TRINITY RIVER AND TRIBUTARIES, TEXAS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, TOGETHER WITH THE REPORT OF THE DISTRICT AND DIVISION ENGINEERS ON THE RE-EVALUATION OF THE NAVIGATION FEATURES OF THE PROJECT FOR THE TRINITY RIVER, TEXAS, PURSUANT TO THE PROVISIONS OF THE RIVER AND HARBOR ACT OF 1965 (PUBLIC LAW 89-298)

JULY 18, 1968.—Referred to the Committee on Public Works and ordered to be printed with illustrations

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U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1968

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 20310

July 15, 1968

Honorable John W. McCormack
Speaker of the House of Representatives
Washington, D. C. 20515

Dear Mr. Speaker:

I am transmitting herewith a report of the Chief of Engineers, Department of the Army, together with the report of the District and Division Engineers on the re-evaluation of the navigation features of the project for the Trinity River, Texas. In accord with the authorization in the River and Harbor Act of 1965, P. L. 89-298, the re-evaluation was based on current criteria.

The Bureau of the Budget states that there would be no objection to the submission of the report to the Congress. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

Stanley R. Resor

STANLEY R. RESOR
Secretary of the Army

Incls
as

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON, D.C. 20503

OFFICE OF
THE DIRECTOR

July 15, 1968

Honorable Stanley R. Resor
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. Robert E. Jordan's letter of July 1, 1968, submitted the report of the Chief of Engineers on the re-evaluation of the navigation features of the Trinity River project, Texas. The project was authorized in the Rivers and Harbors Act of October 27, 1967, P.L. 89-298, subject to the provision that prior to expenditure of any funds for construction of those features designed exclusively for navigation, the Chief of Engineers shall submit to the Congress a re-evaluation based upon current criteria.

You are advised that there would be no objection to the submission of the report to the Congress.

Sincerely yours,

Charles J. Zwick

Charles J. Zwick
Director

TRINITY RIVER AND TRIBUTARIES, TEXAS

REPORT OF THE ACTING CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20315

IN REPLY REFER TO
ENGCW-P

28 June 1968

SUBJECT: Trinity River and Tributaries, Texas Navigation Project

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress the report of the District and Division Engineers on the reevaluation of the navigation economics of the authorized comprehensive improvement of the Trinity River, Texas. The project was authorized by the Rivers and Harbors Act of October 27, 1965, Public Law 89-298, in accordance with the reports in House Document No. 276, 89th Congress, 1st Session, but subject to the provision that prior to expenditure of any funds for construction of those features designed exclusively for navigation, the Chief of Engineers shall submit to the Congress a reevaluation based upon current criteria.

2. Basis for Reevaluation

This reevaluation is limited to those features of the authorized project designed exclusively for navigation. The criteria used for analysis of traffic and savings are those set forth in Section 7 of the Department of Transportation Act, Public Law 89-670, approved October 15, 1966. The estimates of prospective traffic are based upon a field survey of traffic moving in the Trinity River tributary area completed in March 1967. Transportation rates and charges, analyses and forecasts of economic activity in the tributary area, and estimated construction costs are based on current data and 1967 price levels. The estimated costs of features exclusively for navigation are computed as the difference between the estimated costs for a single-purpose flood control channel on the best flood control channel alignment and the estimated costs for a multiple-purpose channel to serve flood control and navigation needs.

3. Navigation Features of Authorized Project.

The authorized project provides for a multiple-purpose channel for navigation, flood control, recreation and fish and wildlife purposes extending from the Houston Ship Canal along the general course of the Trinity River to Dallas and Fort Worth, Texas, a total distance of 362.8 miles. The navigation features of the plan include a navigation channel 12 feet deep and 150 feet wide on the bottom, with spur channels to turning basins 400 feet square at Dallas and Fort Worth; 23 navigation locks, including 19 locks 84 feet wide by 600 feet long below Dallas (including the lock at Wallisville Dam) and 4 locks 56 feet wide by 400 feet long between Dallas and Fort Worth, and 19 navigation dams; the existing navigation channel from the Houston Ship Channel to Liberty, Texas; and the pools of the Wallisville, Livingston and Tennessee Colony Reservoirs. The plan also includes appropriate alterations to existing bridges and utilities to provide navigation clearances, related access and recreational facilities, and necessary aids to navigation.

4. The engineering features of the project plan were reviewed for adequacy on the basis of the estimates of prospective commerce. It was found that the prospective commerce would exceed the physical capacity of the plan proposed in the project document. Based on the studies carried out in this review it was determined that the 84-foot by 600-foot locks below Dallas were adequate, but Lock No. 18 at Dallas should be increased to 84 feet by 600 feet, and the remaining three locks between Dallas and Fort Worth should be increased to 84 feet by 400 feet. It was found also that the channel bottom-width should be increased to 200 feet, the minimum required for the passing of two 5-barge tows with reasonable ease and safety. It was also determined that elimination of three locks below Dallas and increasing the lifts of four of the remaining locks would result in substantial savings in both project construction and barge operating costs.

5. Provisions for Increasing Capacity

The lock capacity studies indicated that the initial system would not have sufficient capacity to pass the prospective commerce throughout the project life. Consideration was given to providing additional capacity by constructing larger locks initially or by constructing additional parallel locks when required in the future. The latter method offers greater flexibility in conforming to future demands in addition to minimizing costs and was adopted. Based on the traffic projections five of the locks below Dallas would require duplicate additions in 2014, the 29th year of the project life, and seven additional locks below Dallas would require duplication by the 48th year. Five of the locks below Dallas and the three locks between Dallas and Fort Worth would not require duplication during the 50 year project life. Concurrent with the addition of the first duplicate lock, the navigation channel would be widened to 250 feet. Since the operation of the additional locks will tax the amount of river water available for navigation, the modified plan includes pumps and appurtenances at each duplicate lock for pumping water back to the upper pools to permit its reuse for lockages.

6. The Modified Plan

The modified plan recommended by the District Engineer provides initially for a channel with a minimum depth of 12 feet, 200 feet wide, extending 362.8 miles from the Houston Ship Channel in Galveston Bay to Fort Worth, with spur channels to turning basins 400 feet square at Dallas and Fort Worth; 20 locks and 16 dams, including the Wallisville lock and dam which were separately authorized. The 17 locks from the Houston Ship Channel to Dallas (from the Wallisville lock through Lock No. 18) would be 84 feet wide by 600 feet long, while the last three locks between Dallas and Fort Worth would be 84 feet wide by 400 feet long. The plan also provides for future widening of the channel to 250 feet and the addition of duplicate locks with facilities for pumping back water to provide additional traffic handling capacity. All bridges and utility relocations would provide clearance for the ultimate channel width, with bridge alterations providing a minimum of 300 feet between piers with minimum vertical clearance of 52 feet above the water surface that will not be exceeded over two per cent of total time. The plan includes all necessary appurtenances, including aids to navigation, access roads, operating equipment and buildings and recreational facilities.

7. Traffic Survey

A traffic survey conducted by the District Engineer found that 137 million tons consisting of 132 commodities moved in the study area in 1966. Data on commodity movements were obtained from 3,440 shippers and receivers. It is estimated that the reported totals obtained through the field traffic survey represent about 90 per cent of the full barge potential traffic that moved in the tributary area in 1966.

8. Traffic Analysis

Based on the traffic movements in the tributary area in 1966, it was determined by screening that slightly over 17 million tons aggregating 36 commodities were adaptable to barge movement. The movements were subjected to a detailed rate analysis to determine whether a savings could be achieved by movement on the Trinity waterway and, if so, whether the savings would be sufficient to attract the movement to the waterway.

9. Prospective Base-Year Waterway Traffic and Savings

Based on the rate analysis and the competitive effects of the Arkansas and Red River navigation projects, the 1966 base-year traffic accepted by the District Engineer as prospective commerce on the Trinity waterway totaled 8.628 million tons. (4.696 million tons upbound and 3.932 million tons downbound). Estimated transportation savings computed as the difference in rates and charges from origins to destinations between existing movements and movements with use of the Trinity waterway totaled $10,685,000 for the base-year 1966.

10. Special Commodity Studies

Three commodity groups i.e., grain, sand and gravel, and iron and steel products account for approximately 86 per cent of the tonnage and 74 per cent of the savings in the base-year. Because of the obvious importance of these commodities to analysis of the waterway, special studies including the use of expert consultants were made to investigate the present and probable future relationship between market areas and supply sources and other factors that could be expected to determine or influence the movement of these commodities on the waterway.

11. Projections of Base-Year Traffic and Savings

Projections were made of base-year traffic and savings for the life of the waterway 1985-2035 using as economic indicators of future growth of the economy of the tributary area population, value added by manufacture, shipments of iron and steel, value of farm products sold, value of new construction contracts, and export grain. Through the use of these indicators, the District Engineer estimates that by 2035 waterway traffic will increase to 93,751,000 tons and savings to $130,772,000.

12. Average Annual Benefits

The District Engineer estimates that the average annual benefits for the navigation features of the authorized comprehensive Trinity River project for the 50-year period 1985-2035 total $51,943,000 as summarized in the following table:

SUMMARY OF BENEFITS

Item	Average Annual Benefits
Transportation savings	$48,041,000
Extended life of existing bridges	549,000
Recreation and fish and wildlife	3,302,000
Economic development	1,887,000
Subtotal	$53,779,000
Less increased cost to vehicular traffic on highway bridges	- 1,836,000
TOTAL BENEFITS	$51,943,000

13. Cost of Navigation Features

The cost of features exclusively for navigation in the District Engineer's report is the difference in the estimated costs of the multiple-purpose channel and a single-purpose flood control channel on an alignment best suited for flood control. The first cost of the features proposed for initial construction is estimated at $591,478,000. The cost of future construction, estimated at $210,911,000, discounted to its worth in 1985 the first year of project operation amounts to $73,827,000. The estimates of investment include interest during construction. The estimates of investment and annual charges based on a 50-year project life and 3.25 per cent interest are as follows:

Investment

Initial Construction	$673,595,000
Future Construction	78,583,000
Total Investment	$752,178,000

Annual Charges

Interest & Amortization	$ 30,636,000
Operation, Maintenance & Replacement	4,829,000
Total Annual Charges	$ 35,465,000

14. Project Justification

A comparison of the average annual benefits and costs in the District Engineer's report indicates that the ratio of benefits to charges is 1.5.

15. Review

As part of overall review of the District Engineer's report in my office, the reasonableness of the assumptions for estimating traffic and savings on the waterway were evaluated. This evaluation was made with respect to rates for alternative movements, unit savings, and present and future supply sources and markets, and applied to the major commodity movements. This review indicates that the assumptions used to screen prospective traffic movements and to calculate the resultant savings are realistic, and that the District Engineer's overall evaluation of the project is reasonable.

16. Conclusions

I concur in the conclusions of the District and Division Engineers that the improvement of the Trinity River for navigation, evaluated upon the basis of current criteria, is justified.

F. J. CLARKE
Major General, USA
Acting Chief of Engineers

REPORT OF THE DISTRICT ENGINEER

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

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U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

May 29, 1968

SUBJECT: Trinity River, Texas, Comprehensive Improvement Project - Reevaluation of Navigation Economics

THROUGH: Division Engineer
U. S. Army Engineer Division, Southwestern
Dallas, Texas

TO: Chief of Engineers
Department of the Army
Washington, D. C.

AUTHORIZATION OF PROJECT

1. The project for comprehensive improvement of the Trinity River, Texas, was authorized by the Rivers and Harbors Act of October 27, 1965, Public Law 89-298, in accordance with the reports in House Document No. 276, 89th Congress, 1st Session. The authorized project provides for a multiple-purpose channel extending from the Houston Ship Channel to Fort Worth, Texas; for four multiple-purpose reservoirs, including one on the main stem of the river, and three on tributary streams; and for five local flood protection projects, including four in the Fort Worth-Dallas area and one at Liberty, Texas; and facilities for water quality improvement. The project was authorized as recommended by the Chief of Engineers, except that the recommendations of the Board of Engineers shall apply and that prior to expenditure of any funds for construction of those features designed exclusively for navigation, the Chief of Engineers shall submit to the Congress a reevaluation based upon current criteria.

PURPOSE AND SCOPE OF REEVALUATION

2. In H. R. 973, the Committee on Public Works of the House of Representatives presented its views and recommendations on items contained in the authorizing Act, Public Law 89-298. With respect to the improvements to the Trinity River and Tributaries, Texas, the committee stated that the economic analysis for reevaluation of the navigation features of the project should be based upon current standards and current criteria as to the assumed useful life of the navigation portion, and upon improved and more current data with respect to the growing volume of commodity shipments available for barge traffic via the canal.

3. This reevaluation and report is limited to reanalysis of those features of the authorized project designed exclusively for navigation. The criteria used for analysis of traffic and savings are provided by Section 7 of the Department of Transportation Act, Public Law 89-670, approved October 15, 1966. The estimates of prospective traffic are based upon a field survey of traffic moving in the Trinity River tributary area completed in March 1967. All transportation rates or charges, all

analyses and forecasts of economic activity on the tributary area, and all costs estimated for construction of the navigation features are based upon current data and 1967 price levels. The estimated costs of features exclusively for navigation are computed as the difference between the estimated costs for a single-purpose flood control channel on the best flood control channel alignment and the estimated costs for a multiple-purpose channel to serve for flood control and navigation, including related general and fish and wildlife recreation, and located along an alignment suitable for barge navigation. The reanalysis period is based upon an assumed useful life period of 50 years for the navigation features, beginning in the year 1985 and ending in 2035. All computations of interest are based on a rate of 3.25 percent.

DESCRIPTION OF NAVIGATION FEATURES OF PROJECT PLAN

4. The authorized project provides for a multiple-purpose channel for navigation, flood control, recreation and fish and wildlife purposes extending from the Houston Ship Channel along the general course of the Trinity River to Fort Worth, Texas, a total channel distance of 362.8 miles. The navigation features of the plan include the navigation channel 12 feet deep and 150 feet wide on the bottom, with spur channels to turning basins 400 feet square at Dallas and Fort Worth, 23 navigation locks, including 19 locks 84 feet wide by 600 feet long below Dallas and 4 locks 56 feet wide by 400 feet long between Dallas and Fort Worth, and 19 navigation dams. The project includes the existing navigation channel from the Houston Ship Channel to Liberty, Texas, the pools of the Wallisville, Livingston, and Tennessee Colony reservoirs, and the navigation lock at the Wallisville dam. The plan also includes appropriate alterations to existing bridges and utilities to provide navigation clearances, related access and recreational facilities, and necessary aids to navigation.

MODIFICATIONS TO THE PROJECT PLAN

5. The engineering features of the project plan were reviewed for adequacy in connection with current estimates of prospective commerce. It was found that the prospective commerce would exceed the physical capacity of the plan proposed in the project document. Various combinations of lock sizes and channel dimensions were studied to develop an optimum combination capable of handling the barge tows required to carry prospective commerce. The determination of lock sizes involved a detailed analysis of the estimated number of tows, both empty and loaded and in upbound and downbound movements, that would transit the locks. It was found that below Dallas, a typical tow would consist of a towboat and five barges, 35 feet wide and 195 feet long with loaded drafts of 10 feet. Between

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Dallas and Fort Worth, the typical tow would consist of a towboat and three barges. Depending upon the commodities carried, the average load per barge would range from 500 to 1,625 tons. The routing of barge tows through the locks was based on a maximum of 21 lockages per day at any one lock. With average loading of barge tows and normal operating conditions for the locks, it is estimated that up to 30 million tons of commerce annually could be passed through the locks 84 feet wide by 600 feet long, and up to 25 million tons annually could be passed through locks 84 feet wide by 400 feet long.

6. Lock and channel sizes.- Based upon these studies, it was determined that the 84-foot by 600-foot locks below Dallas were adequate, but the first lock above Dallas should be increased to 84 feet by 600 feet, and the remaining three locks between Dallas and Fort Worth should be increased to 84 feet by 400 feet. It was found also that the channel width should be increased to 200 feet, the minimum required for the passing of two 5-barge tows with reasonable ease and safety. The studies of the lock system showed that eliminating three locks below Dallas and increasing the lifts of four of the remaining locks would result in substantial savings in cost.

7. Provisions for increasing capacity.- The lock capacity studies also showed that the 84-foot by 600-foot locks would not have sufficient capacity to pass the prospective commerce throughout the project life. Consideration was given to providing additional capacity by constructing larger locks initially or by constructing additional parallel locks, when required in the future. The latter method is considered to offer greater flexibility and conformance to future demand and was adopted. Projections of the prospective commerce indicate that 5 locks below Dallas would require duplicate additions in 2014, or the 29th year of the project life. Additional duplications would be required in subsequent years until the final three would be added in 2032, or the 47th year of the project. The three uppermost locks between Dallas and Fort Worth would not require duplication during the project life. The Wallisville lock would be duplicated in the 31st year of the project. The navigation channel would be widened to 250 feet when the first duplicate lock is constructed. Since the operation of additional locks will tax the amount of river water available for navigation, the plan includes pumps and appurtenances at each duplicate lock for pumping water back to the upper pools to permit its reuse for lockages.

8. Modified plan.- The modified plan, shown on plates 1 and 2, provides essentially for a channel 200 feet wide, a minimum depth of 12 feet and 362.8 miles long extending from the Houston Ship Channel in Galveston Bay to Fort Worth, with spur channels to turning basins 400 feet square at Dallas and Fort Worth. Nineteen locks and 15

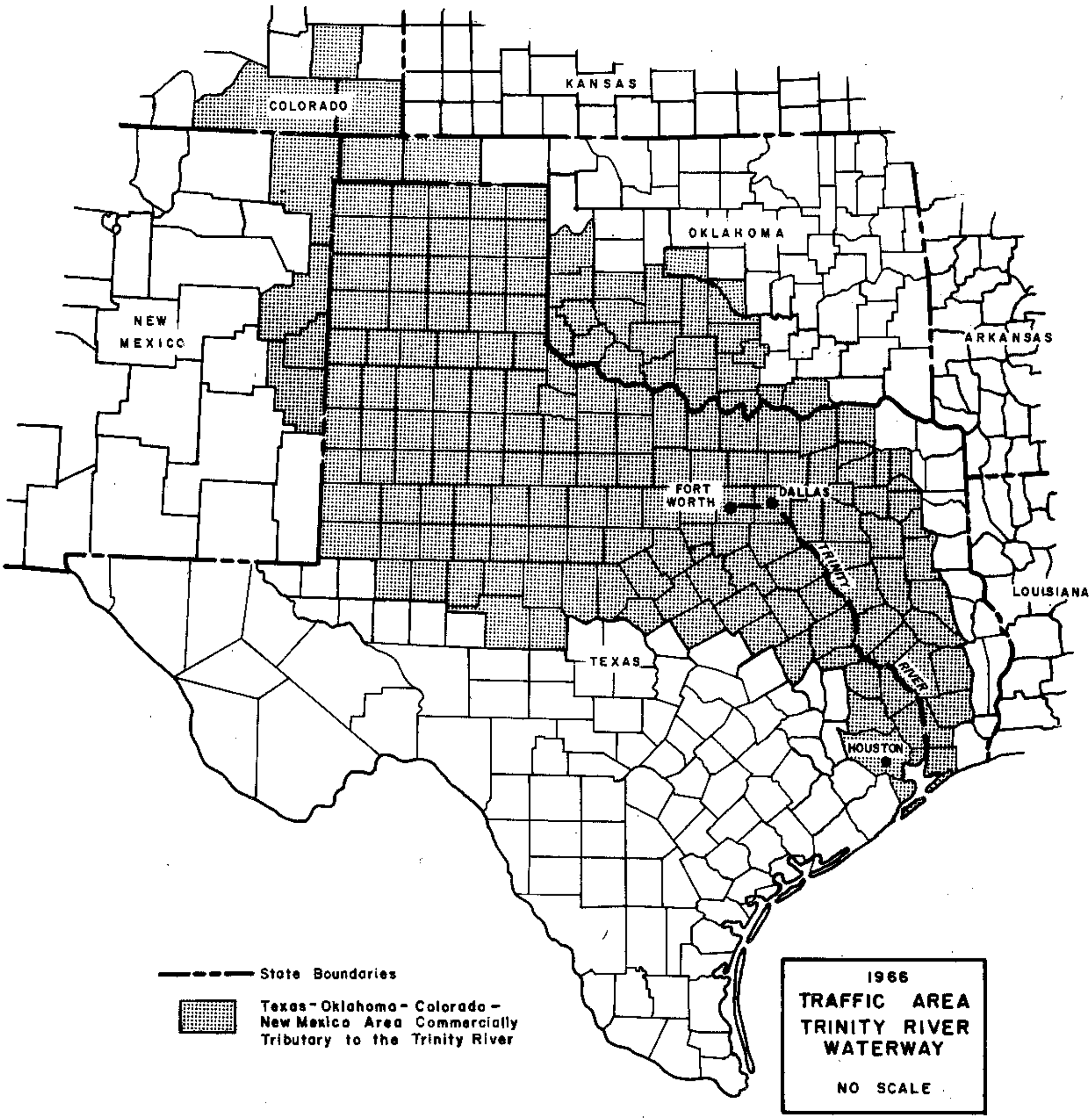
navigation dams would be constructed initially, exclusive of the Wallisville reservoir lock, and dam, which are separately authorized. The 17 locks from the Houston Ship Channel to and including the first lock above Dallas, and including the Wallisville lock, would be 84 feet wide by 600 feet long, while the last three locks from Dallas to Fort Worth would be 84 feet wide by 400 feet long. The plan provides for future widening of the channel to 250 feet and installation of duplicate locks and water pumpback facilities to provide additional traffic handling capacity when required, with the first such additions estimated to be required in 2014, the 29th year of the project. All bridges and utility relocations would provide for the full channel width, with bridge alterations providing a minimum of 300 feet between piers with minimum vertical clearances of 52 feet above the water surface that will not be exceeded over 2 percent of total time. The plan includes all necessary appurtenances, including aids to navigation, access roads, operating equipment and buildings and recreational facilities.

TRAFFIC SURVEY

9. The results of the last comprehensive study of prospective commerce and traffic on the authorized barge navigation project on the Trinity River were published in House Document No. 276, 89th Congress, 1st Session. The estimates contained in that document were based on data compiled from a field survey of traffic moving in the tributary area in 1958. For this economic restudy of the navigation features of the plan, a completely new survey of the present development of economic and transportation conditions existing in the traffic area was made. This field traffic survey was completed in March 1967 and the data compiled were on traffic moving in the tributary area during 1966.

10. Description of traffic area.- The traffic area is defined as the area that could be served at a savings by barge transportation of commodities on the authorized Trinity River project between the Houston Ship Channel and Fort Worth, Texas. Considering the patterns of traffic moving on existing modes of transportation throughout the area and the relationship of the authorized Trinity River waterway to the authorized waterways in the Arkansas River to Catoosa, Oklahoma, and the Red River to Daingerfield, Texas, the traffic area was delineated, as shown on figure 1. The traffic area covers 144 Texas counties, 25 Oklahoma counties, 4 New Mexico counties, and 3 Colorado counties, with a total of about 171,000 square miles. The traffic area extends over a region roughly three times the size of all the six New England states. The area includes several large cities, abundant natural resources, important agricultural production, and rapidly increasing importance in manufacture.

FIGURE 1



KANSAS
COLORADO
OKLAHOMA
NEW MEXICO
ARKANSAS
FORT WORTH
DALLAS
TRINITY
RIVER
LOUISIANA
TEXAS
HOUSTON
State Boundaries
Texas-Oklahoma-Colorado-New Mexico Area Commercially Tributary to the Trinity River
1966
TRAFFIC AREA
TRINITY RIVER
WATERWAY
NO SCALE

11. Field canvass of traffic.- The list of shippers and receivers of commodities to be canvassed in the traffic area was compiled from state and city industrial directories, chambers of commerce and other membership lists, and the Dun and Bradstreet Reference Book of Manufacturers. From these sources, firms were selected giving consideration to such factors as location, size of firm, type of business, manufacturing or processing activity, and adaptibility of raw materials or processed items to barge transportation. By interviews and correspondence field survey teams obtained information from 3,440 shippers and receivers concerning movement of commodities in the traffic area in 1966. Data on grain movements pertained to the 1965 production year, the most recent year for which transportation data were available. The data solicited by the field survey teams included identification and use of commodities, origin and destination points, present means and routing of transportation, amounts shipped and frequency of shipments, scheduling requirements for receipt or shipment, present rates or charges for transportation, and the interest of the firm in waterway transportation on the Trinity River as an alternate or supplement to present mode of transportation. The field traffic survey resulted in reported movement of 132 commodities in the tributary area in 1966 totaling almost 137 million tons. The survey involved a selective process for determining firms to be solicited and a small number of the firms that were solicited declined to furnish information. Accordingly, the information obtained represents somewhat less than the total amount of barge potential traffic that moved in the tributary area in 1966. Based on analysis of the data obtained and comparison between areas where essentially full coverage was obtained and those of lesser coverage, it is estimated that the reported totals obtained through the field traffic survey represent about 90 percent of the full barge potential traffic that moved in the tributary area in 1966.

12. Traffic analysis.- The raw traffic data obtained by the field traffic survey were carefully reviewed to eliminate all commodity movements that obviously had no potential for being moved as waterway traffic on the Trinity River project. The balance of the potential traffic was then examined to eliminate duplications and to eliminate commodities that were not barge adaptable or that would not likely use the Trinity waterway because of insufficient volume, circuitous routing, excessive transfer costs, transit privileges on existing transportation modes, etc. After these preliminary screening procedures, the remainder of the traffic, aggregating 36 separate commodities and slightly over 17 million tons, was analyzed on a specific movement and rate comparison basis to determine whether a savings could be achieved by movement on the Trinity waterway and, if so, whether the savings would be sufficient to attract the movement to the waterway. The analysis is discussed in the commerce section of this report.

13. General.- In the previous analysis of the authorized Trinity River waterway, published in House Document No. 276, 89th Congress, 1st Session, it was found that about 89 percent of the total prospective commerce comprised shipments of grain, iron and steel articles, and sand and gravel. Because of the obvious importance of these commodities to the waterway analysis, special studies were made to investigate the present and probable future relationship between market areas and supply sources and other factors that could be expected to determine or influence the movement of these commodities on the waterway. A professional resource analyst was retained to make the study of sand, gravel and stone, and a professional market analyst performed the iron and steel study. The grain study and analysis of prospective waterway commerce in the other commodities were made by transportation specialists of the Corps of Engineers.

14. Grain study.- In this study, it was found that the only grains of significance to the authorized waterway are wheat and grain sorghum. The study included the identification of producing areas and determination of quantities produced, present marketing patterns, modes of transportation, and transportation charges to the extent that these could be ascertained. The transportation requirements for grain are unique. The total production is harvested in a relatively short period of time and must be moved immediately to market or storage to avoid spoilage or extensive deterioration of quality. The annual production of grain may vary considerably from year to year due to the vagaries of weather and the application of government agricultural policies. This production moves into both the domestic and export marketing and storage centers located within the Trinity River tributary area at Fort Worth, Galveston, and Houston. Historically, the early dependence on rail movement for transportation oriented the extensive storage facilities, required both in the producing areas and in the marketing and milling centers, to rail serviced locations. With the construction of extensive highway networks, the almost total dependence on rail transportation has been reduced and truck transportation has become a significant factor in the movement of grain. For competitive reasons, the railroads have introduced and maintained many special provisions such as quantity rate reductions, stopover privileges for processing and other features designed to attract and hold the grain for rail transportation. With the peak transportation at harvest time, the capabilities of both the railroads and the trucks are severely taxed. The trucks usually operate as unregulated carriers and, for the most part, are privately owned and operated under contract arrangements.

With many special services provided on rail movements and the complicated and varying arrangements for truck movements, the actual charges paid for grain transportation are very difficult to determine.

15. Based on historical data, 1965 was selected as being representative of a normal production year for wheat and grain sorghum and the transportation of the production for that year was analyzed in the grain study. About 9.8 million tons of wheat and 8.5 million tons of grain sorghum were produced in the tributary area in 1965. Of this amount, about 3.03 million tons, or 31 percent of the export wheat and about 0.31 million tons, or 4 percent of the export grain sorghum moved to the export market ports by truck. Another 59 percent of the wheat and 86 percent of the grain sorghum moved either by rail to domestic markets, export markets, or storage or by truck to domestic markets or storage. The remaining 10 percent of both grains were indeterminate because of the variable factors affecting the mode of movement.

16. Sand, gravel and stone study.- The principal uses of sand, gravel and stone are associated with the construction industry for use as aggregates in reinforced concrete construction. The two major market areas in the Trinity River tributary area are the Dallas-Fort Worth and Houston-Galveston metropolitan areas. These areas and the present and prospective sources of supply for these materials are shown on plate 3. A professional resource analyst was retained to determine the distribution of existing and future sand, gravel and stone resources and their relation to the market demands of the two major market areas. The resource analyst's study determined that over 30 million tons of sand, gravel, stone and oyster shell were produced in the Trinity River tributary area in 1966. About 12.7 million tons of sand, gravel and stone moved to the Dallas-Fort Worth area. About 6.1 million tons of oyster shell and 11.4 million tons of sand, gravel and stone moved to the Houston-Galveston area. The major supply sources for the Dallas-Fort Worth market are now the nearby Grand Prairie and Seagoville deposits in the Trinity River basin and the limestone deposits in the Chico-Bridgeport area. The principal supply sources of concrete quality sand and gravel to the Houston-Galveston market are the Columbus-Eagle Lake-Altair and La Grange deposits on the Colorado River and the Victoria area deposits on the Guadalupe River west of Houston. An abundance of low-grade fine sand is available and supplied locally from the nearby San Jacinto River and from deposits on the Trinity near Dayton-Liberty. The special study involved investigation of the existing and projected future market demands and identification of probable supply sources for these demands, with and without the Trinity River waterway. The feasibility of using substitute materials was investigated, including the use of manufactured aggregates from crushed stone in lieu of sand and gravel, and the use of limestone for manufacture of cement in plants along the Gulf coast in lieu of oyster shells from coastal

bays. The resource deposits now serving the market areas were identified and estimates of remaining quantities and probable depletion dates of the deposits were made. The current means of transportation were investigated and information on transportation charges, handling and switching charges and production costs of the materials were obtained to the extent possible. The industry is highly competitive with a large part of the operations being conducted by a relatively small number of major producing companies. To a large extent, the major producers conduct integrated operations from production to marketing, with a major marketed product being transit mix concrete.

17. The study indicated that most of the major deposits of gravel and oyster shell now supplying the Houston-Galveston market area and the deposits of sand and gravel now serving the Dallas-Fort Worth area would be depleted within the next 30 years. With the exception of oyster shell production from coastal bays and production of sand from the San Jacinto River near Houston and the Urbana-Romayor area on the Trinity River, practically all existing deposits are worked by dry-land equipment in pit operations. With depletion of the gravel deposits serving the Houston-Galveston area, major relocations of sand production will occur, even though some sand will remain in the present areas. This is explained by the fact that the deposits comprise mixtures of sand and gravel and, in the process of producing these materials, the excess sand is mixed with the removed overburden and is used to backfill worked deposits. The sand wasted in this manner is not commercially recoverable at any future date. When gravel is exhausted from these deposits, it is expected that sand production will also cease and the market void will be filled by increased production of the quality sand deposits located in the Urbana-Romayor area on the Trinity River.

18. All evidence indicates that many of the existing major market supply sources will not be producing sand and gravel in appreciable quantities during the project life of the Trinity waterway. In his study, the resource analyst identified known reserve deposits of sand, gravel and stone that will be worked and used to supply the market demands when present sources are exhausted. The data included locations and estimates of the quality and recoverable quantities of the materials in the various deposits. Numerous locations of suitable deposits were identified, both in and out of the Trinity River basin. Significant sources of quality sand and gravel that could serve the Dallas-Ft. Worth market are located in the Brazos River basin between Mineral Wells and Waco. The Chico-Bridgeport area has unlimited supplies of hard limestone that can be crushed for quality coarse aggregates. The deposits are the principal source of large size aggregate. Similarly, sources of coarse aggregate for the Houston-Galveston market are located in the sand and gravel

deposits of the Colorado and Guadalupe River Basins until depletion in the year 2000. The Georgetown-San Antonio area offers a supply source for coarse aggregates from crushed limestone in the years beyond. Sources of quality sand for concrete use are located in the deposits of the Colorado and Guadalupe River basins and will be produced along with gravel to the year 2000. Subsequent to 1980 in the Dallas-Ft. Worth Region and 2000 in the Houston-Galveston Region, the deposits located on the Trinity River have the largest potential for satisfying the quality sand demands of both regions. The deposits to serve Dallas-Ft. Worth are located southward from the Seagoville area to the Trinidad and Oakwood areas. Deposits farther south in the Urbana area, have significant potential for serving the Houston-Galveston area in the future.

19. The projected market demands of the Dallas-Fort Worth and Houston-Galveston market regions during the project life period of the Trinity River waterway were related to the probable sources of supply without the waterway in existence, and the results of this analysis were compared with a similar analysis made on the basis of the waterway being in existence. The principle difference found in the Dallas-Ft. Worth Region was in the percentage of the total market demand that would be supplied by the Trinity River deposits below Seagoville. Without the waterway and with the present nearby deposits depleted, it was found that both the Brazos River and the Trinity River deposits will be primary sources of quality sand and coarse aggregate 3/4" or less in size. The Chico-Bridgeport area will be the primary source of coarse aggregate 3/4" greater in size with or without the waterway. The Brazos River reserves are expected to contribute sand and some gravel to the region with or without the waterway. With the waterway, however, the Trinity River deposits are expected to capture a portion of the Brazos River production south of Cleburne because of lower transportation costs. The Houston-Galveston Region will be served by the Colorado and Guadalupe River reserves for quality sand and gravel without the waterway until the year 2000. At this time the source of coarse aggregates will shift to crushed limestone from the San Antonio-Georgetown deposits, while concrete quality sand will be supplied by the Urbana-Romayor reserves located on the Trinity River. With the waterway, significant transportation savings can be realized on shipments of the sand and small gravel from the Urbana-Romayor area.

20. Based on the analyses of projected market demands and the supply sources discussed above, it is estimated that, with the Trinity River waterway in existence, the Trinity River deposits would supply about 25 percent of the total aggregate demand of 12.7 million tons in the Dallas-Fort Worth area and about 15 percent

of the total aggregate demand of 17.5 million tons in the Houston-Galveston area during the project life period. The estimates of prospective commerce and transportation savings from these commodities are discussed in subsequent sections of the report.

21. The possibility that a savings in production costs of sand and gravel might be achieved through the use of hydraulic mining methods, as opposed to dry pit mining methods, was recognized and investigated. Some data relative to production costs by both methods were obtained and were found to vary considerably. No general conclusion could be reached that production costs are cheaper by one or the other of the methods. The costs and the choice of method are affected by numerous factors, including depth of overburden material, depth of mineral deposit, ratio of sand to gravel in the deposit, rate and uniformity of output required to meet market demands, leasing terms with respect to land owners, and several others. It was concluded that extensive investigation on an individual deposit basis would be required to fully assess the savings potential from this source. Sufficient data and time were not available to determine whether or not a savings in production costs could be achieved from hydraulic mining methods and, if so, whether it could be attributed solel to the existence of the waterway.

22. Iron and steel study.- The field traffic survey results were used to develop the estimates of prospective iron and steel traffic for the Trinity River waterway. However, in view of the importance of these commodities in the overall economic analysis, it was considered appropriate that special attention be given to their production, marketing, and transportation to assure reliable estimates with respect to tonnages and transportation savings with the waterway in operation. A professional market analyst was employed to investigate the iron and steel economy of the tributary area and its relationship to major production centers in other parts of the country.

23. The analyst made an analysis of the production of iron and steel in the major steel producing centers and related the production to distribution in the major market areas of the Trinity River trade area. The portion of the iron and steel directly related to petroleum exploration and production was identified and its destination areas were determined. It was found that petroleum related iron and steel were of relatively small importance as items of potential commerce on the Trinity

waterway. Based on market demands and forecast production activity, the analyst estimated the future iron and steel requirements for the tributary area and the probable sources of supply to meet these requirements. When adjusted to the same time frame and balanced with the projections used in the traffic analysis, the results obtained by the analyst agreed closely with the estimates of prospective waterway commerce, which were based on the field traffic canvass of receivers and shippers of iron and steel articles in the tributary area. The estimates of prospective commerce in iron and steel are discussed in the commerce section of this report.

DEVELOPMENT OF TRANSPORTATION RATES AND CHARGES

24. General.- Each shipper and receiver interviewed by the traffic survey team was asked for information on rates, handling charges, switching charges, and transfer charges actually being paid to move the commodities by the transportation modes and routings used by his company. In many cases, these rates and charges were unknown or were not available at the time of the interview. Additionally, the transportation economics analysis of a waterway not in existence required rate determinations on numerous commodity movements, for which there are no existing rates or associated charges. Obviously, there are no existing or published rates for transportation on the waterway itself. In the case of the Trinity waterway, certain portions of its area of influence are determined by the competitive relationship of the Arkansas River navigation project to Catoosa, Oklahoma, which is under construction, and the authorized but unconstructed Red River navigation project to Daingerfield, Texas. There are no existing rates for transportation on either of these competitive waterways. Also, certain commodity movements expected to use the waterway do not exist at the present time. For example, the present principal supply sources of sand and gravel for the Dallas-Fort Worth market will be virtually exhausted prior to construction of the waterway. Other supply sources will be developed involving transportation movements different from those of the present sources. For commodity movements where no specific rates are now in existence, constructed or estimated rates were developed, along with appropriate associated charges, including handling, switching, transfer, etc.

25. Rail and combination rates.- Because of the complex rail rate structure and the necessity for constructing valid rates where no published tariff exists, the services of a commercial freight traffic bureau were obtained. The services were supplied by a leading firm in the area having intimate knowledge of southwest region rates. On the basis of specified commodity movements between designated origin and destination points, the traffic bureau furnished the lowest published rail rates, along with handling, switching and transfer charges, in effect as of March 31, 1967. Where a class rate only was published, a commodity rate was constructed from commodity rates available between similar points and considered comparable. The traffic bureau furnished over six hundred rates for 45 general commodity movements by rail, and combinations of rail-barge and rail-ocean (seatrain), including the citation of appropriate tariff authorities for the rates. The traffic bureau also constructed almost 250 handling and switching-transfer charges. The rates, minimum weight applications, and charges were carefully reviewed by traffic specialists of the Corps of Engineers for accuracy, appropriate applications, and comparability with rates for similar commodity movements developed in other studies. A few revisions to some overland rates and minimum weight applications were made during the traffic analysis.

26. Truck and combination rates.- The determination of truck rates for existing commodity movements is complicated by the large segment of the industry that operates either privately or on a contract basis, for which no rates are published. Based on specified commodity movements, the traffic bureau furnished published truck rates and combination, insofar as such rates were available and applicable. Where no applicable published rates existed, the freight traffic bureau furnished constructed rates based on the best available data concerning comparable movements between points of similar distance. The rates, minimum weight applications, and associated charges were carefully reviewed for accuracy, appropriate applications, and comparability with rates for similar commodity movements developed in other studies and with rates reported by shippers and receivers.

27. For grain, sand, gravel, and stone, which are commodities of major importance in this study and are moved extensively by truck transportation, truck rate schedules are virtually non-existent. As part of the special studies of these commodities, intensive investigations were made to obtain data from which

reasonable truck rate scales related to quantities and distances could be constructed. Data concerning costs of operation and other factors entering into rate structures were obtained from both regulated and non-regulated truck operating companies and from companies operating trucks privately to transport their own products. Based on the best data that could be obtained, separate truck rate scales related to distance hauled were constructed for both grain and for sand, gravel, and stone. After the truck rate scales were constructed, knowledgeable and responsible representatives of the industries concerned were requested to review the scales carefully. These representatives were in general agreement that the constructed scales were representative of comparable actual charges in the industries. The rate scales were also reviewed by traffic specialists of the Corps of Engineers prior to use in the traffic analysis.

28. Barge rates.- Since there are no existing rates applicable to barge transportation on the Trinity River waterway, probable barge rates for each item of prospective commerce were developed by transportation specialists of the Corps of Engineers. The barge rates were estimated on the basis of the physical capability of the waterway to accomodate barge tows of sufficient size to move the prospective commerce with reasonable convenience and safety. The developed rates are applicable to the use of tows consisting of a towboat and 5 large barges in the reach of the waterway below Dallas, and a towboat and 3 large barges in the reach between Dallas and Fort Worth. The data taken into account for the analysis and determination of barge rates included new equipment costs, average operating costs for barges and towboats, port and harbor tug costs, published waterway tariffs and unregulated carrier rates on comparable waterways, statistics on water carrier revenues, and other pertinent data. The developed barge rates include total cost, cargo insurance, and a profit level which is considered reasonable for the industry.

29. Applicable transfer, handling and switching charges available from published tariffs and those developed from the other rate investigations were used to develop appropriate charges for the various items of prospective commerce in consonance with each commodity and the volume of shipments involved. The barge rates used for traffic analysis and estimates of transportation savings include all such associated charges.

PROSPECTIVE COMMERCE AND SAVINGS IN TRANSPORTATION COSTS

30. Existing commerce.- The only existing commerce on the Trinity River is on the 6-foot channel between the mouth and Liberty, Texas. During the period 1961-1965, commerce on this project averaged about 494,000 tons annually, almost all sea-shells and liquid sulfur. This commerce would not be affected by extension of the channel upstream and was not included as prospective commerce for the Trinity River channel to Fort Worth. This traffic will move through the reach containing the Wallisville lock, however, and was included in the lock capacity studies for that reach.

31. Prospective commerce-base year 1966.- The prospective commerce for the Trinity River waterway in the base year 1966 was estimated as that portion of the overall traffic moving in the tributary area, wholly or in part by overland modes of transportation, that would have been attracted to and moved in barges on the Trinity waterway at a savings in transportation cost, if it had been in existence in 1966. In making the estimates the Arkansas River navigation project to Catoosa, Oklahoma, and the Red River navigation project to Daingerfield, Texas, were also considered to have been in existence.

32. As discussed in paragraphs 11 and 12, the field traffic survey developed almost 137 million tons of traffic, which were estimated to be about 90 percent of the total barge potential traffic moved in the tributary area in 1966. By rigorous, preliminary screening procedures, this total was reduced to slightly over 17 million tons, comprising 36 commodities, that were judged to have sufficient potential to warrant rate analysis. By the rate analysis process, the total unit transportation cost for each commodity movement from origin to destination was determined for the transportation modes and routing now in use. This unit cost was then compared with a similar estimate on the basis of using barge transportation on the Trinity waterway for all or part of the movement from origin to destination. If the comparison indicated that no savings would have been realized by water transportation on the Trinity, or that the savings would not have been sufficient to attract the movement to the waterway, it was eliminated as prospective commerce. If the savings were judged sufficient to attract the movement to the waterway, it was accepted as prospective commerce for the base year 1966. This procedure was followed for all commodities except grains, sand, gravel, and stone which were the subjects of special studies. The estimated total base year savings were computed as the product of unit savings and the total amount of the commodity moved.

33. Where portions of the joint land-water hauls could alternatively move via authorized and competing waterways, such as the Arkansas River, with its terminus at Catoosa, Oklahoma, and the Red River, with its terminus at Daingerfield, Texas, constructed rates and transfer charges via the alternative routes were compared with similar data via the Trinity River waterway to determine which route would provide the least costly total transportation charges. If the alternative route were found to be less costly, the prospective traffic was assumed to move by that route and was not further considered as prospective commerce for the Trinity waterway. If the comparison indicated a lesser cost for movement by the Trinity, the movement was accepted as prospective commerce.

34. Based on these analyses, the 1966 base year traffic finally accepted as prospective commerce on the Trinity waterway totaled 1.932 million tons, exclusive of grain, sand, gravel, and stone. As discussed in paragraph 11, it is estimated that the field traffic canvass developed about 90 percent of the full barge potential traffic that moved in the tributary area in 1966. To allow for the portion that was not disclosed by the field traffic canvass, an upward adjustment of 10 percent was applied to the total, giving an estimated total prospective commerce of 2.125 million tons for base year 1966, exclusive of grain, sand, gravel, and stone. Of the 2.125 million tons, 1.596 million tons would have been upbound on the waterway and 0.529 million tons would have been downbound.

35. As discussed in paragraph 15, 18.3 million tons of wheat and grain sorghum were produced in the tributary area in 1965, the latest production for which transportation data were available. About 3.03 million tons of wheat and 0.31 million tons of grain sorghum moved to export markets by truck. This represented about 31 percent of the wheat and 4 percent of the grain sorghum produced. The remainder of both grains moved to domestic markets or storage by truck or to domestic markets, export markets, or storage by rail. The special study of grain determined that the only potential for grain commerce on the Trinity waterway would be export grain moving to the Gulf Coast ports. It was found also that, for a number of reasons, the portion of the export grain moving by rail would not change its mode of movement even with the waterway constructed. Accordingly, only the 3.03 million tons of export wheat and the 0.31 million tons of grain sorghum moving by truck were analyzed on a rate comparison basis for prospective waterway commerce. This resulted in eliminations on the basis of no savings or insufficient savings to reduce the 1965 prospective

waterway commerce of export grain to 1.303 million tons, including 1.105 million tons of wheat and 0.198 million tons of grain sorghum, all downbound on the waterway.

36. Because of impending depletion of primary sources of supply of sand and gravel for both the Dallas-Fort Worth and the Houston-Galveston markets, discussed in paragraphs 16 through 20, the estimates of prospective commerce in these materials could not be based on the existing traffic patterns. Accordingly, a market and production analysis was made to indicate the traffic patterns that would have prevailed in 1966 for sand, gravel, and stone, if the existing sources of supply had been exhausted. It was found that under this condition, and with the Trinity waterway in operation, an estimated 24.4 percent of the demands for sand, gravel, and stone in the Dallas-Fort Worth market and about 14.9 percent of these demands in the Houston-Galveston market would have been supplied from deposits along the Trinity River. The total base year commerce, on this basis, was estimated at 5.2 million tons of sand and gravel, of which 3.1 million tons were upbound to the Dallas-Fort Worth area and 2.1 million tons were downbound to the Houston-Galveston area.

37. Summary of prospective base year commerce and savings.- On the basis of the items discussed above, the total base year commerce for the Trinity waterway was estimated at 8.628 million tons, including 4.696 million tons upbound and 3.932 million tons downbound. Estimated transportation savings, computed as the difference in cost on a rate comparison basis, between existing movements and movements on the Trinity waterway totaled $10,685,000 for the base year 1966. A summary of traffic developed, screened, analyzed, and accepted as base year prospective commerce is shown in table 1. A summary of the prospective commerce and savings, separated as to upbound and downbound movements, is shown in table 2.

TABLE 1

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITY CLASS - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Farm Products (2)	20,307,736	3,727,753	15,900	314,602	1,200	2,031	35,020	3,359,000	1,803,000	219,000	21,000	1,316,000
Forest Products	24,280	24,030				30		24,000				24,000
Fresh Fish and Other Marine Products	6,100,000	0						0				0
Metallic Ores	13,117	0						0				0
Coal	18,000	13,800					13,800	0				0
Crude Petroleum	20,137,656	1,822	1,822					0				0
Nonmetallic Minerals, except Fuels (2)	32,224,770	11,954,620	20,680	36,500	3,200	2,055	5,573,885	6,318,300	957,800			5,360,500
Food and Kindred Products	4,002,925	607,875	108,175	51,877	2,750	4,718	252,205	188,150	106,300			81,850
Basic Textiles	90,201	41,306	20,556	1,250		3,300	16,200	0				0
Lumber and Wood Products	1,144,038	252,720	61,350		15,550	3,030	4,100	168,690	168,690			0
Furniture and Fixtures	40,125	200	200					0				0
Pulp, Paper and Allied Products	1,696,577	791,404	55,515		82,744	8,332	24,988	619,825	517,497			102,328
Printed Matter	21,282	2,624	2,624					0				0
Chemicals and Related Products	10,542,608	1,278,883	175,614	30,000	183,996	10,364	83,396	795,513	279,450	10,000		506,063
Petroleum and Coal Products	24,836,891	153,400	100,660			2,680	5,000	45,060	38,060			7,000
Rubber and Miscellaneous Plastic Products	95,903	3,525	2,980		500	45		0				0
Leather and Leather Products	928	460	460					0				0
Stone, Clay, and Glass Products	4,346,899	362,311	18,268	91,160	7,410	3,903	2,130	239,440	140,440			99,000
Primary Metal Products	8,223,609	1,672,924	274,238		97,719	12,409	342,079	946,479	87,960	43,393		815,126
Fabricated Metal Products except Ordnance, Machinery, and Transportation Equipment	906,328	107,087	59,040		10,000	2,770	11,877	23,400	8,400	15,000		0
Machinery, except Electrical	235,081	35,889	3,290		2,750	3,271	26,578	0				0
Electrical Machinery, Equipment and Supplies	34,302	0						0				0
Transportation Equipment	49,438	1,777				677	1,100	0				0
Instruments, Photographic and Optical Goods, Watches and Clocks	267	0						0				0
Miscellaneous Products of Manufacturing	87,660	81,100	9,600			1,500	70,000	0				0
Waste and Scrap Materials	1,759,490	413,981	22,880		100,031	1,274	21,212	268,584	145,584			123,000
Commodities NEC												193,157
GRAND TOTAL	136,942,111	21,529.491	953,852	525,389	512,850	62,389	6,478,570	12,996,441	4,253,181	287,393	21,000	8,628,054 (1)

NOTE: Tonnages listed in the "Other" columns include: duplication, insufficient data, insufficient tonnage, commodities subject to special transit rates, Red and Arkansas River traffic, and traffic creditable to the Liberty and Victoria Channels.

(1) An adjustment of 10 percent has been added to the tonnage of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

(2) Wheat and grain sorghum and sand and gravel are included in the table to show total commodity movements only. The estimated tonnages for these commodities were developed by analytical procedures in the special studies rather than through the field survey.

TABLE 2

ACCEPTED PROSPECTIVE COMMERCE AND SAVINGS IN TRANSPORTATION CHARGES
BY COMMODITY CLASS
(1966 commerce)

Commodity	UPBOUND		DOWNBOUND		TOTAL	
	Traffic (net tons)	Savings (dollars)	Traffic (net tons)	Savings (dollars)	Traffic (net tons)	Savings (dollars)
Farm Products(1)	13,000	$ 44,300	1,303,000	842,000	1,316,000	$ 886,300
Forest Products	24,000	133,900	-	-	24,000	133,900
Non-Metallic Minerals	3,259,500	3,572,500	2,101,000	1,283,200	5,360,500	4,855,700
Food & kindred Products	76,600	146,700	5,250	16,000	81,850	162,700
Chemicals & Related Products	260,780	1,139,800	245,283	281,300	506,063	1,421,100
Pulp, Paper & Allied Products	97,498	192,300	4,830	6,300	102,328	198,600
Petroleum & Coal Products	7,000	46,000	-	-	7,000	46,000
Primary Metal Products	812,614	2,108,400	2,512	6,700	815,126	2,115,100
Stone, Clay & Glass Products	-	-	99,000	104,900	99,000	104,900
Waste & Scrap Materials	-	-	123,000	290,200	123,000	290,200
Miscellaneous	145,099	400,100	48,088	70,800	193,187	470,900
Grand Total	4,696,091	$7,784,000	3,931,963	$2,901,400	8,628,054 (2)	$10,685,400 (2)

(1) 1965 Commerce
(2) An adjustment of 10 percent has been added to the tonnage and savings of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

PROJECTION OF PROSPECTIVE COMMERCE AND SAVINGS

38. General.- To obtain an estimate of the future commerce and transportation savings that would be realized from the authorized Trinity River navigation project, analysis of historic economic conditions and estimates of future economic activity in the navigation trade area were made. Since this study involves navigation features only, the analysis of economic activities was confined to those associated with current and future savings in transportation costs which shippers and receivers could realize from moving different commodities on the proposed waterway. Future growth of commodity movements can be associated, to some extent, with the expected overall economic growth of the trade area. However, a more reliable estimate of the future volume movement of a specific commodity can be obtained by relating the commodity to the projected future activity of a recognized economic indicator for that sector of the area's economy most nearly associated with the major use or demand for that commodity. Since a fairly large number of commodities have been determined to be prospective waterborne commerce, the commodities have been grouped according to the economic sector most nearly related to the use or demand for the commodity. The volume of future movement of each commodity has then been estimated by assuming a direct relationship to the predicted future activity of the appropriate economic indicator.

