and Tennessee Colony Reservoir sites, Mountain

Creek Reservoir site, the proposed Livingston and Wallisville Reservoir sites, Trinity Bay and the estuaries affected by the Trinity River, and certain reaches of the West Fork of the Trinity River, the Elm Fork of the Trinity River, and Catfish Creek.

Because the Corps of Engineers assumes that Livingston and Wallisville Reservoirs will be impounding water by the time the Trinity River and Tributaries Project gets under way, the Bureau of Sport Fisheries and Wildlife makes a comparable parallel assumption in its study of the project's effects on fish and wildlife resources. No attempt has been made in this report to evaluate the fish and wildlife resources of the proposed Livingston Reservoir which is to be constructed by local interests. During the period of analysis, about 1,250,000 acre-feet of water annually will be diverted from the lower reach of the Trinity River for municipal, industrial, and agricultural uses. These diversions will be made possible by impoundment of Livingston and Wallisville Reservoirs and other upstream locally sponsored reservoirs. Some of the water diverted will be returned to the Galveston Bay system as sewage, industrial, and agricultural effluents. Most of this return flow will enter the bay system by way of the Houston Ship Channel, bypassing Trinity Bay. The Trinity River and Tributaries Project will not affect significantly fish and wildlife at either Wallisville or Livingston Reservoirs.

Past reports by the Bureau of Sport Fisheries and Wildlife on specific projects in the Trinity River basin were:

1. A Report on the Fish and Wildlife Resources in Relation to the Water Development Plan for the Authorized Benbrook Dam and Reservoir Project, Clear Fork of the Trinity River, Western Gulf Basin, Texas, May 1947.

2. A Report on Fish and Wildlife Resources in Relation to the Grapevine Dam and Reservoir, Denton Creek, Trinity River Basin, Texas, October 25, 1950.

3. Report on Lavon Dam and Reservoir, December 12, 1952.

4. A Report on Fish and Wildlife Resources, Garza-Little Elm Dam and Reservoir Project, Elm Fork of Trinity River, Texas, December 19, 1952.

5. Report on the Drainage Program of the Trinity Bay Conservation District in Relation to Wildlife of the Coast Marsh, Chambers and Jefferson Counties, Texas, December 1951.

6. A Preliminary Report on the Fish and Wildlife Resources in Relation to the Richland, Chambers, and Cedar Creeks Project, Trinity River Basin, Texas, July 1953.

7. A Preliminary Report on the Fish and Wildlife Resources of the Trinity River Below Liberty, Texas, Channel to Liberty, July 1953.

8. Letter report of March 4, 1960, to the District Engineer, Galveston, Texas, on the Trinity Bay Soil Conservation District, Chambers, Liberty, and Jefferson Counties, Texas.

9. Letter report of May 3, 1960, to the District Engineer, Fort Worth, Texas, on the Navarro Mills Project, Texas.

10. Letter report of June 6, 1960, to the District Engineer, Fort Worth, Texas, on the West Fork Watershed, Flood Protection, Fort Worth Area.

11. Letter report of August 22, 1960, to the District Engineer, Fort Worth, Texas, on the Bardwell Reservoir Project, Texas.

12. Report on the Fish and Wildlife Resources of the Trinity River Subbasin, Texas, September 1960.

13. Letter report of February 27, 1961, to the District Engineer, Galveston, Texas, on the Wallisville Reservoir Project, Texas.

14. Letter report of November 6, 1961, to the District Engineer, Fort Worth, Texas, on the East Fork of the Trinity River, Texas.

The report of September 1960, entitled "Fish and Wildlife Resources of the Trinity River Subbasin, Texas," was prepared for the Bureau of Reclamation. It presented a general inventory of fish and wildlife resources in the basin and an estimate of present and future uses of these resources. It told of problems affecting optimum development of fish and wildlife and advanced possible solutions to such problems.

Evaluations of the fish and wildlife resources affected by Benbrook, Lavon, Garza-Little Elm, Grapevine, Navarro Mills, Bardwell, and Wallisville Reservoirs in the Trinity River basin have been made on an individual project basis. Each project was credited with high fresh-water fishing benefits, moderate waterfowl benefits, minor upland-game losses, and insignificant to minor big-game losses. Only Wallisville Reservoir was considered for its effects on marine fisheries.

Individually, these reservoirs have affected or will affect in varying degrees the downstream timbered and seasonally flooded wildlife habitat and the habitat of the marine fisheries. Collectively, they will control downstream flows to the extent that further developments in the basin will seriously affect big-game, upland-game, and waterfowl and estuarine habitat within Trinity Bay.

Acknowledgment is made of the assistance rendered the Bureau of Sport Fisheries and Wildlife by the District Engineers, Corps of Engineers at Fort Worth and Galveston, Texas, in furnishing data regarding the proposed plan of development; the Trinity River Authority for making available its proposed Master Plan of Development of the Trinity River Watershed; the Fort Worth Public Works Department, Sanitary Sewer Division, for the City's future sewerage plan of improvement; the U. S. Study Commission - Texas, for the State's human population predictions; the Texas Game and Fish Commission for information leading to the evaluation of fish and wildlife resources within the project area and for assistance in preparing the recommendations contained in this report; and the Bureau of Commercial Fisheries for providing data and proposed recommendations regarding marine fisheries.

April 20, 1962

Mr. Carey H. Bennett
Chief, Division of Technical Services
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque, New Mexico

Dear Mr. Bennett:

Reference is made to your revised sections of the marine fish portion of the draft of the report on the Trinity River Project.

We have reviewed and do concur with the review report.

Sincerely yours,

Eugene A. Walker
Director
Program Planning

TRL:ep
Cc Mr. John Degani
Mr. Bob Hofstetter

INTRODUCTION

1. The Trinity River and Tributaries Project is a multiple-purpose plan of development, designed to provide navigation from a point on the Houston Ship Channel in Galveston Bay to terminals in Dallas and Fort Worth, Texas; and flood control, water conservation, streamflow regulation, pollution abatement, fish and wildlife, and recreational benefits.

2. The project lies in the Trinity River basin in the eastern half of Texas. The basin is bounded on the north by the Red River basin, on the east by the Sabine and Neches Rivers basins, on the west by the Brazos and San Jacinto Rivers basins, and on the south by Trinity Bay.

DESCRIPTION OF THE AREA

3. The Trinity River basin is long and narrow, with a length of 360 miles and a maximum width of about 100 miles. It has a drainage area of about 17,845 square miles.

4. The basin lies in the Central Lowlands and West Gulf Coastal Plain physiographic provinces. The Central Lowlands province includes the headwaters of the Trinity River down to the East Cross Timbers Section and the West Gulf Coastal Plain province encompasses the remainder of the basin. Palo Pinto, West Cross Timbers, and Grand Prairie sections make up the Central Lowlands province; East Cross Timbers, Black Prairie, Forested Coastal Plain, and Coastal Prairie sections are in the West Gulf Coastal Plain province.

5. The Palo Pinto section has high relief and ridged topography, with the main ridges capped by resistant limestones and shales. Hilly topography is characteristic of the West Cross Timbers section, with local relief varying from 200 to 400 feet. Sandstone and shale formations appear in this section. The surface of the Grand Prairie section is nearly flat to rolling and is cut by steep-sided valleys. The Grand Prairie is underlain by limestones and shales.

6. The topography of the East Cross Timbers section is characteristically low, with oval wooded hills less than 200 feet high. The valley walls have moderately steep slopes. The bedrock is dominantly sandstone and sand with minor amounts of clay. The Black Prairie section generally is gently rolling with long

slopes that become steeper near the eastern edge of the area. Marls, calcareous clays, and chalks are the chief rock formations. The Forested Coastal Plain generally has subdued relief, wide but shallow stream valleys, and predominantly gentle slopes. Its surface consists predominantly of clay and sandy soils. The valleys of the Coastal Prairie section are broad and shallow while the uplands are generally flat to gently rolling. Clays predominate in the area.

7. The Trinity River is a turbid meandering stream, with a flat gradient. It is formed by the confluence of the West Fork and the Elm Fork of the Trinity River near Dallas, Texas. It discharges into Trinity Bay. Throughout its length the stream meanders from one side of the valley to the other.

8. The average annual flow of the Trinity River at the Romayor Gage, river mile 94, for a 36-year period has been 7,367 second-feet. The maximum flow was 111,000 second-feet on May 9, 1942; the minimum, 102 second-feet on August 24 and 25, 1956. The flow of the Trinity River is influenced by releases of sewage effluent into the stream from the Cities of Fort Worth and Dallas, by diversions for municipal water supply and other uses, and by floodwater-detention reservoirs on tributary streams.

9. Principal tributaries of the Trinity River, in addition to the West Fork and the Elm Fork, are the Clear Fork and the East Fork of the Trinity River, Richland Creek, and Cedar Creek. The flows of the West Fork, the East Fork, the Clear Fork, and the Elm Fork of the Trinity River are regulated by large impoundments. Releases from these impoundments into the streams are infrequent, except on the Elm Fork, where releases from Garza-Little Elm and Grapevine Reservoirs for flood control and municipal water for the City of Dallas provide an average flow of about 800 second-feet at the Carrollton Gage. Large impoundments are under construction on Richland and Cedar Creeks.

10. West of Fort Worth, the basin is in the sub-humid climatic zone, while to the east and south, the basin becomes more humid. The annual rainfall is fairly well distributed and ranges from an average of less than 30 inches west of Fort Worth to 50 or more inches on the Gulf Coast. The greatest amount of rainfall usually occurs in the spring. The frost-free season amounts to about 200 days near the headwaters and about 300 days on the Gulf Coast.

11. Vegetative types include post oak-savannah, prairies in forests and savannahs, tall-grass prairie, pine-hardwoods, longleaf pine, Gulf Coast marshlands, and bottom-land hardwoods. Approximately 37 percent of the basin is in cultivation; 30 percent in grasslands; 24 percent in pasture-woodland; and 9 percent in woodland.

12. The Trinity River basin contains a greater human population than any other basin in the State. The upper portion, primarily the Dallas-Fort Worth metropolitan area, contains about 95 percent of the total population of the basin. Of importance is the fact that the densely populated San Jacinto and Neches basins lie within easy traveling distance of the extreme lower Trinity River basin, and residents of these basins make high use of the fish and wildlife resources of the project area.

13. The human population in the Trinity River basin, plus certain adjoining areas, as indicated below, was about 2,663,000 in 1960. It is estimated that this will increase to over 3,000,000 by 1975 and well over 6,000,000 by 2010. Half of the population in the San Jacinto River basin and half of the population in the lower and adjoining portions of the Neches and Brazos Rivers basins are included in these estimates since these people are considered users of fish and wildlife resources of the Trinity River basin. Based on population projections compiled by the Corps of Engineers, human population in these areas will be 19 million by the year 2070.

PLAN OF DEVELOPMENT

14. The proposed plan of development includes provisions to:

a. Rectify portions of the West Fork of the Trinity River, construct a floodway on the stream to connect with the existing Fort Worth and Dallas Floodways, and to extend a floodway up Mountain Creek to Mountain Creek Dam.

b. Dredge Mountain Creek below Mountain Creek Dam to bottom widths varying from 100 feet in the upper reach to 300 feet downstream from the Dallas-Fort Worth Toll Road.

c. Rectify and enlarge the Elm Fork of the Trinity River from its mouth to Lewisville Dam (Garza-Little Elm Reservoir) to provide a bottom width of 100 feet and a channel capacity of 15,000 second-feet from the mouth of the stream to Carrollton and a bottom width of 50 feet and a channel capacity of 10,000 second-feet above this reach, and to construct a leveed floodway from the mouth of the stream to Carrollton.

d. Rectify the lower 10,000 feet of Denton Creek to a bottom width of 40 feet and improve the channel above this reach to Grapevine Dam by removing vegetation and debris to provide a channel capacity of 7,000 second-feet.

e. Enlarge the channel capacity of the existing Dallas Floodway to 25,000 second-feet and extend the floodway to the mouth of Five-Mile Creek.

f. Rectify and levee the lower reaches of Farmers Branch, Rawhide Branch, Hackberry Creek, and Five-Mile Creek.

g. Relocate the lower reach of Cook's Branch to empty into the rectified portion of Farmers Branch and Rawhide Branch.

h. Relocate the lower reach of White Rock Creek to the east and levee the creek from its mouth to the railroad bridge at Scyene Road.

i. Relocate the lower reach, rectify the upper portion, and construct levees along Hutton's Branch.

j. Relocate the lower reaches and levee Grapevine Creek, Big Fossil Creek, Little Fossil Creek, Walker Creek, Sulphur Branch, and Bear Creek.

k. Rectify the lower reach and levee the right bank of Joe's Creek.

l. Rectify 5.3 miles of Duck Creek Channel through the City of Garland and provide 0.6 mile of concrete retaining wall.

m. Construct Lakeview Dam and Reservoir on Mountain Creek at the headwaters of Mountain Creek Reservoir. The dam will consist of an earthfill embankment at stream mile 7.2 and a 120-foot net opening ogee-type spillway located in a saddle on the right bank. Three 40- by 28-foot tainter gates will control the spillway. Outlet works will consist of a 12-foot-diameter conduit through the dam. Storage allocations in the reservoir will be 149,100 acre-feet for flood control, 316,800 acre-feet for water conservation, and 22,800 acre-feet for sediment. The reservoir will have a surface area of 11,990 acres at conservation pool elevation 517. 1/

n. Construct Tennessee Colony Dam and Reservoir on the Trinity River. The reservoir will provide a storage capacity of 3,366,800 acre-feet at top of flood control pool elevation 285. About 2,513,400 acre-feet of storage will be for flood control, 758,400 acre-feet for conservation, and 95,000 acre-feet for sediment. The reservoir will have a surface area of 59,950 acres at conservation pool elevation 257. A minimum pool of 12,830 acres will be provided at elevation 235. The dam will be at river mile 339.2 and will consist of an earthfill embankment and a 440-foot net opening ogee-type concrete spillway located in a saddle on the left bank. Eleven 40- by 35-foot tainter gates will control the spillway. Outlet works will consist of four 3- by 6-foot-gated sluices.

o. Construct 8.1 miles of levee around portions of the City of Liberty to protect the city from floods on the Trinity River.

p. Construct a multiple-purpose channel for navigation and flood control from a point on the Houston Ship Channel, in Galveston Bay, to Fort Worth, Texas. Beginning at the Houston Ship Channel, the alignment of the

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1/ All elevations are in feet and refer to mean sea level datum.

proposed channel will be along the existing channel to Anahuac, located in Galveston and Trinity Bays, and then be within or near the river channels of the Trinity River and West Fork of the Trinity River, passing through Wallisville and Livingston Reservoirs and the proposed Tennessee Colony Reservoir. The multiple-purpose channel will have a total length of about 369 miles of which 121 miles will be located in Galveston and Trinity Bays and the three reservoirs, 123 miles within the existing river channels, and 125 miles of land cut near the existing river channels. About 210 miles of the existing river channels will be left in the form of cutoffs or oxbows. The upstream ends of the cutoffs will be plugged with spoil, except through the Dallas and Fort Worth Floodways. The lower ends of the cutoffs will be left open to permit drainage. In the floodways, surplus spoil will be placed in some of the cutoff sections. Twenty-three locks and eighteen dams are proposed in the interest of navigation. The water depths in the navigation channel, below the normal elevations of the various pools, will vary from a minimum of 12 feet to a maximum of 44 feet. The bottom widths of the multiple-purpose channel will vary from 150 to 300 feet.

OPERATION

15. Reservoir and channel operation plans have not, as yet, been established. Ultimately all flood control reservoirs in the Trinity River basin will be integrated into a coordinated system of operation. When possible, flood releases from the reservoirs, including the proposed Lakeview and Tennessee Colony Reservoirs, will be coordinated to provide flows in the multiple-purpose channel not to exceed 35,000 second-feet. The capacity of the channel downstream from Tennessee Colony Reservoir will be about 45,000 second-feet, of which 10,000 second-feet will be reserved for local runoff.

16. No regular water releases are proposed from Lakeview Reservoir. Prior water commitments in the lower basin of about 600,000 acre-feet annually will necessitate constant water releases from Tennessee Colony Reservoir of approximately 250 second-feet initially, increasing to about 480 second-feet by the year 2020.

17. The City of Houston will release water from Livingston Reservoir and remove it from the channel in the headwaters of the proposed Wallisville Reservoir. A constant minimum release of about 1,500 second-feet is proposed.

18. No regular water releases are scheduled from Wallisville Reservoir. Agricultural, industrial, and municipal interests will divert water directly from the reservoir. About 63,000 acre-feet of water annually will discharge into Trinity Bay from lockages.

19. It is proposed to install tainter-gate dams adjacent to lock structures in the multiple-purpose channel to pass flood flows, maintain pools for navigation, and passage of low flows necessary to meet downstream commitments. During periods of normal rainfall, the tainter gates will be partially opened to provide a sustained discharge. During periods of drought, the gates will be closed except for passage of flows to meet downstream requirements.

20. Lands within the reservoir sites will be purchased in fee title to the five-year flood pool elevation. At Tennessee Colony Reservoir, approximately 24,900 acres will be acquired in fee above the conservation pool elevation 257. Flowage easements will be acquired on 73,600 acres extending to elevation 288. About 4,130 acres of the fee area and 22,700 acres of the flowage-easement area will be upstream from the Richland and Tehuacana Creeks damsites and eventually may be occupied by reservoirs under consideration by local interests.

21. At Lakeview Reservoir, 4,960 acres above the conservation pool elevation 517 will be acquired in fee. Flowage easement will be acquired on about 1,400 acres to elevation 531.

22. Right-of-way for the multiple-purpose channel, berm areas, and spoil areas will be furnished by local interests. These areas will be secured in easement, except at lock and dam structures and recreational areas, where fee title less mineral rights will be acquired. About 8,210 acres of right-of-way will be required for the multiple-purpose channel, excluding those portions through Wallisville, Livingston, and Tennessee Colony Reservoirs. About 21,250 acres adjacent to the channel right-of-way will be required for spoil disposal.

23. The Corps of Engineers proposes to develop lands adjacent to the channel for public use. Each of these areas will contain picnic, sanitary, drinking water, parking, and boat-launching facilities and will be served by all-weather roads. Some tentative sites have been selected for public use from available topographic maps and mosaics. The Corps of Engineers estimates that about 2,500 acres, including right-of-way for access roads, will be required to provide for the number of recreational visitors the multiple-purpose channel will attract.

FISH

Without the Project

General

24. Fish habitat of varied quality occurs within the Trinity River basin, consisting of fresh-water types in streams, farm ponds, river-bottom lakes, and reservoirs; and marine types in bays and estuaries. Generally, streams have poor-quality habitat because of pollution, lack of water, or both. The quality of habitat in farm ponds varies; as a result, some ponds provide excellent fishing while others have very poor fishing, usually because of turbidity, improper stocking, and unbalanced fish populations. The status of river-bottom lakes parallels, to some degree, that of farm ponds. Many of these lakes are controlled by private clubs and receive more fishing than most farm ponds.

25. Many reservoirs, especially those federally constructed, provide high-quality fish habitat and accommodate the bulk of the fresh-water fishing in the basin. Most of the Federal reservoirs are in the upper portion of the basin, where fishing demands and human populations are greatest. The lower portion of the basin will lack such adequate facilities until Wallisville and Livingston Reservoirs are constructed. Fresh-water fishing demands in this region and the adjacent Houston area are almost as great as in the upper portion of the basin.

26. Fishing demands in the lower portion of the basin are satisfied primarily by the high-quality marine fish habitat in Trinity, Galveston, San Jacinto, East, and West Bays. Even in these waters, pollution from local sewage wastes have made some of the oysters unsuitable for human consumption.

27. Catfishes, carp, smallmouth buffalo, freshwater drum, bluegill, redear sunfish, green sunfish, gars, red shiner, and blacktail shiner are the principal stream fishes. Many of these fishes, as well as largemouth bass and crappies, occur in farm ponds, river-bottom lakes, and reservoirs. Marine fishes and shellfishes of importance in bays and associated estuaries are redfish, flounder, spotted squeteaque, sand squeteague, croaker, gafftopsail catfish, black drum, anchovy, menhaden, mullet, shrimp, blue crab, and oyster.

Sport Fishing

28. The West Fork of the Trinity River from Fort Worth to Dallas and the Trinity River from Dallas to the vicinity of the proposed Tennessee Colony Reservoir are heavily polluted with municipal sewage and industrial wastes and support no significant fishing. Long-range sewerage improvement plans by the Cities of Fort Worth and Dallas are expected to culminate in the removal of the major sources of stream pollution. Thus, low-quality fish habitat is anticipated in the now-polluted sections of these streams. That portion of the Trinity River downstream from the proposed Tennessee Colony Reservoir is low-quality fish habitat and is lightly to moderately fished. Upon completion of the proposed Livingston Reservoir on the Trinity River upstream from the proposed Wallisville Reservoir, stream fish habitat between these two reservoirs should be of high quality due to reduction of silt and a proposed constant water release from Livingston Reservoir. Fishing on this reach of stream should increase markedly over that of the present, yet lack of adequate access will prevent the full potential use of the stream. The 3.9 miles of the Trinity River downstream from the proposed Wallisville Dam site are tidal and will be saline upon completion of the proposed Wallisville Reservoir.

29. Sport fishing on the 404 miles of the Trinity River and 45 miles of the West Fork of the Trinity River amounts to 85,000 man-days annually. Without the project, this amount of fishing would be expected to continue over the 100-year period of analysis.

30. The Elm Fork of the Trinity River downstream from Garza-Little Elm Reservoir is one of the best fishing streams in the Trinity River basin. Releases of water from Garza-Little Elm and Grapevine Reservoirs for the municipal needs of Dallas maintain good-quality fish habitat in the 30 miles of stream, especially at several small channel dams. Sport fishing would amount to about 14,000 man-days annually over the 100-year period without the project.

31. Catfish Creek sustains fishing from its mouth to about river mile 20. Only about 15 miles of the stream are fished significantly, of which 6.5 miles are within the Texas Game and Fish Commission's Gus Engeling Wildlife Management Area. Fishermen are required to register and obtain a permit to fish on this area, but no fee is charged. Heaviest fishing occurs during the spring and summer months. Fishing would average about 12,000 man-days annually over the 100-year period of analysis without the project.

32. About 72 river-bottom lakes, totaling approximately 4,490 surface acres, lie in the flood plain of the Trinity River. Most of the lakes depend upon overflows of the river for water supply. All are on private property and most are closed to the public. These lakes, however, serve to relieve some of the fishing demands on public waters in the basin. Without the project, the total amount of fishing on these lakes would average about 199,000 man-days annually.

33. Mountain Creek itself has no important fish habitat. Mountain Creek Reservoir, a 2,300-acre impoundment on the creek near Dallas, is dominated by river carpsuckers and carp. Large amounts of sediment have been deposited in the reservoir, and its water is shallow and usually turbid. Public fishing is permitted on portions of the reservoir. Without the project, fishing could be expected to average about 100,000 man-days annually.

34. Heavy fishing is carried out on the estuaries associated with the Trinity River. Presently, about 2,500,000 man-days annually are spent by sport fishermen in the bays associated with the Trinity River and in the adjacent portion of the Gulf of Mexico. Without the project, the annual use could be expected to increase to 15 million man-days by the year 2070, with the average annual use in the vicinity of 8 million man-days.

Commercial Fishing

35. About 85 full- and part-time commercial fishermen operate in the 284 miles of the Trinity River between the headwaters of the proposed Tennessee Colony and Wallisville Reservoirs and in some of the river-bottom lakes. Trotlines, gill nets, and hoop nets are the principal gear used. Catfishes, smallmouth buffalo, carp, and freshwater drum are the principal species taken. The annual take is about 442,000 pounds, valued at $131,000. Catfishes account for about one-third of the annual catch and two-thirds of the value. The catch from river-bottom lakes is mostly smallmouth buffalo and carp and comprises about 25 percent of the annual take. In addition, about 4,500,000 minnows, valued at $45,000, are taken yearly from the Trinity River by about 10 full- and 20 part-time fishermen. Red and blacktail shiners are the principal species taken.

36. For the 100-year period of analysis without the project, a commercial fishery could be expected to develop in the remaining upstream portions of the Trinity River, the West Fork of the Trinity River, and in the proposed Livingston and Wallisville Reservoirs. The extent of the use would depend upon economic conditions, development of markets, new catching and processing techniques, and local fishing regulations.

37. The bay areas associated with the Trinity River provide habitat for marine fish, crabs, shrimp, and oysters of economic value. They also provide important nursery areas for juvenile shrimp and finfish such as menhaden and anchovies. These species serve as forage for many of the other finfish in the bay areas and in the Gulf and are taken by commercial fishermen from these areas. Trinity Bay is one of the most important nursery areas in the bay system. During much of the period of analysis without the project, diversions in the lower reach of the Trinity River made possible by Livingston and Wallisville Reservoirs and other upstream locally sponsored reservoirs would reduce the fresh-water inflow into Trinity Bay and would affect the nursery area in that Bay, particularly for juvenile shrimp, menhaden, and anchovies.

38. The annual take over the period of analysis from the Galveston Bay system could be expected to average 150,000 pounds of finfish; 700,000 pounds of shrimp; 180,000 pounds of crabs; 850,000 pounds of oysters; and 690,000 pounds of bait shrimp, with a total value of $1,361,000. These species, for the most part, would be reared and harvested in the Galveston Bay system.

39. Other finfishes and shellfishes reared in the Galveston Bay system but harvested in the Gulf of Mexico are estimated at 6,240,000 pounds of shrimp, 100,000 pounds of food fishes, 26 million pounds of menhaden, and 20,000 pounds of crabs, with a total dockside value of $1,959,000 annually. Commercial fishing within the Galveston Bay system and the Gulf of Mexico could be expected to continue at the present rate through the 100-year period of analysis without the project.

With the Project

General

40. The quality of fresh-water fish habitat in the Trinity River basin will exceed that without the project. Channelization and rectification of the West Fork and the main stem of the Trinity River and the impoundment of Tennessee Colony Reservoir will result in a complete change in the character of these streams. These changes will be beneficial, for the most part, since water depths will be increased. Instead of widely fluctuating streams subjected to alternate periods of flooding and low flows, a series of stable channel impoundments will exist. On the other hand, shoal and riffle areas, favorable for the spawning of blacktail and red shiners, will be eliminated. The result will be a probable loss of these species from these streams.

The channel, cutoff sections of the streams, and proposed reservoirs will provide the necessary habitat for the other freshwater species. The principal fresh-water fishes will be catfishes, carp, gizzard shad, bluegill, largemouth bass, crappies, freshwater drum, buffalofishes, gars, and river carpsucker.

41. The project's affect on marine fishery habitat is conjectural. Decreased river discharges into Trinity Bay may cause a gradual rise in salinity and a possible drop in turbidity in the bay, and immediate effects on marine flora and fauna may be unnoticeable. A permanent increase in salinity may eventually create an environment less suitable to the larval, postlarval, and juvenile forms of fauna now using, and apparently requiring, the low-salinity habitat of the bay. Local sewage pollution may continue to render oysters in Trinity Bay, the shoreline portions of Galveston Bay west of the Houston Ship Channel, and the eastern portions of East and West Bays unfit for human consumption. The effects of this pollution may be intensified to include the important oyster-producing area of middle Galveston Bay, and ultimately, all of the Bay system.

Sport Fishing

42. Construction and operation of the multiple-purpose channel and Tennessee Colony Reservoir will create water depths of 12 to 44 feet in the channel at normal pool elevation. At conservation pool elevation, the channel depth in Tennessee Colony Reservoir will be 22 feet. Water depths will be increased from 5 to 18 feet in cutoff sections of the Trinity River. Impoundments formed by the dams will trap some of the silt carried by the streams. Fish cover and shallow spawning and forage areas will be lacking in the channel, but the cutoff sections of the Trinity River will provide these facilities. Flows in the channel will be primarily return flows from the Cities of Fort Worth and Dallas, supplemented by local drainage and releases from reservoirs in the basin.

43. The channel and cutoff sections of the Trinity River will be attractive to fishermen. Recreation areas proposed by the Corps of Engineers will provide access to the channel and may provide access, in some instances, to cutoff sections of the river. Many of the river cutoffs will be accessible only by boat, and these areas will attract trotline fishermen. Bank fishermen will congregate below each lock structure on the Trinity River where releases usually will occur during periods of normal flow and where fishing will be good.

44. Fish habitat in the cutoff sections of the West Fork of the Trinity River will be lost by the placement of spoil.

45. Approximately 160,000 man-days of fishing annually will occur in the multiple-purpose channel, and the river cutoffs will receive about 207,000 man-days annually.

46. Channel rectification and deepening of the 30-mile reach of the Elm Fork of the Trinity River downstream from Lewisville Dam will remove fish cover and shallow spawning and foraging areas. Despite this, releases of water from Garza-Little Elm and Grapevine Reservoirs for the City of Dallas can be expected to provide a flow in the Elm Fork of the Trinity River almost always exceeding 50 second-feet. For this reason, sport fishing will be similar to that without the project.

47. Tennessee Colony Reservoir will eliminate about 20 miles of high-quality fish habitat on Catfish Creek and 46 miles of low-quality fish habitat on the Trinity River. The reservoir will be productive since numerous coves and shallow headwater areas will provide an abundance of spawning and foraging areas. The reservoir will have an average depth of about 15 feet at conservation pool elevation.

48. Largemouth bass will be abundant during the early years of impoundment, but as the reservoir ages white crappies, carp, gizzard shad, carpsuckers, and smallmouth buffalo will become predominant in the fish populations. Sport fishing will not become intensive during the early years of the project because fishing by residents within a day-use distance of the reservoir will be satisfied largely by nearby reservoirs such as Cedar Creek, Navarro Mills, and Bardwell. People from all parts of the State will be attracted to the reservoir, however, because of its large size and surrounding scenic beauty. As the human population increases locally, heavy fishing will occur on the reservoir.

49. Conflicts will arise on the reservoir between pleasure-boaters, water skiers, and fishermen and will result in diminished fishing unless the reservoir is properly zoned. The remoteness of the reservoir from large population centers precludes much conflict during the early years of the reservoir except on holidays and weekends. As the human population increases, fishermen will be increasingly hampered by skiers and pleasure-boaters during the warmer months. Without provision for zoning to restrict boating and water skiing, fishing on Tennessee Colony Reservoir will average about 375,000 man-days annually.

50. Construction of the channel and Tennessee Colony Reservoir and flood protection of the Trinity River flood plain will result in the loss of the river-bottom lakes. Some of these lakes will be inundated by the reservoir or will become part of the channel. Others will no longer be subjected to overflows of the river and will have to rely on the small amount of water from their drainages. Fish habitat in these lakes will deteriorate rapidly. No fishing on these lakes is anticipated with the project.

51. High-quality fish habitat will be created by impoundment of Lakeview Reservoir. The water in the reservoir will be clear with an average depth of 28 feet at conservation pool elevation. Gently sloping meadows and croplands in the upper portion of the reservoir will provide excellent spawning and foraging areas. The reservoir will be suitable for the production of largemouth bass, crappies, other sunfishes, and catfishes. Carp also will flourish and river carpsuckers may become abundant.

52. Lakeview Reservoir will lie between the Cities of Dallas and Fort Worth and will be highly attractive to fishermen of these and adjacent areas. Conflicts between fishermen, pleasure-boaters, and skiers will be great on the reservoir and ultimately will result in reduced fishing unless the reservoir is properly zoned. Without zoning to restrict boating and water skiing, fishing will amount to about 500,000 man-days annually.

53. Lakeview Dam will be constructed within the headwater area of Mountain Creek Reservoir, and fish habitat in Mountain Creek Reservoir will be improved slightly. Lesser amounts of silt will be deposited in the reservoir basin; however, the basin already has a heavy blanket of sediment and rolling action of rough fishes and waves will keep the water muddy. No material increase in fishing will occur over without-the-project conditions, and this existing reservoir will continue to support an average of about 100,000 man-days of fishing annually.

54. In an operation study covering 34 years (1924-57), Livingston Reservoir would have reduced fresh-water inflow into Trinity Bay during 15 years to less than the amount required to maintain a suitable habitat for juvenile shrimp and finfishes such as menhaden and anchovies. In 9 of these years, the Trinity River Project would have reduced these flows further, causing greater damages to the nursery areas. The Trinity River Project, itself, would have caused a reduction in the quality of the nursery areas in Trinity Bay in only 3 years of the study period.

55. The reduction in fresh-water flow will result in ecological changes in Trinity Bay and reduce the quality of habitat available for juvenile shrimp and finfishes such as menhaden and anchovies. Habitat for adult finfishes may increase. The loss of habitat for juvenile shrimp and finfishes will result in greater predation on the remaining juvenile forms. This will be reflected in smaller catches in the Bay system and in the Gulf of Mexico. Even though fishing success may decrease, it is expected that sport fishing in the Galveston Bay system will continue at the without-the-project rate of 8 million man-days annually.

Commercial Fishery

56. The multiple-purpose channel, cutoffs of the Trinity River, and Lakeview and Tennessee Colony Reservoirs will provide an abundant supply of catfishes, carp, freshwater drum, and smallmouth buffalo. The extent of commercial fishing for these resources will be governed largely by available markets and county laws. In some areas, county statutes prohibit commercial fishing for catfishes. Based on the trend in legislation and public opinion, the commercial taking of catfishes will not be permitted in Lakeview and Tennessee Colony Reservoirs. On the other hand, the multiple-purpose channel and river cutoffs will offer the opportunity for the commercial use of catfishes equal to that without the project.

57. The annual commercial catch from the navigation channel and river cutoffs will be slightly better than that without the project. Bait-minnow production will be insignificant. Tennessee Colony Reservoir will provide a harvestable population of several hundred thousand pounds of fish annually, but the extent of the commercial catch is unpredictable. It is unlikely that a significant commercial fishery will develop in Lakeview Reservoir.

58. The fate of the commercial marine fishery in the estuaries will depend upon the degree of higher salinities which the Galveston Bay system will experience. Decreased inflows of fresh water will result in increases in estuarine salinity. Since oysters, shrimp, and crabs require lower salinities than finfishes, reduction of fresh-water inflow into Trinity Bay to less than 120,000 acre-feet monthly during the months of March through October will result in reduced populations of shellfishes and finfishes, primarily shrimp and menhaden, in the Galveston Bay system and in the Gulf of Mexico. These resources provide a significant portion of the total take from the bay areas. A take of about 150,000 pounds of finfishes, 800,000 pounds of oysters, 636,000 pounds of shrimp, 180,000 pounds of crabs, and 626,000 pounds of

bait shrimp, with a total value of $1,260,000, will be taken from the Galveston Bay system annually. In addition, about 100,000 pounds of foodfishes, 24 million pounds of menhaden, 5,650,000 pounds of shrimp, and 20,000 pounds of crabs that were reared in the bay will be taken from the Gulf of Mexico annually. With the project, the annual value of this catch will be $1,775,000.

59. A summary of sport and commercial fishing anticipated without and with the project is provided in Tables 1 and 2.

Table 1. Summary of Sport Fishing Annually
Trinity River and Tributaries, Texas

Kind of Fishing	Without the Project (man-days)	With the Project (man-days)
Fresh-water	310,000	1,256,000
Marine	8,000,000	8,000,000

Table 2. Summary of Annual Commercial Fishing Values
Trinity River and Tributaries, Texas

Kind of Fishing	Without the Project	With the Project
Fresh-water	$ 176,000	$ 176,000
Marine	3,320,000	3,035,000

WILDLIFE

Without the Project

General

60. There are approximately 657,000 acres in the project area on which wildlife resources will be affected. About 485,000 acres are in the Trinity River flood plain between Dallas and Trinity Bay. Excluded is that portion of the flood plain within the proposed Wallisville and Livingston Reservoir sites. The remainder of the area is composed of about 155,000 acres associated with the Tennessee Colony Reservoir site and about 17,000 acres associated with the Lakeview Reservoir site.

61. Originally, all of the flood plain except the tidal region was timbered with a complex of southern bottom-land hardwoods. The tidal region reaches to the vicinity of Liberty, Texas, and its vegetation grades from swamp-forest type to coastal marsh. The marsh is vegetated mostly with reed grass and marsh millet.

62. Many of the desirable mast-producing hardwoods, such as southern red oak, overcup oak, bur oak, and water oak, have been removed. The timbered area is now dominated by ash and elm, which are of little importance to wildlife. Some desirable hardwoods persist in the flood plain at the mouths of tributaries. Other common woody plants in the flood plain are native pecan, hickory, cottonwood, sycamore, sweetgum, honey locust, magnolia, willow, river birch, American hornbeam, dogwood, yaupon, and French mulberry.

63. About 40 percent of the flood plain has been cleared and put into cultivation or improved pasture. Principal agricultural crops are cotton, corn, and grain sorghums. The primary land use is cattle grazing. Clearing in the flood plain has been a slow process due primarily to periodic flooding and an abundance of other agricultural lands.

64. The bottom-land soil is wet in winter and droughty in summer and has poor structure. With flood protection and extensive cultivation, the soil structure can be improved to a type suitable for cropland, particularly if organic matter is added. Clearing, sodding, and cultivation are expensive processes, and most landowners can afford to do only a little at a time. Consequently, the land-use trend is toward gradual clearing for improved pasture. By the year 2070, clearing will be extensive; probably 50 percent of the timbered habitat will be cleared to meet the demands of an expanding human population.

65. About 46 percent of the 154,630-acre Tennessee Colony Reservoir area is in cropland and improved pasture, and 53 percent is timbered. It is anticipated that about 35 percent of the timbered area will be cleared during the 100-year period of analysis. The 11,000-acre Gus Engeling Wildlife Management Area, a research unit and game management area of the Texas Game and Fish Commission, is partially included in the reservoir site. About 3,200 acres of the Catfish Creek bottom portion of the Gus Engeling Area are included in the reservoir's guide-contour take line at elevation 288. This bottom is extremely fertile. It is the best mast-producing portion and the primary winter-food producing sector of the Gus Engeling Area. About 2,000 acres of the Catfish Creek bottom land on the Gus Engeling Area are flooded each year from about October to March, and the resulting feeding habitat is superb for waterfowl.

66. The Lakeview Reservoir area encompasses about 16,890 acres. The area is predominantly cultivated. About 80 percent is in cotton, corn, small grains, and grain sorghums; 5 percent in timber; and about 12 percent in native pasture. The reservoir area is densely populated and is prairie-type farm country. It lies between Fort Worth and Dallas and is flanked by suburbs of those cities.

67. Present acreages and estimated future acreages for the year 2070 of habitat types in the Trinity River flood plain and Tennessee Colony and Lakeview Reservoir basins are listed in Table 3.

Table 3. Present and Future Acreages of Habitat Types in the Trinity River Flood Plain and Tennessee Colony and Lakeview Reservoirs

Type	Flood Plain		Tennessee Colony		Lakeview	
	1962 (acres)	2070 (acres)	1962 (acres)	2070 (acres)	1962 (acres)	2070 (acres)
Cultivated and improved pasture	193,478	337,583	71,130	99,814	15,539	15,539
Timber	288,210	144,105	81,954	53,270	844	844
Other	3,501	3,501	1,546	1,546	507	507
Totals	485,189	485,189	154,630	154,630	16,890	16,890

Big Game

68. White-tailed deer are the only big-game animals in the Trinity River basin. The basin contains about 2 million acres of deer habitat, of which about 172,000 acres are in the project area. Habitat of significant potential occurs generally in the project area from the headwaters of the proposed Tennessee Colony Reservoir to the vicinity of Liberty, Texas. Deer density is about 53 animals per square mile on the Gus Engeling Area and ranges from 7 to 18 animals per square mile elsewhere. Deer populations throughout the project area are increasing and are expected to average about 50 animals per square mile in the future.

69. Aside from the Gus Engeling Area, where public hunts are conducted annually, all deer hunting is on a lease basis. Lease fees range from $5.00 per day to $150.00 per gun per season. Without the project, about 13,000 man-days of deer hunting annually could be expected in the project area over the 100-year period of analysis.

Upland Game

70. Fox squirrels, gray squirrels, cottontails, jackrabbits, swamp rabbits, bobwhites, and mourning doves are found on about 655,000 acres of habitat in the project area and provide most of the upland-game hunting. Squirrels are found on about 197,000 acres, rabbits on 307,000 acres, and doves and bobwhites on 440,000 acres.

71. Wild turkeys, once numerous throughout the floodplain area but extirpated years ago, have been restocked by the Texas Game and Fish Commission on the Gus Engeling Area and on other portions of the project area. The birds generally occupy the same habitat as deer but have not increased to the extent that deer have. Turkeys are protected from hunting on the Gus Engeling Area and have spread to the surrounding woodlands.

72. Elsewhere, turkeys are scarce and only a few are taken by hunters. There are about 125,000 acres of turkey habitat in the area influenced by the project.

73. Turkey-hunting privileges are usually included with deer leases. Many landowners restrict hunting of bobwhites or allow only friends and relatives to hunt. Occasionally, hunting rights for bobwhites are leased. Generally, only the landowner's permission is required to hunt squirrels, doves, rabbits, and fur animals. Sport hunting of raccoons, opossums, gray foxes, bobcats, coyotes,

and wolves with dogs has become a popular sport and makes up more than 20 percent of the upland-game hunting. About 16,200 man-days annually are spent upland-game hunting in the area of influence, and this amount of hunting could be expected to continue through the period of analysis on a *without-the-project* basis.

Waterfowl

74. A great number and variety of waterfowl pass through the basin during fall and spring migrations. Wood ducks are permanent residents of the flood-plain area but are numerous only in certain areas, one of which is along Catfish Creek on the Gus Engeling Wildlife Management Area. Lesser Canada geese, blue geese, and snow geese use the Trinity River as a major migration route but seldom stop for more than short periods. Mallards, pintails, gadwalls, blue-winged teals, green-winged teals, shovelers, canvasbacks, redheads, baldpates, scaups, and coots stop over for feeding and resting on bottom-land lakes and seasonally flooded pin-oak flats during the fall, winter, and spring.

75. Under normal conditions of waterfowl habitat in the Central Flyway, waterfowl use would range from 8 to 20 million waterfowl-days annually; most of this use would occur downstream from Tennessee Colony Reservoir including the Wallisville Reservoir area. At present, about 1,200,000 waterfowl-days occur annually on the seasonally flooded Catfish Creek bottom on the Gus Engeling Wildlife Management Area, where no hunting is permitted.

76. Hunting opportunities are rather meager on the bottom-land lakes in the Trinity River flood plain. Almost all of the hunting on these lakes is restricted to club members and landowners and their friends. Waterfowl use of the proposed Lakeview Reservoir site is insignificant, and no hunting occurs. Mountain Creek Reservoir is a favored waterfowl resting area probably because no hunting is allowed by its owners. Exclusive hunting clubs control the marsh area below Wallisville Reservoir, and the area is lightly hunted. Hunting within the area of influence would vary from one extreme to another in the future, depending on waterfowl populations and hunting regulations. Waterfowl hunting could be expected to amount to about 9,000 man-days annually without the project.

Fur Animals

77. Excluding the area in the vicinity of the proposed Lakeview Reservoir, minks occur in fair numbers throughout the area of project influence. Raccoons, opossums, skunks, and gray foxes are numerous almost everywhere, and there are a few otters, badgers, ring-tailed cats, bobcats, nutria, and beavers in the remote portions of the Trinity River flood plain. There is practically no demand for pelts; and the only trapping done is for minks, usually by some of the commercial fishermen. About 70 minks are taken annually. Not much change is anticipated in fur-animal populations or take through the 100-year period of analysis without the project.

With the Project

General

78. The project will provide no big-game, upland-game, or fur-animal benefits. Rather, losses in hunting will result. There will be a loss of wildlife habitat and a displacement of animals on areas that will be permanently or occasionally flooded by Lakeview and Tennessee Colony Reservoirs. There also will be a loss of wildlife habitat within the area to be occupied by the multiple-purpose channel and its spoil areas.

79. About 60,000 acres of wildlife habitat will be inundated by Tennessee Colony Reservoir. Most of it is important to big game and upland game; some of it is important to waterfowl and fur animals. Approximately 92,000 acres still will be habitable by game animals but will be subjected to occasional flooding and to human activities associated with reservoir use. About one-third of the State's Gus Engeling Wildlife Management Area will be within Tennessee Colony Reservoir, and the major function of the area no longer will be possible. Approximately 11,000 acres of upland-game habitat within the Lakeview Reservoir site will be permanently inundated, and another 4,900 acres will be subjected to occasional flooding and intensive human activity.

80. The multiple-purpose channel, the spoil areas, and access right-of-way will occupy an estimated 30,300 acres of big-game, upland-game, and fur-animal habitat. In addition, about 60 river-bottom lakes totaling about 4,400 surface acres, and valuable to waterfowl, will be lost to the multiple-purpose channel.

81. Losses also will occur to portions of habitat in the flood plain not occupied by project structures. Reduction in flooding will be deleterious to the timbered wildlife habitat vital to the winter food and cover requirements of deer, turkeys, squirrels, and some species of waterfowl. Moreover, reduction in flooding will result in intensive agricultural and urban or industrial developments, culminating in additional clearing of timber and other wildlife food and cover plants and subsequent displacement of wildlife.