39. Economic indicators.- The economic indicators selected for the purpose of estimating future movements of commerce on the authorized Trinity River navigation project include the standard statistical indicators for Population, Value Added by Manufacture, Value of Farm Products Sold, Value of New Construction Contracts, and indicators specially developed for Shipments of Iron and Steel, Export Wheat, and Export Grain Sorghum. A brief explanation of each economic indicator is given below.

a. Population.- The growth of population has direct or indirect influence on all types of economic growth. The future production and use of many commodities are directly related to the growth or decline of the population. For example, the requirement for newsprint paper used in the publication of newspapers would be determined almost entirely by population, since the demand for newspapers is generated solely by people. In this study, the individual commodities having their most direct association to the needs and demands of people having been projected by relating the predicted growth rates of this economic indicator.

b. Value Added by Manufacture.- This value represents the difference between the final value of manufactured goods and the cost of raw materials that are used in producing these goods. This indicator is a criterion of the relative economic importance of manufacturing because it measures the contribution of the manufacturing process. Future commerce for all commodities most directly related to manufacturing were estimated by association with the projection factors for this economic indicator. Since the manufacturing process often is not final at a particular plant and transportation to other plants and locations is required before the end product is reached, a thorough evaluation of each commodity movement must be made before associating its growth with that of manufacturing. The future movement of these commodities was determined through the use of the Value Added by Manufacture indicator only when the purpose of movement involved further manufacturing.

c. Shipments of Iron and Steel.- It has been found that the most significant factors affecting the demand for basic iron and steel are the levels of activity in manufacturing and construction. Statistical research has revealed that, historically, the amount of iron and steel per dollar of output in manufacturing and construction has been decreasing for some time. This is attributed to a number of factors including increased use of substitute metals and other materials, steady improvement of the quality of iron and steel, and changes in design practices. A special indicator for shipments of iron and steel was constructed, giving consideration to basic influences in the demand for iron and steel, which is directly related to shipments. The more important factors considered were related to the use of iron and steel in manufacturing and construction, including use as production input, variations in growth rates of manufacturing and construction, and probable further reduction in iron and steel use per dollar of output for both manufacturing and construction.

d. Value of Farm Products Sold.- This total value, as published by the United States Census of Agriculture, has been determined to be a reliable measure of the contribution of agriculture to the economy of a statewide or smaller area. Some commodity movements, such as finished commercial fertilizers, are related to the direct needs of agriculture and thus can be readily assigned to its measuring indicator. The relation of other commodity movements, however, is less readily apparent. For example, the ingredients involved in the manufacture of of commercial fertilizers, require further manufacture or processing before they can be used in agricultural production. Although a further manufacturing process is involved, the basic need is determined by agricultural requirements. For this reason, those commodities would be related to the Value of Farm Products Sold indicator, rather than the manufacturing indicator.

e. Value of New Construction Contracts.- This indicator represents the total dollar value of both public and private construction contracts. It is the most representative indicator for predicting the future movements of commodities associated with new construction. Statistical data for this indicator include values for both military and highway construction, in addition to commercial building activity. These construction values are not usually available in other statistical data pertaining to new construction, especially for individual states or smaller areas. Within the overall economy, the production and use of some commodities are determined almost entirely by the growth or decline in new construction. Examples of this would be sand and gravel. The predicted growth or decline of the need for these commodities would be directly related to the activity of the new construction indicator. Future commerce for all commodities having their most direct relationship to new construction has been estimated by association with the projected growth rates of this economic indicator.

f. Export Grain (Export Wheat and Export Grain Sorghum).- Economic indicators of these commodity movements were constructed especially for this report. Historically, almost all grain moving through the Gulf ports has been for export. The special study of grain production and movements indicated that this pattern would prevail for the foreseeable future and that all future wheat and grain sorghum moving as commerce on the Trinity River would move downbound and into the export market. The indicators of future export grain activity were based on data obtained from the United States Deparmtnet of Agriculture, Economic Research Service, in cooperation with Texas A & M University. Basically, the projections of population and domestic demands for wheat and grain sorghum were related to the projected future production estimates of the grains, with the difference being judged as available for export. For short-term consideration, grain exports can vary widely depending upon such factors as weather effects on production, application of governmental domestic agricultural policies, and foreign aid programs and policies. For long-term consideration, however, these factors tend to come into balance and the long-term indicators should be reasonably valid.

40. Allocation of base year prospective commerce to major economic indicators.- The accepted prospective commerce and savings for the base year 1966, as shown in table 2, has been allocated by individual commodities to the economic indicator for the sector of the economy most closely associated with the

need or demand for each commodity. The allocation of individual commodity movements was based on careful review of each field contact sheet, which sets forth the origin and destination points of the commodity movement, the uses of the commodity, and other pertinent data obtained from shippers and receivers. In many instances, further interviews were conducted to assure accurate identification. The allocation, by major indices, of the commodity, tonnage, and savings for the accepted 1966 prospective commerce on the Trinity River is shown in table 3.

41. Factors of growth and projection of prospective commerce.- In order to estimate the future commerce and savings over the authorized waterway throughout its 50-year project life, the 1966 base year commerce and savings were related to the indicators of future economic activity within the traffic area during this period. The projected future activity of the economic indicators was estimated through a method of disaggregating national growth projections to the state level, and then further to the traffic area of the authorized waterway. In using national economic growth projections as a model for constructing the indicators of state and traffic area growth, the method centered upon the relationships of population, employment by industrial type, and output per employee by industrial type. Unusual or short-term economic influences are not taken into account in the long-term national growth projections, and therefore, were excluded from consideration in relating the indicators of economic activity at the national level to corresponding activity at the state and traffic area levels. Unpredictable influences such as major wars, severe deflationary or inflationary periods, political revolution, etc., are also excluded from the projection processes. The resulting predictions of future economic activity, as shown by the indicators, when compared at the national, state, and traffic area levels, are reasonable with respect to probable long-term economic growth within the area of influence of the waterway.

TABLE 3

ALLOCATION OF PROSPECTIVE COMMERCE TO MAJOR INDICES
(1966 Base Year Commerce)

POPULATION		
COMMODITY	TONS	SAVINGS
Bond Paper	8,400	$ 34,900
Cotton Seed Oil	5,250	16,000
Newsprint	81,928	120,600
Perlite	1,000	2,200
Printing Paper	6,000	18,100
Commodities NEC	10,258	19,200
TOTALS(1)	112,836	$ 211,000

VALUE ADDED BY MANUFACTURE		
COMMODITY	TONS	SAVINGS
Aluminum & Aluminum Alloys	22,000	$ 55,100
Caustic Soda	45,280	233,800
Cement	99,000	104,900
Crude Rubber	24,000	133,900
Lead Ingots	1,712	5,300
Malamin Crystals	3,000	11,900
Misc. Chemical Products	34,000	177,600
Polyvinyl Chloride Resin Compound	5,000	1,300
Polyethylene Pellets	7,500	26,000
Printing Paper	6,000	25,000
Soda Ash	63,500	328,100
Soda Phosphate	5,880	14,300
Solvents	7,000	46,000
Sulfuric Acid	58,000	77,000
Commodities NEC	37,387	124,000
TOTALS(1)	411,259	$1,364,200

SHIPMENTS OF IRON AND STEEL		
COMMODITY	TONS	SAVINGS
Iron & Steel Articles	751,232	$1,889,900
Pipe, Iron & Steel	32,682	161,000
Scrap, Iron & Steel	123,000	290,200
Commodities NEC	90,692	234,100
TOTALS(1)	997,606	$2,575,200

VALUE OF FARM PRODUCTS SOLD		
COMMODITY	TONS	SAVINGS
Ammonium Phosphate	104,403	$ 47,000
Ammonium Sulfate	5,000	8,500
Corn	13,000	44,300
Fish Meal	15,000	11,300
Fertilizer (Urea)	100,000	155,300
Meal & Feed	15,000	32,100
Molasses (Inedible)	29,600	77,900
Phosphate	22,500	105,100
Phosphate Rock	159,500	189,500
Phosphoric Acid	60,000	235,200
Rice Feed	5,000	3,600
Soybean Meal	12,000	21,800
Commodities NEC	54,100	93,200
TOTALS (1)	595,103	$1,024,800

VALUE OF NEW CONSTRUCTION CONTRACTS		
COMMODITY	TONS	SAVINGS
Sand & Gravel	5,200,000	$4,664,000
Aluminum & Aluminum Alloys	7,500	3,800
Commodities NEC	750	400
TOTALS (1)	5,208,250	$4,668,200

EXPORT WHEAT		
COMMODITY	TONS	SAVINGS
Wheat	1,105,000	$ 719,000
TOTALS	1,105,000	$ 719,000

EXPORT GRAIN SORGHUM		
COMMODITY	TONS	SAVINGS
Grain Sorghum	198,000	$ 123,000
TOTALS	198,000	$ 123,000

(1) An adjustment of 10 percent has been added to the accepted tonnage and savings of all commodities except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

42. The multiplier factors of increase from the base year 1966 were developed from projections of future activity of each economic indicator. These factors were determined for 1985, the estimated initial year of the project, the intermediate years 2000, 2010, and 2020 and 2035, which is the end of the economic analysis period for the project. The projection factors or multipliers are shown by major indicator and year in table 4. The projected annual tonnage of commerce and annual savings associated with each of the economic indicators are shown for each of the selected years in table 5.

TABLE 4

MULTIPLIER FACTORS OF GROWTH

Economic Indicators	1966	1985	2000	2010	2020	2035
Population	1.000	1.442	1.901	2.259	2.685	3.599
Value Added by Manufacture	1.000	2.514	5.162	8.228	13.113	26.845
Shipments of Iron & Steel	1.000	2.092	3.503	4.942	6.971	11.679
Value of Farm Products Sold	1.000	1.232	1.507	1.894	2,383	3.007
Value of New Construction Contracts	1.000	2.012	3.375	4.813	6.855	11.735
Export Wheat	1.000	1.061	1.156	1.233	1.316	1.418
Export Grain Sorghum	1.000	1.248	1.299	1.333	1.368	1.567

TABLE 5

PROJECTIONS OF ANNUAL COMMERCE AND SAVINGS

Economic Indicators	1966	1985(1)	2000	2010	2020	2035
	TONNAGE (in thousands)					
Population	113	163	215	255	303	406
Value Added by Manufacture	411	1,034	2,123	3,384	5,393	11,041
Shipments of Iron & Steel	998	2,087	3,495	4,930	6,954	11,651
Value of Farm Products Sold	595	733	897	1,127	1,418	1,789
Value of New Construction Contracts (2)	5,208	10,479	19,266	27,474	39,131	66,987
Export Wheat (3)	1,105	1,172	1,277	1,362	1,454	1,567
Export Grain Sorghum (3)	198	247	257	264	271	310
TOTALS (4)	8,628	15,915	27,530	38,796	54,924	93,751
	SAVINGS (in thousands of dollars)					
Population	$ 211	$ 304	$ 401	$ 477	$ 566	$ 759
Value Added by Manufacture	1,364	3,430	7,042	11,225	17,889	36,622
Shipments of Iron & Steel	2,575	5,387	9,021	12,727	17,952	30,076
Value of Farm Products Sold	1,025	1,263	1,544	1,941	2,442	3,081
Value of New Construction Contracts (2)	4,668	9,392	16,960	24,186	34,447	58,971
Export Wheat (3)	719	763	831	887	946	1,020
Export Grain Sorghum (3)	123	154	160	164	168	193
TOTALS (4)	$10,685	$20,693	$35,959	$51,607	$74,410	$130,722

(1) Assumed initial year of project use.

(2) Base year sand and gravel tonnage of 5,200,000 and savings of $4,664,000 were used to compute tonnage and savings to the year 2000 and 5,700,000 tons and $5,021,000 savings were used to compute tonnage and savings from 2000 to 2035.

(3) Base year for wheat and grain sorghum is 1965.

(4) An adjustment of 10 percent has been added to the tonnage and savings of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

BENEFITS

43. Benefits from transportation savings.- As shown in table 5, the annual savings in transportation costs that would be realized in the initial year of the waterway are estimated at $20,693,000. The annual savings would increase at the projected rates to reach an annual total of $130,722,000 in the 50th year of the project. However, the lock capacity studies, discussed in paragraphs 5 through 7, indicate that the commerce would reach the physical capacity of the waterway in the 48th year, which would preclude a further increase in annual savings after that year. With the totals adjusted for the last 2 years of the project life, the annual benefits throughout the project life were discounted to their 1985 worth, using a compound interest rate of 3.25 percent and redistributed over the 50-year project life to an average annual equivalent value of $48,041,000.

44. Benefits from extended life of bridges.- There are 37 highway crossings and 9 railroad crossings of the Trinity River at the present time that would be affected by construction of the navigation channel. In addition 4 new highway crossings and 4 new railroad crossings are definitely planned or scheduled for construction that will be completed not earlier than the completion of the navigation project. A number of the existing and planned highway crossings involve separate bridge structures for traffic passing in opposite directions. There will be 48 separate highway bridges and 9 railroad bridges that will have some portion of their useful life expired at the time of construction of the navigation project. The age of these bridges at the time of construction of the navigation project will cover a wide range. Each of the bridges would require alteration or replacement to provide adequate clearance for navigation. A benefit would be realized through extension of the useful life of the affected portions of the bridges. The benefit was computed for each bridge, taking into account its age and remaining useful life at the initial year of the project, its type of construction, and the portion of the bridge affected. The total benefit from extended useful life of bridges was discounted to 1985 worth and redistributed over the 50-year project life period to an average annual equivalent benefit of $549,000.

45. Economic loss from increased operating costs of vehicles.- With the raising of the highway bridges to provide adequate vertical clearance for navigation, the operating cost of each vehicle crossing the bridge would be increased by the raise in roadway gradient. Based on 1966 traffic counts furnished by the Texas Highway Department, projections of future increases in vehicular

traffic were made for each bridge extending through the 50-year analysis period of the waterway project. Additional unit operating costs per foot of lift were obtained from the Federal Highway Administration, Department of Transportation. The additional operating costs for vehicles crossing each bridge were computed for the analysis period, and the totals were discounted to 1985 worth and redistributed as an average annual equivalent value of $1,836,000. This would be an economic loss to be deducted from the navigation benefits.

46. Benefits from recreation and fish and wildlife.- Construction of the navigation features would provide recreation opportunities that would not otherwise be realized. Generally, these opportunities are associated with the slack-water pools caused by the navigation dams and in the recreational and sightseeing facilities provided in connection with the navigation lock structures. Increased sport hunting and fishing opportunities would also be realized. Estimates of recreational visitor use of the project facilities were made and, on estimated unit values of $0.75 per visitor day for general recreation and $1.00 per visitor day for sport hunting and fishing, annual totals were estimated through the project life period. The annual totals were discounted to 1985 worth and redistributed over the project life period to an average annual equivalent benefit of $3,302,000.

47. Economic development benefits.- There are nine Texas counties along the route of the Trinity navigation project, that are designated as economically depressed areas by the Economic Development Administration, under the Public Works and Economic Development Act of 1965. The impact that might be expected on the economy of these counties by expenditure of funds for construction and operation of the navigation features was investigated. It was found that employment opportunities would be created for considerable portions of the skilled and unskilled labor markets of the counties and the local economies would be appreciably stimulated during the construction, and on a regressing projection, during the first 20 years of the project operation. The average annual equivalent benefits during the 50-year project life period were estimated at $1,887,000.

48. <u>Summary of benefits</u>.- The average annual equivalent benefits estimated for the navigation features of the authorized Trinity River project from the Houston Ship Channel to Fort Worth, Texas, are as follows:

SUMMARY OF BENEFITS

Item	Average annual equivalent benefits
Transportation savings	$48,041,000
Extended life of existing bridges	549,000
Recreation and fish and wildlife	3,302,000
Economic development	1,887,000
Subtotal	$53,779,000
Less increased cost to vehicular traffic on highway bridges	- 1,836,000
TOTAL BENEFITS	$51,943,000

PROJECT COST ESTIMATES AND ANNUAL CHARGES

49. <u>Estimates of first costs and annual charges</u>.- Estimates of cost of the modified project include new estimates for existing and proposed bridges, for utility relocations, for the locks and dams of modified size, for pumpback facilities and for proposed channel widening. Costs of additional parallel locks were estimated as the same as the cost of the initial lock at each site with additional cost estimated for added difficulties of construction and for approach channel excavation. Estimated costs of other features of the authorized plan were updated, where applicable to 1967 price levels. A new real estate appraisal was made. The cost of features exclusively for navigation is computed as the difference in the estimated costs of the multiple-purpose channel and a single purpose flood control channel on an alignment best suited for flood control. The first cost of the features proposed for initial construction is estimated at $591,478,000. The cost of future construction is estimated at $210,911,000 , which converted from the years in which incurred to its worth in 1985 the first year of the project, amounts

to $73,827,000. The estimates of investment include interest during construction. The estimates of investment and annual charges based on a 50-year project life and 3.25 percent interest rate are as follows:

<u>Investment</u>:

Initial construction - - - - - - - - - - - -	$673,595,000
Future construction - - - - - - - - - - - -	78,583,000
Total investment - - - - - - -	$752,178,000

<u>Annual charges</u>:

Interest & amortization - - - - - - - - - -	$ 30,636,000
Operation, maintenance, & replacement - -	4,829,000
Total annual charges - - - -	$ 35,465,000

PROJECT JUSTIFICATION

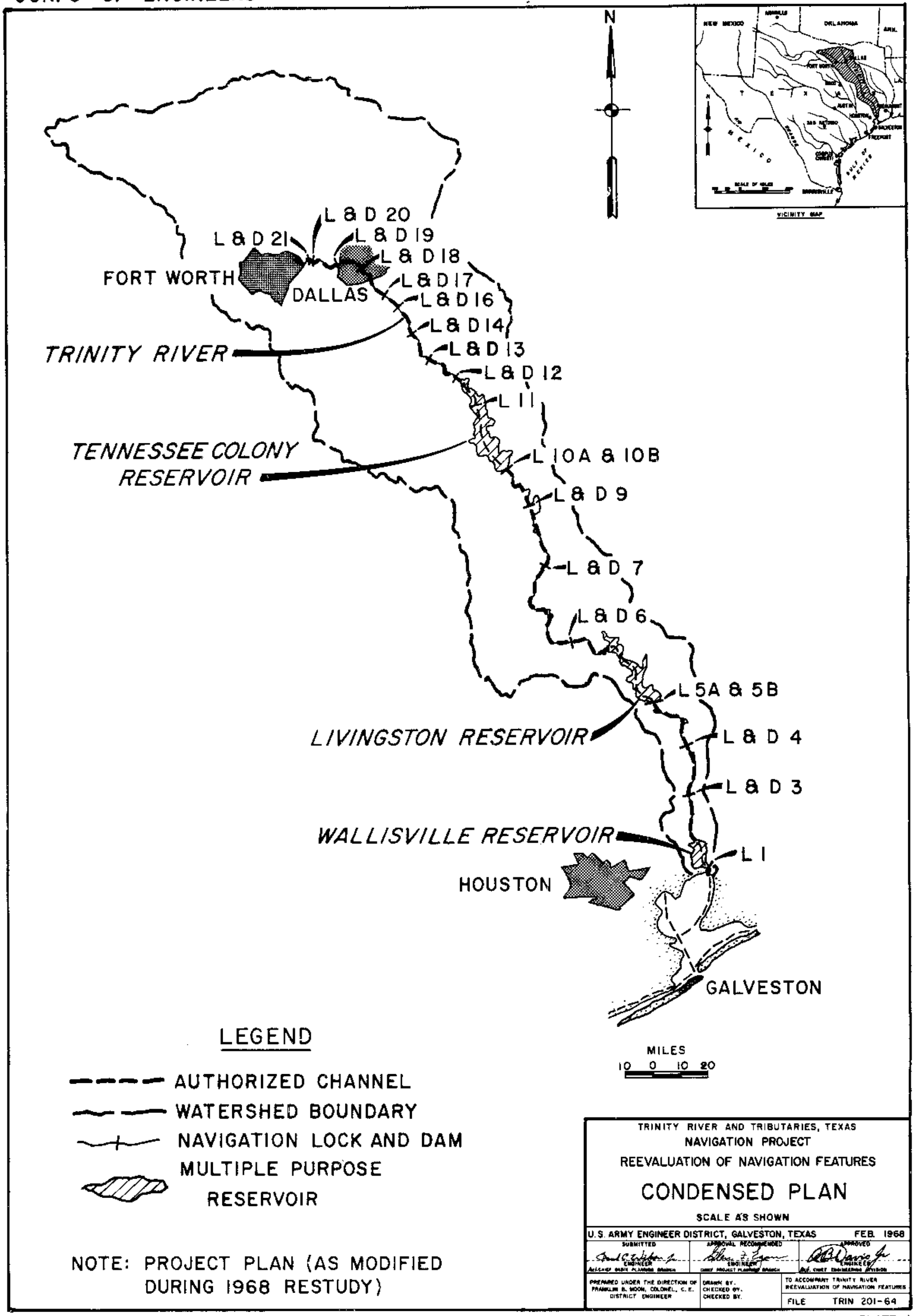
50. <u>Comparison of benefits and costs</u>.- The estimated average annual equivalent benefits, annual charges, and ratio of benefits to charges for the features exclusively for navigation in the comprehensive improvement plan authorized for the Trinity River and tributaries, as discussed herein, are as follows:

Average annual equivalent benefits - - -	$51,943,000
Annual charges - - - - - - - - - - - - - - -	$35,465,000
Ratio of benefits to charges - - - - - - -	1.5

CONCLUSIONS

51. The comprehensive improvement plan provides for the development of the water and related land resources of the Trinity River basin to meet the immediate and long range needs of all of the people in the basin. The navigation features are a vital and integral part of that plan. The results of this reevalation study show that the navigation feature of the plan is well justified on its own merits.

FRANKLIN B. MOON
Colonel, CE
District Engineer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TENNESSEE COLONY RESERVOIR
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NAVIGATION LOCK AND DAM
MULTIPLE PURPOSE RESERVOIR
NOTE: PROJECT PLAN (AS MODIFIED DURING 1968 RESTUDY)
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NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
CONDENSED PLAN
SCALE AS SHOWN
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DISTRICT ENGINEER
TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES
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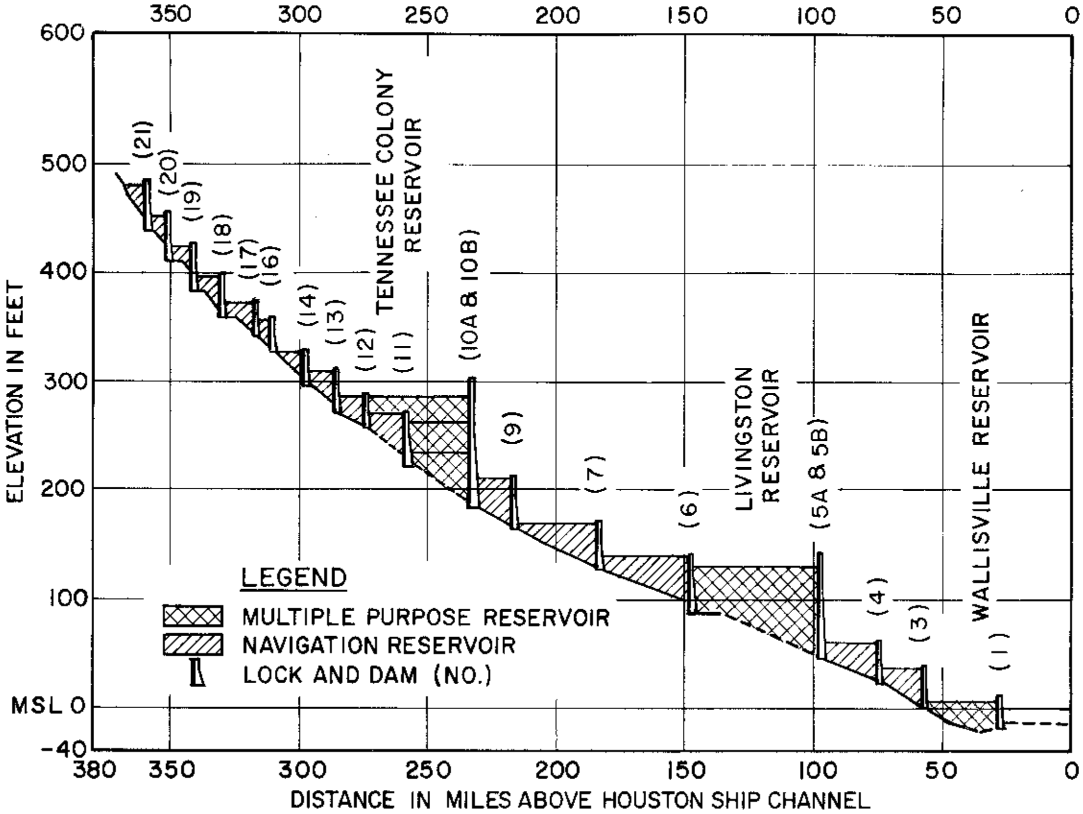
PLATE I



NOTE: PROJECT PLAN (AS MODIFIED DURING 1968 RESTUDY)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

CONDENSED PROFILE

SCALE AS SHOWN

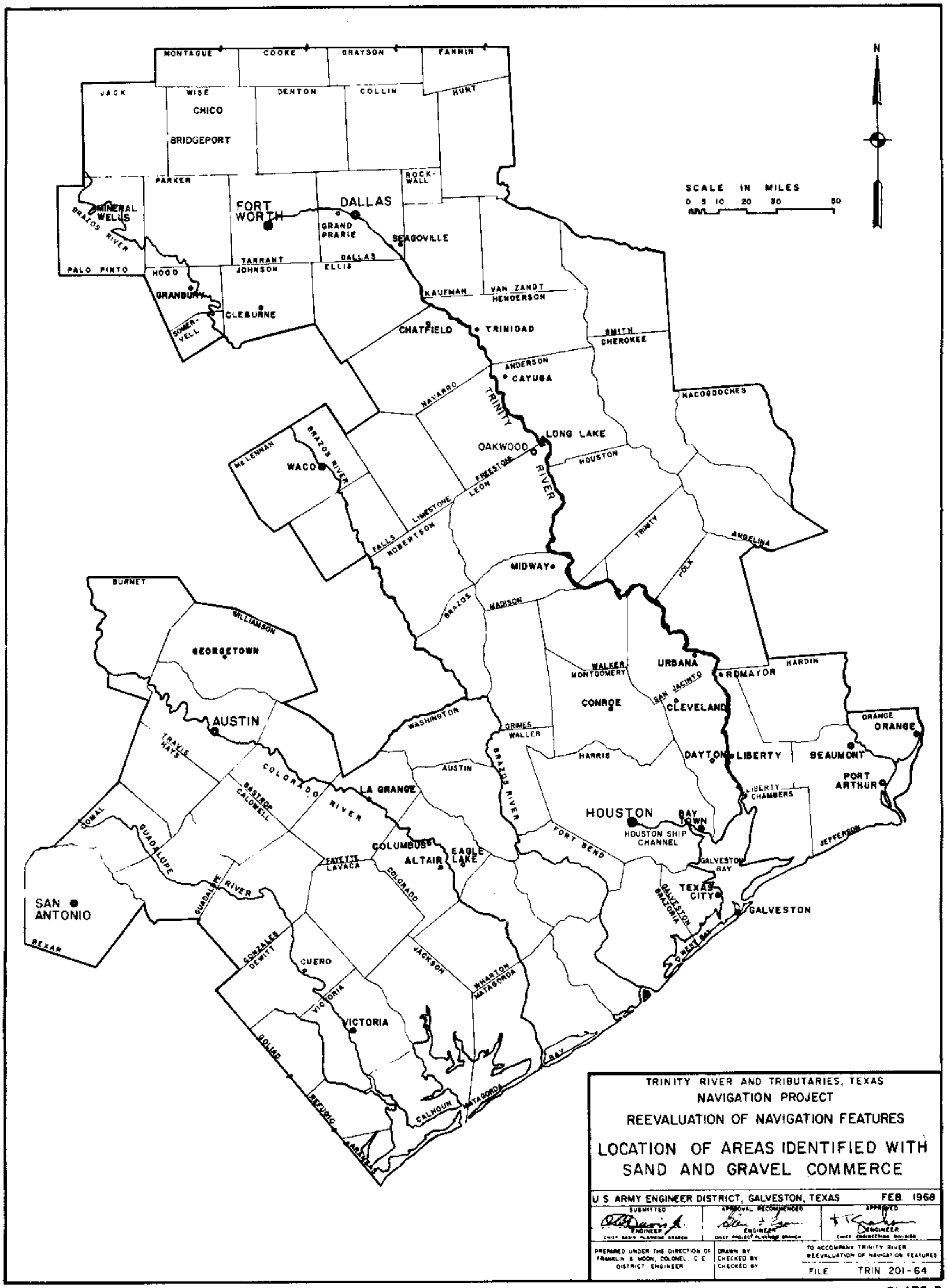
U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS FEB. 1968

PREPARED UNDER THE DIRECTION OF FRANKLIN B. MOON, COLONEL, C. E. DISTRICT ENGINEER

TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES

FILE TRIN 201-64

PLATE 2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NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
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CAYUGA
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LONG LAKE
OAKWOOD
WACO
BRAZOS RIVER
MIDWAY
GEORGETOWN
AUSTIN
COLORADO RIVER
LA GRANGE
URBANA
ROMAYOR
CONROE
CLEVELAND
DAYTON
LIBERTY
BEAUMONT
ORANGE
PORT ARTHUR
HOUSTON
BAY TOWN
HOUSTON SHIP CHANNEL
GALVESTON BAY
TEXAS CITY
GALVESTON
COLUMBUS
ALTAIR
EAGLE LAKE
SAN ANTONIO
GUADALUPE RIVER
CUERO
VICTORIA

PLATE 3

[First endorsement]

SWDPL-E
SUBJECT: Trinity River, Texas, Comprehensive Improvement Project - Re-evaluation of Navigation Economics

DA, Southwestern Division, Corps of Engineers, 1114 Commerce Street, Dallas, Texas 75202 14 June 1968

TO: Chief of Engineers

I concur in the conclusions of the District Engineer.

C. C. HAUG
Major General, USA
Division Engineer

CF:
Galveston District

97-086 O-68—4

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

APPENDIX I
ENGINEERING

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

TRINITY RIVER AND TRIBUTARIES, TEXAS
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APPENDIX I

ENGINEERING

1. Introduction.- This appendix was prepared as a part of the current restudy of the Trinity River and Tributaries project. The 1965 Rivers and Harbors Act specified that at such time as funds are requested for the initiation of construction of features exclusively for navigation, the Chief of Engineers will submit an economic analysis of these features based on current criteria.

2. This appendix was prepared to bring up to date the estimates of costs for navigation features. The inclosed data do not constitute a comprehensive cost analysis of the project, but only an estimate of cost of features for navigation and related recreational potential.

3. Exclusive navigation features.- The following paragraphs are a review of pertinent legislative history and authorized scope of report, and a description of methods used in determining features of the project plan that are exclusively for navigation. The River and Harbor Act of 1965, P. L. 89-298, authorized construction of the Trinity River and Tributaries project. The project was authorized in accordance with the plan in H. D. 276/89/1, as recommended by the Board of Engineers for Rivers and Harbors. The Act specifies that "prior to expenditure of any funds for construction of those features designed exclusively for navigation, the Chief of Engineers shall submit to the Congress a reevaluation based upon current criteria." This wording in the authorizing act probably was referring to the wording contained in the recommendation of the BERH for the multiple-purpose

channel quoted as follows: "with the understanding that at such time as funds are requested for the initiation of construction of features exclusively for navigation, the Chief of Engineers will submit to the Congress an economic analysis of the features."

4. In the views of the BERH supporting the above recommendation, the Board included the following statement: "In view of the favorable benefit-cost ratio indicated above, the Board concludes that the navigation facilities should be authorized." The Board then goes on to state: "The Board notes that a project for flood control, water supply, and water quality control is economically justified without navigation. If construction of the navigation features of the plan is delayed for any reason and construction of the flood control channel is initiated first, it is the opinion of the Board that the flood-control channel should be constructed along the same alignment as that required for navigation."

5. It is believed that this statement indicates Board opinion to the effect that any Trinity River construction should either provide for or be compatible with later provisions for navigation. In accordance with this view, the Galveston and Fort Worth Districts are now requiring that any bridge constructed over the Trinity River provide navigation clearances. If separate construction of a flood control channel is undertaken, utility relocations would provide for future navigation channel requirements. A separate flood control channel constructed on the alignment shown in H. D. 276/89/1 would pass under all but 16 existing bridges. If construction of navigation features were delayed, the channel alignment at these 16 bridges

could be modified so as to pass under the existing bridges. Construction of the single-purpose flood control channel would require only minor modification of the existing bridges. High level bridges are therefore considered to be almost entirely for navigation. The costs for bridge relocations will take into account reduction in cost to be realized by advance participation. Cost for all high level bridge construction is included in this estimate.

6. The features exclusively for navigation are considered to be those features that are required to modify a single-purpose flood control channel to provide a multiple-purpose channel for flood control, navigation, recreation, and fish and wildlife enhancement. These features include the navigation locks and dams and appurtenances such as access roads, buildings, grounds, utilities and operating equipment; additional lands and rights-of-way; enlargement and rectification of the flood control channel to provide for navigation; aids to navigation; and enlargement of bridges to provide navigation clearances. The cost of "exclusively for navigation" features is the difference in cost of the multiple-purpose channel and a single purpose flood control channel on the best flood control alignment. The cost estimates of the single-purpose flood control channel from the project document studies have been reviewed and revised to present price levels. The design and cost estimates of the multiple-purpose channel have been reviewed and revised to provide for a 200-foot navigation channel, and other modifications for navigation and to reflect present price levels. Furthermore, provision is made to provide additional lock capacity when and as required to permit movement of the full amount of projected commerce to the 48th year of the project life.

7. Project document plan.- The authorized project provides for a multiple-purpose channel for navigation, flood control, recreation, and fish and wildlife purposes extending from the Houston Ship Channel along the general course of the Trinity River to Fort Worth, Texas. The channel would have minimum navigable dimensions of 12 feet deep and 150 feet wide and turning basins 400 feet square would be provided at Dallas and Fort Worth. The authorized plan provides for 19 locks below Dallas, each having clear dimensions of 84 feet wide by 600 feet long, and 4 locks between Dallas and Fort Worth, each 56 feet wide by 400 feet long. The plan provides for future enlargement to a minimum navigation channel width of 200 feet. A condensed plan and profile is shown on plate 1.

8. Proposed changes in project document plan.- An initial minimum channel width of 200 feet is proposed with provisions for enlargement to 250 feet when project capacity is reached. A study of lock sizes was made on the basis of new tonnage estimates. The results of this study indicated that locks below Dallas should remain the same and for the locks above Dallas lock 18 should be increased to 84' x 600' and locks 19, 20, & 21 should be increased to 84' x 400'. At such time as capacity of the waterway is reached, parallel locks and widening the channel to 250 feet will be constructed to increase capacity of the waterway. The additional locks would be 84' x 600' in size and would be located so that there would be no interference between tows using the adjacent lock.

9. Analysis of the project plan indicated that a more economical lock configuration was gained by removing locks 2, 8, & 15 and relocating locks 3, 7, and 9 at mile 57.0, 196.0, and 216.4, respectively. These changes would provide for 16 locks below Dallas and 4 locks between Dallas and Fort Worth as shown on plates 2 and 3.

10. The project document specified minimum bridge spans of 300 feet below Dallas and 274 feet between Fort Worth and Dallas and vertical clearance of 50 feet above the 2% flowline. New bridge criteria provides for a vertical clearance of 52 feet above the 2% flowline and a horizontal clearance of 300 feet between piers.

11. Engineering studies.- New bridge designs and cost estimates were made for all replacements and alterations of existing bridges and for proposed high level highway bridges and railroad bridges. Lock designs and cost estimates were made for three 84'x 400' and one 84' x 600' locks above Dallas. Costs in the project document, where applicable, were "updated" using current unit prices. Estimates were made of the additional cost of excavation required by elimination of locks 2, 8, and 15 and of the increase in lift at locks 3, 7, 9, and 16. Relocation estimates were revised to include facilities constructed subsequent to the date of the previous report. New designs and cost estimates were prepared for the 200-foot channel. This estimate includes provisions for future enlargement to 250 feet and construction of new locks when waterway capacity is reached. Channel dimensions for the authorized channel and proposed channel are shown on plates 4 thru 7. A new real estate appraisal was made.

12. Estimated cost of lands and damages.- The lands and damages costs assigned exclusively to navigation were determined by subtracting the lands and damages costs of the single-purpose flood control channel from the land costs of alternate multiple-purpose channel providing for flood control, navigation and public use areas. See tables 2A thru 2I.

13. Lands required for construction and maintenance of the navigable reach of the multiple-purpose channel include lands for channel rights-of-

way, lock and dam sites and public use areas. Public use area land requirements used in the previous study were adopted for the restudy.

14. General discussion.- The gross real estate appraisal was based on land requirements as shown in tables 3 and 4 on pages 8 and 12 of Vol. IV of H. D. No. 276, 89th Congress, 1st Session. Average land values were then applied to revised estimates of land requirements. The project lands extend from the Gulf Coast to North Central Texas. Lands involved are wooded bottom pasture, upland wooded pasture, bottom cropland, upland cropland and industrial areas in the vicinity of Dallas and Fort Worth. There are also numerous sand and gravel deposits, many of which are in production near the alignment. These deposits are mostly located in the upper reaches of the project. The soil type ranges from the heavy clays in the lower reaches to the light sand clay loams in the upper reaches. The right-of-way is located

almost entirely in the flood plain of the Trinity River and will not require relocations of improvements of significant value. Real estate sales indicate an upward trend in prices of approximately 10 percent per year along the Trinity River Valley.

15. Approach to land value.- The market data approach to value was used in arriving at the fair market value placed on the land covered by this report. The market data approach is the comparison of similar lands that have sold on the open market to those lands which would be taken by the proposed multiple-purpose channel. Changes in the alignment or widths can affect the values assigned. In many cases the area along the river is heavily timbered and subject to overflow. Moving the channel a short distance can avoid highly improved farm land or sand and gravel operations.

16. Estates to be acquired.- Real estate interests for right-of-way, spoil areas and access roads will be acquired on a perpetual easement basis with mineral exploration subordinated to the Government's rights to regulate such development in a manner that will not interfere with the project. A fee less mineral interest will be acquired in lock and dam sites and recreation areas with subordination of minerals rights to prohibit exploration.

17. Minerals.- There is a large amount of mineral activity in the Trinity River Valley. The oil and gas production is the greatest in the counties of Anderson, Madison, Houston, Navarro, and Liberty. Gravel mining is very active in Tarrant, Dallas, Ellis, and Kaufman Counties. The comparable sale data reflect the value of gravel in the above mentioned counties. For this appraisal the estimated value for the gravel was included in the estimated land values. It is the appraiser's opinion that there

should be an average of $15 per acre included in the report for the estate to be acquired in the oil and gas interest. The total estimated value for the subordination of minerals is $68,000.

18. Acquisition data.- The proposed acquisition of land covered by this project is estimated to affect 1,008 ownerships. The acquisition cost is estimated to be $1,000 per ownership. The cost of acquiring 1,008 ownerships at $1,000 is $1,008,000. The estimated cost of resettlement is $500 per set of improvements. It is estimated that 150 resettlements will be required in this project. Total estimated cost for resettlement is $75,000.

19. Severance damages.- In estimating the severance damage, consideration was given to location in relation to available access and size of part to be severed. The larger the severance parcel, the smaller the damages per acre. Additional consideration was given to the utilization of the severed acreage after the taking of the channel right-of-way easement.

20. Comparable sales discussion.- The comparable sales used to estimate the fair market value in this appraisal were indexed to counties; and the sales were applied along the reaches where the county adjoined the project. No attempt was made to discuss each individual sale in the appraisal; but all the sales were given consideration in arriving at the fair market value in reaches of the project where the sale occurred.

21. Criteria related to land requirements.- Channel rights-of-way were computed on the basis of providing right-of-way limits 50 feet beyond the top cut of the multiple-purpose channel. Where the multiple-purpose channel is partly or wholly within the river section, it was assumed that a minimum of 50 feet of right-of-way would be required on each side of the channel. Right-of-way requirements were based on side slopes of 1 on 2. An additional

50 feet of right-of-way would be provided outside of top of cut to take care of flatter slopes where needed and also provide for probable future erosion of the channel banks. The proposed channel alignment would cut off many bends of the river leaving areas of severed lands. These severed lands would be used as spoil areas and public use areas whenever practicable.

22. Rights-of-way for lock and dam sites include lands for the locks, dams, esplanades, buildings and service roads. Access roads would be provided from existing all weather roads to lock and dam sites. Land requirements for the access roads were based on providing rights-of-way 100 to 120 feet wide where required for new road construction. Where existing roads are to be improved, additional rights-of-way for the improved roads were based on the consideration that existing rights-of-way would be made available at no additional cost.

23. The lands required in addition to the lands for the authorized channel to Liberty as modified by the recommended Wallisville Reservoir project have been included in the single-purpose flood control channel estimate. Lands now under perpetual easement to the Federal Government for the completed portion of the 9- x 150-foot channel to Liberty project, from the Houston Ship Channel to its upstream ending at channel mile 23.2, are sufficient for the proposed deepening of the channel to 12 feet. From channel mile 23.2 to Lock No. 1 located in the Wallisville Dam at mile 28.3, approximately 18 acres of additional right-of-way would be required for easing of a bend in the river. An additional 34 acres of right-of-way would be required for the multiple-purpose channel river cut-off alginment at

Wallisville. Between mile 35.5 and 47.4, the land requirements of the authorized channel to Liberty were subtracted from land requirements of the alternate projects considered.

24. For the purpose of this report, it is considered that channel rights-of-way through the non-Federal Livingston Reservoir would be required for the channel. The extent of the required lands through the reservoir was determined on the same basis as other sections of the channel. The values of lands in the reservoir required for the channel were estimated as though a reservoir were not under construction by local interests.

25. None of the cost of lands of Tennessee Colony Reservoir are assigned as exclusively navigation costs.

26. Construction spoil area requirements vary with the method of construction. Studies show that hydraulic dredging would be the most economical and practical means of excavating the multiple-purpose channel in the tidal section and pools No. 1, 2, and 5. Hydraulic spoil area requirements were computed on the basis that hydraulic spoil can be economically placed to an average depth of 5 feet over the spoil area. This would amount to about 8,066 cubic yards per acre of spoil area. Some of the spoil near Liberty, Texas, would be used in construction of the Liberty Local Protection project.

27. The existing spoil disposal areas for the completed portion of the channel to Liberty would be used for deposition of spoil dredged in deepening the existing channel between the Houston Ship Channel and channel mile 23.2. No spoil would be placed on live oyster beds and 1,500-foot openings between spoil areas would be provided at intervals of 3,500 feet for the channel

reach between the Houston Ship Channel and Smith Point. Spoil dredged from the channel in Wallisville Reservoir would be deposited in adjacent areas in the reservoir. Spoil from the cut-off below the Wallisville dam and the river cut-off channel at the town of Wallisville would be deposited on 124 acres of spoil area adjoining the Wallisville Reservoir adjacent to the proposed cut-off channels.

28. Spoil dredged from the channel through the Livingston Reservoir would be deposited in the reservoir at separated areas located at a minimum distance of 1,500 feet from the channel. Land requirements for spoil disposal areas in the Livingston Reservoir were based on the assumption that 8,066 cubic yards of spoil can be placed on each acre of spoil area.

29. Excavation of the multiple-purpose channel in pools No. 3,4, and 6 thru 21 would be accomplished by land based dragline equipment. Below channel mile 268 the spoil would be cast onto spoil areas adjacent to the channel, with the exception that some of the spoil would be used to construct river diversion dams across the upstream end of river bends cut off by the proposed channel. Land requirements for dragline spoil areas were computed on the basis that the spoil would be deposited to an average depth of 15 feet in the spoil areas or approximately 24,200 cubic yards of spoil would be placed on each acre of spoil area.

30. Between channel miles 286 and 322, the channel is located within existing agricultural floodway levees. In this reach the spoil would be used to fill severed river bends and low lying areas, or placed inside and adjacent to the levees to a height of about 15 feet.

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31. Above channel mile 322, the channel would be located within existing and proposed leveed floodways. Spoil in this reach would be used for construction of new levees, filling low areas of the flood plain, or filling severed river bends in the floodway. No construction spoil areas would be required above channel mile 322.

32. A breakdown of land requirements and computation of land costs assigned exclusively to navigation for the three alternate plans is shown in tables 2A thru 2I.

33. Bridge relocations.- Estimates of cost were prepared for a single-purpose flood control channel and a multiple-purpose channel with horizontal bridge clearances of 300 feet between piers, and vertical clearances of 52 feet above 2% flowline. The 300-foot horizontal clearance and 52-foot vertical clearance conform to current requirements specified for other navigation projects under construction.

34. The estimate of bridge alteration costs for the single-purpose flood channel assumed the channel alginment would pass under existing bridges. The estimate is based on providing bank and pier protection without modification of the bridge structure. The cost assigned exclusively to navigation is the difference between costs of bridges providing minimum navigation clearances and the cost for modification of bridges for the single-purpose flood control channel.

35. Changes in highway bridge relocation estimates presented in table 12, Vol. IV, of the project document are as follows:

a. New 2-lane highway crossings for F.M. 162, and F.M. 3076 have been added.

b. Highway bridge crossings have been expanded from 2-lane, 2-way to 4-lane divided roadways for U. S. Highway 59, Belt Line Road, State Highway 360, and F. M. 157.

c. Two Interstate 635 Highway bridges, 4 lanes each, have been added.

d. State Highway 19, U. S. Highway 79 & 84, State Highway 31, and State Loop 12 are shown in the project document as 2-lane, 2-way roadways requiring one new bridge at or near each existing bridge. Existing conditions still consist of one crossing at each location; but future planning, according to the Texas Highway Department, provides for 4-lane divided roadways at these locations. The estimated first costs for these 4 additional crossings include only the navigation features. The existing crossings would have to be relocated as specified in the previous report.

e. Roadway widths have been increased in accordance with projected Bureau of Public Roads criteria. Data on Interstate, U. S., State, and F. M. highways were furnished by the Texas Highway Department.

36. Advance participation by the Corps of Engineers in the construction of five highway bridges over the multiple-purpose channel has been authorized. These crossings are:

State Hwy 105

U. S. Hwy 190

State Hwy 31

Interstate Hwy 635

Interstate Hwy 45

Estimated first costs for these bridges are the estimated amounts to be paid out of civil works funds for advance participation in navigation features. Estimated costs were taken from OCE Civil Works Daily Log, 11 Mar 66. A contract for alteration of U. S. Hwy 190 has been issued and this cost is included in the estimate.

37. Bridge relocation costs and costs assigned specifically to navigation are shown on tables 3A & 3B. Costs for bridges constructed under advance participation are treated as project costs and are included in the estimate.

38. Pipeline relocations.- The estimated costs of pipeline relocations required are based on providing the same number and size of pipes which the respective companies have installed. The cost of relocating pipelines in the vicinity of channel mile 30.6 in Wallisville Reservoir are assigned to the multiple-purpose project because these lines need not be relocated at the river crossing to provide for the authorized channel to Liberty project.

39. From channel mile 30.6 to channel mile 47.4, the multiple-purpose channel alignment generally coincides with the authorized alignment of the uncompleted channel to Liberty project. In this reach, pipelines would be

relocated to provide for either the multiple-purpose channel or the authorized channel to Liberty. Since the authorized channel to Liberty project provides for relocating the pipelines affected by the 9- x 150-foot channel, the cost of any additional length of pipeline relocation over that required for the 9- x 150-foot channel is assigned to the multiple-purpose channel. The cost of pipeline relocations upstream of Liberty are assigned to the multiple-purpose channel project. Alteration costs for the pipeline relocations in the Tennessee Colony Reservoir are included in the estimate of cost of Tennessee Colony Reservoir and are not a part of this estimate.

40. The estimated cost of pipeline relocations are based on the pipelines extending 25 feet beyond the bottom width of the channel at a depth of either 25 feet below normal pool, or five feet below the bottom of the multiple-purpose channel, whichever is deeper. The estimate of costs also provides for pipeline valves to be installed on each side of the channel, with manifold headers if required, and the pipelines would be coated or wrapped and secured with sufficient weights. The pipeline relocation cost assigned exclusively to navigation is determined by deleting the cost of relocation for the single-purpose flood control channel from the relocation cost for the particular plan under consideration. The revised cost estimate includes relocation of twenty pipelines constructed subsequent to the previous study. A summary of pipeline relocations costs is given in table 3C. A more detailed estimate of pipeline relocation costs is shown in table 12.

41. Power transmission line relocations.- Powerlines crossing the navigable portion of the channel would be raised to conform with minimum clearance requirements given in an information pamphlet entitled "Permits for Work in Navigable Waterways of the United States." In general, all transmission lines crossing the multiple-purpose channel, having voltages of 115 KV or less would have a minimum vertical clearance of 70 feet; and lines having voltages greater than 115 KV and not more than 138 KV would have minimum vertical clearances of 75 feet above the backwater elevation for the operating discharge at the crossing. Where the transmission lines cross the multiple-purpose channel in river cutoff alignments and extend across the Trinity River, the lines crossing the Trinity River would have a minimum clearance of 25 feet above the 50-year flood elevation at the severed river crossing. Alteration costs for the power transmission lines crossing the Tennessee Colony reservoir are contained in the estimate of cost for the Tennessee Colony Reservoir.

42. The cost for alteration of power transmission lines include the cost of constructing towers on each side of the channel and installing new cable between towers. Salvage value of old cable has been subtracted from the construction cost. Cost of powerline relocation is assumed to be the same for all plans. Minor differences in channel width should have a very negligible effect on spacing of towers. The restudy indicated that three additional power transmission lines have been constructed across the navigable reach of the river since the previous study. A summary of powerline relocation requirements is shown in table 3D.

43. Communication line relocations.- The authorized plan of improvement for the multiple-purpose channel provided for modification of 17 existing communication lines. The restudy has indicated that no new lines have been installed since the previous study. Thirteen of the existing aerial lines are on 35 to 40-foot poles and are to be raised by installing taller poles to provide a vertical clearance of 70 feet. Four of the communication lines are attached to existing bridges and would not have to be modified in connection with construction of the single-purpose flood control channel. These lines would be relocated as part of the high level bridges. Estimated costs for communication line relocations assigned to the navigation features of the project are shown on table 3E.

44. Water and sewer line relocations.- Modification of seven existing water lines and eight sewer lines would be required. Two new lines have been installed since the previous study. The cost of modifying the water and sewer lines is based on placing each line 25 feet below the normal navigation pool or 5 feet below the bottom of the channel, whichever is deeper, and extending the line 25 feet at this depth beyond the bottom edge of the channel. Table 3F gives data and estimated relocation costs for water and sewer lines.

45. Navigation dams.- New designs were made for dams No. 3, 7, 9, and 16. No changes were made in design of remaining navigation dams. Current unit prices were applied to the detailed quantity estimates

prepared in connection with the project document where applicable. A summary of navigation dam costs is shown in table 4. A detailed estimate of first costs for a typical navigation dam is shown in table 14.

46. Navigation locks.- Estimates for locks in H. D. 276 included cost for 84' x 600' locks with 400' guidewalls, and 56' x 400' locks with 300' guidewalls. The restudy estimates include 84' x 600' locks with 600' guidewalls upstream and 350' downstream, 84' x 400' locks with 400' guidewalls upstream and 250' downstream, except both upstream and downstream guidewalls on lock Nos. 5A, 5B, 10A and 10B will be 350'.

47.. Quantities for locks in H. D. 276 were used as a base for lock quantities in the restudy where applicable. The guidewall quantities for the 84' x 600' locks in H. D. 276 were increased to include the additional guidewall.

48. Excluding the guidewall quantities, quantities for the 84' x 600' locks from guidewall to guidewall were obtained by adding the quantities required in widening the locks from 56' to 84' to the quantities for the 56' x 400' in H. D. 276. To obtain quantities for the 84' x 600' lock at lock No. 18, applicable quantities involved in 200 feet of the lock chamber area were added to the 400' lock chamber and the 28 feet required in widening the lock quantities in H. D. 276.

49. The present unit costs for the lock restudy were determined at a conference in Little Rock District on 20 March 1967, between personnel of the Little Rock and Galveston Districts.

50. The portion of first cost of lock 10B assigned exclusively to navigation is the portion between the sixth lock chamber monolith and the upstream guidewall. The incremental cost of the lock was estimated by a ratio of applicable length to the total length times the total cost, plus ten percent to account for the larger size monolith in the upper portion. Table 5 is a summary of navigation lock cost. Tables 15, 16,and 17 are detailed estimates of selected typical locks. Table 15 is an estimate of a gravity wall lock, table 17 shows an estimate of a small lock above Dallas.

51. Access roads to locks and dams.- The access road alignments and designs used in the restudy were the same as those specified in the previous study, excluding access roads to lock Nos. 2, 8 and 15. Current unit costs were applied to the quantity estimates prepared in connection with the previous study. Table 6 contains pertinent data and summary cost information for access roads. Table 13 is a detailed estimate of first costs for access roads.

52. Channels and canals.- Channel design is based on a minimum channel width of 200 feet and a depth of 12 feet below normal pool. The cost item for the channels and canals includes clearing and grubbing the channel, clearing of spoil areas, channel excavation (including bend widening), removal of abandoned locks, construction of tributary inflow structures and channel stabilization works. The cost for exclusively navigation features was determined as the incremental cost incurred by adjusting the best flood control channel configuration and alignment to serve navigation requirements.

A summary of costs for channels and canals are shown in tables 7A thru 7F. Plates 4 thru 7 show channel dimensions by reaches for the authorized 150' channel and proposed 200' channel.

53. Recreation and fish and wildlife facilities.- No preliminary design of facilities was made in connection with this study. Costs of basic facilities were based on cost of facilities to accommodate estimated visitation. Costs of facilities per annual visitor were based on experience obtained from other projects in the area. Public use area land requirements are discussed under lands and damages.

54. Buildings, grounds, utilities, and permanent operating equipment.- No changes were made in the requirements for buildings, grounds, utilities, and permanent operating equipment. Current prices were applied to estimates in the project document. A revised estimate for buildings, grounds and utilities is shown in table 8. A revised estimate for permanent operating equipment is shown in table 9.

55. Aids to navigation.- A revised estimate of cost for aids to navigation furnished by the U. S. Coast Guard is shown in table 10.

56. Operation, maintenance and replacement.- A revised estimate of annual cost for operation, maintenance and replacement is shown in table 11.

57. <u>Waterway capacity</u>.- To determine the capacity of various lock sizes considered for this study, the following was assumed:

Lock size	84' x 400'	84' x 600'
Lockage time	50 minutes	55 minutes
Number of barges per tow	3-35' x 195'	5-35' x 195'
Barge loading, tons		
Sand & gravel	1,625	1,625
Grain	1,525	1,525
Iron & steel	750 to 950 (Avg. 850)	750 to 950 (Avg. 850)
Manufactured products	500 to 1700 (Avg. 1150)	500 to 1700 (Avg. 1150)
Farm products	500 to 1800 (Avg. 1445)	500 to 1800 (Avg. 1445)
Other commodities	700 to 1500 (Avg. 985)	700 to 1500 (Avg. 985)
Percentage empty barges		
Sand & gravel	100%	100%
All other commodities	38%	38%
Percentage pleasure craft	10%	10%

58. The maximum tonnage capacity of a lock is dependent on the number of lockages and the theoretical tonnage that can pass through the lock under ideal conditions. Because of unbalanced distribution of traffic along the waterway, delays, partially loaded and empty return barges, the maximum tonnage capacity of a lock is never attained for a sustained period of time.

59. An analysis of traffic distribution on the waterway indicated that under average conditions about 30 million tons annually could pass through the 84' x 600' locks with an average of 21 lockages a day. The lockages required in 2010, 2020, and 2035 are as follows:

ANNUAL LOCKAGES REQUIRED

Lock No.	Year 2010	Year 2020	Year 2035
1	6,316	8,742	14,392
3	6,056	8,482	14,132
4	6,056	8,482	14,132
5A	2,688	3,686	5,922
5B	2,688	3,686	5,922
6	2,721	3,724	5,971
7	2,720	3,724	5,971
9	2,720	3,724	5,971
10A	3,730	5,155	8,427
10B	3,730	5,155	8,427
11	3,730	5,155	8,427
12	6,706	9,354	15,667
13	6,706	9,354	15,667
14	6,639	9,298	15,595
16	6,639	9,298	15,595
17	6,639	9,298	15,595
18	5,712	7,971	13,405
19	2,629	3,573	5,713
20	2,629	3,573	5,713
21	2,372	3,212	5,102

60. Full capacity of the 84' x 600' locks would be reached as follows:

Lock No.	Project year	Year
1	31	2016
3	32	2017
4	32	2017
5A	*	
5B	*	
6	*	
7	*	
9	*	
10A	47	2032
10B	47	2032
11	47	2032
12	29	2014
13	29	2014
14	29	2014
16	29	2014
17	29	2014
18	34	2019

* Full capacity would not be reached during project life.

61. The foregoing analysis indicates that in 2014 the project would reach full capacity operation of the locks and at that time additional capacity will have to be provided. The construction of additional locks and widening of the channel to 250 feet appear to be the most feasible methods of increasing the capacity of the waterway. On the basis of the projected development of commerce on the waterway, the first measures for increasing the waterway capacity would be construction of additional locks at lock Nos. 12 through 17 and widening the channel. Subsequently, the development of projected downbound commerce would reach capacity of the lower section of the waterway. Depending on the development of through commerce traffic to Dallas and Fort Worth, it eventually would be necessary to provide an additional lock at each of the other locks from lock Nos. 1 through 4 and lock Nos. 10A through 18. This additional capacity would handle the projected commerce of the waterway to the 48th year of the project or 2033.

62. Future construction.- It is considered that the economy of the basin would best be served by initial construction of 84' x 600' locks below Dallas and including lock No. 18. The projected commerce of lock Nos. 19 through 21 could be carried by 84' x 400' locks. Duplicate parallel locks 84' x 600' would be constructed at lock Nos. 1 through 4 and lock Nos. 10A through 18 in the future as required.

63. Engineering considerations of future construction.- The operation of additional locks will strain the water resources of the river that will be available for navigation. Provision is made for installation of pumps and appurtenances to pump water back up to the upper pools and permit reuse of water for lockages. The cost of these items are treated as future expenditures.

64. The design and siting of the parallel locks will be such that separate approach channels will permit full optimum use of both locks without influence by tows using the adjacent lock. Review of the locations of the locks indicates that this can be accomplished with small additional cost of channel dredging.

65. The estimated costs of future construction of locks and related work and channel widening are converted from the year in which the expenditure is incurred to the worth at the first year of the project to determine the initial investment. The interest and amortization of the investment are computed over a 50-year life to determine annual charges, based on an interest rate of $3\frac{1}{4}$ percent. The estimated increased cost of operation and maintenance of the future locks and channel widening are reduced to annual charges with the same method.

66. Future construction cost provides for widening the channel to 250 feet and installation of duplicate locks and water pumpback facilities to provide additional traffic handling capacity when required. The plan includes all necessary appurtenances including aids to navigation, operating equipment, buildings, contingencies, engineering and design, supervision and administration, and interest during construction. The estimated cost for the future construction investment is as follows:

Construction grouping	Future construction	Project year	Present Investment (1985)
Channel	$ 54,487,000	29	$ 21,552,000
Lock No. 1	4,535,000	31	1,683,000
Lock Nos. 3, 4	31,943,000	32	11,479,000
Lock Nos. 10A, 10B & 11	45,477,000	47	11,499,000
Lock Nos. 12,13,14,16, & 17	70,632,000	29	27,938,000
Lock No. 18	13,147,000	34	4,432,000
Total	$ 220,221,000		$ 78,583,000

67. A summary of the project cost as initially proposed is shown in table 1. A summary of total project cost including future construction is shown in table 1A.

TABLE 1
TRINITY RIVER AND TRIBUTARIES, TEXAS
SUMMARY OF ESTIMATED FIRST COST AND INVESTMENT FOR
PROJECT FEATURES REQUIRED EXCLUSIVELY FOR NAVIGATION
($1000)

Item	Cost
First cost	
01.0 Lands & damages	$ 4,103
02.0 Relocations	
Railroads	32,719
Highways	89,183
Pipelines	2,912
Power Trans. lines	1,141
Communications lines	967
Water & sewer lines	49
04.0 Navigation dams	46,039
05.0 Navigation locks	185,573
08.0 Access roads	5,667
09.0 Channels & canals	74,773
14.0 Recreation facilities	4,178
19.0 Buildings, grounds & utilities	2,905
20.0 Permanent operating equipment	1,337
Subtotal first cost	451,546
Contingencies 20%	90,309
Subtotal first cost	541,855
30.0 Engineering & design 4.5%	24,383
31.0 Supervision & administration 4.5%	24,383
U.S. Coast Guard	857
Total first cost	591,478
Interest during construction	82,117
Total investment	$ 673,595

TABLE 1A

TRINITY RIVER AND TRIBUTARIES, TEXAS

SUMMARY OF ESTIMATED FIRST COST INVESTMENT, FUTURE CONSTRUCTION COST INVESTMENT, AND ANNUAL CHARGES FOR PROJECT FEATURES EXCLUSIVELY FOR NAVIGATION

($1000)

Initial first cost investment	$	673,595
Investment of future construction cost		78,583
	$	752,178
Annual charges		
Interest & amort. 50 yr @ $3\frac{1}{4}$%		30,636
Operation, maint., & replacement		4,829
Total annual charges	$	35,465

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TABLE 2A
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES ACQUISITION COST

Pool No.	Flood control channel Cost	Multiple-Purpose Channel Cost	Exclusive navigation cost
1	$ 192	$ 207	15
3	124	130	6
4	101	108	7
5A	1	1	0
5B	1	1	0
6	33	36	3
7	51	55	4
9	29	30	1
10A	1	2	1
10B	-	-	-
11	-	5	5
12	26	30	4
13	14	15	1
14	29	33	4
16	25	30	5
17	69	75	6
18	52	65	13
19	13	15	2
20	54	65	11
21	68	85	17
Subtotal	$ 883	$ 988	$ 105

TABLE 2B
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
RIGHTS-OF-WAY FOR CHANNELS

Pool No.	Flood control channel		Multiple-Purpose Channel		Exclusive navigation
	Quantity (acres)	Cost	Quantity (acres)	Cost	Cost
Tidal			24	$ 14	$ 14
1	934	$ 391	713	287	-104
3	506	207	596	245	38
4	1,058	423	632	253	-170
5A	36	9	177	44	35
5B	793	198	1,151	288	90
6	1,943	291	1,062	159	-132
7	1,451	218	1,337	201	-17
9	319	40	573	72	32
10A	28	6	62	12	6
10B	-	-	-	-	-
11	-	-	-	-	-
12	427	53	529	66	13
13	359	36	452	45	9
14	404	40	496	50	10
16	135	41	238	71	30
17	267	80	624	187	107
18	291	291	304	304	13
19	308	308	308	308	-
20	267	320	267	320	-
21	166	208	176	220	12
Subtotal	9,692	$ 3,160	9,721	$ 3,146	*$ -14

* Negative cost indicates less R.O.W. required due to shorter length of the Multiple-purpose channel.

TABLE 2C
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
LOCK & DAM SITES

Pool No.	Flood control channel: Quantity (acres)	Flood control channel: Cost	Multiple-Purpose Channel: Quantity (acres)	Multiple-Purpose Channel: Cost	Exclusive Navigation: Cost
					$
Tidal	None	None	-	$ -	-
1	-	-	-	-	-
3	-	-	48	14	14
4	-	-	50	15	15
5A	-	-	30	8	8
5B	-	-	30	8	8
6	-	-	43	6	6
7	-	-	58	8	8
9	-	-	40	5	5
10A	-	-	30	6	6
10B	-	-	-	-	-
11	-	-	-	-	-
12	-	-	49	6	6
13	-	-	48	5	5
14	-	-	45	5	5
16	-	-	44	13	13
17	-	-	51	15	15
18	-	-	38	38	38
19	-	-	37	45	45
20	-	-	42	50	50
21	-	-	41	51	51
Subtotal				$ 298	$ 298

TABLE 2D
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
ACCESS ROADS R.O.W.

Pool No.	Flood control channel Cost	Multiple-Purpose Chan: Quantity (acres)	Multiple-Purpose Chan: Cost	Exclusive navigation cost
Tidal	None	-	$ -	$ -
1	-	-	-	-
3	-	83	25	25
4	-	15	5	5
5A	-	21	6	6
5B	-	-	-	-
6	-	67	10	10
7	-	79	12	12
9	-	72	9	9
10A	-	122	25	25
10B	-	-	-	-
11	-	44	6	6
12	-	61	8	8
13	-	23	4	4
14	-	2	0	0
16	-	24	22	22
17	-	6	5	5
18	-	2	2	2
19	-	7	9	9
20	-	22	27	27
21	-	2	3	3
Subtotal		652	$ 178	$178

TABLE 2E

ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR($1000)

LANDS & DAMAGES

CONSTRUCTION SPOIL

Pool No.	Flood control channel Quantity (acres)	Flood control channel Cost	Multiple-Purpose Channel Quantity (acres)	Multiple-Purpose Channel Cost	Exclusive navigation Cost
Tidal	-	-	461	$ 69	$ 69
1	1,508	$ 162	3,234	445	283
3	193	39	838	168	129
4	338	51	766	115	64
5A	-	-	-	-	-
5B	-	-	4,402	220	220
6	268	20	2,425	182	162
7	-	-	1,677	126	126
9	-	-	1,109	83	83
10A	-	-	-	-	-
10B	-	-	-	-	-
11	75	6	-	-	-6
12	5	0	648	49	49
13	332	17	510	26	9
14	157	8	793	39	31
16	133	20	302	45	25
17	72	11	-	-	-11
18	0	0	-	-	-
19	0	0	-	-	-
20	0	0	-	-	-
21	0	0	-	-	-
Subtotal	3,081	$ 334	17,165	$ 1,567	$ 1,233

TABLE 2F
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
MAINTENANCE SPOIL

Pool No.	Flood control Channel		Multiple-Purpose Channel		Exclusive navigation cost
	Quantity (acres)	Cost	Quantity (acres)	Cost	
Tidal	-	-	-	-	-
1	-	-	-	-	-
3	50	$ 10	459	$ 92	$ 82
4	75	11	666	100	89
5A	-	-	83	8	8
5B	-	-	-	-	-
6	125	9	1,136	85	76
7	-	-	1,057	79	79
9	-	-	472	35	35
10A	-	-	43	4	4
10B	-	-	-	-	-
11	25	2	-	-	-2
12	150	11	352	26	15
13	150	8	349	17	9
14	100	5	411	21	16
16	75	11	206	31	20
17	150	23	414	62	39
18	-	-	334	167	167
19	-	-	261	131	131
20	-	-	238	143	143
21	-	-	138	86	86
Subtotal	900	$90	6,619	$1,087	$ 997

TABLE 2G
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR ($1000)
LANDS & DAMAGES
SEVERANCE DAMAGES

Pool No.	Flood control channel		Multiple-Purpose Channel		Exclusive navigation Cost
	Quantity (acres)	Cost	Quantity (acres)	Cost	
Tidal	-	-	-	-	-
1	1,587	$ 81	1,020	$ 71	$ -10
3	615	31	1,410	71	40
4	0	0	1,014	26	26
5A	0	0	-	-	-
5B	388	10	-	-	-10
6	337	8	79	2	- 6
7	1,609	40	3,263	82	42
9	2,145	56	1,252	32	-24
10A	38	1	-	0	-1
10B	0	0	-	0	0
11	63	2	-	0	-2
12	581	16	142	4	-12
13	136	4	66	2	-2
14	335	9	743	19	10
16	75	4	107	6	2
17	290	15	845	43	28
18	73	18	73	18	0
19	192	50	192	50	0
20	71	21	71	21	0
21	23	7	21	7	0
Subtotal	8,558	$ 373	10,308	$ 454	$ 81

TABLE 2H
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
IMPROVEMENTS, MINERALS & RESETTLEMENT

Pool No.	Flood control channel Cost	Multiple-Purpose Channel Cost	Exclusive navigation Cost
Tidal	$ 0	$ 0	$ 0
1	97	103	6
3	31	33	2
4	160	170	10
5A	1	1	0
5B	15	16	1
6	12	13	1
7	33	35	2
9	10	11	1
10A	1	1	0
10B	0	0	0
11	1	1	0
12	6	6	0
13	5	5	0
14	7	7	0
16	3	3	0
17	6	6	0
18	3	3	0
19	3	3	0
20	67	71	4
21	37	39	2
Subtotal	$ 498	$ 527	$ 29

TABLE 2"I"
ESTIMATED COST OF LANDS FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)
LANDS & DAMAGES
PUBLIC-USE AREA COSTS

Channel miles	Item	Flood control channel Cost	Multiple-Purpose Channel Quantity (acres)	Multiple-Purpose Channel Cost	Exclusive navigation cost
0.0 to 35.5	Public use area	None	175	$80.5	$80.5
0.0 to 35.5	Access road	-	30	13.8	13.8
35.5 to 47.4	Public use area	-	125	57.5	57.5
47.4 to 233.5	Public use area	-	1,075	494.5	494.5
47.4 to 233.5	Access road	-	84	38.6	38.6
233.5 to 274.4	Public use area	-	175	80.5	80.5
233.5 to 274.4	Access road	-	12	5.5	5.5
274.4 to 322.0	Public use area	-	475	218.5	218.5
274.4 to 322.0	Access road	-	84	38.7	38.7
322.0 to 326.7	Public use area	-	0	0	0
322.0 to 326.7	Access road	-	-	0	0
326.7 to 331.1	Public use area	-	0	0	0
326.7 to 331.1	Access road	-	0	0	0
331.1 to 338.8	Public use area	-	125	57.5	57.5
331.1 to 338.8	Access road	-	10	4.6	4.6
338.8 to 362.8	Public use areas	-	200	92.0	92.0
338.8 to 362.8	Access road	-	30	13.8	13.8
362.8 to 369.8	Public use areas	-	0	0	0
362.8 to 369.8	Access road	-	0	0	0
Total				$1,196.0	$1,196.0

TABLE 3A
ESTIMATED COST OF RAILROAD BRIDGE RELOCATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND
NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Name of Railroad	Channel Mile	Flood control channel	Multiple-Purpose Chan. Costs	Exclusive navigation costs
Texas & New Orleans (SP	47.94	$ 3	$ 2,486	$ 2,483
Missouri Pacific	52.57	7	2,480	2,473
Gulf, Colorado & Santa Fe	77.28	71	2,478	2,407
Texas & New Orleans (SP)	91.93	0	2,492	2,492
Missouri Pacific	136.08	0	2,468	2,468
Missouri Pacific	219.70	26	2,446	2,420
St. Louis Southwestern Texas	264.14	0	2,288	2,288
Texas & New Orleans (SP)	328.30	94	2,620	2,526
Missouri-Kansas-Texas (MKT)	330.28	12	2,760	2,748
Gulf, Colorado & Santa Fe (AT & SF)	331.09	36	2,596	2,560
Texas and Pacific (TP)	333.66	11	2,849	2,838
Gifford Hill Gravel Co.	341.86	70	2,572	2,502
Chicago, Rock Island & Pacific	350.54	89	2,603	2,514
Subtotal		$ 419	$ 33,138	$ 32,719

TABLE 3B
ESTIMATED COST OF HIGHWAY BRIDGE RELOCATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND
NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Name of bridge	Channel Mile	Flood control channel Cost	Multiple-Purpose Channel Cost	Exclusive navigation Cost
Interstate Hwy 10	30.36	$ -	$ 3,528	$ 3,528
U.S. Hwy 90	47.84	11	3,913	3,902
F.M. Rd No. 162		16	1,491	1,475
State Hwy No. 105	75.78	8	1,150	1,142
U.S. Hwy No. 59	91.86	-	3,350	3,350
County Road	98.90	-	1,159	1,159
U.S. Hwy No. 190	111.54	2,214	2,750	536
State Hwy No. 19	136.15	-	3,159	3,159
F.M. Rd. No. 3076		35	932	897
State Hwy No. 21	171.63	10	1,496	1,486
State Hwy No. 7	196.68	-	1,411	1,411
U.S. Hwy 79 & 84	220.55	69	3,385	3,316
U.S. Hwy No. 287	249.99	35	6,073	6,038
State Hwy No. 31	264.52	35	2,520	2,485
State Hwy No. 1129	285.60	35	1,391	1,356
State Hwy No. 34	298.04	12	1,431	1,419
Malloy County Road	312.84	36	1,165	1,129
Belt Line Road	315.57	31	1,137	1,106
Dowdy Ferry	319.92	10	1,098	1,088
Interstate Hwy Loop 635	322.0	35	4,645	4,610
State Hwy Loop 12	326.19	44	3,746	3,702
Interstate No. 45	328.46	97	3,960	3,863
Forest Avenue	330.65	15	1,539	1,524
Corinth St.	331.41	36	1,618	1,582
Interstate Hwy 35E	332.22	90	3,936	3,846
Houston St.	332.61	34	1,605	1,571
Dallas Ft.Worth Turnpike	333.12	15	2,889	2,874
Commerce St.	333.50	31	2,172	2,141
Continental St.	333.93	24	1,498	1,474
Sylvan Avenue	334.89	17	1,181	1,164
Hampton Road	336.33	25	1,675	1,650
Westmoreland Road	337.26	14	1,280	1,266
State Hwy Loop 12	340.39	58	2,809	2,751
Meyers Road	342.94	68	1,180	1,112
Belt Line Road	345.25	130	2,210	2,080
State Hwy No. 360	350.75	54	2,792	2,738
F.M. Road No. 157	354.00	176	3,180	3,004
Arlington-Bedford Road	357.00	110	1,384	1,274
Arlington-Smithfield Rd.	359.95	110	1,292	1,182
U.S.Hwy Loop 820	362.11	22	2,860	2,838
Handley-Ederville Rd.	362.70	106	1,061	955
Total		$3,868	$93,051	$89,183

TABLE 3C
ESTIMATED COST OF PIPELINE RELOCATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL
AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Name of owner	Channel Mile	No. & size of pipe	Flood control channel: Pipe-line (LF)	Cost: Misc.	Cost: Pipe-line	Cost: Valves	Cost: Total	Multiple Purpose Channel Cost *	Exclusive navigation cost
Sinclair P.L.Co.	29.6	1-8"						$ 18	$18
Humble P.L. Co.	30.6	1-8"						12	12
Union Carbide Corp.	30.6	1-6"						15	15
Texas Eastern	30.6	2-30"						154	154
Texas Eastern	30.6	1-16"						37	37
Texas Eastern	30.6	2-20"						93	93
Service P.L. Co.	30.6	1-8"						18	18
Humble P.L. Co.	30.6	1-30"						79	79
Humble P.L. Co.	30.6	1-3"						9	9
Humble P.L. Co.	30.6	1-8"						13	13
Humble P.L. Co.	30.6	1-10"						20	20
United Gas P.L. Co.	30.6	1-20"						46	46
Tennessee Gas P.L. Co.	30.6	1-6"						9	9
Tennessee Gas P.L. Co.	30.6	1-30"						78	78
Warren Pet. Co.	30.6	1-8"						16	16
Gulf Oil Corp	30.6	1-8"						17	17
Gulf Refining Co.	30.9	1-10"						28	28
Colonial P.L. Co.	34.8	1-36"	634	27	57	33	117	103	-14
Sinclair P.L. Co.	34.8	1-12"	-	-	-	-	-	-	-
Texas P. L. Co.	34.8	1-20"	-	-	-	-	-	-	-
Trans Southern P.L.Co.	35.0	2-10"	-	-	-	-	-	-	-
Magnolia P.L. Co.	41.0	1-14"	150	3	5	-	8	9	1
Magnolia P.L. Co.	41.0	1-12"	150	3	4	-	7	8	1
Magnolia P.L. Co.	41.0	5-8"	750	4	13	-	17	22	5
Blacklake P.L. Co.	41.1	1-8"	150	5	3	-	8	7	-1
Sun P.L. Co.	42.1	1-6"	150	4	2	-	6	6	-
Cities Service	42.9	1-12"	150	4	4	-	8	8	-
Gulf Oil Corp.	44.5	2-8"	200	3	4	-	7	7	-
Humble P.L. Co.	44.6	1-7"	100	3	2	-	5	4	-1
Gulf Oil Corp.	45.9	1-4"	100	3	1	-	4	4	-
United Gas P.L. Co.	45.7	1-6"	100	3	1	-	4	4	-
United Gas P.L. Co.	45.7	1-10"	100	3	2	-	5	6	1
Gulf Oil Corp.	45.7	1-6"	-	-	-	-	-	4	4
Industrial Gas Sup.Co.	46.4	1-10"	100	4	2	-	6	7	1
Gulf Oil Corp.	47.4	1-6"	-	-	-	-	-	4	4
Humble Oil Co.	47.4	1-8"	100	3	2	-	5	6	1
United Gas P.L.Co.	47.8	1-8"	584	10	16	3	29	33	4
Sun P.L. Co.	49.3	1-8"	802	14	14	3	31	27	-4
Sun P.L. Co.	49.1	1-6"	804	13	10	1	24	22	-2

TABLE 3C (CONT'D)

Name of owner	Channel Mile	No. & size of pipe	Flood control channel: Pipe-line (LF)	Cost: Misc.	Cost: Pipe-line	Cost: Valves	Cost: Total	Multiple Purpose Channel Cost *	Exclusive navigation cost
Sinclair P.L.Co.	49.1	1-12"	802	17	23	5	$ 45	$ 36	$ -9
Nat.Gas P.L. Co. of Am.	50.7	1-30"	54	21	58	27	106	120	14
Magnolia P.L. Co.	51.9	2-8"	1200	10	20	5	35	36	1
Trans. Cont. Gas P.L.Co.	52.4	2-24"	88	20	75	28	123	133	10
Trans. Cont. Gas P.L.Co.	52.4	1-30"	604	12	47	27	86	93	7
Magnolia P.L. Co.	55.2	1-10"	548	7	13	4	24	30	6
Magnolia P.L. Co.	55.2	1-8"	48	1	9	3	13	25	12
Houston P.L. Co.	59.6	1-18"	-	-	-	-	-	143	143
Houston P.L. Co.	59.6	1-12"	548	8	16	5	29	37	8
Atlantic P.L. Co.	64.6	2-10"	1128	10	26	8	44	50	6
Trunkline Gas Sup. Co.	65.9	2-24"	932	21	64	28	113	137	24
Gulf Oil Corp.	77.9	1-10"	510	7	12	4	23	30	7
Tennessee Gas P.L. Co.	85.0	1-12"	-	-	-	-	-	47	47
Tennessee Gas P.L. Co.	85.0	1-6"	-	-	-	-	-	27	27
Tennessee Gas P.L. Co.	86.3	1-30"	-	-	-	-	-	116	116
Tennessee Gas P.L. Co.	86.3	1-26"	-	-	-	-	-	97	97
Tennessee Gas P.L. Co.	86.3	1-24"	-	-	-	-	-	152	152
Nat. Gas P.L. Co.	90.2	2-24"	-	-	-	-	-	156	156
Nat. Gas P.L. Co. of Am.	90.2	1-30"	-	-	-	-	-	129	129
United Gas P.L. Co.	91.8	5-8"	-	-	-	-	-	102	102
United Gas P.L. Co.	91.8	3-20"	-	-	-	-	-	178	178
Service P. L. Co.	93.0	1-12"	-	-	-	-	-	42	42
Shell P. L. Co.	93.0	2-10"	-	-	-	-	-	48	48
Shell P. L. Co.	93.0	1-6"	-	-	-	-	-	23	23
Texas Eastern	116.7	1-24"	-	-	-	-	-	110	110
Texas Eastern	116.7	1-16"	-	-	-	-	-	54	54
American Liberty	125.4	1-8"	-	-	-	-	-	27	27
United Gas P.L. Co.	135.7	2-6"	-	-	-	-	-	75	75
Morgas Pipe Line	153.9	1-8"	-	-	-	-	-	46	46
Morgas Pipe Line	153.9	1-12"	-	-	-	-	-	58	58
Pure Trans. Co.	168.2	1-6"	503	16	6	1	23	25	2
Lone Star Gas Co.	171.0	1-12"	505	18	15	5	38	44	6
Gulf Oil Corp.	190.6	1-26"	585	15	41	15	71	142	71
Lone Star Gas Co.	205.9	2-6"	-	-	-	-	-	37	37
Humble P.L. Co.	205.9	1-4"	-	-	-	-	-	26	26
Humble P.L. Co.	207.8	1-4"	-	-	-	-	-	25	25
Humble Oil & Refining Co.	207.9	1-4"	-	-	-	-	-	16	16
Humble Oil & Refining Co.	207.9	1-2½"	-	-	-	-	-	14	14
Magnolia P. L. Co.	209.8	2-20"	-	-	-	-	-	121	121

TABLE 3C (CONT'D)

Name of owner	Channel Mile	No. & size of pipe	Flood control channel: Pipe-line (LF)	Flood control channel: Cost: Misc.	Flood control channel: Cost: Pipe-line	Flood control channel: Cost: Valves	Flood control channel: Cost: Total	Multiple Purpose Channel cost *	Exclusive navigation cost
Sinclair P.L. Co.	219.0	1-4"	762	14	7	1	$ 22	$ 22	$ -
Lone Star Gas Co.	220.8	1-12"	510	12	15	5	32	30	-2
Gulf Oil Corp.	221.4	1-10"	548	15	13	4	32	32	-
Gulf Oil Corp.	221.4	2-10"	1,096	4	25	8	37	61	24
Humble P.L. Co.	230.5	1-10"	478	8	11	4	23	36	13
Humble P.L. Co.	230.5	2-8"	944	3	16	5	24	45	21
Sinclair P.L. Co.	231.5	2-12"	988	14	29	10	53	65	12
Humble P.L. Co.	276.2	1-4"	498	8	5	1	14	14	0
Magnolia P. L. Co.	277.0	1-20"	498	12	22	17	51	58	7
United Gas P. L. Co.	322.8	1-18"	576	10	18	13	41	49	8
Lone Star Gas Co.	323.7	1-24"	490	12	30	14	56	69	13
United Gas P. L. Co.	324.6	1-20"	448	9	20	17	46	61	15
Lone Star Gas Co.	328.1	3-12"	1,320	11	38	16	65	62	-3
Lone Star Gas Co.	330.7	1-6"	420	4	5	1	10	26	16
Lone Star Gas Co.	332.7	1-16"	438	7	16	11	34	45	11
United Gas P.L. Co.	331.1	1-12"	434	6	13	5	24	31	7
Texas P.L. Co.	337.8	1-6"	440	5	5	1	11	17	6
Lone Star Gas Co.	339.0	1-6"	448	5	5	1	11	22	11
Lone Star Gas Co.	340.0	1-20"	442	11	19	17	47	69	22
Humble P.L. Co.	340.1	1-8"	440	8	8	3	19	32	13
Texas P.L. Co.	341.8	1-8"	477	6	8	3	17	20	3
Lone Star Gas Co.	353.3	1-10"	954	12	22	4	38	29	-9
Sinclair P.L. Co.	354.5	1-10"	555	7	13	4	24	30	6
Magnolia P.L. Co.	360.9	1-16"	483	9	18	11	38	51	13
United Gas P.L. Co.	362.0	1-16"	508	8	18	11	37	46	9
Total							$1,870	$4,782	$2,912

* See Table 12 for detail cost.

TABLE 3D
ESTIMATED COST OF POWERLINE RELOCATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL
AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Name of owner	Channel Mile	Voltage (K.V.)	Flood control channel Cost	Multiple-Purpose Chan Cost	Exclusive navigation cost
Gulf State Utilities	47.30	69	$	$ 29	$ 29
Gulf State Utilities	47.30	138		63	63
Gulf State Utilities	47.30	69		29	29
Gulf State Utilities	76.70	38.5		29	29
Sam Houston Electric Co.	77.27	12.5		26	26
Gulf State Utilities	91.91	34.5		22	22
Sam Houston Elec. Co.	114.50	12.5		42	42
Gulf State Utilities	127.72	138.0		51	51
Gulf State Utilities	136.05	69.0		46	46
Gulf State Utilities	137.28	33.0		45	45
Gulf State Utilities	167.71	13.2		42	42
Houston County Elec.Coop.	171.60	12.5		26	26
Texas Power & Light Co.	196.69	138.0		45	45
Texas Power & Light Co.	216.19	138.0	5	42	37
Texas Power & Light Co.	219.70	12.5		36	36
Texas Power & Light Co.	220.57	7.5		11	11
Texas Power & Light Co.	220.57	12.5		16	16
Texas Power & Light Co.	299.70	12.5		16	16
Texas Power & Light Co.	311.00	345.0	5	51	46
Texas Power & Light Co.	312.91	11.0		16	16
Texas Power & Light Co.	315.5	138.0		45	45
Texas Power & Light Co.	320.00	2.4		11	11
Texas Power & Light Co.	326.0	138.0	5	47	42
Texas Power & Light Co.	326.0	69.0	5	35	30
Dallas Power & Light Co.	326.7	60.0		15	15
Dallas Power & Light Co.	328.8	60.0		47	47
Dallas Power & Light Co.	331.1	60.0		10	10
Dallas Power & Light Co.	332.6	13.0		7	7
Dallas Power & Light Co.	333.5	13.0		7	7
Dallas Power & Light Co.	334.0	60.0		17	17
Dallas Power & Light Co.	339.0	60		16	16
Dallas Power & Light Co.	340.0	138	5	43	38
Texas Power & Light Co.	342.9	12.5		17	17
Texas Electric Serv. Co.	345.2	12.5	5	28	23
Texas Power & Light Co.	348.1	138		38	38
Texas Electric Serv. Co.	351.4	12.5	5	62	57
Texas Electric Serv. Co.	362.8	66	10	58	48
Subtotal			$ 45	1,186	1,141

TABLE 3E
ESTIMATED COST OF COMMUNICATION LINES RELOCATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND
NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Owner	Channel Mile	Type of Crossing	Flood control channel Cost	Multiple-Purpose Cost	Exclusive navigation cost
Gulf Oil Corp.	45.6	7 wire, aerial	$	$ 4	$ 4
SW Bell Telephone Co.	47.8	2 cables, aerial		10	10
SW Bell Telephone Co.	47.9	1 cable, aerial		18	18
Atlantic P.L. Co.	64.6	2 wires, aerial		6	6
SW Bell Telephone Co.	77.3	30 wires, aerial		10	10
SW Bell Telephone Co.	91.9	1 cable, aerial		8	8
SW Bell Telephone Co.	136.1	26 wires, aerial		9	9
SW Bell Telephone Co.	171.6	2 wires, aerial		6	6
SW Bell Telephone Co.	219.0	10 wires, aerial		8	8
SW Bell Telephone Co.	326.2	2 buried cables	49	65	16
SW Bell Telephone Co.	332.2	6 cables, aerial	0(1)	280	280
SW Bell Telephone Co.	332.6	9 cables, aerial	0(1)	147	147
SW Bell Telephone Co.	333.5	4 cables, aerial	0(1)	197	197
SW Bell Telephone Co.	338.5	3 cables, aerial	0(1)	223	223
SW Bell Telephone Co.	342.7	1 cable, aerial		12	12
SW Bell Telephone Co.	345.3	1 cable, aerial	17	17	0
SW Bell Telephone Co.	354.1	1 cable, buried		13	13
Total			$ 66	$1,033	$ 967

(1) Cables suspended from existing bridges.

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TABLE 3F
ESTIMATED COST OF WATER AND SEWER LINE MODIFICATIONS REQUIRED
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION
FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Name of owner	Channel Mile	No. & size of pipe	Flood control channel: Pipeline (LF)	Flood control channel Cost: Misc.	Pipeline	Valves	Total	Multiple Purpose Channel Cost	Exclusive navigation cost
Dallas City Water Works	322.85	1-72"	460	$ 12	$ 62	None	$ 74	$ 76	$ 2
"	324.27	1-24"	409	8	23		31	34	3
"	326.2	1-18"	390	7	18		25	32	7
"	328.92	1-24"	492	-	-		-	-	-
"	328.92	1-36"	442	-	-		-	-	-
"	328.92	1-84"	50	37	85		122	113	-9
"	329.9	2-36"	932	20	103		123	133	10
"	331.43	1-24"	390	15	25		40	48	8
"	332.05	1-60"	406	7	45		52	68	16
"	332.59	1-24"	388	7	25		32	29	-3
"	335.70	1-36"	446	10	38		48	50	2
"	337.23	1-48"	452	12	48		60	62	2
City of Grand Prairie	345.21	1-36"	528	12	45		57	62	5
*City of Fort Worth	356.1	1-60"	693	133	94		227	227	-
*City of Fort Worth	360.0	1-36"	478	12	38		50	56	6
Subtotal				$ 292	$649		$941	$990	$ 49

*Constructed after submission of Project Document

TABLE 4
ESTIMATED COST OF NAVIGATION DAMS
FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL
($1000)

Dam No.	Number & size of tainter gates(ft.)	Flood control channel cost	Multiple-purpose channel cost	Exclusive navigation costs
1	4-40x20(1)	None	-	-
3	6-40x30.5	-	$3,699	$ 3,699
4	6-40x36	-	3,513	3,513
5A	-	-	-	-
5B	-	-	-	-
6	5-40x44	-	3,669	3,669
7	5-40x44	-	3,328	3,328
9	6-40x46	-	3,825	3,825
10A	-	-	-	-
10B	-	-	-	-
11	Overflow spillway	-	2,355	2,355
12	5-40x28	-	2,354	2,354
13	6-40x32	-	3,293	3,293
14	5-40x26	-	2,410	2,410
16	5-40x27	-	2,611	2,611
17	5-40x30	-	2,519	2,519
18	5-40x34.5	-	2,740	2,740
19	6-40x24	-	3,237	3,237
20	6-40x28	-	3,272	3,272
21	6-40x31	-	3,214	3,214
Subtotal			$ 46,039	$ 46,039

(1) Cost included in Wallisville Reservoir project.

TABLE 5
ESTIMATED COST OF NAVIGATION LOCKS FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR($1000)

Lock No.	Flood control channel Cost	Multiple-Purpose channel cost	Exclusive navigation cost
1	None	None	None
3	-	$ 10,753	$ 10,753
4	-	11,498	11,498
5A	-	10,407	10,407
5B	-	12,130	12,130
6	-	9,971	9,971
7	-	11,052	11,052
9	-	11,366	11,366
10A	-	10,243	10,243
10B	-	*4,553	4,553
11	-	10,167	10,167
12	-	8,793	8,793
13	-	10,684	10,684
14	-	10,174	10,174
16	-	10,333	10,333
17	-	9,165	9,165
18	-	9,110	9,110
19	-	7,844	7,844
20	-	8,578	8,578
21	-	8,752	8,752
Subtotal		$ 185,573	$ 185,573

* Costs shown is for downstream portion of lock, which would be constructed after dam is completed. Upstream portion of lock would be constructed integrally with dam.

TABLE 6
ESTIMATED COST OF ACCESS ROADS TO LOCKS & DAMS FOR
NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION
FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Pool No.	Flood control channel Cost	Multiple-Purpose Channel Cost *	Exclusive navigation cost
Tidal	None	None	None
1	-	-	-
3	-	$ 379	$ 379
4	-	152	152
5A	-	87	87
5B	-	20	20
6	-	556	556
7	-	635	635
9	-	924	924
10A	-	485	485
10B	-	-	-
11	-	186	186
12	-	431	431
13	-	834	834
14	-	18	18
16	-	109	109
17	-	27	27
18	-	135	135
19	-	33	33
20	-	647	647
21	-	9	9
Subtotal		$ 5,667	$ 5,667

* See table 13 detail costs.

TABLE 7A
ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH
OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)

CLEARING AND GRUBBING R.O.W.

Pool No.	Flood control Chan. Quantity (acres)	Flood control Chan. Cost	Multiple-Purpose Chan. Quantity (acres)	Multiple-Purpose Chan. Cost	Exclusive navigation Cost
Tidal	-	-	-	-	-
1	934	$ 360	599	$231	* $-129
3	506	111	536	118	7
4	1,258	208	460	76	-132
5A	36	6	58	10	4
5B	793	131	-	-	-131
6	1,943	152	860	67	-85
7	1,451	367	1,064	273	-94
9	319	75	439	103	28
10A	28	6	61	13	7
10B	-	0	1,120	431	431
11	-	0	418	92	92
12	427	94	487	107	13
13	359	79	516	114	35
14	404	88	543	119	31
16	135	30	253	56	26
17	267	59	590	130	71
18	20	6	71	8	2
19	216	24	220	24	0
20	232	38	232	38	0
21	80	13	80	13	0
Subtotal	9,408	$ 1,847	8,607	$ 2,023	$ 176

* Negative cost indicates less R.O.W. required due to shorter length of the multiple-purpose channel.

TABLE 7B
ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH
OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)

CLEARING OF SPOIL AREAS

Pool No.	Flood control Chan. Quantity (acres)	Flood control Chan. Cost	Multiple-Purpose Chan. Quantity (acres)	Multiple-Purpose Chan. Cost	Exclusive navigation Cost
Tidal	-	$ -	-	-	-
1	612	67			$-67
3	808	89	820	90	1
4	338	27	742	59	32
5A	-	-	-	-	-
5B	206	23	-	-	-23
6	605	67	2,389	263	196
7	1,004	140	1,453	192	52
9	766	84	1,102	121	37
10A	29	3	-	-	-3
10B	-	-	2,825	622	622
11	138	15	437	48	33
12	586	64	676	74	10
13	468	51	605	67	16
14	387	43	746	82	39
16	208	23	292	32	9
17	-	-	-	-	-
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
21	-	-	-	-	-
Subtotal	6,155	$696	12,087	$1,650	$ 954

TABLE 7C
ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH
OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR($1000)

COMMON EXCAVATION

Pool No.	Flood control channel Quantity (CY)	Flood control channel Cost	Multiple-Purpose channel Quantity (CY)	Multiple-Purpose channel Cost	Exclusive navigation Cost
Tidal			4,912,000	$ 1,375	$ 1,375
1	36,043,400	$ 10,702	33,492,400	9,867	-835
3	19,972,100	5,392	20,275,500	5,474	82
4	8,433,000	2,699	18,209,600	5,827	3,128
5A	-	-	460,500	147	147
5B	5,318,300	2,606	45,346,400	22,220	19,614
6	14,680,100	4,698	55,595,500	17,791	13,093
7	23,979,300	8,198	34,086,700	11,888	3,690
9	18,696,100	6,357	26,831,100	9,123	2,766
10A	948,900	323	233,500	79	-244
10B	-	-	22,787,600	6,608	6,608
11	3,339,600	1,069	10,586,800	3,388	2,319
12	13,632,200	5,044	15,683,700	5,803	759
13	11,914,000	3,813	15,238,200	4,876	1,063
14	10,476,100	3,352	19,171,900	6,135	2,783
16	5,297,100	1,960	7,319,000	2,708	748
17	9,008,500	3,333	13,093,700	4,845	1,512
18	7,926,200	2,933	10,048,200	3,718	785
19	7,780,000	2,879	7,917,200	2,929	50
20	8,474,600	3,136	8,474,600	3,136	-
21	4,898,400	1,812	5,527,100	2,045	233
Subtotal	210,817,900	$ 70,306	375,291,200	$129,982	$ 59,676

TABLE 7D

ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR ($1000)

ROCK EXCAVATION

Pool No.	Flood control channel Quantity (CY)	Flood control channel Cost	Multiple-Purpose Chan Quantity (Cy)	Multiple-Purpose Chan Cost	Exclusive navigation cost
6	810,900	$ 2,838	3,080,500	$10,782	$7,944
7	1,083,100	3,791	1,850,000	6,475	2,684
12	881,700	3,086	1,013,500	3,547	461
20	89,400	313	89,100	312	-1
21	378,100	1,323	426,900	1,494	171
Subtotal	3,243,200	$11,351	6,460,000	$22,610	$11,259

TABLE 7E
ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH OF
MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR ($1000)

RIVER DIVERSION DAMS

Pool No.	Flood control Chan. Quantity (Each)	Flood control Chan. Cost	Multiple-Purpose Quantity (Each)	Multiple-Purpose Chan. Cost	Exclusive navigation cost
Tidal	-	-	-	-	-
1	14	$ 361	16	$ 412	$ 51
3	5	129	8	206	77
4	3	77	7	181	104
5A	-	-	-	-	-
5B	4	103	4	103	-
6	10	258	11	284	26
7	9	232	10	258	26
9	2	52	4	103	51
10A	-	-	-	-	-
10B	3	77	-	-	-77
11	-	-	5	129	129
12	4	103	7	181	78
13	7	181	5	129	-52
14	13	335	4	103	*-232
16	3	77	-	-	-77
17	3	77	-	-	-77
18	-	-	-	-	-
19	-	-	-	-	-
20	-	-	-	-	-
21	-	-	-	-	-
Subtotal	80	$2,062	81	$2,089	$ 27

*Additional diversion dams required for single-purpose channel alignment crossing river alignment.

TABLE 7F

ESTIMATED COST OF CHANNEL WORK FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR ($1000)

BANK STABILIZATION, REMOVAL OF ABANDONED LOCKS & TRIBUTARY INFLOW DROP STRUCTURES

Channel Mile	Item	Flood control channel Cost	Multiple-Purp. channel Cost	Exclusive navigation cost
35.5 - 47.4	Bank stabilization	-	$ 387	$ 387
129.2	Removal of abandoned lock	-	24	24
47.4 - 233.5	Bank stabilization	-	2,222	2,222
47.4 - 233.5	Tributary inflow drop structures	$ 72	72	0
311.0	Removal of abandoned lock	-	24	24
325.0	Removal of abandoned lock	-	24	24
Subtotal		$ 72	$2,753	$ 2,681

TABLE 8
ESTIMATED COST OF BUILDINGS, GROUNDS, & UTILITIES
REQUIRED FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL
AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Channel Mile	No.Units Required	Flood control channel Cost	Multiple-Purpose Chan. Cost	Exclusive navigation cost
0.0 to 35.5	1	0	0	0
35.5 to 47.4	-	-	-	-
47.4 to 233.5	8	-	1,223	1,223
233.5 to 274.4	2	-	306	306
274.4 to 322.0	5	-	764	764
322.0 to 326.7	-	-	-	-
326.7 to 331.1	-	-	-	-
331.1 to 338.8	1	-	153	153
338.8 to 362.8	3	-	459	459
Subtotal			$ 2,905	$ 2,905

TABLE 9
ESTIMATED COST OF PERMANENT OPERATING EQUIPMENT
REQUIRED FOR NAVIGABLE REACH OF MULTIPLE-PURPOSE
CHANNEL AND NAVIGATION FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Channel Mile	Operation equipment for Lock No.	Heavy duty maintenance & equipment (sets)	Flood control channel Cost	Multiple-Purpose channel Cost	Exclusive navigation Cost
0.0 to 35.5	1(1)	None	None	$ 6	$ 6
35.5 to 47.4	1(1)	None	-	11	11
47.4 to 233.5	3,4,5A,6,7,& 9	2	-	598	598
233.5 to 274.4	10B & 11	½	-	146	146
274.4 to 322.0	12 thru 17	½	-	309	309
322.0 to 326.7	None	None		3	3
326.7 to 331.1	None	None	-	3	3
331.1 to 338.8	18	¼	-	64	64
338.8 to 362.8	19, 20, & 21	3/4	-	197	197
Subtotal				$1,337	$ 1,337

(1) Cost of operating equipment for Lock No. 1 is included in cost of Wallisville Reservoir project.

TABLE 10
ESTIMATED COST OF AIDS TO NAVIGATION REQUIRED FOR NAVIGABLE
REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES IN
TENNESSEE COLONY RESERVOIR
($1000)

Channel Mile	Current cost: Single pile daybeacons	Third class RR buoys	Light attendant station	Buoy boat 45-ft	Flood control channel Cost	Multiple-Purpose Channel cost	Exclusive navigation cost
0.0 to 35.5					-	-	-
35.5 to 47.4					-	-	-
47.4 to 233.5	142.50	10.0	150.00	150.00	-	$ 452.5	$ 452.5
233.5 to 274.4		17.0	150.00	150.00	-	317.0	317.0
274.4 to 322.0	47.00				-	47.0	47.0
322.0 to 326.7	4.50				-	4.5	4.5
326.7 to 331.1	4.50				-	4.5	4.5
331.1 to 338.8	7.50				-	7.5	7.5
338.8 to 362.8	24.00				-	24.0	24.0
Total - Mile 0.0 to 369.8						$857.0	$857.0

TABLE 11
ESTIMATED ANNUAL COST OF MAINTENANCE, OPERATION AND REPLACEMENT
FOR DESIGNATED REACHES OF MULTIPLE-PURPOSE CHANNEL
HOUSTON SHIP CHANNEL TO FORT WORTH, TEXAS

Item of annual cost	0.0 to 35.5 (1)	35.5 to 47.4 (2)	47.4 to 233.5 (3)	233.5 to 274.4 (4)	274.4 to 322.0 (5)	322.0 to 326.7 (6)	326.7 to 331.1 (7)	331.1 to 338.7 (8)	338.7 to 362.8 (9)	362.8 to 369.8 (10)	Total
Locks, dams and river observation system											
Operating personnel	-	-	$ 605,300	$151,100	$378,200	-	-	$ 75,500	$226,600	-	$ 1,436,700
Ordinary maintenance supplies	-	-	65,200	17,100	41,600	-	-	8,500	25,500	-	157,900
Major repair and painting	-	-	146,000	36,400	91,200	-	-	18,100	54,500	-	346,200
Major replacements:											
Dams	-	-	31,200	-	30,700	-	-	6,100	18,300	-	86,300
Locks	-	-	56,000	14,700	35,000	-	-	6,900	20,900	0	133,500
Permanent Operating equipment	-	-	37,200	9,400	23,200	-	-	4,700	14,100	-	88,600
Access Roads											
Maintenance	-	-	29,000	14,300	10,100	-	-	-	3,200	-	56,600
Major replacement	-	-	60,600	27,700	20,100	-	-	-	6,200	-	114,600
Railroad bridges											
Maintenance & operation	-	-	138,000	23,000	-	-	46,000	46,000	46,000	-	299,000
Major replacement	-	-	20,800	3,500	-	-	6,900	6,900	6,900	-	45,000
Channel dredging	-	32,400	625,500	252,900	243,500	31,200	36,000	38,600	167,200	-	1,427,300
Channel revetment	-	9,200	48,300	-	-	-	-	-	-	-	57,500
Aids to navigation	-										
Maintenance	-	-	42,500	42,500	-	-	-	-	-	-	85,000
Major replacement	-	-	12,900	3,000	3,300	300	300	500	1,700	-	22,000
Recreational facilities	29,000	8,000	103,000	-	70,000	-	-	11,000	30,000	-	251,000
Total	29,000	49,600	2,021,500	595,600	946,900	31,500	89,200	222,800	621,100		$ 4,607,200

(1) Houston Ship Channel to upper Reach of Wallisville Reservoir.
(2) Upper Reach of Wallisville Reservoir to head of authorized channel to Liberty.
(3) Head of authorized channel to Liberty to Tennessee Colony Reservoir dam.
(4) Tennessee Colony dam to Lock and Dam No. 12.
(5) Lock and Dam No. 12 to Five-mile Creek.
(6) Five-mile Creek to Dallas Terminus.
(7) Dallas Terminus to Dallas Floodway.
(8) Dallas Floodway.
(9) Dallas Floodway to Fort Worth terminus.
(10) Fort Worth terminus to and including Riverside Drive bridges.