82. Although hunting will persist on private lands, on public lands within Lakeview and Tennessee Colony Reservoir areas, and along the multiple-purpose channel, only waterfowl hunting will be greater than that which could be expected without the project.

Big Game

83. Loss of big-game habitat will cause a reduction in hunting within the project area. It is estimated that 4,300 man-days of big-game hunting annually will occur over the 100-year period of analysis with the project.

Upland Game

84. Project-caused reduction of habitat for turkeys, squirrels, rabbits, bobwhites, and mourning doves will result in less hunting for these animals. An estimated 10,300 man-days of upland-game hunting annually will occur within the project area over the 100-year period of analysis with the project.

Fur Animals

85. Although there will be a reduction of habitat suitable for fur-animals, the project will have no significant effect on the populations or take of these animals.

Waterfowl

86. Waterfowl use of the project area will increase. While seasonally flooded bottom-land timber and cropland areas will be reduced in quantity and quality through inundation or dewatering, the overall project area is expected to be attractive to migrating

waterfowl. Large expanses of water, linked to the coast by a series of channel impoundments and river cutoffs, in all likelihood will cause more birds to use the Trinity River as a migration route, but waterfowl use of these areas probably will be of short duration during migration periods because of lack of feeding and protected resting areas.

87. Tennessee Colony Reservoir is expected to receive about 3 million waterfowl-days use annually, mostly by ducks and coots. Waterfowl hunting on the reservoir will average about 3,500 man-days per year with the project.

88. Lakeview Reservoir will be attractive to ducks and geese because of nearby grainfields. However, heavy use by visitors and rather dense human population around the reservoir probably will keep annual waterfowl use to about 1 million bird-days. There probably will be about 1,500 man-days of waterfowl hunting annually with the project.

89. Waterfowl use of the multiple-purpose channel probably will be light but the birds are expected to use the river cutoffs extensively. Waterfowl hunting is not expected to increase much on these areas, since most of the areas will be bordered by private property. Neither waterfowl use nor the amount of hunting on the flood plain downstream from Wallisville Reservoir is expected to change significantly with the project. Waterfowl hunting on the cutoffs, the channel, and the flood plain of the Trinity River will be about 9,400 man-days annually with the project.

90. A summary of annual hunting, without and with the project, is listed in Table 4.

Table 4. Summary of Hunting Annually
Trinity River and Tributaries, Texas

Type	Without the Project (man-days)	With the Project (man-days)
Big game	13,000	4,300
Upland game	16,200	10,300
Waterfowl	9,000	14,400

DISCUSSION

91. The proposed project will create fresh-water fish habitat of great importance. It also will provide opportunities for managing waterfowl and waterfowl habitat, subjects of national importance. Losses of big-game and upland-game habitat will occur. Reduction of the estuarine fish habitat may be anticipated. Of paramount significance is the project's effects on the State's Gus Engeling Wildlife Management Area, where research is conducted to determine techniques and practices necessary to maintain optimum conditions for white-tailed deer, turkeys, squirrels, and bobwhites in the Post Oak-Savannah sections of east Texas.

92. Fish and wildlife evaluations presented in this report are based upon the assumption that there will be provision of adequate public access to all project lands and water except those set aside for public safety and efficient operation of the project.

93. For optimum use by hunters and fishermen, a minimum of 8 parking areas will be required at Lakeview Reservoir and 10 at Tennessee Colony Reservoir. At Tennessee Colony Reservoir, one parking area should be located immediately below the dam to facilitate fisherman access to the reservoir's tailwater. Each parking area should be a minimum of 10 acres in size and should contain a concrete boat-launching ramp, sanitary facilities, and drinking fountains. These areas should be relatively equally spaced around the reservoirs and should be served by all-weather roads connecting with State or Federal highways.

94. Access to the multiple-purpose channel should be provided at each dam and lock structure and main highway crossing. Each access area should be so located and of sufficient size to permit use of the channel cutoff sections of the stream.

95. Islands formed by construction of the channel, particularly in the immediate vicinity of a lock and dam structure or a main highway crossing, should be developed for public use. Access to these areas should be provided even though it may require the construction of an overhead driveway or walkway across the plugged section of the cutoff.

96. To capitalize fully on the fishing potentials of Tennessee Colony and Lakeview Reservoirs and to conduct fishery research and management on these reservoirs, 6 seining areas should be provided in Tennessee Colony Reservoir, and 3 seining areas in Lakeview Reservoir. These areas should be cleared of all vegetation

and obstructions to ground level and each should be about 200 acres in extent. Specific location of seining areas will be determined by the Texas Game and Fish Commission and the Bureau of Sport Fisheries and Wildlife during the more advanced planning stages of development.

97. Moderate stands of timber in reservoir basins are effective fish attractors and provide shelter to fishermen and hunters during periods of high winds. They also serve as wood-duck nesting habitat and as natural blinds for waterfowl hunters. On the other hand, dense stands of timber impede access by hunters and fishermen and hamper fishing.

98. The Tennessee Colony Reservoir site is densely timbered. Access by hunters and fishermen to the headwater and cove areas of the reservoir by boat will be extremely difficult. Furthermore, the dense timber will pose a hazard to boating.

99. To attain maximum sport fishing in Tennessee Colony Reservoir, passage lanes should be cut through the timbered areas to provide fisherman access to the headwaters of the reservoir and to the upper reaches of the coves. The access lanes should be laid out in a manner that would keep water skiers and pleasure-boaters from using the areas. The Texas Game and Fish Commission and the Bureau of Sport Fisheries and Wildlife will be pleased to assist the Corps of Engineers in designing the passage lanes.

100. Unrestricted use of reservoirs by water skiers and speed-boaters has resulted in unsatisfactory and unsafe conditions for fishermen and hunters. The problem of conflicting use by water skiers, pleasure-boaters, and fishermen has become so acute on some reservoirs, particularly near large centers of population, that fishing has declined. Unless properly zoned, Lakeview Reservoir and Tennessee Colony Reservoir will experience the same problem. Proper zoning will restrict portions of the reservoirs to fishing and hunting and will enhance fish and wildlife benefits. With proper reservoir zoning, sport-fishing use would increase by 125,000 man-days annually on Tennessee Colony Reservoir and by 150,000 man-days annually on Lakeview Reservoir.

101. In the interest of preserving waterfowl throughout the Central Flyway, there is a continuing need for acquiring habitat for migrating and wintering waterfowl. National wildlife refuges and other waterfowl management areas are urgently needed to maintain proper distribution of ducks and geese thereby sustaining efficient waterfowl management on a Flyway basis. An opportunity exists to provide these facilities on the proposed Tennessee Colony Reservoir and, to a lesser extent, on certain stretches of the multiple-purpose channel.

102. Croplands suitable for cultivation of small grains occur on the east side of the Tennessee Colony Reservoir site. Because of its favorable location in the Central Flyway, the reservoir could have definite value in carrying out the national migratory bird management program. A national wildlife refuge established at Tennessee Colony Reservoir could provide much-needed feeding and resting habitat as well as an opportunity for a wildlife management program in conjunction with furnishing future hunting, fishing, and recreation.

103. A suitable area for a national wildlife refuge within the reservoir site exists north of U. S. Highway No. 287 and east of the proposed navigation channel. Preliminary investigations indicate an estimated 600 acres of land above elevation 288 plus about 20,400 acres of project lands and waters within the guide-taking line elevation 288 would be required for adequate waterfowl habitat management. Plate II shows the preliminary boundary of the proposed refuge. Additional studies will be needed to develop planning for a refuge. At such time as more specific project plans are proposed by the Corps of Engineers, these studies will be made.

104. Benefits attributable to establishment of a refuge would be an amount at least equal to its cost plus those accruing as a result of local waterfowl hunting and from visitation for scientific studies, nature observations, and allied uses made possible only by this refuge. It is estimated that the benefits from hunting would amount to approximately $70,000 annually. It is estimated that 100,000 man-days annually of general recreational and educational uses also would occur on the refuge.

105. Tennessee Colony Reservoir will inundate most of the prime winter-food producing area of the State's Gus Engeling Wildlife Management Area. It will curtail all research and management projects on the area, and complete abandonment of the primary function of the management area will be necessary. The area has been established by the Texas Game and Fish Commission with funds made available through the Federal Aid in Wildlife Restoration Act, as amended (50 Stat. 917; 16 U.S.C., Sec. 669). Total investment to date is well in excess of 1 million dollars.

106. It is important to purchase lands and construct improvements at project expense to replace the Gus Engeling Wildlife Management Area development. The location of the area to be purchased and the improvements to be constructed will require the help and assistance of the Texas Game and Fish Commission in cooperation with the Bureau of Sport Fisheries and Wildlife. The Commission is presently investigating sites in the East Texas Timber Country section to determine an area of equitable replacement.

107. Reduction of fresh-water inflows into Trinity Bay will result in increased bay salinity and will have detrimental effects on juvenile shrimp and finfishes, such as menhaden and anchovies. Salinities in the Trinity Bay system range from less than 1 o/oo[1/] near the mouth of the Trinity River to 25 o/oo in Galveston Bay near the Gulf passes. Salinities sometimes equal or exceed 35 o/oo in the absence of fresh-water inflow. The salinity in the Gulf of Mexico is about 35 o/oo.

108. Oysters; white, brown, and pink shrimp; and many finfishes, such as menhaden, anchovies, redfish, black drum, squeteague, croakers, and flounders, are either permanent residents of estuaries or spend a portion of their life cycles therein. Oysters are permanent residents and do best in salinities ranging from 10 o/oo to 20 o/oo. They can exist in near-sea-water salinity. At higher salinities, oyster predators become so numerous that oysters are rapidly decimated. White, brown, and pink shrimp spawn in the Gulf of Mexico, and their larval forms require residence in brackish waters. These waters serve as nursery areas for shrimp from March through October, and maximum productivity can be obtained when salinities range from 5 o/oo to 17 o/oo with an average of 8 o/oo during these months.

109. The Bureau of Commercial Fisheries states that salinity levels in Trinity Bay are highly dependent upon discharges of the Trinity River and, to a lesser extent, upon local precipitation, tides, winds, and evaporation. The Bureau further states that if discharges into Trinity Bay are drastically reduced, an effort should be made to provide adequate fresh-water inflows into the bay when the juvenile forms of shrimp and finfishes are in the estuaries. This period is usually from March through October. It is estimated that a mean monthly fresh-water discharge of about 120,000 acre-feet during that period is required to maintain salinity conditions in the bay. Further study would be required to determine whether a lower discharge rate could be made without damage to the estuarine habitat.

1/ The symbol o/oo denotes parts chloride (salt) per thousand parts water.

CONCLUSIONS

110. Construction and operation of the Trinity River and Tributaries Project will result in the creation of productive fish habitat in the proposed Lakeview and Tennessee Colony Reservoirs, improvement in the fishing of the West Fork of the Trinity River, and attractive fishing in the multiple-purpose channel and cutoff sections of the Trinity River. On the other hand, reduced fresh-water inflow into the estuaries associated with the Trinity River will cause loss of a highly valuable portion of the nursery habitat in the Galveston Bay system.

111. Big-game and upland-game habitat and hunting will be reduced throughout the project area. While only a limited amount of waterfowl habitat will come into being, there will be a gain of waterfowl hunting attributable to the project.

112. Recommendations are made herein to protect fish and wildlife and to assure optimum use of the project lands and waters for fishing and hunting. These recommendations include suggestions for public-access development; measures to aid fish management in the reservoirs; a proposal for the consideration of establishment of a national wildlife refuge on Tennessee Colony Reservoir; advocacy of the necessity to provide land and development measures at project expense to replace the Texas Game and Fish Commission's Gus Engeling Wildlife Management Area; and advice that a mean monthly fresh-water discharge into Trinity Bay during the period from March through October is necessary to protect marine fish habitat.

113. Although construction of the project will entail a loss in marine fishing and hunting within the project area, adoption and implementation of the recommendations would result in overall benefits attributable to the project. As advocated in Recommendation No. 6, adequate zoning to reduce conflicts between competing forms of recreation on the proposed Tennessee Colony and Lakeview Reservoirs would result in significant benefits to fishing. A national wildlife refuge established on Tennessee Colony Reservoir, as proposed in Recommendation No. 7, would contribute to the national waterfowl management program and would result in substantial benefits to local waterfowl hunting. Replacement of the State's Gus Engeling Area, as advanced in Recommendation No. 8, would compensate for the loss of a highly valuable wildlife research and management area. Provision for the maintenance of adequate fresh-water discharges into Trinity Bay, as urged in Recommendation No. 9, would prevent a reduction in quality of the nursery areas in Trinity Bay for juvenile shrimp and finfishes such as menhaden and anchovies.

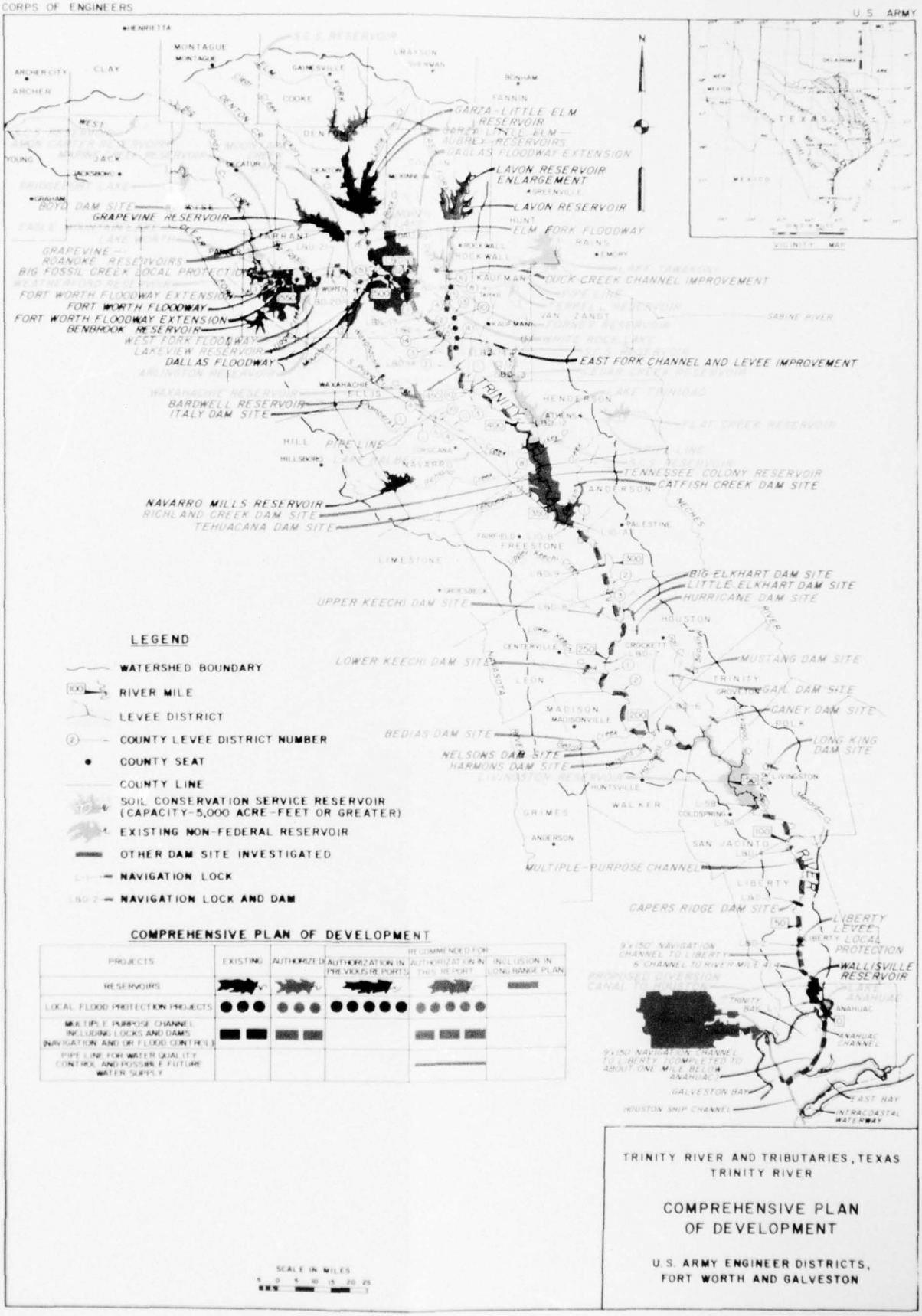
114. Table 5 presents a summary of the evaluations of fishing and hunting within the project area both without and with the project and without and with acceptance of recommendations contained in this report.

Table 5. Summary of Fishing and Hunting Evaluations
Trinity River and Tributaries Project, Texas

Item	Without the Project	With the Project	
		Without Recommendations	With Recommendations
Fishing			
Fresh-water sport	$ 155,000	$ 1,065,000	$ 1,340,000
Marine sport	12,000,000	12,000,000	12,000,000
Fresh-water commercial	176,000	176,000	176,000
Marine commercial	3,320,000	3,035,000	3,320,000
Sub-total	$ 15,651,000	$ 16,276,000	$ 16,836,000
Hunting			
Big game	38,000	13,000	13,000
Upland game	21,000	13,000	13,000
Waterfowl	41,000	55,000	125,000
Sub-total	$ 100,000	$ 81,000	$ 151,000
Grand Total	$ 15,751,000	$ 16,357,000	$ 16,987,000

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

- WATERSHED BOUNDARY
- RIVER MILE
- LEVEE DISTRICT
- COUNTY LEVEE DISTRICT NUMBER
- COUNTY SEAT
- COUNTY LINE
- SOIL CONSERVATION SERVICE RESERVOIR (CAPACITY-5,000 ACRE-FEET OR GREATER)
- EXISTING NON-FEDERAL RESERVOIR
- OTHER DAM SITE INVESTIGATED
- NAVIGATION LOCK
- NAVIGATION LOCK AND DAM

COMPREHENSIVE PLAN OF DEVELOPMENT

PROJECTS	EXISTING	AUTHORIZED	RECOMMENDED FOR AUTHORIZATION IN PREVIOUS REPORTS	RECOMMENDED FOR AUTHORIZATION IN THIS REPORT	INCLUSION IN LONG RANGE PLAN
RESERVOIRS	■	■	■	■	■
LOCAL FLOOD PROTECTION PROJECTS	● ● ●	● ● ●	● ● ● ● ●	● ● ● ● ●	
MULTIPLE PURPOSE CHANNEL INCLUDING LOCKS AND DAMS (NAVIGATION AND OR FLOOD CONTROL)	■ ■	■ ■		■ ■ ■	
PIPE LINE FOR WATER QUALITY CONTROL AND POSSIBLE FUTURE WATER SUPPLY				▬	

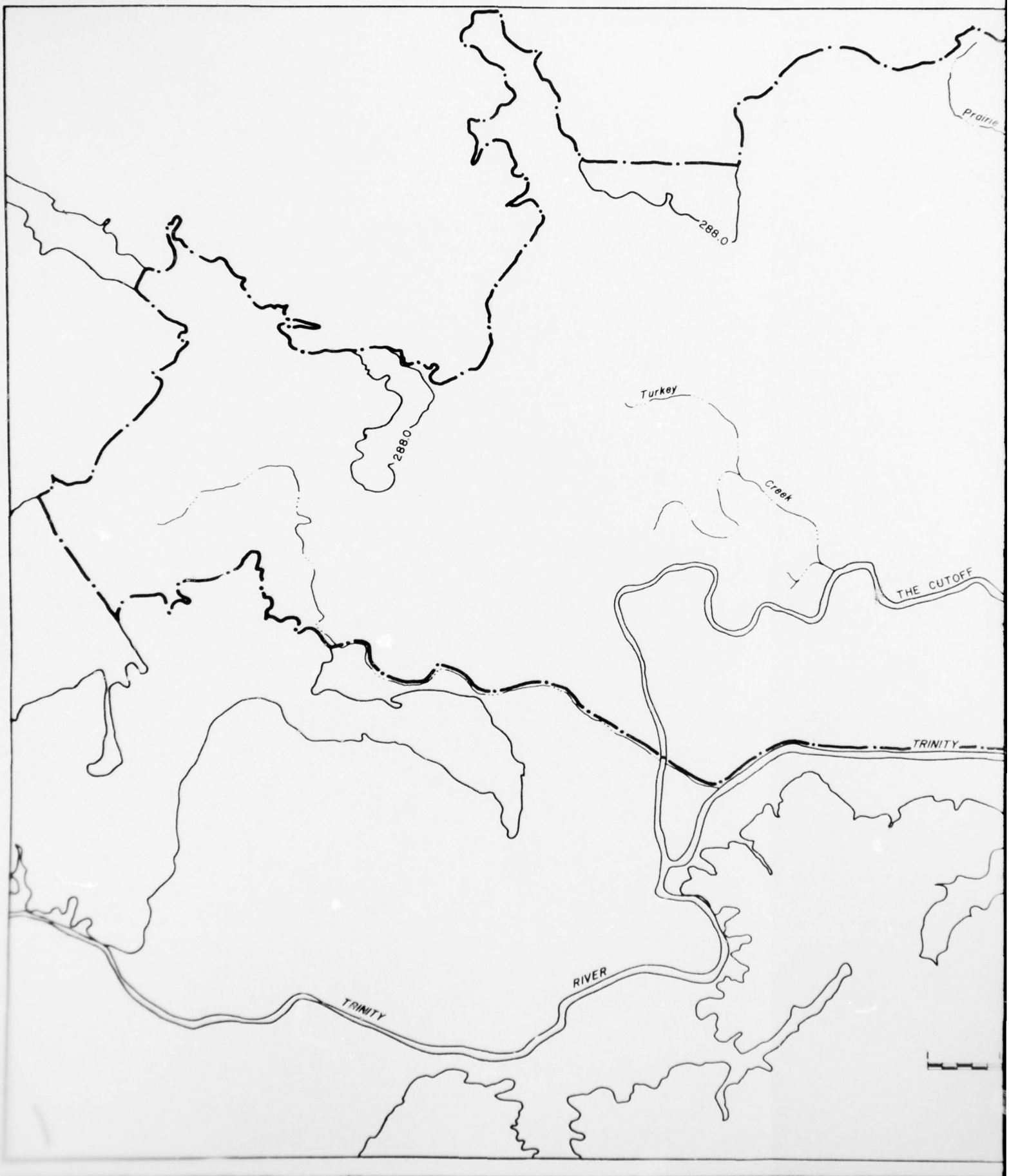
SCALE IN MILES

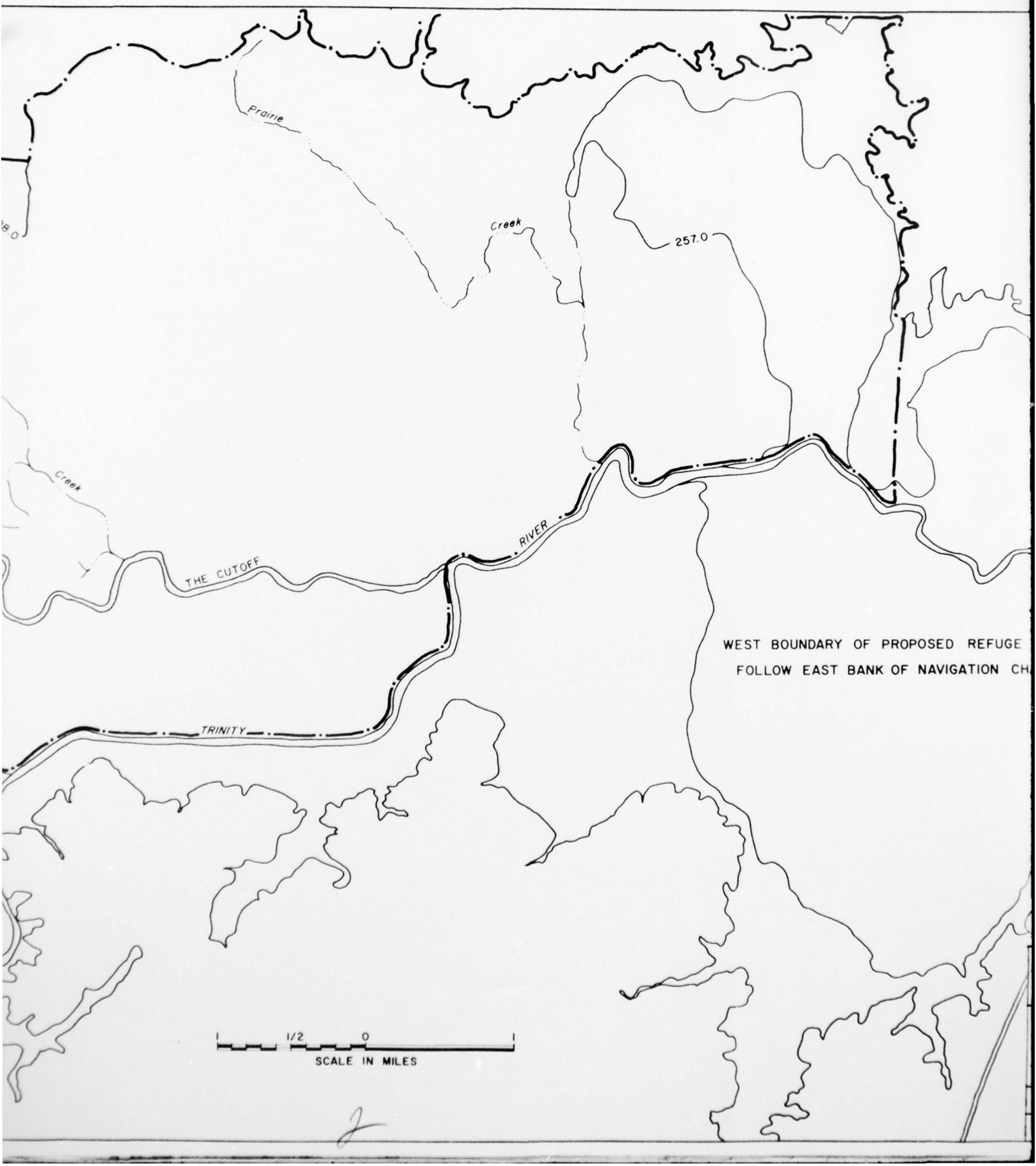
5 0 5 10 15 20 25

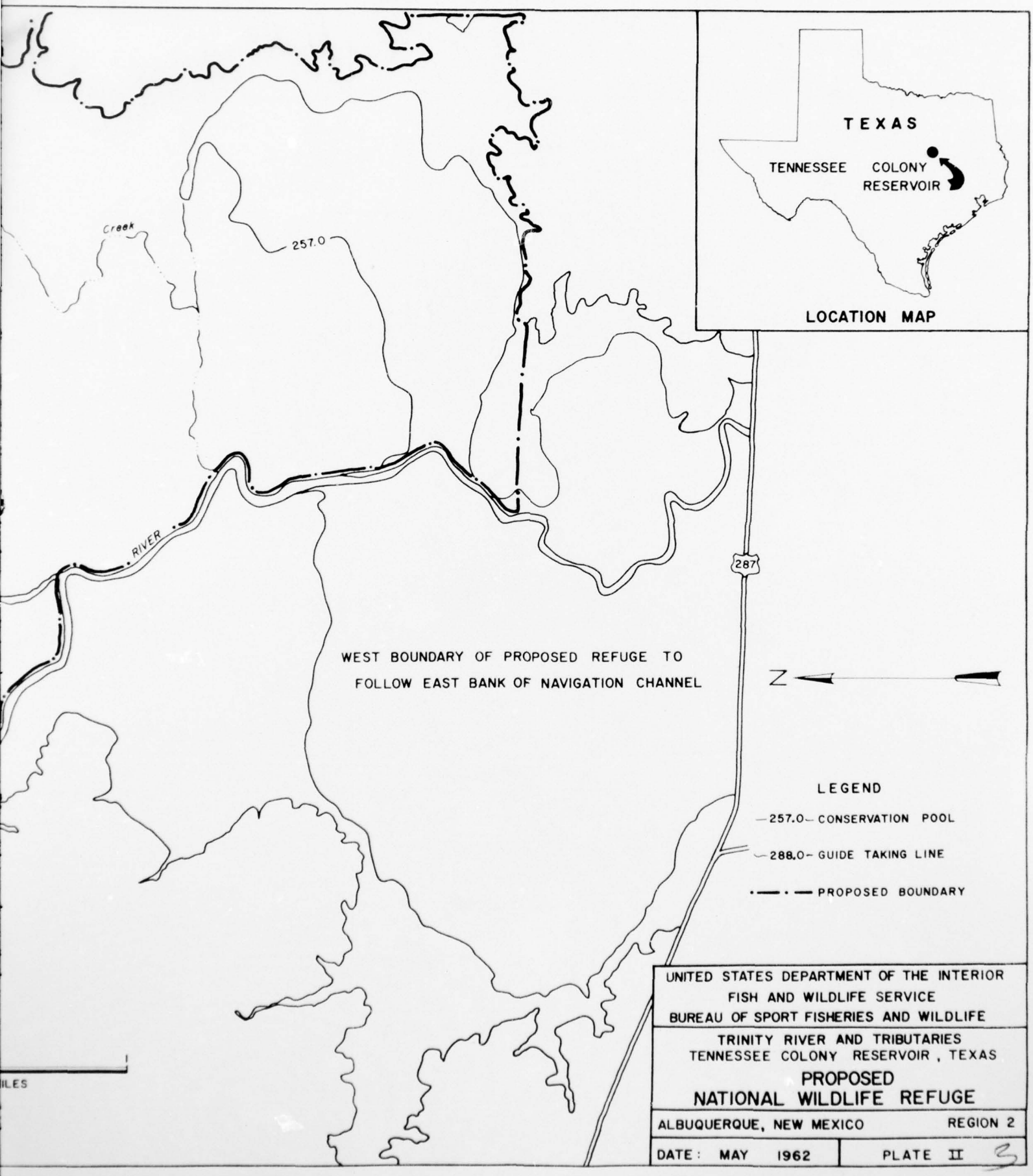
TRINITY RIVER AND TRIBUTARIES, TEXAS
TRINITY RIVER

COMPREHENSIVE PLAN OF DEVELOPMENT

U.S. ARMY ENGINEER DISTRICTS, FORT WORTH AND GALVESTON


Prairie
288.0
288.0
Turkey
Creek
THE CUTOFF
TRINITY
TRINITY
RIVER


Prairie
Creek
257.0
Creek
THE CUTOFF
RIVER
TRINITY
WEST BOUNDARY OF PROPOSED REFUGE
FOLLOW EAST BANK OF NAVIGATION CH
1/2
0
SCALE IN MILES



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

TRINITY RIVER AND TRIBUTARIES
TENNESSEE COLONY RESERVOIR, TEXAS

PROPOSED NATIONAL WILDLIFE REFUGE

ALBUQUERQUE, NEW MEXICO — REGION 2

DATE: MAY 1962 — PLATE II

RECONNAISSANCE REPORT

RECREATIONAL ASPECTS of the

TRINITY RIVER BASIN

IMPROVEMENT PROPOSALS

TEXAS

TENNESSEE COLONY RESERVOIR PROJECT

LAKEVIEW RESERVOIR PROJECT

TRINITY RIVER CHANNELIZATION PROJECT

Prepared by

Ben R. Chambers, Park Landscape Architect

Division of Recreation Resource Planning

Region Three Office

National Park Service

For

U. S. Army Engineer District, Fort Worth

Corps of Engineers

February 1962

APPENDIX V, EXHIBIT 2

INTRODUCTION

Authority

The Park, Parkway, and Recreation Area Study Act of June 1936 is general authority for National Park Service cooperation in recreation studies and planning for Corps of Engineers projects. This study was requested by the Deputy District Engineer, Fort Worth District, in his letter to the Regional Director, Region Three, dated 2 November 1961.

Details of the projects were explained to Park Landscape Architect Ben R. Chambers, representing the Service, by F. K. Mixon, in the Fort Worth District Office, on 20 November. Following this, Messrs. Chambers, Victor H. Kaliin, of the Fort Worth District, and P. Frank Dunn, of the Galveston District, inspected the sites of Tennessee Colony and Lakeview Reservoirs, as well as typical lock and dam sites and highway crossings of the canalization project. On the return to the Fort Worth Office on the 22nd, marked maps and related data were made available.

Purpose

The studies requested relate to the potential recreational resources and needs of each of the projects, the recommended type of development, an estimated annual attendance for recreational purposes, and

a recommended unit of monetary value for visitor-day to be used in determination of the anticipated benefits from the proposed developments.

GENERAL DESCRIPTION

The Trinity River rises in its four principal forks west and north of the Fort Worth-Dallas area and flows through East Texas into Trinity Bay, Galveston Bay, and the Gulf of Mexico, east of Houston and Galveston. The river flows through the gently rolling Post Oak and Pine Belts of the Gulf Coastal Plain.

The canalization feature contemplates a realignment of the Trinity River from the Houston Ship Channel 370 miles upstream to Fort Worth. It would create a multiple purpose channel for flood control and navigation. The navigation channel is proposed for twelve feet by 150 feet to Dallas and twelve feet by 125 feet, Dallas to Fort Worth. The flood control channel would vary from 150 feet to 300 feet.

There would be a series of 21 dams with locks, located at intervals along the length of the channel. These would aid in both navigation and flood control. Also contributing to the flood control program, in addition to providing water supply and creating other benefits, are a series of existing and potential dams and reservoirs on the main stem and tributaries. Of direct consideration in the investigated plan of improvement are two, Tennessee Colony and Lakeview Reservoirs.

TENNESSEE COLONY RESERVOIR

The reservoir dam site is at mile 339.2 on the main stem. At that point the Trinity River is the boundary between Freestone and Anderson Counties. The 59,950 acre reservoir would extend into Navarro and Henderson Counties. Proposed pertinent reservoir data include:

Item	Elevation (feet-msl)	Area (acres)	Capacity (acre-feet)
Spillway gate sill	250.0	42,190	470,200
Top, conservation pool	257.0	59,950	824,900
Five-year pool	261.0	70,000	1,085,300
Top of F.C. pool	285.0	119,500	3,366,800
Guide taking line	288.0	127,800	3,737,100
Max. design W.S.	297.8	151,920	5,109,200

Tennessee Colony Reservoir site has physical qualities quite correctly described as park-like. The shore setting is of gentle relief and contains both open and wooded areas, the latter including quite a wealth of southern hardwoods, as well as pines and juniper. The irregular shoreline contours indicate a number of small bays and reaches will be formed by the impoundment, well adapted to public use developments. Moreover, the expanse of open water should be adequate for the various types of use to be expected, without crowding or conflict.

In addition to having good potentialities for reservoir-type nonurban recreation, the project is in a section of Texas where demand for such outlet has not been fully met. Tennessee Colony Reservoir is within easy travel proximity of the people living within the neighboring eight counties.[1/] According to the 1960 U. S. Census, all of these counties lost population during the last decade. The losses appear to result from the migration trend from the country to the towns, and particularly to the cities. Except for Navarro County (wherein is Corsicana, the largest town of the area) each county has more inhabitants classed by the Bureau of the Census as rural than urban.

Since this migration trend is apt to continue, albeit probably slowing within the decades ahead, the primary drawing area of the reservoir may be expected to show but little increase in numbers except as modified by other economic influences. Among these other factors is the influence of the project itself. New industry catering to travel to and public use of the reservoir can be expected to have substantial direct and indirect benefits on the economy of the neighboring area.

Sources of visitation will not be limited to the eight-county section referred to as the primary drawing area. Encircling this

1/ Anderson, Freestone, Henderson, Navarro, Leon, Limestone, Houston, Crockett

area is another, embracing some 25 to 30 counties (or in some instances a portion of the county) in which the people will consider Tennessee Colony near enough to visit and enjoy. While some of their visitation may be completed within a day, most trips will include one or more nights, often on weekends.

This second zone has ten times the population of the more proximal or primary area. It contains many predominantly rural counties but also a number of significant population concentrations, including the metropolitan areas of Dallas, Waco, and Tyler. Most of the people in this outer band live as close to one or several other developed reservoirs as to the Tennessee Colony site. They thus will have a choice, but can be expected to include the new reservoir in some of their excursions.

A growing characteristic of population groups having access to several reservoir objectives is increased interest in the diversions made possible by public use reservoir developments. Demand in most sections has continued to keep abreast of available opportunities.

Tennessee Colony Reservoir planning should accordingly recognize rather large day and overnight potential visitation. Its facilities should include both picnic and camping areas, the latter recognizing a need for the simple or basic accommodations desired

by one- and two-night campers. Uses will range from the quite active, such as skiing and speed boating, to the relatively passive, including leisurely relaxing and sightseeing.

The public use sites tentatively designated by the Corps of Engineers planners appear well selected. While not all of the sites may receive initial development, it is important that they be included in the long range public use plan, some being held as buffer zones as long as actual development is not required to meet public access needs. For initial development, the Greens Bluff-Yard peninsula, the Catfish Creek reach, and the Tehuacana Creek arm appear particularly desirable. Also, considering the volume of lake visitors from the northwest over U. S. 287, it is believed that the peninsula now traversed by that highway at Alligator Creek will prove to be an important reservoir access point.

Use of the reservoir by people from a great distance, such as tourists and those on vacation, will largely be incidental, while passing through the section, or while drawn to the general region by its combined attractions. Most of their visits will in effect be day use or overnight. In this respect, however, Tennessee Colony Reservoir will complement rather than compete with the other reservoirs of northeast Texas.

Annual visitation is dependent on a number of factors. Among these is the development, the provision of facilities for public use. Assuming this to be as outlined by the Corps of Engineers planners, the annual visitation figure on which recreation benefits can be computed for Tennessee Colony Reservoir is conservatively estimated at 850,000.

LAKEVIEW RESERVOIR

The dam site is at mile 7.2 on Mountain Creek, within Greater Dallas. As planned, the dam will extend across the upper section of existing Mountain Creek Lake, the left abutment being just across the county line, in Tarrant County. The reservoir would extend southward beyond the extreme southwest corner of Dallas County into Ellis County, with its westward Fish Creek and Walnut Creek arms reaching into Tarrant County.

Proposed reservoir data pertinent to public use planning are as follows:

Item	Elevation (feet-msl)	Area (acres)	Capacity (acre-feet)
Spillway gate sill	500.0	7,910	170,700
Top, conservation pool	517.0	11,990	337,300
Five-year pool	522.0	13,570	401,200
Top, F.C. pool	528.0	15,650	488,700
Guide taking line	531.0	16,890	537,500
Max. design W.S.	538.8	21,210	686,300

From the standpoint of location, Lakeview Reservoir will be a metropolitan-area lake. The site is located within the densely populated complex of towns and subdivisions which form the adjoining metropolitan areas of Dallas and Fort Worth. Important shore area sites are within 12 miles of downtown Dallas and 22 miles of downtown Fort Worth, over a network of streets and roads, including U.S. 80-180, and the Dallas-Fort Worth limited access Turnpike toll road.

The site is relatively flat, open and devoid of forest, its black land being largely devoted to residences and to small farming operations. The shore will be subject to considerable horizontal fluctuations as periodic drawdown and refilling take place. At one section, Cedar Hill, the land rises a bit above the rest of the terrain, forming a potentially interesting moderate lake overlook.

The main open area of the lake at full conservation pool will be from one to two miles across for a length of five or more miles. In addition, the several tributary sections will form sizeable reaches of half-mile average widths extending from a mile to five miles in length. All of these appear adaptable to boat harbor and supporting developments such as are contemplated by the Corps of Engineers planners.

Unlike the situation near the Tennessee Colony site, Lakeview Reservoir is located within a densely populated urban area. In close day-use proximity of Lakeview live more people than are found within comparable distance of any other reservoir in Texas, except several of the other reservoirs within or near the Fort Worth-Dallas metropolitan areas. Over 90 per cent of the 1,700,000 or more people who can reach the Lakeview site within an hour of travel time are classed by the Bureau of Census as urban, and increasing in numbers, the increase during the 1950-60 decade being 45 percent.

This day-use drawing area has access also to a number of reservoirs within it or nearby. These include Grapevine, Benbrook, Garza-Little Elm, Lavon, Eagle Mountain, Worth, White Rock, North, Arlington, and others. Included also will be the Bardwell Reservoir, now in the preconstruction planning stage. Considering the over-all needs of the two metropolitan areas, the current proposals will be more supplementary than competitive, all functioning as needed units in providing outlet for the expanding demand for reservoir-type recreation. As an indication of this demand, the first four reservoirs named above are reported by the Corps of Engineers to have received in 1960 a total of seven million visits.

The Lakeview Reservoir can be expected to receive some visitation classed as overnight and weekend, but most of this will originate within the above-described day-use serving area, rather than from the greater drawing distances of many reservoirs, including the proposed Tennessee Colony. Lakeview should be considered as primarily of day-use potentialities. Its expected volume of visitor use will be more directly related to convenience of access by large numbers of people than by any special attractiveness of the site in comparison to other reservoirs.

The visitation which the new lake will receive will be related, more than on some, to the adequacy of its facilities and services. As illustrated at existing Mountain Creek Lake, nominal use may

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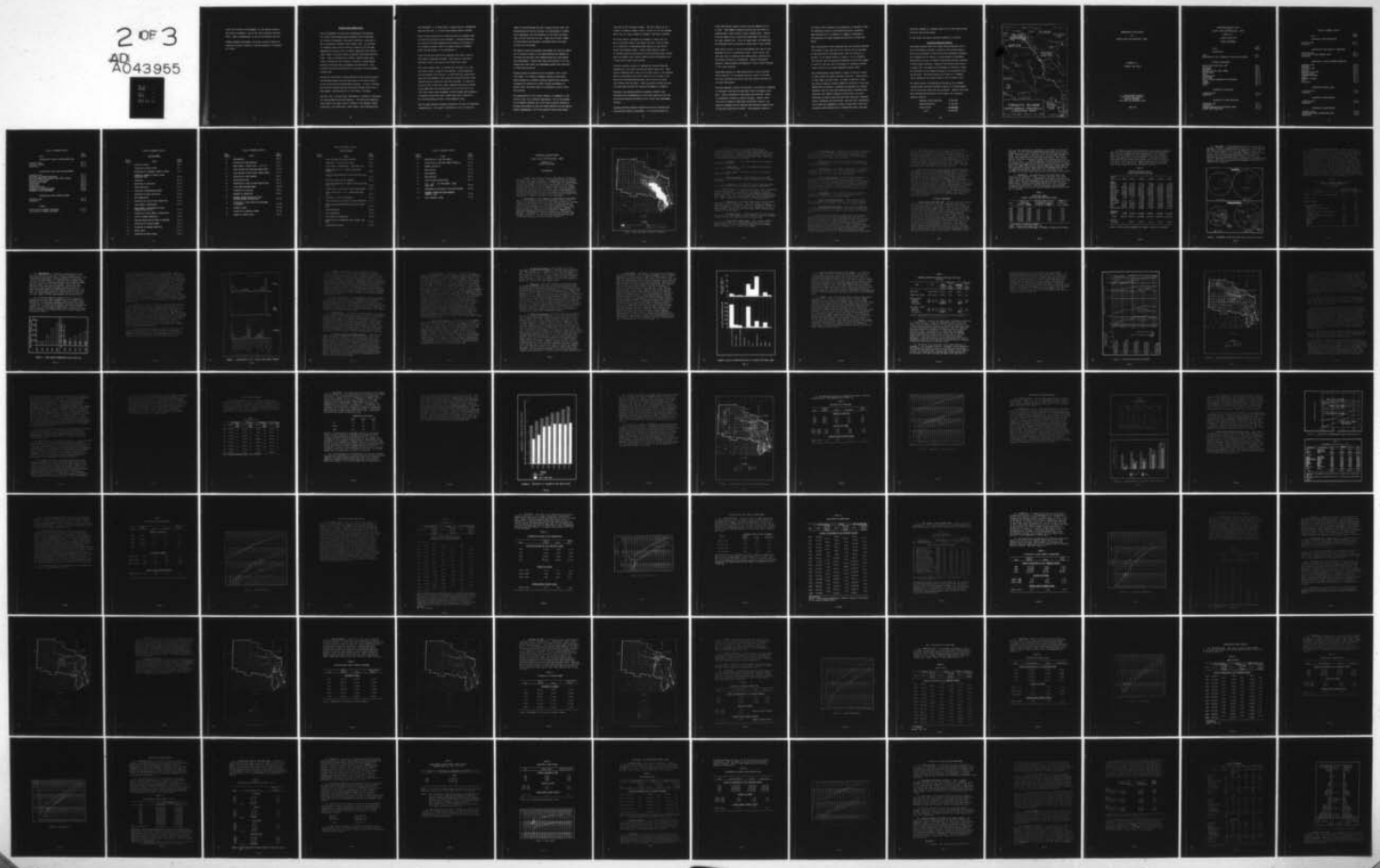


occur with virtually no development, but the typical reservoir day-visitor now expects - and in this case can easily find elsewhere - basic accommodations, as well as concessioner services.

Assuming adequate development, the annual visitation figure for computing recreation benefits on Lakeview Reservoir is estimated at 970,000.

TRINITY RIVER CHANNELIZATION

From the standpoint of public-use consideration and planning, the Trinity River channelization proposals could be described as a series of elongated, river-narrow reservoirs, lying end to end, each having a different water-surface level. For purposes of navigation there would be locks in connection with the dams impounding the several units, to permit barges and other shallow-draft traffic to proceed between the Houston Ship Channel and Fort Worth. Three of the dams would, however, impound larger water volume, creating the more typically "reservoir" surface expanse. These are Tennessee Colony, Livingston, and Wallisville. Only Tennessee Colony Dam and Reservoir is included in this improvement program study.

The Houston Ship Channel crosses Galveston Bay and connects Houston and Galveston harbors with the deep waters of the Gulf of Mexico, as well as with the Gulf Intracoastal Waterway. A 9-foot x 150-foot spur from this Channel has been constructed through Trinity Bay to near Anahuac, and authorized on to the vicinity of Liberty.

The first lock, at Trinity Bay, near Anahuac, is planned in connection with the proposed Wallisville Reservoir. The Wallisville Reservoir level would in its upper reach be confined to the deepened channel authorized to be constructed to near Liberty, just downstream from

Lock and Dam No. 2, at which point a turning basin is contemplated. Dams and Locks Nos. 2, 3, and 4 would impound channel sections.

Locks 5-A and 5-B would be in connection with the Livingston Dam, now under construction by local interests. Livingston Reservoir, the second of the three expansive water areas to be utilized in the navigation project would in its upper reaches be extended within the new channel to Lock and Dam No. 6.

Locks 10-A and 10-B would be at Tennessee Colony Dam, a unit of this general improvement proposal. The reservoir, previously described, would be the third of the larger water areas.

The various channel units, on through Lock and Dam No. 21, near Fort Worth, would, in some of the stretches, coincide generally with the present river location. In other sections, particularly where the river meanders, the constructed navigation-flood control channel would cut across the river bows and bends. In such situations the old cut-off river loops, separated from the new channel at the upper end, but connected with it at the lower end of the river loop, would create elongated, crescent-shaped side extensions or reaches of relatively quiet, stable water area, connected to but not functioning as a part of the navigation canal.

Each of these potential backwater situations will have its individual characteristics. The length of old-river cut off, the size and

shape of the land between the river crescent and the canal, the attractiveness of the site setting, its relationship to traffic, and to population, and the suitability of the water for public uses, all will vary with the site. Where all or quite a number of these factors are favorable, substantial public use potentialities will be created.

The degree to which each possible development can serve the public will be directly related to the appropriateness and adequacy of the facilities provided, their administration and, particularly their maintenance. Granted that these are favorable, it is considered that their public use development benefit-cost ratio will be found quite attractive.

Potential public use sites will not be limited to the cut-off river bends. At a number of highway crossings, particularly where pressures for nonurban recreation opportunities are great, convenience of access will no doubt justify developments at channel sites, even where there is no adjoining cut-off or backwater section.

Two characteristics of the project channel, in comparison to the historic river, are of special significance. One is the prospect of but moderate flooding, due to the flood retention function of the main-stem reservoirs (both the large reservoirs and the smaller channel impoundments), and of the system of large flood-control

reservoirs on the tributary streams. The other feature is the prospect of moderate channel current, neither too fast for optimum public use, nor static enough for stagnant conditions to develop.

The latter feature, sustained slow movement of water, while it may be just about right in the channel sections, could be found to be ineffective in maintaining water quality in the cut-off finger-like backwater areas. Careful study should be given to the possible need for installing controlled diversion works through which, as needed, some volume of water could be introduced at the "closed" end of the cut-off sections.

Pollution could be a factor in reducing the attractiveness and desirability of the water for various kinds of public use. Under project conditions this is apt to be of most concern in the sections where it now exists in the river, such as in the vicinity of the Dallas-Fort Worth metropolitan area, and in the more sluggish river section near the coast. These two general sections are also the areas where the need for nonurban developments is greatest.

Recreation use planning should be intimately related to the evaluations and recommendations of the public health and the fish and wildlife agencies pertaining to the Trinity River improvement projects.

Assuming the above problems recognized and solved, detailed site potentialities should be determined. It is believed these will

reveal that several classes of public use developments will be in order. Some highway crossing situations may best serve as roadside parks, often currently called roadside rests. Several sites are almost sure to justify more development than that of the usual roadside stop. In all of these cases, the Texas Highway Department may be interested in adding them to their system.

Other sites, such as in the Fort Worth-Dallas area, may be found adaptable for city or metropolitan parks. Actual project park sites may occur in locations which under present conditions are uninviting, uninspiring, sub-marginal. Required development measures, though extensive and expensive, could be highly desirable to the cities concerned.

Downstream, possibly at some distance above or below Tennessee Colony Reservoir, it is probable that one or more of the potential site situations may warrant study for possible inclusion in the State Park system.

The above approach to public use has been on the basis of evaluation of individual sites and the needs which their development could meet. This is considered to have great potentialities, subject to satisfactory solution of certain problems. However, there will also be created an additional recreational resource, its potential stemming from the combined water-connected possibilities of the entire canalization project. The navigation feature of

the Trinity River proposals is as significant to Recreation (with its expanding interest in water-based activities, especially speed boating) as it is important to Commerce (interested in the possibility of barge shipping from the Gulf to inland Fort Worth).

While the majority of boat enthusiasts may not initially undertake "full-length" trips, many will do so, and all will be intrigued by the possibility of extended travel, from one reservoir to another, or one channel section to another. It is considered that this new type of potential recreational activity will expand in interest, that the use of the project in recreation distance-travel could grow into a most significant project asset.

This reconnaissance study presents a number of factors, touched on above, which will affect potential visitation. These factors, at this stage, are quite fluid. In order to arrive at a base upon which to make an initial estimate of visitation, it has been assumed that the factors or problems will generally be resolved favorably, that the later more detailed Corps of Engineers planning study will reveal a minimum of twelve public use sites (exclusive of those of the three main-stem reservoirs, Tennessee Colony, Livingston, and Wallisville), and that their developments will include two comparable in scope to state parks, three functioning as well-developed city or metropolitan parks, and seven

serving as roadside (or community-park) units of more-than-average facilities and attractiveness.

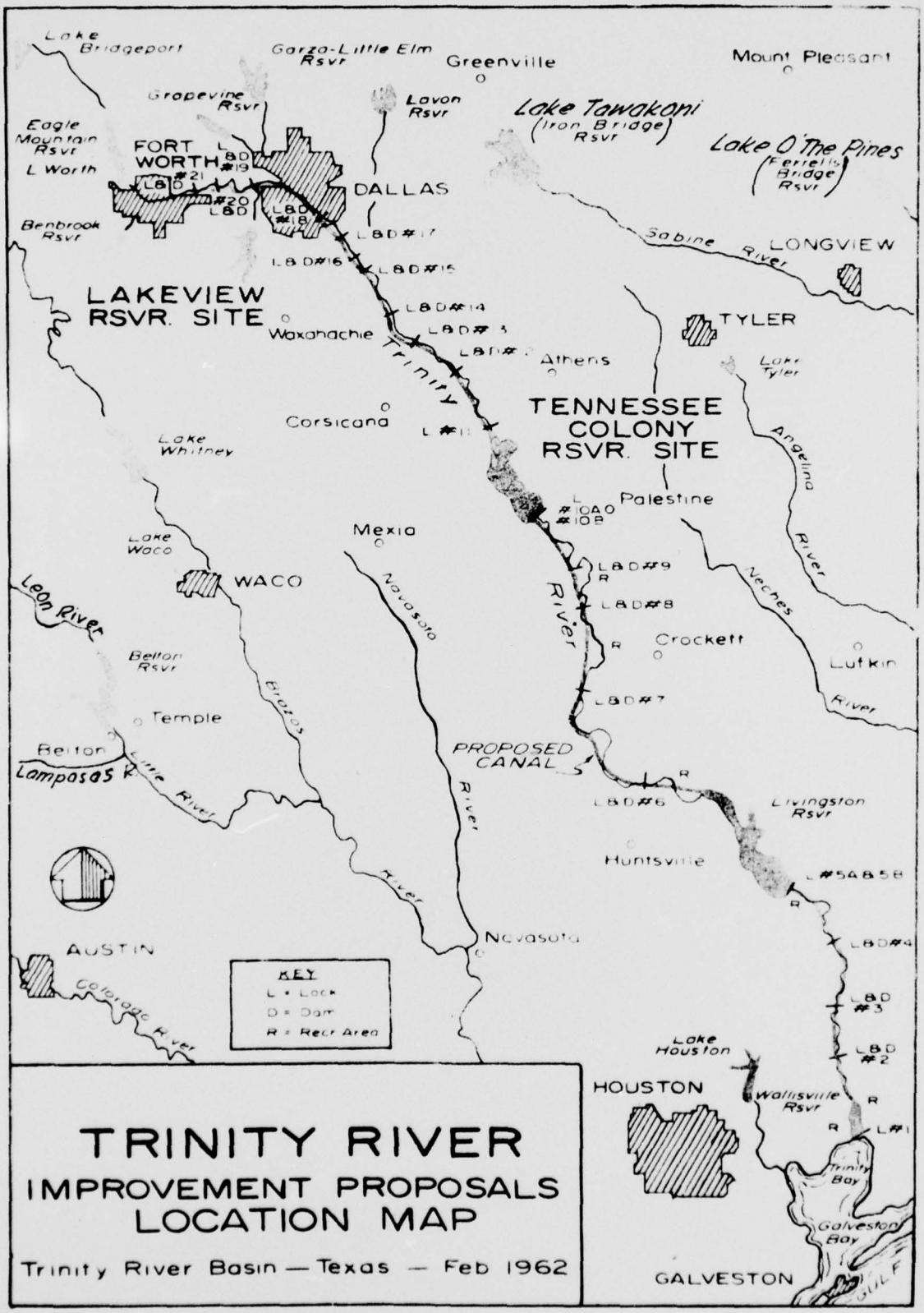
On this basis, the annual visitation estimate is 1,200,000.

ESTIMATED RECREATION BENEFITS

The primary benefits which will result from recreational use of public developments provided on reservoir and related projects, such as are envisioned in the Trinity River Improvement Proposals, are intangible and not subject to usual methods of measurement. Nevertheless, by using "A Method of Evaluating Recreation Benefits of Water Control Projects", adopted by the National Park Service in August 1957, the measure of the benefits is related to a monetary evaluation of the benefits enjoyed by the individuals visiting the areas. The method employs the concept of a "judgment value" approach to the problem based on derived market values.

The annual benefit is determined by multiplying the estimated average annual recreation attendance figure by a computed market value of $1.60 per visitor day for recreation. Based on the attendance estimates given earlier in this report, the recreation benefits would be:

Tennessee Colony Reservoir	$1,360,000
Lakeview Reservoir	$1,552,000
Trinity River	$1,920,000
Total	$4,832,000



TRINITY RIVER
IMPROVEMENT PROPOSALS LOCATION MAP

Trinity River Basin — Texas — Feb 1962

COMPREHENSIVE SURVEY REPORT

ON

TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX VII

ECONOMIC BASE STUDY

U. S. ARMY ENGINEER DISTRICTS
FORT WORTH AND GALVESTON
CORPS OF ENGINEERS
FORT WORTH AND GALVESTON, TEXAS

JUNE 1962

COMPREHENSIVE SURVEY REPORT
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ECONOMIC BASE STUDY

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APPENDIX VII
ECONOMIC BASE STUDY

INTRODUCTION

1. SCOPE.- This appendix identifies and measures, insofar as practicable, the social, economic, and technological factors relevant to economic development and growth. Fundamental trends in pertinent factors are projected into the future, in the light of expected change, to obtain an estimate of the probable time pattern of the economic forces which will constitute the framework within which the proposed projects will operate over their economic lives. These projections are reasoned conclusions about the future direction and magnitude of economic activity, based upon objective analysis of the relevant past and careful estimates of the effect of new forces and development that are expected to influence trends of future development.

2. RELATIONSHIP OF THIS APPENDIX TO OTHER PARTS OF THIS REPORT.- This study establishes a broad and comprehensive concept of the probable economic growth of the base study area and forms the framework within which projections of economic growth of areas affected by specific project purposes can be developed. Developments of these projections are included in the following appendices: Appendix II - Hydrology, Hydraulic Design, and Water Resources; Appendix III - Navigation and Navigation Economics; Appendix IV - Flood Control Economics; and Appendix V - Recreation and Fish and Wildlife. The geographic location of the base study area and the areas pertinent to the various project purposes are shown in figure 1.

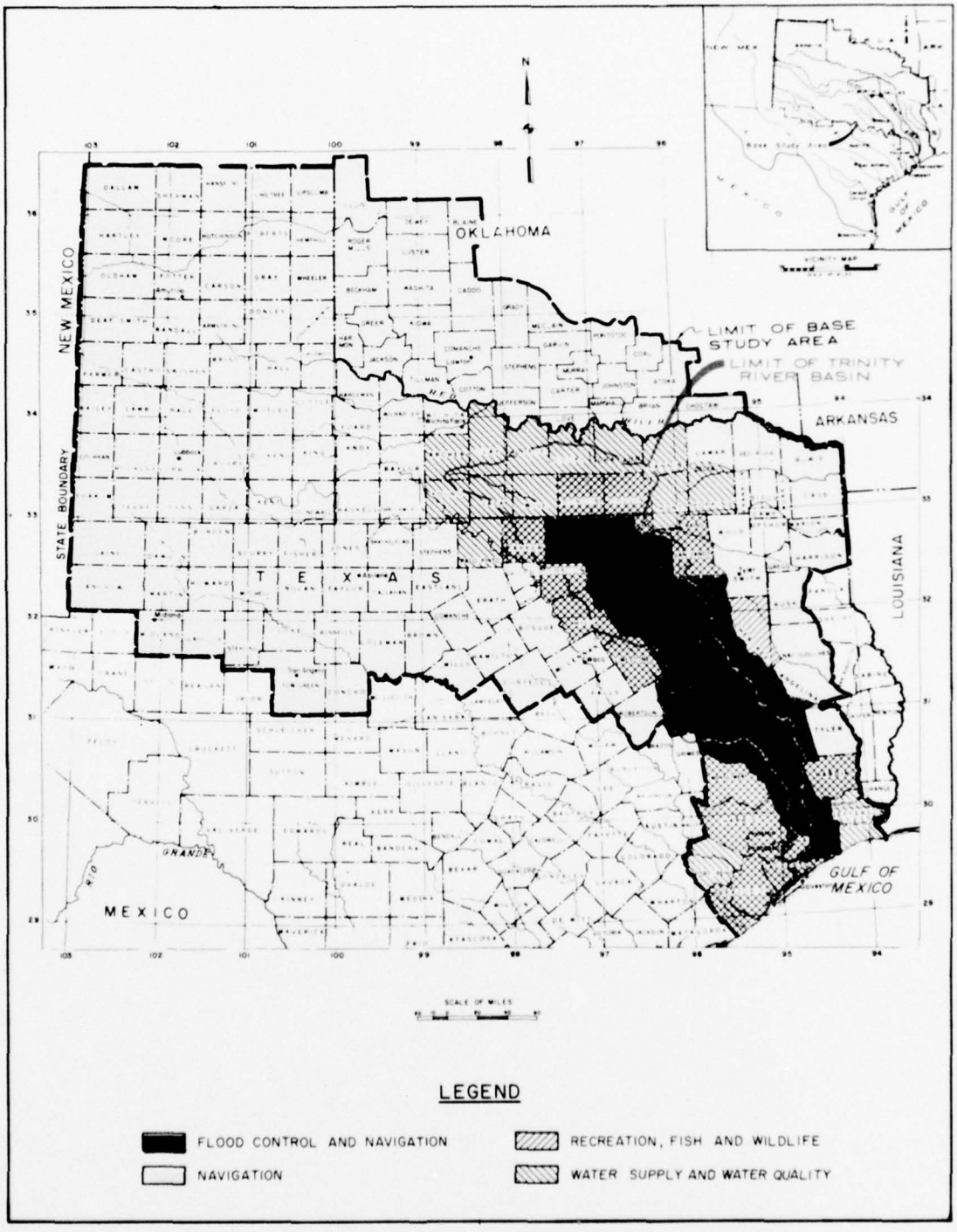

FIGURE I. AREAS PERTINENT TO PROJECT PURPOSES

3. In order to analyze the economic characteristics, development, and past trends and to project future growth and needs, relevant areas for the various project purposes were selected. The base study area is a composite of the areas selected for the various project purposes considered in the basic plan. Guides used in selecting these areas are as follows:

a. Navigation.- Traffic area tributary to the proposed navigation improvement.

b. Flood Control.- Area in and immediately adjacent to areas subject to flood damages.

c. Water Supply.- Area that will affect the potential demand for water.

d. Fish and Wildlife.- Area from which will be drawn recipients of fish and wildlife benefits resulting from the proposed improvements.

e. Recreation.- Area from which will be drawn recipients of recreation benefits resulting from the proposed improvements.

4. Certain factors or economic indicators are used in estimating future growth and needs. The indicators selected for this study include: population, new construction, value added by manufacture, mineral production, retail sales, bank deposits, total personal income, wheat exports, labor force and employment, and value of farm products sold. These indicators were selected for the following reasons:

a. Population.- All economic growth stems from activities undertaken to satisfy human needs. Thus, all project uses may be considered related to population in some way. Population provides the base for demands for all resource uses and is considered to be the basic economic indicator upon which all other economic indicators are dependent in varying degrees.

b. New Construction.- Construction activity sets the pace for activity in a large number of supply industries and was, therefore, selected as an economic indicator for use in this study.

c. Value Added by Manufacture - This economic indicator was selected because it is a measure of industrial activity and because a major portion of the national income and gross national product originate in this sector of the economy.

d. Mineral Production.- Mining is one of the basic industries of the modern society and ready availability of mineral resources is the principal factor which has caused the rapid development of the Trinity River Base Study Area. The indicator is included because of its relationship to all sectors of the economy.

e. Retail Sales.- Retail trade is the most widespread of the non-agricultural industries. As an indicator it reflects changes in business and commerce.

f. Bank Deposits.- The volume of bank deposits is a measure of money available throughout the economic system and is significant in showing total purchasing power. This indicator also has been selected to reflect activity in business and commerce.

g. Total Personal Income.- The gross national product is considered the most comprehensive measure of economic activity. Although gross state and base study area product data are not available at present, data on total personal income are available. Therefore, total personal income has been selected as an economic indicator since it is the principal component of the gross product, and is the best indicator for which data are available for use in all of the areas considered in this study.

h. Wheat Exports.- This economic indicator was chosen to represent that component of the over-all grain movement that is susceptible to movement on the proposed waterway.

i. Value of Farm Products Sold.- Value of farm products sold is a measure of agricultural activity. This economic indicator is closely related to navigation, flood control, and water supply.

j. Labor Force and Employment.- Labor force and employment is considered an appropriate indicator of the needs for raw material including water, and for basic services, such as power and transportation.

5. In establishing estimates of growth trends for the various economic indicators, data for the United States were projected to establish the general trend. Next, the applicable data for the states involved were projected in a manner comparable to that of the United States, with consideration being given to present and prospective future conditions in the individual states. Data of the same nature were then summated and projected within the general framework of the data for the states, consideration being given to present and prospective conditions in the base study area. The projected amounts of the economic indicators at the end of various time periods were then divided

by the corresponding amounts for 1960 to give factors of growth based on 1960, thus assigning the 1960 amounts a value of 1.00. By this procedure, estimates of trends take the form of numerical measures of growth by which the estimates of needs for water resources and benefits under 1960 conditions of development are converted to estimates under conditions which are expected during the life of the projects considered. For the purpose of economic analysis, it was necessary to adopt a time period of project life. Therefore, all projects have been analyzed for the period 1970 to 2070. Estimates of growth factors were made for 1970, 2020, and 2070.

6 The basic data used in this study were extracted from the best available sources including "United States Census of Population," "United States Census of Agriculture," "United States Census of Manufacture," all by Bureau of the Census, United States Department of Commerce; "Survey of Current Business" by office of Business Research, United States Department of Commerce; "Water Resources Activities in the United States," Select Committee on Water Resources, United States Senate; and "A Report to the President and to the Congress," U. S. Study Commission - Texas. Data and initial projections contained in the Trinity River navigation study prepared by the Board staff of the Board of Engineers for Rivers and Harbors have been adapted to this report. All historical data and projections for the United States used in this study pertain to continental United States, i.e., United States, excluding Alaska and Hawaii. All basic data in the form of dollar values used in this study have been rebased on 1960 constant dollars.

ECONOMIC DEVELOPMENT

7. **TRINITY RIVER BASE STUDY AREA.-** The base study area comprises 153 counties in Texas and 30 counties in Oklahoma, and contains 161,300 square miles (land area) which is about 9 times the area of the Trinity River Basin. Approximately 7 million people live within the study area and are dependent upon its water resources for their economic and social wellbeing. Surface and ground water resources of the base study area furnish about 860 and 690 million gallons, respectively, of water daily for use in homes, farms, offices, factories, and other institutions. The surface waters also provide for recreation, irrigation, navigation, and commercial fishing. The base study area slopes gradually southeastward from above 4,000 feet elevation in the extreme northwest to sea level at the coast. It occupies three distinct physiographic provinces: Great Plains, Central Lowland, and Coastal Plain. The first of these, the Great Plains, comprises approximately the western one-fourth of the area and is characterized by level, treeless plains principally devoted to farming and ranching. The West Texas rancher, traditional to this

area, has been progressively supplanted by the farmer and "feed-lot" operator. In 1959, land irrigated with ground water in these Great Plains amounted to about 67 percent of the total acreage irrigated in Texas. The industries of this portion of the base study area are mainly those associated with agricultural production. The central portion of the base study area occupies the rolling prairies of the Central Lowland. Farming, ranching, and petroleum production and processing are the principal occupations in this portion of the area. The eastern approximate one-half of the study area occupies the Coastal Plain and ranges from densely timbered swamp lands in East Texas to the intensely cultivated, highly productive Blackland Prairies, and to highly industrialized urban areas. Over 70 percent of the population of the base study area resides in the coastal plain portion.

8. POPULATION.- The population of the Trinity River base study area was 6,844,000 in 1960, or about 4 percent of the total United States population. A comparison of the growth rates given in table 1 shows that the population of the study area has had an average annual rate of increase considerably greater than the rate of the United States, except for the decade from 1940 to 1950. During the 70-year period from 1890 to 1960 the study area's average annual population growth rate was 2.22 percent compared with a national rate of 1.50 percent.

TABLE 1

POPULATION GROWTH
TRINITY RIVER BASE AREA AND UNITED STATES

Year	Population (thousands)		Average annual percent of growth per period		TRBSA as percent of U. S. total
	U. S. *	TRBSA	U. S. *	TRBSA	
1890	62,948	1,468	-	-	2.33
1900	75,995	2,094	1.90	3.62	2.75
1910	91,972	3,230	1.92	4.43	3.51
1920	105,711	3,802	1.40	1.64	3.60
1930	122,775	4,613	1.51	1.95	3.76
1940	131,669	4,952	0.70	0.71	3.76
1950	150,697	5,613	1.30	1.26	3.72
1960	178,464	6,844	1.71	2.00	3.83

* Exclusive of Alaska and Hawaii
TRBSA - Trinity River Base Study Area
Source: United States Department of Commerce, Bureau of the Census

9. Within the study area there are 16 cities having a population over 50,000 which comprise about 45 percent of the total population. These 16 cities together with their populations at the decennial years from 1910 to 1960 and the intercensal percent of increase of their total population are given in table 2. An analysis of these data shows that the average annual growth rate for the 16 cities was 4.19 percent, which is about 2.5 times the growth rate of the base study area for the same period. The national urban average growth rate for the period of 1910 to 1960 was 2.20 percent.

TABLE 2

POPULATION OF MAJOR CITIES
TRINITY RIVER BASE STUDY AREA

State & City	1910	1920	1930	1940	1950	1960
Texas						
Abilene	9,204	10,274	23,175	26,612	45,570	90,368
Amarillo	9,957	15,494	43,132	51,686	74,246	137,969
Beaumont	20,640	40,422	57,732	59,061	94,014	119,175
Dallas	92,104	158,976	260,475	294,734	434,462	679,684
Fort Worth	73,312	106,482	163,447	177,662	278,778	356,268
Galveston	36,981	44,255	52,938	60,862	66,568	67,175
Houston	78,800	138,276	292,352	384,514	596,163	938,219
Lubbock	1,938	4,051	20,520	31,853	71,747	128,691
Midland	2,192	1,795	5,484	9,352	21,713	62,625
Pasadena	-	-	1,647	3,436	22,483	58,737
Port Arthur	7,663	22,251	50,902	46,140	57,530	66,676
San Angelo	10,321	10,050	25,308	25,802	52,093	58,815
Tyler	10,400	12,085	17,113	28,279	38,968	51,230
Waco	26,425	38,500	52,848	55,982	84,706	97,808
Wichita Falls	8,200	40,079	43,690	45,112	68,042	101,724
Oklahoma						
Lawton	7,788	8,930	12,121	18,055	34,757	61,697
Total	395,925	651,920	1,122,884	1,319,142	2,041,840	3,076,861
Percent Increase	-	64.66	72.24	17.48	54.79	50.69

Source: United States Department of Commerce, Bureau of the Census.

10. EMPLOYMENT.- Total employment for the base study area in 1960 was 2,569,000, or slightly under 4 percent of the total national employment. Between 1940 and 1960 total employment in the study area rose 55 percent compared to the over-all national increase of 40 percent. The increased rate of employment expansion relative to the nation reflects the rapid industrialization of the study area especially in the metropolitan areas of Dallas, Fort Worth, and Houston. Comparisons of the change of agricultural and nonagricultural employment and types of nonagricultural employment between 1940 and 1960 are shown in figure 2.

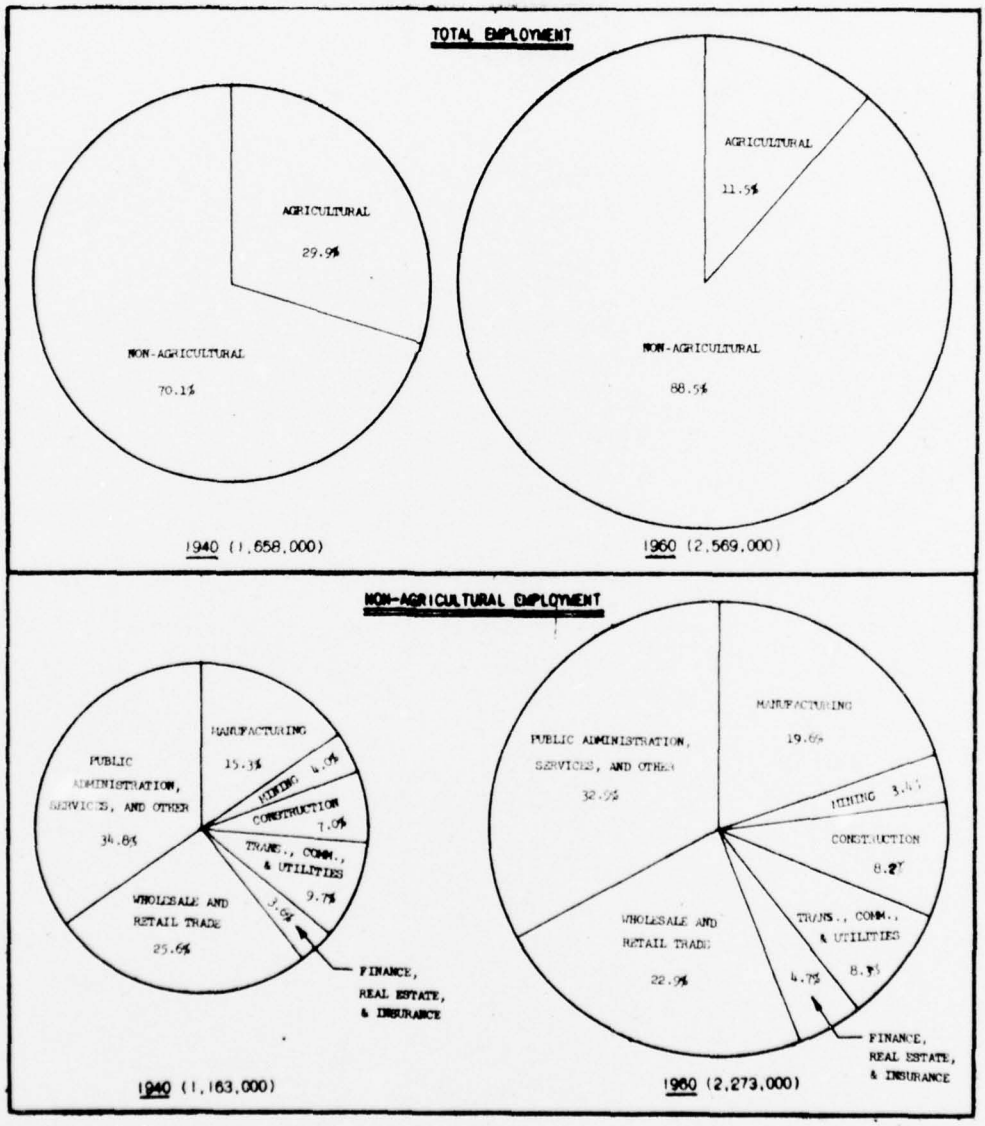

FIGURE 2. EMPLOYMENT IN THE BASE STUDY AREA (1 SQ. IN. = 417,200)

11. PERSONAL AND PER CAPITA INCOME.- Personal income is the most comprehensive available measure of economic activity. There is a close and generally constant relationship between that series and gross national product over the long run. At the national level it has been found that personal income exhibits the same 3 percent average annual growth rate that characterizes the secular trend of gross national product. In 1960, the 6.8 million residents of the base study area provided a labor force of 2.7 million and received $13.7 billion of personal income. On the basis of a per capita total this amounted to $2,015 which is about 10 percent below that for the nation as a whole. However, between 1940 and 1960, total personal income for the study area increased at an average annual rate of 5.74 percent which was one-quarter greater than the national average of 4.54 percent for the same period. The relative significance of major economic activities in percent of their over-all contribution to total personal income in 1940 and 1960 is shown in table 3.

TABLE 3

DISTRIBUTION OF PERSONAL INCOME BY SOURCE
TRINITY RIVER BASE STUDY AREA
1940 and 1960

Source	Percent of total	
	1940	1960
Personal income total (excluding military)	100.0	100.0
Property income	15.5	15.8
Transfer payments	3.1	6.2
Civilian earning total	81.4	78.0
Manufacturing	10.2	16.0
Wholesale and retail trade	17.9	17.4
Services	9.1	9.8
Public Utilities, transportation, & communication	8.5	7.4
Finance, insurance & real estate	3.2	4.3
Construction	3.5	5.3
Government	9.9	7.6
Farms	14.2	5.9
Mining	4.7	4.1
Other	0.2	0.2

12. **MANUFACTURING.-** The growth of manufacturing has been more rapid than that of any other economic development in the region and has been brought about by changing market demands, rapid technological improvements, increasing mobility of people and goods, and wartime emergencies. Raw materials for manufacturing are many, but those coming from mining and agricultural activities have the biggest role in the area economy. Many of the raw materials of the study area are adaptable to industrial needs. The current trend is toward increased chemical processes in manufacturing as compared to the mechanical processes used in the past. The principal raw materials available from the study area which are easily adaptable to use in the chemical industries are oil, gas, lignite, cotton, grain sorghums, and forest products.

13. The growing industrial character of the study area is evidenced in the value added by manufacture, which jumped from $841 million in 1939 to $4.3 billion in 1958, an increase of about 400 percent. The study area contributed 84 percent of the State of Texas' and 3.0 percent of the nation's value added by manufacture, respectively. The value added by manufacture in the base study area as a percent of the United States and the amounts of the value added by manufacture in the base study area from 1929 through 1958 are shown in figure 3.

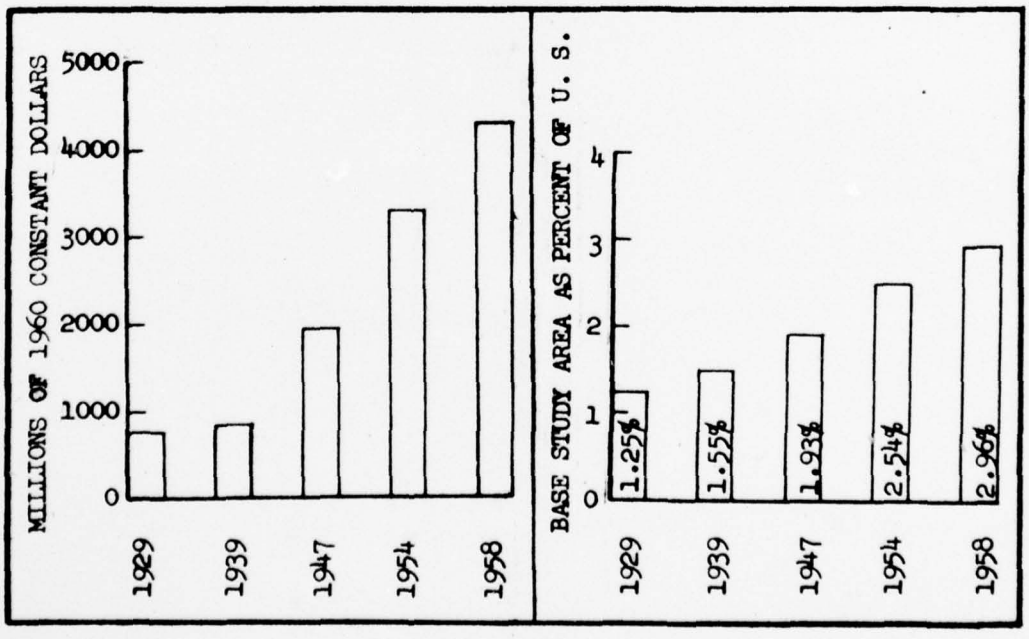

FIGURE 3. VALUE ADDED BY MANUFACTURE—BASE STUDY AREA

The four largest industry groups in the study area are chemical, petroleum, transportation equipment, and food products. The chemical industry is one of the newest and fastest growing in the area, and the abundance of raw materials available for petrochemical development indicate that it will continue to grow in the future. The manufacture of chemicals and associated products within the study area is concentrated in the Houston and Beaumont-Port Arthur area. The petroleum refining industry, which ranks second to petrochemicals in the value of manufactured products in Texas, is concentrated mainly along the Houston Ship Channel and Sabine-Neches Waterway. The transportation vehicle and equipment industry is principally concentrated in the military aircraft factories in the Dallas-Fort Worth complex and constitutes 40 percent of the value added by manufacture for Dallas-Tarrant Counties. The production of food and kindred products is also one of the area's leading industries, and some of the largest establishments are found in the larger population centers of Houston, Dallas, and Fort Worth.

14. Textile mill products, while not relatively important at the present time, give indications of becoming a large industry in the future. The production of wearing apparel and related products has grown rapidly due to the adequate supply of labor in the larger cities, with its greatest concentration in Dallas. The lumber and wood products industry is located principally in the East Texas forest area and is expected to grow rapidly in the future due to the fact that forests are now producing timber faster than it is cut. Printing and publishing is probably the most widely distributed industry in the area, but Dallas is the leading city in the State in volume of business. Other significant industries in the study area include stone, clay, and glass products, leather and leather goods, primary metals, and machinery manufacturing.

15. The value added by manufacture in 1958 for the three major cities of the base study area, Dallas, Fort Worth, and Houston, aggregate 60 percent of the base study area value and 50 percent of the Texas value. A breakdown of the value added for the various industries in 1958 for the three cities is shown in figure 4.

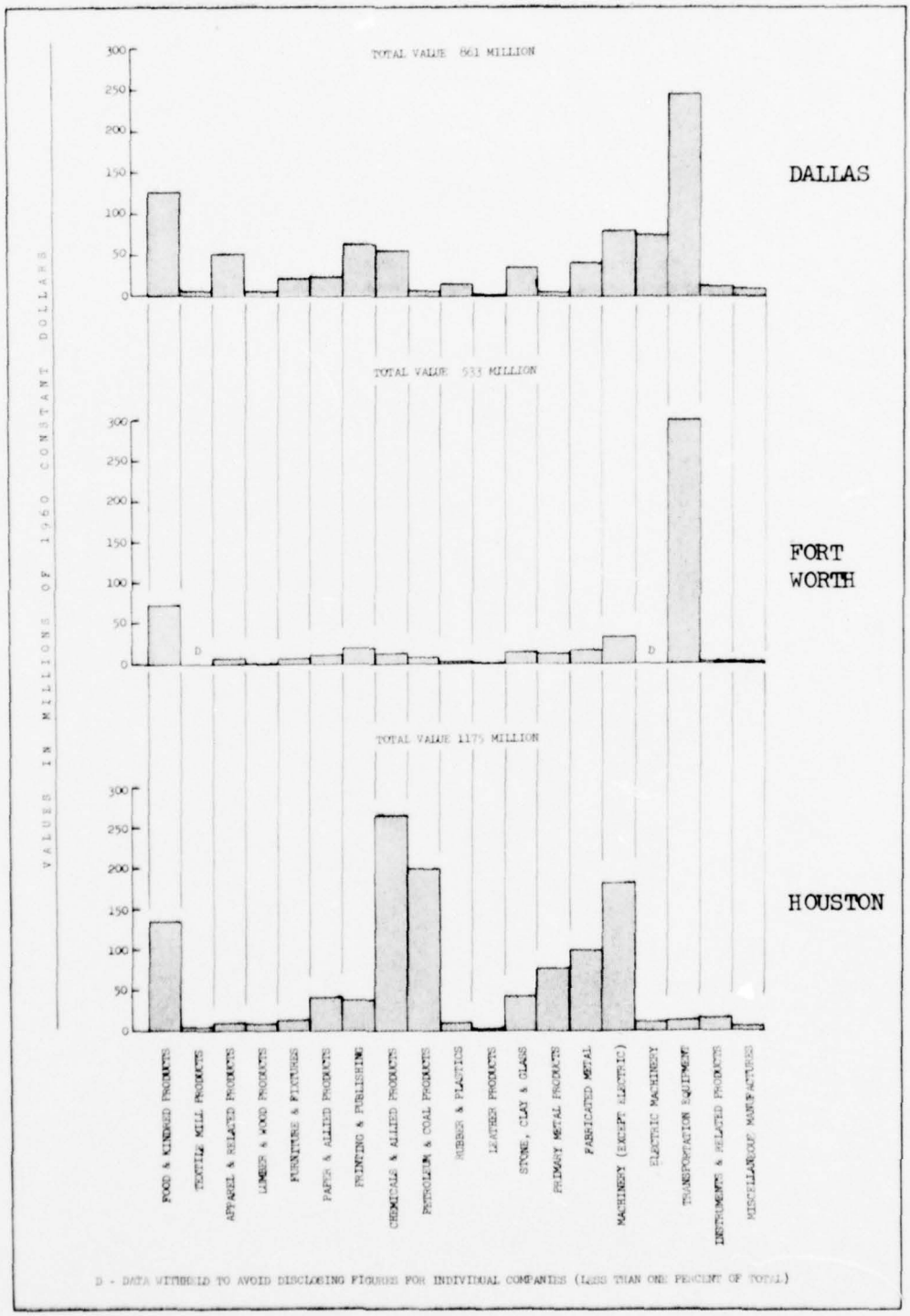

FIGURE 4. MANUFACTURE IN 1958 - DALLAS, FORT WORTH, HOUSTON

16. POWER.- The growth of electric generating capacity in Texas is the fastest of any state in the nation. The tremendous increase in power production has taken place mainly within the study area as evidenced by the increase from 1.7 billion kilowatt hours in 1937 to an estimated 14.4 billion kilowatt hours in 1960 which is a total increase of about 750 percent. Comparable figures for the United States show an expansion from 180 billion kilowatt hours to 850 billion kilowatt hours or a total increase of 370 percent. The hydroelectric capacity in the base study area is about one percent of the total installed capacity as of 1960. The remainder of the requirements are being met by steam-electric plants with some minor internal combustion plants used principally for peaking purposes. The majority of thermal-electric plants are fueled by natural gas which is readily available throughout the area.

17. Future development of conventional-type hydroelectric plants is considerably restricted due to the incompatibility of methods of operation of storages for hydro-power and water conservation in multiple-purpose reservoirs, the prevalence of low-cost gas fuel for steam-generating facilities, and the high cost of low-head hydroelectric equipment. The priority of uses of water resources by the State of Texas places hydroelectric power development subordinate to development for municipal and industrial water uses.

18. TRANSPORTATION.- Availability of transportation is essential to free exchange of goods and products which is, in turn, essential to economic growth. The urbanization and growth of any area is directly dependent upon adequate and economical transportation. Without efficient and economical transportation, the growth of cities and the concentration of industry and manufacturing would be limited by the ability to derive a food supply for inhabitants and all other basic necessities for the general economy from the immediate locality. The cost of transportation is an integral part of the cost of production, and the free exchange of goods and products can be effected only to the extent that efficient and economical transportation is available.

a. Modes of Intercity Freight Transport.- There are five significant modes of transport for intercity freight in the United States. Statistics show that in 1958 railroads carried about 46 percent of all intercity freight, with the remainder being divided among highways, 21 percent; inland waterways, 16 percent; oil pipelines, 17 percent; and airlines, a small fraction of one percent. Based on the forecasted growth of the gross national product and a continuation of the present relationship between the gross national product and intercity freight traffic, it has been estimated that by 1980 the United States will need a transportation system having a capacity, in ton-miles, of about double the nation's present freight traffic. By the year 2000, freight traffic is estimated to be at least four times the present volume.

b. Rail Transport.- Although, at this time, railroads generally are operating at less than physical capacity, the emergency demands of World War II strained the freight-carrying capacity of the railroads to the utmost. Since World War II, numerous branch lines have been abandoned. However, the use of improved rolling stock and more efficient operating practices have increased the total freight-carrying capacity of the lines remaining in operation. Undoubtedly, the railroads could absorb a considerable increase in freight volume with little increase in track mileage. This is true because, in the past, many railroads were built with little regard to the total demands for freight movement. Consequently, except for war emergency periods, there has been a chronic surplus of rail capacity in many parts of the nation. With the projected future demands for intercity transportation, it is not likely that this condition, in general, will endure beyond the next few years. The base study area is served by the rail transportation facilities of seven major railroad systems, which provide a network pattern of main lines with feeder and distributor branches through the basin. The north-south main lines provide connections between the central transcontinental routes of the Union Pacific system and the southern transcontinental routes of the Southern Pacific and Atchison, Topeka, and Santa Fe systems. Generally, the north-south main lines from St. Louis, Kansas City, Wichita, and Denver, converge on the Dallas-Fort Worth area, and, following diverging routes through eastern and central Texas, continue southward to Houston and Galveston, Waco, Austin, San Antonio, and the Rio Grande Valley.

c. Motor Truck Transport.- A network of improved highways provides facilities for motor transport in all parts of the base study area. The highway facilities are being augmented at this time by construction of an elaborate system of modern highways, through the interstate highway program. As with the railroads, there is no doubt that motor freight carriers could move larger amounts of freight than they are now moving; although the joint use of the highways by motor trucks and private automobiles presents serious problems in traffic control and highway construction and maintenance as the total volume of traffic increases. With the certainty of a large increase in the demands for intercity freight transportation in future years, it is probable that by 1980 the carrying capacity of existing facilities will have been reached, if additions to the transportation system are not made before that time.

d. Air Freight Transport.- Air freight is of little significance in the over-all pattern of intercity feight transportation. The advantage of air freight lies in ultra-rapid movement of small, light-weight items. There is no doubt that the movement of air freight will continue to increase, perhaps by larger percentages than other modes of transport. However, the limitations of size, weight, and high cost will preclude the movement of any significant portion of the total intercity freight by air.

e. Pipelines.- An extensive network of pipelines extends in and through the base study area. The pipelines principally are for gathering and distributing natural gas or for gathering crude oil from producing oil fields and transporting the oil to refining centers, chiefly in the Houston, Beaumont, and Port Arthur areas. Some of the pipelines serve as common carriers; but, for the most part, they are owned by major oil companies and are used for integration of a particular company's oil production and refining operations. Pipelines are used also for moving liquid refined products from refineries to large centers of distribution. The volume of liquid petroleum moving in pipelines may vary, depending upon such factors as depletion of old oil fields, discovery of new fields, and governmental regulation of oil production. Pipelines will remain an important factor in transportation of liquid petroleum commodities. However, being limited to the movement of liquids, they can be assigned only a small field of application in satisfying the general mass transportation demands.

f. Water Transportation.- The base study area is served by the deep water ports of the Gulf Coast, six of which are within its limits. These are Beaumont, Galveston, Houston, Port Arthur, Sabine Pass, and Texas City. One of these, the port of Houston, 50 miles inland from Galveston, handled 60 million tons of commerce in 1959, a volume surpassed in the Nation only by the Port of New York. The six ports together accounted for 130 million tons, 12 percent of the total for the United States. Foreign exports amounted to 14 million tons and consisted principally of distillate fuel oils, residual fuel oils, lubricating oils and greases, iron and steel scrap, coke, cotton, corn, barley, rye, grain sorghum, rice, ammonium sulfate and dry sulphur. Foreign imports amounted to 4 million tons and consisted principally of crude petroleum, residual fuel oil, rolled finished steel mill products, iron ore and concentrates, gypsum, inedible molasses and sugar. About 112 million, over 85 percent of the commerce handled by these ports, was domestic commerce consisting mainly of crude petroleum, gasoline, benzol, kerosene, alcohol, iron and steel pipe, rolled finished steel mill products, unmanufactured shell, phosphate rock, sand and gravel, crushed rock, clays and earths, dry sulphur and sugar. Nearly 30 percent of the domestic commerce was carried by barge on the Intracoastal Waterways. No city in the study area further inland than Houston is directly served by barge transportation.