TABLE 11
ESTIMATED ANNUAL COST OF MAINTENANCE,
OPERATION & REPLACEMENT

Table 12
Estimated Cost of Pipeline Relocations Required for Navigable Reach of Multiple-Purpose Channel and Navigation Features in Tennessee Colony Reservoir (200' Bottom Width at 12' Depth)

Name of owner	Channel Mile	No. of pipe, size and commodity	Pipe (L.F.)	Unit cost ($)	Pipe cost ($1000)	Excavation (Yds.)	Unit cost ($)	Cost ($1000)	Wt. & coat misc.**	Cost ($1000)	No. of valves	Unit cost ($1000)	Valves cost ($1000)	Total cost ($1000)
Sinclair Pipeline Co.	29.6	1-8"	574	17	9.7	6,493	.70	4.5	574	1.5	2	1.3	2.6	18.3
Humble Pipeline Co.	30.6	1-8"	390	17	6.6	2,627	.70	1.8	390	1.2	2	1.3	2.6	12.3
Union Carbide Corp.	30.6	1-6"	626	12	7.5	8,499	.70	5.9	626	1.1	2	.4	.9	15.4
Texas Eastern	30.6	2-30"Gas	900	77	69.3	14,530	.70	10.1	900	21.5	4	13.3	53.1	154.1
Texas Eastern	30.6	1-16"Prod.	475	37	17.5	6,165	.70	4.3	475	3.8	2	5.4	10.8	36.5
Texas Eastern	30.6	2-20"Gas	900	44	39.6	12,082	.70	8.4	900	10.6	4	8.6	34.3	93.0
Service P. L. Co.	30.6	1-8"Prod.	475	17	8.0	8,498	.70	5.9	475	1.3	2	1.3	2.6	18.0
Humble P. L. Co.	30.6	1-30"Gas	475	77	36.5	6,938	.70	4.8	475	11.0	2	13.3	26.5	79.0
Humble P. L. Co.	30.6	1-3"Gas	475	6	2.8	7,907	.70	5.5	475	.2	2	.2	.4	9.0
Humble P. L. Co.	30.6	1-8"Gas	455	17	7.7	2,423	.70	1.7	455	1.3	2	1.3	2.6	13.4
Humble P. L. Co.	30.6	1-10"Gas	525	23	12.0	2,939	.70	2.0	525	1.9	2	1.9	3.8	19.9
United Gas P. L. Co.	30.6	1-20"Gas	455	44	20.0	4,841	.70	3.4	455	5.3	2	8.6	17.1	45.9
Tennessee Gas P. L. Co.	30.6	1-6"Prod.	475	12	57.0	0	.70	-	475	2.4	2	.4	.9	8.9
Tennessee Gas P. L. Co.	30.6	1-30"Gas	475	77	36.6	6,100	.70	4.3	475	11.0	2	13.3	26.5	78.4
Warren Pet. Co.	30.6	1-8"Eth.	475	17	8.1	5,224	.70	3.6	475	1.4	2	1.3	2.6	15.7
Gulf Oil Corp.	30.6	1-8"Eth.	455	17	7.7	7,246	.70	5.0	455	1.3	2	1.3	2.6	16.7
Gulf Refining Co.	30.9	1-10"	654	23	15.0	9,956	.70	6.9	654	2.2	2	1.9	3.8	28.1
Colonial P. L. Co.	34.8	1-36"	514	90	45.2	9,111	.70	6.4	514	17.1	2	16.5	33.0	102.8
Sinclair P. L. Co.	34.8	1-12"Oil	(No charge-cost included in authorized project.)											
Texas P. L. Co.	34.8	1-20"Oil	( )											
Trans-Southern P. L. Co.	35.0	2-10"L.P.	( )											
Magnolia P. L. Co.	41.0	1-14"Gas	200	33	6.6	2,500	.70	1.7	200	.6				8.9
Magnolia P. L. Co.	41.0	1-12"Prod.	200	29	5.8	2,500	.70	1.7	200	.5				8.0
Magnolia P. L. Co.	41.0	5-8"Gas	1,000	17	17.0	5,030	.70	3.5	1,000	1.9				22.4
Blacklake P. L. Co.	41.1	1-8"Gas	200	17	3.4	5,040	.70	3.5	200	.4				7.3
Cities Service	42.1	1-12"Oil	200	29	5.8	2,030	.70	1.4	200	.5				7.7
Sun P. L. Co.	42.1	1-6"Oil	200	12	2.4	4,050	.70	2.8	200	.3				5.5
Gulf Oil Corp.	44.5	2-8"Oil	250	17	4.2	3,000	.70	2.1	250	.5				6.8
Humble P. L. Co.	44.6	1-7"Gas	150	17	2.5	1,980	.70	1.4	150	.3				4.2
Gulf Oil Corp.	45.6	1-4"Oil	150	9	1.4	4,049	.70	2.8	150	.2				4.3

Table 12 (Cont'd)
200' Bottom Width

Name of owner	Channel Mile	No. of pipe, size and commodity	Pipe (L.F.)	Unit cost ($)	Pipe cost ($1000)	Excavation (Yds.)	Unit cost ($)	Cost ($1000)	Wt. & coat misc.**	Cost ($1000)	No. of valves	Unit cost ($1000)	Valves cost ($1000)	Total cost ($1000)
United Gas P. L. Co.	45.7	1-6"Gas	150	12	1.8	3,500	.70	2.4	150	.2				4.4
United Gas P. L. Co.	45.7	1-10"Gas	150	23	3.4	2,500	.70	1.7	150	.3				5.5
Gulf Oil Corp.	45.7	1-6"Oil	150	12	1.8	3,000	.70	2.1	150	.2				4.1
Gulf Oil Corp.	47.4	1-6"Oil	150	12	1.8	3,000	.70	2.1	150	.2				4.1
Industrial Gas Sup. Co.	46.4	1-10"Gas	150	23	3.4	4,020	.70	2.8	150	.3				6.6
Humble Oil Co.	47.4	1-8"Oil	150	17	2.5	5,000	.70	3.5	150	.3				6.3
United Gas P.L. Co.	47.8	1-8"Gas	1,110	17	18.8	13,850	.70	9.7	1,110	2.2	2	1.3	2.6	33.4
Sun P. L. Co.	47.3	1-8"Oil	590	17	10.0	18,260	.70	12.8	590	1.6	2	1.3	2.6	27.0
Sun P. L. Co.	49.1	1-6"Oil	590	12	7.0	18,260	.70	12.8	590	1.0	2	.5	.9	21.8
Sinclair P. L. Co.	49.1	1-12"Oil	576	29	16.7	15,940	.70	11.1	576	2.6	2	2.6	5.3	35.7
Nat. Gas Pipeline Co.ofAm.	50.7	1-30"Gas	810	77	62.3	24,155	.70	16.9	810	14.4	2	13.3	26.6	120.3
Magnolia P. L. Co.	51.9	2-8"Oil	1,116	17	18.9	12,960	.70	9.1	1,116	3.0	4	1.3	5.2	36.3
Trans.Cont.Gas P. L. Co.	52.4	2-24"Gas	1,132	69	78.1	15,000	.70	10.5	1,132	15.7	4	7.1	28.7	132.9
Trans. Cont. Gas P. L. Co.	52.4	1-30"Gas	566	77	43.6	15,000	.70	10.5	566	11.9	2	13.3	26.6	92.6
Magnolia P. L. Co.	55.4	1-10"LPG	576	23	13.2	15,940	.70	11.1	576	2.0	2	1.9	3.8	30.3
Magnolia P. L. Co.	55.4	1-8"Oil	576	17	9.8	15,940	.70	11.1	576	1.6	2	1.3	2.6	25.1
Houston P. L. Co.	59.6	1-18"Gas	850	38	32.3	15,940	.70	91.1(1)	850	6.0	2	6.7	13.5	142.9
Houston P. L. Co.	59.6	1-12"Gas	564	29	16.3	18,600	.70	13.0	564	2.6	2	2.6	5.3	37.2
Atlantic P. L. Co.	64.6	2-10"Oil	1,156	23	26.6	15,940	.70	11.1	1,156	4.1	4	1.9	7.7	49.5
Trunkline Gas Sup. Co.	65.9	2-24"Gas	1,156	69	79.7	17,670	.70	12.4	1,156	15.8	4	7.1	28.7	136.6
Gulf Oil Corp.	77.9	1-16"LPG	578	23	13.3	15,900	.70	11.1	578	2.0	2	1.9	3.8	30.3
Tennessee Gas P. L. Co.	85.0	1-12"Gas	776	29	23.5	23,200	.70	16.2	776	3.1	2	2.6	5.2	47.2
Tennessee Gas P. L. Co.	85.0	1-6"Gas	776	12	9.3	23,200	.70	16.2	776	1.3	2	.4	.9	27.7
Tennessee Gas P. L. Co.	86.3	1-30"Gas	775	77	59.7	23,200	.70	16.2	778	13.9	2	13.3	26.6	116.4
Tennessee Gas P. L. Co.	86.3	1-26"Gas	778	70	54.5	23,200	.70	16.2	778	11.1	2	7.6	15.1	97.0
Tennessee Gas P. L. Co.	86.3	3-16"Gas	2,274	37	84.1	29,500	.70	20.6	2,274	14.5	6	5.4	32.4	151.8
Nat. Gas P. L. Co.	90.2	2-24"Gas	1,304	69	89.9	29,800	.70	20.8	1,304	16.7	4	7.1	28.7	156.2
Nat. Gas P. L. Co.	90.2	1-30"Gas	890	77	68.5	27,257	.70	19.1	890	15.3	2	13.3	26.5	129.4
United Gas P. L. Co.	91.8	5-8"Gas	3,240	17	55.1	36,600	.70	25.6	3,240	8.5	10	1.3	13.1	102.4
United Gas P. L. Co.	91.8	3-20"Gas	1,944	44	85.5	32,100	.70	22.4	1,944	18.7	6	8.6	51.4	178.2
Service P. L. Co.	93.0	1-12"Oil	622	29	18.0	22,900	.70	16.0	622	2.7	2	2.6	5.3	42.1
Shell P. L. Co.	93.0	2-10"Oil	1,106	23	25.4	15,620	.70	10.9	1,106	3.9	4	1.9	7.7	48.0
Shell P. L. Co.	93.0	1-6"Oil	554	12	6.6	20,800	.70	14.6	554	.9	2	.4	.9	23.1

Table 12 (Cont'd)
200' Bottom Width

Name of owner	Channel Mile	No. of pipe, size and commodity	Pipe (L.F.)	Unit cost ($)	Pipe cost ($1000)	Excavation (Yds.)	Unit cost ($)	Cost ($1000)	Wt. & coat misc.**	Cost ($1000)	No. of valves	Unit cost ($1000)	Valves cost ($1000)	Total cost ($1000)
Texas Eastern	116.7	1-24"Gas	656	69	45.3	61,100	.70	42.7	656	8.1	2	7.2	14.3	110.4
Texas Eastern	116.7	1-16"Gas	656	37	24.3	21,000	.70	14.7	656	4.5	2	5.4	10.8	54.3
American Liberty	125.4	1-8"Oil	606	17	10.3	18,600	.70	13.0	606	1.5	2	1.3	2.6	27.4
United Gas P. L. Co.	135.3	2-6"Gas	1,768	12	21.2	30,300	.70	21.2	1,768	2.9	4	.4	1.8	74.8
Morgas Pipe Line Co.	153.9	1-8"	684	17	11.6	43,000	.70	30.1	684	1.7	2	1.3	2.6	46.1
Morgas Pipe Line Co.	153.9	1-12"	684	29	19.8	43,000	.70	30.1	684	2.9	2	2.6	5.3	58.1
Gulf Oil Corp.	190.6	1-26"Gas	1,316	70	92.1	27,700	.70	19.4	1,316	15.3	2	7.6	15.2	142.0
Pure Trans. Co.	168.2	1-6"Oil	616	12	7.4	22,300	.70	15.6	616	1.0	2	4.6	.9	25.0
Lone Star Gas Co.	171.0	1-12"Gas	634	29	18.4	25,000	.70	17.5	634	2.8	2	2.6	5.3	43.9
Lone Star Gas Co.	205.9	2-6"Gas	1,316	12	15.8	24,800	.70	17.4	1,316	2.3	4	.5	1.8	37.3
Humble P. L. Co.	205.9	1-4"Oil	654	9	5.9	25,600	.70	17.9	654	.8	4	.2	1.0	25.6
Humble P. L. Co.	207.8	1-4"Oil	654	9	5.9	25,600	.70	17.9	654	.8	2	.2	.5	25.1
Humble Oil & Refg. Co.	207.9	1-4"SaltH^2O	552	9	5.0	14,700	.70	10.3	552	.6	2	.2	.5	16.4
Humble Oil & Refg. Co.	207.9	1-2½"Gas	552	6	3.3	14,700	.70	10.3	552	.3	2	.2	.4	14.3
Magnolia P. L. Co.	209.8	2-20"Oil	1,256	44	55.3	26,700	.70	18.7	1,256	12.3	4	8.6	34.3	120.6
Sinclair P. L. Co.	219.3	1-4"Oil	510	9	4.6	23,100	.70	16.1	510	.7	2	.2	.5	21.9
Lone Star Gas Co.	220.8	1-12"Gas	520	29	15.0	9,700	.70	6.8	520	2.5	2	2.6	5.3	29.6
Gulf Oil Corp.	221.4	1-10"Prod.	578	23	13.3	16,200	.70	13.4	578	1.9	2	1.9	3.8	32.4
Gulf Oil Corp.	221.4	2-10"LPG	1,296	23	29.8	26,900	.70	18.8	1,296	4.4	4	1.9	7.6	60.7
Humble P. L. Co.	230.5	1-10"Oil	628	23	14.4	22,000	.70	15.4	628	2.2	2	1.9	3.8	35.8
Humble P. L. Co.	230.5	2-8"LPG	1,256	17	21.3	22,000	.70	15.4	1,256	3.3	4	1.3	5.2	45.3
Sinclair P. L. Co.	232.8	2-12"Oil	1,204	29	34.9	20,500	.70	14.3	1,204	5.4	4	2.6	10.5	65.2
Humble P. L. Co.	276.2	1-4"Oil	558	9	5.0	11,680	.70	8.2	558	.7	2	.2	.5	14.4
Magnolia P. L. Co.	277.0	1-20"Oil	566	44	24.9	15,000	.70	10.5	566	5.8	2	8.5	17.2	58.4
United Gas P. L. Co.	322.8	1-18"Gas	552	38	20.9	13,500	.70	9.4	522	4.6	2	6.7	13.5	48.5
United Gas P. L. Co.	324.6	1-20"Gas	590	44	25.9	17,700	.70	12.4	590	5.9	2	8.5	17.1	61.3
Lone Star Gas Co.	323.7	1-24"N.Gas	540	69	37.3	13,200	.70	9.2	540	7.7	2	7.2	14.3	68.5
Lone Star Gas Co.	328.1	3-12"Gas	1,278	29	37.0	3,051	.70	2.1	1,278	6.7	6	2.6	15.8	61.7
Lone Star Gas Co.	330.7	1-6"Gas	628	12	7.5	23,100	.70	16.2	628	1.1	2	.5	.9	25.7

Table 12 (Cont'd)
(200' Bottom Width)

Name of owner	Channel Mile	No. of pipe, size and commodity	Pipe (L.F.)	Unit cost ($)	Pipe cost ($1000)	Excavation (Yds)	Unit cost ($)	Cost ($1000)	Wt. & coat misc.**	Cost ($1000)	No. of valves	Unit cost ($1000)	Valves cost ($1000)	Total cost ($1000)
Lone Star Gas Co.	332.7	1-16"Gas	552	37	20.4	13,500	.70	9.4	552	4.1	2	5.4	10.8	44.8
United Gas P. L. Co.	333.1	1-12"Gas	532	29	15.4	10,900	.70	7.6	532	2.5	2	2.6	5.3	30.8
Texas P. L. Co.	337.8	1-6"	514	12	6.1	12,200	.70	8.5	514	.9	2	.5	.9	16.5
Lone Star Gas Co.	339.0	1-6"Gas	596	12	7.1	18,400	.70	12.8	596	1.1	2	.4	.9	22.0
Lone Star Gas Co.	340.0	1-20"Gas	680	44	29.9	22,200	.70	15.5	680	6.4	2	8.6	17.2	69.0
Humble P. L. Co.	340.1	1-8"Prod.	634	17	10.7	24,100	.70	16.8	634	1.7	2	1.3	2.6	31.9
Texas P. L. Co.	341.8	1-8"Prod.	478	17	8.1	11,700	.70	8.2	478	1.4	2	1.3	2.6	20.3
Lone Star Gas Co.	353.3	1-10"Gas	602	23	13.8	13,850	.70	9.7	602	2.1	2	1.9	3.8	29.4
Sinclair P. L. Co.	354.5	1-10"Prod.	576	23	13.2	15,920	.70	11.1	576	2.0	2	1.9	3.8	30.3
Magnolia P. L. Co.	360.9		596	37	22.0	20,400	.70	14.3	596	4.2	2	5.4	10.8	51.4
United Gas P. L. Co.	362.0		558	37	20.6	14,600	.70	10.2	558	4.1	2	5.4	10.8	45.8
Total														$4,785.8

*Unit cost of pipe is the installed price for line pipe & casing.

**Misc. includes casing cradles, seals, and vents. Also 45° weld ells and weld neck flanges are included in this item.

(1) Estimate covers 2 - 100-foot towers and suspension bridge to carry elevated pipeline providing 52-foot clearance above maximum navigation elevation.

TABLE 13
ESTIMATED COST OF ACCESS ROADS TO LOCKS AND DAMS FOR
NAVIGABLE REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION
FEATURES IN TENNESSEE COLONY RESERVOIR
($1000)

Lock No.	Clearing & grubbing	Excavation	Select base material	Flexible base	Prime coat	Double bituminous treatment	Bridge: Structure	Bridge: Approach fill	Drainage structure	Fencing	Marking & traffic signs	Rework exist. road crown	Total
1													0.00(1)
3	29,015	24,000	100,200	100,200	5,262	60,210	0	0	11,500	48,160	550	0	$379,097
4	2,904	87,300	17,610	17,610	924	10,548	4,680	0	2,000	8,448	300	0	152,324
5A	4,120	7,176	15,960	21,960	1,570	17,955	0	0	3,500	14,368	320	399	87,328
5B	0	0	5,970	7,380	488	5,544	0	0	0	0	50	0	19,501
6	20,100	16,896	54,675	67,320	3,696	42,255	285,000	0	10,000	46,480	500	9,388	556,310
7	23,625	27,450	67,380	79,080	6,005	68,670	285,000	8,959	12,500	54,880	575	940	635,064
9	10,725	23,310	51,780	71,220	5,100	58,320	622,060	18,921	11,000	49,840	550	1,295	924,121
10A	36,600	34,900	116,600	106,800	7,650	87,300	0	0	18,000	76,900	300	0	485,050
10B	-	-	-	-	-	-	-	-	-	-	-	-	(2)
11	6,540	15,210	41,310	46,500	3,325	38,016	-	-	3,500	30,400	400	469	185,670 (2)
12	18,180	21,120	56,340	112,500	4,625	52,830	104,500	6,477	10,000	43,120	500	705	430,897
13	6,888	4,800	16,020	14,652	1,050	11,988	760,000	0	2,500	16,000	300	0	834,198
14	344	8,116	2,667	2,445	175	1,998	0	0	500	1,600	200	0	18,045
16	3,600	8,400	26,130	25,680	1,838	21,015	0	0	4,000	16,800	250	890	108,603
17	1,800	2,004	6,675	6,120	438	5,004	0	0	1,000	4,000	200	0	27,241
18	675	810	135	150	17	150	133,000	-	-	-	200	-	135,140
19	1,050	2,490	8,280	7,620	543	6,201	1,500	-	-	4,960	200	-	32,844
20	6,600	5,299	14,580	15,960	1,144	13,725	570,000	-	3,500	15,200	300	1,423	647,661
21	300	642	2,160	1,950	168	1,602	500	-	-	1,280	200	-	8,802
Total													$5,667,896

Note: Prices are as of January 1967
(1) Costs for access road to Lock No.1 are contained in estimated cost of recommended Wallisville Reservoir.
(2) Access road to Lock 10A passes through Lock site 10 B - all cost of road has been to Lock 10A.

TABLE 14

Detailed Estimate of First Cost for a Typical Navigation Dam for Navigable Reach of Multiple-Purpose Channel and Navigation Features in Tennessee Colony Reservoir

	Dam No. 4			
	Six gates 40' x 36'			
Designation	Unit	Quantity	Unit Price	Amount
Clearing	Acre			
Care & diversion of water	Job	Sum		$ 57,000
Excavation & grading				
Common	CY	990,000	$ 0.60	594,000
Rock	CY			
Steel bearing piles(14BP73)				
Sill[1]	LF	52,000	9.75	507,000
Apron	LF	5,180	9.75	50,510
Steel sheet piles				
Cut-off (MA-31)	SF	6,560	5.50	36,080
Cut-off (MA-22)	SF	8,250	4.50	37,130
Stor. yd. wall (Z-38)	SF	16,800	6.40	107,520
Concrete				
Apron	CY	1,710	26.00	44,460
Sill	CY	6,450	26.00	167,700
Pier	CY	7,150	40.00	286,000
Abutment ftgs & walls	CY	3,340	31.00	103,540
6" stor. yd. paving & slope protection	CY	230	24.00	5,520
Cement	BBL	23,600	5.00	118,000
Reinforcement	LB	566,400	0.15	84,960
Fill (incl.stor.yd)	CY	8,700	0.65	5,660
Embankment dike	CY			
Filter blanket	CY	1,620	7.00	11,340
Riprap (inc.cement)	CY	3,100	22.00	68,200
Service bridge	LB	218,000	0.35	76,300
Tainter gate (anchorage & emb. met.)	LB	260,000	0.41	106,600
Tainter gate (movable pts)	LB	865,000	0.41	354,650
Pier nose armor	LB	4,750	1.00	4,750
Water stops (copper)	LB	1,200	2.85	3,420
Stop logs	Job	Sum		103,000
Metal, misc.	LB	246,000	0.75	184,500
Lighting system & power sply.	Job	Sum		70,700
Tainter gate opr. equip.	Each	6	32,000.00	192,000
Rubber seals. molded	LB	6,000	3.00	18,000
Gratings	SF	5,650	5.40	30,510
Handrail	LF	900	5.00	4,500
Crane track-80 Lb rail	Tr.Ft.	336	16.00	5,380
Stor. yd track-60 Lb.rail	Tr.Ft.	110	12.50	1,380
12 Ton track-crane (instal)	Job	Sum		50,000
Stor. yd cars	Each	6	600.00	3,600
Pick-up device	Each	1	1,400.00	1,400
Stor. yd. pier superstruc.	Job	Sum		8,000
Cathodic protection	Job	Sum		10,000
Total				$3,513,310

TABLE 15
ESTIMATED COST OF TYPICAL NAVIGATION LOCK FOR NAVIGABLE
REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR

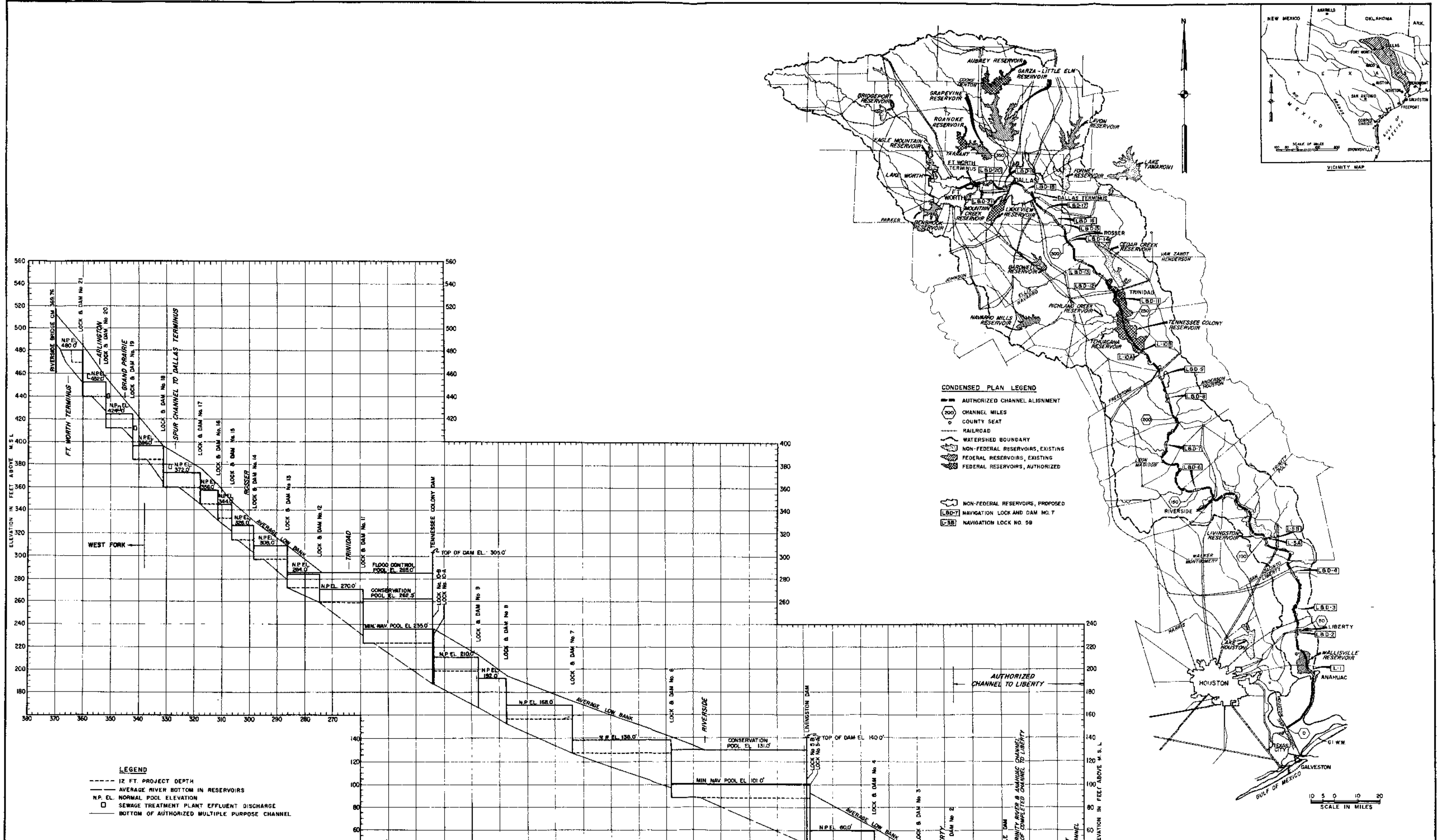
Designation	Lock No. 4 - Gravity type 84' x 600' chamber 600' guidewalls upstream 350' guidewalls downstream			
	Unit	Quantity	Unit price	Amount
Clearing	Acre			
Care & diversion of water	Job			$ 560,000
Excavation & grading, common	CY	51,500	0.60	30,900
Steel bearing piles (14 BP73)				
Guardwall to guardwall	LF	375,000	9.50	3,562,500
Cellular guidewalls	LF	28,700	9.40	269,780
Steel sheet piles				
Cut-off (MA-22)	SF	64,100	4.50	288,450
Cellular guidewalls	CY	45,600	4.75	216,600
Fill, cellular guidewalls	CY	2,750	4.50	12,380
Concrete				
Floors, struts & sills	CY	17,400	26.00	452,400
Walls	CY	89,000	29,00	2,581,000
Cellular guidewalls	CY	8,100	50.00	405,000
Cement	BBL	143,200	5.00	716,000
Reinforcement	LB	1,252,000	0.15	187,800
Water stops	LF	13,500	3.00	40,500
Wall armor				
Guardwall to guardwall	LB	407,000	0.25	101,750
Cellular guidewalls	LB	420,000	0.25	105,000
Fill (incl esplanade)	CY	20,900	0.65	13,590
Filter blanket	CY	7,360	7.00	51,520
Riprap (incl. cement)	CY	18,250	22.00	401,500
Miter gate (anchorage & emb met)	LB	76,000	0.50	38,000
Miter gate (movable parts)	LB	506,000	0.50	253,000
Tainter valve (anchorage & emb)	LB	31,000	0.90	27,900
Tainter valve (movable parts)	LB	83,000	0.90	74,700
Metal, misc.	LB	312,000	0.75	234,000
Timber, YP creosoted	MBFM	25	600.00	15,000
Electrical system	Job	1		149,000
Miter gate operating equipment	Each	4	32,000.00	128,000
Tainter valve operating equipment	Each	4	21,400.00	85,600
Rubber seals, molded	LB	1,100	3.00	3,300
Hydraulic system	Job	1		103,000
Gratings	SF	8,900	5.40	48,060
Floating mooring bits	Each	12	10,000.00	120,000
Stop logs	Job	1		50,000
Central control house	Job	1		60,000
Handrail	LF	5,800	5.00	29,000
Tile gages	LF	60	48.00	2,880
Cathodic protection	Job	1		10,000
Instrumentation	Job	1		10,000
Field office & work area	Job	1		60,000
Total				$11,498,110

TABLE 16
ESTIMATED COST OF TYPICAL NAVIGATION LOCK FOR NAVIGABLE
REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR

	Lock No. 6 - U-Frame type 84' x 600 chamber 600' guidewalls upstream 350' guidewalls downstream			
Designation	Unit	Quantity	Unit price	Amount
Clearing	Acre	8	200.00	$ 1,600
Care & diversion of water	Job	1		456,000
Excavation & grading, common	CY	546,660	0.60	328,000
Excavation & grading, rock	CY	None		
Steel bearing piles (14 BP73)				
Guardwall to guardwall	LF	2,170	9.50	20,620
Cellular guidewalls	LF	19,895	9.40	187,010
Steel sheet piles				
Cut-off (MA-22)	SF	43,560	4.50	196,020
Cellular guidewalls (SA-23)	SF	34,100	4.75	161,980
Fill, cellular guidewalls	CY	3,530	4.50	15,890
Concrete				
Floors, struts & sills	CY	57,000	26.00	1,482,000
Walls	CY	46,500	29.00	1,348,500
Cellular guidewalls	CY	8,920	50.00	446,000
Cement	BBL	133,600	5.00	668,000
Reinforcement	LB	15,533,000	0.15	2,329,950
Water stops	LF	22,400	3.00	67,200
Wall armor				
Guardwall to guardwall	LB	251,000	0.25	62,750
Cellular guidewalls	LB	420,000	0.25	105,000
Fill (incl esplanade)	CY	207,000	0.65	134,550
Filter blanket	CY	6,300	7.00	44,100
Riprap (incl. cement)	CY	15,620	22.00	343,640
Miter gate (anchorage & emb met)	LB	91,000	0.50	45,500
Miter gate (movable parts)	LB	607,000	0.50	303,500
Tainter valve (anchorage & emb)	LB	31,000	0.90	27,900
Tainter valve (movable parts)	LB	83,000	0.90	74,700
Metal, misc.	LB	329,000	0.75	246,750
Timber, MP creosoted	MBFM	23.2	600.00	13,980
Electrical system	Job			149,000
Miter gate operating equipment	Each	4	32,000.00	128,000
Tainter valve operating equipment	Each	4	21,400.00	85,600
Rubber seals, molded	LB	1,100	3.00	3,300
Hydraulic system	Job			103,000
Gratings	SF	8,890	5.40	48,010
Floating mooring bits	Each	12	10,000.00	120,000
Stop logs	Job			50,000
Central control house	Job			60,000
Handrail	LF	5,800	5.00	29,000
Tile gages	LF	73	48.00	3,500
Cathodic protection	Job			10,000
Instrumentation	Job			10,000
Field office & work area	Job			60,000
Total				$9,970,550

TABLE 17
ESTIMATED COST OF TYPICAL NAVIGATION LOCK FOR NAVIGABLE
REACH OF MULTIPLE-PURPOSE CHANNEL AND NAVIGATION FEATURES
IN TENNESSEE COLONY RESERVOIR

	Lock No. 19 - Gravity Type 84' x 400' chamber 400' guidewalls upstream 250' guidewalls downstream			
Designation	Unit	Quantity	Unit price	Amount
Clearing	Acre	1	$ 200.00	$ 200
Care & diversion of water	Job			128,000
Excavation & grading, common	CY	430,000	0.60	258,000
Excavation & grading, rock	CY	20,200	5.00	101,000
Steel bearing piles (14 BP73)				
Guardwall to guardwall	LF	142,000	9.50	1,349,000
Cellular guidewalls	LF	11,300	9.40	106,220
Steel sheet piles				
Cut-off (MA-22)	SF	16,200	4.50	72,900
Cellular guidewalls (SA-23)	SF	30,333	4.15	125,880
Fill, cellular guidewalls	CY	2,550	4.50	11,480
Concrete				
Floors, struts & sills	CY	17,100	26.00	444,600
Walls	CY	79,000	29.00	2,291,000
Cellular guidewalls	CY	4,850	50.00	242,500
Cement	BBL	106,600	5.00	533,000
Reinforcement	LB	810,000	0.15	121,500
Water stops	LF	10,100	3.00	30,300
Wall armor				
Guardwall to guardwall	LB	418,000	0.25	104,500
Cellular guidewalls	LB	256,000	0.25	64,000
Fill (incl esplanade)	CY	26,800	0.65	17,420
Filter blanket	CY	6,240	7.00	43,680
Riprap (incl. cement)	CY	15,670	22.00	344,740
Miter gate (anchorage & emb met)	LB	81,000	0.50	40,500
Miter gate (movable parts)	LB	538,000	0.50	269,000
Tainter valve (anchorage & emb)	LB	31,000	0.90	27,900
Tainter valve (movable parts)	LB	83,000	0.90	74,700
Metal, misc.	LB	285,000	0.75	213,750
Timber, YP creosoted	MBFM	26.9	600.00	16,140
Electrical system	Job	sum		144,100
Miter gate operating equipment	Each	4	32,000.00	128,000
Tainter valve operating equipment	Each	4	21,400.00	85,600
Rubber seals, molded	LB	1,100	3.00	3,300
Hydraulic system	Job	sum		95,000
Gratings	SF	7,900	5.40	42,660
Floating mooring bits	Each	10	10,000.00	100,000
Stop logs	Job	sum		50,000
Central control house	Job	sum		60,000
Handrail	LF	4,100	5.00	20,500
Tile gages	LF	64	48.00	3,070
Cathodic protection	Job	sum		10,000
Instrumentation	Job	sum		10,000
Field office & work area	Job	sum		60,000
Total				$ 7,844,140



TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

CONDENSED PLAN AND PROFILE

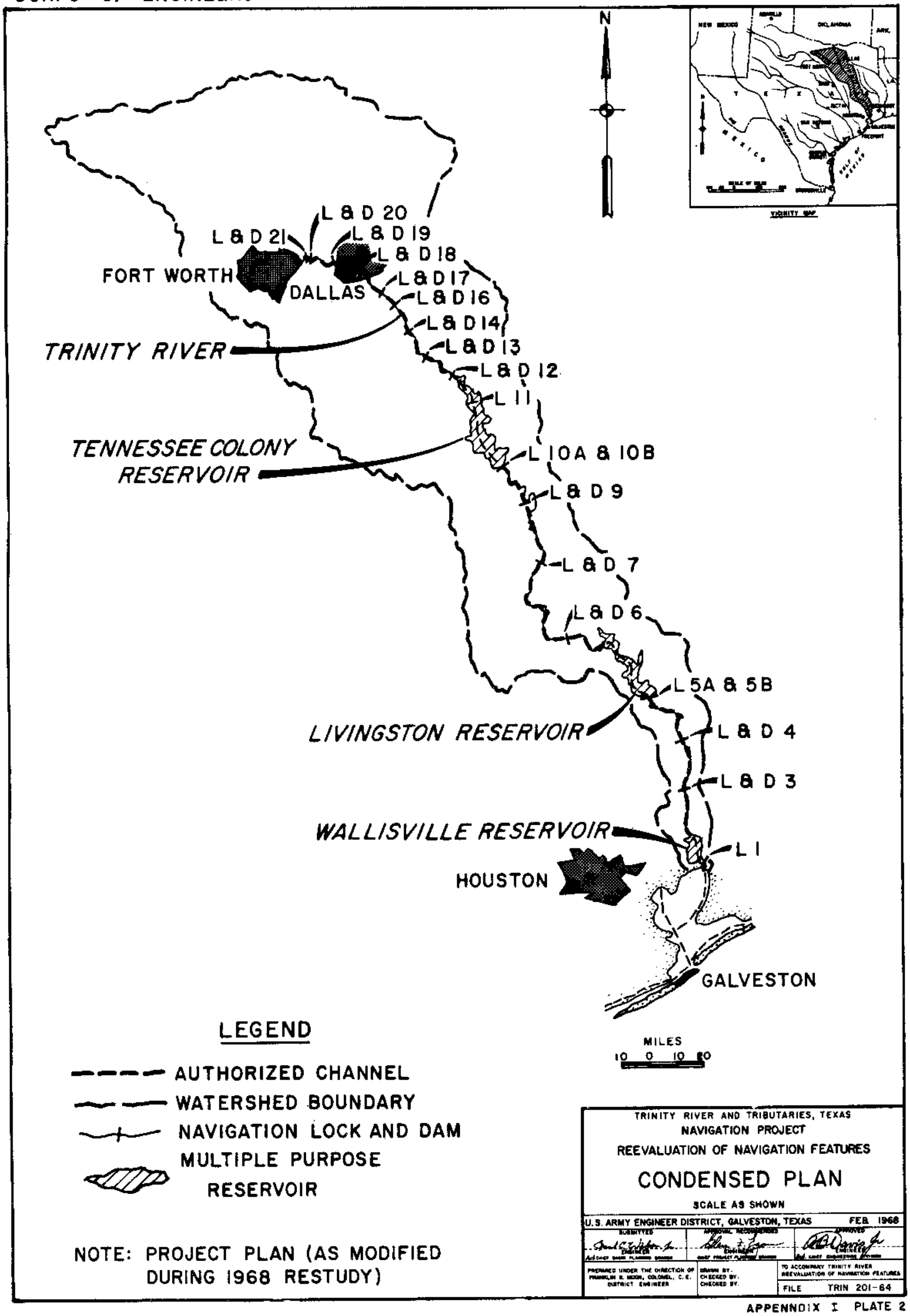
PROJECT DOCUMENT PLAN

SCALE AS SHOWN

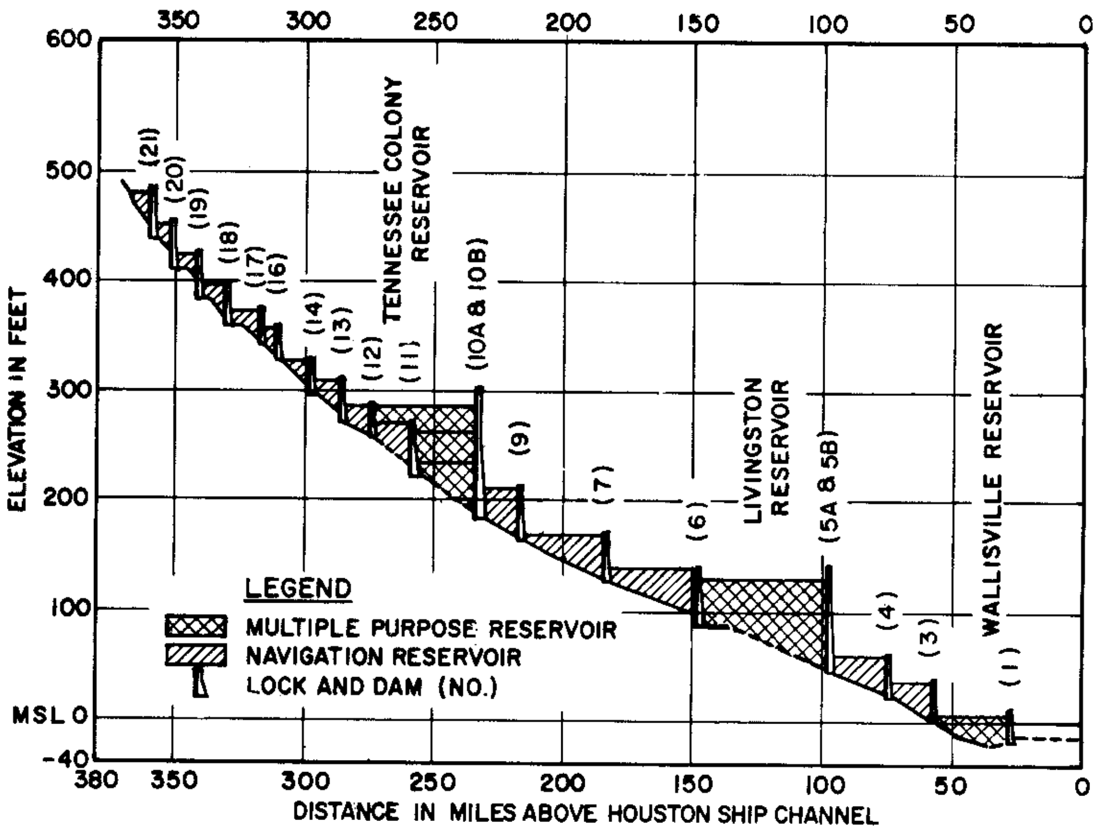
U.S. ARMY ENGINEER DISTRICT, GALVESTON — FEB. 1968

SUBMITTED	APPROVAL RECOMMENDED:	APPROVED:
[signature] ENGINEER	[signature] ENGINEER, Act. CHIEF, BASIN PLANNING BRANCH	[signature] ENGINEER, Act. CHIEF, ENGINEERING DIVISION
PREPARED UNDER THE DIRECTION OF FRANKLIN B. MOON, COLONEL, C.E. DISTRICT ENGINEER	DRAWN BY: CHECKED BY:	TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES. FILE: TRIN 201-64

97-086 O-68 (Face blank p. 114)



APPENNDIX I PLATE 2



NOTE: PROJECT PLAN (AS MODIFIED DURING 1968 RESTUDY)

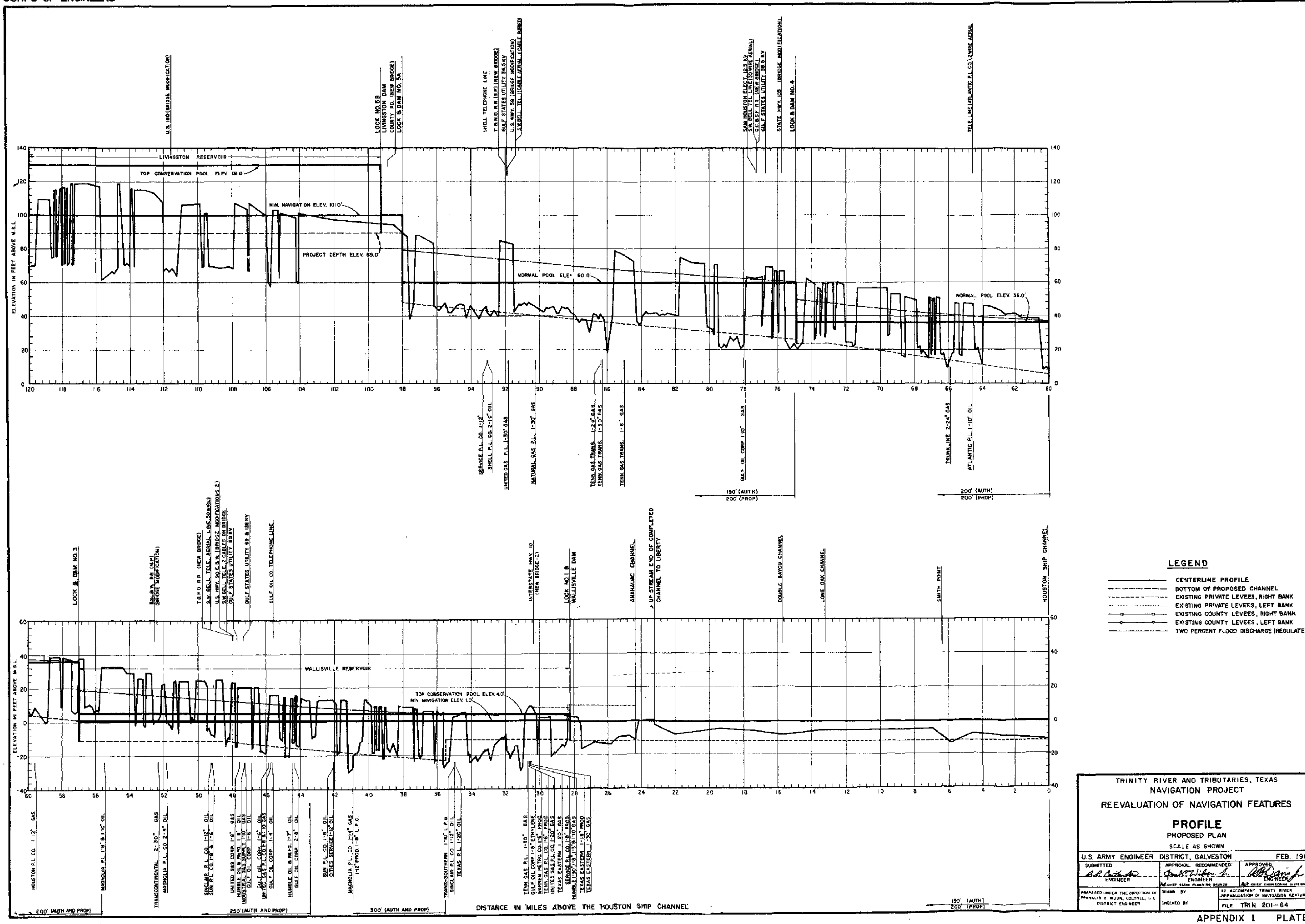
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

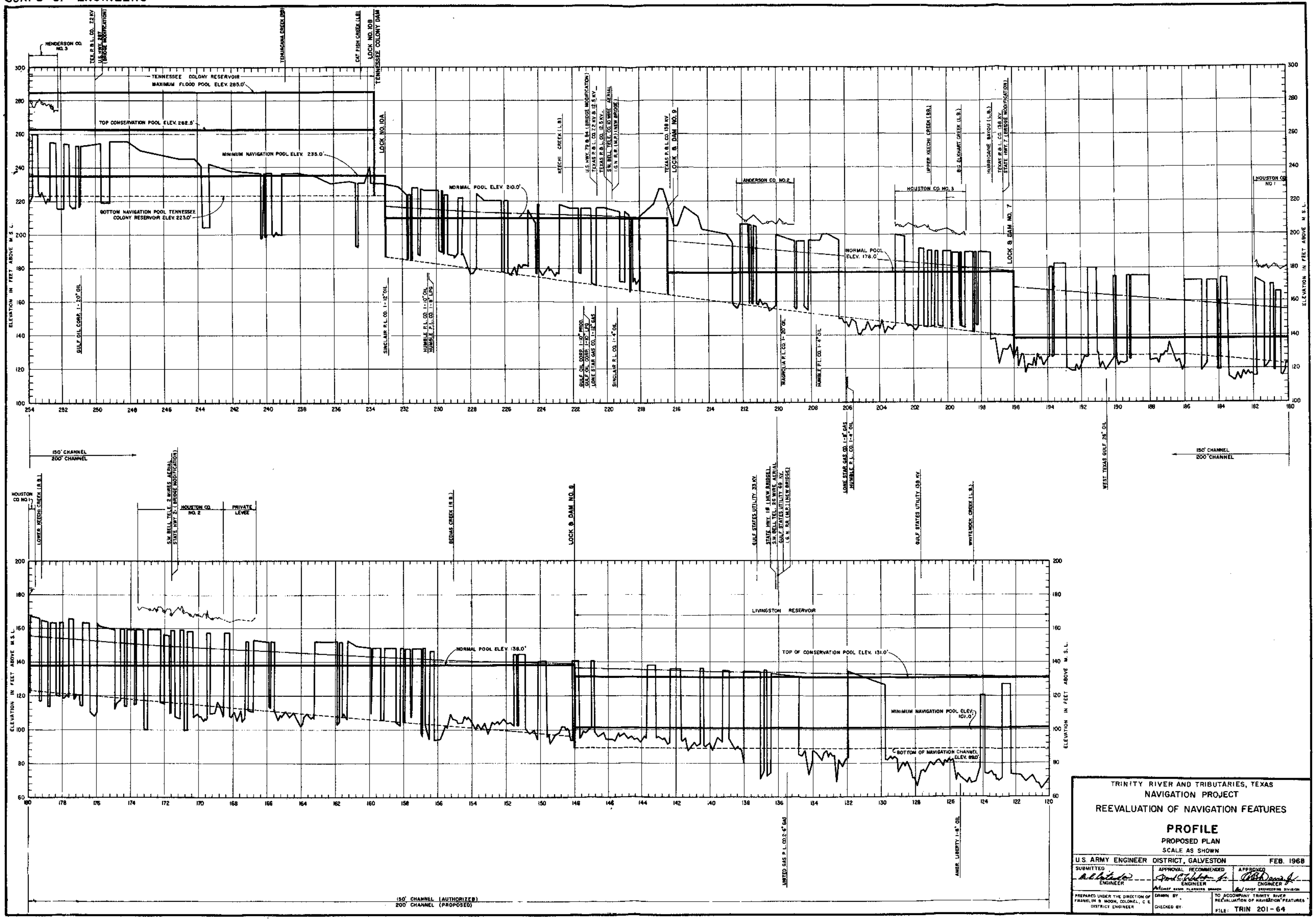
CONDENSED PROFILE

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, GALVESTON, TEXAS FEB 1968

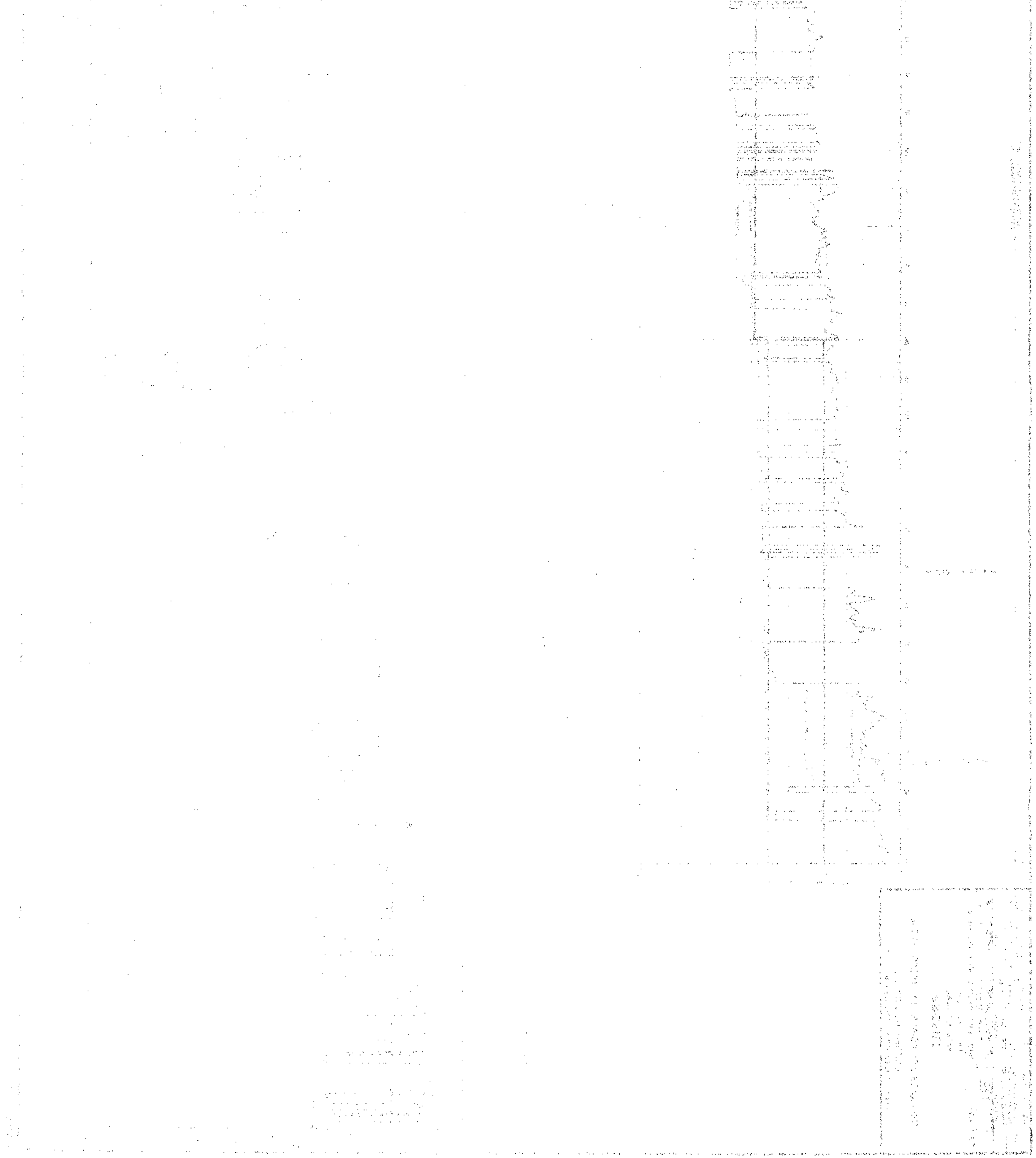
FILE TRIN 201-64

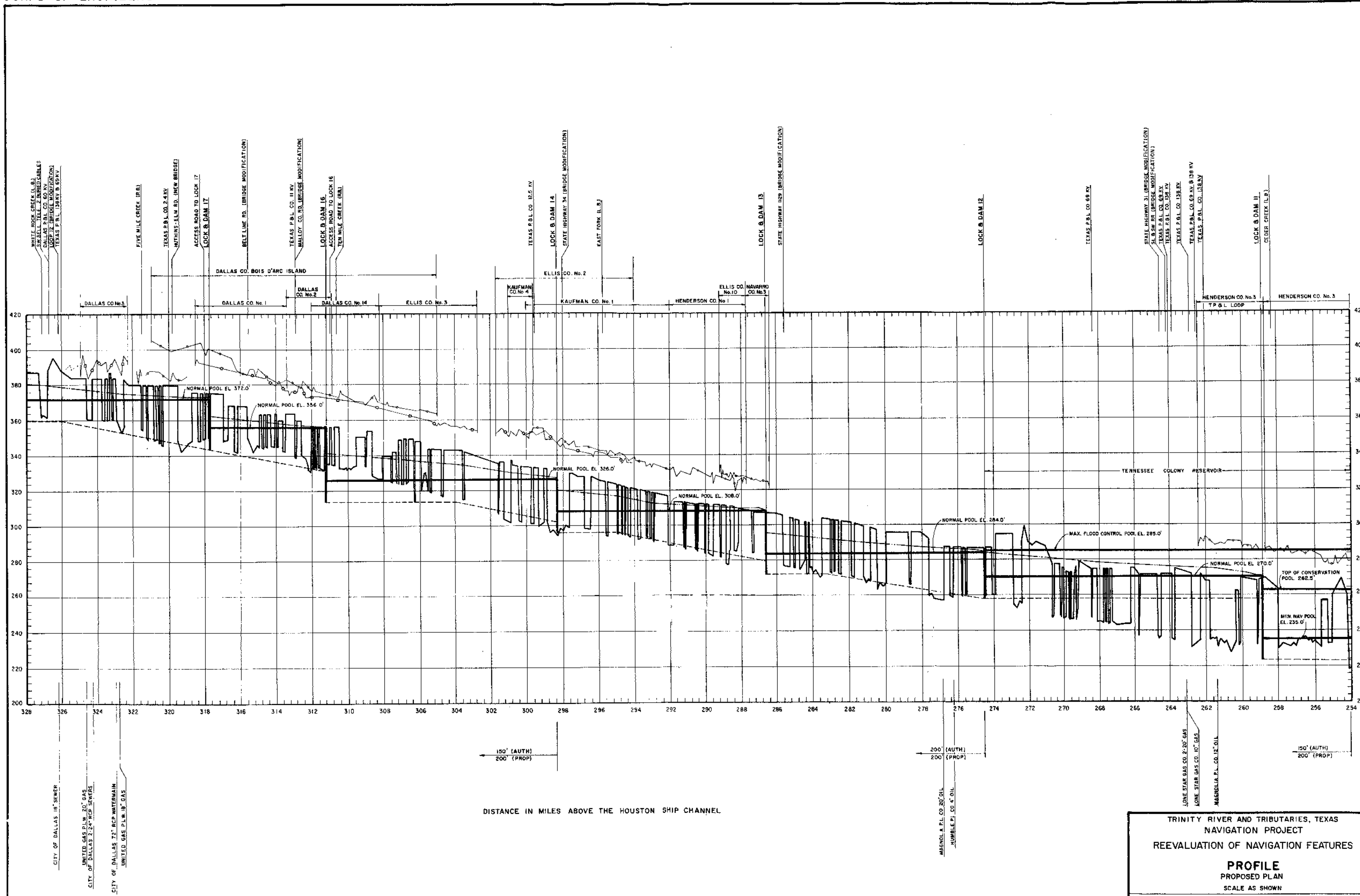

LIVINGSTON RESERVOIR
TOP CONSERVATION POOL ELEV. 131.0'
MIN. NAVIGATION ELEV. 101.0'
PROJECT DEPTH ELEV. 89.0'
NORMAL POOL ELE= 60.0'
NORMAL POOL ELEV. 38.0'
U.S. 190 (BRIDGE MODIFICATION)
LOCK NO. 5B
LIVINGSTON DAM
COUNTY RD. (NEW BRIDGE)
LOCK & DAM NO. 5A
SHELL TELEPHONE LINE
LOCK & DAM NO. 4
ELEVATION IN FEET ABOVE M.S.L.
150' (AUTH)
200' (PROP)
200' (AUTH)
200' (PROP)
LOCK & DAM NO. 3
WALLISVILLE RESERVOIR
TOP CONSERVATION POOL ELEV. 4.0'
MIN. NAVIGATION ELEV. 1.0'
LOCK NO. 1 & WALLISVILLE DAM
ANAHUAC CHANNEL
UP STREAM END OF COMPLETED CHANNEL TO LIBERTY
DOUBLE BAYOU CHANNEL
LONE OAK CHANNEL
SMITH POINT
HOUSTON SHIP CHANNEL
200' (AUTH AND PROP)
250' (AUTH AND PROP)
300' (AUTH AND PROP)
DISTANCE IN MILES ABOVE THE HOUSTON SHIP CHANNEL
150' (AUTH)
200' (PROP)
LEGEND
CENTERLINE PROFILE
BOTTOM OF PROPOSED CHANNEL
EXISTING PRIVATE LEVEES, RIGHT BANK
EXISTING PRIVATE LEVEES, LEFT BANK
EXISTING COUNTY LEVEES, RIGHT BANK
EXISTING COUNTY LEVEES, LEFT BANK
TWO PERCENT FLOOD DISCHARGE (REGULATED)
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
PROFILE
PROPOSED PLAN
SCALE AS SHOWN
U.S. ARMY ENGINEER DISTRICT, GALVESTON
FEB. 1968
FILE TRIN 201-64