19. AGRICULTURE.- Although the base study area is undergoing rapid industrialization, agricultural development is still of major importance in the area and will remain so for many years to come. Rapid development and transition have taken place in this field, with new crops being planted, new procedures being used, and new land use practices such as beef production and tree farming. There has also been a steady rise in the standard of living on the farm, based on the construction of farm-to-market roads and the extension of electric, telephone, and natural gas services. Crop rotation, erosion control, development of improved seed strains, improved pest and disease control, improved fertilization, and improved strains of beef and dairy cattle have all resulted in increased production of farm products. Also, mechanization has resulted in a rapid increase in the size of farms and has greatly increased man-hour production. Although there was only a slight change in total land area in farms in the base study area, about one percent decrease, from 1954 to 1959, there was a 30 percent increase in the average size of farms and the number of farms decreased 24 percent. In comparison, the Texas total area in farms decreased about two percent, the size of farms increased 27 percent, and the number of farms decreased 22 percent. The principal farm products produced in the base study area are grain sorghums, cotton, rice, wheat and livestock. Figure 5 shows graphically farm production in 1959 for the base study area in absolute values and in terms of percentages of production in the United States for the same year. For the base study area, the value of farm products sold in 1959 amounted to 1.5 billion dollars.

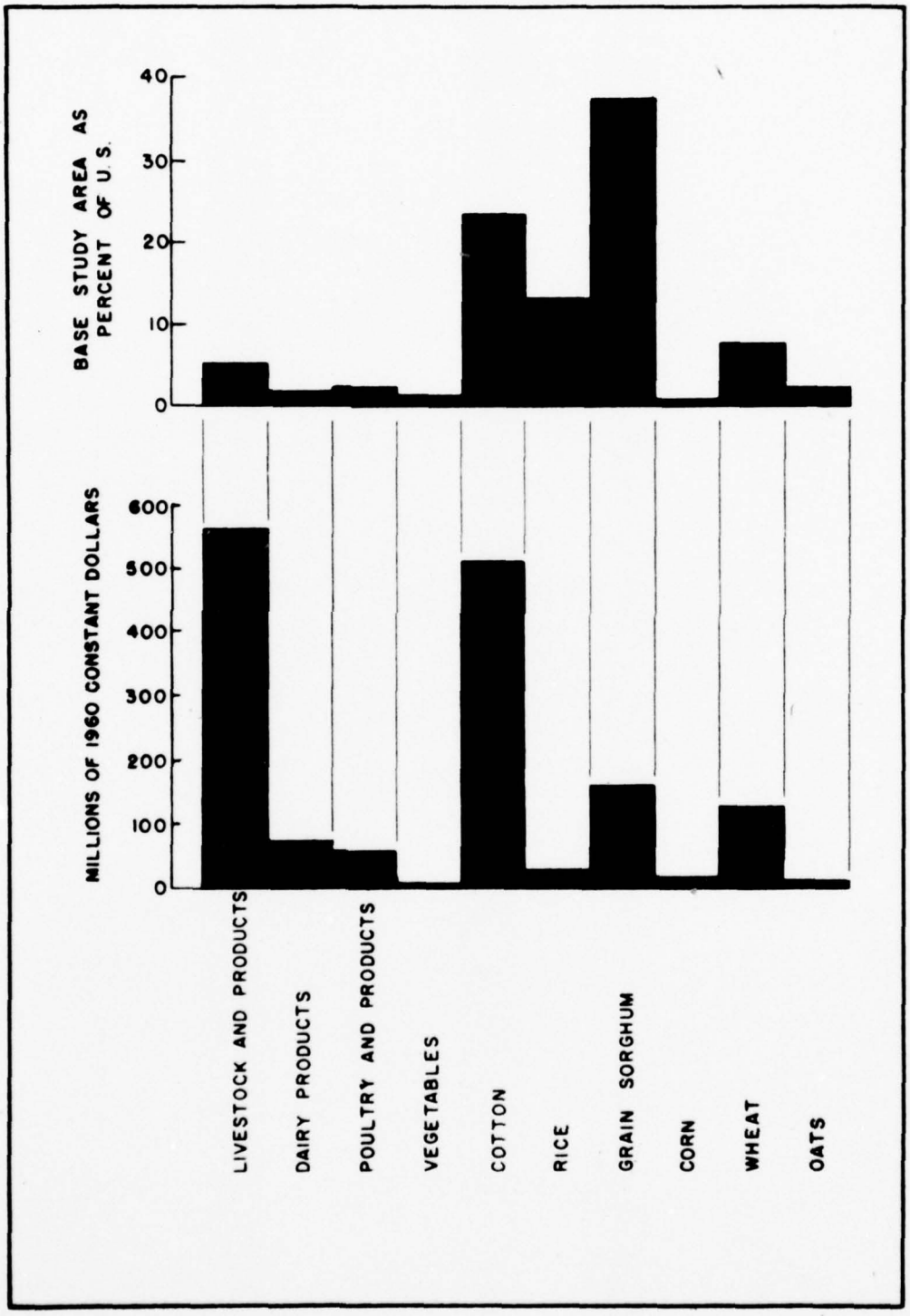

FIGURE 5. VALUE OF FARM PRODUCTION IN THE BASE STUDY AREA-1959

20. ROLE OF NATURAL RESOURCES IN THE ECONOMY.- The expansion of the economy of the base study area from frontier subsistence to a growing urban-industrial complex has occurred largely since the Reconstruction period following the Civil War and as a result of the vast and varied resources of the region. The first of several economic stages, the colonial era of cotton and cattle, was an energetic period of rapidly advancing frontier, gathering momentum with the westward push of the railroads. The second stage, that of forest and mineral exploitation, began near the turn of the century and continued a rapid increase until 1940. This middle period of exploitation of natural resources spawned the next major period of development in the study area, that of industrialization and urbanization, which is of utmost importance today.

21. TIMBER.- Most of the heavily timbered areas in this region are located in 43 counties in East Texas and 17 counties in East Oklahoma. The base study area encompasses three of the Oklahoma counties and 34 of the counties in Texas. Timber interests first undertook large-scale operations in forest exploitation toward the end of the 19th century and by 1907 more than two billion board feet were being removed, mainly from the East Texas area. The tremendous production of timber during the early part of this century caused rapid depletion of the forest reserves and brought about the establishment of a conservation program in 1915 by the Texas State Department of Forestry (later changed to Texas Forest Service). The conservation program assured adequate forest reserves and during the period from 1915 to 1958 lumber production for the State of Texas averaged a billion board feet annually. Today timber is being growr more rapidly in the East Texas Forest Belt than it is being harvested and has been established as an important permanent resource. The commercial forest land in the study area and the amount of growing stock and saw timber volume is given in table 4.

TABLE 4

COMMERCIAL FOREST IN TRINITY RIVER BASE STUDY AREA
1953-1956

Item	Unit	TEXAS 34-county total	Percent of State total	OKLAHOMA 3-county total	Percent of State total
Land area	1,000 acres	17,935.5	10.6	1,473.3	3.3
Commercial forest	1,000 acres	9,471.3	77.8	744.0	13.2
Growing stock:					
Softwood	Mil. cu. ft.	2,872.6	71.4	2.1	0.4
Hardwood	Mil. cu. ft.	2,736.8	78.0	162.5	19.8
All species		5,609.4		164.6	
Saw timber volume:					
Softwood	Mil. bd. ft.	12,576.5	71.6	7.8	0.4
Hardwood	Mil. bd. ft.	7,341.9	75.9	414.9	20.5
All species		19,918.4		422.7	

Source: United States Department of Agriculture, Forest Service, Forest Survey releases 77 and 79.

22. MINERALS.- About 30 different kinds of minerals are produced on a commercial scale in Texas and Oklahoma and most of these are found in the study area. However, there are very few mines in the original sense of the word, and most of the mineral production is made up of petroleum and allied petroleum minerals. The first commercial petroleum production of importance in Texas came from discovery at Corsicana in 1894. Since then all oil exploration has expanded rapidly throughout the Southwest and in 1961, Texas and Oklahoma produced about 895 million and 191 million barrels of crude oil, respectively, which was 43 percent of the total United States production. Crude oil production within the study area for 1959 of about 620 million barrels in Texas and 90 million barrels in Oklahoma constituted 28 percent of the national output.

23. The future of oil production in the region naturally is dependent on the recoverable reserves. Although a reserve-production ratio decline has actually occurred over the past six-year period, it should be noted that there has been some increase in total national reserves, with Texas reserves remaining about steady through 1960. In late 1960, a new major discovery was made on the James Reef in

the Fairway Field which is located within the study area in Henderson and Anderson Counties, Texas. Although the limits of the Fairway Field have not been fully established, it was evident, by the end of 1961, that the field is a major producing field, with a potential recovery presently estimated to exceed one-half billion barrels. New discoveries such as this, together with advanced technology in oil discovery and production, present an optimistic forecast for the possibility of future oil reserves in the study area. Figure 6 is a graphic presentation of crude oil production and proven reserves for Texas and the United States from 1940 to 1961, and figure 7 shows the distribution of crude oil production in 1958 by counties of the base study area.

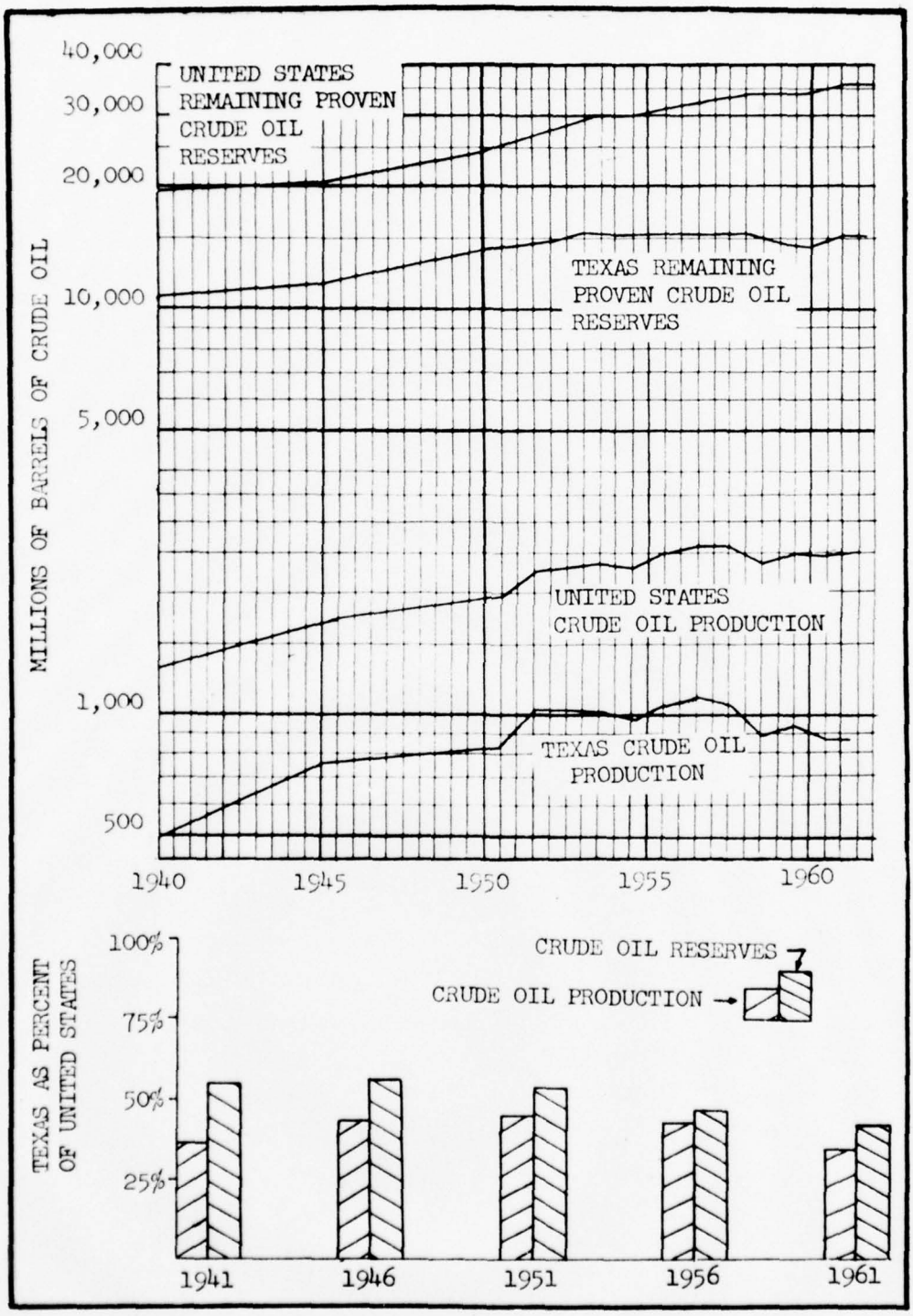

FIGURE 6. PETROLEUM PRODUCTION & RESERVES

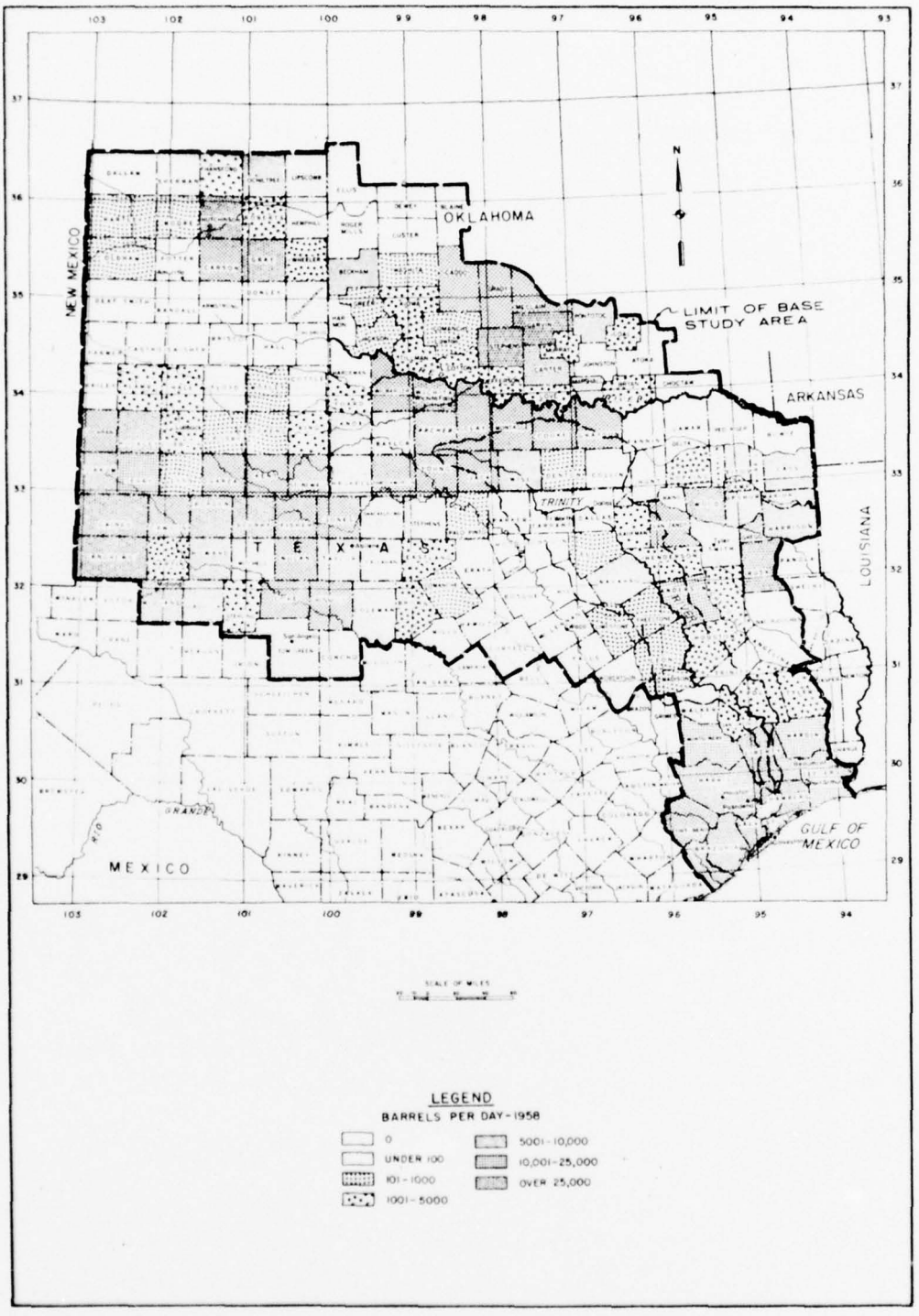

FIGURE 7. PETROLEUM PRODUCTION IN TRINITY BASE STUDY AREA-1958

24. In addition to its widespread use as an efficient domestic and industrial fuel, natural gas occupies an important place in our economy, and in recent years it has been increasingly used as a raw material for a wide variety of products of the modern chemical industries. In 1961, natural gas production in Texas was about six trillion cubic feet which is 45 percent of the national production and valued at $600 million. / Oklahoma contributed 6.5 percent of the national output with 857,000 million cubic feet. Although natural gas resources are widely distributed throughout the southwest region, gas in commercial quantities is not as widely found as crude oil. Within the study area natural gas production of about two trillion cubic feet constituted 16 percent of the production for the United States in 1961.

25. Texas' natural gas resources are widely distributed, with the major fields being located in the Panhandle, the Permian Basin area of West Texas, North Central Texas, East Texas, and the Gulf Coast. The State has nearly one-half of the nation's underground proven reserves of this mineral.

26. Natural gas liquids are also produced in large quantities in the base study area. Liquid gas products, whether obtained from natural gas or processing in refineries, are defined by the Bureau of Mines as natural and finished gasolines, ethane, propane, butane, isobutane, etc. The study area's production was over 100 million barrels of natural gas liquids in 1959 and is second only to crude oil production in total monetary value of minerals. The American Gas Association Reserves Committee estimated recoverable reserves of natural gas liquids in the United States at the end of 1959 of 6,522 million barrels which was an increase of 362 million barrels or 6 percent over the previous year. The State of Texas, including the offshore area in the Gulf, accounted for 53 percent of the total estimated reserves.

27. Other mineral resources available in large quantities from the study area are sand and gravel, stone, lignite, common salt, and sulphur. Sand, gravel, and stone production in 1959 totaled over 40 million tons valued at greater than $50 million.

28. WATER.- Of the total surface water yield from the base study area in 1957, 50 million acre-feet flowed out of the base study area unused, whereas the area's consumptive uses, including municipal, industrial, and irrigation uses, amounted to only 5 million acre-feet, indicating the potential for further water resource development. The residents of the southwest region made a rather late start toward conserving their water resources. Like most frontier people, they took an adequate water supply for granted and only with the rapid growth of urban population in the last 20 years has there been

realization that adequate future water supply was one of the area's big problems. The critical drought which occurred in this area during the period 1950-1957 caused restriction on uses of water in about one-half the incorporated places in Texas and demonstrated the seriousness of the water problem. In addition to surface waters, a large portion of the study area is underlaid by great natural underground water reservoirs. These ground water supplies have played a tremendous part in the economic development of the area, furnishing water for municipal and industrial needs and irrigation. The five major sources of underground water located in the study area are the Trinity, Paluxy, and Woodbine sands; the Carrizo sand and Wilcox group; the Gulf Coast aquifers; the Ogallala formation; and the alluvial deposits within the flood plains of the various streams. In most of these aquifers there has been a general lowering of the water table, but by future increase in the use of surface waters and the possibility of recharging the groundwater reserves by injection of surface waters, it is anticipated that underground water resources will be available for many years in the future.

29. Water as a natural resource and its development will continue to be a major requirement in providing for the rapid growth and industrial activity of the area. As the population continues to expand along with higher living standards during the next century, an even greater reliance must be placed on the water resources of the base study area.

30. Maintenance of water quality and reduction of stream pollution are essential in the future consideration of water as a natural resource. The future expansion of population and industrial activity in the base study area with resultant increased waste loads being discharged into the streams will direct more attention to contributions that can be made to the improvement of water quality either through direct reduction of waste loads, or by dilution from increased streamflow. Failure to recognize future trends in water use would add to the over-all water quality problems and might result in preventing the full development of the water resources.

31. In summary, the base study area has been the principal contributing area of the nation for the past three decades in the production of petroleum, refinery products, natural gas, sulphur, cotton, cattle, and grain sorghums. For the past 15 years, it has been a top ranking area in the important nonferrous metals and chemical industries. Rapid industrialization and mushrooming urban population growth, supported more and more by a diversity of manufacturing enterprises, are characteristic of the study area today. In this connection, it is generally recognized that many of the existing manufacturing corporations with their establishments

centered in the northeastern portion of the United States are gradually shifting their activities toward the Southwest, a great portion of which region lies within the base study area. The rapid economic growth of the base study area is further evidenced by a comparison of historical data on the economic indicators selected for this study. The average annual percent of increase for all indicators except the value of farm products sold has been greater for the study area than for the United States. The factors which have caused this expansion, i.e., climate, area for expansion, raw materials, transportation facilities, and a viable, energetic labor market, will continue to support this dynamic growth.

PROJECTION OF POPULATION

32. HISTORICAL DATA.- Table 5 contains historical data pertaining to population which has been extracted from publications of the U. S. Department of Commerce, Bureau of the Census, and the computed average annual rates of change for each decennial period. The term "United States" refers to the 48 states and the District of Columbia and excludes Alaska and Hawaii. The data for Oklahoma prior to 1910 are considered incomplete.

TABLE 5

POPULATION: 1890 - 1960

Year	United States		Texas		Oklahoma		Base study area	
	Population	Average annual percent change	Population	Average annual percent change	Population	Average annual percent change	Population	Average annual percent change
1890	62,947,714	1.90	2,235,527	3.15	258,657	11.82	1,468,279	3.62
1900	75,994,575	1.92	3,048,710	2.49	790,391	7.68	2,094,355	4.43
1910	91,972,266	1.40	3,896,542	1.79	1,657,155	2.04	3,229,895	1.64
1920	105,710,620	1.51	4,663,228	2.25	2,028,283	1.68	3,801,588	1.95
1930	122,775,046	0.70	5,824,715	0.97	2,396,040	(-)0.25	4,613,173	0.71
1940	131,669,275	1.30	6,414,824	1.86	2,336,434	(-)0.45	4,952,485	1.26
1950	150,697,361	1.71	7,711,194	2.19	2,233,351	0.42	5,612,973	2.00
1960	178,464,236		9,579,677		2,328,284		6,843,956	

Source: United States Department of Commerce, Bureau of the Census.

33. PROJECTION.- The projection of the population of the United States as adopted for this report was based on the results of several projections. In the Economic Base Survey of the Delaware River Service Area, prepared by the U. S. Department of Commerce, Office of Business Economics, for the Corps of Engineers, U. S. Army Engineer District, Philadelphia, Pennsylvania, June 1958, the population of the United States at year 1980 is estimated to be 248,000,000 and at year 2010 is estimated to be 370,000,000. The findings of the United States Senate Select Committee on National Water Resources as reported in Committee Print No. 5, "Population Projections and Economic Assumptions," March 1960, contain basic projections for studies as tabulated below:

	Population in Millions		
	1970	1980	2000
Low	201	225	267
Middle	207	244	329
High	222	278	431

Tentative estimates based on population increase at the average annual increase experienced in the past were compared with the results of extrapolating the above projections. As a result, a limiting population of 800,000,000 at year 2070 was adopted. The population of the continental United States in 1960 was 178,464,236 according to the Department of Commerce, Bureau of the Census. This amount, projected at the adopted rates, gives an estimated population in 1970 of 206,000,000 and an estimated population in 2070 of 800,000,000. Using the 1960 population as a base value of 1.00, the resultant factors are 1.15 for 1970 and 4.48 for 2070. The average annual rate of increase, 1960 to 2070, is 1.4 percent.

34. In determining the future population of the State of Texas, all available projections were considered and various projections were computed, including a formula projection using a cubic equation, based on historical data for 1880 to 1960, derived by use of a Bendix G-15 computer. In the period 1890-1960, the population of

Texas increased at the average rate of 2.1 percent per year. This is about one and one-half times the average rate of increase of the United States for the same period. A projection of the population of the State expressed as a percent of the population of the United States gave a high percentage at 2070 of about 7.0 percent and a low of about 6.5 percent. After comparing the various trends and resulting population figures, the estimated population of 11,400,000 was adopted for 1970 and 54,000,000 was adopted for 2070. The population of Texas in 1960 was 9,579,677 according to the Department of Commerce, Bureau of the Census. Using the 1960 population as the base value of 1.00, the resultant factors are 1.19 for 1970 and 5.64 for 2070. The average annual rate of increase, 1960 to 2070, is 1.6 percent. Figure 8 shows graphically the populations of Texas and the base study area expressed as percent of the population of the United States for the decennial years 1890 through 1960.

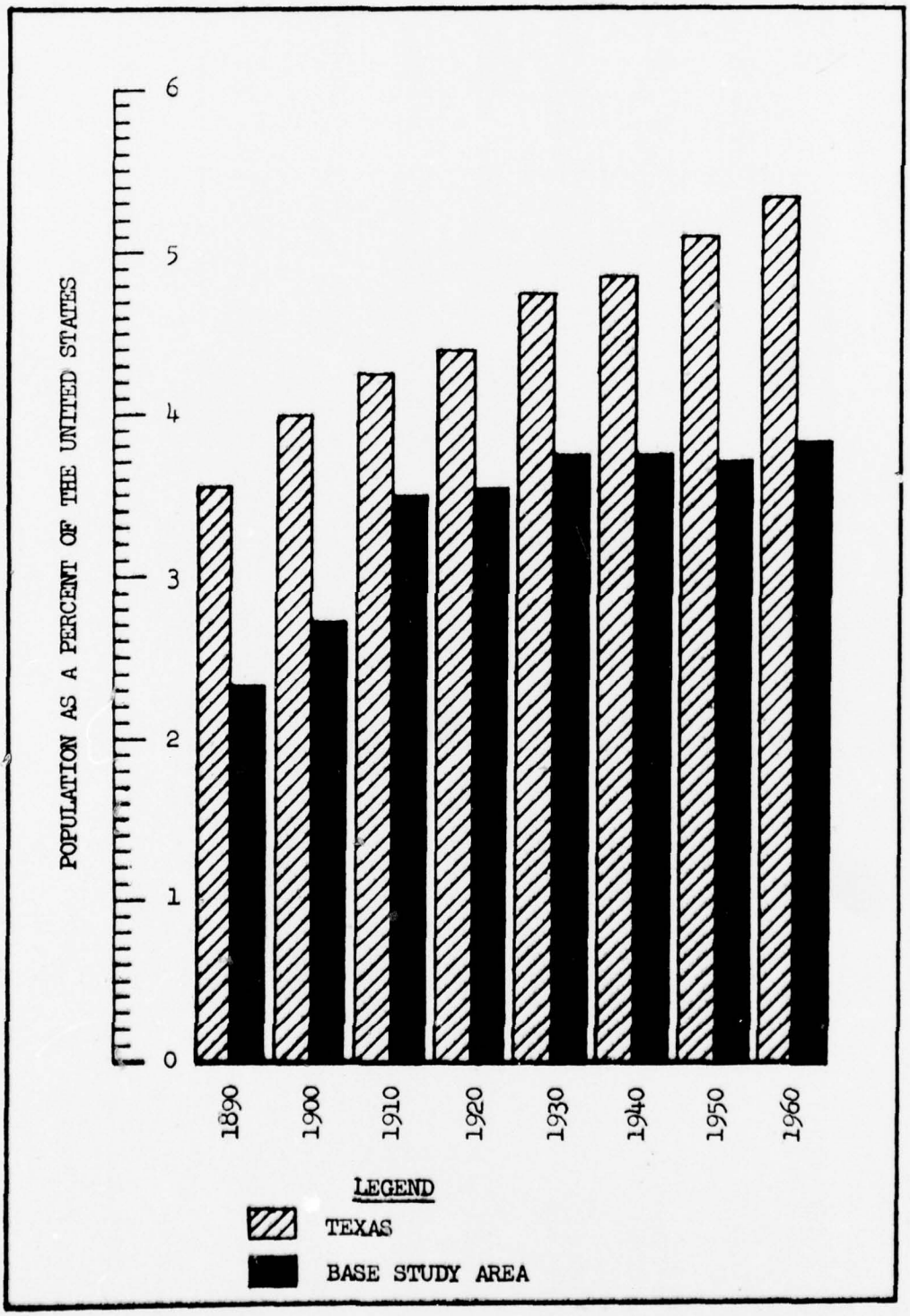

FIGURE 8. POPULATION AS A PERCENT OF THE UNITED STATES

35. Studies, projections, and comparisons of population similar to those for Texas were made for Oklahoma, except that no use was made of the Bendix G-15 computer. Prior to 1930, the intercensal percentage increases for Oklahoma were greater than for the United States. In 1940 and 1950 the population of Oklahoma showed an absolute decline over that of the preceding census. There was a slight increase, 1960 over 1950, but the intercensal increase was substantially less than for the United States. A projection of the population of the State expressed as a percent of the population of the United States indicated an approach to 1.00 percent at 2070. Comparison of the various projections resulted in the adoption of population figures of 2,403,500 at 1970 and 8,000,000 at 2070. The population of Oklahoma was 2,328,284 in 1960. Using this as the base of 1.00, the resultant factors are 1.03 for 1970 and 3.44 for 2070. The average annual rate of increase, 1960 to 2070, is 1.1 percent.

36. Figure 9 is a graphic presentation of the 1960 population of the study area and shows the concentration of the population by counties. The total population in 1960 was 6,843,956 of which about 5,300,000 or 77 percent resided in the eastern half of the area. About 3,634,000 or 53 percent were concentrated in eleven counties of the eastern half. Studies were made of the growth of the 153 Texas counties and the 30 Oklahoma counties in the study area in relation to the growth of the individual States. On the basis of these studies, it is predicted that the population of the study area will increase to 8,085,000 in 1970 and to 35,600,000 in 2070. Using the 1960 population as the base of 1.00, the resultant factors are 1.18 for 1970 and 5.20 for 2070. The average annual rate of increase 1960 to 2070 is 1.5 percent.

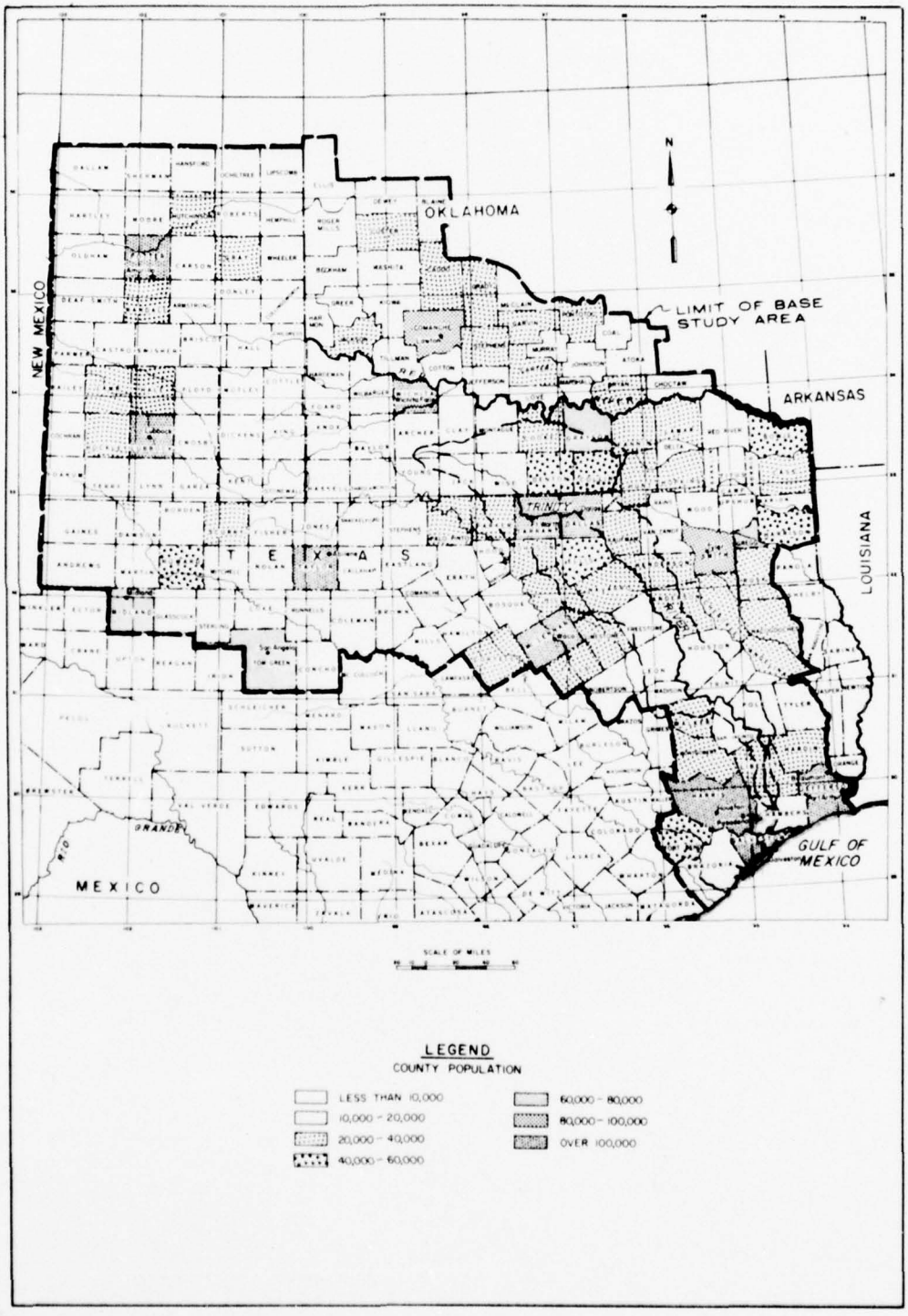

FIGURE 9. COUNTY POPULATION 1960 WITHIN BASE STUDY AREA

37. Population projections are summarized in table 6, and data on population are shown graphically in figure 10.

TABLE 6

PROJECTION OF POPULATION

Year	United States	Texas	Oklahoma	Study area
		AMOUNTS IN MILLIONS		
1960	178.5	9.6	2.3	6.8
1970	206.0	11.4	2.4	8.1
2020	422.0	27.7	4.4	18.6
2070	800.0	54.0	8.0	35.6
		FACTORS OF GROWTH		
1970 ÷ 1960	1.15	1.19	1.03	1.18
2020 ÷ 1960	2.36	2.89	1.88	2.72
2070 ÷ 1960	4.48	5.64	3.44	5.20
		AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	1.37	1.58	1.13	1.51

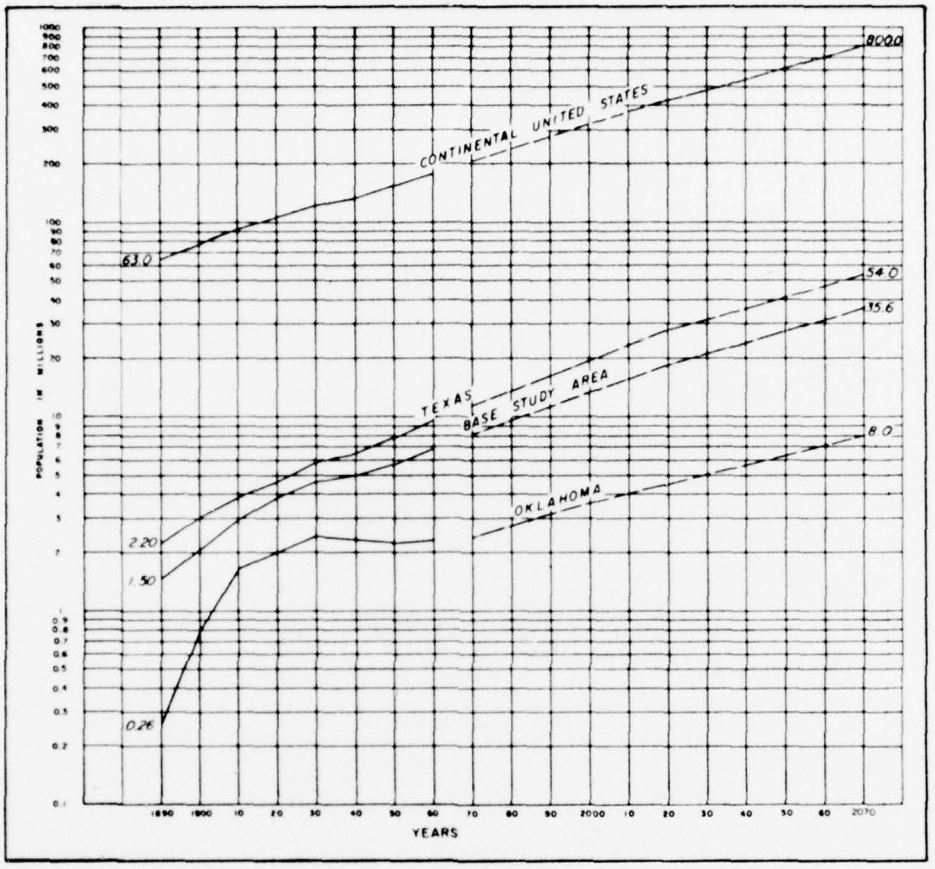

FIGURE 10. POPULATION - PAST AND PROJECTED

PROJECTION OF URBAN POPULATION

38. HISTORICAL DATA.- Data on urban population were extracted from reports of censuses by the U. S. Department of Commerce, Bureau of the Census. Table 7 presents the urban population of the United States, Texas, Oklahoma, and the base study area for the decennial years from 1890 to 1960, inclusive.

39. PROJECTION.- Figure 11 shows graphically the urban population of the United States, Texas, Oklahoma, and the base study area in terms of percent of the total population of each geographical unit for the decennial years 1920 through 1960. Since 1890 the intercensal rate of increase of urban population of the United States has exceeded the rate of increase of the total population by an average of about 75 percent. This is true even after discounting the effect of the change in the urban-rural definition in 1950. This high rate of urbanization is recognized in all available projections for United States urban population. Data and projections from Committee Print No. 5 of the Select Committee on National Water Resources, United States Senate, were used to establish the trend for the projection in this report. The projection of the urban population of the United States in this study assumes the urban population will increase from about 70 percent of the total in 1960 to about 93 percent of the total in 2070. At the adopted rates of increase, the census amount of 124,699,022 in 1960 will increase to 150,100,000 in 1970 and to 746,000,000 in 2070. Using the 1960 population as the base of 1.00, the resultant factors are 1.20 for 1970 and 5.98 for 2070. The average annual rate of increase 1960 to 2070 is 1.6 percent.

TABLE 7

URBAN POPULATION
1890-1960

Year	United States		Texas		Oklahoma		Base Study Area	
	Population	Average Annual Percent Change	Population	Average Annual Percent Change	Population	Average Annual Percent Change	Population	Average Annual Percent Change
1890	22,106,265		349,511		(1)		(1)	
		3.16%		4.07%				
1900	30,159,921		520,759		58,417(1)		455,450(1)	
		3.37%		6.06%		18.55%		6.88%
1910	41,998,932		938,104		320,155		885,693	
		2.58%		4.89%		5.35%		2.63%
1920	54,157,973		1,512,689		539,480		1,148,471	
		2.44%		4.68%		4.36%		4.47%
1930	68,954,823		2,389,348		821,681		1,778,696	
		0.77%		2.00%		0.68%		1.80%
1940	74,423,702		2,911,389		879,663		2,125,124	
		2.63%		5.21%(2)		2.63%(2)		4.88%
1950	96,467,686		4,838,060		1,139,481		3,423,898	
		2.60%		4.04%		2.54%		4.02%
1960	124,699,022		7,187,470		1,464,786		5,074,906	

Source: United States Department of Commerce, Bureau of the Census

(1) Data for Oklahoma and the base study area prior to 1910 are considered incomplete.
(2) The rates of increase for the decade from 1940 to 1950 when the population figures for the old definition are compared are: United States, 1.70%; Texas, 4.71%; and Oklahoma, 2.33%.

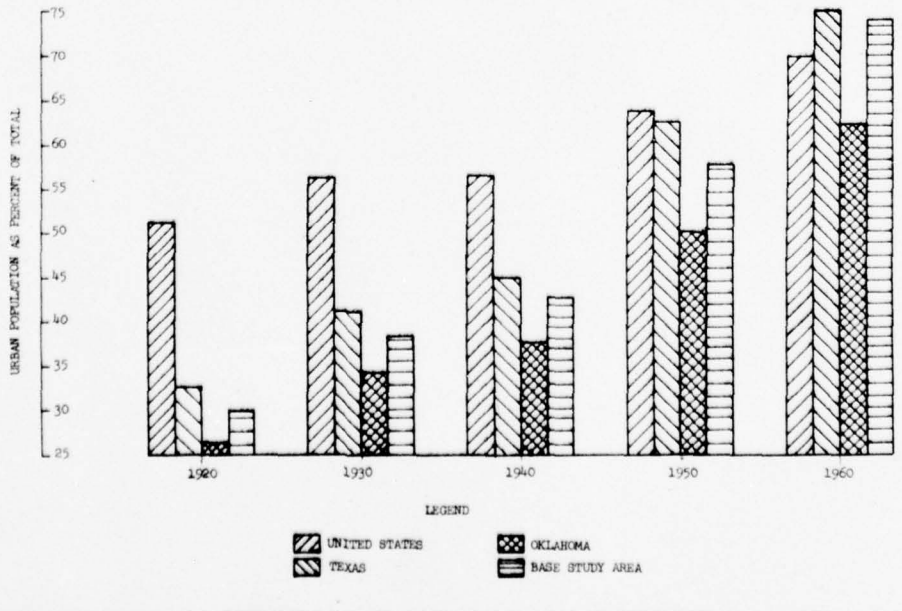

FIGURE 11. URBAN POPULATION AS PERCENT OF TOTAL POPULATION

40. The urbanization of the base study area and the State of Texas has been progressing at an even faster rate than the United States. A projection of the urban population of the State using data and trends contained in Committee Print No. 5 and in the report prepared by the United States Study Commission - Texas as guides gives 9,000,000 for 1970 and 51,500,000 for 2070. Using the 1960 urban population of 7,187,470 as the base of 1.00, the resultant factors are 1.25 and 7.16 for 1970 and 2070, respectively. The average annual rate of increase, 1960 to 2070, is 1.8 percent.

41. Since 1930 the intercensal change in the urban population of Oklahoma has been at nearly the same rate as for the United States for the same period. A projection of the Oklahoma population, using data and trends contained in Committee Print No. 5 as guides, assumes that the urban population of Oklahoma will be about 90.0 percent of the total for the State at year 2070. The 1960 urban population of 1,464,786 increases in 1970 to 1,543,500 and in 2070 to 7,130,000. Using the 1960 population as a base of 1.00, the resultant factors are 1.05 for 1970 and 4.87 for 2070. The average annual rate of increase from 1960 to 2070 is 1.4 percent.

42. STANDARD METROPOLITAN STATISTICAL AREAS.- About 64% of the population of the study area in 1960 was concentrated in the 15 metropolitan areas listed in table 8. Figure 12 is a comparison of the growth rates of these areas with the growth rates of the study area and of the states of Oklahoma and Texas. These 15 areas comprise twenty-one counties within the base study area in Texas and one in Oklahoma. Their combined population has increased from 1,764,981 in 1930 to 4,361,338 in 1960. The three principal cities of the area, Houston, Dallas, and Fort Worth in combination with their satellite areas comprise seven counties and make up the greatest urban complexes of Texas. The combined population of these three metropolitan areas in 1960 was 2,899,974, over 42 percent of the total population of the study area.