APPENDIX I PLATE 5

97-086 O-68 (Face p. 116) No. 2





TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

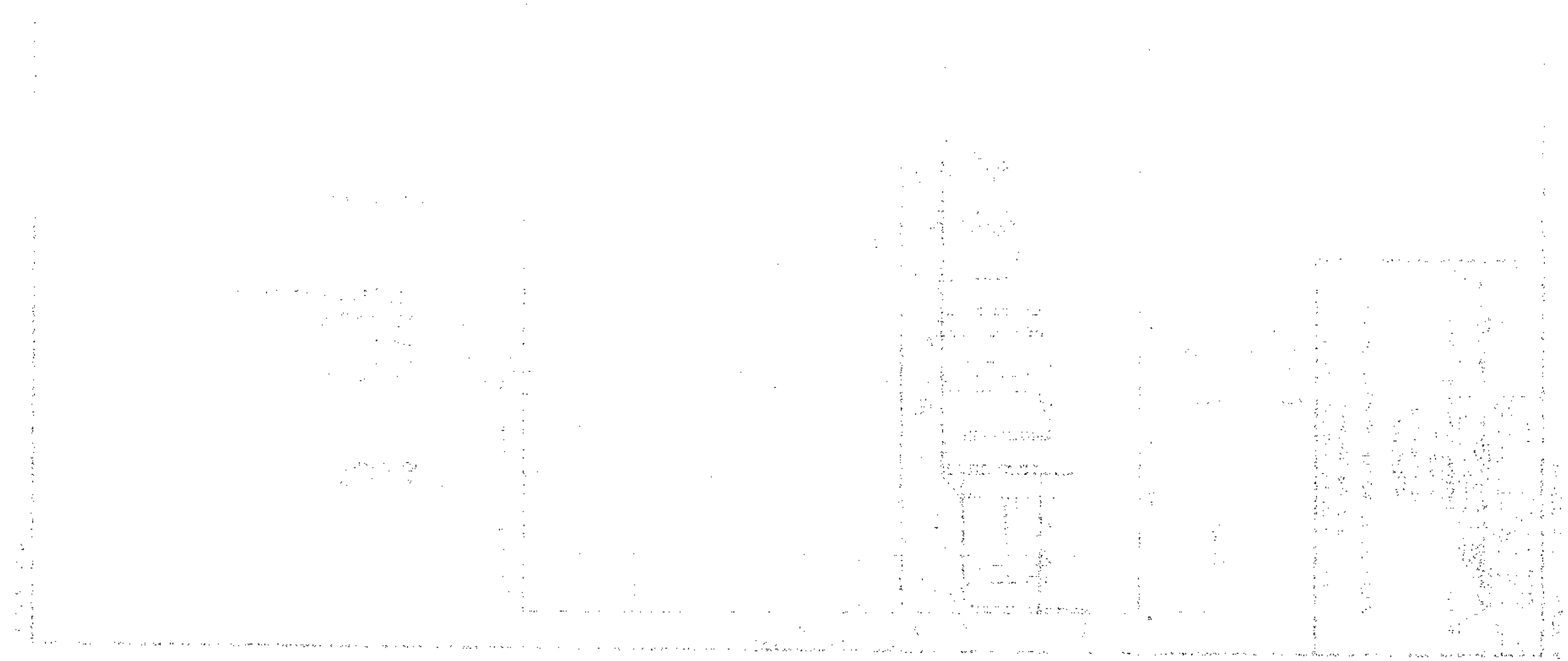
PROFILE
PROPOSED PLAN
SCALE AS SHOWN

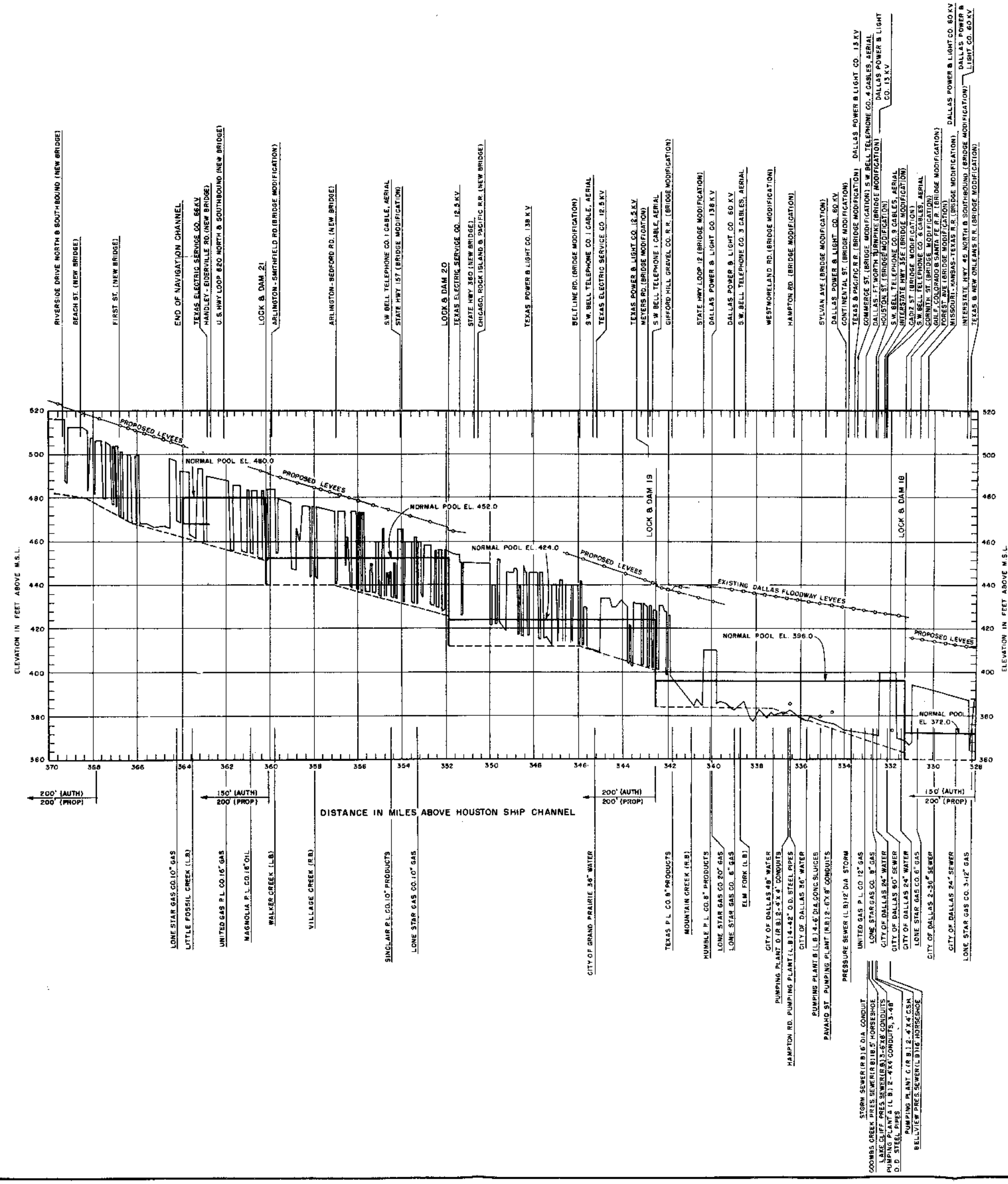
U.S. ARMY ENGINEER DISTRICT, GALVESTON FEB. 1968

SUBMITTED — ENGINEER
APPROVAL RECOMMENDED — ENGINEER
APPROVED: — ENGINEER

PREPARED UNDER THE DIRECTION OF FRANKLIN B. MOON, COLONEL, C.E. DISTRICT ENGINEER
DRAWN BY:
CHECKED BY:
TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES
FILE: TRIN. 201-64

97-086 O-68 (Face p. 116) No. 3





TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

PROFILE

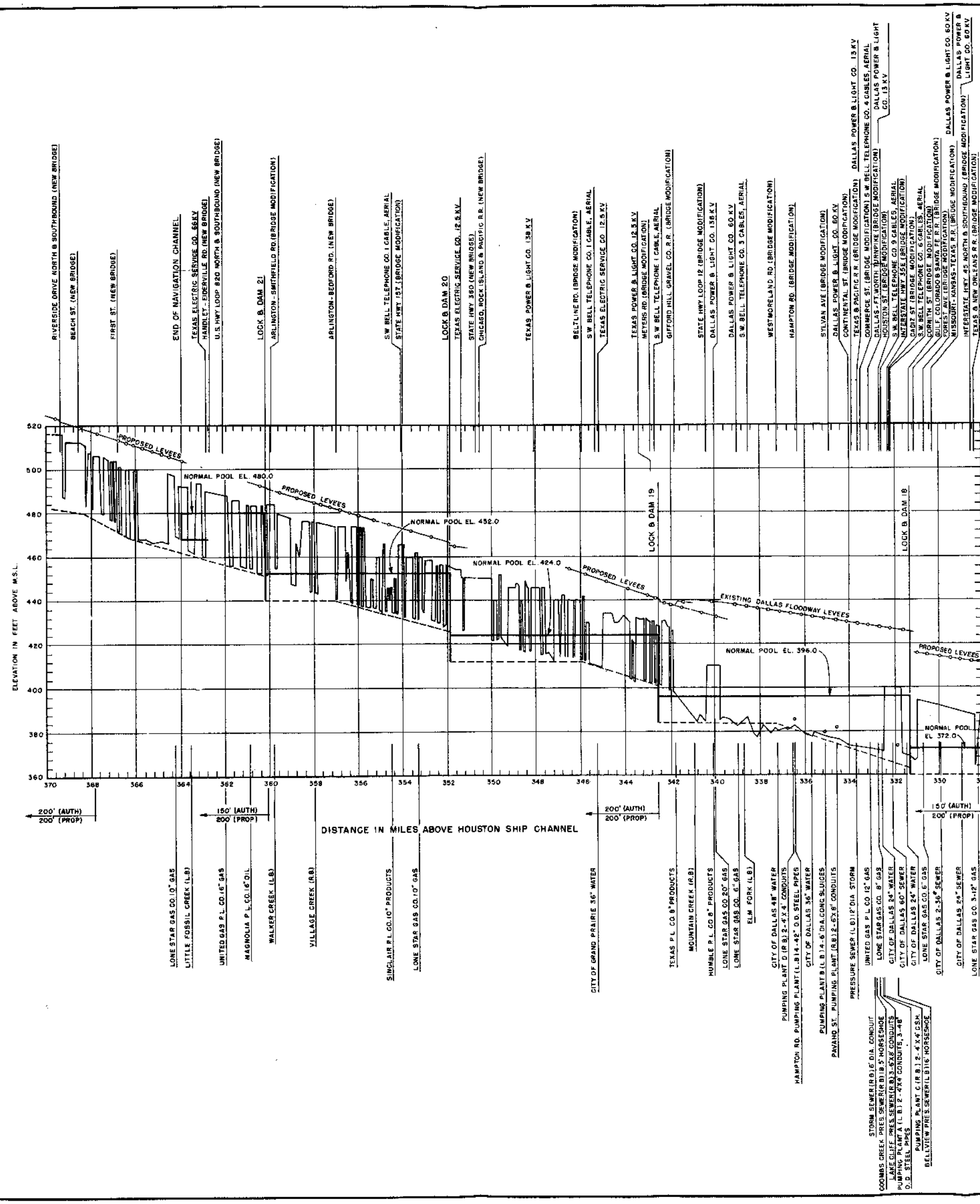
PROPOSED PLAN

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, GALVESTON — FEB. 1968

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
ENGINEER	ENGINEER	ENGINEER
PREPARED UNDER THE DIRECTION OF FRANKLIN B. MOON, COLONEL, C.E. DISTRICT ENGINEER	DRAWN BY P.K. CHECKED BY J.S.	TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES FILE: TRIN. 201-64

97-086 O-68 (Face p. 116) No. 4



TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

PROFILE

PROPOSED PLAN

SCALE AS SHOWN

U.S. ARMY ENGINEER DISTRICT, GALVESTON FEB. 1968

SUBMITTED	APPROVAL RECOMMENDED	APPROVED
ENGINEER	ENGINEER / CHIEF BASIN PLANNING BRANCH	ENGINEER / CHIEF ENGINEERING DIVISION
PREPARED UNDER THE DIRECTION OF FRANKLIN B. MOON, COLONEL, C.E. DISTRICT ENGINEER	DRAWN BY P.K. / CHECKED BY J.S.	TO ACCOMPANY TRINITY RIVER REEVALUATION OF NAVIGATION FEATURES / FILE TRIN. 201-64

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TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

APPENDIX II
NAVIGATION ECONOMICS

U. S. ARMY ENGINEER DISTRICT, GALVESTON
CORPS OF ENGINEERS
GALVESTON, TEXAS

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

APPENDIX II
NAVIGATION ECONOMICS

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TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

APPENDIX II
TRANSPORTATION ECONOMICS

GENERAL

1. General.- This appendix contains the detailed data and analyses of the transportation, economics, and related studies pertaining to a reevaluation of the navigation features of the multi-purpose project for Trinity River and Tributaries, Texas, as authorized by the Rivers and Harbors Act of October 27, 1965, Public Law 89-298.

2. The information and economic analyses presented in this appendix are in compliance with a provision of the authorizing act which requires a reevaluation of the economics of the navigation features of the authorized project prior to expenditure of funds for construction of those features designed exclusively for navigation.

3. Purpose.- The analyses of traffic, economics, and related commodity studies presented in this appendix are for the purpose of identifying and evaluating the annual benefits directly related to features of the authorized project that are provided exclusively for navigation. The benefits from the several other purposes of the authorized project as presented in House Document 276, 89th Congress, 1st Session, have been included only to the extent that they can be attributed to the navigation features.

4. Scope.- This appendix comprises a comprehensive investigation of the economic aspects of providing a navigation channel for barge tow operation from the Houston Ship Channel via the authorized channel to Liberty and the Trinity River to Fort Worth, Texas.

5. The investigations presented herein are based upon surveys and statistical data on the present development of economic and transportation conditions existing in the area to be served by the proposed project. The study included a complete field survey of traffic moving in the tributary area.

6. The economic studies include the field survey of traffic; estimates of prospective waterborne commerce that would move over the channel; savings in transportation charges creditable to the movement of commerce on the channel; estimates of benefits creditable to recreational use of features of the navigation project, including recreation associated with fish and wildlife; and estimates of employment effects on counties designated under the Public Works and Economic Development Act of 1965 as economically depressed counties.

7. Related studies include investigations of current barge-line operating costs; transfer and terminal handling costs; switching and other charges incidental in determining full costs of traffic movement on the channel; overland rates and related charges; individual major commodity studies on (1) sand, gravel, and stone, (2) iron and steel, and (3) wheat and grain sorghum; economic growth factors; and several sub-studies concerning production costs of different methods of recovery of sand and gravel, truck rates, barge rates on authorized but not completed competing waterways, and statistical analyses to support the major investigations.

8. Tributary area.- The tributary area that would be served by the proposed Trinity River navigation channel is the immediate area, to or from which commodities could move over the project channel to connecting waterways serving other parts of the United States or world markets at a savings in transportation cost. The tributary area is essentially the same as that described in House Document 276/89/1 and is shown on figure 1.

9. Connecting waterways.- The project channel will connect with deep water ports at Galveston and Houston and the shallow-draft Gulf Intracoastal Waterway. Major connecting waterways, mileages, and key ports that are used in the estimates of prospective traffic in this appendix are shown in figure 2.

TRAFFIC STUDIES

10. General.- The traffic survey, on which the analyses of traffic were based, was made to develop data on present economic and transportation conditions in the tributary area and was completed in March 1967. The amounts of commodities and other basic data developed by the survey are as of December 1966.

11. Traffic available for transportation by barge on the proposed waterway would consist of traffic now moving by other modes of transportation within the tributary area, between the tributary area

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FIGURE 1

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

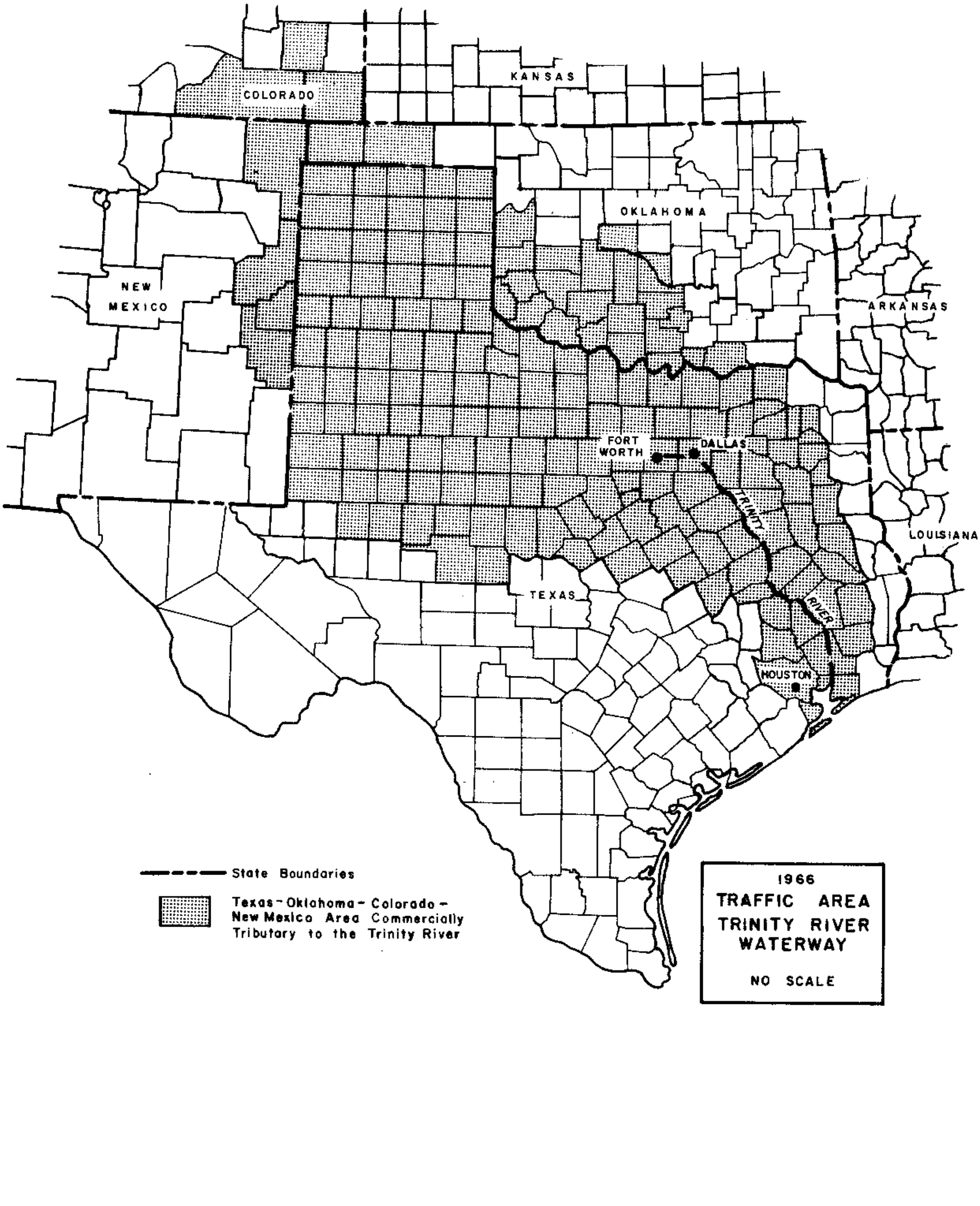
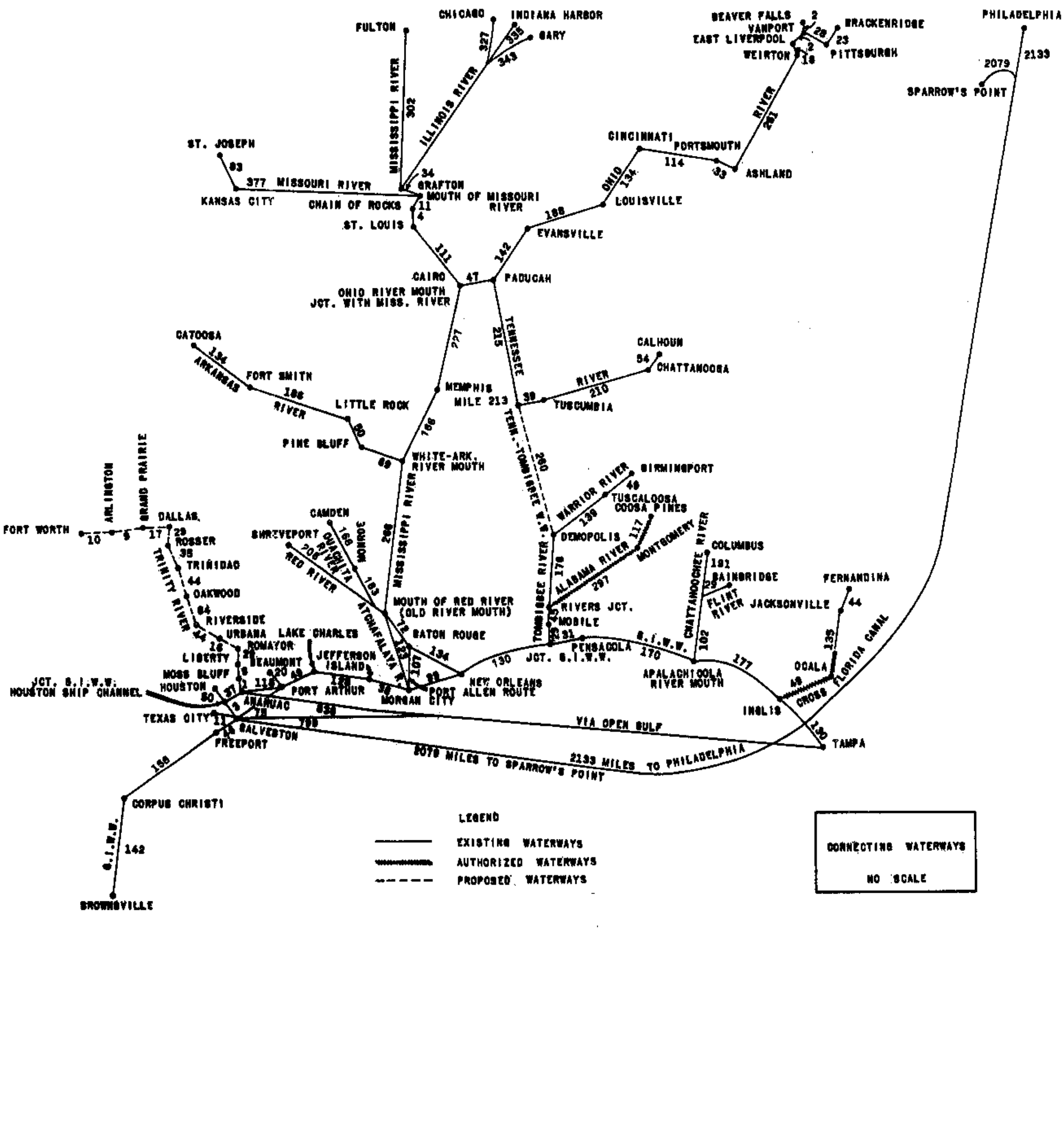


FIGURE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES



and other areas of the United States, and to deep water ports serving world and coastwise domestic markets. As a basis of approach to the traffic studies, pertinent data from the 1958 field traffic survey, which was the basis of the 1962 report, were reviewed to identify major items of traffic that would warrant individual investigation in the current restudy.

12. In the 1958 traffic study, as shown in table 1, it was found that grain (wheat and grain sorghum), sand, gravel, and stone, and iron and steel contributed about 90 percent of the prospective commerce. All other commodities represented only about 10 percent of the prospective waterway traffic. From the standpoint of savings, however, the sand, gravel, and stone represented less than 10 percent, while grain and iron and steel accounted for about 70 percent of the estimated total. The analysis of the 1958 traffic relationship is given in table 1.

TABLE 1

SUMMARY OF ANALYSIS OF RELATIVE COMMODITY RANK
1958 TRAFFIC STUDY

Commodity	Accepted traffic (1)	Percent of total traffic	Transportation savings (2)	Percent of total savings
Grain	2,210	31.9	2,428	24.6
Iron & Steel	1,028	14.9	4,363	44.3
Sand, Gravel, and Stone	2,934	42.4	764	7.8
All other	750	10.8	2,299	23.3
TOTAL	6,922	100.0	9,854	100.0

(1) In thousands of tons of 2000 lbs.

(2) In thousands of dollars.

13. Based on the above analysis, coupled with problems concerning resources, markets, and industry practices in the movement of commodities encountered in the 1958 traffic survey, it was concluded that the reevaluation should include traffic studies consisting of (1) a

comprehensive field traffic survey for general commodities; (2) an investigation of the grain (wheat and grain sorghum); (3) an investigation of sand, gravel, and stone; and (4) an investigation of iron and steel. Details of the traffic studies presented herein are based on these four major studies.

14. Field survey of traffic.- The list of shippers and receivers of commodities to be canvassed in the traffic area was compiled from state and city industrial directories, chambers of commerce and other membership lists, and the Dun and Bradstreet Reference Book of Manufacturers. From these sources, firms were selected giving consideration to such factors as location, size of firm, type of business, manufacturing or processing activity, and adaptability of raw materials or processed items to barge transportation. By interviews and correspondence, field survey teams obtained information from 3,440 shippers and receivers concerning movement of commodities in the traffic area in 1966. Data on grain movements pertained to the 1965 production year, the most recent year for which transportation data were available. The data solicited by the field survey teams included identification and use of commodities, origin and destination points, present means and routing of transportation, amounts shipped and frequency of shipments, scheduling requirements for receipt or shipment, present rates or charges for transportation, and the interest of the firm in waterway transportation on the Trinity River as an alternate or supplement to present mode of transportation. The type of information obtained and the manner it was recorded is illustrated in figure 3. The field traffic survey resulted in reported movements of commodities in the tributary area in 1966 totaling over 136 million tons. The survey involved a selective process for determining firms to be solicited and a small number of the firms that were solicited declined to furnish information. Accordingly, the information obtained represents somewhat less than the total amount of barge potential traffic that moved in the tributary area in 1966. Based on analysis of the data obtained and comparison between areas where essentially full coverage was obtained and those of lesser coverage, it is estimated that the reported totals obtained through the field traffic survey represent about 90 percent of the full barge potential traffic that moved in the tributary area in 1966.

15. The raw field data representing the total traffic reported were reviewed by Corps of Engineers transportation specialists. This review served to eliminate as prospective waterborne commerce those commodities obviously not suited to barge movement. The total potential waterborne traffic was then examined on the basis of individual commodity movements and further screened to eliminate traffic because of: (1) duplication

FIGURE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

EXAMPLE FIELD CONTACT SHEET

CORPS OF ENGINEERS **WATERWAY ECONOMIC SURVEY**	NAME OF PROJECT STUDY: TRINITY RIVER RESTUDY	DISTRICT OFFICE AND ADDRESS: Galveston, Texas	Form Approved Budget Bureau No. 49-R-363.2
NAME OF FIRM: John Doe Chemical Co.	OFFICE ADDRESS *(Street, City and State)*: 300 W. 10th Street Dallas, Texas	OFFICE TELEPHONE NUMBER: CE-3-1821	PLANT LOCATION *(Street, City and State)*: same
NATURE OF BUSINESS: commercial fertilizer	PERSON INTERVIEWED AND TITLE: John Doe, owner	INTERVIEWED BY AND DATE: Howard & Janecka 10 February 1967	

If any of your traffic could or would use the proposed improved waterway, please furnish the following information:

COMMODITY	PRESENT ANNUAL NET TONNAGE *(LATEST YEAR)*	ANNUAL NET TONNAGE THAT MIGHT USE WATERWAY	ORIGIN	DESTINATION	PRESENT MODE OF SHIPMENT AND FREIGHT RATE PAID	NAME OF SHIPPER OR RECEIVER
Ammonium Nitrate	10,000	10,000	Cherokee, Ala.	Dallas, Tex.	Rail (bags) $8.90/ton	John Doe Chemical Co.
Phosphate	14,000	14,000	Inglis, Fla.	" "	barge to Houston @ 4.90/ton rail Houston to Dallas	" " " "
Ammonium Phosphate	20,000	20,000	Cherokee, Ala.	" "	Rail (bulk) $8.90/ton	" " " "
Ammonium Sulfate	5000	5000	Houston, Tex	" "	Rail $4.90/ton	" " " "
Fertilizer (chemical)	19,000	0	Dallas, Tex	" "	Truck	" " " "
Fertilizer (chemical)	30,000	0	" "	Southern Oklahoma & New Mexico	Truck	" " " "

In connection with the frequency of service required, please furnish the following information:

COMMODITY	NET TONS	PER *(DAY, WEEK, MONTH)*	EXPENSES INCURRED PER NET TON: LOADING	UNLOADING	TRANSFER, STORAGE	WHO CONTROLS ROUTING	WHO PAYS THE FREIGHT
Ammonium Nitrate	832	Month				Shipper	Shipper
Phosphate	1170	"				"	"
Ammonium Phosphate	1660	"				"	"
Ammonium Sulfate	416	"				"	"
Fertilizer (Chemical)	4085	"				"	"

ENG FORM 1 JUL 63 3669 *(ER 1120-2-101)* REPLACES RHB FORM 45, 1 APR 61, WHICH IS OBSOLETE. *(OVER)*

FIGURE 3 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

EXAMPLE FIELD CONTACT SHEET

If movement is, or were, via the waterway, please indicate below the terminal services involved and expenses incurred.

COMMODITY	TRANSFER COST PER NET TON FROM OR TO PLANT						WAREHOUSING OR STORAGE	IF MOVEMENT IS NOW BY STEAMSHIP	
	AT ORIGIN			AT DESTINATION				DEEPWATER PORT USED	AVERAGE TONS PER SHIPMENT
	RAIL	TRUCK	OTHER	RAIL	TRUCK	OTHER			
Phosphate	$1.00			$1.00			—	Houston, Texas	

Comments on probability of plant relocation to waterside. Very Possible

Do you have any plans for expansion in this waterway area? ☒ Yes ☐ No. If so, please describe briefly plans for expansion and consequent increase in waterborne commerce.

They are looking foward to future development. However, they have no set plans as of yet.

Please indicate estimated average saving per net ton, by commodity, considered necessary to induce shipper/receiver to use water transportation.

0.10¢/ton

Remarks

They don't manufacture any of the products sold by the company at their present location. Due to zoing restrictions and their location, they are restricted to mixing raw materials and distribution of their products. Their plans to expand require moving to an industrial area, which will probably be located on the Trinity River.

U.S. GOVERNMENT PRINTING OFFICE : 1964 OF—728-979

(2) not barge adaptable, (3) excessive circuity, (4) insufficient volume, and (5) other reasons (i.e. excessive transfer costs, transit privileges). After this process, the remainder of the traffic, representing the traffic accepted for detailed rate analysis, was posted to individual rate analysis sheets (see figure 4 for example) to show the origin, destination, commodity, and tonnage of each movement. Subsequently, these individual movements were analyzed through a rate comparison process to determine whether a savings could be achieved by waterway movement on the Trinity River project and, if so, if the savings were sufficiently large to effect a probable movement on the waterway if it were constructed. The detailed rate analysis is discussed further under the commerce section of this appendix. The 3,400 field contact sheets and 400 rate analysis sheets are on permanent file with the Corps of Engineers.

16. Grain study.- The unique character of the grain business in the southwest precluded the use of conventional methods of analysis to develop reliable estimates of grain traffic that would be adaptable to waterway transport. A separate but concurrent field traffic survey and market analyses were made by Tulsa and Galveston District personnel, Corps of Engineers, to identify producing areas and establish quantities, modes of transport, and distribution of grain.

17. The results of the grain study are discussed in detail in exhibit 1 to this appendix. Generally, the study revealed that the only grains of significance to the authorized waterway are wheat and grain sorghum, which move into export markets by rail and truck. However, only truck movements of grain were analyzed as potential waterway traffic since statistical information could not be developed to substantiate the allocation of rail movements as potential waterway traffic. Based on historical production and transportation data and computed production trends of wheat and grain sorghum, 1965 was determined to be the most representative of a normal production year and was, therefore, selected as the base year for grain traffic analysis. A further discussion of the evaluation of the base year grain traffic used to estimate prospective commerce is given in the commerce section of this appendix.

18. Sand, gravel, and stone.- Sand, gravel, and stone commerce, as presented in the 1958 study, represented the highest percentage of the total traffic in terms of volume, while the lowest in terms of savings. The industry in general is highly competitive, and the most flexible segment of the total market price of these materials is the transportation cost. Thus,

FIGURE 4

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

3315

EXAMPLE

RATE ANALYSIS SHEET
TRAFFIC SURVEY FOR TRINITY RIVER

Commodity: Structural Shapes   Annual tonnage: 20,000 tons (short tons)

Origin: Chicago Ill. (Inter)   Destination: Dallas, Texas

Plant to dock 0 Miles   Dock to plant T/s Miles

(1) Existing rate (~~rail~~) (truck) (~~pipeline~~) $ 16.30 N.T.
Barge to Houston then by truck   B-1 - T-3 + Handling charge

LOWEST AVAILABLE ROUTE
Red River

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port				$
Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge	– see reverse side –			
Other (specify)				
TOTAL				$ 14.56

Trinity River ROUTE to Ft. Worth

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Chicago, Ill.	0		$ —
Port-to-port	(Via)		B	9.47
(5) Rate from 2d port	Dallas, Tex.			0.58 T/s
Constant factor				
Handling charge	1 @ $1.45			1.45
Switching charge				
Other (specify)				
TOTAL				$ 11.50

REMARKS: Unit Savings $ 3.06 N.T.

Authority for rates: Total Savings $ 61,200

(1)

(2)

(3)

(4)

(5)

Computed by   Date

ELIMINATED (check reason)
- Duplication
- Not now moving
- Not barge adaptable
- Insufficient volume
- Insufficient saving
- No saving
- Circuity
- Other

SWD Form 51(C)
6 Feb 1964

Survey Sheet No. 1501

FIGURE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

EXAMPLE

Red River ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Chicago Ill.	0		—
(2) Port-to-port	(Via)		B	7.41
(3) Rate from 2d port	Jefferson Tex.			5.70 R-12
Constant factor				1.45
Handling charge	1 @ 1.45			
Switching charge				
Other (specify)				
TOTAL				$ 14.56

Authority for rates:
(1)
(2)
(3)

Arkansas River ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Chicago, Ill.	0		—
(2) Port-to-port	(Via)		B	6.95
(3) Rate from 2d port	Moskogee, Okla.			7.30 OCE RATE
Constant factor				1.45
Handling charge	1 @ 1.45			
Switching charge				
Other (specify)				
TOTAL				$ 15.70

Authority for rates:
(1)
(2)
(3)

Mississippi River ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Chicago, Ill.	0		—
(2) Port-to-port	(Via)		B	8.25
(3) Rate from 2d port	Houston, Tex			6.60 T-3
Constant factor				
Handling charge	1@1.45			1.45
Switching charge				
Other (specify)				
TOTAL				$ 16.30

Authority for rates:
(1)
(2)
(3)

the location of producing areas, both present and future, along with present and future methods of transportation and production, are of paramount importance to the industry and the Trinity River project. The analysis of the potential commerce for these commodities in the 1958 study did not consider the market and production areas, marketing and transportation methods, or the impact of the waterway on this industry. A secondary problem stemming from the economic aspects of the sand and gravel business was the evaluation of possible savings in production costs through hydraulic mining methods as opposed to land based equipment and if such a saving was found, determining whether it would be attributable to the existence of the waterway. It was evident that a substantial amount of research would be required to develop an understanding of the current sand and gravel business with respect to sources of supply, markets served, and probable changes that would occur in these areas during the 50 year period of evaluation. Therefore, in order to avoid the deficiencies in the 1958 study, a comprehensive sand, gravel, and stone study was made as part of the economic reevaluation of this project. The services of a professional resource analyst were obtained to resolve these questions. The results of the contractor's investigations are contained in exhibit 2 of this appendix. In order to be consistent with the methodology used in the traffic analysis of other commodities, estimates of prospective sand and gravel traffic and transportation savings were developed by the Corps of Engineers. This analysis is described in the commerce section of this appendix.

19. Iron and steel.- During the 1958 traffic study, it was found that the commodities of iron and steel ranked first, in terms of transportation savings creditable to the waterway, as shown in table 1. In view of the importance of these commodities, it was considered appropriate that special attention be given to their production, marketing, and transportation to assure reliable estimates of both tonnage and transportation savings that would be realized if the proposed channel were in operation. Considerable amounts of iron and steel articles are used in connection with the petroleum industry in portions of the tributary area. Due to possible depletion of resources, the long-term future of the petroleum industry in the area is somewhat less certain than other segments of the economy. It was considered appropriate that identification of petroleum related steel and the assessment of its relative importance from both a tonnage and transportation savings viewpoint be made. Accordingly, a professional market analyst was retained to investigate the iron and steel economy of the tributary area. The results of this study are presented in

exhibit 3 of this appendix. Based on the analyst's investigation and data obtained in the field traffic survey, estimates of prospective iron and steel traffic and transportation savings were developed by the Corps of Engineers and are described in the commerce section of this appendix.

RELATED STUDIES

20. General.- A transportation economics study of an entire river basin, particularly a major river in which there is relatively no existing waterway traffic, requires several related investigations to develop data and estimates to support or complement the specific transportation economics of the navigation project.

21. In the category of support investigations, it was necessary to develop overland rates and charges; construct probable waterway rates and charges for the project under investigation for the Trinity River, as well as the authorized but uncompleted competing waterways in the Arkansas-White Rivers and the Red River; develop transfer, switching and handling charges; develop estimates of traffic volumes between ports for waterway capacity analyses; select appropriate economic indicators and develop estimates of factors of growth for selected years during the project life; evaluate the relative costs of different methods of sand and gravel production (i.e. hydraulic versus dry-pit methods); evaluate the added costs to vehicular traffic from transiting bridges that have been raised to provide navigation clearances; and evaluate the relative worth of extending the useful life of the modified portions of existing bridges.

22. Complementary studies included an economic assessment of the recreation and fish and wildlife influence of the navigation project and assessment of the economic impact of expenditures for project construction, maintenance and operation on depressed area counties, designated under the Public Works and Economic Development Act of 1965. A description of the related studies will be presented in the order given above.

23. Overland rates.- Rail and truck rates used in analyses contained in this appendix were obtained from tariffs in effect as of March 1967. Details of the acquisition or construction of these rates are given in the following subparagraphs.

a. Truck rates-grain.- A detailed investigation of grain truck rates was made to establish a basis for comparison of costs between truck and truck-barge transportation. The study disclosed that a truck rate scale for grain is non-existent. However, based on a number of factors involving quantities, distances, and long and short haul rates for non-regulated carriers, contract haulers, and independent truckers, a general pattern was determined and a constructed truck rate scale was developed as shown in table 3. The derivation of the truck rate scale is described in paragraphs 34 through 43 of exhibit 1. The constructed truck scale for grain was submitted to representatives of major grain companies, who concurred that the constructed charges were representative of actual conditions. This scale provides the basis for the rate analyses of grain movement via the proposed waterway.

b. Truck rates-sand, gravel, and stone.- A similar situation to the grain truck rates was encountered in the study of truck rates for sand and gravel. There is no uniform truck rate scale for sand and gravel. Analysis of available cost data from producers revealed that truck hauls of sand and gravel are primarily in the short-haul category, with equity between truck and rail occurring at about a 75 mile haul distance. Based, upon all data that could be obtained from industry sources, a truck rate scale was constructed as described in paragraphs 53 through 55 of the traffic analysis supplement to exhibit 2. The constructed truck rate scale was coordinated with major sand and gravel operators, and they were in general agreement that the constructed scale was representative of comparable costs in the industry. The constructed scale for truck haul for sand, gravel, and stone is given in table 2.

TABLE 2

CONSTRUCTED TRUCK RATE SCALE FOR SAND, GRAVEL, AND STONE

Mileage	Rate/Ton Mile	Total Charge Per Ton
0-16	Min. Rate	$ .50
17-30	$.03	$.51 - $ .90
31-36		$ .90
37-75	$.025	$.93 - $1.88

c. Truck rates-shippers.- In some instances where general commodities moved overland by truck under published tariff rates, the specific rate furnished by the shipper on the field contact

TABLE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

CONSTRUCTED TRUCK SCALE FOR WHEAT AND GRAIN SORGHUM

MILEAGE	CHARGE/TON	MILEAGE	CHARGE/TON	MILEAGE	CHARGE/TON
0-35	$1.66	201-210	$3.48	521-540	$6.96
36-40	1.71	211-220	3.58	541-560	7.17
41-45	1.76	221-230	3.69	561-580	7.39
46-50	1.82	231-240	3.79	581-600	7.60
51-60	1.92	241-250	3.90	601-620	7.81
61-70	2.02	251-260	4.00	621-640	8.02
71-80	2.13	261-281	4.21	641-660	8.23
81-90	2.23	281-300	4.42	661-680	8.44
91-100	2.34	301-320	4.63	681-700	8.66
101-110	2.44	321-340	4.85	701-720	8.87
111-120	2.54	341-360	5.06	721-740	9.08
121-130	2.65	361-380	5.27	741-760	9.29
131-140	2.75	381-400	5.48	761-780	9.50
141-150	2.86	401-420	5.69	781-800	9.71
151-160	2.96	421-440	5.90	801-820	9.92
161-170	3.06	441-460	6.12	821-840	10.14
171-180	3.17	461-480	6.33	841-860	10.35
181-190	3.27	481-500	6.54	861-880	10.56
191-200	3.38	501-520	6.75	881-900	10.77

NOTE: Using actual costs of truck movements, the constructed truck scale was developed from data furnished by grain shippers and truckers.

sheet for the commodity movement was applied. All truck rates obtained from the shippers were reviewed by the Corps of Engineers' traffic specialists prior to use in the traffic analyses.

d. Truck rates-contractor.- For general commodity movements wherein the mode of transport was by truck and the commodity moved under published truck tariff rates, appropriate truck rates with tariff references were furnished by a commercial traffic bureau, retained under contract. The rate contract is discussed in the following subparagraph.

e. Rail rates.- In order to acquire comparable movement costs by rail for traffic analysis purposes, rail rates were developed for each existing rail movement accepted as potential barge commerce on the waterway. Because of the complex rail rate structure and the necessity for constructing valid rates in those instances where no published tariff exists, the services of a commercial freight traffic bureau were obtained by contract. These services were furnished by a leading firm in the area having intimate knowledge of southwest region rates. The contractor performed the necessary research of published rates from commodity movement data furnished by the Corps of Engineers. The contractor also furnished the appropriate switching and handling charges where required. In those cases where a class rate only was published, a commodity rate was constructed from comparable available commodity rates between similar points. The contractor rates were reviewed by Corps of Engineers' rate specialists and are shown in table 4.

24. Barge rates.- Since there is no existing waterway traffic moving over the major section of the Trinity River between Liberty and Fort Worth, Texas, a detailed study of the barge transportation industry on comparable existing waterways was made to develop probable barge rates that would be applied to the commodities that would move on the channel if it were in existence. As the overall study assumed that the Arkansas River with terminus at Catoosa, Oklahoma and the Red River with terminus at Daingerfield, Texas, were alternate waterways which are authorized and which may compete with the Trinity River waterway, it was necessary to construct land-water rates for the latter two rivers so as to screen the tonnage for the least costly movement via alternate waterways as compared to the constructed barge rates for the Trinity River.