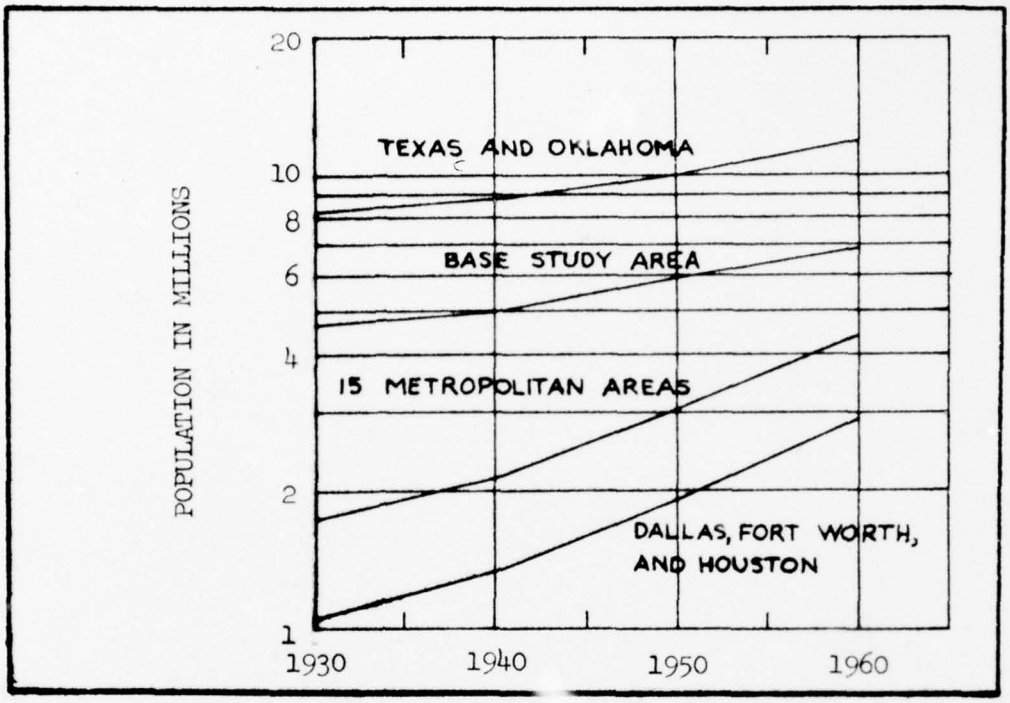

FIGURE 12. POPULATION OF METROPOLITAN AREAS IN THE STUDY AREA

TABLE 8

POPULATION OF METROPOLITAN AREAS

Metropolitan Area	Counties Included	Population 1930	1940	1950	1960
Dallas	Collin, Dallas, Denton, Ellis	458,656	527,145	743,501	1,083,601
Fort Worth	Johnson, Tarrant	230,870	255,901	398,643	573,215
Houston	Harris	359,328	528,961	806,701	1,243,158
Subtotal		1,048,854	1,312,007	1,942,845	2,899,974
Abilene	Jones, Taylor	65,256	67,525	85,517	120,377
Amarillo	Potter, Randall	51,151	61,450	87,140	149,493
Beaumont-Port Arthur	Jefferson[1]	133,391	145,329	195,083	245,659
Galveston-Texas City	Galveston	64,401	81,173	113,066	140,364
Lubbock	Lubbock	39,104	51,782	101,048	156,271
Midland	Midland	8,005	11,721	25,785	67,717
San Angelo	Tom Green	36,033	39,302	58,929	64,630
Texarkana	Bowie[2]	48,563	50,208	61,966	59,971
Tyler	Smith	53,123	69,090	74,701	86,350
Waco	McLennan	98,682	101,898	130,194	150,091
Wichita Falls	Archer, Wichita	84,098	81,203	105,309	129,638
Lawton[3]	Comanche	34,320	38,988	55,165	90,803
Total		1,764,981	2,111,676	3,036,748	4,361,338

[1]Orange County is in the Beaumont-Port Arthur metropolitan area, but is omitted since it is outside the base study area.

[2]Miller County in Arkansas is in the Texarkana metropolitan area, but is omitted since it is outside the base study area.

[3]Oklahoma

43. In 1930 the urban population of the base study area was 1,778,696. By 1960 there had been an increase in the urban population of 3,296,210 or over 185 percent of the 1930 amount. This increase in urban population was accompanied by a positive decline in non-urban population of 1,065,427, about one-third of the increase in the urban population. A small part of these differences is due to the change in urban definition in 1950.

44. FUTURE URBAN POPULATION.- Probable continued rapid urbanization of the area is recognized in Committee Print No. 5 of the Select Committee on National Water Resources, United States Senate by the following statement, "On the basis of past trends of growth, however, comparatively rapid growth would be indicated for the . . . Dallas, Fort Worth, Houston, . . . standard metropolitan statistical areas." Using data and trends contained in Print No. 5 and in publications of the United States Study Commission - Texas, projections were made of population of counties and groups of counties within the base study area and the results summated to give the projection for the area. Although the urban population of certain of the counties is increasing and will continue to increase at rates far in excess of the average, the normalizing influence of the counties of Central and West Texas and Oklahoma results in projection factors slightly below those computed for the State of Texas. The 1960 urban population of 5,074,906 will increase to 6,315,000 in 1970 and to 33,800,000 in 2070. Using the 1960 population as a base of 1.00, the resultant factors are 1.24 for 1970 and 6.66 for 2070. The average annual rate of increase 1960 to 2070 is 1.7 percent.

45. Data pertaining to urban population are shown graphically in figure 13 and are summarized in table 9.

TABLE 9

PROJECTION OF URBAN POPULATION

Year	United States	Texas	Oklahoma	Study area
		AMOUNTS IN MILLIONS		
1960	124.7	7.2	1.5	5.1
1970	150.1	9.0	1.5	6.3
2020	368.1	25.2	3.5	16.8
2070	746.0	51.5	7.1	33.8
		FACTORS OF GROWTH		
1970 ÷ 1960	1.20	1.25	1.05	1.24
2020 ÷ 1960	2.95	3.51	2.40	3.31
2070 ÷ 1960	5.98	7.16	4.87	6.66
		AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	1.64	1.80	1.45	1.74

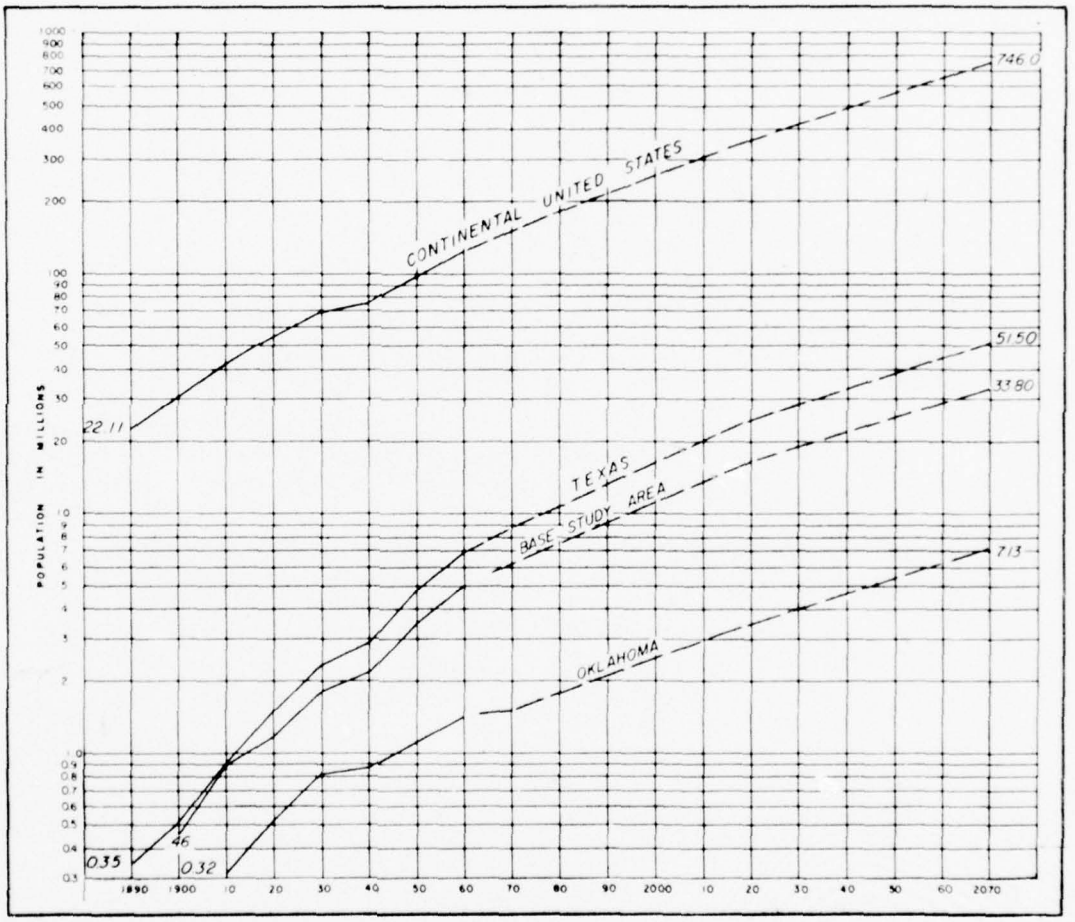

FIGURE 13. URBAN POPULATION

PROJECTION OF NEW CONSTRUCTION

46. HISTORICAL DATA.- Data on the value of new construction put in place during the year, as reported by the Department of Commerce, Bureau of the Census, were used to establish the national trend for this indicator. Comparative data for Texas and Oklahoma were prepared by taking a two-year moving average of the value of construction contracts awarded in these two states. The basic data are found in the publication of the United States Bureau of the Census, "Statistical Abstract of the United States" for 1948, 1954, and 1960, which contain the historical figures published currently by the F. W. Dodge Corporation, New York, N. Y., in "Statistical Research Service." Use was made of the two-year moving average as being a close approximation of value of construction put in place. In the initial stages of formulation data from the University of Texas Bureau of Business Research publication "Construction in Texas" on the value of building permits were used to establish trends for Texas and for the base study area. The trend thus established for the State of Texas is similar to the trend obtained from the data on new construction. Comparison with other indicators; i.e., employment and personal income by industry, shows a closer relationship to exist with new construction than with building permits. Therefore, the data on new construction for the two states, Texas and Oklahoma, were modified and used for the base study area. Table 10 shows the data on which projections are based.

TABLE 10

NEW CONSTRUCTION

Year	United States: Value	United States: Average annual percent change	Texas: Value	Texas: Average annual percent change	Base Study Area: Value	Base Study Area: Average annual percent change
	VALUE OF CONSTRUCTION PUT IN PLACE MILLIONS OF 1960 CONSTANT DOLLARS					
1939	$23,423					
		2.96				
1940	24,117		$609		$442	
		-10.95		-3.95		-4.40
1945	13,509		498		353	
		29.81		22.29		22.46
1949	38,354		1114		794	
		14.98		19.03		19.40
1950	44,110		1326		948	
		3.09		23.98		22.89
1951	45,471		1644		1165	
		3.03		6.45		6.35
1952	46,851		1750		1239	
		2.62		-10.34		-5.00
1953	48.077		1569		1177	
		2.34		2.10		-3.65
1954	49,203		1602		1134	
		6.85		7.30		9.17
1955	52,576		1719		1238	
		-1.05		5.00		4.85
1956	52,022		1805		1298	
		0.96		2.49		1.16
1957	52,522		1850		1313	
		-0.95		8.76		9.22
1958	52,024		2012		1434	
		10.24		5.37		10.55
1959	57,709		2120		1513	
		3.73				
1960	55,556		NA		NA	

Source: United States: 1952 and prior, U. S. Bureau of the Census, "Historical Statistics of the United States, Colonial Times to 1957;" 1953-1959, U. S. Bureau of the Census "Statistical Abstract of the United States (Published Annually). Texas and Base Study Area: estimated from data on contract awards from F. W. Dodge, N. Y., "Statistical Research Service," as contained in U. S. Bureau of the Census "Statistical Abstract of the United States" (Published Annually)
NA - Not available

47. PROJECTION .- The value of new construction put in place increased from 1940 to 1959 by about 139 percent in the United States, about 248 percent in Texas, and about 242 percent in the study area. However, the projections in this study assume a rate of increase for the Nation of about one-half the historical rate and a rate of increase for Texas and the base study area of slightly over one-third the historical rates for these areas. Table 11 summarizes the projections and figure 14 is a graphic presentation of the data on this indicator.

TABLE 11

PROJECTION OF VALUE OF NEW CONSTRUCTION

Year	United States	Texas	Study Area
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS		
1960	55,556	2,200	1,550
1970	70,000	2,840	2,030
2020	260,000	11,090	7,870
2070	880,000	36,980	25,960
	FACTORS OF GROWTH		
1970 ÷ 1960	1.26	1.29	1.31
2020 ÷ 1960	4.68	5.04	5.08
2070 ÷ 1960	15.84	16.81	16.75
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	2.54	2.60	2.60

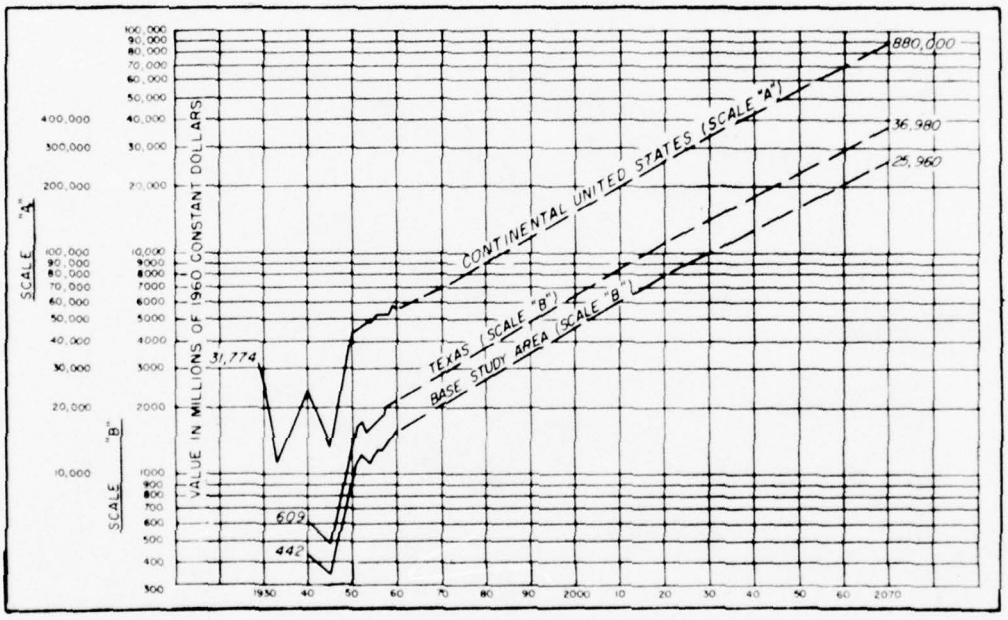

FIGURE 14. NEW CONSTRUCTION

PROJECTION OF VALUE ADDED BY MANUFACTURE

48. HISTORICAL DATA.- The basic source of comprehensive data on manufactures has been the "Census of Manufactures" conducted by the Bureau of the Census. Historical data based on this source on the value added by manufacture for the United States, Texas, and the base study area from 1929 to 1958, both years inclusive, are contained in table 12. To minimize the effect of war and depression, the data stated in terms of average annual percent of change may be summarized as follows:

Period	Average Annual Percent of Change		
	United States	Texas	Base study area
1929 to 1939	-1.01	0.97	1.12
1939 to 1947	7.98	11.25	10.95
1947 to 1954	3.92	7.75	8.11
1954 to 1958	2.51	6.92	6.51

Actual amounts are not available for 1960; therefore, estimates were made in the following amounts: United States $155.0 billion, Texas $5.5 billion, and Base Study Area $4.5 billion. Using these figures, the average annual percent of increase from 1929 to 1960 is about three **percent for the United States and six percent for Texas and the base study area.**

TABLE 12

VALUE ADDED BY MANUFACTURE

Year	United States		Texas		Base study area	
	Value	Avg ann percent change	Value	Avg ann percent change	Value	Avg ann percent change
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS					
1929	59,982		902.5		752.2	
		-13.77		-14.85		-14.71
1931	44,604		654.4		547.2*	
		-10.95		-4.31		-4.15
1933	35,371		599.2		502.7*	
		10.06		6.65		6.82
1935	42,848		681.5		573.6*	
		11.21		16.58		16.76
1937	52,996		926.1		782.0*	
		1.10		3.52		3.68
1939	54,175		992.3		840.6	
		7.98		11.25		10.95
1947	100,121		2,328.2		1,930.0	
		-2.32		-0.63		-0.57
1949	95,521		2,299.0		1,908.2*	
		14.72		20.49		20.78
1950	109,585		2,770.1		2,304.7*	
		3.16		16.86		17.14
1951	113,051		3,237.1		2,699.7*	
		9.48		12.29		12.56
1952	123,766		3,635.0		3,038.9*	
		10.70		8.00		8.26
1953	137,003		3,925.9		3,289.9*	
		-4.33		0.00		1.27
1954	131,068		3,926.0		3,331.7	
		10.09		16.07		15.55
1955	144,296		4,557.0		3,850.0*	
		1.63		4.58		4.23
1956	146,652		4,765.8		4,012.8*	
		0.54		2.21		1.85
1957	147,444		4,871.3		4,087.0*	
		-1.86		5.30		4.90
1958	144,698		5,129.3		4,287.1	

*Interpolated

Source: United States Department of Commerce, Bureau of the Census, "U. S. Census of Manufactures."

49. VALUE ADDED BY MAJOR INDUSTRY GROUP.- Table 13 gives the value added in 1958 by major industry group. The importance of the petroleum industry to Texas and the base study area is disclosed by

TABLE 13

VALUE ADDED BY MANUFACTURE
BY MAJOR INDUSTRY GROUP IN 1958

Standard industrial classification		United States		Texas		Trinity River Base Study Area	
No.	Major industrial group	Value	Percent of total	Value	Percent of total	Value	Percent of total
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS						
20	Food and kindred products	17,848.2	12.41	723.6	14.07	573.8	13.39
21	Tobacco products	1,438.9	1.00	-	-	-	-
22	Textile mill products	4,945.1	3.44	34.2	0.67	27.1	0.63
23	Apparel and related products	6,111.9	4.25	142.6	2.78	106.6	2.49
24	Lumber & wood products	3,233.8	2.25	80.0	1.56	55.9	1.30
25	Furniture & fixtures	2,391.8	1.66	68.5	1.33	56.3	1.31
26	Paper & allied products	5,810.2	4.04	115.8	2.25	85.5	1.99
27	Printing & publishing	8,065.6	5.61	215.1	4.19	172.0	4.01
28	Chemicals & allied products	12,491.2	8.69	1,074.1	20.90	851.1	19.87
29	Petroleum & coal products	2,563.8	1.78	603.6	11.75	563.9	13.16
30	Rubber & plastics products	3,335.6	2.32	63.5	1.24	32.3	0.75
31	Leather & leather products	1,931.6	1.34	12.2	0.24	7.3	0.17
32	Stone, clay & glass products	5,628.5	3.91	240.7	4.69	179.4	4.19
33	Primary metal industries	11,881.4	8.26	303.4	5.91	213.4	4.98
34	Fabricated metal industries	9,581.6	6.66	243.4	4.74	177.9	4.15
35	Machinery (except electrical)	12,614.2	8.77	386.3	7.52	394.3	9.20
36	Electrical machinery	10,582.5	7.36	95.7	1.86	99.8	2.33
37	Transportation equipment	15,558.8	10.82	619.5	12.05	605.1	14.12
38	Instrument & related products	2,958.7	2.06	48.2	0.94	32.3	0.75
39	Miscellaneous manufactures	4,839.8	3.37	67.1	1.31	51.7	1.21
	Total	143,813.2	100.00	5,137.5	100.00	4,285.7	100.00

Source: United States Bureau of the Census. U. S. Census of Manufactures: 1958 Vol. III, Area Statistics.

the large percentage of the total value added which is accredited to the chemical industry and to the petroleum and coal products industry, both of which are dependent mainly upon the petroleum mining industry for raw materials. In 1958, these two industries accounted for over 33 percent of the value added in Texas and in the base study area as compared to about 10 percent of the total for the United States.

50. PROJECTION.- In making projections of this indicator, consideration was given to its prominence in the economy and to historic and projected increase in productivity. In 1960, it is estimated that manufacturing contributed 23 percent of the income of the Nation, 14 percent of the income of Texas, and 16 percent of the income of the base study area. In the 29 years from 1929 to 1958, value added increased at the rate of 3.1 percent per year at the national level while in Texas and the study area, it increased at the rate of 6.2 percent, almost exactly twice the national rate of increase. A principal contributor to the accelerated rate of growth in the southwestern region is the petrochemical industry, which advanced in recent years from a position of minor importance to first place.

51. The projections for Texas and the study area assume this growth will continue at a somewhat lesser rate for the first 50 years than in the past, then proceed at the national rate. Table 14 shows the projections for this indicator and the resultant factors of growth. (See also figure 15.)

TABLE 14

PROJECTION OF VALUE ADDED BY MANUFACTURE

Year	United States	Texas	Study area
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS		
1960	155,000	5,500	4,500
1970	230,000	9,000	7,300
2020	1,200,000	60,000	50,000
2070	4,723,000	236,100	196,800
	FACTORS OF GROWTH		
1970 ÷ 1960	1.48	1.64	1.62
2020 ÷ 1960	7.74	10.91	11.11
2070 ÷ 1960	30.47	42.93	43.73
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	3.16	3.48	3.48

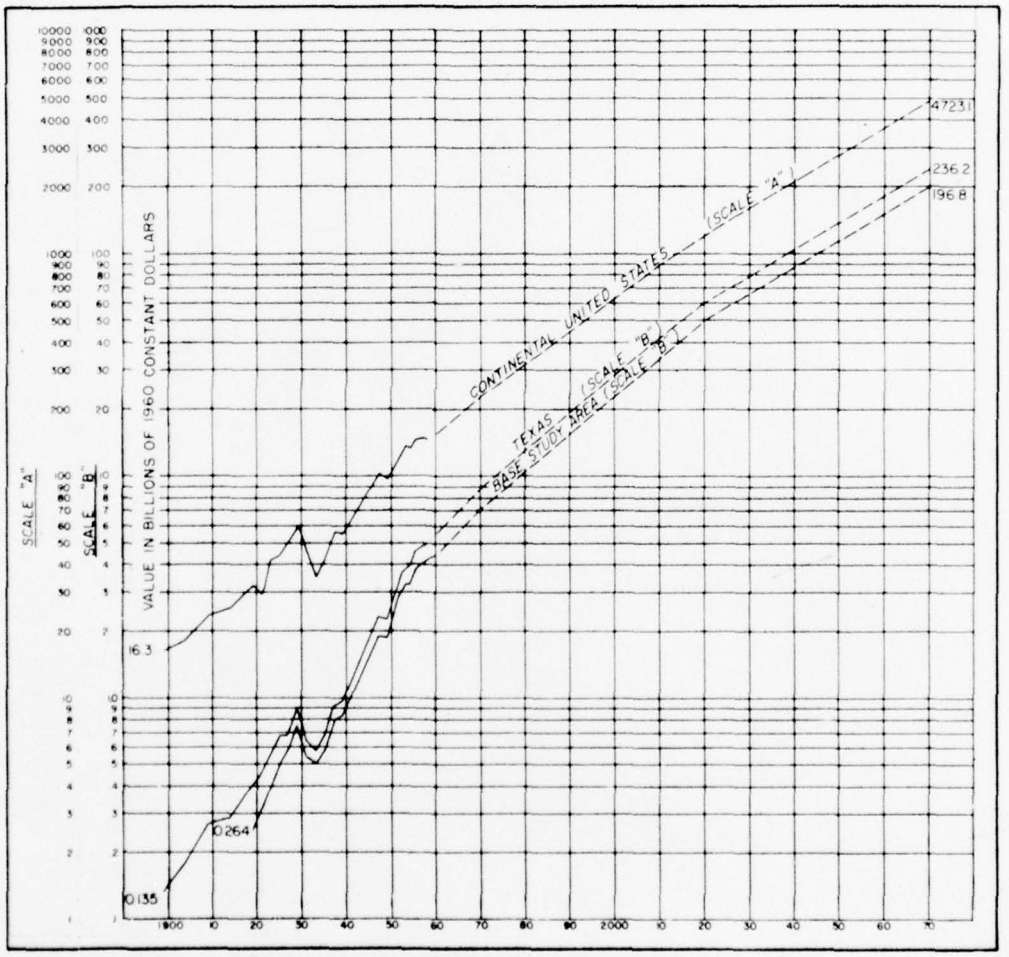

FIGURE 15. VALUE ADDED BY MANUFACTURE

PROJECTION OF VALUE OF MINERAL PRODUCTION

51. HISTORICAL DATA.- Historical data on mineral production were extracted from reports of the United States Department of the Interior, Bureau of Mines. Table 15 presents the total value of production for selected years since 1928. Mineral fuels supplied 93 percent of the value of mineral production in Texas in recent years as compared to about 70 percent for the Nation. Based on values about one-fourth of the mineral production of the Nation, including one-third of the mineral fuels, originates in Texas. Of the Texas volume, two-thirds is produced in the study area. It is estimated that less than one-fourth of the minerals produced in the study area is actually consumed in the area, the rest being exported, principally in the form of energy producing materials; i.e., natural gas, gasoline, natural gas liquids.

TABLE 15

VALUE OF MINERAL PRODUCTION

Year	United States		Texas		Base study area	
	Value	Average annual percent change	Value	Average annual percent change	Value	Average annual percent change
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS					
1929	8,007		679		NA	
		-6.22		6.48		
1930	7,509		723		NA	
		-12.26		24.85		
1932	5,780		1,127		NA	
		4.63		2.37		
1934	6,352		1,181		NA	
		6.24		3.71		
1936	7,169		1,270		NA	
		4.08		13.43		
1938	7,766		1,634		NA	
		9.36		-1.60		
1940	9,288		1,582		NA	
		-2.20		-5.42		
1942	8,883		1,415		NA	
		-0.12		15.23		
1944	8,862		1,879		NA	
		-3.00		-1.99		
1946	8,338		1,805		NA	
		13.48		16.80		
1948	10,738		2,458		NA	
		1.28		0.51		
1950	11,014		2,483		NA	
		3.43		9.40		
1952	11,782		2,972		2,097	
		7.14		9.22		11.27
1954	13,526		3,545		2,596	
		13.02		9.12		7.77
1956	17,279		4,220		3,015	
		-4.65		-4.68		-5.58
1958	15,711		3,834		2,688	
		6.72		3.85		2.08
1960	17,892		4,135		2,801	

Source: "Minerals Yearbook," United States Department of the Interior, Bureau of Mines (Annual)

NA - Not Available

52. RESOURCES.- In making projections of this indicator it has been assumed that mining will continue to occupy about the same position in the economy as in recent years. This presupposes that minerals will continue to be available to satisfy future requirements. The subject of future availability of petroleum and allied products is discussed in the section on Economic Development. Other minerals which are known to exist in Texas and in the study area in large quantities include lignite and iron ore. Neither of these is consumed in large quantities in the area although it is estimated that they account for a major portion of the nearly $50,000,000 in items produced annually, the individual value of which cannot be disclosed.

53. LIGNITE AND COAL.- Lignite was mined in Texas as early as the middle of the last century and increased in importance until supplanted as a fuel by oil and gas. Large reserves of this fuel are available. An estimate prepared in 1928 indicated reserves in the State of Texas (principally in the counties within the base study area) of about 23 billion tons.

54. There is a wide variation in the thickness and extent of lignite beds. Some are thin, others are 25 feet thick. All production has been from open pits. The principal user of this fuel at this time in Texas is a 240,000 kw. steam-electric plant in Milam County which furnishes power for aluminum reduction.

55. Bituminous coal is also available in large deposits. No estimate of the amount of reserve is available. Prior to the great oil discoveries this fuel was mined in the central portion of the base study area in volumes of above 1,000,000 tons per year. The distribution of lignite and coal in the base study area is shown in figure 16. Continued increase of natural gas as a source of material for the petrochemical industry as well as fuel for heating and cooking by the ever-increasing population is stimulating the interest of public utilities and manufacturers in economical source of fuel. Private industries have indicated that the prices of energy fuels are rapidly approaching the point at which lignite will again be one of the major sources of energy. Use of the fuel at the aluminum reduction plant at Rockdale has demonstrated its economy when used at source.

56. Additional uses include greater use as material in the chemical industry and possible use as fuel in steel production. Research has disclosed a possible method of making briquettes for this use.

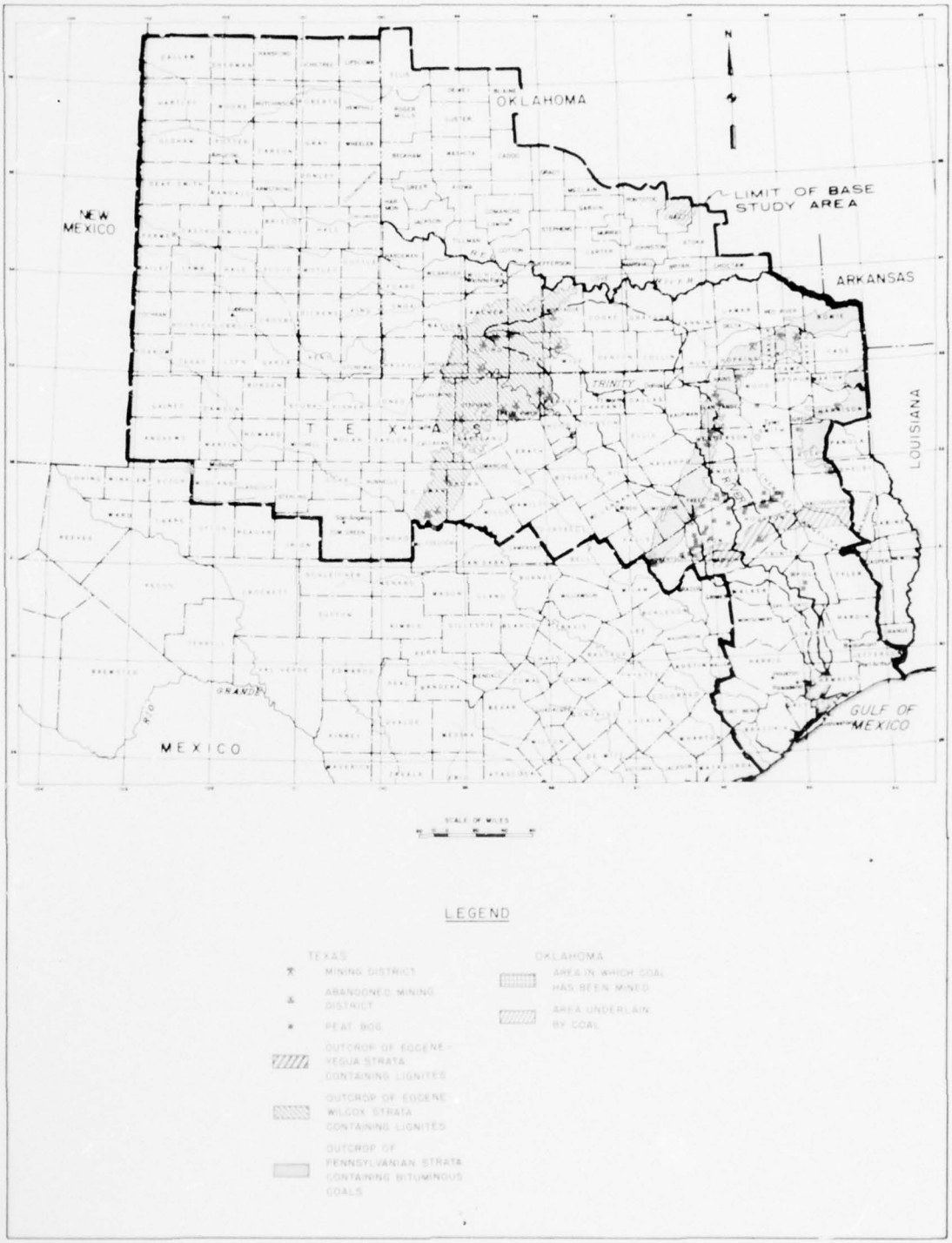

FIGURE 16. DISTRIBUTION OF BITUMINOUS COAL, LIGNITE AND PEAT

57. IRON ORE.- The ores of East Texas were mined continuously from prior to the Civil War to the first part of the present century. However, except for one abortive effort about 1919, no material amount was produced after 1909 until the early 1940's when the Lone Star Steel at Lone Star in Morris County and Sheffield Steel at Houston in Harris County commenced operations. Production at the Lone Star plant was suspended about the end of World War II and resumed in 1953. Since 1955 the quantity produced in Texas has not been disclosed by the Bureau of Mines. During that year 875,443 long tons of this material were produced, all from strip mines within the base study area.

58. RESERVES OF IRON ORE.- The iron ores of the base study area occur entirely in the eastern portion of the area. The approximate limits of the deposits are shown in figure 17. They are predominantly of the brown ore type and occur in a nearly continuous laminated ledge averaging about two feet in thickness close enough to the surface to be strip-mined. No accurate estimate is available of the total reserves but the total recoverable amount, based on the best available information, is estimated at about 175 million tons of material containing about 50 percent iron.

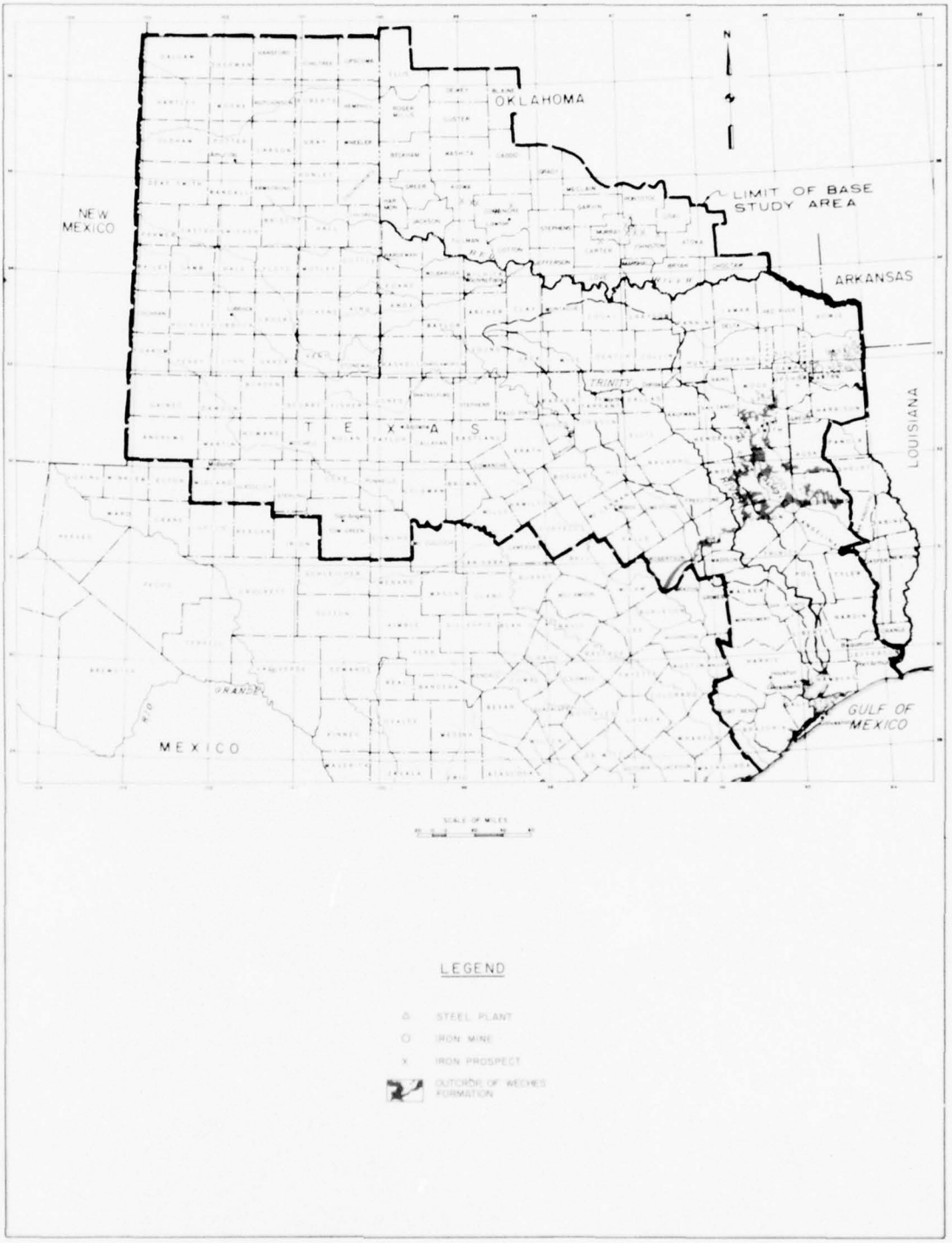

FIGURE 17. DISTRIBUTION OF IRON

59. SAND AND GRAVEL.- In 1960, 30 million tons of sand and gravel were produced in Texas and of this amount, about 20 million tons were produced in the base study area. The widespread distribution of these minerals is shown in figure 18. The principal uses are in building and construction. Other uses of sand include glass, molding, blast, engine, and filtration. Although data are not available for an accurate estimate of sand and gravel reserves in the base study area, rough estimates indicate that reserves are adequate to meet the needs beyond year 2070. Table 16 gives the amounts of sand and gravel sold or used each year in the United States, Texas, and the base study area from 1955 to 1960, inclusive.

TABLE 16

SAND AND GRAVEL SOLD OR USED BY PRODUCERS

Year	United States	Texas	Base study area
	THOUSANDS OF TONS		
1955	592,153	31,518	23,634
1956	626,495	29,336	22,042
1957	632,255	23,685	17,875
1958	684,498	32,871	24,982
1959	730,205	35,295	25,943
1960	707,254	29,844	22,611

Source: Department of the Interior, Bureau of Mines

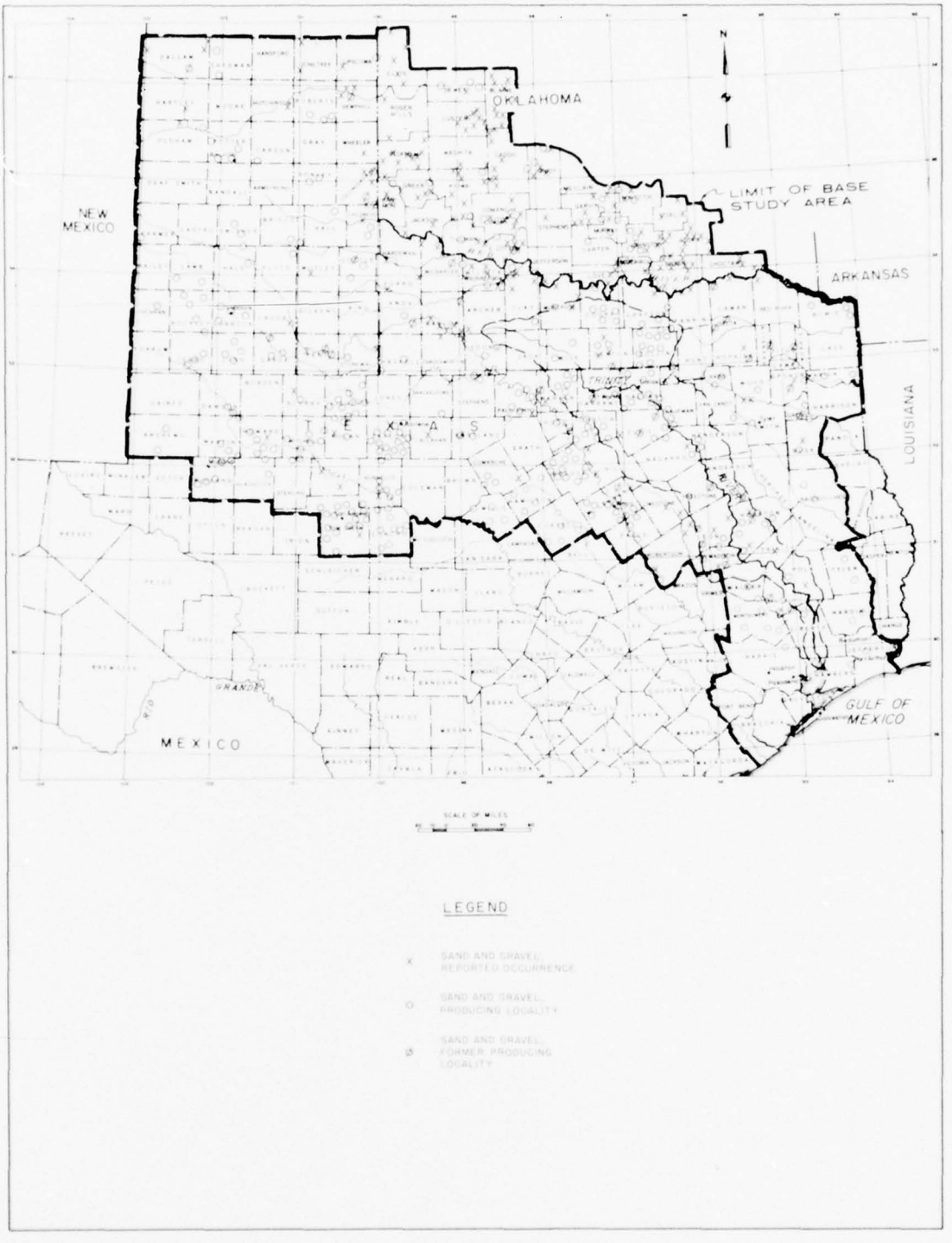

FIGURE 18. DISTRIBUTION OF SAND AND GRAVEL

60. LIMESTONE AND SHELL.- The principal use of these materials is in production of portland cement. There were 20 cement plants operating in Texas in 1960 with a total production capacity of 38.9 million barrels annually. A multimillion dollar plant, at Midlothian, with a 1.4 million barrel annual capacity began production in 1960 bringing the total number of plants operating in the base study area to 12. Production of portland cement in the State amounted to 23 million barrels of which about 15 million barrels were produced in the base study area. Over two million tons of shell and over four million tons of limestone were used in Texas in 1960 in the production of portland cement. Data are not available for an accurate estimate of the reserves of portland cement materials in the base study area but it is estimated that these reserves will sufficiently meet the needs for more than 100 years hence. Figure 19 shows the distribution of portland cement materials in the study area. Table 17 gives the amounts of portland cement produced each year in the United States, Texas, and the base study area from 1955 to 1960, inclusive.

TABLE 17

PRODUCTION OF PORTLAND CEMENT

Year	United States	Texas	Base study area
	THOUSANDS OF BARRELS		
1955	297,453	24,241	18,152
1956	316,438	25,665	19,083
1957	298,424	21,845	16,642
1958	311,471	25,645	19,235
1959	339,091	27,111	20,309
1960	319,009	23,190	17,761

Source: Department of the Interior, Bureau of Mines

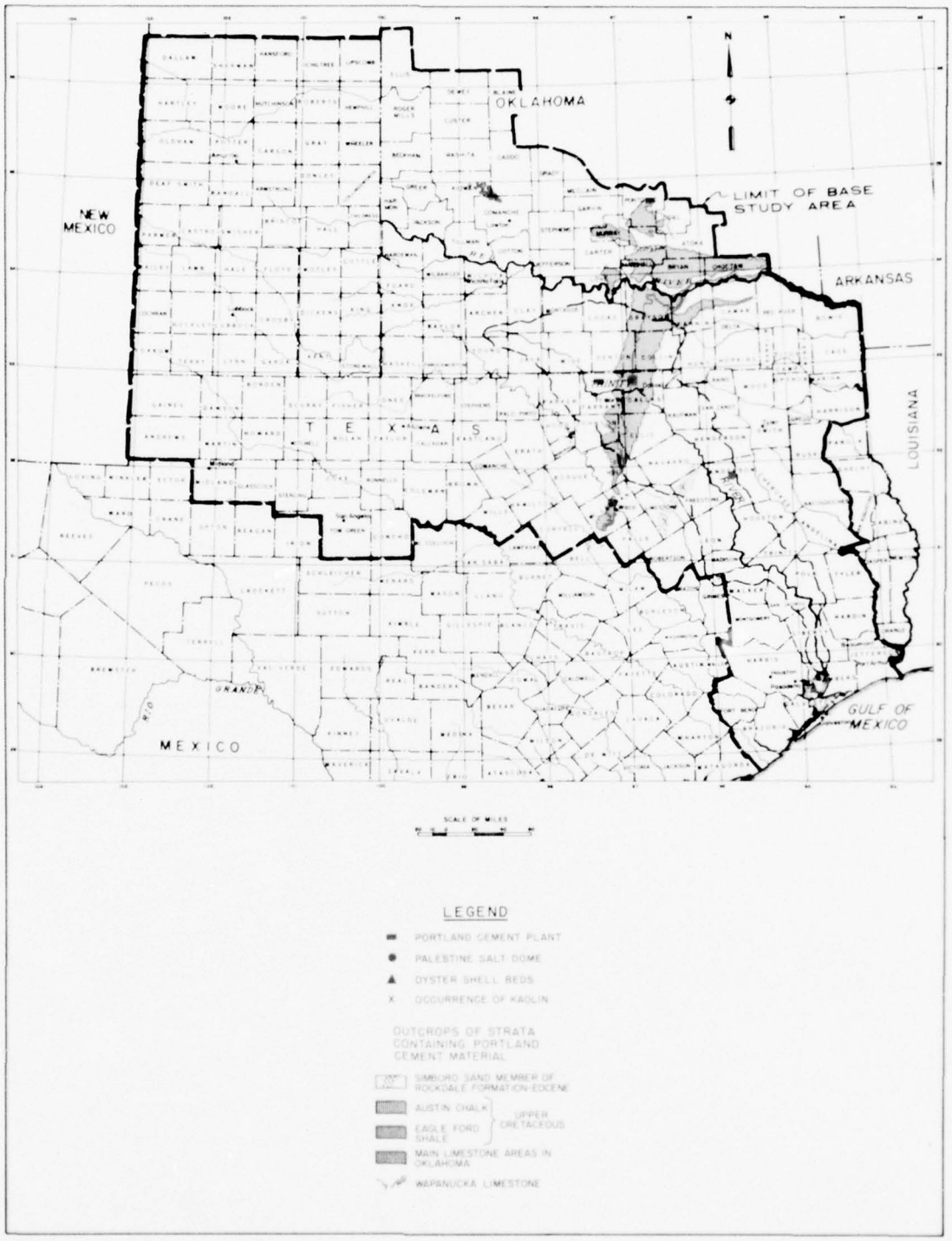

FIGURE 19. DISTRIBUTION OF PORTLAND CEMENT MATERIALS

61. SULFUR.- Although sulfur production in Texas in 1959 amounted to over one-half of the national total it supplied only 1.5 percent of the value of mineral production in the State. There are three major sources of this mineral. Probably 92 percent is obtained by the Frasch process from sulfur mines. However, increasing amounts are recovered in the purification of "sour gas" and from industrial waste.