25. Probable barge rates were developed for each commodity that are comparable to the overland rates acquired for the analysis of prospective commerce. The barge rate study included detailed analyses of present new equipment cost data, average operating costs for both barges and towboats, operating conditions on

TABLE 4

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation COMMON CARRIER TRUCKLOAD

SHEET 1 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT(2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4) RATE	OCE REVISIONS TO CONTRACT DATA (4) MINIMUM WEIGHT
T-1	Iron or Steel Bars	Houston, Texas	Ft. Worth, Texas	33	80,000	SWMFT 3-T ITEM 5160		
T-2	Iron or Steel Bars	Dallas, Texas	Ft. Worth, Texas	21	36,000	SWMFT 1-X ITEM 15570 Col. 7		
T-3	Iron or Steel Bars	Houston, Texas	Dallas, Texas	33	80,000	SWMFT 3-T ITEM 5160		
T-4	Iron or Steel Bars	Houston, Texas	Burleson, Texas	43	30,000	SWMFT 3-T ITEM 8080 257.5 Miles		
T-5	Iron or Steel Bars	Houston, Texas	Dallas, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-6	Iron or Steel Bars	Houston, Texas	Carrollton, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-7	Iron or Steel Bars	Dallas, Texas	Carrollton, Texas (Intra)	13½	80,000	SWMFT 25-L ITEM 10610 14.7 Miles		
T-8	Iron or Steel Bars	Houston, Texas	Grand Prairie, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-9	Iron or Steel Bars	Dallas, Texas	Grand Prairie, Texas (Intra)	13½	80,000	SWMFT 25-L ITEM 10610 12.0 Miles		
T-10	Iron or Steel Bars	Beaumont, Texas	Dallas, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-11	Iron or Steel Bars	Houston, Texas	Waco, Texas	30½	80,000	SWMFT 25-L ITEM 10610 186.7 Miles		
T-12	Iron or Steel Bars	Daingerfield, Texas	Dallas, Texas	31	30,000	SWMFT 3-T ITEM 8080 142.0 Miles		
T-13	Iron or Steel Bars	Chicago, Ill.	Dallas, Texas	125	44,000	SWMFT 90 ITEM 26160		
T-14	Iron or Steel Bars	Ft. Smith, Ark.	Dallas, Texas	48	40,000	SWMFT 1-X ITEM 15390 Constructed Rate		
	Iron or Steel Bars	Ft. Smith, Ark.	Dallas, Texas	66	30,000	SWMFT 1-X ITEM 15390 Col. 7 287.0 Miles Pres.		
T-15	Iron or Steel Bars	Bessemer, Ala.	Dallas, Texas	95	30,000	SMCRC 515-L ITEM 105590 Com. Col. 30-F		
T-16	Iron or Steel Bars	Houston, Texas	Tyler, Texas (Intra)	34	42,000	SWMFT 25-L ITEM 8675		
T-17	Iron or Steel Bars	Trinidad, Texas	Tyler, Texas (Intra)	16½	80,000	SWMFT 25-L ITEM 10610 51.9 Miles		
T-18	Iron or Steel Bars	Jefferson, Texas	Tyler, Texas (Intra)	20½	80,000	SWMFT 25-L ITEM 10610 83.1 Miles		
T-19	Iron or Steel Bars	Oakwood, Texas	Waco, Texas	33	40,000	Constr.		
	Iron or Steel Bars	Oakwood, Texas	Waco, Texas	50	30,000	Present SWMFT 1-X ITEM 15390 153.1 Miles		
T-20	Iron or Steel Bars	Houston, Texas	Grapevine, Texas	45	30,000	SWMFT 3-T ITEM 8080 267.3 Miles		
T-21	Iron or Steel Bars	Houston, Texas	Ennis, Texas	33	80,000	SWMFT 3-T ITEM 5160		
T-22	Iron or Steel Bars	Rosser, Texas	Ennis, Texas	20	40,000	Constr.		
	Iron or Steel Bars	Rosser, Texas	Ennis, Texas	35	30,000	Present SWMFT 1-X ITEM 15390 58.6 Miles		
T-23	Iron or Steel Bars	Houston, Texas	Lubbock, Texas	75	30,000	SWMFT 3-T ITEM 8080		
T-24	Iron or Steel Bars	Dallas, Texas	Lubbock, Texas	54	40,000	Constr.		
	Iron or Steel Bars	Dallas, Texas	Lubbock, Texas	72	30,000	Present SWMFT 1-X ITEM 15390		
T-25	Iron or Steel Bars	Ft. Worth, Texas	Lubbock, Texas	52	40,000	Constr.		
	Iron or Steel Bars	Ft. Worth, Texas	Lubbock, Texas	70	30,000	Present SWMFT 1-X ITEM 15390		
T-26	Iron or Steel Bars	Houston, Texas	Grand Prairie, Texas	33	80,000	SWMFT 1-X ITEM 5160		
T-27	Iron or Steel Bars	Eagle Pass, Texas	Dallas, Texas	77	40,000	SWMFT 1-X ITEM 15390 440.9 Miles		
T-28	Iron or Steel Bars	Eagle Pass, Texas	Corpus Christi, Texas	50	40,000	SWMFT 1-X ITEM 15390 309.5 Miles		
T-29	Iron or Steel Bars	Houston, Texas	Mineral Wells, Texas	47	42,000	SWMFT 3-T ITEM 5165		
T-30	Iron or Steel Bars	Dallas, Texas	Mineral Wells, Texas	26	40,000	Constr. SWMFT 1-X ITEM 15390		
	Iron or Steel Bars	Dallas, Texas	Mineral Wells, Texas	40	30,000	Present		
T-31	Iron or Steel Bars	Ft. Worth, Texas	Mineral Wells, Texas	20	40,000	Constr.		
	Iron or Steel Bars	Ft. Worth, Texas	Mineral Wells, Texas	35	30,000	Present. SWMFT 1-X ITEM 15390		
T-32	Iron or Steel Bars	Daingerfield, Texas	Mineral Wells, Texas	41	40,000	Constr.		
	Iron or Steel Bars	Daingerfield, Texas	Mineral Wells, Texas	58	30,000	Present SWMFT 1-X ITEM 15390		
T-33	Iron or Steel Bars	Dallas, Texas	Grapevine, Texas	21	36,000	SWMFT 1-X ITEM 15570 Col. 7		
T-34	Iron or Steel Bars	Arlington, Texas	Grapevine, Texas	20	40,000	Constr. 15930		
	Iron or Steel Bars	Arlington, Texas	Grapevine, Texas	26	30,000	Present SWMFT 1-X ITEM 15570		
T-35	Iron or Steel Bars	Eagle Pass, Texas	Denton, Texas	83	30,000	SWMFT 1-X ITEM 15390		
T-36	Iron or Steel Bars	Dallas, Texas	Denton, Texas	20	40,000	Constr.		
	Iron or Steel Bars	Dallas, Texas	Denton, Texas	24	36,000	Present SWMFT 1-X ITEM 159 0 Col. 7 37.1 Miles		
T-37	Iron or Steel Bars	Ft. Worth, Texas	Denton, Texas	20	40,000	Constr. 15390		
	Iron or Steel Bars	Ft. Worth, Texas	Denton, Texas	24	36,000	Present SWMFT 1-X ITEM 15570 Col. 7		
T-38	Iron or Steel Bars	Houston, Texas	Arlington, Texas	33	80,000	SWMFT 3-T ITEM 5160		
T-39	Iron or Steel Bars	Dallas, Texas	Arlington, Texas	17	36,000	SWMFT 1-X ITEM 15570 Col. 7		
T-40	Iron or Steel Bars	Houston, Texas	Waco, Texas (Intra)	33	42,000	SWMFT 25-L ITEM 8675		
T-41	Iron or Steel Bars	Oakwood, Texas	Waco, Texas (Intra)	24	34,000	SWMFT 25-L ITEM 10600 Col. C 83.9 Miles		
T-42	Iron or Steel Bars	Houston, Texas	McGregor, Texas	36	30,000	SWMFT 3-T ITEM 8080 198.2 Miles		
T-43	Iron or Steel Bars	Oakwood, Texas	McGregor, Texas	34	40,000	Constr.		
	Iron or Steel Bars	Oakwood, Texas	McGregor, Texas	51	30,000	Present SWMFT 1-X ITEM 15390 161.1 Miles		
T-44	Iron or Steel Bars	Jefferson, Texas	McGregor, Texas	43	40,000	Constr.		
	Iron or Steel Bars	Jefferson, Texas	McGregor, Texas	59	30,000	Present SWMFT 1-X ITEM 15390		
T-45	Iron or Steel Bars	Houston, Texas	Arlington, Texas	33	45,000	SWMFT 25-L ITEM 8710		
T-46	Iron or Steel Bars	Dallas, Texas	Houston, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-47	Iron or Steel Bars	Daingerfield, Texas	Ft. Worth, Texas	38	40,000	Constr.		
	Iron or Steel Bars	Daingerfield, Texas	Ft. Worth, Texas	52	30,000	Present SWMFT 1-X ITEM 15930 171.8 Miles		
T-48	Iron or Steel Bars	Dallas, Texas	Grand Prairie, Texas	17	36,000	SWMFT 1-X ITEM 15570		
T-49	Iron or Steel Bars	Ft. Worth, Texas	Hurst, Texas (Intra)	12	34,000	SWMFT 25-L ITEM 10600 Col. C 10 Miles		
T-50	Iron or Steel Bars	Dallas, Texas	Hurst, Texas (Intra)	13	34,000	SWMFT 25-L ITEM 10600 Col. C 17 Miles		
T-51	Iron or Steel Bars	Dallas, Texas	Paris, Texas (Intra)	27	34,000	SWMFT 25-L ITEM 10600 Col. C 100.7 Miles		
T-52	Iron or Steel Bars	Daingerfield, Texas	Paris, Texas (Intra)	28	34,000	SWMFT 25-L ITEM 10600 Col. C 114.1 Miles		
T-53	Wrought Iron Pipe	Daingerfield, Texas	Ft. Worth, Texas	49	30,000	SWMFT 1-X ITEM 15070 Col. 4 171.8 Miles		
T-54	Wrought Iron Pipe	Ft. Smith, Ark.	Ft. Worth, Texas	65	30,000	SWMFT 1-X ITEM 15070 Col. 4 291.1 Miles		

(1) Rates are C.W.T unless otherwise noted
(2) Highest minimum weight rate to be quoted
(3) Interstate rate unless otherwise specified
(4) Tariff authority not furnished with O.C.E. revisions

TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project: TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation: COMMON CARRIER TRUCKLOAD

SHEET 2 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
T-55	Wrought Iron Pipe	Dallas, Texas	Ft. Worth, Texas	20	30,000	SWMFT 1-X ITEM 15070 Col. 4 27.0 Miles		
T-56	Wrought Iron Pipe	Houston, Texas	Lubbock, Texas	75	30,000	SWMFT 3-T ITEM 8080		
T-57	Wrought Iron Pipe	Ft. Worth, Texas	Lubbock, Texas	71	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-58	Wrought Iron Pipe	Dallas, Texas	Lubbock, Texas	75	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-59	Wrought Iron Pipe	Dallas, Texas	Grand Prairie, Texas	15	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-60	Wrought Iron Pipe	Daingerfield, Texas	Grand Prairie, Texas	46	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-61	Wrought Iron Pipe	Ft. Smith, Ark.	Grand Prairie, Texas	63	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-62	Wrought Iron Pipe	Dallas, Texas	Carrollton, Texas	15	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-63	Wrought Iron Pipe	Daingerfield, Texas	Carrollton, Texas	44	30,000	SWMFT 1-X ITEM 15070 Col. 4		
T-64	Wrought Iron Pipe	Houston, Texas	Dallas, Texas (Intra)	61½	30,000	RRC 6-H ITEM 260	44	
T-65	Wrought Iron Pipe	Houston, Texas	Dallas, Texas	33	80,000	SWMFT 3-T ITEM 8080		
T-66	Wrought Iron Pipe	Galveston, Texas	Dallas, Texas (Intra)	68½	30,000	RRC 6-H ITEM 260		
T-67	Wrought Iron Pipe	Ft. Worth, Texas	Houston, Texas (Intra)	63½	30,000	RRC 6-H ITEM 260		
T-68	Wrought Iron Pipe	Ft. Worth, Texas	Dallas, Texas (Intra)	23	20,000	SWMFT 25-L ITEM 10600 Col. B		
T-69	Wrought Iron Pipe	Daingerfield, Texas	Dallas, Texas (Intra)	27	42,000	SWMFT 25-L ITEM 8675 Col. 2		
T-70	Iron or Steel	Dallas, Texas	Houston, Texas (Intra)	84	20,000	SWMFT 33-D ITEM 900 Col. 6		
	Vessels S. U.							
T-71	Aluminum Plate	Houston, Texas	Carrollton, Texas (Intra)	99	20,000	SWMFT 25-L ITEM 1620	45	90,000
T-72	Aluminum Plate	Dallas, Texas	Carrollton, Texas (Intra)	33	20,000	SWMFT 25-L ITEM 1620	13½	90,000
T-73	Steel Scrap	Ft. Worth, Texas	Dallas, Texas (Intra)	14½	80,000	SWMFT 25-L ITEM 10610		
T-74	Steel Scrap	Houston, Texas	Ft. Worth, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710 Col. 1		
T-75	Steel Scrap	Dallas, Texas	Houston, Texas	34	30,000	SWMFT 3-T ITEM 8080		
T-76	Newsprint	Mobile, Ala.	Ft. Worth, Texas	85	36,000	SMCRC 515-L ITEM 218530 Intermediate Application		
T-77	Newsprint	Lufkin, Texas	Houston, Texas (Intra)	26½	72,000	SWMFT 25-L ITEM 9045 TOFC		
T-78	Newsprint	Lufkin, Texas	Urbana, Texas (Intra)	11½	72,000	SWMFT 25-L ITEM 9045 Constructed Rate		
T-79	Newsprint	Mobile, Ala.	Ennis, Texas	91	36,000	SMCRC 515-L ITEM 218530 Intermediate Application		
T-80	Newsprint	Rosser, Texas	Ennis, Texas	22	34,000	SWMFT 1-X ITEM 15620 Col. 6		
T-81	Converted Paper	Ennis, Texas	Birmingham, Ala.	95	36,000	SMCRC 515-L ITEM 151916		
T-82	Converted Paper	Ennis, Texas	Rosser, Texas	22	34,000	SWMFT 1-X ITEM 15620 Col. 6		
T-83	Corrugated Fibre-	West Monroe, La.	Ft. Worth, Texas	57	34,000	SWMFT 1-X ITEM 15620 Col. 6		
	board Sheet							
T-84	Corrugated Fibre-	Dallas, Texas	Ft. Worth, Texas	22	34,000	SWMFT 1-X ITEM 15620 Col. 6		
	board Sheet							
T-85	Corrugated Fibre-	Daingerfield, Texas	Ft. Worth, Texas	39	34,000	SWMFT 1-X ITEM 15620 Col. 6		
	board Sheet							
T-86	Rough Green Hardwood	Goodrich, Texas	Houston, Texas (Intra)	18	32,000	SWMFT 25-L ITEM 10620		
T-87	Rough Green Hardwood	Goodrich, Texas	Urbana, Texas (Intra)	12	32,000	SWMFT 25-L ITEM 10620		
T-88	Brick	Coleman, Texas	Houston, Texas (Intra)	26	32,000	SWMFT 25-L ITEM 7310		
T-89	Sand	Seagoville, Texas	Dallas, Texas (Intra)	18	30,000	RRC 6-H ITEM 370		
T-90	Sand	Seagoville, Texas	Rosser, Texas (Intra)	18	30,000	RRC 6-H ITEM 370		
T-91	Iso-Propyl Alcohol	Houston, Texas	Dallas, Texas (Intra)	73	30,000	SWMFT 25-L ITEM 10080		
T-92	Caustic Soda	Freeport, Texas	Dallas, Texas (Intra)	50	40,000	SWMFT 25-L ITEM 10100 Col. 9		
T-93	Caustic Soda	Freeport, Texas	Ft. Worth, Texas (Intra)	50	40,000	SWMFT 25-L ITEM 10100 Col. 9		
T-94	Caustic Soda	Dallas, Texas	Ft. Worth, Texas (Intra)	21	40,000	SWMFT 25-L ITEM 10100 Col. 9		
T-95	Caustic Soda	Houston, Texas	Dallas, Texas (Intra)	46	40,000	SWMFT 25-L ITEM 10100 Col. 9		
T-96	Soda Ash	Lake Charles, La.	Palestine, Texas	53	33,000	SWMFT 1-X ITEM 15020 Col. 4		
T-97	Soda Ash	Oakwood, Texas	Palestine, Texas	21	33,000	SWMFT 1-X ITEM 15020 Col. 4		
T-98	Soda Ash	Lake Charles, La.	Dallas, Texas	55	40,000	SWMFT 1-X ITEM 6345		
T-99	Melamine Crystals	Galveston, Texas	Dallas, Texas	43½	105,000	SWMFT 3-T ITEM 5755 Rated as Plastic Granules		
T-100	Plastic Resin or	Houston, Texas	Mineral Wells, Tex.(Intra)	58	68,000	SWMFT 25-L ITEM 5720 Rated as Plastic material		
	Polyvinyl Chloride							
	Resin Compound							
T-101	Plastic Resin or	Dallas, Texas	Mineral Wells, Tex. (Intra)	35	68,000	SWMFT 25-L ITEM 5720 Rated as Plastic material		
	Polyvinyl Chloride							
	Resin Compound							
T-102	Plastic Resin or	Ft. Worth, Texas	Mineral Wells, Tex. (Intra)	29	68,000	SWMFT 25-L ITEM 5720 Rated as Plastic material		
	Polyvinyl Chloride							
	Resin Compound							
T-103	Fertilizer	Houston, Texas	Greenville, Texas (Intra)	40	46,000	SWMFT 25-L ITEM 10320 Col. 2		
T-104	Formalin	Bishop, Texas	Dallas, Texas (Intra)	105	30,000	SWMFT 25-L ITEM 7460 Intermediate application		
T-105	Solvents (Tank Truck)	Freeport, Texas	Dallas, Texas (Intra)	52½	36,000	RRC 10-E ITEM 105 Col. 1		
T-106	Toluene (Tank Truck)	Houston, Texas	Dallas, Texas (Intra)	44½	36,000	RRC 10-E ITEM 105 Col. 1		
T-107	Formalin	Bishop, Texas	Corpus Christi, Texas	38	36,000	SWMFT 25-L ITEM 2660		
			(Intra)					
T-108	Crude Rubber	Houston, Texas	Dallas, Texas (Intra)	50	80,000	SWMFT 25-L ITEM 9395		
T-109	Perlite	Ft. Worth, Texas	Houston, Texas (Intra)	44	37,000	SWMFT 25-L ITEM 9095		
T-110	Cottonseed	Denton, Texas	Sugarland, Texas (Intra)	34½	36,000	RRC 8-B In bulk		
T-111	Cottonseed	Denton, Texas	Dallas, Texas (Intra)	13½	36,000	RRC 8-B Construction rate in bulk		

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(3) Interstate rate unless otherwise specified
(4) Tariff authority not furnished with O.C.E. revisions

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation COMMON CARRIER TRUCKLOAD

SHEET 3 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
T-112	Cottonseed	Dentor, Texas	Fort Worth, Texas (Intra)	13½	36,000	RRC 8-B Constructed rate in bulk		
T-113	Molasses	Houston, Texas	Dallas, Texas (Intra)	37½	36,000	RRC 10-E Tank truck		
	Molasses	Houston, Texas	Dallas, Texas (Intra)	57	38,000	SWMFT 25-L ITEM 10370 Rated as syrup in drums		
T-114	Molasses	Houston, Texas	Ft. Worth, Texas (Intra)	37½	36,000	RRC 10-E Tank truck		
	Molasses	Houston, Texas	Ft. Worth, Texas (Intra)	57	38,000	SWMFT 25-L ITEM 10370 Rated as syrup in drums		
T-115	Molasses	Dallas, Texas	Ft. Worth, Texas (Intra)	12½	36,000	RRC 10-E Tank Truck		
	Molasses	Dallas, Texas	Ft. Worth, Texas (Intra)	26	38,000	SWMFT 25-L ITEM 10370 Rated as syrup in drums		
T-116	Cottonseed Meal	Freeport, Texas	Carthage, Texas (Intra)	30½	36,000	RRC 8-B		
T-117	Cottonseed Meal	Oakwood, Texas	Carthage, Texas (Intra)	21½	36,000	RRC 8-B		
T-118	Cottonseed Meal	Shreveport, La.	Carthage, Texas	25½	60,000	SWL 2004-H ITEM 10350 Constructed rate		
T-119	Cottonseed Oil	Waxahachie, Texas	Houston, Texas	39½	60,000	SWL 2004-H ITEM 10350 Constructed rate		
T-120	Cottonseed Oil	Waxahachie, Texas	Rosser, Texas	25½	60,000	SWL 2004-H ITEM 10350 Constructed rate		
T-121	Fatty Acid	Dallas, Texas	Houston, Texas (Intra)	32	42,500	SWMFT 25-L ITEM 10865 Rated as petroleum fatty acid		
T-122	Syrup	Houston, Texas	Nacogdoches, Tex. (Intra)	42	38,000	SWMFT 25-L ITEM 10370 Col. 3		
T-123	Flour	Dallas, Texas	Houston, Texas (Intra)	45	30,000	SWMFT 25-L ITEM 10560		
	T-124 thru T-132 are continued on Page ((							
			TYPE OF TRANSPORTATION	- RAIL-CARLOAD				
R-1	(Iron, Steel Plate or Sheet)	Houston, Texas	Dallas, Texas (Intra)	33	120,000	TL FB 60-I ITEM 28500	30½	120,000
R-2	(Iron, Steel Plate or Sheet)	Chicago, Ill.	Ft. Worth, Texas	98	80,000	SWL 301-D ITEM 2750 RB 934		
R-3	(Iron, Steel Plate or Sheet)	Dallas, Texas	Ft. Worth, Texas	14½	80,000	TL FB 2-U ITEM 7930 RB 27.4		
R-4	(Iron, Steel Plate or Sheet)	Granite City, Ill.	Dallas, Texas	77	80,000	SWL 301-D ITEM 2750 RB 674		
R-5	(Iron, Steel Plate or Sheet)	Ft. Smith, Ark.	Dallas, Texas	41	80,000	SWL 301-D ITEM 2750 RB 287		
R-6	(Iron, Steel Plate or Sheet)	Granite City, Ill.	Ft. Worth, Texas	77	80,000	SWL 301-D ITEM 2750 RB 674		
R-7	(Iron, Steel Plate or Sheet)	Houston, Texas	Ft. Worth, Texas (Intra)	33	80,000	TL FB 60-J ITEM 28500	30½	120,000
R-8	(Iron, Steel Plate or Sheet)	Chicago, Ill.	Dallas, Texas	98	80,000	SWL 301-D ITEM 2750 RB 934		
R-9	(Iron, Steel Plate or Sheet)	Youngstown, Ohio	Waxahachie, Texas	122	80,000	SWL 301-D ITEM 2750 RB1229		
R-10	(Iron, Steel Plate or Sheet)	Fairfield, Ala	Dallas, Texas	77	80,000	SWL 301-D ITEM 2750 RB 676		
R-11	(Iron, Steel Plate or Sheet)	Fairfield, Ala.	Birmingham, Ala.	11½	10,000	SFTB 240-I ITEM 50128		
R-12	(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Dallas, Texas	28½	80,000	TL FB 2-U ITEM 7930 RB 162		
R-13	(Iron, Steel Plate or Sheet)	Chicago, Ill	Waxahachie, Texas	98	80,000	SWL 301-D ITEM 2750 RB 946		
R-14	(Iron, Steel Plate or Sheet)	Rosser, Texas	Waxahachie, Texas	13½	80,000	TL FB 2-U ITEM 7930 NOTE: No rail service presently available between Rosser, Waxahachie. Rate is that which would apply if service was available		
R-15	(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Waxahachie, Texas	29½	80,000	TL FB 2-U ITEM 7930 RB 164		
R-16	(Iron, Steel Plate or Sheet)	Midland, Pa.	Dallas, Texas	122	80,000	SWL 301-D ITEM 2750 RB1243		
R-17	(Iron, Steel Plate or Sheet)	Chicago, Ill.	Burleson, Texas	100	80,000	SWL 301-D ITEM 2750 RB 964		
R-18	(Iron, Steel Plate or Sheet)	Dallas, Texas	Burleson, Texas	15½	80,000	TL FB 2-U ITEM 7930 RB 40.7		
R-19	(Iron, Steel Plate or Sheet)	Ft. Worth, Texas	Burleson, Texas	13½	80,000	TL FB 2-U ITEM 7930 RB 14.5		
R-20	(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Burleson, Texas	31½	80,000	TL FB 2-U ITEM 7930 RB 193		
R-21	(Iron, Steel Plate or Sheet)	Houston, Texas	Dallas, Texas	36½	120,000	TL FB 2-U ITEM 7930 RB 242	30½	120,000
R-22	(Iron, Steel Plate or Sheet)	Kansas City, Kansas	Dallas, Texas	61½	80,000	SWL 3-1-D ITEM 2750 RB 503		
R-23	(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Grand Prairie, Texas	28½	80,000	TL FB 2-U ITEM 7930 RB 162		
R-24	(Iron, Steel Plate or Sheet)	Dallas, Texas	Garland, Texas	13½	80,000	TL FB 2-U ITEM 7930 RB 15.6		

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(4) Tariff authority not furnished with O.C.E. revisions

TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project - - - TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation - - RAIL-CARLOAD

SHEET 4 OF 12

ITEM NO.		COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT(2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4) RATE	OCE REVISIONS TO CONTRACT DATA (4) MINIMUM WEIGHT
R-25		(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Garland, Texas	28½	80,000	TL FB 2-U ITEM 7930 RB 162		
R-26		(Iron, Steel Plate or Sheet)	Wood River, Ill.	Dallas, Texas	77	80,000	SWL 301-D ITEM 2750 RB 674		
R-27		(Iron, Steel Plate or Sheet)	Gary, Indiana	Terrell, Texas	98	80,000	SWL 301-D ITEM 2750 RB 934		
R-28		(Iron, Steel Plate or Sheet)	Rosser, Texas	Kaufman, Texas	13	80,000	TL FB 2-U ITEM 7930 Constructed rate		
R-29		(Iron, Steel Plate or Sheet)	Daingerfield, Texas	Kaufman, Texas	26½	80,000	TL FB 2-U ITEM 7930 Constructed rate	4.70NT	
R-30		(Iron, Steel Plate or Sheet)	Birmingham, Ala.	Dallas, Texas	78	80,000	SWL 301-D ITEM 2750 RB 692		
R-31		(Iron, Steel Plate or Sheet)	Houston, Texas	Lubbock, Texas (Intra)	63½	80,000	TL FB 60-J ITEM 15942 533.7 Miles		
R-32		(Iron, Steel Plate or Sheet)	Dallas, Texas	Lubbock, Texas (Intra)	45½	80,000	TL FB 60-J ITEM 15942 351.0 Miles		
R-33		(Iron, Steel Plate or Sheet)	Ft. Worth, Texas	Lubbock, Texas (Intra)	43½	80,000	TL FB 60-J ITEM 15942 322.4 Miles		
R-34		(Iron, Steel Plate or Sheet)	Houston, Texas	Waco, Texas	30½	80,000	TL FB 2-U ITEM 7930		
R-35		(Iron, Steel Plate or Sheet)	Oakwood, Texas	Waco, Texas	28½	80,000	TL FB 2-U ITEM 7930		
R-36		(Iron, Steel Plate or Sheet)	Houston, Texas	Hurst, Texas (Intra)	33	80,000	TL FB 60-J ITEM 28500		
R-37		(Iron, Steel Plate or Sheet)	Houston, Texas	Waxahachie, Texas	33½	120,000	TL FB 75-M ITEM 15336		
R-38		(Iron, Steel Plate or Sheet)	Houston, Texas	Paris, Texas (Intra)	45½	80,000	TL FB 60-J ITEM 15942 343.6 Miles		
R-39		(Iron, Steel Plate or Sheet)	Bethlehem, Pa.	Dallas, Texas	150	80,000	SWL 301-D ITEM 2750		
R-40		(Iron, Steel Plate or Sheet)	Bethlehem, Pa.	Trenton, N. J.	19	80,000	PRR 483-C		
R-41		(Iron, Steel Plate or Sheet)	Houston, Texas	Kaufman, Texas	30½	80,000	TL FB 75-M ITEM 15336		
R-42		(Iron, Steel Plate or Sheet)	Houston, Texas	Ft. Worth, Texas	30½	120,000	TL FB 75-M ITEM 15354		
R-43		(Iron, Steel Plate or Sheet)	Bessemer, Ala.	Birmingham, Ala.	11½	80,000	SFTB 240-I ITEM 50128		
R-44		(Iron, Steel Plate or Sheet)	Chicago, Ill.	McGregor, Texas	104	80,000	SWL 301-D ITEM 2750		
R-45		(Iron, Steel Plate or Sheet)	Weirton, W. Va.	Waxahachie, Texas	120	80,000	SWL 301-D ITEM 2750		
R-46		(Iron, Steel Plate or Sheet)	Houston, Texas	Ennis, Texas	32½	80,000	TL FB 2-U ITEM 7930		
R-47		(Iron, Steel Plate or Sheet)	Rosser, Texas	Ennis, Texas	17½	80,000	TL FB 2-U ITEM 7930 Constructed		
R-48		Wrought Iron Pipe	Wood River, Ill.	Dallas, Texas	98	70,000	SWL 259-E ITEM 6590	10.60NT	
R-49		Wrought Iron Pipe	Bethlehem, Pa.	Dallas, Texas	136	70,000	SWL 259-E ITEM 15590		
R-50		Wrought Iron Pipe	Bethlehem, Pa.	Trenton, N. J.	19	80,000	PRR 483-C		
R-51		Wrought Iron Pipe	Ft. Smith, Ark.	Carrollton, Texas	77	40,000	TL 2-U ITEM 8200		
R-52		Wrought Iron Pipe	Houston, Texas	Lubbock, Texas (Intra)	97	40,000	TL FB 60-J ITEM 17260 533.7 Miles		
R-53		Wrought Iron Pipe	Dallas, Texas	Lubbock, Texas (Intra)	73	40,000	TL FB 60-J ITEM 17260 351.0 Miles		
R-54		Wrought Iron Pipe	Ft. Worth, Texas	Lubbock, Texas (Intra)	71	40,000	TL FB 60-J ITEM 17260 NOTE 6 322.4 Miles		
R-55		Wrought Iron Pipe	Pittsburg, Pa.	Ft. Worth, Texas	120	70,000	SWL 259-E ITEM 6926		
R-56		Wrought Iron Pipe	Sparrows Pt., Md.	Ft. Worth, Texas	133	70,000	SWL 259-E ITEM 15926		
R-57		Wrought Iron Pipe	Chicago, Ill.	Grand Prairie, Texas	110	70,000	SWL 259-E ITEM 7062		
R-58		Wrought Iron Pipe	Benwood, W. Va.	Grand Prairie, Texas	124	70,000	SWL 259-E ITEM 16062		
R-59		(Iron or Steel Vessels S. U.)	Dallas, Texas	Houston, Texas	65½	24,000	SWL 2004-H ITEM 13900 Com Col 272		
R-60		Tin Plate	Fairfield, Ala.	Dallas, Texas	10.02 NT	100,000	SWL 301-D ITEM 5400	10.10NT	
R-61		Tin Plate	Fairfield, Ala.	Birmingham, Ala.	11	100,000	SFTB 240-I		
R-62		Lead Ingots	Dallas, Texas	Houston, Texas	38½	100,000	TL FB 60-J ITEM 28860		
R-63		Zinc Slab	Houston, Texas	Amarillo, Texas	11.90 NT	100,000	TL FB 75-M ITEM 11840	10.71NT	
R-64		Zinc Slab	Dallas, Texas	Amarillo, Texas	7.29 NT	100,000	Constructed Rate No Commodity Rate Published	8.20NT	
R-65		Zinc Slab	Ft. Worth, Texas	Amarillo, Texas	702	100,000	Constructed Rate No Commodity Rate Published	8.20NT	
R-66		Steel Scrap	Ft. Worth, Texas	Eagle Pass, Texas	54½	75,000	TL 70-G ITEM 7040		
R-67		Steel Scrap	Corpus Christi, Texas	Eagle Pass, Texas	4.81 Ton of 2240	100,000	TL 70-G ITEM 2719	4.29NT	

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation RAIL-CARLOAD

SHEET 5 OF 12

ITEM NO.		COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4) RATE	MINIMUM WEIGHT
R-68		Steel Scrap	Dallas, Texas	Houston, Texas	28½	100,000	SWL 2004-H ITEM 13050	29½	
R-69		Steel Scrap	Dallas, Texas	Laredo, Texas	55½	75,000	TL 70-G ITEM 7043		
R-70		Steel Scrap	Corpus Christi, Texas	Laredo, Texas	4.81 Ton of 2240	100,000	TL 70-G ITEM 2719	4.29NT	
R-71		Steel Scrap	Dallas, Texas	Eagle Pass, Texas	54½	75,000	TL 70-G ITEM 7040	55½	
R-72		Steel Scrap	Corpus Christi, Texas	Eagle Pass, Texas	4.81 Ton of 2240	100,000	TL 70-G ITEM 2719	4.29NT	
R-73		Newsprint	Calhoun, Tenn.	Dallas, Texas	98	40,000	SWL 281-G ITEM 1560 Col. F	13.58NT	100,000
R-74		Newsprint	Daingerfield, Texas	Dallas, Texas	26	100,000	SWL 306-C ITEM 4470 Col. 3	4.75NT	
R-75		Newsprint	Calhoun, Tenn.	Ft. Worth, Texas	98	40,000	SWL 281-G ITEM 1560 Col. F	13.58NT	100,000
R-76		Newsprint	Dallas, Texas	Ft. Worth, Texas	16	100,000	SWL 306-C ITEM 4470 Col. 3	2.90NT	
R-77		Newsprint	Daingerfield, Texas	Ft. Worth, Texas	28	100,000	SWL 306-C ITEM 4470 Col. 3	4.75NT	
R-78		Newsprint	Calhoun, Tenn.	Lubbock, Texas	114	40,000	SWL 281-G ITEM 1560 Col. F	15.95NT	100,000
R-79		Newsprint	Ft. Worth, Texas	Lubbock, Texas	42	100,000	SWL 306-C ITEM 4470 Col. 3	7.58NT	
R-80		Newsprint	Dallas, Texas	Lubbock, Texas	43	100,000	SWL 306-C ITEM 4470 Col. 3	7.58NT	
R-81		Newsprint	Daingerfield, Texas	Lubbock, Texas	54	100,000	SWL 306-C ITEM 4470 Col. 3	9.95NT	
R-82		Newsprint	Coosa Pines, Ala.	Dallas, Texas	89	40,000	SWL 281-G ITEM 1560 Col. F	12.33NT	100,000
R-83		Newsprint	Houston, Texas	Dallas, Texas (Intra)	35	100,000	SWL 306-C ITEM 4470 Col. 3	6.53NT	
R-84		Newsprint	Ft. Smith, Ark.	Dallas, Texas	36	100,000	SWL 306-C ITEM 4470 Col. 3	6.73NT	
R-85		Newsprint	Pine Bluff, Ark.	Dallas, Texas	42	100,000	SWL 306-C ITEM 4470 Col. 3	7.78NT	
R-86		Newsprint	Lufkin, Texas	Corpus Christi, Tex(Intra)	43	100,000	TL 60-J ITEM 17025	7.78NT	
R-87		Newsprint	Herty, Texas	Corpus Christi, Tex(Intra)	43	100,000	TL 60-J ITEM 17025	7.78NT	
R-88		Newsprint	Herty, Texas	Abilene, Texas (Intra)	45	100,000	TL 60-J ITEM 17025	8.18NT	
R-89		Newsprint	Herty, Texas	Urbana, Texas (Intra)	16	100,000	TL 60-J ITEM 17025	3.63NT	
R-90		Newsprint	Herty, Texas	Riverside, Texas (Intra)	25	100,000	TL 60-J ITEM 17025	4.55NT	
R-91		Newsprint	Ft. Worth, Texas	Abilene, Texas (Intra)	26	100,000	TL 60-J ITEM 17025	5.08NT	
R-92		Newsprint	Dallas, Texas	Abilene, Texas (Intra)	29	100,000	TL 60-J ITEM 17025	5.08NT	
R-93		Newsprint	Lufkin, Texas	Ft. Worth, Texas (Intra)	32	100,000	TL 60-J ITEM 17025	5.80NT	
R-94		Newsprint	Lufkin, Texas	Riverside, Texas (Intra)	25	100,000	TL 60-J ITEM 17025	4.55NT	
R-95		Newsprint	Lufkin, Texas	Lubbock, Texas (Intra)	56	100,000	TL 60-J ITEM 17025	10.15NT	
R-96		Newsprint	Lufkin, Texas	Oakwood, Texas (Intra)	21	100,000	TL 60-J ITEM 17025	3.63NT	
R-97		Newsprint	Ft. Worth, Texas	Lubbock, Texas (Intra)	42	100,000	TL 60-J ITEM 17025	7.58NT	
R-98		Newsprint	Dallas, Texas	Lubbock, Texas (Intra)	43	100,000	TL 60-J ITEM 17025	7.58NT	
R-99		Newsprint	Herty, Texas	Dallas, Texas (Intra)	29	100,000	TL 60-J ITEM 17025	5.80NT	
R-100		Newsprint	Herty, Texas	Oakwood, Texas (Intra)	21	100,000	TL 60-J ITEM 17025	3.63NT	
R-101		Paper Scrap	Houston, Texas	Dallas, Texas (Intra)	26½	50,000	TL 60-J ITEM 31950		
R-102		Paper Scrap	Kansas City, Kan.	Dallas, Texas	36½	80,000	SWL 2006-H ITEM 15600		
R-103		Paper Scrap	Ft. Smith, Ark.	Dallas, Texas	28	80,000	SWL 2004-H ITEM 15600		
R-104		Paper Scrap	Daingerfield, Texas	Dallas, Texas	22	80,000	SWL 2004-H ITEM 15600		
R-105		Wrapping Paper	Savannah, Ga.	Waco, Texas	70	90,000	SWL 281-G ITEM 2045 Col. A		
R-106		Wrapping Paper	Oakwood, Texas	Waco, Texas	23	90,000	SWL 281-G ITEM 2045		
R-107		Wrapping Paper	Houston, Texas	Southard, Okla.	48	90,000	SWL 306-C ITEM 4610 Col. A		
R-108		Wrapping Paper	Dallas, Texas	Southard, Okla.	33	90,000	SWL 306-C ITEM 4610 Col. A		
R-109		Wrapping Paper	Tulsa, Okla.	Southard, Okla.	23	90,000	SWL 306-C ITEM 4610 Col. A	25	
R-110		Wrapping Paper	Houston, Texas	Sweetwater, Texas (Intra)	41	90,000	TL 60-J ITEM 16945 Com. Col. 1118		
R-111		Wrapping Paper	Ft. Worth, Texas	Sweetwater, Texas (Intra)	27	90,000	TL 60-J ITEM 16945 Com. Col. 1118		
R-112		Wrapping Paper	Dallas, Texas	Sweetwater, Texas (Intra)	29	90,000	TL 60-J ITEM 16945 Com. Col. 1118		
R-113		Wrapping Paper	Lufkin, Texas	Houston, Texas (Intra)	21	90,000	TL 60-J ITEM 16945 Com. Col. 1118		
R-114		Wrapping Paper	Lufkin, Texas	Urbana, Texas (Intra)	15	90,000	TL 60-H' ITEM 16945 Com. Col. 1118		
R-115		Wrapping Paper	West Monroe, La.	Dallas, Texas	35	90,000	SWL 306-C ITEM 4610 Col. A		
R-116		Wrapping Paper	Daingerfield, Texas	Dallas, Texas	23	90,000	SWL 306-C ITEM 4610 Col. A		
R-117		Wrapping Paper	West Monroe, La.	Wichita Falls, Texas	42	90,000	SWL 306-C ITEM 4610 Col. A		
R-118		Wrapping Paper	Ft. Worth, Texas	Wichita Falls, Texas	21	90,000	SWL 306-C ITEM 4610 Col. A		
R-119		Wrapping Paper	Dallas, Texas	Wichita Falls, Texas	23	90,000	SWL 306-C ITEM 4610 Col. A		
R-120		Wrapping Paper	Daingerfield, Texas	Wichita Falls, Texas	30	90,000	SWL 306-C ITEM 4610 Col. A		
R-121		Wrapping Paper	Bogalusa, La.	Dallas, Texas	49	90,000	SWL 281-G ITEM 2045 Col. A		
R-122		Wrapping Paper	Pine Bluff, Ark.	Waco, Texas	41	90,000	SWL 306-C ITEM 4610 Col. A		
R-123		Wrapping Paper	Daingerfield, Texas	Waco, Texas	27	90,000	SWL 306-C ITEM 4610 Col. A	26	
R-124		Wrapping Paper	Hartsville, S. C.	Dallas, Texas	74	90,000	SWL 281-G ITEM 2045 Col. A		
R-125		Wrapping Paper	Jacksonville, Fla.	Dallas, Texas	69	90,000	SWL 281-G ITEM 2045 Col. A		
R-126		Fiberboard, Pulpboard	Alton, Ill.	Dallas, Texas	52	90,000	SWL 281-G ITEM 2045 Col. B		
R-127		Fiberboard, Pulpboard	Daingerfield, Texas	Dallas, Texas	22	90,000	SWL 306-C ITEM 4610 Col. B	23	
R-128		Fiberboard, Pulpboard	Waynesville, N. C.	Ft. Worth, Texas	70½	90,000	SWL 281-G ITEM 2045 Col. B		
R-129		Fiberboard, Pulpboard	Demopolis, Ala.	Waco, Texas	47½	90,000	SWL 281-G ITEM 2045 Col. B	50½	
R-130		Fiberboard, Pulpboard	Oakwood, Texas	Waco, Texas	22	90,000	SWL 306-C ITEM 4610 Col. B		
R-131		Fiberboard, Pulpboard	Brewton, Ala.	Ft. Worth, Texas	52½	90,000	SWMFT281-G ITEM 2045 Col. B		
R-132		Fiberboard, Pulpboard	Brewton, Ala	Pensacola, Fla.	39	90,000	SFTB 867-D ITEM 59508 RB 404		
R-133		Fiberboard, Pulpboard	Dallas, Texas	Ft. Worth, Texas	13	90,000	SWL 306-C ITEM 4610		

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION FEATURES
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project __ TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation __ RAIL-CARLOAD

SHEET 6 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4) RATE	OCE REVISIONS TO CONTRACT DATA (4) MINIMUM WEIGHT
R-134	Fiberboard, Pulpboard	Daingerfield, Texas	Ft. Worth, Texas	23½	90,000	SWL 306-C ITEM 4610	23	
R-135	Fiberboard, Pulpboard	Quincy, Ill.	Arlington, Texas	51	90,000	SWL 281-G ITEM 2045		
R-136	Fiberboard, Pulpboard	Bogalusa, La.	Dallas, Texas	47	90,000	SWL 281-G ITEM 2045		
R-137	Fiberboard, Pulpboard	Counce, Tenn.	Arlington, Texas	47½	90,000	SWL 281-G ITEM 2045		
R-138	Fiberboard, Pulpboard	Dallas, Texas	Arlington, Texas	13	90,000	SWL 306-C ITEM 4610		
R-139	Fiberboard, Pulpboard	Hattiesburg, Miss.	Carrollton, Texas	44½	90,000	SWL 281-G ITEM 2045		
R-140	Fiberboard, Pulpboard	Hattiesburg, Miss.	Bogalusa, La.	20	90,000	SWL 281-G ITEM 2045		
R-141	Fiberboard, Pulpboard	Dallas, Texas	Carrollton, Texas	13	90,000	SWL 306-C ITEM 4610		
R-142	Fiberboard, Pulpboard	Pine Bluff, Ark.	Waco, Texas	39	90,000	SWL 281-G ITEM 2045		
R-143	Fiberboard, Pulpboard	Rome, Ga.	Carrollton, Texas	58	90,000	SWL 281-G ITEM 2045		
R-144	Fiberboard, Pulpboard	Fernadnia, Fla.	Ft. Worth, Texas	66½	90,000	SWL 281-G ITEM 2045		
R-145	Pulpwood	Trinity, Texas	Pasadena, Texas (Intra)	18 Cords @ 2.92/Cord	52.56/ car	TFLB 60-J ITEM 17580 NOTE: 1 Cord=4800 lbs. or 2.4 tons		
R-146	Pulpwood	Trinity, Texas	Riverside, Texas (Intra)	18 Cords @ 1.92/Cord	34.56/car	TLFB 60-J ITEM 17580		
R-147	Pulpwood	Huntsville, Texas	Pasadena, Texas (Intra)	18 Cords @ 2.74/Cord	49.32/car	TLFB 60-J ITEM 17580		
R-148	Pulpwood	Huntsville, Texas	Riverside, Texas (Intra)	18 Cords @ 2.09/Cord	37.62/car	TLFB 60-J ITEM 17580		
R-149	Coke	St. Louis, Mo.	Ft. Worth, Texas	9.75 NT	80,000	SWL 36-T ITEM 2405-B	7.20NT	
R-150	Coke	Ft. Smith, Ark.	Ft. Worth, Texas	5.54 NT	80,000	SWL 36-T ITEM 2405-B		
R-151	Coke	Daingerfield, Texas	Ft. Worth, Texas	4.78 NT	80,000	SWL 36-T ITEM 2405-B Constructed Rate		
R-152	Coke	Dallas, Texas	Ft. Worth, Texas	3.24	80,000	SWL 36-T ITEM 2405-B Constructed Rate		
R-153	Timber Raw	Woodville, Texas	Houston, Texas (Intra)	16½	30,000	TLFB 36-H ITEM 5810		
R-154	Timber Raw	Woodville, Texas	Urbana, Texas (Intra)	12½	30,000	TLFB 36-H ITEM 5810 Constructed Rate		
R-155	Woodchips	Crockett, Texas	Pasadena, Texas (Intra)	1.81 NT	95,000	TLFB 60-J ITEM 39800		
R-156	Woodchips	Crockett, Texas	Riverside, Texas (Intra)	1.02 NT	95,000	TLFB 60-J ITEM 39840 Constructed Rate		
R-157	Brick	Coleman, Texas	Houston, Texas (Intra)	18½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-158	Brick	Coleman, Texas	Ft. Worth, Texas (Intra)	12½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-159	Brick	Coleman, Texas	Dallas, Texas (Intra)	13½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-160	Brick	Coleman, Texas	Beaumont, Texas (Intra)	22½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-161	Brick	Malakoff, Texas	Houston, Texas (Intra)	13½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-162	Brick	Malakoff, Texas	Trinidad, Texas (Intra)	06	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-163	Brick	Malakoff, Texas	New Orleans, La.	44½	80,000	SWL 142-L ITEM 7010	22	120,000
R-164	Brick	Malakoff, Texas	Trinidad, Texas (Intra)	06	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-165	Brick	Teague, Texas	New Orleans, La.	45½	80,000	SWL 142-L ITEM 7010	23	120,000
R-166	Brick	Teague, Texas	Oakwood, Texas	19½	80,000	SWL 142-L ITEM 7010 Constructed Rate	08	120,000
R-167	Brick	Teague, Texas	Houston, Texas	12½	100,000	TLFB 60-J ITEM 13450 Com. Col. 935		
R-168	Brick	Teague, Texas	Baton Rouge, La.	42½	80,000	SWL 142-L ITEM 7010	21	120,000
R-169	Silica Sand	Teague, Texas	Houston, Texas (Intra)	3.54 NT	100,000	TLFB 84-I ITEM 520		
R-170	Silica Sand	Teague, Texas	Oakwood, Texas (Intra)	1.83 NT	100,000	TLFB 84-I ITEM 520 Constructed Rate		
R-171	Silica Sand	Mill Creek, Okla.	Laredo, Texas	6.03 NT	80,000	SWL 162-W ITEM 9800 Scale 2		
R-172	Silica Sand	Mill Creek, Okla.	Dallas, Texas	3.03 NT	80,000	SWL 162-W ITEM 3680		
R-173	Silica Sand	Corpus Christi, Texas	Laredo, Texas	3.63 NT	80,000	SWL 162-W ITEM 9800 Scale 2		
R-174	Silica Sand	Milburn, Okla.	Houston, Texas	4.74 NT	80,000	SWL 162-W ITEM 9800 Scale 2		
R-175	Silica Sand	Milburn, Okla.	Dallas, Texas	3.16 NT	80,000	SWL 162-W ITEM 9800 Scale 2		
R-176	Sand and Gravel	Midway, Texas	Houston, Texas (Intra)	1.52 NT	100,000	TLFB 84-I ITEM 480		
R-177	Sand and Gravel	Midway, Texas	Riverside, Texas (Intra)	.75 NT	100,000	TLFB 84-I ITEM 480		
R-178	Sand	Teague, Texas	Ft. Worth, Texas (Intra)	1.46 NT	100,000	TLFB 84-I ITEM 480		
R-179	Sand	Dallas, Texas	Ft. Worth, Texas (Intra)	.75 NT	100,000	TLFB 84-I ITEM 480		
R-180	Liquid Sulphuric acid in drums	Ft. Worth, Texas	Houston, Texas (Intra)	42	80,000	TLFB 60-I ITEM 12510	4.92NT	90,000
R-181	Liquid Sulphuric acid in drums	Ft. Worth, Texas	Dallas, Texas (Intra)	18	80,000	TLFB 60-J ITEM 12510	09	90,000
R-182	Caustic Acid	Lake Charles, La.	Ft. Worth, Texas	63½	70,000	SWL 2004-H ITEM 18250 Part 2	47½	100,000
R-183	Caustic Acid	Dallas, Texas	Ft. Worth, Texas	25½	70,000	SWL 2004-H ITEM 18250 Part 2	19	100,000
R-184	Caustic Acid	Lake Charles, La.	Dallas, Texas	63½	70,000	SWL 2004-H ITEM 18250 Part 2	47½	100,000
R-185	Caustic Soda	Lake Charles, La.	Miles, Texas	77	70,000	SWL 2004-H ITEM 18250 Part 1	57	100,000
R-186	Caustic Soda	Dallas, Texas	Miles, Texas	53½	70,000	SWL 2004-H ITEM 18250 Part 1	40	100,000
R-187	Caustic Soda	Ft. Worth, Texas	Miles, Texas	50½	70,000	SWL 2004-H ITEM 18250 Part 1	40	100,000
R-188	Caustic Soda	Port Neches, Texas	Dallas, Texas (Intra)	40½	100,000	TL 60-J ITEM 37040 In Tank Cars		
	Caustic Soda	Port Neches, Texas	Dallas, Texas (Intra)	57½	70,000	TL 60-J ITEM 18300 In Drums		
R-189	Soda Ash	Freeport, Texas	Waco, Texas (Intra)	36½	80,000	TL 60-J ITEM 36460	29	190,000
R-190	Soda Ash	Oakwood, Texas	Waco, Texas (Intra)	41½	70,000	TL 60-J ITEM 18300	25½	190,000
R-191	Soda Ash	Painesville, Ohio	Dallas, Texas	122	70,000	SWL 2005-H ITEM 18250 Part 1	1.16NT	190,000
R-192	Soda Ash	Daingerfield, Texas	Dallas, Texas	42½	70,000	SWL 2004-H ITEM 18250 Part 1		
R-193	Soda Ash	Fort Smith, Ark.	Dallas, Texas	56½	70,000	SWL 2004-H ITEM 18250 Part 1		
R-194	Soda Ash	Lake Charles, La.	Dallas, Texas	63½	70,000	SWL 2004-H ITEM 18250 Part 1	7.14NT	190,000
R-195	Soda Ash	Corpus Christi, Texas	Corsicana, Texas (Intra)	36½	80,000	TL 60-J ITEM 36460	31	190,000

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation RAIL-CARLOAD

SHEET 7 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
R-196	Soda Ash	Trinidad, Texas	Corsicana, Texas (Intra)	26½	70,000	TL 60-J ITEM 18300	14½	190,000
R-197	Soda Ash	Corpus Christi, Texas	Waxahachie, Texas (Intra)	49½	80,000	TL 60-J ITEM 36460 Intermediate Application	7.33NT	190,000
R-198	Soda Ash	Rosser, Texas	Waxahachie, Texas (Intra)	33½	70,000	TL 60-J ITEM 18300	18½	190,000
R-199	Malamine Crystals	Galveston, Texas	Dallas, Texas	55½	68,000	TL 60-J ITEM 17345		
R-200	Silicate of Soda	Dallas, Texas	Ft. Worth, Texas (Intra)	14½	100,000	TL 60-J ITEM 37080 In Tank Cars	07½	
	Silicate of Soda	Dallas, Texas	Ft. Worth, Texas (Intra)	27½	70,000	TL 60-J ITEM 18300 In Drums		
R-201	Elem. Phosphorus	Columbia, Tenn.	Dallas, Texas	129	100,000	SWL 1-E ITEM 20105		
R-202	Elem. Phosphorus	Daingerfield, Texas	Dallas, Texas	32	80,000	SWL 2004-H ITEM 9750		
R-203	Elem. Phosphorus	Muscle Shoals, Ala.	Brownfield, Texas	104	80,000	SWL 2007-G ITEM 9750		
R-204	Elem. Phosphorus	Daingerfield, Texas	Brownfield, Texas	65	80,000	SWL 2004-H ITEM 9750		
R-205	Elem. Phosphorus	Dallas, Texas	Brownfield, Texas	53	80,000	SWL 2004-H ITEM 9750		
R-206	Elem. Phosphorus	Ft. Worth, Texas	Brownfield, Texas	51	80,000	SWL 2004-H ITEM 9750		
R-207	Elem. Phosphorus	Muscle Shoals, Ala.	Florence, Ala.	20½	80,000	SFTB-S-2011-L ITEM 26442		
R-208	Phosphate	Dallas, Texas	Ft. Worth, Texas (Intra)	18	80,000	TLFB 60-J ITEM 12510	3.50NT	60,000
R-209	Elem. Phosphorus	Columbia, Tenn.	Brownfield, Texas	12.00 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	12.10NT	
R-210	Elem. Phosphorus	Dallas, Texas	Brownfield, Texas	7.20 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	6.70NT	
R-211	Elem. Phosphorus	Ft. Worth, Texas	Brownfield, Texas	6.80 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	6.70NT	
R-212	Elem. Phosphorus	Daingerfield, Texas	Brownfield, Texas	8.40 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	8.30NT	
R-213	Phosphate	Tampa, Fla.	Sulphur Springs, Texas	12.00 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	12.10NT	
R-214	Phosphate	Daingerfield, Texas	Sulphur Springs, Texas	3.08 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	2.40NT	100,000
R-215	Phosphate	Dallas, Texas	Sulphur Springs, Texas	3.40 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	2.40NT	100,000
R-216	Phosphate	Houston, Texas	Ft. Worth, Texas (Intra)	39	80,000	TLFB 60-J ITEM 12510	6.90NT	60,000
R-217	Phosphate	Houston, Texas	Dallas, Texas	5.60 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	5.30NT	
R-218	Phosphate	Daingerfield, Texas	Dallas, Texas	4.40 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	3.37	100,000
R-219	Soda Phosphate	Dallas, Texas	Chicago, Ill.	119	80,000	SWL 2006-H ITEM 9750	74½	70,000
R-220	Soda Phosphate	Dallas, Texas	Daingerfield, Texas	32	80,000	SWL 2004-H ITEM 9750	23	70,000
R-221	Soda Ash	Baton Rouge, La.	Dallas, Texas	57	80,000	SWL 2004-H ITEM 9750	7.74NT	190,000
R-222	Soda Ash	Corpus Christi, Texas	Dallas, Texas (Intra)	46½	36,000	TL 60-J ITEM 18205	7.33NT	190,000
R-223	Ammonium Phosphate	Cherokee, Ala.	Dallas, Texas	9.20 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	8.90NT	
R-224	Ammonium Phosphate	Cherokee, Ala.	Florence, Ala.	2.65 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	1.29NT	100,000
R-225	Ammonium Phosphate	Daingerfield, Texas	Dallas, Texas	4.40 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	3.37NT	100,000
R-226	Ammonium Sulfate	Houston, Texas	Dallas, Texas (Intra)	4.90 NT	100,000	TL 60-J ITEM 14830		
R-227	Ammonium Nitrate	Yazoo City, Miss.	Sulphur Springs, Texas	7.80 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	7.10NT	
R-228	Ammonium Nitrate	Dallas, Texas	Sulphur Springs, Texas	3.40 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	2.40NT	100,000
R-229	Ammonium Nitrate	Daingerfield, Texas	Sulphur Springs, Texas	3.08 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	2.40NT	100,000
R-230	Ammonium Nitrate	Cherokee, Ala.	Dallas, Texas	9.20 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	8.90NT	
R-231	Ammonium Nitrate	Cherokee, Ala.	Florence, Ala.	2.59 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	1.29NT	100,000
R-232	Ammonium Nitrate	Daingerfield, Texas	Dallas, Texas	4.90 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	3.37NT	100,000
R-233	Urea	Kerens, Texas	Galveston, Texas	5.60 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	3.70NT	
R-234	Urea	Kerens, Texas	Trinidad, Texas	2.38 NT	60,000	SWL 273-C ITEM 1518-C As Fertilizer	1.29NT	10,000
R-235	Urea	Kerens, Texas	Houston, Texas	5.20 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	3.70NT	
R-236	Urea	Trinidad, Texas	Houston, Texas	3.68 NT	100,000	SWL 75-M ITEM 4537-A As Fertilizer Supl. 32	4.30NT	
R-237	Fertilizer	Houston, Texas	Rockwell, Texas (Intra)	5.50 NT	100,000	TL 60-J ITEM 14830		
R-238	Fertilizer	Dallas, Texas	Rockwell, Texas (Intra)	1.29 NT	100,000	TL 60-J ITEM 14830		
R-239	Fertilizer	Houston, Texas	Waco, Texas (Intra)	3.70 NT	100,000	TL 60-J ITEM 14830		
R-240	Fertilizer	Oakwood, Texas	Waco, Texas (Intra)	2.87 NT	100,000	TL 60-J ITEM 14830		
R-241	Fertilizer	Houston, Texas	Greenville, Texas (Intra)	5.90 NT	100,000	TL 60-J ITEM 14830		
R-242	Fertilizer	Dallas, Texas	Greenville, Texas (Intra)	1.53 NT	100,000	TL 60-J ITEM 14830		
R-243	Polyethylene Pellets	Texas City, Texas	Ft. Worth, Texas (Intra)	53½	68,000	TL 60-J ITEM 17345	42½	
R-244	Polyethylene Pellets	Dallas, Texas	Ft. Worth, Texas (Intra)	24½	68,000	TL 60-J ITEM 17345	20½	
R-245	Phosphoric Acid	Tampa, Fla.	Trinidad, Texas	12.00 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	12.10NT	
R-246	Nitrogen Solution	Houston, Texas	Brownfield, Texas	8.80 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer	8.50NT	
R-247	Nitrogen Solution	Dallas, Texas	Brownfield, Texas	7.20	100,000	SWL 273-C ITEM 1518-C As Fertilizer	6.70NT	
R-248	Nitrogen Solution	Ft. Worth, Texas	Brownfield, Texas	7.00	100,000	SWL 273-C ITEM 1518-C As Fertilizer	6.70NT	
R-249	Nitrogen Solution	Daingerfield, Texas	Brownfield, Texas	8.40	100,000	SWL 273-C ITEM 1518-C As Fertilizer	8.30NT	
R-250	Solvents (Tank Car)	Freeport, Texas	Dallas, Texas (Intra)	52½	60,000	TL 60-J ITEM 14010		
R-251	LPG (Tank Car)	Ranger, Texas	Houston, Texas (Intra)	57½	60,000	TLFB 48-R ITEM 30200	28½	
R-252	LPG (Tank Car)	Ranger, Texas	Dallas, Texas (Intra)	39½	60,000	TLFB 48-R ITEM 30200	19½	
R-253	LPG (Tank Car)	Ranger, Texas	Ft. Worth, Texas (Intra)	33½	60,000	TLFB 48-R ITEM 30200	19½	
R-254	LPG (Tank Car)	Ft. Worth, Texas	Houston, Texas (Intra)	50½	60,000	TLFB 48-R ITEM 30200	26½	
R-255	LPG (Tank Car)	Ft. Worth, Texas	Dallas, Texas (Intra)	20½	60,000	TLFB 48-R ITEM 30200	13	
R-256	LPG (Tank Car)	Sherman, Texas	Houston, Texas (Intra)	55½	60,000	TLFB 48-R ITEM 30200	27½	
R-257	LPG (Tank Car)	Sherman, Texas	Dallas, Texas (Intra)	28½	60,000	TLFB 48-R ITEM 30200	18	
R-258	LPG (Tank Car)	Houston, Texas	Pierce Jct., Texas (Intra)	19½	60,000	TLFB 48-R ITEM 30200	11	
R-259	Phosphate Rock	Mulberry, Fla.	Ft. Worth, Texas	8.40 NT	100,000	SFTB 876-B ITEM 30970		
R-260	Phosphate Rock	Mulberry, Fla.	Tampa, Fla.	1.94 NT	100,000	SFTB 876-B ITEM 30970	1.14NT	
R-261	Phosphate Rock	Tampa, Fla.	Nacogdoches, Texas	8.15 NT	100,000	SFTB 876-B ITEM 30970	7.53NT	
R-262	Phosphate Rock	Oakwood, Texas	Nacogdoches, Texas	2.70 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate	2.40NT	