62. RESERVES OF SULFUR.- In some instances the large fields which furnished most of the Nation's sulfur in the past have been abandoned due to depletion of reserves. However, new producing areas inland and new discoveries offshore give promise of reserves to assure production for many years in the future.

63. SALT.- Production of this element in recent years has been nearly 18 percent of the national total. Estimates by private interests indicate a nearly "inexhaustible" supply.

64. PROJECTION.- In making projections of this indicator it has been assumed that mineral production will continue to occupy the same relative position in the economy as at present. Rate of growth is the same for the United States, Texas, and the base study area. The projections are summarized in table 18 and data are presented graphically in figure 20.

TABLE 18

PROJECTION OF MINERAL PRODUCTION

Year	United States	Texas	Study area
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS		
1960	17,892	4,135	2,801
1970	24,187	5,590	3,786
2020	109,198	25,237	17,095
2070	449,248	103,825	70,329
	FACTORS OF GROWTH		
1970 ÷ 1960	1.35		
2020 ÷ 1960	6.10	(Same as United States)	
2070 ÷ 1960	25.11		
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	2.97	(Same as United States)	

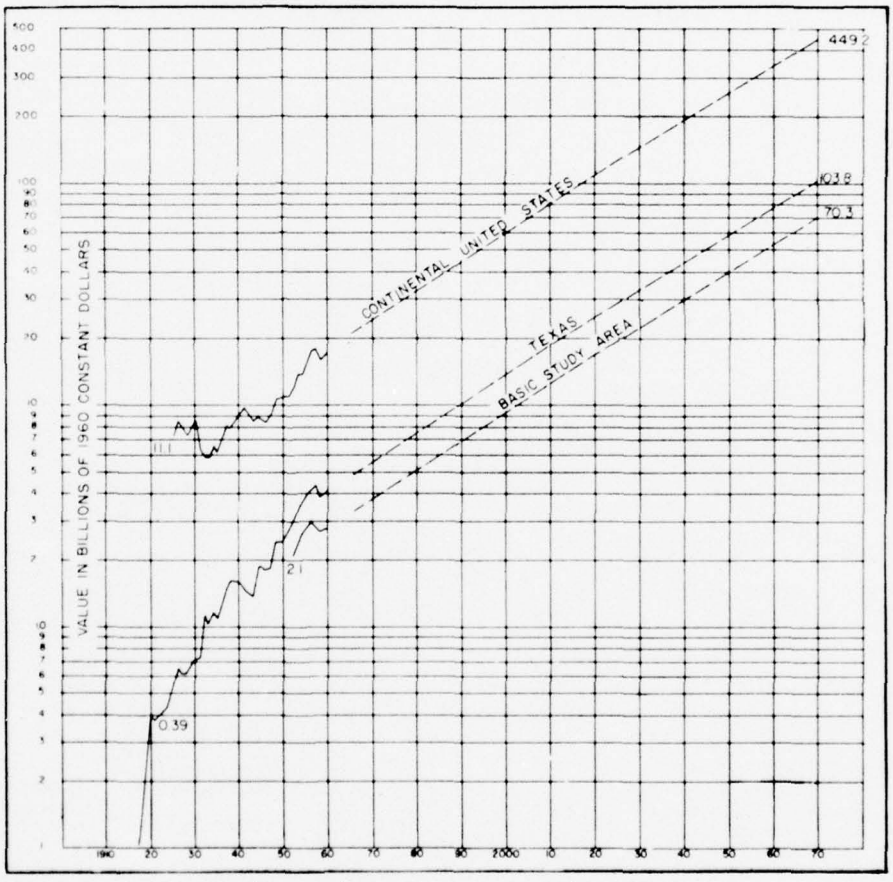

FIGURE 20. MINERAL PRODUCTION

VIII - PROJECTION OF RETAIL SALES

65. HISTORICAL DATA.- The Department of Commerce, Bureau of the Census, is the source of retail sales data for United States and Texas. Retail sales data for the base study area counties are based, in part, on "Sales Management Survey of Buying Power" and, in part, on "U. S. Census of Business," Department of Commerce, Bureau of the Census. These data are shown in table 19.

TABLE 19

RETAIL SALES

Year	United States		Texas		Base study area	
	Values	Avg ann percent change	Values	Avg ann percent change	Values	Avg ann percent change
	VALUE IN MILLIONS OF 1960 CONSTANT DOLLARS					
1929	83,694		3,449		2,700*	
		-9.52		-11.12		-11.28
1933	56,103		2,152		1,673*	
		12.23		12.96		13.68
1935	70,670		2,746		2,162	
		6.06		8.73		8.00
1939	89,451		3,838		2,941	
		9.38		1.69		2.11
1940	97,838		3,903		3,003	
		3.38		5.41		4.87
1943	108,094		4,572		3,463*	
		8.23		11.75		11.85
1948	160,542		7,969		6,063	
		4.92		8.43		7.54
1950	176,739		9,368		7,011	
		1.35		1.51		1.66
1954	186,477		9,948		7,489	
		2.44		2.68		2.64
1958	205,328		11,058		8,313	
		6.80		5.17		3.48
1959	219,289		11,630		8,602*	
		0.14		-1.05		0.47
1960	219,600		11,508		8,642	

* Estimated

Source: See text.

66. PROJECTION.- During the period from 1940 to 1960, the annual increase in retail sales for the United States amounted to 4.1 percent, while Texas and the base study area retail sales increased 5.6 and 5.4 percent, respectively, during the same period. Based on these historical annual increases and an analysis of the probable future disposable income, retail sales were projected as shown in table 20. These projections are shown graphically in figure 21.

TABLE 20

PROJECTION OF RETAIL SALES

Year	United States	Texas	Study area
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS		
1960	219,600	11,508	8,642
1970	301,000	16,100	11,900
2020	1,303,300	85,000	57,800
2070	5,337,600	360,300	237,500
	FACTORS OF GROWTH		
1970 ÷ 1960	1.37	1.40	1.38
2020 ÷ 1960	5.93	7.39	6.69
2070 ÷ 1960	24.31	31.31	27.48
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	2.94	3.18	3.06

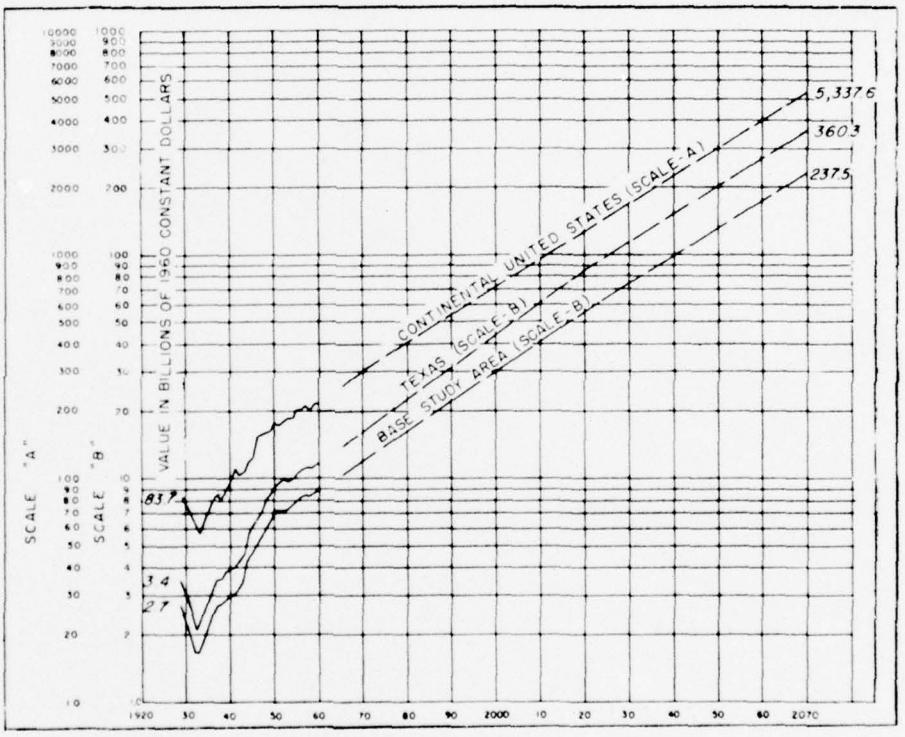

FIGURE 21. RETAIL SALES

PROJECTION OF BANK DEPOSITS

67. HISTORICAL DATA.- The source of data on bank deposits is the Board of Governors of the Federal Reserve System. These data are shown in table 21.

TABLE 21

BANK DEPOSITS

Year	United States		Texas		Base study area	
	Values	Avg ann percent change	Values	Avg ann percent change	Values	Avg ann percent change
	VALUE IN MILLIONS OF 1960 CONSTANT DOLLARS					
1948	185,615		7,581		5,647	
		3.02		8.17		7.65
1949	191,228		8,200		6,079*	
		2.27		8.78		6.78
1950	195,564		8,920		6,491*	
		-4.38		-2.06		-1.20
1951	187,004		8,736		6,413*	
		7.53		7.21		6.69
1952	201,089		9,366		6,842*	
		3.01		4.90		4.38
1953	207,148		9,825		7,142	
		5.17		6.90		8.78
1954	217,859		10,503		7,769*	
		4.59		3.84		5.64
1955	227,850		10,906		8,207*	
		6.46		1.39		3.12
1956	242,564		11,058		8,463*	
		-0.76		-2.84		-1.22
1957	240,710		10,744		8,360	
		5.34		9.08		6.95
1958	253,558		11,720		8,941*	
		1.23		0.23		-1.77
1959	256,669		11,747		8,783*	
		3.71		4.92		2.79
1960	266,196		12,325		9,028	

* Estimated
Source: See text.

68. PROJECTION. Bank deposits in the United States increased at a rate of 2.6 percent annually from 1940 to 1960, whereas Texas bank deposits increased 5.8 percent during the same period. No data are available for the base study area prior to 1948. Annual percent increases in bank deposits for United States, Texas, and the base study area for the period 1948 to 1960 were 3.0, 4.1, and 4.0, respectively. Guided by these past rates of increase and total personal income projections, projections of bank deposits were made as shown in table 22. These projections are shown graphically in figure 22.

TABLE 22

PROJECTION OF BANK DEPOSITS

Year	United States	Texas	Study area
	VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS		
1960	266,196	12,325	9,028
1970	363,000	17,800	13,100
2020	1,602,500	100,700	68,400
2070	6,672,000	450,400	296,900
	FACTORS OF GROWTH		
1970 ÷ 1960	1.36	1.44	1.45
2020 ÷ 1960	6.02	8.17	7.58
2070 ÷ 1960	25.06	36.54	32.89
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	2.97	3.32	3.23

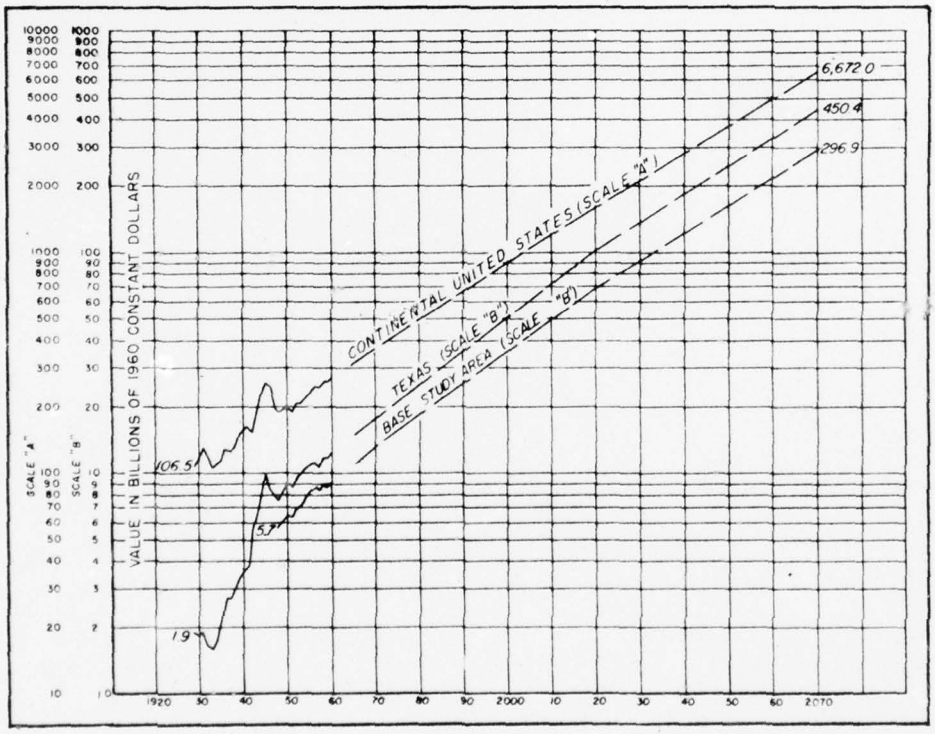

FIGURE 22. BANK DEPOSITS

PROJECTION OF WHEAT EXPORTS

69. HISTORICAL DATA.- The Bureau of the Census furnished statistics on total United States exports of wheat during the 10-year period 1950-59. These statistics are contained in table 23. Statistics for 1956-59 are comparable. Those for 1950-55 are also comparable, but they are not completely comparable with statistics for the latter period, 1956-59. This, according to the Census, is because the reported exports for 1950-55 do not include exports for relief that were made other than by the Federal Government (such as by private relief agencies).

70. For years prior to 1956, relief exports of wheat other than by the Federal Government were included in the statistics of exports of other foods for relief and charity, according to the Census. Some indication of the importance of these exports in past years other than by the Federal Government is afforded by the statistics for 1956-59. For that 4-year period as a whole, statistics furnished by the Census show that exports of wheat for relief and charity (other than those made by the Federal Government) amounted to about one-seventh of the total of all wheat exports.

TABLE 23

WHEAT EXPORTS, UNITED STATES, 1950-59

Year	Wheat exports*	
	Bushels	Tons
1950	206,068,194	6,192,000
1951	423,044,308	12,691,000
1952	374,911,619	11,247,000
1953	235,573,421	7,067,000
1954	192,249,522	5,767,000
1955	221,515,014	6,645,000
1956	638,789,286	19,164,000
1957	436,588,770	13,098,000
1958	330,669,201	9,920,000
1959	357,773,949	10,733,000
Average, 1954-1958	363,962,358	10,919,000

*Grain only. The reported quantities, according to the Census, include exports under Titles I, II, and III of the Agricultural Trade Development and Assistance Act of 1954. Public Law 480, approved 10 July 1954, and under Section 402 of the Mutual Security Act of 1954, Public Law 665, approved 26 August 1954, as well as regular commercial exports, except that for years prior to 1956 exports for relief other than by the Federal Government are not included.

Source: U. S. Department of Commerce. Bureau of the Census. Furnished by the Foreign Trade Division from published sources.

71. EXPORTS FROM PORTS IN BASE STUDY AREA.- Statistics on exports from Galveston, Houston, and Port Arthur during the 5-year period 1954-58 are contained in table 24. Galveston, with about half of the three-port total, ranked first in importance, and Houston, with a little over a third of the total, ranked second. Further indication of the importance of these ports is afforded by the arrangement in table 24 showing exports from Galveston, Houston, and Port Arthur in terms of percentages of total United States exports.

TABLE 24

WHEAT EXPORTS FROM SPECIFIED TEXAS PORTS, 1954-58

Year		Wheat exports in tons	Percent of total United States
		GALVESTON	
1954		259,895	4.51
1955		1,089,925	16.40
1956		1,690,310	8.82
1957		1,484,017	11.33
1958		1,440,351	14.52
	Average	1,192,900	
		HOUSTON	
1954		461,725	8.00
1955		477,837	7.19
1956		929,168	4.85
1957		1,014,854	7.75
1958		1,289,646	13.00
	Average	834,646	
		PORT ARTHUR	
1954		103,265	1.79
1955		266,540	4.01
1956		297,380	1.55
1957		515,759	3.94
1958		502,852	5.07
	Average	337,160	
		THREE-PORT TOTAL	
1954		824,885	14.30
1955		1,834,302	27.60
1956		2,916,858	15.22
1957		3,014,630	23.02
1958		3,232,856	32.59
	Average	2,364,706	

Source: Corps of Engineers "Waterborne Commerce of the United States", Part 2.

72. PROJECTION.- In a report on "Land and Water Potentials and Future Requirements for Water," the Senate Select Committee on National Water Resources, Eighty-Sixth Congress, First Session, offers the following explanation, in Committee Print No. 12, regarding the outlook for exports of wheat: "With the exception of Europe, where imports are likely to decline, import requirements are likely to increase in all major areas of the world, and especially in the Far East where rice supplies are likely to show a decline relative to needs. The major wheat-exporting countries will be able to expand production more easily than the less-developed countries. Foreign demand for United States wheat is expected to increase substantially, especially in the latter half of the 40-year period." (Reference is to the 40-year period ending with 2000.)

73. The Committee offers also the explanation that its projections of foreign commercial demand for selected United States agricultural products allow for population growth in accordance with the 1958 revised U. N. projections of 4.2 billion for 1980 and 6.3 billion for 2000, and that they take into consideration the likely trends of production in other surplus-producing areas and their ability to meet world needs. These estimates of 1980 population and 2000 population, incidentally, are 1.47 and 2.21 times as great, respectively, as the mid-year 1958 world estimate of 2,852 million established by the Statistical Office of the United Nations (See The World Almanac, 1960, page 265).

74. Estimates of future exports of wheat from the United States are contained in table 25. Premised on the percentage relationship between exports of wheat from Galveston, Houston, and Port Arthur and corresponding total United States exports for the period 1954-58, estimates of 2070 exports creditable to these three ports become established as follows:

Galveston	3,815,000 tons
Houston	2,660,000 tons
Port Arthur	1,085,000 tons
Total	7,560,000 tons

75. This overall estimate of 2070 exports, 7,560,000 tons, for the three-port area is 2.34 times as great as 1958 exports of wheat from those same three ports, and 3.21 times as great as the corresponding 1954-58 average of exports.

TABLE 25

WHEAT EXPORTS OF THE FUTURE, UNITED STATES,
ESTIMATES FOR 1980, 2000, and 2070

Year	Estimates of future wheat exports*
	Tons
1980	11,700,000
2000	20,850,000
2070	35,000,000

*Grain, for practical purposes, though the possibility of a relatively small grain equivalent of certain wheat products is recognized.

Source: The 1980 and 2000 estimates shown above were prepared from data in the U. S. Senate Select Committee on National Resources (Eighty-sixth Congress, First Session) Committee Print No. 12, "Land and Water Potentials and Future Requirements for Water," page 24, table 3. This source described these estimates as "foreign commercial demand."
The estimate for 2070 is an extrapolation on ratio paper at a constantly decreasing rate per year.

76. The estimated future exports of wheat from the three ports for 1960 are 3,240,000 tons, for 1970, 3,350,000 tons, and for 2070, 7,560,000 tons. Using the 1960 estimate as the base of 1.00, the corresponding factors are 1.03 for 1970 and 2.33 for 2070, as shown in table 26. (See also figure 23.)

TABLE 26

PROJECTIONS OF WHEAT EXPORTS

Year	United States	Three-port total *
	VALUES IN THOUSANDS OF TONS	
1960	10,800	3,240
1970	11,200	3,350
2020	27,000	5,780
2070	35,000	7,560
	FACTORS OF GROWTH	
1970 ÷ 1960	1.04	1.03
2020 ÷ 1960	2.50	1.78
2070 ÷ 1960	3.24	2.33
	AVERAGE ANNUAL PERCENT INCREASE	
1960 to 2070	1.1	0.8

* Three ports are Galveston, Houston and Port Arthur.

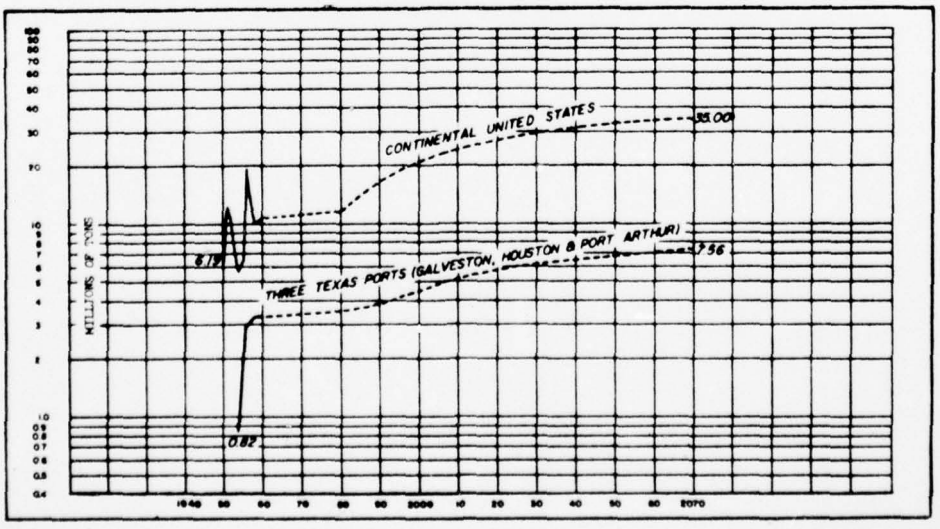

FIGURE 23. WHEAT EXPORTS

PROJECTION OF VALUE OF FARM PRODUCTS SOLD

77. HISTORICAL DATA.- The value of farm products sold was extracted from the United States Censuses of Agriculture, Department of Commerce. Table 27 shows these data for the census years, 1929 through 1959, inclusive, with the exception of the value for the Nation for 1959. This was not available when the table was prepared.

TABLE 27

FARM PRODUCTS SOLD

Year	United States		Texas		Base study area	
	Value	Avg ann percent change	Value	Avg ann percent change	Value	Avg ann percent change
	VALUES IN THOUSANDS OF 1960 CONSTANT DOLLARS					
1929	15,499,870		1,073,800		800,000	
		0.75		1.28		0.63
1939	16,703,950		1,219,620		851,543	
		3.20		1.80		4.86
1944	19,555,000		1,333,600		1,079,519	
		1.44		4.20		2.99
1949	21,000,900		1,638,360		1,251,832	
		2.64		-0.74		-1.37
1954	23,926,920		1,578,912		1,168,612	
		-		5.96		5.22
1959	Not available		2,108,881		1,507,032	

Source: United States Department of Commerce, Bureau of the Census, "U. S. Census of Agriculture" for the census years.

78. PRINCIPAL PRODUCTS.- The principal agricultural products in the base study area are rice, wheat, oats, sorghum, cotton, livestock, and poultry and dairy products. Since 1929 the total value of all farm products sold in the study area has ranged from 4.9 to 6.0 percent of the national production, averaging about 5.3 percent. Data on production is presented graphically in figure 5.

79. PROJECTION.- In constructing the future value of farm products consideration was given to projections prepared by the Soil Conservation Service, U. S. Department of Agriculture for the U. S. Study Commission-Texas, and the report "A 50-year Look Ahead at U. S. Agriculture," United States Department of Agriculture, Washington, D. C., June 1959. In view of the rapidly increasing population and ever

increasing demands for food, it is believed the projections are conservative. Table 28 summarizes the projections and gives the factors of growth. Figure 24 shows graphically the historical data and the projection.

TABLE 28

PROJECTION OF VALUE OF FARM PRODUCTS SOLD

Year	United States	Texas	Study area
	VALUES IN THOUSANDS OF 1960 CONSTANT DOLLARS		
1960	30,340,400	2,180,000	1,540,000
1970	35,397,200	2,580,000	1,800,000
2020	84,278,000	6,200,000	3,940,000
2070	200,019,500	14,910,000	8,470,000
	FACTORS OF GROWTH		
1970 ÷ 1960	1.17	1.18	1.17
2020 ÷ 1960	2.78	2.84	2.56
2070 ÷ 1960	6.59	6.84	5.50
	AVERAGE ANNUAL PERCENT CHANGE		
1960 to 2070	1.73	1.77	1.56

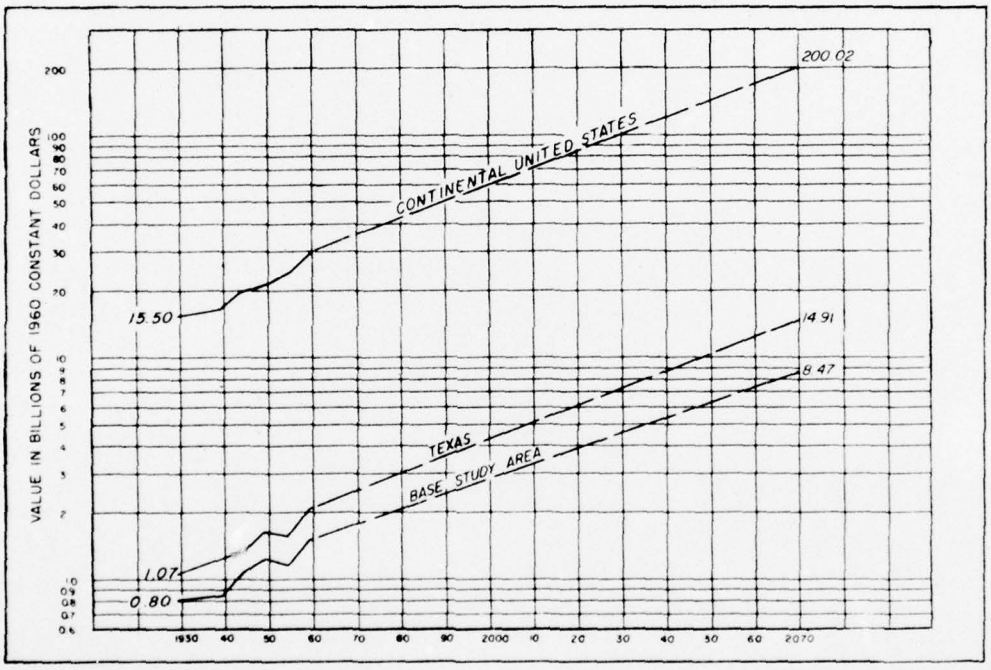

FIGURE 24. VALUE OF FARM PRODUCTS SOLD

PROJECTION OF LABOR FORCE AND EMPLOYMENT

80. HISTORICAL DATA.- The two major sources of statistics on labor force and employment are household interviews and payroll reports from employers. The decenial census by the Bureau of the Census is an extremely comprehensive household survey resulting in a wealth of data on the number and characteristics of the inhabitants of the United States, including data on employment and unemployment. Additional household surveys and payroll reports are conducted by the Bureau of Labor Statistics.

81. EMPLOYMENT AND EARNING STATISTICS.- Data on number, employment status, age, sex, color, marital status, occupation, hours of work, and duration of employment of persons 14 years of age and over are obtained from a sample survey of the population. This survey is conducted each month by the Bureau of the Census for the Bureau of Labor Statistics. The information is collected by trained interviewers from a sample of about 35,000 households in 333 areas throughout the country.

82. Data based on establishment payroll records are compiled each month from mail questionnaires by the Bureau of Labor Statistics, in cooperation with State agencies. The payroll survey provides detailed industry information on nonagricultural wage and salary employment, average weekly hours, average hourly and weekly earnings, and labor turnover for the Nation, states and metropolitan areas.

83. The data obtained from these two surveys are adjusted, compiled and published by the United States Department of Labor, Bureau of Labor Statistics. The most recent publication available is Bulletin No. 1312, "Employment and Earnings Statistics, for the United States, 1909 - 60," issued 1961.

84. RELATION BETWEEN THE HOUSEHOLD AND PAYROLL SERIES.- The household and payroll data supplement one another, each providing significant types of information that the other cannot suitably supply. Population characteristics, for example, are readily obtained only from the household survey whereas detailed industrial classifications can be reliably derived only from establishment reports. Data from these two sources differ from each other because of differences in definition and coverage, sources of information, methods of collection, and estimating procedures. Sampling variability and response errors are additional reasons for discrepancies. The factors which have a differential effect on levels and trends of the two series are described below:

a. Employment.

(1) Coverage.- The household survey definition of

employment comprises wage and salary workers (including domestics and other private household workers), self-employed persons, and unpaid workers who worked 15 hours or more during the survey week in family-operated enterprises. Employment in both farm and nonfarm industries is included. The payroll survey covers only wage and salary employees on the payrolls of nonfarm establishments.

(2) Multiple jobholding.- The household approach provides information on the work status of the population without duplication since each person is classified as employed, unemployed, or not in the labor force. Employed persons holding more than one job are counted only once and are classified according to the job at which they worked the greatest number of hours during the survey week. In the figures based on establishment records, persons who worked in more than one establishment during the period of reporting are counted each time their names appear on payrolls.

(3) Unpaid absences from jobs.- The household survey includes among the employed all persons who had jobs but were not at work during the survey week--that is, were not working or looking for work but had jobs from which they were temporarily absent because of illness, bad weather, vacation, labor-management dispute, or because they were taking time off for various other reasons, whether or not they were paid by their employers for the time off. In the figures based on payroll reports, persons on paid sick leave, paid vacation, or paid holiday are included, but not those on leave without pay for the entire payroll period.

b. Hours of Work.- The household survey measures hours actually worked whereas the payroll survey measures hours paid for by employers. In the household survey data, all persons with a job but not at work are excluded from the hours distributions and the computations of average hours. In the payroll survey, employees on paid vacation, paid holiday, or paid sick leave are included and assigned the number of hours for which they were paid during the reporting period.

85. DATA USED IN THIS STUDY.- The Census Reports of the U. S. Department of Commerce, and Bulletin 1312, cited above, are the principal sources of data used in the study of Labor Force and Employment. These have been supplemented by similar historical data extracted from "Historical Statistics of the United States, Colonial Times to 1957" and from the annual publication, "Statistical Abstract of the United States." Both of the latter are prepared by the United States Department of Commerce, Bureau of the Census. Additional information at the state and local levels has been received from the Texas Employment Commission and the Oklahoma Employment Security Commission.

86. Statistical series prepared under Bureau of Labor concept of employment differ from similar statistics prepared under the Bureau of Census concept, in large part, due to the definition of employment and multiple job holding. In most instances, data on non-agricultural employment are in reasonably close agreement. In the field of agricultural employment figures for the past three census reports differ from BLS amounts for the same years by seven to 32 percent. The following tabulation gives comparative data on agricultural, nonagricultural and total employment for the United States as reported by the two agencies and their relative magnitude.

	Bureau of Labor Statistics	Bureau of the Census	BLS ÷ BC
	(Numbers in thousands)		
1940			
Agricultural	9,540	8,475	1.13
Non-agricultural	37,980	36,691	1.04
Total	47,520	45,166	1.05
1950			
Agricultural	7,497	7,005	1.07
Non-agricultural	52,251	49,234	1.06
Total	59,748	56,239	1.06
1960			
Agricultural	5,723	4,350	1.32
Non-agricultural	60,958	60,289	1.01
Total	66,681	64,639	1.03

From the above, it might be concluded that about 2 million persons or 3 percent of the total in 1960 held multiple jobs.

87. In order to develop a statistical series at the local level comparable to the national series it has been necessary in some instances to extrapolate Bureau of the Census data for counties at the rate indicated for the States. Table 29 gives the civilian labor force, unemployment, and employment by major industries for the United States, Texas, and the base study area in 1940, 1950, and 1960 and the percent of each, based on total employment.

TABLE 29

LABOR FORCE AND EMPLOYMENT

Industry	1940		1950		1960	
	Number in thousands	Percent of total employed	Number in thousands	Percent of total employed	Number in thousands	Percent of total employed
UNITED STATES						
Agricultural	9,540	20.08	7,497	12.55	5,723	8.58
Non-agricultural	37,980	79.92	52,251	87.45	60,958	91.42
Mining	945	1.99	929	1.56	661	0.99
Construction	2,128	4.48	3,115	5.21	3,858	5.79
Manufacture	10,944	23.03	15,145	25.35	17,708	26.56
Transportation, Communications, and Utilities	3,222	6.78	4,142	6.93	4,507	6.76
Wholesale and Retail Trade	7,804	16.42	10,474	17.53	11,924	17.88
Finance, Insurance and Real Estate	1,520	3.20	2,211	3.70	2,725	4.09
Public Administration, Services and Other	11,417	24.02	16,235	27.17	19,575	29.35
Total Employment	47,520	100.00	59,748	100.00	66,681	100.00
Unemployed	8,120		3,351		3,931	
Total Labor Force	55,640		63,099		70,612	
TEXAS						
Agricultural	639	29.89	443	16.08	402	11.53
Non-agricultural	1,499	70.11	2,312	83.92	3,084	88.47
Mining	61	2.85	90	3.27	107	3.07
Construction	111	5.19	236	8.57	259	7.43
Manufacture	211	9.87	373	13.54	547	15.69
Transportation, Communications, and Utilities	140	6.55	227	8.24	253	7.26
Wholesale and Retail Trade	381	17.82	590	21.41	710	20.36
Finance, Insurance and Real Estate	57	2.67	89	3.23	144	4.13
Public Administration, Services and Other	538	25.16	707	25.66	1,064	30.53
Total Employment	2,138	100.00	2,755	100.00	3,486	100.00
Unemployed	124		160		161	
Total Labor Force	2,262		2,915		3,647	
BASE STUDY AREA						
Agricultural	495	29.86	335	16.07	296	11.53
Non-agricultural	1,163	70.14	1,749	83.93	2,273	88.47
Mining	47	2.83	72	3.45	78	3.04
Construction	81	4.88	174	8.35	186	7.24
Manufacture	178	10.74	308	14.78	446	17.36
Transportation, Communications, and Utilities	113	6.82	174	8.35	189	7.35
Wholesale and Retail Trade	298	17.97	441	21.16	520	20.23
Finance, Insurance and Real Estate	42	2.53	71	3.41	107	4.17
Public Administration, Services, and Other	404	24.37	509	24.43	747	29.08
Total Employment	1,658	100.00	2,084	100.00	2,569	100.00
Unemployed	96		121		149	
Total Labor Force	1,754		2,205		2,718	

Source: As given in the text.

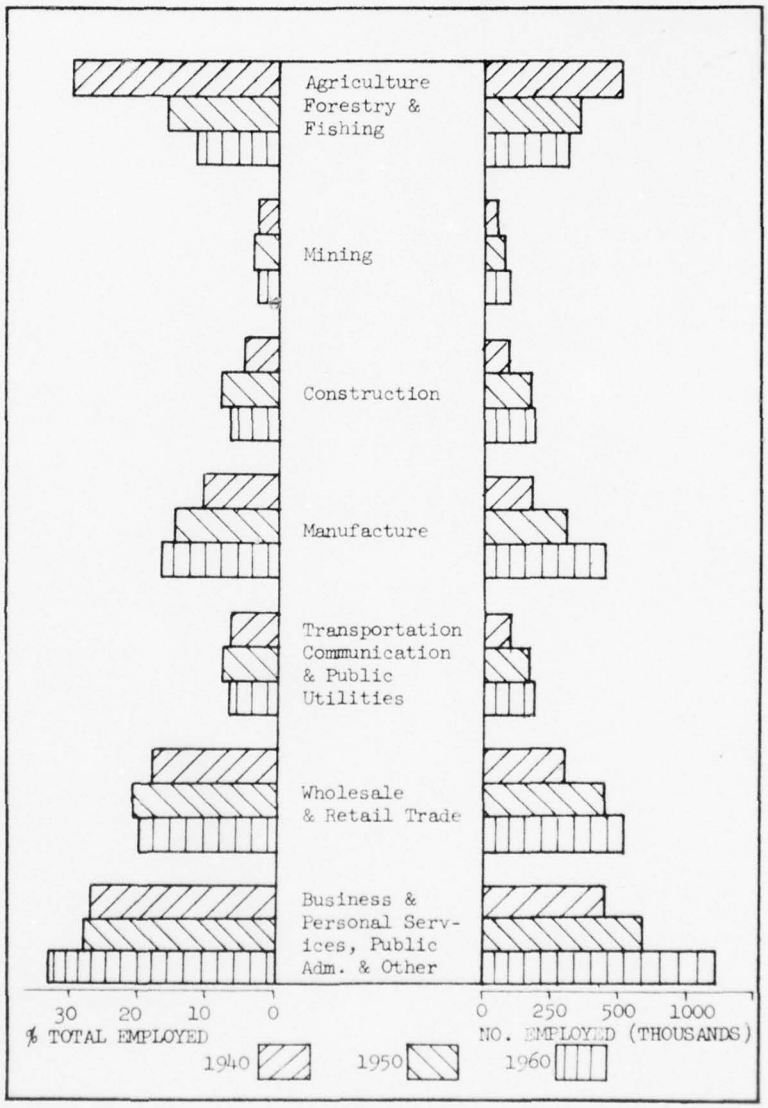

FIGURE 25. 1940 - 1950 - 1960 EMPLOYMENT - BASE STUDY AREA

88. CHANGES IN EMPLOYMENT.- The changing pattern of employment in the base study area is illustrated in figure 25, which compares the employment in 1940, 1950 and 1960, both as to amounts and as to percent of total employment. Employment in agriculture, forestry and fishing decreased from about 495 thousand in 1940 to about 296 thousand in 1960, a decrease of about 40 percent, while the non-agricultural employment increased about 95 percent.

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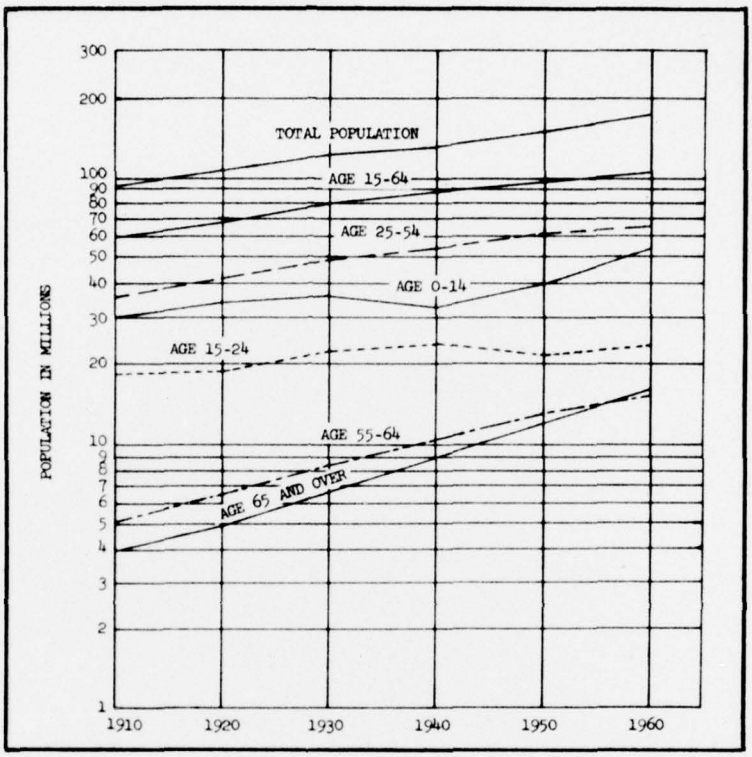


FIGURE 26. POPULATION BY AGE GROUP OF THE UNITED STATES

89. **LABOR FORCE.-** Estimates of available labor force are based on the number of persons in the age group from 15 to 64, inclusive. Table 30 presents the population by age group of the United States and Texas for the census years 1930 through 1960, and the base study area for the census years 1930 through 1950. Figure 26 shows similar data for the United States from 1910 through 1960. Represented as a percent of the total population, the age group 15-64 decreased between 1930 and 1960 from about 65 percent to about 60 percent, while the number of persons over 65 increased from about 5 percent to about 9 percent during the same period.

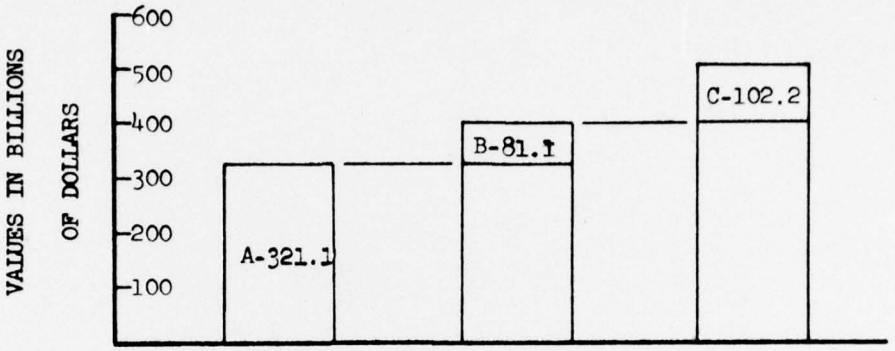
90. **PRODUCTIVITY.-** For the purpose of this study, it was found helpful to use a measurement of productivity which was constructed on the civilian income received by persons for participation in current production, by industrial sources. As is illustrated in figure 27, this component of the national income, which consists of wages and salaries, other labor income, and proprietor's income, in 1960 amounted to 64 percent of the gross national product. Since 1929 when it amounted to 55 percent, it has ranged to a high of 67 percent in 1946 and has averaged about 63 percent since 1948. For ease in reference, it is called production income of persons.

TABLE 30

POPULATION BY AGE GROUP FOR THE UNITED STATES, TEXAS AND THE BASE STUDY AREA

Age group	Population in thousands			
	1930	1940	1950	1960
UNITED STATES				
0 - 14	36,085	32,973	40,483	55,487
15 - 64	80,051	89,676	97,944	106,451
15 - 24	22,439	23,922	22,099	23,873
25 - 54	49,209	55,182	62,551	67,053
55 - 64	8,403	10,572	13,294	15,525
65 and over	6,639	9,020	12,270	16,526
Total	122,775	131,669	150,697	178,464
TEXAS				
0 - 14	1,877	1,797	2,247	3,173
15 - 64	3,715	4,271	4,951	5,662
15 - 24	1,188	1,205	1,235	1,372
25 - 54	2,216	2,645	3,150	3,538
55 - 64	311	421	566	752
65 and over	233	347	513	745
Total	5,825	6,415	7,711	9,580
BASE STUDY AREA				
0 - 14	1,492	1,360	1,576	NA
15 - 64	2,938	3,317	3,635	NA
15 - 24	948	928	863	NA
25 - 54	1,742	2,058	2,339	NA
55 - 64	248	331	433	NA
65 and over	183	275	401	NA
Total	4,613	4,952	5,913	6,844

NA - Not available
Source: United States Department of Commerce, Bureau of the Census.



	INCOME RECEIVED BY PERSONS FOR PARTICIPATION IN CURRENT PRODUCTION	TOTAL PERSONAL INCOME	GROSS NATIONAL PRODUCT
TOTAL VALUE	$321.1	$402.2	$504.4

	BILLIONS
A - Wages and salaries	$ 271.3
Proprietors income	48.2
Other labor income	10.9
Minus personal contributions for social insurance	- 9.3
Total	$ 321.1
B - Rental income	$ 11.7
Dividends	14.1
Personal interest income	26.2
Transfer payments	29.1
Total	$ 81.1
C - Capital consumption allowances	$ 43.1
Indirect business tax and nontax liability	45.6
Business transfer payments	1.8
Minus subsidies less current surplus of government enterprises	- .5
Statistical discrepancy	- 2.6
Corporate profits and inventory valuation adjustment	45.1
Contributions for social insurance	20.7
Excess of wage accruals over disbursements	.0
Minus Government transfer payments	- 27.3
Net interest paid by government	- 7.8
Dividends	- 14.1
Business transfer payments	- 1.8
Total	$ 102.2

FIGURE 27. PERSONAL INCOME AND GROSS NATIONAL PRODUCT - 1960

91. Data on production income of persons at the national level as well as by states are available in publications of the U. S. Department of Commerce, Office of Business Economics. Data from 1929 to 1955, inclusive, are contained in "Personal Income by States Since 1929" and current data are published monthly in the "Survey of Current Business." It has been estimated at the level of the base study area by relation with other indicators.

92. **PRODUCTION PER HOUR.-** The income received by persons for participation in current production was reduced to an hourly rate based on the number of persons employed and upon the average weekly hours worked by individuals in industry. Table 31 compares the gross national product per hour, total personal income per hour, and production income of persons per hour, for selected years from 1929 to 1960, inclusive. Table 32 gives the production income per hour, in 1940 and 1960, by industry, for the United States, Texas and the base study area.

TABLE 31

MEASURES OF PRODUCTION

Year	Gross national product per hour	Total personal income per hour	*Production income per hour
	VALUES IN 1960 CONSTANT DOLLARS		
1929	1.77	1.28	0.98
1933	1.64	1.21	0.89
1940	2.19	1.52	1.21
1946	2.57	2.09	1.73
1948	2.59	1.94	1.61
1950	2.80	2.14	1.73
1955	3.30	2.46	2.02
1958	3.40	2.70	2.17
1960	3.56	2.83	2.20
	AVERAGE ANNUAL PERCENT CHANGE		
1929 to 1960	2.31	2.59	2.64
1940 to 1960	2.50	3.16	3.04

* Civilian income received by persons for participation in current production.

TABLE 32

PERSONAL INCOME PER HOUR OF THOSE PERSONS ENGAGED IN PRODUCTION

Industry	1940 : 1960 constant dollars	1960 : 1960 constant dollars	Avg ann percent increase 1940 - 1960
UNITED STATES			
All industries	1.21	2.20	3.04
Agricultural	0.43	1.07	4.66
Non-agricultural	1.47	2.32	2.31
Mining	1.52	3.04	3.84
Construction	1.35	2.77	3.66
Manufacture	1.57	2.51	2.37
Other*	1.61	2.18	1.53
TEXAS			
All industries	0.98	1.92	3.42
Agricultural	0.48	1.18	4.60
Non-agricultural	1.21	2.02	2.60
Mining	2.50	3.48	1.67
Construction	1.12	2.03	3.02
Manufacture	1.28	2.31	3.00
Other*	1.25	2.00	2.38
BASE STUDY AREA			
All industries	0.96	1.91	3.50
Agricultural	0.45	1.13	4.71
Non-agricultural	1.21	2.02	2.60
Mining	2.31	3.36	1.89
Construction	1.10	2.01	3.06
Manufacture	1.28	2.32	3.01
Other*	1.25	2.06	2.53

*Other includes: Transportation, communication, utilities, wholesale & retail trade, finance, insurance, real estates, business & personal services, public administration, and remaining unclassified industries.

93. ESTIMATES OF FUTURE EMPLOYMENT.- The estimates of future employment in this study assume an overall increase in productivity of about 1.9 percent per year. Table 33 gives the estimated civilian employment in the United States, Texas and in the study area by major industry in 1970, 2020 and 2070 compared to the actual employment in 1960. It also shows the factors of growth. The four basic industries, agriculture, mining, manufacture and construction are separately estimated. All other industries; i.e., transportation, communication, and other public utilities; wholesale and retail trade; finance, insurance, and real estate; education, both public and private; federal, state and local government; recreational services; etc.; are all grouped under "Other Industries."

TABLE 33

PROJECTION OF LABOR FORCE AND EMPLOYMENT BY INDUSTRY

Industry	1960 Thousands of Employees	1970 Thousands of Employees	1970 ÷ 1960	2020 Thousands of Employees	2020 ÷ 1960	2070 Thousands of Employees	2070 ÷ 1950
UNITED STATES							
Agriculture	5,723	6,431	1.12	7,454	1.30	7,987	1.40
Non-Agriculture	60,958	74,977	1.23	154,594	2.54	299,213	4.91
Mining	661	814	1.23	1,621	2.45	3,072	4.65
Construction	3,858	4,640	1.20	8,589	2.23	15,053	3.90
Manufacture	17,708	21,818	1.23	45,211	2.55	70,042	3.96
Other industries	38,731	47,705	1.23	99,173	2.56	211,046	5.45
Total Employment	66,681	81,408	1.22	162,048	2.43	307,200	4.61
Unemployment	3,931	3,392	0.86	6,752	1.72	12,800	3.26
Total Labor Force	70,612	84,800	1.20	168,800	2.39	320,000	4.53
TEXAS							
Agriculture	402	455	1.13	511	1.27	601	1.50
Non-Agriculture	3,084	3,923	1.27	10,126	3.28	20,135	6.53
Mining	107	136	1.27	340	3.16	622	5.81
Construction	259	311	1.20	585	2.26	975	3.76
Manufacture	547	718	1.31	2,138	3.91	3,650	6.67
Other industries	2,171	2,758	1.27	7,063	3.25	14,888	6.86
Total Employment	3,486	4,378	1.26	10,637	3.05	20,736	5.95
Unemployment	161	182	1.13	443	2.75	864	5.37
Total Labor Force	3,647	4,560	1.25	11,080	3.04	21,600	5.92
TRINITY BASE STUDY AREA							
Agriculture	296	323	1.09	343	1.16	396	1.34
Non-Agriculture	2,273	2,782	1.22	6,799	2.99	13,274	5.84
Mining	78	93	1.19	221	2.83	396	5.08
Construction	186	217	1.17	407	2.19	697	3.75
Manufacture	446	578	1.30	1,764	3.96	3,213	7.20
Other industries	1,563	1,894	1.21	4,407	2.82	8,968	5.74
Total Employment	2,569	3,105	1.21	7,142	2.78	13,670	5.32
Unemployment	149	129	0.87	298	2.00	570	3.83
Total Labor Force	2,718	3,234	1.19	7,440	2.74	14,240	5.24

94. INCREASE IN TOTAL EMPLOYMENT.- The increase in total employment reduced to an average annual percent is presented below:

Increase in Total Employment

Area	Average Annual Percent 1960-1970	1970-2020	2020-2070	1960-2070
United States	2.02	1.39	1.29	1.40
Texas	2.30	1.79	1.34	1.63
Base study area	1.91	1.68	1.31	1.53

PROJECTION OF TOTAL PERSONAL INCOME

95. HISTORICAL DATA.- The historical data for the United States and Texas were extracted from publications of the United States Department of Commerce. Data for the base study area are based, in part, on "Sales Management Survey of Buying Power," and in part on independent estimates developed by the Fort Worth District.

96. Personal income is considered the most comprehensive measure of economic activity available in all the areas of this study. It is the principal component of the gross national product, and at the national level the average rate of growth since 1929 has been about 3.3 percent per year, practically the same as the rate of growth of the gross national product. Figure 27, page 82, illustrates the relationship of personal income to the gross national product, and table 34 shows the historical data for the United States, Texas, and the base study area from 1929 to 1960, inclusive.

TABLE 34

PERSONAL INCOME

Year	United States Values	United States Avg Ann Percent Change	Texas Values	Texas Avg Ann Percent Change	Base Study Area Values	Base Study Area Avg Ann Percent Change
			VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS			
1929	147,946		4,753		3,721	
		-7.98		-10.50		-10.64
1930	136,135		4,254		3,325	
		-6.25		-6.51		-6.65
1931	127,621		3,977		3,104	
		-15.16		-15.04		-15.17
1932	108,273		3,379		2,633	
		-0.41		3.20		3.00
1933	107,831		3,487		2,712	
		9.73		9.12		8.96
1934	118,323		3,805		2,955	
		9.47		10.46		10.25
1935	129,534		4,203		3,258	
		12.53		13.99		13.81
1936	145,763		4,791		3,708	
		4.40		9.66		9.47
1937	152,171		5,254		4,059	
		-5.72		-0.32		-0.49
1938	143,465		5,237		4,039	
		7.90		5.63		5.47
1939	154,794		5,532		4,260	
		7.02		5.87		5.68
1940	165,658		5,857		4,502	
		16.54		18.83		18.24
1941	193,064		6,960		5,323	
		15.08		25.73		25.12
1942	222,172		8,751		6,660	
		14.19		26.27		25.66
1943	253,691		11,050		8,369	
		6.25		8.52		7.99
1944	269,559		11,992		9,038	
		0.40		-1.68		-2.16
1945	270,640		11,791		8,843	
		-1.49		-4.77		-5.24
1946	266,618		11,229		8,380	
		-6.07		-1.72		-2.21
1947	250,433		11,036		8,195	
		1.87		0.92		0.41
1948	255,122		11,137		8,229	
		0.04		9.07		8.52
1949	255,220		12,147		8,930	
		8.67		5.05		4.54
1950	277,335		12,761		9,335	
		4.00		5.67		5.83
1951	288,438		13,485		9,879	
		3.99		5.09		5.26
1952	299,944		14,172		10,399	
		4.42		1.57		1.73
1953	313,208		14,395		10,579	
		0.33		2.45		2.62
1954	314,250		14,748		10,856	
		7.81		7.74		7.90
1955	338,782		15,890		11,714	
		6.12		5.61		5.76
1956	359,499		16,781		12,389	
		2.11		3.85		4.02
1957	367,078		17,427		12,887	
		0.57		0.92		1.07
1958	369,160		17,587		13,025	
		5.41		4.10		4.27
1959	389,137		18,308		13,581	
		3.36		1.09		1.24
1960	402,200		18,508		13,749	

Source: See text.

97. PROJECTION.- Projections have been constructed at a lower average annual rate of increase than the historical rate. The current trends indicate that the rate of growth for Texas and the base study area will exceed the rate of growth of the United States. The growth factors for population and for per capita income for Texas and the base study area are both greater than the comparable rates for the United States. Continued urbanization and industrialization, especially in the coastal region where chemical manufacturing exerts a large influence, contribute to the high rate of increase predicted for the base study area. Table 35 summarizes the projections and the factors of growth. Figure 28 shows the data in graphic form.

TABLE 35

PROJECTION OF PERSONAL INCOME

Year	United States	Texas	Base study area
VALUES IN MILLIONS OF 1960 CONSTANT DOLLARS			
1960	402,200	18,508	13,749
1970	557,600	26,500	19,400
2020	2,574,200	157,900	107,300
2070	11,120,000	750,600	494,800
FACTORS OF GROWTH			
1970 ÷ 1960	1.39	1.43	1.41
2020 ÷ 1960	6.40	8.53	7.80
2070 ÷ 1960	27.65	40.56	35.66
AVERAGE ANNUAL PERCENT CHANGE			
1960 to 2070	3.06	3.42	3.31

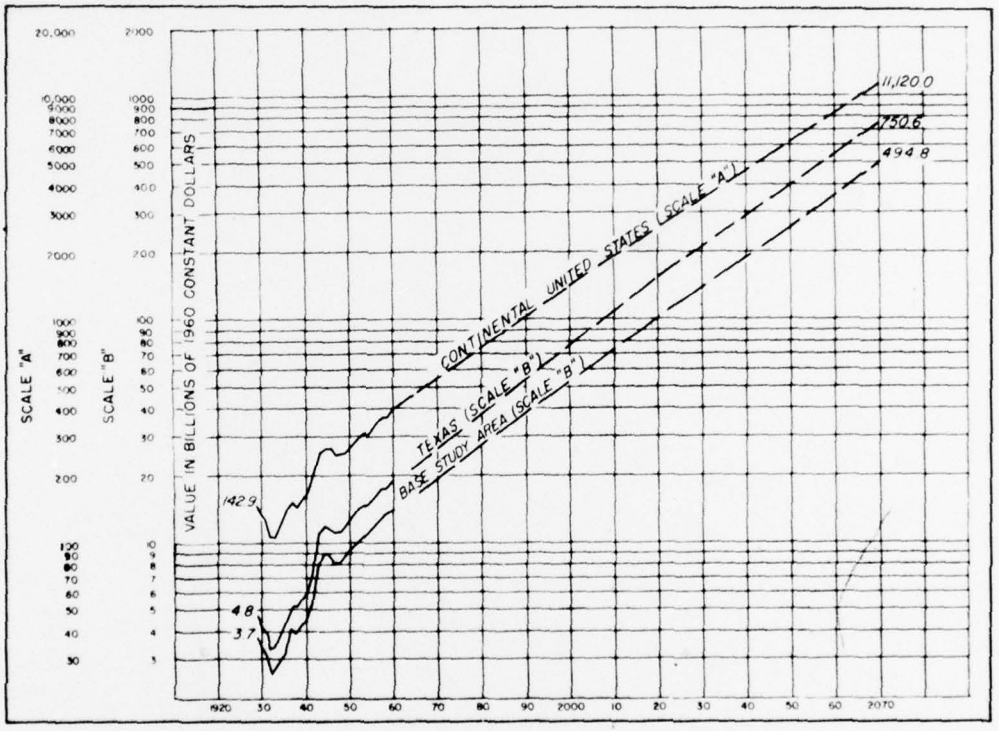


FIGURE 28. TOTAL PERSONAL INCOME

SUMMARY

98. GROWTH RATES OF ECONOMIC INDICATORS.- A summary of historical and future growth rates for the various indicators in this study is given in table 36.

TABLE 36

SUMMARY OF GROWTH RATES

Economic indicator	Average annual percent increase					
	United States		Texas		Base study area	
	1940 to 1960 except as noted	1960 to 2070	1940 to 1960 except as noted	1960 to 2070	1940 to 1960 except as noted	1960 to 2070
Population	1.5	1.4	2.0	1.6	1.6	1.5
Urban population	2.6	1.6	4.6	1.8	4.4	1.7
New construction	4.3	2.5	6.6	2.6	6.5	2.6
Value added by manufacture	5.1(1)	3.2	8.9(1)	3.5	8.3(1)	3.5
Mineral production	3.3	3.0	4.9	3.0	4.7	3.0
Retail sales	4.1	2.9	5.6	3.2	5.4	3.1
Bank deposits	2.6	3.0	6.4	3.3	6.3	3.2
Wheat exports	5.7(2)	1.1	-	-	25.6(3)(4)	0.8(3)
Value of farm products sold	2.9(1)	1.7	2.8(1)	1.8	2.9(1)	1.6
Employment	1.7	1.4	2.5	1.6	2.2	1.5
Personal income	4.5	3.1	5.9	3.4	5.7	3.3

(1) 1940 data not available; 1939 to 1960 used.
(2) Based on 1950 to 1960.
(3) From three Texas ports, Galveston, Houston, and Port Arthur.
(4) Based on 1954 to 1960.

99. APPLICATION OF ECONOMIC INDICATORS.- Indicators have been selected from two standpoints: availability of basic data, and applicability to the various project purposes to be considered. Application of the indicators will be accomplished in the appendices pertaining to the individual purposes. This will require adaptation and modification. Population and economy differ from one place to another and the indicators will be adapted to the sub-area and purposes. The broad indicators to be considered for each project purpose are as follows:

Project Purpose	Indicator
A. Navigation	Population
	New construction
	Value added by manufacture
	Wheat exports
	Value of farm products sold
B. Flood control	Population
	New construction
	Value added by manufacture
	Mineral production
	Retail sales
	Value of farm products sold
	Personal income
	Bank deposits
C. Recreation and fish and wildlife	Population
D. Water supply	Population
	New construction
	Value added by manufacture
	Personal income

COMPREHENSIVE SURVEY REPORT

ON

TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX VIII

COMMENTS OF OTHER AGENCIES

U. S. ARMY ENGINEER DISTRICTS
FORT WORTH AND GALVESTON
CORPS OF ENGINEERS
FORT WORTH AND GALVESTON, TEXAS

JUNE 1962

COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX VIII
COMMENTS OF OTHER AGENCIES

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COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX VIII

COMMENTS OF OTHER AGENCIES

INTRODUCTION

In accordance with the Interagency Agreement on Coordination of Water and Related Land Resources Activities approved by the President on May 26, 1954, draft copies of the Main Report and appendixes were sent to other Federal agencies at field level and the Texas Water Commission for review. Letters from these agencies containing their comments and replies where appropriate are presented in this appendix.

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Southwest Region
Santa Fe, New Mexico

IN REPLY REFER TO:

L7423

AUG 3 - 1962

District Engineer,
U. S. Army Engineer District, Fort Worth
P. O. Box 1600
Fort Worth, Texas

Dear Sir:

Thank you for the privilege of reviewing the draft of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas" dated June 1962, inclosed in your letter of 11 July 1962, SWFGP. We are quite interested in the Main Report and Appendix V, Recreation, and Fish and Wildlife, in view of our recreation studies and cooperative work on your project and on various other water resource proposals in that general State section.

Our review discloses that we have no comments. The draft of the main report and the appendices (II, III, IV, V, VI, and VII), serial number 10, are being returned as you requested. When distribution in final form is made, one copy of the Main Report and of Appendix V will serve the needs of this office.

Sincerely yours,

Leslie P. Arnberger
Assistant Regional Director

Enclosures

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE

PUBLIC HEALTH SERVICE

1114 Commerce Street
Dallas 2, Texas

August 9, 1962

Your Reference:
SWFGP

District Engineer
U. S. Army Engineer District, Fort Worth
P. O. Box 1600
Fort Worth, Texas

Dear Sir:

The draft copy (Serial Number 12) of your "Comprehensive Survey Report on the Trinity River and Tributaries, Texas," dated June 1962, has been reviewed.

Our "Water Resources Study, Trinity River Basin, Texas," which evaluates municipal and industrial water supply and water quality control requirements, is included in the report as Exhibit 1, Appendix II. Several minor inconsistencies of data and reporting were revealed by our review, however, all of these have been resolved in meetings with your staff. We have no further comment.

The draft copy of this report is being returned as requested. The opportunity to review the report is appreciated.

Sincerely yours,

Jerome H. Svore
for

E. C. Warkentin
Associate Regional Health Director
for Environmental Health Services

Separate cover:
Report

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

06-41

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

Austin, Texas

July 25, 1962

IN REPLY REFER TO:

Colonel R. P. West
District Engineer
Corps of Engineers
100 West Vickery Boulevard
Fort Worth 4, Texas

Dear Colonel West:

The draft copy (serial number 14) of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas" forwarded with your letter dated July 11, 1962 has been reviewed and is returned herewith.

The construction of the multiple-purpose channel requires the construction, replacement and modification of 44 high-level highway bridges. In addition to the high-level bridges crossing the navigation channel, a new bridge to replace the existing First Street bridge and modification of the Beach Street and the two Riverside Drive bridges in Fort Worth will be required.

It is noted that the estimated cost of the Tennessee Colony Reservoir, including highway relocations within the reservoir area, is to be borne by local co-operation. The basic regulations of the Bureau of Public Roads will not permit the use of Federal-aid highway funds to be used to relieve local interests of obligations they agree to assume as a condition of any approved project.

We appreciate the opportunity to review the draft report on this project.

Sincerely yours,

L. S. Cox
Division Engineer

REGION SIX
ARKANSAS
LOUISIANA
OKLAHOMA
TEXAS

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
P. O. BOX 12037
FORT WORTH 16, TEXAS

July 30, 1962

IN REPLY REFER TO:
06-00.1

Colonel R. P. West
District Engineer
U. S. Army Corps of Engineers
100 West Vickery Blvd.
Fort Worth 4, Texas

Dear Colonel West:

Reference is made to your letter dated 11 July 1962 addressed to Mr. J. M. Page, Division Engineer, Austin, Texas, and the enclosed draft copy of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas," dated June 1962. We have reviewed the informational copies of your letter and report which were furnished this office.

Mr. Page has retired and Mr. L. S. Coy is now Division Engineer in Austin. The original of Mr. Coy's July 25 reply incorporating his comments on the report is enclosed. The draft copies of the reports furnished the Division and Regional offices, serial numbers 14 and 17, are being returned.

In addition to Mr. Coy's comment about highway relocations within the Tennessee Colony Reservoir, we wish to point out that the same restrictions against the use of Federal-aid highway funds apply in all other areas where highway and bridge relocations and alterations are determined to be the responsibility of local interests, such as in the multipurpose channel and local flood protection projects.

We appreciate the opportunity you have afforded the Division and Regional offices to review and comment on the draft copy of your proposed report.

Sincerely yours,

Bill L. Andrews
Assistant Regional Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
P. O. BOX 1306
ALBUQUERQUE, NEW MEXICO

ADDRESS ONLY THE
REGIONAL DIRECTOR

SOUTHWEST REGION
(REGION 2)
ARIZONA
COLORADO
KANSAS
NEW MEXICO
OKLAHOMA
TEXAS
UTAH
WYOMING

August 3, 1962

District Engineer
Corps of Engineers, U. S. Army
P. O. Box 1600
Fort Worth 1, Texas

Dear Sir:

By letter dated July 11, 1962, reference SWFGP, you requested our comments on the draft of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas, dated June 1962."

We have reviewed the draft of the Comprehensive Survey Report including Appendixes II through VII. We are pleased to note that the Bureau of Sport Fisheries and Wildlife report dated May 1962 has been attached in Appendix V, "Recreation and Fish and Wildlife." Our report was based upon information we received from the Corps of Engineers prior to December 1, 1961, and does not reflect recent changes in and additions to the proposed plan of development. Our report also does not reflect the joint policies of the Departments of the Interior and of the Army relative to acquisition of reservoir project lands approved February 19, 1962. Neither does it include consideration of the enlargement of the conservation storages in the existing Garza-Little Elm and Grapevine Reservoirs, the enlargement proposed for Lakeview and Tennessee Colony Reservoirs, the construction of Aubrey and Roanoke Reservoirs, the provision of water-quality control on the West Fork and the main stem of the Trinity River, nor the provision of local flood protection to the cities of Garland and Liberty, Texas. A supplement to our May 1962 report is being prepared to reflect these changes and additions to the plan of development.

We view with interest Paragraph 37, pages V-22 to V-25, of Appendix V in which you comment on the recommendations contained in our report. The consideration you have given our recommendations is appreciated.

It is noted that you recognize the importance of establishing a national wildlife refuge in connection with Tennessee Colony Reservoir as proposed in Recommendation No. 7 of our report. We view with disappointment, however, your decision that the proposal for a refuge

should be considered separately from the reservoir project. It was our recommendation that the proposed refuge should be made an integral part of the plan for improvement of the Trinity River and Tributaries. This aspect of the recommendation is in agreement with the wording contained in Paragraph 1, page V-1, of Appendix V of your report wherein it is stated, "Described here are the methods and techniques employed in this report to meet requirements placed upon recreation and fish and wildlife as equal physical and economic purposes served by the multiple-purpose plan of development for the water resources of the Trinity River Basin." (Underscoring supplied). We trust your report can be revised to include the establishment of a national wildlife refuge as an integral part of the plan for the project. In this regard, the Bureau of Sport Fisheries and Wildlife stands ready to support the proposal before Congress or at such times and places as are appropriate.

It should be mentioned that our estimate of waterfowl use for Tennessee Colony Reservoir without a refuge was based on much less visitation to the reservoir by general recreationists than the estimate in your report. We note that you estimate an average expected use of 6 million visitor-days annually for general recreation. This amount of visitation will interfere with and prevent even moderate use of the reservoir by waterfowl. For this reason, we conclude that Tennessee Colony Reservoir will be of only nominal value to waterfowl and will be used but little by waterfowl unless an area is set aside specifically for waterfowl management. We wish to point out that intensive management of a water area is the key to making the area attractive to waterfowl, not the water alone.

In order that our report may reflect the increase expected in general recreation on Tennessee Colony Reservoir, the forthcoming supplement to our report will present scaled-down estimates of waterfowl hunting without a national wildlife refuge.

It should be noted that our estimate of 100,000 visitor-days annually for visitation to the proposed refuge would be over and above your estimates of 6 million visitor-days annually for general recreation on the reservoir. Thus, benefits accruing as a result of the 100,000 visitor days should be considered attributable only to the refuge.

In your economic evaluation of projects recommended for authorization, first given in Paragraph 165, page 91, of the main report and subsequently carried throughout your entire report, we note that benefits

for fish and wildlife were computed on the basis of the Corps of Engineers' estimates of total annual attendance at each project locality. Estimated annual fish and wildlife benefits attributable to the project were calculated on the assumption that 35 percent of all visitors would be hunters and fishermen. A constant unit value of $1.00 per visitor-day for hunting and fishing was assigned to each segment of the project. By this system of calculation, fish and wildlife benefits accruing as a result of the project were stated to be $6,300,000 annually, rather than $1,236,000 as stated in the Bureau of Sport Fisheries and Wildlife report included in Appendix V.

The system of estimating fish and wildlife benefits appearing in your report makes no allowance for project-caused losses. Moreover, it is not a biologically sound approach since it gives no real consideration to the many interrelated biological factors which bear upon populations of fish and wildlife at any given site. In the final analysis, it is the populations of fish and wildlife that ultimately determine the extent of hunting and fishing.

The estimated net annual benefit to fish and wildlife of $1,236,000 shown in our report was arrived at through the cooperative efforts of our Bureau, the Bureau of Commercial Fisheries, and the Texas Game and Fish Commission. Our experience and judgment indicates this figure to be quite realistic.

We appreciate the opportunity extended to us to comment on your comprehensive survey report on the proposed plan of improvement Under separate cover we are returning copy No. 8 of your draft report including appendixes.

Sincerely yours,

Carey H. Bennett
Acting Regional Director

cc:
Executive Secretary, Texas Game and Fish Commission, Austin, Texas
Regional Director, Region 2, Bureau of Commercial Fisheries, St. Petersburg Beach, Florida
Director, Biological Laboratory, Bureau of Commercial Fisheries, Galveston, Texas
Field Supervisor, Branch of River Basin Studies, Bureau of Sport Fisheries and Wildlife, Fort Worth, Texas

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
100 WEST VICKERY BOULEVARD
FORT WORTH 4, TEXAS

ADDRESS REPLY TO
P. O. BOX 1600
FORT WORTH, TEXAS
IN REPLY REFER TO

SWFGP

4 September 1962

Regional Director
U. S. Department of the Interior
Bureau of Sport Fisheries and Wildlife
P. O. Box 1306
Albuquerque, New Mexico

Dear Sir:

This is in reply to your letter dated August 3, 1962, furnishing your comments on the draft of our "Comprehensive Survey Report on Trinity River and Tributaries, Texas," dated June 1962.

You indicate that the Bureau of Sport Fisheries and Wildlife stands ready to support the proposal for a refuge before Congress or at such times and places as are appropriate. However, you express disappointment that our recommendation did not include the establishment of the proposed refuge as an integral part of the plan for the project. Studies have shown that the refuge as proposed is a separable economic component which could be included or excluded from the overall development without affecting the justification for or the other purposes of the reservoir. The refuge will be made an integral part of the Tennessee Colony Reservoir if the Congress gives favorable consideration to and approves the establishment of a national wildlife refuge at the Tennessee Colony Reservoir as recommended by both agencies.

The comprehensive survey report does not estimate an average annual visitation of six million for general recreation. The estimated average annual visitation of six million would consist of 3,900,000 visitors participating in general recreation activities and 2,100,000 visitors participating in fish and wildlife activities.

The statements incorporated in comment on page V-25, of the comprehensive survey report acknowledge that your estimated 100,000 man-days annual visitors, for scientific studies, nature observations and allied uses would not be realized unless the national wildlife refuge is established. The factors and basis used in estimating the number of visitors the project will attract are discussed in the text of and illustrated by graphs in Appendix V. The basis for assuming that 65 per cent of the estimated visitors will participate in general recreation activities and 35

per cent in fish and wildlife activities is outlined in the text of Appendix V.

The annual benefit applicable to fish and wildlife of $6,300,000 shown in the comprehensive survey report was based on experienced visitor use at comparable operating Corps reservoirs throughout the area.

To further substantiate our estimated man-days of fish and wildlife activities, your attention is invited to statements incorporated on page 71 of the Outdoor Recreation Resources Review Commission (ORRRC) report dated January 31, 1962, which reads, "The demand for fishing opportunities is expected to increase over the coming years - 50 percent by 1976 and 150 percent by 2000. There may be a slight reduction in the amount of fish each angler will be able to land, but opportunities can generally be adequate if the needed action is taken." On the basis of attendance records and studies cited in Appendix V, it is estimated that the four existing upper Trinity Reservoir projects under the jurisdiction of the Corps of Engineers attracted about 2,745,000 fishermen in 1961. Based on ORRRC prediction, the fishing demand at these four reservoirs could be about 4,100,000 by 1976 and about 6,860,000 by 2000. Our estimated annual fishing and hunting visitation for these four reservoirs is 4,900,000. The comprehensive report recommends the construction of two additional reservoirs in the immediate vicinity. Our estimated annual fishing and hunting visitation for these two reservoirs is about 2,450,000 or a total of 7,350,000 for the six reservoir projects in the upper Trinity River Basin. The above comparison does not include the Tennessee Colony Reservoir. However, a reservoir project under the jurisdiction of the Corps of Engineers, located in an area with a comparable population density, attracted about 1,734,500 fishermen during 1961. Based on ORRRC prediction the fishing demand for that Corps reservoir could be about 2,600,000 by 1976 and about 4,300,000 by 2000. Our estimated annual fishing and hunting visitation to the Tennessee Colony Reservoir, which has a surface area four times greater, is 2,100,000.

It is realized that other water resource projects, both existing and proposed, are located within and adjacent to the Trinity Basin, which provide fishing opportunities. Many of these water resource projects, under the jurisdiction of other agencies, were in existence during 1961 when the Corps projects attracted the number of fishermen indicated. The majority of the projects proposed by others are not scheduled for construction until after the year 2000.

It is believed that our estimated visitation for fish and wildlife activities to the project is conservative and that the estimated benefits can be considered as net benefits.

SWFGP
Regional Director

4 September 1962

Copies of your letter of comments and this reply will accompany the report to the Congress.

Sincerely yours,

R. P. WEST
Colonel, CE
District Engineer

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 648
Temple, Texas
August 13, 1962

Colonel R. Paul West
District Engineer
U. S. Army Corps of Engineers
Box 1600
Ft. Worth, Texas

Dear Colonel West:

Thank you for the opportunity to review the draft of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas".

The plan presented in the report provides specific measures to satisfy the present and projected needs for water supply and water quality, flood protection, navigation, recreation and fish and wildlife. Projects recommended for authorization include a multiple-purpose channel from the Houston Ship Channel to Fort Worth, including a series of navigation locks and dams; four multiple-purpose reservoirs-Roanoke, Aubrey, Lakeview, and Tennessee Colony with a wildlife refugee and water control distribution facilities, including a pipe line to the existing Benbrook Reservoir; and five local flood protection projects - West Fork Floodway, Dallas Floodway Extension, Duck Creek Channel Improvement and Liberty Levee.

The total estimated construction cost of the projects recommended for authorization is $900,747,000, of which $776,042,000 is designated to be paid from Federal funds. Annual costs for operation and maintenance and replacement are estimated to be $8,461,000 and $7,169,000, respectively.

Annual benefits from the recommended projects are $63,200,000. Water supply, water quality control, navigation, fish and wildlife, and improvements for recreation are the major sources of benefits. Information is not presented in sufficient detail to determine agricultural benefits from reduction of flood damages. However, by comparison of property values, it is estimated that they constitute less than 5 percent of the total project benefits based on expected future development.

The application of projections used to calculate benefits from future development is difficult to follow. For example, in Reach 7 above Dallas, which includes the West Fork Floodway and a multiple-purpose channel, the report shows annual flood prevention benefits of $74,300, based on 1960 economic development. Projected future development is expected to show a 2.7 percent average annual increase during the life of the project. Property values are estimated to increase 18.8 times

during the period 1960 to 2070. Project benefits in Reach 7 are shown as $3,182,000, which amounts to 42.8 times the benefits estimated under current economic development. Apparently, estimated benefits in 2070 would be many times more than the ratio of 42.8 to 18.8 if appropriate discounting were used. It is felt that some clarification of this would strengthen the report.

Land required for the multiple-purpose project is about 274,000 acres, according to the report. This estimate includes only the multiple-purpose reservoir and channel site requirements for projects recommended for authorization. Additional land will be needed for other elements of the comprehensive plan which have been authorized or were recommended for authorization in previous reports.

The report does not indicate that investigations were made to determine effects of the multiple-purpose channel on productivity of adjacent agricultural land. It appears the locks and dams may be expected to create local drainage problems.

Highly developed agricultural lands are involved in the multiple-purpose reservoir and channel sites, and some of these lands comprise benefit areas of recently installed Federal flood prevention projects. In these projects, installation costs may not be recovered for several years. The report includes estimates of site acquisition costs; however, it does not indicate whether the land acquisition costs reflect values of unrecovered Federal and other investments. The inclusion of these would reflect more accurately the costs of the recommended plan.

It is noted that the report projects development of the authorized Soil Conservation Service program in the Trinity basin on the basis of existing and authorized developments current during coordination of Corps of Engineers and Soil Conservation Service programs in planning for the U. S. Study Commission - Texas. If the recommended projects in the report are authorized, data pertinent to the Soil Conservation Service program should be revised, and activities coordinated on the basis of the new improvements which are being proposed. It is felt the need for such coordination is expressed in paragraph 99, page 60, and elsewhere in the report.

The report states that after consideration was given to Federal project-type irrigation facilities, it was concluded that irrigable areas along the Trinity River are best suited for development by individual landowners. Information developed by this Service indicates that some irrigable areas are well-adapted to project-type development under Public Law 566, as amended. It appears desirable that the report recognize these possibilities.

In paragraph 109, on page 64, it is stated that the Soil Conservation Service upon request, may provide technical and planning assistance. Actually, the authority for this assistance includes also financial assistance. Please change the sentence to read "The Soil Conservation Service, upon request, may provide technical and financial assistance in planning and installation of works of improvement".

The following comments pertain to material presented in Appendix II of the draft report:

Page 57, paragraph 61 - a corrected statement should show that land classification was a joint study of the Bureau of Reclamation and the Soil Conservation Service.

Page 186, paragraph 135 - The combined release rate of structures below Tennessee Colony is given as 10,000 second-feet. This appears to be in error. If it is assumed that all storms could occur simultaneously, the total release would be approximately 4,000 second-feet. This is made up by Lake Creek, 64 second-feet; Lower Keechi, 537 second-feet; Upper and South Bedias Creek, 2,710 second-feet; Town Branch, 15 second-feet; White Rock Creek, 520 second-feet; Tantabogue Creek, 188 second-feet.

An apparent discrepancy exists between data presented in paragraph 162 and Table 14 of the main report. Probably it has already been corrected, but the narrative shows water supply and water control benefits to be $8,029,000 whereas the tabulated data shows $8,266,000.

Personnel of the Soil Conservation Service reviewing technical aspects of the report draft found it to be well prepared. Illustrative material is informative and arranged for effective presentation, thereby aiding the reader in review of the report. Our comments are presented for your use in preparation of the survey report in final form. With consideration to these comments, it is felt that the treatment of agricultural phases and recognition of Soil Conservation Service programs, together with coordination of activities of our respective agencies, will be presented adequately in the report.

We shall be available and happy to work with you for the purpose of considering problems involved in comprehensive coordinated planning in the Trinity basin.

Draft copies (serial nos. 2 and 9) of the report are returned as per the request in your letter of transmittal.

Very truly yours,

H. N. Smith

H. N. Smith
State Conservationist

Enclosures (2)

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Agricultural Office Building, 15th and Quebec
Tulsa 12, Oklahoma
August 17, 1962

District Engineer
U. S. Army Corps of Engineers
Post Office Box 1600
Fort Worth, Texas

Dear Sir:

According to our information, under date of August 13, 1962, you were furnished a letter of field level comments on the comprehensive survey report on Trinity River and Tributaries, Texas, by the Texas State Conservationist, H. N. Smith.

This is to advise that Mr. Smith's letter of comments constitutes the field level review comments of the Department of Agriculture. Thank you for the opportunity of reviewing the draft of this report.

In accordance with your request, we are returning one copy of the draft report, number 3. With your permission, we would like to retain copies number 4 and 5 for reference until the final draft is distributed.

Yours very truly,

John A. Short

John A. Short
River Basin Representative

A Through Agricultural Progress

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
100 WEST VICKERY BOULEVARD
FORT WORTH 4, TEXAS

ADDRESS REPLY TO
P. O. BOX 1600
FORT WORTH, TEXAS
IN REPLY REFER TO

SWFGP

31 August 1962

Mr. H. N. Smith
State Conservationist
Soil Conservation Service
P. O. Box 648
Temple, Texas

Dear Mr. Smith:

Receipt is acknowledged of your letter dated 13 August 1962 regarding our "Comprehensive Survey Report on Trinity River and Tributaries, Texas."

With regard to comments contained in the fifth paragraph of your letter, the increases in property values cannot be compared to the increase in project benefits since there is no direct correlation between these values. However, in order to clarify some of the points raised, the following information is submitted. Reach 7, as shown on plates 9 and 10 and in table 1 of appendix IV, extends from the mouth of Elm Fork in the vicinity of Dallas to Lake Worth Dam on the West Fork and Benbrook Dam on the Clear Fork of the Trinity River. This entire reach is the area in which the property values are expected to increase 18.8 times (2.7 percent average annual increase) during the period 1960-2070. Much of this area will be afforded protection by projects presently authorized or recommended in prior reports of the Corps of Engineers (Fort Worth Floodway Extensions parts 1 and 2). As stated in the first sentence of paragraph 3 of appendix IV, the flood control benefits evaluated in the current report are based on prevention of residual damages remaining after all existing, authorized, and previously recommended projects are in operation. For this reason, most of the estimated increase of $1,360,181,000 in the value of property in the flood plain will occur in the area between the existing Dallas Floodway and the existing Fort Worth Floodways, an area in which there is relatively light development at present. This is the same portion of reach 7 in which benefits from prevention of damages have been evaluated in the current report.

With regard to the question raised in the ninth paragraph of your letter, the land acquisition costs included in the report reflect the value of unrecovered Federal and other investments. The gross appraisal of the

area concerned was based on an estimated fair market value of the lands which was established by giving full consideration to present land uses, agricultural production values, improvements, and the fact that certain of these lands had been afforded flood protection by previously installed flood prevention projects. The land costs so derived were included in the total estimated project costs and have therefore been considered in determining the economic justification of the proposed improvements.

With respect to the comment contained in paragraph 10, I wish to advise that the main report has been revised to indicate that certain irrigable lands are well adapted to project-type development under Public Law 566, as amended.

In regard to the comment contained in paragraph 11, the report has been changed to include your suggested statement.

Your comments on appendix II of the draft report are being taken care of as follows:

Page 57, paragraph 61 - The statement will be revised to show that the referred to land classification was a joint survey by the Bureau of Reclamation and the Soil Conservation Service.

Page 186, paragraph 135 - This, and the following paragraph (paragraph 136) will be corrected to point out that total releases from structures in the area below Tennessee Colony Reservoir would amount to about 4,000 second-feet, and that additional spills from the long-range water supply reservoirs in this area were estimated at about 6,000 second-feet for a combined total regulated flow of 10,000 second-feet.

Your review and comments on our Trinity River report are appreciated.

Sincerely yours,

R. P. WEST
Colonel, CE
District Engineer

FEDERAL POWER COMMISSION
REGIONAL OFFICE
100 North University Drive
Fort Worth 7, Texas
August 16, 1962

The District Engineer
U. S. Army Engineer District, Fort Worth
P. O. Box 1600
Fort Worth, Texas

Dear Sir:

Reference is made to your letter of July 11, 1962 transmitting a draft copy of your report entitled "Comprehensive Survey Report on Trinity River and Tributaries, Texas" to this office for our review and comments.

We have reviewed the report and the improvements recommended therein with particular attention as to whether or not power should be included as a function in the multi-purpose development of the Trinity River Basin. Investigation of the power potentiality of each of the projects recommended for authorization in this report reveals that, with the exception of Tennessee Colony, hydroelectric power could not be economically developed due primarily to a lack of sufficient head and yield. In the case of Tennessee Colony, however, our studies indicate that the planned conservation storage releases could be economically utilized for power generation purposes. On the basis of data presented in your report, an installation of about 15,000 kw operating at a minimum annual load factor (initially) of 10 percent and an average annual load factor of about 50-60 percent is indicated. This installation, when evaluated as an increment to your recommended project and in terms of the cost of the most likely alternative source, would have a benefit-cost ratio slightly in excess of unity.

In view of the above described studies, we are of the opinion that facilities for generation of power should not be recommended at this time at any of the projects proposed. However, with respect to the Tennessee Colony project, it is our opinion that a hydroelectric installation shows promise of economic feasibility and that inclusion of this multiple purpose feature should be thoroughly investigated in cooperation with this office at the time of preconstruction planning.

Our investigations have also revealed that the proposed improvements will not affect any existing or economically potential hydroelectric power resources and that, due to the low terrain, the possibility of economic justification for pumped storage installations in connection with the recommended projects would be remote.

The opportunity to review and comment on your draft report is appreciated. It is to be noted that our comments as included herein are submitted at field level and as such are not to be construed as those of the Federal Power Commission. The draft report is returned herewith in accordance with your request.

Sincerely yours,

Edgar S. Coffman
Regional Engineer

By Lenard B. Young
Lenard B. Young, Acting

Enclosure No. 103431:
7 reports (u.s.c.)

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
100 WEST VICKERY BOULEVARD
FORT WORTH 4, TEXAS

ADDRESS REPLY TO:
P. O. BOX 1600
FORT WORTH, TEXAS
IN REPLY REFER TO:

SWFGP

31 August 1962

Regional Engineer
Federal Power Commission
100 North University Drive
Fort Worth 7, Texas

Dear Sir:

Receipt is acknowledged of your letter dated 16 August 1962 returning the draft copies of our "Comprehensive Survey Report on Trinity River and Tributaries, Texas," with your comments thereon.

This office concurs with your views that facilities for generation of power should not be recommended at this time at any of the proposed projects. The power potentialities of the proposed Tennessee Colony project will be restudied at time of preconstruction planning.

Your review and comments of the Trinity River report are appreciated.

Sincerely yours,

R. P. WEST
Colonel, CE
District Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGIONAL OFFICE, REGION 5
P. O. BOX 1609
AMARILLO, TEXAS

IN REPLY
REFER TO: 5-700

AUG 17 1962

Col. R. P. West, District Engineer
U.S. Army Engineer District, Fort Worth
Corps of Engineers
P. O. Box 1600
Fort Worth, Texas

Dear Colonel West:

We appreciate the opportunity for this office and our Austin Development Office to review your proposed Comprehensive Survey Report on Trinity River and Tributaries, Texas, transmitted by your July 11, 1962, letter.

We have no comments to offer at field level.

The details of your report are of interest to this office in connection with our Texas Basins Project. We, therefore, desire to retain the copy of the report and the appendixes furnished this office until copies of your final report become available.

Sincerely yours,

Acting Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION IV

DIVISION OF
MINERAL RESOURCES

ROOM 206 FEDERAL BUILDING
BARTLESVILLE, OKLAHOMA

August 20, 1962

Reference - SWFGP

Colonel R. P. West
District Engineer
U.S. Army Engineer District, Fort Worth
P.O. Box 1600
Fort Worth, Texas

Dear Colonel West:

Thank you for sending the Federal Bureau of Mines the copy of "Comprehensive Survey Report on Trinity River and Tributaries, Texas", dated June 1962, for our field level review and comments. This report, sent to us on July 11, 1962, consisted of the main report and six appendixes (II through VII).

The report proposes Federal authorization of four multi-purpose reservoirs identified as Lakeview, Aubrey, Roanoke, and Tennessee Colony. The report also recommends Federal authorization of a 98-mile, 84-inch water pipeline from the proposed Tennessee Colony Reservoir to the existent Benbrook Reservoir. The report recommends Federal authorization of five local flood protection projects on the Trinity River which are: West Fork Floodway, Elm Fork Floodway, Dallas Floodway Extension, Duck Creek Channel and Liberty Levee. The major project recommended for Federal authorization is the Multi-purpose Channel on the Trinity River from the Houston Ship Channel to Fort Worth.

This review is based on information available in the Regional office and time did not permit field examination of the four reservoirs, five flood protection measures, the Trinity Channel and water pipeline as follows:

MULTI-PURPOSE RESERVOIRS (Pertinent data in Table 1) -

1. Lakeview Reservoir - This reservoir will adjoin upstream on Mountain Creek, the current Mountain Creek Reservoir. The dam will be located about 22 miles south of Dallas and be in Dallas County with outreaches into Tarrant and Ellis County.

a. Mineral Resources - No known oil and gas resources will be affected. Sand and gravel are not found in the proposed

reservoir, but several deposits are located within five miles of the site. Commercial limestone deposits and manufacturing cement facilities are located within five miles of the reservoir, but not in the site. No other known minerals are affected.

b. Pipelines - Two pipelines that cross the reservoir site are adequately considered within the report by an allotment of $170,000 for relocation. The relocations consist of a one-mile segment of an 18-inch gas pipeline of Lone Star Gas Co., and a ½-mile segment of a 16-inch oil pipeline of Mobil Oil Co.