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project: TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation: RAIL-CARLOAD

SHEET 8 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
R-263	Phosphate Rock	Shreveport, La	Nacogdoches, Texas	2.90 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate		
R-264	Phosphate Rock	Nichols, Fla.	Trinity, Texas	8.30 NT	100,000	SFTB 876-B ITEM 30970		
R-265	Phosphate Rock	Nichols, Fla.	Tampa, Fla.	1.94 NT	100,000	SFTB 876-B ITEM 30970	1.14NT	
R-266	Phosphate Rock	Riverside, Texas	Trinity, Texas	1.40 NT	100,000	SFTB 876-B ITEM 30970 Constructed Rate		
R-267	Phosphate Rock	Tampa, Fla.	Sulphur Springs, Texas	8.20 NT	100,000	SFTB 876-B ITEM 30970		
R-268	Phosphate Rock	Dallas, Texas	Sulphur Springs, Texas	2.75 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate		
R-269	Phosphate Rock	Daingerfield, Texas	Sulphur Springs, Texas	2.30 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate		
R-270	Phosphate Rock	Bonnie, Fla.	Ft. Worth, Texas	8.40 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate		
R-271	Phosphate Rock	Bonnie, Fla.	Tampa, Fla.	1.14 NT	100,000	SFTB 876-B ITEM 1370		
R-272	Phosphate Rock	Dallas, Texas	Ft. Worth, Texas	1.60 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate	1.80NT	
R-273	Phosphate Rock	Daingerfield, Texas	Ft. Worth, Texas	4.20 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate	3.00NT	
R-274	Phosphate Rock	Tampa, Fla.	Kerens, Texas	8.30 NT	100,000	SFTB 876-B ITEM 201		
R-275	Phosphate Rock	Trinidad, Texas	Kerens, Texas	1.40 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate		
R-276	Phosphate Rock	Jefferson, Texas	Kerens, Texas	3.70 NT	100,000	SFTB 876-B ITEM 201 Constructed Rate	2.80NT	
R-277	Newsprint	Mobile, Ala.	Ft. Worth, Texas	81	40,000	SWL 281-G ITEM 1560	11.08NT	
R-278	Lime (Bulk)	Cleburne, Texas	Houston, Texas	3.66 NT	50,000	TLFB 75-M ITEM 7575 For Export		
R-279	Lime (Bulk)	Cleburne, Texas	Ft. Worth, Texas	8½	100,000	TLFB 60-J ITEM 16180 Constructed Rate	10½	
R-280	Lime (Bulk)	Cleburne, Texas	Dallas, Texas	10½	100,000	TLFB 60-J ITEM 16180 Constructed Rate	17½	
R-281	Limestone	Salusaw, Oklahoma	Houston, Texas	4.64 NT	80,000	SWL 162-W ITEM 18420		
R-282	Limestone	Salusaw, Oklahoma	Dallas, Texas	3.68 NT	80,000	SWL 161-W ITEM 18420		
R-283	Limestone	Salusaw, Oklahoma	Ft. Smith, Ark.	1.28 NT	80,000	SWL 162-W ITEM 18420		
R-284	Lightweight Aggregate	Strawn, Texas	Houston, Texas (Intra)	2.18 NT	80,000	TLFB 84-I ITEM 480		
R-285	Lightweight Aggregate	Strawn, Texas	Ft. Worth, Texas (Intra)	75 NT	80,000	TLFB 84-I ITEM 480		
R-286	Lightweight Aggregate	Strawn, Texas	Dallas, Texas (Intra)	75 NT	80,000	TLFB 84-I ITEM 480		
R-287	Cement	Midlothian, Texas	Houston, Texas (Intra)	26	60,000	TLFB 58-H Section 2		
R-288	Cement	Midlothian, Texas	Dallas, Texas (Intra)	9	60,000	TLFB 58-H Section 2		
R-289	Corn (Feed)	Kansas City, Mo.	Ft. Worth, Texas	43	40,000	SWL 182-1 ITEM 5042		
R-290	Corn (Feed)	Dallas, Texas	Ft. Worth, Texas	23½	40,000	SWL 182-1 1 Constructed Rate		
R-291	Corn (Feed)	Ft. Smith, Ark.	Ft. Worth, Texas	35½	40,000	SWL 182-1 Constructed Rate		
R-292	Corn (Feed)	Daingerfield, Texas	Ft. Worth, Texas	27½	40,000	SWL 182-1 Constructed Rate		
R-293	Corn (Feed)	Arlington, Texas	Grapevine, Texas	24½	40,000	SWL 182-1 Constructed Rate		
R-294	Corn (Feed)	Dallas, Texas	Grapevine, Texas	22½	40,000	SWL 182-1 Constructed Rate		
R-295	Corn (Feed)	Omaha, Neb.	Grapevine, Texas	54	40,000	SWL 182-1 ITEM 5204		
R-296	Rice Hulls	Houston, Texas	Ft. Worth, Texas (Intra)	26½	50,000	TLFB 60-J ITEM 17755		
R-297	Rice Hulls	Dallas, Texas	Ft. Worth, Texas (Intra)	13½	50,000	TLFB 60-J ITEM 17755		
R-298	Flour	Greenville, Texas	Houston, Texas (Intra)	47½	40,000	TLFB 61-J		
R-299	Flour	Greenville, Texas	Dallas, Texas (Intra)	13½	40,000	TLFB 61-H Constructed Rate		
R-300	Flour	Denton, Texas	Houston, Texas (Intra)	45½	40,000	TLFB 61-J		
R-301	Flour	Denton, Texas	Dallas, Texas (Intra)	15½	40,000	TLFB 61-H Constructed Rate		
R-302	Flour	Denton, Texas	Ft. Worth, Texas (Intra)	14½	40,000	TL 61-H Constructed Rate		
R-303	Flour	Ft. Worth, Texas	Houston, Texas	45	40,000	TL 61-H		
R-304	Flour	Ft. Worth, Texas	Dallas, Texas	13½	40,000	SWL 182-I Constructed Rate		
R-305	Flour Shorts	Houston, Texas	Marshall, Texas (Intra)	45	40,000	TL 61-H		
R-306	Flour Shorts	Trinidad, Texas	Marshall, Texas (Intra)	26	40,000	TL 61-H		
R-307	Flour Shorts	Jefferson, Texas	Marshall, Texas (Intra)	11½	40,000	TL 61-H Constructed Rate		
R-308	Stock Feeds	Marshall, Texas	Houston, Texas (Intra)	45	40,000	TL 61-H	5.30NT	
R-309	Stock Feeds	Marshall, Texas	Trinidad, Texas (Intra)	23½	40,000	TL 61-H	2.66NT	
R-310	Stock Feeds	Marshall, Texas	Jefferson, Texas (Intra)	11½	40,000	TL 61-H Constructed Rate	1.54NT	
R-311	Stock Feeds	Marshall, Texas	Port Arthur, Texas (Intra	45	40,000	TL 61-H	4.70NT	
R-312	Stock Feeds	Marshall, Texas	Beaumont, Texas (Intra)	43	40,000	TL 61-H	4.70NT	
R-313	Stock Feeds	Corpus Christi, Texas	Ft. Worth, Texas (Intra)	54	40,000	TL 61-H	7.06NT	
R-314	Stock Feeds	Dallas, Texas	Ft. Worth, Texas (Intra)	13½	40,000	TL 61-H Constructed Rate	1.62NT	
R-315	Rice, Rough	Houston, Texas	Longview, Texas (Intra)	27	80,000	TL 60-H ITEM 17740		
	Rice, Clean	Houston, Texas	Longview, Texas (Intra)	34½	30,000	TL 60-H ITEM 17755		
R-316	Rice, Rough	Trinidad, Texas	Longview, Texas (Intra)	15	80,000	TL 60-H ITEM 17740		
	Rice, Clean	Trinidad, Texas	Longview, Texas (Intra)	24½	30,000	TL 60-H ITEM 17755		
R-317	Rice Feed	Houston, Texas	Ada, Okla.	64	50,000	SWL 326-A		
R-318	Rice Feed	Dallas, Texas	Ada, Okla.	37	50,000	SWL 326-A Constructed Rate		
R-319	Cottonseed Cake	Corsicana, Texas	Houston, Texas (Intra)	16	80,000	TL 88-D ITEM 610		
R-320	Cottonseed Cake	Corsicana, Texas	Trinidad, Texas (Intra)	11	80,000	TL 88-D Constructed Rate	7.50NT	
R-321	Cottonseed Oil	Lubbock, Texas	Houston, Texas	74	60,000	TL 37-S ITEM 1013	43	
R-322	Cottonseed Oil	Lubbock, Texas	Dallas, Texas	48	60,000	TL 37-S Constructed Rate	32½	
R-323	Cottonseed Oil	Lubbock, Texas	Ft. Worth, Texas	44	60,000	TL 37-S Constructed Rate	32½	
R-324	Cottonseed Meal	Houston, Texas	Sugarland, Texas (Intra)	7½	80,000	TL 88-D ITEM 610		
R-325	Fish Meal	Houston, Texas	Ft. Worth, Texas	5.30 NT	100,000	TL 60-J ITEM 14920		
R-326	Fish Meal	Dallas, Texas	Ft. Worth, Texas	1.62 NT	100,000	TL 60-J ITEM 14920		
R-327	Soybean Meal	Decatur, Ill.	West, Texas	76½	40,000	SWL 182-I ITEM 29812	63½	
R-328	Soybean Meal	Daingerfield, Texas	West, Texas	31½	40,000	SWL 182-I Constructed Rate	25½	

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project: TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation: RAIL-CARLOAD

SHEET 9 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
R-329	Soybean Meal	Oakwood, Texas	West, Texas	27½	40,000	SWL 182-I Constructed Rate	22½	
R-330	Soybean Meal	Decatur, Ill.	Grapevine, Texas	70½	40,000	SWL 182-I ITEM 29812	61½	
R-331	Soybean Meal	Decatur, Ill.	Beardstown, Ill.	28½	40,000	SWL 182-I Constructed Rate	14½	
R-332	Soybean Meal	Arlington, Texas	Grapevine, Texas	24½	40,000	SWL 182-I Constructed Rate	10½	
R-333	Soybean Meal	Dallas, Texas	Grapevine, Texas	22½	40,000	SWL 182-I Constructed Rate	11	
R-334	Soybean Meal	Daingerfield, Texas	Grapevine, Texas	27½	40,000	SWL 182-I Constructed Rate	22½	
R-335	Soybean Meal	Ft. Smith, Ark.	Grapevine, Texas	35½	40,000	SWL 182-I Constructed Rate	29½	
R-336	Molasses	Houston, Texas	Ft. Worth, Texas (Intra)	57½	36,000	TL 60-J ITEM 16500	37½	
R-337	Molasses	Houston, Texas	Marshall, Texas (Intra)	57½	36,000	TL 60-J ITEM 16500	37½	
R-338	Molasses	Trinidad, Texas	Marshall, Texas (Intra)	21½	36,000	TL 60-J ITEM 16500 Constructed Rate	22½	
R-339	Molasses	Shreveport, La.	Marshall, Texas (Intra)	15½	60,000	SWL 2004-H ITEM 14650 Constructed Rate	11½	
R-340	Molasses	Corpus Christi, Texas	Ft. Worth, Texas (Intra)	61½	36,000	TL 60-J ITEM 16500	44½	
R-341	Syrup	Houston, Texas	Nacogdoches, Texas (Intra)	45½	36,000	TL 60-J ITEM 16500	23½	
R-342	Syrup	Oakwood, Texas	Nacogdoches, Texas (Intra)	21½	36,000	TL 60-J ITEM 16500 Constructed Rate	20½	
R-343	Steel Plate or Sheet	Jefferson, Texas	McGregor, Texas	32½	80,000	SWL 2-U ITEM 7930		
R-344	Steel Plate or Sheet	Dallas, Texas	Carrollton, Texas	13½	80,000	SWL 2-U ITEM 7930		
R-345	Steel Plate or Sheet	Ft. Worth, Texas	Hurst, Texas (Intra)	12½	80,000	TL 60-J ITEM 15942		
R-346	Steel Plate or Sheet	Dallas, Texas	Hurst, Texas (Intra)	13½	80,000	TL 60-J ITEM 15942		
R-347	Steel Plate or Sheet	Dallas, Texas	Arlington, Texas	13½	80,000	SWL 2-U ITEM 7930		
R-348	Steel Plate or Sheet	Oakwood, Texas	Waco, Texas (Intra)	28½	80,000	TL 60-J ITEM 15942		
R-349	Steel Plate or Sheet	St. Louis, Missouri	Dallas, Texas	77	80,000	SWL 301-D ITEM 2750		
R-350	Steel Plate or Sheet	Gary, Indiana	Dallas, Texas	98	80,000	SWL 301-D ITEM 2750		
R-351	Steel Plate or Sheet	Waukegan, Ill.	Dallas, Texas	98	80,000	SWL 301-D ITEM 2750		
R-352	Steel Plate or Sheet	Houston, Texas	Carrollton, Texas	38½	80,000	SWL 2-U ITEM 7930		
R-353	Steel Plate or Sheet	Dallas, Texas	Ft. Worth, Texas (Intra)	14½	80,000	TL 60-J ITEM 15942		
R-354	Steel Plate or Sheet	Dallas, Texas	Grapevine, Texas	13½	80,000	SWL 2-U ITEM 7930		
R-355	Steel Plate or Sheet	Arlington, Texas	Grapevine, Texas	13½	80,000	SWL 2-U ITEM 7930		
R-356	Steel Plate or Sheet	Daingerfield, Texas	Grapevine, Texas	28½	80,000	SWL 2-U ITEM 7930		
R-357	Steel Plate or Sheet	Dallas, Texas	Denton, Texas	14½	80,000	SWL 2-U ITEM 7930		
R-358	Steel Plate or Sheet	Eagle Pass, Texas	Corpus Christi, Texas	41½	80,000	SWL 2-U ITEM 7930		
R-359	Steel Plate or Sheet	Ft. Worth, Texas	Denton, Texas	14½	80,000	SWL 2-U ITEM 7930		
R-360	Steel Plate or Sheet	Daingerfield, Texas	Ft. Worth, Texas	28½	80,000	SWL 2-U ITEM 7930		
R-361	Steel Plate or Sheet	Dallas, Texas	Grand Prairie, Texas (Intra)	13½	80,000	TL 60-J ITEM 15942		
R-362	Steel Plate or Sheet	Dallas, Texas	Grand Prairie, Texas (Intra)	13½	80,000	SWL 2-U ITEM 7930		
R-363	Steel Plate or Sheet	Daingerfield, Texas	Grand Prairie, Texas	28½	80,000	SWL 2-U ITEM 7930		
R-364	Steel Plate or Sheet	Dallas, Texas	Mineral Wells, Texas	20½	80,000	SWL 2-U ITEM 7930		
R-365	Steel Plate or Sheet	Ft. Worth, Texas	Mineral Wells, Texas	16½	80,000	SWL 2-U ITEM 7930		
R-366	Steel Plate or Sheet	Daingerfield, Texas	Mineral Wells, Texas	32½	80,000	SWL 2-U ITEM 7930		
R-367	Steel Plate or Sheet	Oakwood, Texas	McGregor, Texas	29½	80,000	SWL 2-U ITEM 7930		
R-368	Steel Plate or Sheet	Houston, Texas	Lubbock, Texas	51½	80,000	SWL 2-U ITEM 7930		
R-369	Steel Plate or Sheet	Ft. Worth, Texas	Lubbock, Texas	43½	80,000	SWL 2-U ITEM 7930		
R-370	Steel Plate or Sheet	Dallas, Texas	Lubbock, Texas	43½	80,000	SWL 2-U ITEM 7930		
R-371	Steel Plate or Sheet	Dallas, Texas	Paris, Texas (Intra)	23½	80,000	TL 60-J ITEM 15942		
R-372	Steel Plate or Sheet	Daingerfield, Texas	Paris, Texas (Intra)	23½	80,000	TL 60-J ITEM 15942		
R-373	Steel Plate or Sheet	Trinidad, Texas	Tyler, Texas	14½	80,000	SWL 2-U ITEM 7930		
R-374	Steel Plate or Sheet	Jefferson, Texas	Tyler, Texas	18½	80,000	SWL 2-U ITEM 7930		
R-375	Steel Plate or Sheet	Trinidad, Texas	Tyler, Texas (Intra)	16½	80,000	TL 60-J ITEM 15942		
R-376	Iron Plate or Sheet	Jefferson, Texas	Tyler, Texas (Intra)	20½	80,000	TL 60-J ITEM 15942		
R-377	Wrought Iron Pipe	Ft. Worth, Texas	Lubbock, Texas	41	40,000	Constructed Rate Present Rate 82	11.80NT	
R-378	Wrought Iron Pipe	Dallas, Texas	Lubbock, Texas	43	40,000	Constructed Rate Present Rate 82	11.80NT	
R-379	Wrought Iron Pipe	Houston, Texas	Lubbock, Texas	68	40,000	TL 75-M ITEM 17713		
R-380	Wrought Iron Pipe	Dallas, Texas	Ft. Worth, Texas	18½	40,000	Constructed Rate		
	Wrought Iron Pipe	Dallas, Texas	Ft. Worth, Texas	34½	40,000	SWL 2-U ITEM 8200		
R-381	Wrought Iron Pipe	Dallas, Texas	Carrollton, Texas	14½	40,000	Constructed Rate		
	Wrought Iron Pipe	Dallas, Texas	Carrollton, Texas	25½	40,000	SWL 2-U ITEM 8200		
R-382	Wrought Iron Pipe	Daingerfield, Texas	Carrollton, Texas	27½	40,000	Constructed Rate Present Rate 63½		
R-383	Wrought Iron Pipe	Daingerfield, Texas	Ft. Worth, Texas	29½	40,000	Constructed Rate Present Rate 63½		
R-384	Wrought Iron Pipe	Ft. Smith, Ark.	Ft. Worth, Texas	74	40,000	SWL 2004-H ITEM 16250		
R-385	Wrought Iron Pipe	Ft. Worth, Texas	Dallas, Texas (Intra)	18½	40,000	SWL 2-U ITEM 8200 Constructed Rate		
R-386	Wrought Iron Pipe	Dallas, Texas	Grand Prairie, Texas	14½	40,000	SWL 2-U ITEM 8200 Constructed Rate		
R-387	Wrought Iron Pipe	Daingerfield, Texas	Grand Prairie, Texas	27½	40,000	Constructed Rate Present Rate 63½	8.60NT	
R-388	Wrought Iron Pipe	Ft. Smith, Ark.	Grand Prairie, Texas	74	40,000	SWL 2004-H ITEM 16250	10.40NT	
R-389	Steel Scrap	Ft. Worth, Texas	Houston, Texas (Intra)	28½	100,000	TL 60-J ITEM 18030	5.90NT	
R-390	Steel Scrap	Ft. Worth, Texas	Dallas, Texas (Intra)	12½	100,000	TL 60-J ITEM 18130		
R-391	Steel Scrap	Ft. Worth, Texas	Chicago, Ill.	76	75,000	SWL 2006-H ITEM 13050 Part 1		
R-392	Steel Scrap	Ft. Worth, Texas	Dallas, Texas	16½	75,000	SWL 2006-H ITEM 13050 Constructed Rate		
R-393	Steel Scrap	Ft. Worth, Texas	Ft. Smith, Texas	40½	75,000	SWL 2006-H ITEM 13050 Constructed Rate		
R-394	Steel Scrap	Ft. Worth, Texas	Daingerfield, Texas	31½	75,000	SWL 2006-H ITEM 13050 Constructed Rate		

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project: TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation: RAIL-CARLOAD

SHEET 10 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
R-395	Steel Scrap	Dallas, Texas	Houston, Texas (Intra)	28½	100,000	TL 60-J ITEM 18030		
R-396	Aluminum Wire & Cable	Bristol, Rhode Island	Irving, Texas	178	50,000	SWL 2005-H ITEM 5300		
R-397	Aluminum Wire & Cable	Dallas, Texas	Irving, Texas	22	50,000	SWL 2005-H ITEM 5300 Constructed Rate		
R-398	Aluminum Wire & Cable	Grand Prairie, Texas	Irving, Texas	22	50,000	SWL 2005-H ITEM 5300 Constructed Rate		
R-399	Aluminum Wire & Cable	Bay Minette, Ala.	Irving, Texas	79	50,000	SWL 2007-G ITEM 5300 Part 4		
R-400	Aluminum Wire & Cable	New Orleans, La.	Irving, Texas	64	50,000	SWL 2001-G ITEM 5300 Part 4		
R-401	Tin Plate	Daingerfield, Texas	Dallas, Texas	29	80,000	SWL 301-D Constructed Rate		
R-402	Wire	Rosser, Texas	Ennis, Texas					
R-403	Copper Wire & Cable	Bristol, Rhode Island	Irving, Texas	178	50,000	SWL 2005-H ITEM 5300		
R-404	Copper Wire & Cable	Dallas, Texas	Irving, Texas	22	50,000	SWL 2005-H ITEM 5300 Constructed Rate		
R-405	Copper Wire & Cable	Grand Prairie, Texas	Irving, Texas	22	50,000	SWL 2005-H ITEM 5300 Constructed Rate		
R-406	Caustic Soda (Liquid)	Houston, Texas	Dallas, Texas (Intra)	42½	70,000	TL 60-J ITEM 14016		
R-407	Caustic Soda (Liquid)	Dallas, Texas	Ft. Worth, Texas (Intra)	17½	70,000	TL 60-J ITEM 14016		
R-408	Sulfuric Acid	Ft. Worth, Texas	Houston, Texas (Intra)	5.92 NT	90,000	TL 60-J ITEM 13060 Tank Car	4.92NT	180,000
R-409	Sulfuric Acid	Ft. Worth, Texas	Dallas, Texas (Intra)	.09	Tank Cars	TL 60-J ITEM 20580 Car Cap not less than 26,000		
	Sulfuric Acid	Ft. Worth, Texas	Dallas, Texas (Intra)	.18 In	Drums 80,000	ITEM 12510		
R-410	Phosphoric Acid	Pierce, Fla.	Kerens, Texas	1340 NT	100,000	SWL 273-B ITEM 710-H As Fertilizer		
R-411	Phosphoric Acid	Pierce, Fla.	Tampa, Fla.	460	100,000	Constructed Rate As Fertilizer		
R-412	Phosphoric Acid	Bartow, Fla	Kerens, Texas	1320 NT	100,000	SWL 273-B ITEM 710-H As Fertilizer		
R-413	Phosphoric Acid	Bartow, Fla.	Tampa, Fla.	420	100,000	Constructed Rate As Fertilizer		
R-414	Formalin	Bishop, Texas	Corpus Christi, Tex (Intra)	.07	Tank Car	TL 60-J ITEM 20010 Car Cap not less than 26,000		
	Formalin	Bishop, Texas	Corpus Christi, Tex (Intra)	.18 In	Drums 80,000	TL 60-J ITEM 12510		
R-415	Nitrogen Solution	Kerens, Texas	Houston, Texas	4.04 NT	10,000	SWL 273 Fertilizer Grade As Fertilizer		
R-416	Toluene & Xylene	Houston, Texas	Dallas, Texas (Intra)	39	60,000	TLFB 48-R ITEM 30200 Tank Car Cap not less than 26,000		
R-417	Butane (LPG)	Ft. Worth, Texas	Pierce Jct., Texas (Intra)	50½		TLFB 48-R ITEM 30200 Car Cap not less than 26,000		
R-418	Newsprint	Houston, Texas	Corpus Christi, Tex (Intra)	42½	50,000	TL 60-J ITEM 17030		
R-419	Newsprint	Houston, Texas	Dallas, Texas (Intra)	48½	50,000	TL 60-J ITEM 17030		
R-420	Newsprint	Lufkin, Texas (Herty)	Houston, Texas (Intra)	28 3/4	50,000	TL 60-J ITEM 31780		
R-421	Newsprint	Lufkin, Texas	Urbana, Texas (Intra)	16	100,000	TL 60-J ITEM 17025		
R-422	Newsprint	Lufkin, Texas	Dallas, Texas (Intra)	29	50,000	TL 60-J ITEM 17025		
R-423	Newsprint	Rosser, Texas	Ennis, Texas	16	100,000	SWL 306-C ITEM 4470		
R-424	Newsprint	Daingerfield, Texas	Ennis, Texas	28	100,000	SWL 306-C ITEM 4470		
R-425	Wrapping Paper	Beaumont, Texas	Sherman, Texas (Intra)	37	90,000	TL 60-J ITEM 16945		
R-426	Wrapping Paper	Hartsville, S. Carolina	Myrtle Beach, S. Carolina	13½	90,000	SFTB 867-D Constructed Rate		
R-427	Wrapping Paper	Dallas, Texas	Sherman, Texas (Intra)	16	90,000	TLFB 60-I ITEM 16945		
R-428	Wrapping Paper	Waynesville, N. Carolina	Knoxville, Tennessee	25	90,000	SFTB 867-D ITEM 59507		
R-429	Converted Paper Prods	Ennis, Texas	Rosser, Texas	13½	90,000	SWL 281-G ITEM 2045 Constructed Rate		
R-430	Converted Paper Prods	Birmingport, Ala.	Birmingham, Ala.	38.50/car		Switching Charge		
R-431	Molasses (Inedible)	Dallas, Texas	Ft. Worth, Texas (Intra)	21½	46,000	TLFB 60-J ITEM 16500		
R-432	Polyvinyl Chloride	Dallas, Texas	Mineral Wells, Tex (Intra)	38	40,000	TLFB 60-J ITEM 16855		
	Resin Compound							
R-433	Polyvinyl Chloride	Ft. Worth, Texas	Mineral Wells, Tex (Intra)	31	40,000	TLFB 60-J ITEM 16855		
	Resin Compound							
R-434	Sodium Phosphate	Dallas, Texas	Chicago, Ill.	56	80,000	SWL 354-A ITEM 1940 Intermediate Application		
R-435	Ammonium Phosphate	Kerns, Texas	Houston, Texas (Intra)	4.00 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer		
R-436	Elemental Phosphorus	Columbia, Tenn.	Brownfield, Texas	12.00 NT	100,000	SWL 273-C ITEM 1522-F As Fertilizer		
R-437	Phosphate Rock	Houston, Texas	Nacogdoches, Texas	2.77 NT	100,000	SWL 273-C ITEM 1518-C A: Fertilizer		
R-438	Phosphate Rock	Lake, Charles, La.	Ft. Worth, Texas	6.40 NT	100,000	SWL 273-C ITEM 1518-C As Fertilizer		
R-439	Soda Ash	Oakwood, Texas	Palestine, Texas	18½	70,000	SWL 2004-H ITEM 18250 Constructed Rate		
R-440	Soda Ash	Corpus Christi, Texas	Dallas, Texas (Intra)	49½	80,000	TL 60-J ITEM 36420		
R-441	Soda Ash	Lake Charles, La.	Dallas, Texas	47½	80,000	SWL 8-X ITEM 5895		
R-442	Soda Ash	Baton Rouge, La.	Dallas, Texas	50½	80,000	SWL 8-X ITEM 5885		
R-443	Sand & Gravel	Seagoville, Texas	Rosser, Texas (Intra)	.75 NT	90% of Car	90,000		
					Cap Aver	TL 84-T ITEM 480 Constructed Rate		
R-444	Cottonseed Oil	Waxahachie, Texas	Rosser, Texas	11	80,000	TL 37-S Constructed Rate		
R-445	Cottonseed Meal	Dallas, Texas	Denton, Texas (Intra)	11½	50,000	TL 88-D Constructed Rate		
R-446	Cottonseed Meal	Ft. Worth, Texas	Denton, Texas (Intra)	11½	50,000	TL 88-D Constructed Rate		
R-447	Cottonseed Meal	Oakwood, Texas	Carthage, Texas (Intra)	16½	50,000	TL 88-D Constructed Rate		
R-448	Cottonseed Meal	Shreveport, La.	Carthage, Texas (Intra)	12½	50,000	TL 88-D Constructed Rate		
R-449	Newsprint	Coosa Pines, Ala.	Birmingport, Ala.	3.85 NT		SFT 867-D ITEM 59507		
R-450	Soda Ash	Painesville, Ohio	Pittsburg, Pa.	4.30 NT	70,000	TLCT2009-G ITEM 25430		
R-451	Sand & Gravel	Oakwood, Texas	Sims Bayou, Texas	1.97 NT	90,000	TLFB 84-I ITEM 480		
R-452	Sand & Gravel	Urbana, Texas	Sims Bayou, Texas	1.28 NT	90,000	TLFB 84-I ITEM 480		
R-453	Limestone	Chico, Texas	Channelview, Texas	2.54 NT	90,000	TLFB 84-I ITEM 480		
R-454	Limestone	Midlothian, Texas	Channelview, Texas	2.31 NT	90,000	TLFB 84-I ITEM 480		
R-455	Limestone	New Braunfels, Texas	Channelview, Texas	2.11 NT	90,000	TLFB 84-I ITEM 480		
R-456	Limestone	San Marcos, Texas	Channelview, Texas	2.06 NT	90,000	TLFB 84-I ITEM 480		
R-457	Sand & Gravel	Oakwood, Texas	Channelview, Texas	2.06 NT	90,000	TLFB 84-I ITEM 480		

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TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation RAIL-CARLOAD, TRUCK, SEATRAIN, SEALAND, BARGE

SHEET 11 OF 12

ITEM NO.	COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
							RATE	MINIMUM WEIGHT
R-458	Sand & Gravel	Urbana, Texas	Channelview, Texas	1.46 NT	90,000	TLFB 84-I ITEM 480		
R-459	Sand & Gravel	Austonio, Texas	Channelview, Texas	1.88 NT	90,000	TLFB 84-I ITEM 480		
R-460	Sand & Gravel	Midway, Texas	Channelview, Texas	1.81 NT	90,000	TLFB 84-I ITEM 480		
R-461	Sand & Gravel	Rosser, Texas	Channelview, Texas	2.31 NT	90,000	TLFB 84-I ITEM 480		
R-462	Sand & Gravel	Trinidad, Texas	Grand Prairie, Texas	1.52 NT	90,000	TLFB 84-I ITEM 480		
R-463	Sand & Gravel	Midway, Texas	Sims Bayou, Texas	1.75 NT	90,000	TLFB 84-I ITEM 480		
R-464	Sand & Gravel	Trinidad, Texas	Dallas, Texas	1.23 NT	90,000	TLFB 84-I ITEM 480		
R-465	Sand & Gravel	Oakwood, Texas	Grand Prairie, Texas	2.11 NT	90,000	TLFB 84-I ITEM 480		
R-466	Sand & Gravel	Oakwood, Texas	Dallas, Texas	1.83 NT	90,000	TLFB 84-I ITEM 480		
	NOTE: All rates established for Items R-451-R-466 apply to Limestone, Sand, & Gravel.							
T-124	Iron or Steel Bars	Houston, Texas	Ft. Worth, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710		
T-125	Iron or Steel Bars	Houston, Texas	Burleson, Texas (Intra)	33	45,000	SWMFT 25-L ITEM 8710 Ft. Worth Intermediate		
T-126	Iron or Steel Bars	Houston, Texas	Tyler, Texas	34	42,000	SWMFT 3-T ITEM 5165		
T-127	Wrought Iron Pipe	Galveston, Texas	Dallas, Texas	34	80,000	SWMFT 3-T ITEM 5160		
T-128	Aluminum Bar Stock	Houston, Texas	Carrollton, Texas	45	90,000	SWMFT 3-T ITEM 3050 Supp. 51		
T-129	Aluminum Bar Stock	Dallas, Texas	Carrollton, Texas	20	90,000	SWMFT 3-T ITEM 3050 Constructed Rate		
T-130	Newsprint	Houston, Texas	Dallas, Texas (Intra)	59	36,000	SWMFT 25-L ITEM 10840		
T-131	Fiberboard, Pulpboard	Demopolis, Ala.	Waco, Texas (Intra)	90	36,000	SFTB 515-L ITEM151916		
T-132	Steel Vessels	Dallas, Texas	Houston, Texas	72	36,000	OFH 10-D ITEM 920		
			TYPE OF TRANSPORTATION - SEATRAIN					
S-1	Iron or Steel Plate	Sparrows Point, Md.	Dallas, Texas	111½ *	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-2	Iron or Steel Plate	Sparrows Point, Md.	Ft. Worth, Texas	111½*	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-3	Iron or Steel Plate	Sparrows Point, Md.	Mineral Wells, Texas	116½ *	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-4	Iron or Steel Plate	Sparrows Point, Md.	Waxahachie, Texas	111½ *	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-5	Iron or Steel Plate	Sparrows Point, Md.	Grapevine, Texas	111½ *	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-6	Iron or Steel Plate	Bethlehem, Pa.	Ft. Worth, Texas	111½ *	100,000	Seatrain Tariff G-2-A ITEM 2501-B Comb. Rates		
S-7	Iron or Steel Plate	Bethlehem, Pa.	Houston, Texas	85 *	100,000	Seatrain Tariff G-2-A ITEM 2500		
S-8	Iron or Steel Plate	Sparrows Point, Md.	Kaufman, Texas	111½	100,000	Seatrain G-2-A ITEM 2501-B Constructed Rate		
	NOTE: Show rates in effect when Sea Train service was suspended.							
	* Seatrain rate includes water and land freight rate.							
			TYPE OF TRANSPORTATION - SEA LAND					
SL-1	Iron or Steel Plate	Sparrows Point, Md.	Dallas, Texas	140 **	80,000	Sealand Tariff 81-H ITEM 4538		
SL-2	Iron or Steel Plate	Sparrows Point, Md.	Ft. Worth, Texas	140 **	80,000	Sealand Tariff 81-H ITEM 4538		
SL-3	Iron or Steel Plate	Sparrows Point, Md.	Mineral Wells, Texas	151 **	80,000	Sealand Tariff 81-H ITEM 4538 Comb. Rates		
SL-4	Iron or Steel Plate	Sparrows Point, Md.	Waxahachie, Texas	140 **	80,000	Sealand Tariff 81-H ITEM 4538 Intermediate Appl.		
SL-5	Iron or Steel Plate	Sparrows Point, Md.	Grapevine, Texas	145 **	80,000	Sealand Tariff 81-H ITEM 4538 Comb. Rates		
SL-6	Iron or Steel Plate	Bethlehem, Pa.	Ft. Worth, Texas	140 **	80,000	Sealand Tariff 81-H ITEM 4538		
SL-7	Iron or Steel Plate	Sparrows Point, Md.	McGregor, Texas	1.45	80,000	Sealand Tariff 81-H ITEM 4538		
	**Sealand rate includes water and land freight rate							
			TYPE OF TRANSPORTATION - BARGE					
B-1	Iron, Steel, Plate or Sheet	Chicago, Ill.	Houston, Texas	8.25 NT	600 Ton	Federal Barge Lines 229-N ITEM 1695		
B-2	Iron, Steel Plate or Sheet	Wheeling, West Va.	Houston, Texas	10.07 NT	600 Ton	Federal Barge Lines 229-N ITEM 4360		
B-3	Iron, Steel Plate or Sheet	Youngstown, Ohio	Houston, Texas	10.07 NT	600 Ton	Federal Barge Lines 229-N ITEM 4360		
B-4	Iron, Steel Plate or Sheet	Pittsburgh, Pa.	Houston, Texas	8.90 NT	600 Ton	Federal Barge Lines 229-N ITEM 4360		
B-5	Iron, Steel Plate or Sheet	Fairfield, Ala.	Houston, Texas	8.90 NT	600 Ton	Federal Barge Lines 229-N ITEM 14205		
B-6	Iron, Steel Plate or Sheet	Granite City, Ill.	Houston, Texas	6.92 NT	600 Ton	Federal Barge Lines 229-N ITEM 5180		
B-7	Iron, Steel Plate or Sheet	Ashland, Ky.	Houston, Texas	9.37 NT	600 Ton	Federal Barge Lines 229-N ITEM 4753		
B-8	Iron, Steel Plate or Sheet	Bethlehem, Pa.	Houston, Texas			No Barge Service Available See S-7		
B-9	Iron, Steel Plate or Sheet	VOID						
B-10	Phosphate	Inglis, Fla.	Houston, Texas	10.63 NT	600 Ton	Federal Barge Tariff 229-N ITEM 15808 Fertilizer Grade		
B-11	Nitrogen Solution	Henderson, Ky.	Houston, Texas	8.35 NT	600 Ton	Federal Barge Tariff 229-N ITEM 10035 Fertilizer Grade		

(1) Rates are C.W.T unless otherwise noted
(2) Highest minimum weight rate to be quoted
(3) Interstate rate unless otherwise specified
(4) Tariff authority not furnished with O.C.E. revisions

TABLE 4 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRAFFIC FOR DETERMINATION OF FREIGHT RATES

Name of Project TRINITY RIVER NAVIGATION RESTUDY

Type of Transportation BARGE

SHEET 12 OF 12

ITEM NO.		COMMODITY	ORIGIN	DESTINATION	RATE (1) (3)	MINIMUM WEIGHT (2)	TARIFF AUTHORITY	OCE REVISIONS TO CONTRACT DATA (4)	
								RATE	MINIMUM WEIGHT
B-11		Nitrogen Solution	Henderson, Ky.	Houston, Texas	11.11 NT	600 Ton	Federal Barge Tariff 229-N ITEM 10035 Other than Fert. Grade		
B-12		Nitrogen Solution	Vicksburg, Miss.	Houston, Texas	4.63 NT	600 Ton	Federal Barge Tariff 229-N ITEM 14210 Fertilizer Grade		
		Nitrogen Solution	Vicksburg, Miss.	Houston, Texas	6.16 NT	600 Ton	Federal Barge Tariff 229-N ITEM 14210 Other than Fert. Grade		
B-13		Nitrogen Solution	Vicksburg, Miss.	Houston, Texas	4.63 NT	600 Ton	Federal Barge Lines ITEM 14210 As Fertilizer		
B-14		Nitrogen Solution	Henderson, Ky.	Houston, Texas	8.35 NT	600 Ton	Federal Barge Lines ITEM 10035 As Fertilizer		
B-15		Phosphate Rock	Tampa, Fla.	Houston, Texas	10.63 NT	600 Ton	Federal Barge Lines ITEM 15808 As Fertilizer		

(1) Rates are C.W.T unless otherwise noted
(2) Highest minimum weight rate to be quoted
(3) Interstate rate unless otherwise specified
(4) Tariff authority not furnished with O.C.E. revisions

existing waterways, published waterway tariffs, unregulated carrier rates, port and harbor tug expenses, waterway carrier revenues, and other data pertinent to constructing barge rates.

26. The above study and analyses provided the basis for construction of a mathematical transportation model of the barge transportation industry. The model was constructed by entering input data on cost, physical factors of the waterway, and port and harbor data into a computer program. The results provided the appropriate constructed barge rates used in the traffic analyses in this restudy of the navigation economics.

27. The completed results of the computer program for barge rates are contained in four volumes: (1) Trinity River Grain Studies, (2) Trinity River Iron and Steel Studies, (3) Trinity River newsprint, pulp and paper, chemicals, phosphates and fertilizer materials and (4) Trinity River diversified commodities. These volumes are on permanent file with the Corps of Engineers.

28. The barge rates developed by the foregoing method and used in the several analyses of traffic covered in this appendix are given in table 5.

29. Transfer, switching and handling charges.- Transfer, switching and handling charges were acquired under the overland rate contract discussed in paragraph 23e above. As a general rule, the switching and transfer charges were obtained from the published tariffs, according to the highest minimum weight and type of commodity covered by the tariff. In those instances where a rate had to be constructed by the contractor, appropriate switching and handling charges were estimated by the contractor on the same basis as the rate constructed.

30. The handling charges were developed as industry averages, depending on the commodity and volume involved, that would be representative for the movement. Where available, handling charges were taken directly from published tariffs. All transfer, switching and handling charges were reviewed for consistency, applicability and accuracy by Corps' transportation specialists prior to use in traffic analysis computations.

31. The list of transfer, switching and handling charges developed by the rate contractor and used in the traffic analyses, presented in this appendix, is shown in table 6. Charges used in the grain and sand, gravel and stone studies were developed through contacts with railroad, trucking and industry personnel and are discussed in detail in their respective studies.

TABLE 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Origin	Commodity / Destination	Rate Per Net Ton
	ALUMINUM PRODUCTS	
Mobile	Grand Prairie	6.25
Mobile	Dallas	6.13
New Orleans	Grand Prairie	5.47
New Orleans	Dallas	5.35
Houston	Dallas	2.10
	AMMONIUM NITRATE	
Florence	Dallas	6.27
Yazoo City	Dallas	4.44
Yazoo City	Catoosa	2.97
Yazoo City	Muskogee	2.74
Yazoo City	Ft. Smith	2.35
Yazoo City	Daingerfield	3.13
Yazoo City	Jefferson	3.00
	AMMONIUM PHOSPHATE	
Florence	Daingerfield	3.74
Florence	Dallas	6.27
Trinidad	Houston	1.44
	AMMONIA SULPHATE	
Houston	Dallas	1.68
Florence	Dallas	6.27
	ANHYDROUS PHOSPHATE	
Florence	Ft. Worth	6.27
	BOND PAPER	
Mobile	Rosser	4.64
Mobile	Jefferson	3.56
	BRICK	
Oakwood	New Orleans	2.16
Oakwood	Baton Rouge	2.57
Oakwood	Houston	1.07
Trinidad	Houston	1.27
Trinidad	New Orleans	2.29
Dallas	Beaumont	1.22
Ft. Worth	Beaumont	1.42
Dallas	Houston	1.54
Ft. Worth	Houston	1.72
	CAUSTIC SODA OR CAUSTIC ACID	
Lake Charles	Ft. Worth	2.47
Lake Charles	Dallas	2.20
Houston	Dallas	1.87
Freeport	Dallas	1.90
Freeport	Ft. Worth	2.18
Port Neches	Dallas	2.00
	CEMENT	
Houston	Dallas	1.56
	COKE	
St. Louis	Ft. Worth	7.73
St. Louis	Dallas	7.51
	CORN OR CORN BY-PRODUCTS	
Kansas City	Ft. Worth	5.41
Kansas City	Dallas	5.08
Omaha	Dallas	5.63
	COTTONSEED CAKE	
Trinidad	Houston	1.25

TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Origin	Destination	Rate Per Net Ton
COTTONSEED MEAL		
Ft. Worth	Houston	1.87
Dallas	Houston	1.69
Freeport	Oakwood	1.32
COTTONSEED OIL		
Rosser	Houston	1.76
Ft. Worth	Houston	2.77
Dallas	Houston	2.48
CRUDE RUBBER		
Houston	Dallas	2.02
FATTY ACID		
Dallas	Houston	1.93
FERTILIZER, INORGANIC		
Houston	Dallas	1.68
Houston	Oakwood	1.16
FISH MEAL		
Houston	Ft. Worth	3.00
Houston	Dallas	2.68
FORMALIN (LIQUID)		
Corpus Christi	Dallas	2.85
GRAIN		
Ft. Worth	Houston	1.27
Dallas	Houston	1.12
HARDWOOD, GREEN ROUGH LUMBER		
Urbana	Houston	1.05
ISOPROPYL ALCOHOL		
Houston	Dallas	1.93
LEAD INGOTS		
Dallas	Houston	2.60
Ft. Worth	Houston	2.89
LIGHTWEIGHT AGGREGATE		
Ft. Worth	Houston	2.20
Dallas	Houston	1.98
LIME		
Ft. Worth	Houston	1.83
Dallas	Houston	1.63
LIMESTONE		
Dallas	Houston	1.57
L.P.G.		
Dallas	Houston	3.81
Ft. Worth	Houston	4.36
MALAMIN CRYSTALS		
Galveston	Dallas	2.52
MEAL AND FEED		
Corpus Christi	Ft. Worth	2.75
Corpus Christi	Dallas	2.45

TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Sheet 3 of 7

Rates Per Net Ton At Destination Listed

Origin	Mississippi-Houston	Daingerfield	Jefferson	Catoosa
Birmingport (Includes Loading)	6.47	8.25	8.10	8.82
Pittsburgh, Wheeling, Alquippa, Wierton, Benwood	10.07	8.02	7.90	7.58
Portsmouth, Ashland	9.37	7.23	7.11	6.80
St. Louis, Alton, Granite City	6.92	5.95	5.79	5.25
Chicago, Gary, Ind. Harbor	8.25	7.54	7.41	7.11
Kansas City	9.14	8.04	7.89	7.46

Origin	Oakwood	Rosser	Muskogee	Ft. Smith
Birmingport (Includes Loading)	8.05	8.49	8.72	8.55
Pittsburgh, Wheeling, Alquippa, Wierton, Benwood	11.00	11.36	7.40	7.11
Portsmouth, Ashland	10.41	11.39	6.60	6.30
St. Louis, Alton, Granite City	8.50	8.24	5.02	4.66
Chicago, Gary, Ind. Harbor	8.99	10.27	6.95	6.78
Kansas City	10.72	10.49	7.27	7.08
Houston	1.60	2.12	-	-

Origin	Dallas	Trinidad	Grand Prairie Arlington Ft. Worth
Birmingport (Includes Loading)	7.70	-	7.98
Pittsburgh, Wheeling, Alquippa, Wierton, Benwood	11.50	-	11.79
Portsmouth, Ashland	10.96	-	11.29
St. Louis, Alton, Granite City	8.38	-	8.68
Chicago, Gary, Ind. Harbor	9.47	-	9.78
Kansas City	10.64	-	10.98
Houston	2.33	1.90	2.61
Corpus Christi	4.50	-	4.79
Beaumont	2.79	-	-
Galveston	2.12	-	2.40

TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Sheet 4 of 7

Commodity

Origin	Destination	Rate Per Net Ton
MOLASSES AND SYRUP		
Houston	Dallas	2.07
Houston	Fort Worth	2.18
Houston	Trinidad	1.91
Corpus Christi	Fort Worth	3.05
Corpus Christi	Dallas	3.03
Houston	Oakwood	1.83
NEWSPRINT*		

*Note: Rates shown do not include a handling charge. Use $1.72 for handling charge.

Origin	Destination	Rate Per Net Ton
Calhoun	Houston	7.70
Calhoun	Dallas	8.75
Calhoun	Ft. Worth	9.03
Calhoun	Catoosa	7.62
Calhoun	Muskogee	7.41
Calhoun	Ft. Smith	7.05
Calhoun	Daingerfield	7.72
Calhoun	Jefferson	7.62
Birmingport	Dallas	5.87
Birmingport	Houston	6.18
Birmingport	Jefferson	5.09
Birmingport	Daingerfield	5.24
Birmingport	Ft. Worth	6.16
Mobile	Rosser	4.64
Mobile	Dallas	5.23
Mobile	Ft. Worth	5.48
Mobile	Houston	3.36
Mobile	Jefferson	3.56
Pine Bluff	Ft. Smith	1.18
Pine Bluff	Daingerfield	4.22
Pine Bluff	Dallas	6.20
Pine Bluff	Catoosa	1.91
Pine Bluff	Muskogee	1.64
Pine Bluff	Houston	4.14
Houston	Dallas	2.02

Commodity

Origin	Destination	Rate Per Net Ton
NEWSPRINT (Continued)		
Riverside	Dallas	1.29
Riverside	Ft. Worth	1.57
Riverside	Houston	1.40
Riverside	Corpus Christi	2.44
Urbanna	Houston	1.40
Riverside	Houston	1.40
Urbanna	Corpus Christi	2.44
Riverside	Corpus Christi	2.44
NITROGEN SOLUTION		
Vicksburg	Ft. Worth	4.65
Vicksburg	Dallas	4.24
Vicksburg	Houston	2.43
Vicksburg	Jefferson	2.26
Trinidad	Houston	1.98
Henderson	Ft. Worth	5.06
Henderson	Dallas	4.78
Henderson	Daingerfield	3.35
Henderson	Jefferson	3.27
Henderson	Catoosa	3.25
Henderson	Muskogee	3.08
Henderson	Ft. Smith	2.80
PAPER PRODUCTS-Paper bags, wrapping paper, waste paper, paperboard, boxboard, pulpboard, fiberboard, corrugated paper, and converted paper products.		
Demopolis	Jefferson	7.67
Demopolis	Oakwood	7.63
Demopolis	Daingerfield	7.90
Pine Bluff	Oakwood	8.37
Pine Bluff	Catoosa	2.66
Pensacola	Dallas	7.44
Pensacola	Ft. Worth	7.80
Fernandina or St. Marks	Dallas	10.18
Fernandina or St. Marks	Ft. Worth	10.60

TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Commodity		
Origin	Destination	Rate Per Net Ton
PAPER PRODUCTS-Paper bags, wrapping paper, waste paper, paperboard, boxboard, pulpboard, fiberboard, corrugated paper, and converted paper products. (Continued)		
Knoxville	Dallas	14.07
Knoxville	Ft. Worth	14.32
Knoxville	Jefferson	12.08
Bogalusa	Dallas	8.76
Bogalusa	Daingerfield	6.83
Birmingport*	Dallas	9.51
Birmingport*	Jefferson	8.36
Birmingport*	Daingerfield	8.58
Rosser	Birmingport	9.29
West Monroe	Ft. Worth	10.05
West Monroe	Dallas	9.68
West Monroe	Daingerfield	6.56
Houston	Dallas	3.22
Houston	Ft. Worth	3.58
Houston	Dallas	2.02
Kansas City	Dallas	11.82
Kansas City	Daingerfield	9.32
Kansas City	Catoosa	7.47
Alton	Dallas	9.72
Alton	Daingerfield	6.90
Alton	Ft. Smith	5.64
Alton	Muskogee	6.15
Alton	Catoosa	6.44
Quincy	Dallas	10.97
Quincy	Arlington	11.09
Quincy	Daingerfield	6.90
Quincy	Catoosa	6.30
Counce	Dallas	10.23
Counce	Arlington	10.35
PAPER ROLLS		
Beaumont	Dallas	2.79
Houston	Ft. Worth	3.58
Houston	Dallas	3.22

*For traffic originating at Rome, use Birmingport as first port.

Commodity		
Origin	Destination	Rate Per Net Ton
PERLITE		
Ft. Worth	Houston	2.76
Dallas	Houston	2.48
PHOSPHATES		
(Super, Triple Super, and Diammonia)		
Inglis or Tampa	Dallas	4.45
Houston	Ft. Worth	1.45
Houston	Dallas	1.29
Tampa	Jefferson	3.93
PHOSPHATE ROCK*		
Tampa	Trinidad	3.62
Tampa	Oakwood	3.44
Tampa	Riverside	3.12
Tampa	Dallas	3.86
Tampa	Ft. Worth	4.07
Tampa	Jefferson	3.34
Tampa	Shreveport	3.06
Lake Charles	Ft. Worth	1.87
Lake Charles	Dallas	1.66
PHOSPHORIC ACID		
Tampa	Trinidad	8.33
PLASTIC RESIN		
Houston	Ft. Worth	3.50
Houston	Dallas	3.12

*Does not include transfer from ocean-going barge at Galveston to river barge. When product is railed to Tampa, the transfer rate from rail to barge is included in rail rate.