2. Aubrey Reservoir - This reservoir, to be located between the towns of Aubrey and Sanger on the Elm Fork of the Trinity River, is 30 river miles upstream from the current Lewisville (Garza-Little Elm) Reservoir. The dam is to be in Denton County and the reservoir will extend into Cooke and Grayson Counties.

a. Mineral Resources - A small oilfield called the Pilot Point oilfield lies on the reservoir's edge, located on the Isle du Bois Creek segment at the Denton-Cooke county line. This marginal field, operated by L. W. Powell, currently has three wells producing from a depth of 1,550 feet. Apparently these wells were not noted when the report was written and should be considered during the preconstruction planning stage. There are no sand and gravel deposits found within the reservoir, but several are found within five miles of the reservoir. Limestone was not found within or nearby to the reservoir.

b. Pipelines - The report indicated that one mile of pipelines would require relocation but the cost was not itemized in the total relocation cost. Therefore, it is suggested that this cost item be confirmed.

3. Roanoke Reservoir - This reservoir will be located near the town of Roanoke on Denton Creek, a tributary of Elm Fork of the Trinity River. The dam and most of the reservoir is to be in Denton County; a small arm reaches into Tarrant County.

a. Mineral Resources - No known oil and gas resources are affected. A sand and gravel pit is located within the reservoir, west of Denton Creek and midway between the towns of Denton and Justin. There are no reports showing that sand is being extracted commercially, but the deposit should be considered in the preconstruction planning stage. Other sand and gravel deposits also occur within five miles of the reservoir site. There are no known commercial deposits of limestone.

b. Pipelines - The report indicated that five miles of two pipelines would require relocation, but the cost was not itemized

in the total relocation cost. Therefore, it cannot be determined if cost of pipeline relocations is adequate. Size and type of these lines were not shown, but it is believed that they comprise a 24-inch and an 8-inch gas transmission line of Lone Star Gas Co.

4. Tennessee Colony Reservoir - This reservoir damsite on the Trinity River, to be located about 16 miles west of Palestine or about 7 miles southeast of Tennessee Colony townsite, will impound water about 76 miles upstream. The dam and lower reservoir will be in Anderson and Freestone Counties and branches will extend into parts of Henderson and Navarro Counties.

a. Mineral Resources - There are four oil and gas fields affected by this reservoir. The largest one is Cayuga oil and gas (Trinity) field in Anderson, Freestone, and Henderson Counties where about 25 gas wells and 23 oil wells of the 141 field wells will be affected. These 25 wells (depth 4,000) are now allowed a combined production of 2,475 barrels per producing day and 512 million cubic feet per month for 13 operators. The $2,493,000 provided for mineral subordination in the Cayuga field appears to be adequate. Nearby Cayuga oil and gas field is the Cayuga Northwest (Simmons) oilfield, Henderson County, where all three oil wells will be affected. Just north of the Cayuga field is the Malakoff South (Bacon Lime) field in Henderson County. This field (13 wells, 2 operators, depth 7,500 feet, 312 barrels oil per producing day) may be partly affected and should be examined. At the very north end of the reservoir is the Bazette oilfield in Henderson County (1 well, 1 operator, 3,000 feet depth, and 15 barrels oil per producing day). This field also should be examined.

There are bituminous coal outcrops of commercial value within the middle two-thirds of the reservoir. Commercial sand and gravel deposits are not found in the reservoir, but are found within five miles of the reservoir at several sites. Limestone deposits were not found in or near the reservoir site.

b. Pipelines - There are 15 oil and gas pipelines that cross the reservoir and three other oil and LPG pipelines immediately below the damsite. Reported provision to relocate 52 miles of the 15 pipelines at an estimated cost of $7,066,480 appears to be adequate. The pipeline sizes vary from 8" to 20". The pipelines are operated principally by Lone Star Gas Co.; others by Texaco, Inc., West Texas Gulf Oil Co., and Mobil Oil Co.

WATER PIPELINE - A 98-mile, 84-inch water pipeline is recommended for Federal authorization to deliver water from the recommended Tennessee Colony Reservoir to the existing Benbrook Reservoir. The pipeline will cross Anderson, Freestone, Navarro, Ellis, Johnson, and Tarrant Counties; it will deliver 80 million gallons of water

daily and cost over $56 million. The pipeline plans seem to be adequate, including the pump stations.

MULTI-PURPOSE CHANNEL - (See Table 2) - The proposed channel will be from the Houston Ship Channel in Galveston Bay to Fort Worth, Texas - a distance of 370 river miles. The report requests Federal authorization of the channel in connection with the proposed Tennessee Colony Reservoir and flood protection projects at the West Fork Floodway, Elm Fork Floodway, Dallas Floodway Extension, Duck Creek Channel, and Liberty Levee protection. Total estimated first cost is nearly $569 million. The channel, to be 9 feet deep and 150 feet wide, will be controlled by 21 dams, 22 locks and 2 navigation pools.

1. Mineral Resources -

a. Oil - The channel will cross eleven oil and gasfields in addition to the four oil and gasfields already mentioned in the Tennessee Colony Reservoir (only reservoir crossed by channel). The largest field affected is the Liberty South oilfield in Liberty County (contains 339 wells, depths varying from 1,600 to 10,000 feet, 9,800 barrels oil allowed per producing day) and at least 4 wells adjoining the bank stabilization work will need new roads and a connecting roadway in the levee protection project. The next largest oil and gasfield affected by the channel is the Navarro Crossing field in Houston and Leon Counties. This field has 90 oil wells and 45 gas wells with 15 operators; oil production is from 5,900 feet depth, and gas from the Woodbine. The gas allowable is 362 million cubic feet per month and oil allowable is 516 barrels per producing day. It is not known how many of the 135 wells will be affected by the channel. The next largest oilfields affected are the Long Lake Fields in Leon and Anderson Counties. The two fields have 98 wells producing from 5,100 feet and 5,000 feet (sub-Clarksville) depths and have an oil allowable of 3,775 barrels per producing day. It is not known how many oil wells in these two fields will be affected by the channel. Other oilfields affected are Fort Trinidad in Madison and Houston Counties (16 wells, 4 operators, Glen Rose formation, 10,000 feet producing depth, 4,635 barrels of oil allowed per producing day); Jackson Pasture and Jackson Pasture East fields in Chambers County (3 wells, 8,300 and 8,100 feet producing depths, 2 operators, 202 barrels of oil allowed per producing day); Double Bayou field in Chambers County (1 well, 9,000 feet, Frio "B", 200 barrels of oil allowed per producing day); Flag Lake oilfield in Henderson and Navarro Counties (5 oil wells, 2 operators, 3,100 feet producing depth, 53 barrels allowed per producing day); Prairie Lake gasfield in Anderson and Freestone Counties (10 gas wells, 3 operators, 9,000 feet depth in lower Rodessa, 100 million cubic feet per month allowable); and Oakwood gasfield in Leon and Houston Counties (13 gas wells, 3 operators, Woodbine formation, 106 million cubic feet per month allowable). The last three fields were not covered in the report. It is recommended that each of these fields be investigated prior to construction to determine the number of wells affected and the protective measure applicable.

b. Sand and gravel deposits are found all along the Trinity River bottoms, mostly as river sand. Deposits that could be used in channel construction are easily located.

c. Limestone - Limestone deposits are found nearby to the channel in the western two-thirds of Dallas County and the eastern one-fourth of Tarrant County.

d. Bituminous Coal - As was mentioned in the Tennessee Colony reservoir, the middle two-thirds of that reservoir on the Trinity River contains bituminous coal outcrops. In addition, lignite is found in the middle half of Houston County and the southern part of Leon and the northern part of Madison Counties.

e. Iron Ore - Outcrops of iron ore are found in the Weches formation crossing the channel at the midpoint of the common line between Houston and Leon Counties.

2. Pipelines - There are 95 pipeline crossings of the channel which transport oil, gas, products, LPG, and petrochemicals. These $2\frac{1}{2}$- to 30-inch pipelines are operated by 21 companies. The estimated relocation cost is nearly $4 million for an estimated 9 miles total length. This relocation estimate seems to be a little on the high side and should be more than adequate for weighting, wrapping, and some actual relocations.

LOCAL FLOOD PROTECTION PROJECTS (See table 2) -

1. West Fork Floodway - This project, in Tarrant and Dallas Counties, extends 31 miles from the mouth of the West Fork in the Dallas Floodway to the Fort Worth Floodway. Estimated first cost is nearly $18 million; purpose is channel improvement and levee construction.

a. Mineral Resources - Sand and gravel are found along the sides of the proposed floodway and levee project and can be used for construction. Limestone is found within five miles of the project and can be used for riprap and construction.

b. Pipelines - Thirteen oil, gas and products pipelines (estimated $1\frac{1}{4}$ miles length) cross the project and are operated by six companies. Costs for relocation and protection of pipelines are not itemized under the $470,000 allocated for total relocations.

2. Elm Fork Floodway - This project, in Dallas, Denton, and Tarrant Counties, extends over 68 miles from the mouth of the Elm Fork in Dallas Floodway to both Grapevine and Lewisville (Garza-Little Elm) Reservoirs. Estimated first cost is nearly $17 million; purpose is channel improvement and levee construction.

a. Mineral Resources - Sand and gravel are found along the sides of the proposed floodway and levee project and can be used for construction. Limestone is found over the entire area of the project and can be used for riprap and construction.

b. Pipelines - One 16-inch gas pipeline crosses the project and $10,000 has been allocated for protection of a 1/10-mile section - which appears to be adequate.

3. Dallas Floodway Extension - This project, in Dallas County, would extend the Dallas Floodway 18 miles from the mouth of Elm Creek to Five Mile Creek. Estimated first cost is over $14 million; purpose is channel improvement and levee construction.

a. Mineral Resources - Sand and gravel are found all along the sides of the proposed floodway and levee project and can be used for construction. Limestone is found over the entire area of the project and can be used for riprap and construction.

b. Pipelines - None

4. Duck Creek Channel - This project, in Dallas County, is located east of Dallas in Garland townsite and extends 6½ miles from Oates Road to Buckingham Road. Estimated first cost is over $5 million; purpose is channel improvement.

a. Mineral Resources - Sand and gravel are found all along the side of the proposed channel and can be used for construction. Limestone is found over the entire area of the channel and can be used for riprap and construction.

b. Pipelines - None

5. Liberty Levee Protection - This levee project, in Liberty County, extends 12 miles north, west, and south of Liberty on the Trinity River. Estimated first cost is over $2 million; purpose is protection of local towns and other improvements.

a. Mineral Resources - Sand and gravel are found nearby to levee construction and may be used for other construction; limestone deposits were not found. The levee project crosses the Liberty South Oilfield and about 4 of the 339 oil wells in the field will need protection and raised access roadways. It is assumed that funds were provided for this work in the $10,500 allocation for relocations other than pipeline relocations.

b. Pipelines - Nine oil pipelines (about 3/4 mile total crossing length) cross the levee project, ranging in size from 4 to 8 inches. The $59,000 budgeted for this pipeline relocation seems adequate.

CONCLUDING STATEMENT

The Federal Bureau of Mines review of the report requesting Federal authorization is based on available office maps, records, and reports. Time did not permit any field investigations.

The Federal Bureau of Mines does not object to the request for Federal authorization of the listed projects in the "Comprehensive Survey Report on Trinity River and Tributaries, Texas", provided that mineral resources and mineral producing and handling facilities are protected for continued operation and development so that the Nation can be assured of all possible output and ultimate recovery of these resources; and provided that further thorough mineral investigations be conducted during the preconstruction planning, to insure that any recent changes in the mineral situation are adequately considered and evaluated.

Your letter of July 11, 1962, requested that the draft report copy, Serial No. 13, be returned to your office. However, we will need to review the report later from our Washington level and will need the entire report for reference. We are, therefore, retaining the draft copy of the report. We are enclosing Table 1 on pertinent data on the Multi-purpose Reservoirs; Table 2 on pertinent data on the Channels and Levees, and also an Abstract for your use in the main report.

Sincerely,

Joseph C. Arundale
Assistant Chief
Division of Mineral Resources
Region IV

TABLE I.--Multi-purpose Reservoirs

Reservoir	Lakeview*	Aubrey*	Roanoke*	Tennessee Colony*
Counties	Dallas, Tarrant & Ellis	Denton, Cooke & Grayson	Denton & Tarrant	Anderson, Freestone, Henderson & Navarro
Purpose	FC, WC, F&W & Recr.	FC, WC, F&W & Recr.	FC & WC	FC, WC, Nav., F&W, & Recr.
River location	Mountain Creek	Elm Fork of Trinity River	Denton & Henrietta Creeks	Trinity River
Type dam	Earth Fill	Earth Fill	Earth Fill	Earth Fill
Length of dam incl. spillway (ft)	22,180	13,660	13,800	27,175
Type spillway	Concrete gravity	Concrete ogee	Concrete gravity	Concrete gravity
Length spillway (ft)	276	688	600	762
Spillway crest elev. (ft)	500	600	584	250
Total controlled storage (acre-ft)	488,700	899,900	249,900	3,366,800
Total controlled areal ext. (acres)	15,650	30,750	9,720	199,500
(Gates) Flood control Elev. (ft)	528	635	619	285
Conservation pool storage (acre-ft)	306,400	603,800	0	1,032,500
Conservation pool areal ext. (acres)	12,300	24,340	--	73,540
Conservation pool elev. (ft)	518	625½	--	262½
Sediment storage (acre-ft)	45,600	37,800	26,200	190,000
Flood control storage (acre ft)	136,700	258,300	223,700	2,144,300
Flowage easement land (acres)	2,300 (531')	1,500 (638')	11,990 (624')	7,000 (288')
Fee simple land (acres)	15,400 (531')	37,700	1,200	166,244 (288')
Top of dam elev. (ft)	518	646	631	305
Height above streambed (ft)	94	116	75	113
Total first cost ($)	31,180,000	34,073,000	16,900,000	137,138,000
(Relocations (&))	2,038,000	2,351,000	3,370,000	27,283,000
Mineral subordination ($)	0	0	0	2,493,000
Pipeline relocations (miles)	1.5	1.0	5.0	52.0
Cost of pipeline relocations ($)	170,000	Not broken out	Not broken out	7,066,480
Number of pipelines	2	est. 2	2	15
Mineral deposits: Oil	No	Yes	No	Yes
Gas	No	No	No	Yes
Sand & gravel	Nearby	Nearby	Yes & nearby	Nearby
Bituminous coal deposits	No	No	No	Yes
Stone & cement materials	Nearby	No	No	No

* Recommended for Federal authorization in this report

TABLE 2.--Channels and Levees

	Multi-Purpose Channel*	Local Flood Protection Projects				
		West Fork Floodway*	Elm Fork Floodway*	Dallas Floodway Extension*	Duck Creek Channel*	Liberty Local Protection Levee*
Counties	Tarrant, Dallas, Ellis, Henderson, Navarro, Anderson, Freestone, Leon, Houston, Madison, Walker, Trinity, Polk, San Jacinto, Liberty & Chambers	Tarrant & Dallas	Dallas, Denton & Tarrant	Dallas,	Dallas	Liberty
Channel length (mi.)	370	31	68½	18	6½	12
Channel location	Houston Ship Channel to Fort Worth	Mouth of West Fork in Dallas Floodway to end of Ft. Worth Floodway	Mouth of Elm Fork in Dallas Floodway to both Grapevine & Lewisville Dams	Extend Dallas Floodway System from mouth of Elm Creek to Five Mile Creek	East of Dallas in Garland from Oates Road to Buckingham	North, west, & south of Liberty on Trinity River
First cost ($)	568,737,710	17,809,000	16,823,000	14,327,000	5,024,000	2,090,670
Relocations & alterations ($)	101,248,250	470,000 (NF)	2,747,000 (F & NF)	1,256,000 (NF)	369,000 (NF)	69,740 (NF)
Pipelines ($)	3,875,410	?	10,000	0	0	59,240
Pipelines (miles)	est. 9	est. 1.25	0.1	0	0	3/4
Non-Federal fee simple land (acres)	2,350	8,430	2,454	4,032	190	0
Purpose	Navigation & flood control	Channel impr. & levees	Channel impr. & levees	Channel impr. & levees	Channel impr.	Levees
Other items	21 dams 22 locks 2 navigation pools					

* Recommended for Federal authorization in this report.

ABSTRACT

by

Federal Bureau of Mines

The Federal Bureau of Mines does not object to the request for Federal authorization for the 11 projects in "Comprehensive Survey Report on Trinity River and Tributaries, Texas", provided that mineral resources (oil, gas, sand and gravel, limestone, coal, lignite, and iron ore) and mineral producing and handling facilities (oil, gas, LPG, products, and petrochemicals pipelines) are protected for continued operation and development. Investigations should be conducted during the preconstruction planning stage to insure that any changes in the mineral situation are adequately considered and evaluated.

The multi-purpose channel requesting Federal authorization for flood protection and navigation is the major project involved and for the most part, appears to be adequate except that some oilfields and gasfields were apparently overlooked. Sand and gravel and limestone deposits were found near the project, but not within the project. Bituminous coal, lignite, and iron ore deposits are within the project area. At least 11 oilfields and gasfields are crossed by the project. All of these were not considered in the report and should be more adequately investigated during preconstruction planning. The 95 pipeline crossings of oil, gas, products, LPG, and petrochemicals appear to be adequately considered and protected.

Four multi-purpose reservoirs are included for Federal authorization; they are Lakeview, Aubrey, Roanoke, and Tennessee Colony. Only the Tennessee Colony Reservoir needed mineral subordination provisions; adequate provisions were made. Sand and gravel deposits are found near all four reservoirs and within Aubrey Reservoir. Limestone deposits are found near Lakeview Reservoir. Coal deposits are found in and near Tennessee Colony Reservoir. Oilfields are crossed by Aubrey and Tennessee Colony Reservoirs. Oil, gas, LPG, and products pipelines cross all four reservoirs; estimated relocation costs appear to be adequate.

Five local flood protection projects requesting Federal authorization are West Fork Floodway, Elm Fork Floodway, Dallas Floodway extension, Duck Creek Channel, and Liberty Levee. Sand and gravel deposits are

found near the five projects and may be used for construction; commercial deposits were not found within any project area. Limestone deposits are found near the West Fork project and within the Elm Fork, Dallas, and Duck Creek projects. No limestone is found in or near the Liberty project. Oil and gasfields are crossed by the Liberty Levee project and will need additional road work and levee protection for an estimated four oil wells.

Federal authorization is requested for a 98-mile, 84-inch water pipeline to deliver water from the proposed Tennessee Colony Reservoir to the existing Benbrook Reservoir. No major mineral resources are involved except some pipeline crossings. Cost of construction and pump station plans appear to be adequate.

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
100 WEST VICKERY BOULEVARD
FORT WORTH 4, TEXAS

ADDRESS REPLY TO
P. O. BOX 1600
FORT WORTH, TEXAS
IN REPLY REFER TO

SWFGP

4 September 1962

Mr. Joseph C. Arundale
Assistant Chief, Region IV
U. S. Department of the Interior
Bureau of Mines
Room 206 Federal Building
Bartlesville, Oklahoma

Dear Mr. Arundale:

This will acknowledge receipt of your letter dated August 20, 1962, concerning our "Comprehensive Survey Report on Trinity River and Tributaries, Texas."

It is noted that the Federal Bureau of Mines does not object to the Federal authorizations of the projects contained in our comprehensive plan of development for the Trinity River, as recommended in the above report, provided that protection for continued operation and development is given the mineral resources and mineral producing and handling facilities.

I wish to advise that investigations will be conducted during the preconstruction planning of the various projects to insure that any changes in the mineral situation will be adequately considered and evaluated.

Sincerely yours,

R. P. WEST
Colonel, CE
District Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON 25, D. C.

August 29, 1962

District Engineer
U. S. Army Engineer District,
Fort Worth
P. O. Box 1600
Fort Worth, Texas

Dear Sir:

Thank you for your letter of July 11, 1962, enclosing a draft copy of your "Comprehensive Survey Report on Trinity River and Tributaries, Texas", for our review and comments.

Your office is to be commended for the thoroughness of the investigation leading to the preparation of the report.

A review of pertinent portions of the report indicates that the interests of this Administration will not be affected by the proposed improvements. The report states that hydroelectric power in its conventional form and equipment has been considered and found not feasible. However, in future investigations dealing with specific projects, it is requested that consideration be given to the possible installation of integral bulb-type generating units, such as those being considered in the Passamoquoddy Project and in the Rance River Project in France, which are highly adaptable to low-head generation. Topographic limitations preclude any large pumped storage development in the basin. The development of Extra High Voltage transmission will permit utilization of peaking capacity from such installations outside the area for integration with fuel electric generation. As the individual units of the plan of development are studied in detail this Administration will be glad to cooperate in any manner possible. It is requested that upon completion a copy of the survey report be furnished this Administration.

The draft report is returned to your office as requested.

Sincerely yours,

Virgil B. Stanley
for Douglas G. Wright
Administrator

Enclosure

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SOUTHWEST FIELD COMMITTEE, REGION SIX
807 Brazos Street
Austin 14, Texas

August 29, 1962

Colonel R. P. West, District Engineer
U. S. Army Engineer Cistrict, Fort Worth
Corps of Engineers
P. O. Box 1600
Fort Worth, Texas

Re: File SWFGP

Dear Colonel West:

Thank you for the opportunity to review a draft copy (Serial No. 6) of the Corps of Engineers' "Comprehensive Survey Report on the Trinity River and Tributaries, Texas", dated June 1962 in accordance with the Inter-Agency Agreement approved by the President on 26 May 1954.

Time did not permit a detailed review of this multiple volume report which anticipates a construction cost to the Federal Government of $776,042,000 and an annual operation and maintenance and replacement cost of $7,169,000. The stated purpose of the investigation is supported by facts. Progressive and far-sighted business men and concerned governmental officials at local, State, and National level have demonstrated their interest in using the full potential of the human and natural resources of the Trinity River watershed so that it will become an even more important, economic segment of the Nation. The comprehensive program proposed in the Corps' report anticipates major future water-use and water-control needs.

The U. S. Geological Survey's concern in the proposed development is to make available to the planning agency all basic data and interpretive reports that the Survey has on quantity and quality of surface and ground-water resources, geology, topographic maps, minerals, etc. A reconnaissance review of the report indicates that the available Survey data have been used.

Creating a navigable channel from the Gulf of Mexico up the mainstem of the Trinity River to Fort Worth will require radical changes in the Geological Survey's basic investigations and the network of hydrologic stations on the Trinity River and tributaries that record streamflow, reservoir contents, suspended sediment, and chemical quality of the surface water resources. All of the streamflow stations on the navigable channel essential to future operation and planning needs will have to be converted from "stage-discharge" stations to "stage-fall-discharge" stations. New streamflow, chemical quality and sediment stations will be required to facilitate flood control, navigation, water use and conservation, pollution abatement, and recreation operations. A

program of ground-water observation should be started to investigate conditions prior to construction and to measure any effects, such as water logging, that the construction might have on the ground-water resources.

The continuous hydrologic investigation program of the Geological Survey will have to be broadened and records perfected to meet the needs of water control and water-use agencies as well as private concerns, municipal, State and Federal regulating agencies.

A comprehensive water development of the Trinity basin, therefore, will require planning and development of comprehensive hydrologic studies and basic data collection programs. Much of the reconnaissance type of studies will not meet future needs. The Corps of Engineers' program compliments that of the Trinity River Authority, Cities of Fort Worth, Dallas, Houston, private enterprise and others. As the water resources development approaches full development, there will be a major need, therefore, to fully coordinate water project operations of all. To do this will require an accurate and efficient hydrologic basic data collection program throughout the basin. An efficient communications system to relay these data to the various water project operations during floods and other emergencies will be required. The hydrologic program will further require analytical and interpretive reports of the surface and ground water resources in view of the then conditions.

The Geological Survey's Water Resources Division, Texas District Offices, wish to be kept informed as to advancements of the Corps of Engineer' development. Such information will assist these offices in modifying or expanding their water resources study programs as funds are made available to meet planning and operational needs of the Corps and others operating in the basin. The Geological Survey will cooperate with the Corps, the Soil Conservation Service, the Texas Water Commission and others in planning and developing essential hydraulic programs essential to perfect and operate the comprehensive water plans of the Trinity basin of Texas.

The draft copy (Serial No. 6) of the Report is being returned under separate cover. Please furnish me a copy of the final report when available.

Very truly yours,

Trigg Twichell
Contact Official of
the Geological Survey

cc: Douglas R. Woodward, Washington, D. C.
S. K. Jackson, Div. Hydrologist, Denver, Colo.
A. G. Winslow, GW, Austin, Tex.
C. H. Hembree, QW, Austin, Tex.

U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
100 WEST VICKERY BOULEVARD
FORT WORTH 4, TEXAS

ADDRESS REPLY TO
P. O. BOX 1600
FORT WORTH, TEXAS
IN REPLY REFER TO

SWFGP

6 September 1962

Mr. Trigg Twichell, District Engineer
Surface Water Branch, Geological Survey
U. S. Department of the Interior
807 Brazos Street
Austin 14, Texas

Dear Mr. Twichell:

Receipt is acknowledged of your letter dated 29 August 1962 containing your comments on our "Comprehensive Survey Report on Trinity River and Tributaries, Texas," and with which you returned serial No. 6 of the report.

It is believed that sufficient funds are included in the cost estimates of the various projects recommended in our plan of development to provide for the changes you state will be necessary in the Geological Survey's basic investigations and the network of hydrologic stations on the Trinity River and tributaries.

Considerable study was given to the possibility of water logging of adjacent lands by construction of the multiple-purpose channel. All proposed improvement works, including the navigation locks and dams, were planned so that the projects would not be detrimental to drainage and, wherever possible, would provide improved drainage conditions.

Your review and comments of our Trinity River report are appreciated.

Sincerely yours,

R. P. WEST
Colonel, CE
District Engineer

TEXAS WATER COMMISSION

P. O. BOX 2311
CAPITOL STATION
AUSTIN 11, TEXAS

September 11, 1962

Colonel R. Paul West, District Engineer
Corps of Engineers, Fort Worth District
Box 1600
Fort Worth, Texas

Dear Colonel West:

The Commission by letter of August 27, 1962 transmitted comments upon the initial draft of "Comprehensive Survey Report on Trinity River and Tributaries, Texas" prepared by the Corps of Engineers, Fort Worth and Galveston Engineer Districts.

Subsequently, on September 4, 1962, a conference of staff personnel from each of our agencies was held at Dallas to discuss the report and some of the Commission's comments. It is understood that considerable revision had been made in the draft of the report by the Corps of Engineers prior to and subsequent to our comments of August 27, 1962. It is also understood that the draft of the report and appendices are being further edited and revised which make some of our previous comments inapplicable. Because of this, the Commission hereby withdraws its letter of August 27, 1962.

The Commission does not believe it appropriate to comment on the report until it is in final form. Following careful consideration of this matter, particularly the magnitude and scope of the various proposals, the Commission has concluded to withhold its comments pending public hearing in accordance with Article 7472e, Vernon's Civil Statutes of Texas.

As the report was prepared in part by the Galveston District Office, Corps of Engineers, a copy of this letter is being transmitted to Colonel Maxwell.

Very truly yours,

Joe D. Carter

Joe D. Carter
Chairman

JDC:es
cc: Colonel James S. Maxwell, Galveston, Texas

COMPREHENSIVE SURVEY REPORT

ON

TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX IX

RESOLUTIONS, PUBLIC HEARINGS, PRIOR REPORTS

U. S. ARMY ENGINEER DISTRICTS
FORT WORTH AND GALVESTON
CORPS OF ENGINEERS
FORT WORTH AND GALVESTON, TEXAS

JUNE 1962

COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX IX
RESOLUTIONS, PUBLIC HEARINGS, PRIOR REPORTS

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COMPREHENSIVE SURVEY REPORT
ON
TRINITY RIVER AND TRIBUTARIES, TEXAS

APPENDIX IX

RESOLUTIONS, PUBLIC HEARINGS, PRIOR REPORTS

1. INTRODUCTION.- This appendix contains the resolutions authorizing the studies in the Trinity River Basin, a tabulation and brief resume of the public hearings held in the basin to determine the improvements desired by local interests, and a list of prior reports on various water problems in the basin. Other appendixes to this report present the results of investigations made under these authorizations and in response to requests made by local interests. The plan of development as presented in this report is designed to supplement the existing and authorized projects in the Trinity River Basin which are described fully in prior reports. Appendix I, Project Formulation, was based on economic evaluations as determined in Appendixes III, IV, and VII, Navigation and Navigation Economics, Flood Control Economics, and Economic Base Study, respectively, and the hydrology and hydraulic design as presented in Appendix II, Hydrology, Hydraulic Design, and Water Resources. Appendix VI, Cost Estimates, Geology, and Design Information, presents the general geologic features of the basin, including foundation conditions at the dam sites, availability of construction materials, and pertinent design information and cost estimates for each unit in the proposed plan of development for the Trinity River Basin. The Main Report and the appendixes referred to above were sent to other agencies for review and comment. The letters from these reviewing agencies are contained in Appendix VIII, Comments of Other Agencies.

2. CONGRESSIONAL RESOLUTIONS.- Authority for preparation of this report is contained in the following congressional authorizations, the pertinent portions of which are quoted.

a. Resolution by the Committee on Rivers and Harbors of the House of Representatives, adopted March 31, 1944:

"Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby requested to review the reports on the Trinity River and tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, first session, with a view to determining whether any modification should be made in the recommendations therein at this time with respect to work for navigation and local flood

protection along the main stem and major tributaries of the Trinity River."

b. Resolution by the Committee on Rivers and Harbors of the House of Representatives adopted February 28, 1945:

"Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors created under Section 3 of the Rivers and Harbors Act, approved June 13, 1902, be, and is hereby requested to review the reports on the Trinity River and tributaries, Texas, contained in House Document Numbered 403, Seventy-seventh Congress, first session, with a view to determining whether any modifications should be made in the recommendations therein at this time with respect to works for navigation, flood control and allied purposes."

c. Resolution by the Committee on Rivers and Harbors of the House of Representatives adopted November 30, 1945:

"Resolved by the Committee on Rivers and Harbors of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Trinity River and tributaries, Texas, submitted in House Document Numbered 403, Seventy-seventh Congress, first session, with a view to determining whether any changes contained in said document are advisable at and above Garza Dam."

d. Resolution by the Committee on Public Works of the House of Representatives adopted August 6, 1948:

"Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on the Trinity River and tributaries, Texas, published as House Document No. 403, Seventy-seventh Congress, first session, and other reports, with a view to determining whether improvement of White Rock Creek for flood control and allied purposes is advisable at this time."

e. Resolution by the Committee on Public Works of the Senate dated January 20, 1958:

"Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports on Trinity River and tributaries, Texas, submitted in House Document Numbered 403, Seventy-seventh Congress, first session, and previous and subsequent reports, with a view to determining whether any modification of previous recommendations is advisable at this time."

f. Rivers and Harbors Act of 1958, approved July 3, 1958, Public Law 85-500, Eighty-fifth Congress, Senate Document Numbered 3910, Title I - Rivers and Harbors:

"Section 112. The Secretary of the Army is hereby authorized and directed to cause surveys to be made at the following named localities and subject to all applicable provisions of section 110 of the Rivers and Harbors Act of 1950:

* * * *

"Trinity River, Texas . . . ."

3. PUBLIC HEARINGS - CORPS OF ENGINEERS

a. The views of interested parties concerning improvements for navigation, flood control, and allied purposes were obtained at a number of public hearings held by the Corps of Engineers at various locations within the basin as shown in the following tabulation:

PUBLIC HEARINGS - CORPS OF ENGINEERS

No.	Date	Location	Subject
		NAVIGATION, FLOOD CONTROL & ALLIED PURPOSES	
1	Apr 16, 1946	Denton, Texas	Trinity River and tributaries for navigation and flood control
2	Apr 18, 1946	Corsicana, Texas	"
3	May 2, 1946	Liberty, Texas	"
4	Jun 22, 1951	Liberty, Texas	Trinity River below Liberty for navigation, flood control, and allied purposes. Lake Liberty for streamflow regulation, silt abatement, and prevention of salt water intrusion.
5	Dec 9, 1957	Haltom City, Tex	Big Fossil Creek for flood control.
6	Jan 22, 1958	Wylie, Texas	Trinity River, East Fork for flood control.
7	Feb 19, 1958	Fort Worth, Tex	Trinity River, West Fork and Clear Fork and tributaries for flood control.

PUBLIC HEARINGS - CORPS OF ENGINEERS (Cont'd)

No.	Date	Location	Subject
		NAVIGATION, FLOOD CONTROL & ALLIED PURPOSES (Cont'd)	
8	Dec 20, 1961	Fort Worth, Texas	Trinity River and tributaries for navigation and flood control (presentation of investigated plan of improvement).
		RESERVOIR DEVELOPMENT FOR RECREATION - UPPER TRINITY	
9	Apr 15, 1952	Grapevine, Texas	Recreational aspects of development and management of Grapevine Reservoir.
10	July 10, 1952	Wylie, Texas	Recreational aspects of development and management of Lavon Reservoir.
11	Nov 20, 1952	Benbrook, Texas	Recreational aspects of development and management of Benbrook Reservoir.
12	Mar 26, 1953	Lewisville, Texas	Recreational aspects of development and management of Garza-Little Elm Reservoir.
		NATIONAL WILDLIFE REFUGE - LOWER TRINITY	
13	Dec 15 - 16 1960	Liberty, Texas	Proposed wildlife refuge on the Lower Trinity River.

b. The most recent public hearing was held at Fort Worth, Texas, on December 20, 1961. A notice of the hearing was sent to the Texas members of the United States Congress, Congressional Committees on Public Works, Texas State officials, Texas State Legislature, federal, state, and local governmental agencies, navigation districts, railroads, news media, oil and pipeline companies, and other interested parties. A total of 1209 notices were issued. The hearing was attended by approximately 1400 persons. The hearing was held in order to provide an opportunity for all interested parties to be informed and to express their views concerning

an investigated multiple-purpose plan of development for the Trinity River Basin.

c. Representatives at this hearing gave testimony regarding the need for flood control, water conservation and particularly stressed the need for the barge navigation channel from the Houston Ship Channel to Fort Worth. Ninety-seven speakers presented their views at the hearing. Of this number, 90 were in favor of the proposed improvement, 4 were opposed to the project, and 3 speakers appeared in opposition to the proposed Wallisville project. A total of 320 briefs were submitted prior to, during, and after the public hearing for incorporation in the record of the hearing. There were 274 briefs in favor of the project, 35 opposed to the project, and 6 briefs were noncommital on the improvement. Five of the total number of briefs presented were in opposition to the previously recommended Wallisville Reservoir Project which was not a matter to be considered at this hearing.

d. A numerical summary of the briefs presented for incorporation in the record of hearing is shown below:

Category	For	Against	Neutral
U. S. Congress	6	-	-
State Legislature	6	-	1
State Officials	5	-	-
Counties and county officials	11	2	-
Cities and city officials	65	1	-
Chambers of Commerce	56	22	1
Associations	30	1	-
Service Clubs	18	-	-
Newspapers	2	1	-
Banks, firms and individuals	75	8	4
Total	274	35	6

e. Congressmen Jim Wright of Fort Worth and John Dowdy of Athens spoke in favor of the recommended plan and presented briefs for incorporation in the record. Briefs were received from Senator Ralph Yarborough, Congressmen Olin Teague, Jack Brooks and Bruce Alger, and from Governor Price Daniel endorsing the recommended plan of development. State Senator George Parkhouse spoke at the hearing in favor of the plan and presented a brief for the record. Briefs were also presented at the hearing by State Representative Rayford Price and George Richards. Other State Representatives attending the hearing were Bill Jones, Tom James, Paul Curington and Bill Walker. Additional briefs were received from State Senators Ray Roberts and Doyle Willis and State Representatives Bob Johnson and Joe Ratcliff.

f. Proponents of the multiple-purpose improvement plan were introduced by officials of the Trinity Improvement Association, the Chambers-Liberty Counties Navigation District, and county officials from throughout the Trinity River Basin. The majority of the speakers were from the Dallas-Fort Worth area and included prominent representatives from county and municipal government, Chambers of Commerce, industry, banking and mercantile interests.

g. Proponents of the plan called the barge navigation channel from the Houston Ship Channel to Fort Worth a necessity for the further development of the North Central Texas area and termed it as having the greatest potential impact of any project in recent years on the economy of the region, as well as the entire state. Industrial leaders from the fields of steel, petroleum, power, and aircraft production stated that the project was needed to develop the vast untapped resources that lie dormant in the Trinity River Valley.

h. Opponents of the plan consisted largely of the Texas Railroad Association and West Texas municipalities. The railroads presented a brief stating that the volume of traffic for barge navigation and its subsequent savings would not be sufficient to justify the barge channel, that ample transportation facilities to handle all traffic to, from, and within the Trinity River area, already exists in the area, and that barge transportation on the Trinity would not create growth and development that would not otherwise occur. The railroad report presented transportation costs and figures which the Association argued did not justify the expenditure for the navigation channel.

i. Representatives from the West Texas municipalities who opposed the barge navigation channel based their opposition on the contention that barge traffic to Dallas-Fort Worth would reduce freight rates to that area and enable wholesalers in the North Texas area to market merchandise at a much lower cost than wholesalers in the West Texas area. The West Texas spokesmen also voiced the opinion that the entire state would be made to pay for a project that would only benefit one region of the state.

j. The opposition was made solely against the barge navigation channel phase of the improvement plan. No objections were registered to the proposed flood control and water conservation phases of the plan.

k. The Wallisville Landowners Association, an organization of landowners in the Wallisville Reservoir area, voiced opposition to the previously recommended Wallisville Reservoir, but were informed that the Wallisville project was not a matter for discussion at this hearing.

l. Briefs submitted by the Tarrant County Water Control and Improvement District No. 1 and the Dallas Power and Light Company requested conservation storage in the proposed Lakeview Reservoir. The proposed

Tennessee Colony Reservoir was hailed by several speakers and noted in many briefs as a long recognized necessity in the Mid-Trinity Valley region.

m. Representatives from the eastern portion of Dallas County and the area in the eastern watershed of the Trinity River requested that an investigation be conducted as to the feasibility of navigation on the East Fork of the Trinity River at some future date.

4. PUBLIC HEARINGS - TRINITY RIVER AUTHORITY.- The Trinity River Authority of Texas during 1956 and 1957 held a public hearing for each of the seventeen counties within the Trinity River Authority's boundaries in order to ascertain the views of local interests with respect to improvements desired for development of a comprehensive plan of improvement. Subsequent to these hearings, the Trinity River Authority prepared a Master Plan and a supplement thereto reflecting the desires of local interests. The plan of improvement developed by the Corps of Engineers is not in conflict but generally in accord with the Trinity River Authority's master plan.

5. WATER-USE CONFERENCES - U.S. STUDY COMMISSION-TEXAS.- In April 1960, the U. S. Study Commission - Texas held two Water-Use Conferences, one in Huntsville and one in Corsicana, to obtain the estimates of local interests concerning present and future water requirements throughout the basin.

6. PRIOR REPORTS.- A list of reports on the Trinity River, Texas, submitted to the Congress from October 1, 1941, to the present is given in table 1. Reports submitted from May 31, 1917, to October 1, 1941, are discussed in House Document No. 403, Seventy-seventh Congress, first session. House Document 989, Sixty-sixth Congress, third session, contains a list of all reports made prior to May 31, 1917.

7. PRINCIPAL REPORT BEING REVIEWED.- The principal report being reviewed is published in House Document No. 403, Seventy-seventh Congress, first session. This document comprises a report covering a survey of the Trinity River and tributaries for navigation, flood control, and allied purposes. In this report, the Chief of Engineers recommended adoption of a comprehensive plan of improvement for the Trinity River Basin including Benbrook, Aubrey, Little Elm, Grapevine, and Lavon Reservoirs, modification of the existing Garza Reservoir, improvement of the levees and floodways at Fort Worth and Dallas, and provision of a navigable channel extending up the Trinity River, by means of locks and dams, from the Houston Ship Channel to a terminus at Fort Worth, Texas. Recommended for immediate construction were Benbrook, Little Elm, and Grapevine Reservoirs, modification of Garza Dam, and the improvement of the levees and floodways at Fort Worth and Dallas for flood protection and water conservation in the Trinity River Basin, and provision of a navigable channel on the lower 49 miles of the Trinity River from the Houston Ship Channel to Liberty, Texas.

TABLE 1

PRIOR REPORTS

October 1941 to Present

Title of Report	Scope	Date Submitted by District Engineer	Recommendations
Review of Reports on Trinity River and Tributaries, Texas - East Fork	Review (Survey)	Nov 1943	Recommended Lavon Reservoir project.
Review of Reports on Trinity River and Tributaries, Texas - Trinity Bay Section	Review (Survey)	Jan 1945	Recommended the relocation of the section of navigat channel below Anahuac nearer to the eastern shore o Trinity Bay.
Interior Drainage Improvements at Dallas and Fort Worth Floodway Extension	Interim (Survey)	Dec 1948	Recommended modification of existing Dallas Floodway Project to include interior drainage facilities and modification of the Fort Worth Floodway to provide protection for the Crestwood-Brookside area.
Richland, Chambers, and Cedar Creeks -	Interim (Survey) Part I	Jun 1953	Recommended Navarro Mills Reservoir on Richland Cree
Richland, Chambers, and Cedar Creeks - Waxahachie Creek	Interim (Survey) Part II	Apr 1956	Recommended Bardwell Reservoir on Waxahachie Creek.
Big Fossil Creek Watershed	Interim (Survey)	Jul 1959	Recommended that local flood protection works be authorized for construction on Big Fossil Creek.
West Fork Watershed Flood Protection - Fort Worth area	Review (Survey) Part I	Aug 1959	Recommended the extension of the Fort Worth Floodway on the West Fork to the vicinity of Lake Worth Dam.
Trinity River and Tributaries, Texas (Wallisville Reservoir)	Interim (Survey)	Apr 1960	Recommended reservoir near Wallisville for navigation, salinity control, water supply, fish and wildlife, recreation, and other uses.
West Fork Watershed Flood Protection - Fort Worth area	Review (Survey) Part II	May 1960	Recommended the extension of existing improvements on the Clear Fork up to Southwest Loop 217.
Review of Reports on Trinity River and Tributaries, Texas, Covering East Fork Watershed	Review (Survey)	Nov 1961	Recommended channel and levee improvement works below Forney Dam and enlargement of Lavon Reservoir.

TABLE 1

PRIOR REPORTS

October 1941 to Present

Recommendations	Date of Transmittal to Congress	Congressional Document	Authorization
Lavon Reservoir project.	Mar 1944	H. D. 533/78/2	Survey authorized by Committee Resolution of 1943. Project authorized by River and Harbor Act approved March 2, 1945 and Flood Control Act approved July 24, 1946.
the relocation of the section of navigation w Anahuac nearer to the eastern shore of	May 1946	H. D. 634/79/2	Survey authorized by Committee Resolution of 1944. Project authorized by River and Harbor Act July 24, 1946.
modification of existing Dallas Floodway nclude interior drainage facilities and of the Fort Worth Floodway to provide or the Crestwood-Brookside area.	June 1949	H.D. 242/81/1	Survey authorized by Committee Resolutions of 1944 and 1945. Project authorized by River and Harbor Act approved May 17, 1950.
Navarro Mills Reservoir on Richland Creek.	Aug 1954	H.D. 498/83/2	Survey authorized by Committee Resolutions of 1944 and 1945. Project authorized by Flood Control Act approved September 3, 1954.
Bardwell Reservoir on Waxahachie Creek.	Jul 1958	H.D. 424/85/2	Survey authorized by Committee Resolutions of 1944 and 1945. Project authorized by Flood Control Act approved March 31, 1960.
that local flood protection works be or construction on Big Fossil Creek.	May 1960	H.D. 407/86/2	Survey authorized by Committee Resolution of 1945. Project authorized by Flood Control Act approved July 14, 1960.
the extension of the Fort Worth Flood- est Fork to the vicinity of Lake Worth	April 1960	H.D. 402/86/2	Survey authorized by Committee Resolution of 1957. Project authorized by Flood Control Act approved July 14, 1960.
reservoir near Wallisville for navi- nity control, water supply, fish and creation, and other uses.	Jul 1961	H.D. 215/87/1	Survey authorized by Committee Resolution of 1958.
the extension of existing improvements Fork up to Southwest Loop 217.	Not yet Submitted	-	Survey authorized by Committee Resolution of 1957.
channel and levee improvement works Dam and enlargement of Lavon Reservoir.	Not yet Submitted	-	Survey authorized by Committee Resolution of 1957.

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8. Since the publication of House Document No. 403, the Garza-Little Elm Reservoir was constructed in lieu of the separate projects of modifying the existing Garza Dam and construction of the Little Elm Dam and Reservoir. The Benbrook, Grapevine, and Lavon Reservoirs have been completed and the improvement of the levees and floodways at Fort Worth and Dallas have been accomplished, together with a modification of the Dallas project to include interior drainage facilities. Also, the lower portion of the channel to Liberty project from the Houston Ship Channel to about one mile below Anahuac, Texas, was completed in 1950.