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TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Origin	Destination	Rate Per Net Ton
	POLYETHYLENE	
Texas City	Ft. Worth	2.35
Texas City	Dallas	2.24
	POULTRY AND STOCK FEEDS	
Trinidad	Houston	1.37
Trinidad	Port Arthur	1.80
Trinidad	Beaumont	1.74
	PRINTING PAPER AND ROLLED PAPER STOCK	
Pine Bluff	Oakwood	8.37
Jacksonville or St. Marks	Dallas	10.12
Jacksonville or St. Marks	Jefferson	9.02
Myrtle Beach	Dallas	11.74
Myrtle Beach	Jefferson	10.84
Savannah or St. Marks	Oakwood	11.20
Houston	Dallas	3.22
Houston	Ft. Worth	3.58
Quincy	Arlington	11.09
Riverside	Houston	1.96
	PULPWOOD	
Riverside	Pasadena	1.96
	RICE	
Houston	Trinidad	1.39
	RICE FEED	
Houston	Dallas	1.68

Origin	Destination	Rate Per Net Ton
	RICE HULLS AND BRAN	
Houston	Ft. Worth	4.49
Houston	Dallas	4.05
	SAND & GRAVEL	
Trinidad	Houston	.95
Trinidad	Grand Prairie	.55
Oakwood	Houston	.85
Oakwood	Grand Prairie	.64
Midway	Houston	.74
Midway	Grand Prairie	.79
Urbana	Houston	.55
Urbana	Grand Prairie	.94
	SCRAP IRON AND STEEL	
Dallas	Houston	2.46
Dallas	Corpus Christi	3.58
Ft. Worth	Corpus Christi	3.99
Houston	Dallas	2.46
Houston	Ft. Worth	2.75
Ft. Worth	Chicago	6.44
Dallas	Chicago	6.14
	SODA ASH OR SODA PHOSPHATE	
Dallas	Chicago	7.07
Daingerfield	Chicago	6.05
Jefferson	Chicago	5.97
Muskogee	Chicago	6.10
Catoosa	Chicago	6.16
Corpus Christi	Dallas	2.58
Corpus Christi	Trinidad	1.92
Corpus Christi	Rosser	2.01

TABLE 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE RATES

Sheet 7 of 7

Origin	Destination	Rate Per Net Ton	Origin	Destination	Rate Per Net Ton
	SODA ASH OR SODA PHOSPHATE (Continued)			SULPHURIC ACID	
			Dallas	Houston	1.87
Freeport	Oakwood	1.40	Ft. Worth	Houston	2.14
Lake Charles	Dallas	1.92			
Lake Charles	Oakwood	1.59		TOLUENE OR XYLENE	
Painesville or Pittsburgh	Dallas	6.72	Houston	Dallas	1.74
Painesville or Pittsburgh	Catoosa	5.17		UREA	
Painesville or Pittsburgh	Muskogee	5.02	Trinidad	Houston	1.27
			Trinidad	Galveston	1.06
Painesville or Pittsburgh	Ft. Smith	4.76			
				ZINC, SLABS	
Painesville or Pittsburgh	Daingerfield	5.36			
			Houston	Ft. Worth	2.89
Painesville or Pittsburgh	Jefferson	5.29	Houston	Dallas	2.60
Baton Rouge	Dallas	3.54			
	SILICATE OF SODA (LIQUID)				
Dallas	Ft. Worth	0.56			
	SOLVENTS				
Freeport	Dallas	1.85			
	SOYBEAN MEAL				
Beardstown	Dallas	6.73			
Beardstown	Oakwood	5.18			
Beardstown	Catoosa	3.81			
Beardstown	Muskogee	3.63			
Beardstown	Ft. Smith	3.34			
Beardstown	Daingerfield	4.10			
Beardstown	Jefferson	4.04			

TABLE 6

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRANSFER/SWITCHING & HANDLING CHARGES

Sheet 1 of 4

COMMODITY	CHARGES	
	Handling	Transfer/Switching
	(Rate/Ton)	
Aluminum Bars	1.32	0.78
Aluminum Ingot Billets	1.32	0.78
Aluminum Wire & Cable	1.38	1.40
Ammonium Nitrate (in bulk)	0.82	0.70
Ammonium Nitrate (in drums)	1.48	0.70
Ammonium Phosphate (in bulk)	0.82	0.70
Ammonium Phosphate (in drums)	1.48	0.70
Ammonium Sulfate (in bulk)	0.82	0.70
Ammonium Sulfate (in drums)	1.48	0.70
Anhydrous Phosphate (in bulk)	0.79	0.70
Anhydrous Phosphate (in drums	1.48	0.70
Blackstrap Molasses Inedible (in bulk)	0.75	1.52
Blackstrap Molasses Inedible (in drums)	1.42	1.52
Brick (on pallets)	1.52	0.58
Caustic Soda & Acid (liquid) (in bulk)	0.82	0.70
Caustic Soda & Acid (liquid) (in drums)	1.48	0.70
Cement (in bulk)	0.78	1.17
Cement (in bags)	1.46	1.17
Coil Plate Steel	1.25	0.58
Coiled Flat Steel Sheets	1.20	0.58
Coke (in bulk)	0.90	0.88
Converted Paper Products	1.70	0.78
Copper Wire & Cable	1.38	1.40
Corn (in bulk)	0.85	1.75
Corn Glueten Mean (in bulk)	0.85	1.75
Corrugated Fiberboard	1.85	0.78
Corrugated Rolled Stock Paper	1.85	0.78
Cottonseed Cake	1.45	0.88
Cottonseed Meal	1.45	0.88
Cottonseed Oil (in bulk)	0.90	1.17
Crude Rubber (bales)	1.52	0.88
Deflourinated Phosphate (in bulk)	0.85	0.70
Diammonia Phosphate (in bulk)	0.85	0.70
Drill Pipe	1.25	0.88
Drum Plate	1.20	0.58

TABLE 6 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRANSFER/SWITCHING & HANDLING CHARGES

Sheet 2 of 4

COMMODITY	CHARGES Handling (Rate/Ton)	Transfer/Switching
Elemental Phosphorus (in bulk)	0.89	0.70
Fabricated Shapes	1.45	0.58
Fatty Acid (in bulk)	0.89	1.65
Fertilizer (Urea) (in bulk)	0.90	0.70
Fertilizer (Urea) (in bags)	1.50	0.70
Fish Meal (in bulk)	0.85	0.70
Fish Meal (in bags)	1.50	0.70
Flat Steel	1.20	0.58
Flour Shorts (in bags)	1.50	1.75
Formalin (in bags)	1.65	0.88
Irrigation Pipe	1.25	0.88
Isopropyl Alcohol (in bulk)	0.90	1.75
Isopropyl Alcohol (in drums)	1.48	1.75
Lead Ingots	1.30	0.70
Lightweight Aggregate (in bulk)	1.05	0.88
Lime (dry bulk)	0.78	0.70
Liquid Petroleum Gas	1.05	1.17
Malamin Crystals (in bags)	1.45	0.67
Newsprint	1.72	0.44
Nitrogen Solution (in bulk)	0.90	0.70
Nitrogen Solution (in drums)	1.40	0.70
Oilfield Pipe	1.25	0.88
Paper Bags and Wrapping Paper	1.80	0.78
Paperboard	1.72	0.78
Paperboard Rolls	1.72	0.78
Paper Rolls	1.72	0.78
Pennsylvania Glass Sand	0.80	0.70
Perlite	0.85	1.08
Phosphate (in bulk)	0.85	0.70
Phosphate Rock (in bulk)	0.80	0.70
Phosphoric Acid (in bulk)	0.82	0.70
Phosphoric Acid (in drums)	1.48	0.70
Polyethylene Pellets (in bags)	1.65	1.03
Polyvinyl Chloride Resin Compound (in bags)	1.65	1.03

TABLE 6 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRANSFER/SWITCHING & HANDLING CHARGES

Sheet 3 of 4

COMMODITY	CHARGES	
	Handling	Transfer/Switching
	(Rate/Ton)	
Poultry & Stock Feeds (in bulk)	0.85	1.75
Poultry & Stock Feeds (in bags)	1.50	1.75
Printing Paper	1.72	0.70
Pulpboard	1.72	0.78
Pulpwood	1.60	0.78
Rice (in bulk)	0.80	1.75
Rice (in bags)	--	1.75
Rice Feed (in bulk)	0.80	1.40
Rice Feed (in bags)	1.45	1.40
Rice Hulls & Bran (in bulk)	0.90	1.40
Rice Hulls & Bran (in bags)	1.45	1.40
Rough Green Hardwood	2.10	1.75
Scrap Steel	1.38	0.70
Silica Sand	0.80	0.70
Silicate of Soda (in bulk)	0.79	0.70
Silicate of Soda (in drums)	1.48	1.00
Sheet Corrugated Fiberboard	1.85	0.78
Sheet Steel	1.20	0.58
Soda Ash (in bulk)	0.82	0.37
Soda Ash (in drums or bags)	1.48	0.37
Soda Phosphate (in bulk)	0.82	0.88
Soda Phosphate (in drums)	1.48	0.88
Solvents (Chlor. Hydrocarbons)(in bulk)	0.90	1.17
Soybean Meal (in bulk)	0.85	1.75
Steel Bars	1.20	0.58
Steel Coils	1.25	0.58
Steel Forgings	1.20	0.58
Steel Pipe	1.25	0.88
Steel Pipe & Wire	1.25	0.58
Steel Plate	1.20	0.58
Steel Shapes	1.45	0.58
Steel Tubing	1.25	0.88
Strip Steel	1.20	0.58
Structural Steel	1.20	0.58
Stone Aggregate (in bulk)	0.90	--

TABLE 6 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TRANSFER/SWITCHING & HANDLING CHARGES

Sheet 4 of 4

COMMODITY	CHARGES	
	Handling	Transfer/Switching
	(Rate/Ton)	
Sulfuric Acid (in bulk)	0.85	0.39
Timber (rough)	2.10	1.75
Tin Plate	1.20	0.70
Toluene & Xylene (in bulk)	0.85	0.88
Tricalcium Phosphate Rock (in bulk)	0.80	0.70
Triple Super Phosphate (in bulk)	0.85	0.70
Vessels (Steel Tanks)	1.80	1.75
Waste Paper	1.72	0.88
Wire	1.25	1.40
Wood Chips (loose)	0.90	0.74
Zinc Slab (in bulk)	0.90	0.70

32. Traffic volumes.- Estimates of port-to-port prospective traffic volumes were developed from base year traffic accepted for waterway movement. The 1966 base year traffic was projected to the initial project year of 1985 and thereafter for selected years over the 50-year project life to provide the data for developing estimates of traffic volumes at each lock structure throughout the project life period. These studies were made to analyze on a time-phase basis, the projected traffic requirements, related to the physical capacities of individual locks, and to determine the future point in time that construction of additional lock capacities would be required to provide for future traffic loads if the capacities of the initially installed locks were exceeded. The estimates of port-to-port traffic from which lock capacity studies were developed are given in table 7. The basis and methods of projection are discussed in the following paragraphs 33 through 41.

33. Economic indicators.- To obtain an estimate of the future benefits that would be realized from the authorized Trinity River navigation project, analyses of historic economic conditions and estimates of future economic activity in the navigation trade area were made. Since this study involves navigation features only, the analysis of economic activities was confined to those associated with current and future savings in transportation costs which shippers and receivers could realize from moving different commodities on the proposed waterway.

34. Future growth of commodity movements can be associated, to some extent, with the expected overall economic growth of the trade area. However, a more reliable estimate of the future volume movement of a specific commodity can be obtained by relating the commodity to the projected future activity of a recognized economic indicator for that sector of the area's economy most nearly associated with major use or demand for that commodity.

35. Since a fairly large number of commodities were determined to be prospective waterborne commerce, the commodities were grouped according to the economic sector most nearly related to the use or demand for the commodity. The volume of future movement of each commodity was then estimated by assuming a direct relationship to the predicted future activity of the appropriate economic indicator.

36. The economic indicators selected for the purpose of estimating future movements of commerce on the authorized Trinity River navigation channel include the standard statistical indicators for Population, Value of New Construction Contracts, Value Added by Manufacture, Value of Farm Products Sold, and special indicators

TABLE 7

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					DOWNBOUND TRAFFIC							
2326	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	P
1997	5,250	5,250	5,250	5,250	5,250	5,250	5,250	------	------	------	------	P
2473	1,700	1,700	1,700	------	------	------	------	------	------	------	------	P
2473	3,130	3,130	3,130	------	------	------	------	------	------	------	------	P
2129	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	M
1368	5,880	5,880	5,880	5,880	5,880	5,880	5,880	5,880	------	------	------	M
3138	104,403	104,403	104,403	104,403	104,403	104,403	------	------	------	------	------	F
3138	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	------	------	F
3138	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	------	------	F
1530	55,000	55,000	55,000	55,000	55,000	55,000	------	------	------	------	------	F
977	99,000	99,000	99,000	99,000	99,000	99,000	99,000	99,000	------	------	------	M
2178	800	800	800	800	800	800	800	800	800	800	800	I
39	1,712	1,712	1,712	1,712	1,712	1,712	1,712	1,712	------	------	------	M
1084	54,000	54,000	54,000	54,000	54,000	54,000	54,000	54,000	------	------	------	I
1235	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	------	------	------	I
1235	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	------	------	------	I
1271	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	------	------	I
1387	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	------	------	------	I
1429	28,800	28,800	28,800	28,800	28,800	28,800	28,800	28,800	------	------	------	I
1429	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	------	------	------	I
2158	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	I
2158	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	I
					Subtotals by Economic Factors of Growth							
Pop.	11,080	11,080	11,080	6,250	6,250	6,250	6,250	1,000	1,000	1,000	1,000	
Value Added by Mfg.	156,592	156,592	156,592	156,592	156,592	156,592	156,592	156,592	50,000	50,000	50,000	
Ship-ments of Iron & Steel	123,800	123,800	123,800	123,800	123,800	123,800	123,800	123,800	9,800	9,800	9,800	
Value of Farm Prods. Sold	189,403	189,403	189,403	189,403	189,403	189,403	------	------	------	------	------	
Value of New Const. Cont-racts	2,100,000	2,100,000				------	------	------	------	------	------	(2)
Ex-port Wheat	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,055,000	1,055,000	1,055,000	(2)
Ex-port Grain Sor-ghum	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000	195,000	195,000	195,000	(2)

(1) Rate Analysis sheets.

(2) These tonnages have been added from special studies and are not included in the above table.

TABLE 7 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
						UPBOUND TRAFFIC						
2291	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	F
2400	7,200	7,200	7,200	7,200	7,200	7,200	7,200	7,200	------	------	------	F
2400	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	------	------	------	F
2400	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	------	------	------	F
1445	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	------	------	------	M
2219	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	F
2314	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	F
3138	100,000	100,000	100,000	100,000	100,000	100,000	------	------	------	------	------	F
3235	20,000	20,000	20,000	20,000	20,000	------	------	------	------	------	------	F
3291	5,000	5,000	5,000	------	------	------	------	------	------	------	------	F
2314	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	F
2314	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	F
2904	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	------	------	------	F
2400	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	------	------	F
850	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	F
850	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	------	------	------	F
2314	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	F
2314	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	F
3235	2,100	2,100	2,100	2,100	2,100	------	------	------	------	------	------	F
1231	7,590	7,590	7,590	7,590	7,590	7,590	7,590	7,590	------	------	------	P
1231	3,680	3,680	3,680	3,680	3,680	3,680	3,680	3,680	------	------	------	P
1231	10,350	10,350	10,350	10,350	10,350	10,350	10,350	10,350	------	------	------	P
1238	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	------	------	------	P
1238	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	------	------	------	P
1821	------	------	------	------	4,348	4,348	4,348	4,348	------	------	------	P
2070	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	P
2127	------	------	31,200	31,200	31,200	31,200	31,200	31,200	31,200	31,200	31,200	P
2165	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	P
2165	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	P
0036	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	P
0036	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
1890	8,400	8,400	8,400	8,400	8,400	8,400	8,400	------	------	------	------	P
250	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	------	------	------	M
767	11,000	11,000	11,000	11,000	11,000	11,000	11,000	11,000	------	------	------	M
1603	2,080	2,080	2,080	2,080	2,080	2,080	2,080	2,080	------	------	------	M
3390	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
3413	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	M
3413	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
250	20,500	20,500	20,500	20,500	20,500	20,500	20,500	20,500	------	------	------	M
1368	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
1368	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
1368	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	------	------	------	M
1530	60,000	60,000	60,000	60,000	60,000	60,000	------	------	------	------	------	F
1583	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	------	------	------	M
1667	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	------	------	------	M
3124	8,000	8,000	8,000	8,000	8,000	8,000	------	------	------	------	------	M
3260	12,000	12,000	12,000	12,000	12,000	------	------	------	------	------	------	M

(1) Rate Analysis sheets.

TABLE 7 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					UPBOUND TRAFFIC (Cont'd)							
3396	4,200	4,200	4,200	4,200	4,200	4,200	4,200	4,200	------	------	------	M
3396	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	M
3401	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	------	------	------	M
2250	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	M
2598	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	M
125	10,500	10,500	10,500	10,500	10,500	10,500	10,500	10,500	------	------	------	F
125	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	------	------	------	F
2314	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	F
1106	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	F
1106	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	------	------	------	F
1583	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	------	------	------	M
1667	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	------	------	------	M
3413	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	------	------	------	M
3413	3,500	3,500	3,500	3,500	3,500	3,500	3,500	3,500	------	------	------	M
03	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	------	------	------	I
92	33,000	33,000	33,000	33,000	33,000	33,000	33,000	33,000	------	------	------	I
133	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	------	------	------	I
316	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	I
803	7,920	7,920	7,920	7,920	7,920	7,920	7,920	7,920	------	------	------	I
923	5,727	5,727	5,727	5,727	5,727	5,727	5,727	5,727	5,727	5,727	5,727	I
923	10,637	10,637	10,637	10,637	10,637	10,637	10,637	10,637	------	------	------	I
945	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	------	------	------	I
945	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	------	------	------	I
945	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	I
945	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	I
1117	4,093	4,093	4,093	4,093	4,093	4,093	4,093	4,093	------	------	------	I
1117	1,216	1,216	1,216	1,216	1,216	1,216	1,216	1,216	------	------	------	I
1117	307	307	307	307	307	307	307	307	------	------	------	I
1122	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	------	------	------	I
1122	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	I
1153	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	------	------	------	I
1250	7,290	7,290	7,290	7,290	7,290	7,290	7,290	7,290	------	------	------	I
1250	810	810	810	810	810	810	810	810	------	------	------	I
1287	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	------	I
1287	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	------	I
1287	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	------	------	------	I
1314	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	------	------	------	I
1344	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	------	------	I
1348	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	------	------	------	I
1366	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	------	------	------	I
1366	2,780	2,780	2,780	2,780	2,780	2,780	2,780	2,780	------	------	------	I
1366	2,780	2,780	2,780	2,780	2,780	2,780	2,780	2,780	------	------	------	I
1431	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	I
1431	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	------	I
1431	750	750	750	750	750	750	750	750	------	------	------	I
1431	750	750	750	750	750	750	750	750	------	------	------	I
1431	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	------	------	I
1431	500	500	500	500	500	500	500	500	------	------	------	I

(1) Rate Analysis sheets.

TABLE 7 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAIVGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

Sheet 4 of 7

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					UPBOUND TRAFFIC (Cont'd)							
1479	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	------	------	------	I
1483	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	------	------	------	I
1501	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	------	------	------	I
1501	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	------	------	------	I
1628	480	480	480	480	480	480	480	480	------	------	------	I
1637	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	------	------	------	I
1658	550	550	550	550	550	550	550	550	------	------	------	I
1658	550	550	550	550	550	550	550	550	------	------	------	I
1658	550	550	550	550	550	550	550	550	------	------	------	I
1689	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	I
1796	3,840	3,840	3,840	3,840	3,840	3,840	3,840	3,840	------	------	------	I
1804	600	600	600	600	600	600	600	600	------	------	------	I
1848	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	------	------	------	I
1908	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	------	------	------	I
2080	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	180,000	I
2082	23,800	23,800	23,800	23,800	23,800	23,800	23,800	23,800	23,800	23,800	23,800	I
2082	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2082	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2121	500	500	500	500	500	500	500	500	500	500	500	I
2134	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	I
2178	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	I
2178	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	I
2178	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	I
2178	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	I
2180	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	I
2180	900	900	900	900	900	900	900	900	900	------	------	I
2180	800	800	800	800	800	800	800	800	800	------	------	I
2246	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	I
2254	600	600	600	600	600	600	600	600	600	600	600	I
2254	600	600	600	600	600	600	600	600	600	600	600	I
2254	600	600	600	600	600	600	600	600	600	600	600	I
2254	600	600	600	600	600	600	600	600	600	600	600	I
2289	1,480	1,480	1,480	1,480	1,480	1,480	1,480	1,480	1,480	1,480	1,480	I
2289	720	720	720	720	720	720	720	720	720	720	720	I
2289	960	960	960	960	960	960	960	960	960	960	960	I
2315	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	I
2315	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	I
2366	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	I
2441	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	3,200	I
2448	600	600	600	600	600	600	600	600	600	600	------	I
2522	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	------	------	------	I
803	5,280	5,280	5,280	5,280	5,280	5,280	5,280	5,280	------	------	------	I
923	5,318	5,318	5,318	5,318	5,318	5,318	5,318	5,318	------	------	------	I
923	2,863	2,863	2,863	2,863	2,863	2,863	2,863	2,863	2,863	2,863	2,863	I
945	2,625	2,625	2,725	2,625	2,625	2,625	2,625	2,625	------	------	------	I
945	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	------	------	------	I

(1) Rate Analysis sheets.

TABLE 7 (Cont'd)

TRINITY RIVER AND TIRUBTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					UPBOUND TRAFFIC (Cont'd)							
945	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	2,625	I
945	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	I
1306	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	------	------	------	I
1306	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	------	------	------	I
1314	500	500	500	500	500	500	500	500	------	------	------	I
1331	1,725	1,725	1,725	1,725	1,725	1,725	1,725	1,725	------	------	------	I
1331	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	------	------	------	I
1331	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	------	------	------	I
1331	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	------	------	------	I
1331	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	------	------	------	I
1431	750	750	750	750	750	750	750	750	------	------	------	I
1469	7,800	7,800	7,800	7,800	7,800	7,800	7,800	7,800	------	------	------	I
1484	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	------	I
1552	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	------	------	------	I
1552	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	------	------	------	I
1614	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	------	------	------	I
1628	480	480	480	480	480	480	480	480	------	------	------	I
1658	1,312	1,312	1,312	1,312	1,312	1,312	1,312	1,312	------	------	------	I
1714	2,520	2,520	2,520	2,520	2,520	2,520	2,520	2,520	------	------	------	I
1776	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	------	I
1776	600	600	600	600	600	600	600	------	------	------	------	I
1787	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	------	------	I
1787	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	------	------	------	I
1845	1,084	1,084	1,084	1,084	1,084	1,084	1,084	1,084	------	------	------	I
1847	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	------	------	------	I
1848	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	I
1936	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	------	------	------	I
2082	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2082	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2082	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	I
2169	2,610	2,610	2,610	2,610	2,610	2,610	2,610	2,610	2,610	2,610	2,610	I
2172	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	I
2180	600	600	600	600	600	600	600	600	600	------	------	I
2180	500	500	500	500	500	500	500	500	500	------	------	I
2180	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	1,550	------	------	I
2180	600	600	600	600	600	600	600	600	600	------	------	I
2180	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	------	------	I
2183	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	3,750	I
2184	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	I
2244	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	I
2254	900	900	900	900	900	900	900	900	900	900	900	I
2254	900	900	900	900	900	900	900	900	900	900	900	I
2254	900	900	900	900	900	900	900	900	900	900	900	I
2254	900	900	900	900	900	900	900	900	900	900	900	I
2271	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	1,750	I
2289	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	2,220	I
2289	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	1,440	I
2289	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	I

(1) Rate Analysis sheets.

TABLE 7 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

Sheet 6 of 7

R.A. (1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					UPBOUND TRAFFIC (Cont'd)							
2315	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2315	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	I
2598	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	I
923	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864	2,864	I
923	5,318	5,318	5,318	5,318	5,318	5,318	5,318	5,318	------	------	------	I
1348	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	I
1348	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	I
1431	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	------	------	------	I
1808	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	------	------	------	I
1858	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	------	------	------	I
2161	375	375	375	375	375	375	375	375	375	375	375	I
2161	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	I
2161	375	375	375	375	375	375	375	375	375	375	375	I
2161	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	1,125	I
3216	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	------	------	I
3216	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	------	------	I
3216	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	------	------	I
3216	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	1,050	------	------	I
1524	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	48,000	------	I
1524	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	I
1689	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	------	------	------	I
1942	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800	------	------	------	I
2180	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	------	------	I
2180	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	I
2225	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	I
2225	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	I
2225	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	I
2225	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	I
1652	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	------	------	------	I
1652	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	------	------	------	I
1404	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	------	------	------	C
298	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	M
1404	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	------	------	------	M
1858	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	------	------	------	M
					Subtotals by Economic Factors of Growth							
Pop.	67,220	67,220	102,768	102,768	67,220	67,200	67,200	58,820	40,400	40,400	40,400	
Value Added by Mfg.	217,280	217,280	217,280	217,280	217,280	217,280	209,280	197,280	24,500	24,500	24,500	
Shipments of Iron & Steel	783,114	783,114	783,114	783,114	783,114	783,114	783,114	781,514	434,800	421,214	360,614	
Value of Farm Prods. Sold	351,600	351,600	351,600	346,600	346,600	324,500	164,500	164,500	84,000	84,000	84,000	
Value of New Const. Contracts	7,500	7,500	7,500	7,500	787,500	3,107,500	3,107,500	3,107,500	3,100,000	------	------	(2)
Export Wheat	------	------	------	------	------	------	------	------	------	------	------	(2)
Export Grain Sorghum	------	------	------	------	------	------	------	------	------	------	------	(2)

(1) Rate Analysis sheets.
(2) These tonnages have been added from special studies and are not included in the above table.

TABLE 7 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ESTIMATED PORT-TO-PORT WATERWAY TRAFFIC
(1966 Base Year Traffic - Tons of 2000 lbs)

R.A.(1) Sheet No.	Houston Ship Channel Mile 0.00 (Tons)	Urbana Mile 91.86 (Tons)	River-side Mile 136.15 (Tons)	Midway Mile 171.63 (Tons)	Oakwood Mile 220.55 (Tons)	Trini-dad Mile 264.52 (Tons)	Rosser Mile 298.00 (Tons)	Dallas Mile 326.70 (Tons)	Grand Prairie Mile 342.94 (Tons)	Arling-ton Mile 354.00 (Tons)	Fort Worth Mile 364.00 (Tons)	Econ. Factor of Growth
					DOWNBOUND AND UPBOUND TRAFFIC Totals by Economic Factors of Growth							
Pop.	78,300	78,300	113,848	109,018	73,470	73,450	73,450	59,820	41,400	41,400	41,400	
Value Added by Mfg.	373,872	373,872	373,872	373,872	373,872	373,872	365,872	353,872	74,500	74,500	74,500	
Ship-ments of Iron & Steel	906,914	906,914	906,914	906,914	906,914	906,914	906,914	905,314	444,600	431,014	370,414	
Value of Farm Prods. Sold	541,003	541,003	541,003	536,003	536,003	513,903	164,500	164,500	84,000	84,000	84,000	
Value of New Const. Cont-racts	2,107,500	2,107,500	7,500	7,500	787,500	3,107,500	3,107,500	3,107,500	3,100,000	-------	-------	(2)
Export Wheat	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,105,000	1,055,000	1,055,000	1,055,000	(2)
Export Grain Sorg-hum	198,000	198,000	198,000	198,000	198,000	198,000	198,000	198,000	195,000	195,000	195,000	(2)
Grand Total	5,310,589	5,310,589	3,246,137	3,236,307	3,980,759	6,278,639	5,921,236	5,894,006	4,994,500	1,880,914	1,820,314	

(1) Rate Analysis sheets.

(2) These tonnages have been added from special studies and are not included in the above table.

developed for Export Wheat, Export Grain Sorghum, and Shipments of Iron and Steel. A brief explanation of each economic indicator is given below.

a. Population.- The growth of population has either direct or indirect influence on all types of economic growth. The future production and use of many commodities are directly related to the growth or decline of the population. For example, the requirement for newsprint paper used in the publication of newspapers would be determined almost entirely by population, since the demand for newspapers is generated solely by people. In this study, the individual commodities having their most direct association to the needs and demands of people have been projected by relating the predicted growth rates of this economic indicator.

b. Value Added by Manufacture.- This value represents the difference between the final value of manufactured goods and the cost of raw materials that are used in producing these goods. This indicator is a criterion of the relative economic importance of manufacturing because it measures the contribution of the manufacturing processes. Future commerce for all commodities most directly related to manufacturing were estimated by association with the projection factors for this economic indicator. Since the manufacturing process often is not final at a particular plant, and transportation to other plants and locations is required before the end product is reached, a thorough evaluation of each commodity movement must be made before associating its growth with that of manufacturing. The future movement of these commodities was determined through the use of the Value Added by Manufacture indicator only when the purpose of movement involved further manufacturing.

c. Shipments of Iron and Steel.- It has been found that the most significant factors affecting the demand for basic iron and steel are the levels of activity in manufacturing and construction. Statistical research has revealed that, historically, the amount of iron and steel per dollar of output in manufacturing and construction has been decreasing for some time. This is attributed to a number of factors including increased use of substitute metals and other materials, steady improvement of the quality of iron and steel, and changes in design practices. A special indicator for basic iron and steel was constructed, giving consideration to the following influences in the demand for iron and steel:

(1) The relative use of each segment, manufacturing and construction, of iron and steel as production inputs.

(2) The different rates of growth in manufacturing and construction.

(3) The anticipated further reduction in iron and steel use per dollar of output in manufacturing and construction. 1/

d. Value of Farm Products Sold.- This total value, as published by the United States Census of Agriculture, has been determined to be the best measure available for determining the contribution of agriculture to the economy of a statewide or smaller area. Some commodity movements, such as finished commercial fertilizers, are related to the direct needs of agriculture and thus can be readily assigned to its measuring indicator. The relation of other commodity movements, however, is less readily apparent. For example, the ingredients involved in the manufacture of commercial fertilizers require further manufacture or processing before they can be used in agricultural production. Although a further manufacturing process is involved, the basic need is determined by agricultural requirements. For this reason, those commodities would be related to the agricultural economic indicator rather than the manufacturing indicator.

e. Value of New Construction Contracts.- This indicator represents the total dollar value of both public and private construction contracts. It is the most representative indicator for predicting the future movements of commodities associated with new construction. Statistical data for this indicator include values for both military and highway construction in addition to commercial building activity. These construction values are not usually available in other statistical data pertaining to new construction, especially for individual states or smaller areas. Within the overall economy, the production and use of some commodities are determined almost entirely by the growth or decline in new construction. Examples of this would be sand and gravel. The predicted growth or decline of the need for these commodities would be directly related to the predicted activity of the new construction indicator. Future commerce for all commodities having their most direct relationship to new construction has been estimated by association with the projected growth rates of this economic indicator.

f. Export grain (Export Wheat and Export Grain Sorghum).- Economic indicators on these commodity movements were constructed especially for this report. Historically, almost all grain moving through the Gulf ports has been for export. The special study of grain production and movements made for this report indicated that this pattern would prevail for the foreseeable future and that all

1/ Projections obtained from Resources in America's Future; John Hopkins Press, Baltimore, Md., were used as a guide in estimating this reduction.

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future grain moving as commerce on the Trinity River would move downbound and into the export market. The method and details of computations used to construct these special indicators, together with the existing and projected grain movements, are described in the Grain Study attached as exhibit 1 of this report.

37. Factors of growth.- In order to estimate the prospective commerce over the authorized waterway during its 50-year project life, it was necessary to estimate future economic development within the traffic area during this period.

38. The method used for projecting future activity of the economic indicators basically consisted of disaggregating national growth projections to the state level, and then further to the traffic area of the authorized waterway. In using national economic growth projections as a model for constructing the indicators of state and traffic area growth, the method centered upon the relationships of population, employment by industrial type, and output per employee by industrial type.

39. Unusual or short-term economic influences are not taken into account in the long-term national growth projections, and therefore, were excluded from consideration in relating the indicators of economic activity at the national level to corresponding activity at the state and traffic area levels. Unpredictable influences such as major wars, severe deflationary or inflationary periods, political revolution, etc. are also excluded from the projection processes.

40. The resulting predictions of future economic activity, as shown by the indicators, when compared at the national, state, and traffic area levels, are reasonable with respect to probable long-term economic growth within the area of influence of the proposed waterway.

41. The economic factors of growth developed as described in paragraphs 37 through 40 above for each of the economic indicators discussed in paragraphs 33 through 36 are given in table 8.

TABLE 8

ECONOMIC FACTORS OF GROWTH

Economic Indicators	1966	1985(1)	2000	2010	2020	2035
Population	1.000	1.442	1.901	2.259	2.685	3.599
Value Added by Manufacture	1.000	2.514	5.162	8.228	13.113	26.845
Shipments of Iron & Steel	1.000	2.092	3.503	4.942	6.971	11.679
Value of Farm Products Sold	1.000	1.232	1.507	1.894	2.383	3.007
Value of New Construction Contracts	1.000	2.012	3.375	4.813	6.855	11.735
Export Wheat(2)	1.000	1.061	1.156	1.233	1.316	1.418
Export Grain Sorghum(2)	1.000	1.248	1.299	1.333	1.368	1.567

(1) Assumed initial year of project use.
(2) Base year for wheat and grain sorghum is 1965.

42. Production costs - sand and gravel.- As mentioned in paragraph 18, it was recognized that the possibility of economic savings through production of sand and gravel by hydraulic mining methods as opposed to dry-pit methods of mining might have a bearing on waterway economics. Production costs savings that could be achieved only through existence of the waterway, would be related waterway benefits over and above any transportation savings derived from movement of the sand and gravel over the waterway. However, if hydraulic production equipment could be assembled and used in a confined body of water independent of the waterway, any resultant reduction in production costs would not be solely attributable to the waterway project and, thus, could not be properly credited as a waterway benefit.

43. The resource analyst, in making the special study on sand, gravel and stone, given in exhibit 2 to this appendix, developed considerable information on both methods of production. In paragraphs 105 through 122 of exhibit 2, he presents summary data for direct, indirect, and fixed costs for both methods of operation. These data were compiled from basic information furnished by industry operators and used to identify cost elements

associated with sand and gravel production. The data, however, are generalized and are not sufficient for application to firm estimates for specific locations on the authorized waterway.

44. Undoubtedly there will be opportunities for producers to reduce costs of production of sand and gravel at specific locations along the waterway. However, to evaluate production savings, detailed information is required for each specific production site (i.e. amount of overburden, depth of deposit, percentage of sand-to-gravel etc.). Because of the highly competitive nature of this commodity market, operators are reluctant to disclose specific detailed information concerning deposits they have under lease for future production. Such information, when entered into benefit computations, would be readily identifiable with a specific producer and location. In view of this situation, it was not possible to obtain the additional information required for reliable estimates of benefits from this source and, accordingly, none of these benefits have been credited to the waterway.

45. Extended life of bridges.- Benefits from the extended useful life of bridges crossing the Trinity River that would be obtained by alteration or reconstruction of the bridges for the project navigation channel were estimated as recommended in the paragraph titled, "Extension of Useful Life," in the report of, "Proposed Practices for Economic Analysis of River Basin Projects," prepared by the subcommittee on Evaluation Standards for the Inter-Agency Committee on Water Resources (May 1958).

46. Computations from which the estimates of these benefits are derived were based on the following criteria:

a. 50-year average life - highway bridges,
b. 37-year average life - railway timber trestles,
c. 70-year average life - railway steel superstructures,
d. 100-year average life - railway substructures,
e. All replacement costs are on 1967 constant dollars,
f. The period of analysis is the 50-year project life beginning in 1985 and extending through 2035,
g. Interest rate of 3.25 percent compounded annually.

47. The benefits that would be derived from the extended useful life of existing bridges were computed separately for highway and railway bridges for each of two reaches and for the entire river. The lower reach extends from channel mile 0.00 to channel mile 326.70 inclusive, and the upper reach from channel mile 326.70 to Fort Worth. There are 28 highway bridges and 5 railroad bridges in the upper reach and 20 highway bridges and 4 railroad bridges in the lower reach. Five new highway bridges and 4 new railroad

bridges are definitely planned or scheduled for construction. These bridges will be completed on or after the completion of the navigation project. The 9 existing and 4 new railroad bridges are shown as 13 crossings in table 3A and the 48 existing and 5 new highway bridges are shown as 41 crossings in table 3B of appendix I. These tables describe the crossing, channel mile, and the estimated bridge relocation costs. Benefits from extended life of bridges have been evaluated for the 48 existing highway bridges and the 9 existing railroad bridges only, since the 5 new highway bridges and the 4 new railroad bridges will not be completed prior to completion of the navigation project.

48. The average annual charges for amortizing the replacement cost of the affected portion of the bridge over a 50-year period were determined. The unexpired life, in years, of the affected portion of the bridge was considered a benefit beginning at the end of the project life and the worth of the unexpired life was determined at that point. This discounted amount was then further discounted to determine the present (1985) worth of the benefit.

49. This present worth was then distributed over the 50-year period of the navigation project as an annual annuity payment, which is the equivalent annual benefit for extended life of the affected portion of a given bridge. Table 9 shows the detailed computations to arrive at the average annual equivalent benefits for extending the life of the highway bridges. The results are summarized in table 18.

50. The affected portions of the railway bridges were computed in a similar manner except that the different service lives of 37 years for timber trestles, 70 years for steel superstructure, and 100 years for substructure were taken into account and were prorated and computed separately. The average annual benefits for each portion of a given bridge were added together to obtain the average annual benefit for the bridge. The computations for arriving at the average annual equivalent benefits for extending railroad bridge life are given in table 10. The results are summarized in table 18.

51. Vehicular traffic (bridges).- Construction of a navigation channel in the Trinity River would require alteration of 48 existing Federal, state, county, and municipal highway bridges to provide navigation clearances for the waterway traffic. The cost of operating vehicles over the existing bridges, or bridges planned for construction prior to 1985, will be increased when the roadway gradients are raised by the bridge alterations. This increased vehicular cost represents an economic loss to the vehicular traffic, which must be deducted from benefits creditable to the navigation project.

TABLE 9

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BENEFITS FROM EXTENSION OF USEFUL LIFE OF HIGHWAY BRIDGES

Bridge (1)	Channel Mile (2)	Year Built (3)	Estimated Life Years (4)	Remaining Years 1985 (4 - 6)(1) (5)	Life Used Years 1985 (4 - 5)(1) (6)	Estimated Affected Portion Of Bridge Replacement Cost 1967(2) (7)	Estimated New Portion Years (8)	Estimated Replacement Cost 1985(2) (9)	Capital Recovery Factor 50-Years @ 3.25% (10)	Average Annual Charge (9 x 10) (11)	Present Worth of 1 Per Period Factor @ 3.25% (12)	Present Worth At Year Shown From Extended Life (11 x 12) (13)	Extended Life From 1985 (14)	Present Worth Factor For 1985 from Year Shown (15)	Present Worth For 1985 From Years Shown (13 x 15) (16)	Capital Recovery Factor @ 3.25% for 50 years (17)	Average Annual Equivalent Benefits (16 x 17) (18)
LOWER REACH (Channel Mile 0.00 to Dallas Terminus)																	
Interstate 10	30.36	1955	50	20	30	$1,510,000	50	$1,510,000	.040730	$ 61,500	18.981917	$1,167,390	2005	.527471	$ 615,760	.040730	$ 25,080
U. S. Hwy. 90 (E)	47.84	1930	50	45	5	342,800	50	342,800	.040730	13,930	4.547199	63,340	2030	.237108	15,020	.040730	610
U. S. Hwy. 90 (W)	47.90	1962	50	27	23	402,500	50	402,500	.040730	16,390	16.024214	262,640	2012	.421666	110,750	.040730	4,510
F. M. Rd. 162	62.00	1967	50	32	18	631,300	50	631,300	.040730	25,710	13.467260	346,240	2017	.359350	124,420	.040730	5,070
State Hwy. 105	75.78	1926	50	41	9	111,900	50	111,900	.040730	4,560	7.696122	35,090	2026	.269468	9,460	.040730	390
U. S. Hwy. 59	91.86	1950	50	15	35	1,239,500	50	1,239,500	.040730	50,480	20.723893	1,046,140	2000	.618941	647,500	.040730	26,370
Co. Rd.	98.90	1985	50	50	0	496,100	50	496,100	.040730	20,200	-----	-----	----	-----	-----	-----	-----
U. S. Hwy. 190	111.54	IN LIVINGSTON RESERVOIR														-----	-----
State Hwy. 19	136.15	1941	50	6	44	1,352,100	50	1,352,100	.040730	55,070	23.236473	1,279,632	1991	.825391	1,056,195	.040730	43,020
F.M. Rd. 3076	160.00	1985	50	50	0	383,900	50	383,900	.040730	15,640	----	----	----	-----	-----	-----	-----
State Hwy. 21	171.63	1959	50	24	26	816,200	50	816,200	.040730	33,240	17.373233	577,490	2009	.464129	268,020	.040730	10,920
State Hwy. 7	196.68	1957	50	22	28	391,700	50	391,700	.040730	15,950	18.203291	290,340	2007	.494787	143,650	.040730	5,850
U. S. Hwy 79 & 84	220.55	1955	50	20	30	1,422,000	50	1,422,000	.040730	57,920	18.981917	1,099,430	2005	.527471	579,920	.040730	23,620
U. S. Hwy. 287	249.99	1934	50	49	1	2,584,300	50	2,584,300	.040730	105,260	.968523	101,950	2034	.208635	21,270	.040730	870
State Hwy. 31	264.52	1932	50	47	3	1,063,600	50	1,063,600	.040730	43,320	2.815070	121,950	2032	.222416	27,120	.040730	1,100
State Hwy. 1129	285.60	1958	50	23	27	572,200	50	572,200	.040730	23,300	17.794898	414,620	2008	.479213	198,690	.040730	8,090
State Hwy. 34	298.04	1934	50	49	1	603,100	50	603,100	.040730	24,560	.968523	23,790	2034	.208635	4,960	.040730	200
Malloy Co. Rd.	312.84	1955	50	20	30	680,800	50	680,800	.040730	27,730	18.981917	526,370	2005	.527471	277,640	.040730	11,310
Beltline Rd.	315.57	1955	50	20	30	650,300	50	650,300	.040730	26,490	18.981917	502,830	2005	.527471	265,230	.040730	10,800
Dowdy-Ferry Rd.	319.92	1953	50	18	32	465,700	50	465,700	.040730	18,970	19.712296	373,940	2003	.562314	210,280	.040730	8,560
Interstate Hwy. Loop 635	320.00	1985	50	50	0	1,973,100	50	1,973,100	.040730	80,360	----	----	----	-----	-----	-----	-----
State Hwy. Loop 12 (E) (3)	326.19	1954	50	19	31	1,584,500	50	1,584,500	.040730	64,540	19.352946	1,249,040	2004	.544614	680,240	.040730	27,790
State Hwy. Loop 12 (W) (3)	326.20	1954	50	19	31	------	--	-----	----	----	-----	-----	----	-----	-----	-----	-----
																Subtotal	$ 214,160
UPPER REACH (Dallas Terminus to Ft. Worth Terminus)																	
Interstate Hwy. 45 (N)	328.46	1938	50	3	47	1,148,900	50	1,148,900	.040730	46,800	23.925643	1,119,720	1988	.90851022	1,017,280	.040730	41,430
Interstate Hwy. 45 (S)	328.47	1950	50	15	35	1,170,500	50	1,170,500	.040730	47,670	20.723893	987,910	2000	.618941	611,460	.040730	24,900
Forest Ave.	330.65	1953	50	18	32	896,100	50	896,100	.040730	36,500	19.712296	719,500	2003	.562314	404,580	.040730	16,480
Corinth St.	331.41	1931	50	46	4	1,088,400	50	1,088,400	.040730	44,330	3.694983	163,800	2031	.229645	37,620	.040730	1,530
Cadiz St.	332.22	1931	50	46	4	1,237,000	50	1,237,000	.040730	50,380	3.694983	186,150	2031	.229645	42,750	.040730	1,740
Interstate Hwy. 35 (E)	332.28	1957	50	22	28	1,503,200	50	1,503,200	.040730	61,220	18.203291	1,114,400	2007	.494787	551,390	.040730	22,460
Houston St.	332.61	1911	50	26	24	1,065,100	50	1,065,100	.040730	43,380	16.488343	715,260	2011	.435370	311,400	.040730	12,680
Dallas-Ft. Worth Turnpike	333.12	1956	50	21	29	2,011,800	50	2,011,800	.040730	81,940	18.598829	1,523,990	2006	.510868	778,550	.040730	31,710
Commerce St.	333.50	1931	50	46	4	1,498,700	50	1,498,700	.040730	61,040	3.694983	225,540	2031	.229645	51,790	.040730	2,110
Continental St.	333.93	1931	50	46	4	980,200	50	980,200	.040730	39,920	3.694983	147,500	2031	.229645	33,870	.040730	1,380
Sylian Ave.	334.89	1955	50	20	30	130,400	50	130,400	.040730	5,310	18.981917	100,790	2005	.527471	53,160	.040730	2,170
Hampton Ave.	336.33	1953	50	18	32	1,135,200	50	1,135,200	.040730	46,240	19.712296	911,500	2003	.562314	512,550	.040730	20,880
Westmoreland Rd.	337.26	1962	50	27	23	167,100	50	167,100	.040730	6,810	16.024214	109,120	2012	.421666	46,010	.040730	1,870
State Hwy. Loop 12	340.39	1954	50	19	31	1,157,800	50	1,157,800	.040730	47,160	19.352946	912,680	2004	.544614	497,060	.040730	20,240
Meyers Rd.	342.94	1952	50	17	33	117,900	50	117,900	.040730	4,800	20.060336	96,290	2002	.580589	55,900	.040730	2,280
Beltline Rd.	345.25	1954	50	19	31	334,900	50	334,900	.040730	13,640	19.352946	263,970	2004	.544614	143,760	.040730	5,860
State Hwy. 360	350.75	1959	50	24	26	1,171,900	50	1,171,900	.040730	47,730	17.373232	786,990	2009	.464129	365,260	.040730	14,880
F.M. Rd. 157	354.00	1931	50	46	4	93,200	50	93,200	.040730	3,800	3.694983	14,040	2031	.229645	3,220	.040730	130
F.M. Rd. 157	354.00	1955	50	20	30	178,700	50	178,700	.040730	7,280	18.981917	138,190	2005	.527471	72,890	.040730	2,970
Arlington-Bedford Rd.	357.00	1931	50	46	4	545,300	50	545,300	.040730	22,210	3.694983	82,070	2031	.229645	18,850	.040730	770
Arlington-Smithfield Rd.	359.95	1931	50	46	4	108,700	50	108,700	.040730	4,430	3.694983	16,370	2031	.229645	3,760	.040730	150
U. S. Hwy. Loop 820 (N)(3)	362.11	1963	50	28	22	1,214,700	50	1,214,700	.040730	49,470	15.545001	769,010	2013	.408393	314,060	.040730	12,790
U. S. Hwy. Loop 820 (S)(3)	362.12	1963	50	28	22	------	--	-----	----	----	------	-----	----	-----	-----	-----	----
Handley-Ederville Rd.	362.70	1960	50	25	25	408,700	50	408,700	.040730	16,650	16.937862	282,020	2010	.449519	126,770	.040730	5,160
																Subtotal	$ 246,570
																Total average annual benefit for extension of highway bridge life	$ 460,730

(1) If a highway bridge is over the estimated life of 50 years, the assumption is made that the bridge has been reconstructed and the life used of the existing bridges is figured from this reconstruction date.

(2) Estimates of bridge replacement cost in columns 7 and 9 are on the same bases as project cost estimates which are based on 1967 constant dollars.

(3) The estimated replacement cost for dual bridges built during the same time period have been combined for ease of computation.

TABLE 10

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BENEFITS FROM EXTENSION OF USEFUL LIFE OF RAILROAD BRIDGES

Bridge (1)	Channel Mile (2)	Year Built (3)	Estimated Life Years (4)	Remaining Life Years 1985 (4-6) (5)	Used Years (4-5)(1) (6)	Estimated Affected Portion of Bridge Replacement Cost - 1967(2) (7)	Estimated Life New Portion Years (8)	Estimated Replacement Cost-1985(2) (9)	Capital Recovery Factor @ 3.25% (10)	Average Annual Charge (9 x 10) (11)	Present Worth of 1 Per Period Factor @ 3.25% (12)	Present Worth At Years Shown From Extended Life (11 x 12) (13)	Extended Life From 1985 (14)	Present Worth Factor For 1985 from Year Shown (15)	Present Worth For 1985 From Years Shown (13 x 15) (16)	Capital Recovery Factor @ 3.25% for 50 Years (17)	Average Annual Equivalent Benefits (16 x 17) (18)
LOWER REACH (Channel Mile 0.00 to Dallas Terminus)																	
Missouri Pacific Railroad	52.57	1908															
Superstructure			70	63	7	$ 480,500	70	$ 480,500	.036377	$17,479	6.171999	$107,880	2048	.133329	$ 14,384	.040730	$ 586
Substructure			100	23	77	135,400	100	135,400	.033884	4,588	28.147536	129,141	2008	.479213	61,886	.040730	2,521
Timber Trestle			37	34	3	29,700	37	29,700	.046846	1,391	2.815070	3,916	2019	.337083	1,320	.040730	54
Gulf, Colorado & Santa Fe	77.28	1901															
Timber Trestle			37	27	10	66,000	37	66,000	.046846	3,092	8.422395	26,042	2012	.421665	10,981	.040730	447
Texas & New Orleans	91.93	1921															
Timber Trestle			37	10	27	52,400	37	52,400	.046846	2,455	17.794898	43,686	1995	.726272	31,728	.040730	1,292
St. Louis Southwestern Texas	264.14	1938															
Superstructure			70	23	47	394,900	70	394,900	.036377	14,365	23.925643	343,692	2008	.479213	164,702	.040730	6,708
Substructure			100	53	47	101,800	100	101,800	.033834	3,449	23.925643	82,520	2038	.183580	15,149	.040730	617
Timber Trestle			37	27	10	105,800	37	105,800	.046846	4,956	8.422395	41,741	2012	.421665	17,601	.040730	717
																Subtotal	$12,942
UPPER REACH (Dallas Terminus to Ft. Worth Terminus)																	
Texas & New Orleans	328.30	1920															
Superstructure			70	5	65	202,800	70	202,800	.036377	7,377	26.920985	198,596	1990	.852216	169,247	.040730	6,893
Substructure			100	35	65	57,200	100	57,200	.033884	1,938	26.920985	52,173	2020	.326473	17,033	.040730	694
Timber Trestle			37	9	28	415,100	37	415,100	.046846	19,446	18.203291	353,981	1994	.749876	265,442	.040730	10,811
Missouri-Kansas-Texas	330.28	1918															
Superstructure			70	3	67	427,400	70	427,400	.036377	15,548	27.159435	422,275	1988	.908510	383,641	.040730	15,626
Substructure			100	33	67	120,600	100	120,600	.033884	4,086	27.159435	110,973	2018	.348039	38,623	.040730	1,573
Timber Trestle			37	7	30	247,600	37	247,600	.046846	11,599	18.981917	220,171	1992	.799410	176,007	.040730	7,169
Gulf, Colorado & Santa Fe	331.09	1931															
Superstructure			70	16	54	336,300	70	336,300	.036377	12,234	25.298398	309,501	2001	.599458	185,533	.040730	7,557
Substructure			100	46	54	94,900	100	94,900	.033884	3,216	25.298398	81,360	2031	.229645	18,684	.040730	761
Timber Trestle			37	20	17	91,600	37	91,600	.046846	4,291	12.904946	55,375	2005	.527471	29,209	.040730	1,190
Texas & Pacific	333.66	1931															
Superstructure			70	16	54	[illegible]	70	[illegible]	.036377	32,048	25.298398	810,76[illegible]	2001	.599458	486,018	.040730	17,796
Substructure			100	46	54	238,500	100	238,500	.033884	8,081	25.298398	204,436	2031	.229645	46,948	.040730	1,912
Gifford-Hill Gravel Co.	341.86	1933															
Superstructure			70	16	52	54,600	70	54,600	.036377	1,986	24.937016	49,512	2003	.599458	29,680	.040730	1,209
Substructure			100	46	52	15,400	100	15,400	.033884	522	24.937016	13,014	2033	.229645	2,988	.040730	122
Timber Trestle			37	20	15	13,700	37	13,700	.046846	642	11.724899	7,527	2007	.527471	3,970	.040730	162
																Subtotal	$75,47[illegible]
														Total average annual benefits for extension of railroad bridge life			$8[illegible]

(1) If a portion or portions of a railroad bridge are over the estimated life - 70 years for steel superstructure, 100 years for substructure and 37 years for timber trestle - it is assumed that portion or portions of the bridge have been reconstructed and the life used of the existing bridge (6) is figured from the reconstruction date.

(2) Estimates of bridge replacement cost in columns 7 and 9 are on the same basis as project cost estimates which are based on 1967 constant dollars.

52. The estimates of economic loss from increased cost of vehicle operation due to the provision of navigational requirements in bridge construction on the Trinity River, were based on the following criteria:

a. Traffic volume will increase at a rate related to projected increases in population and vehicular registrations.

b. The traffic capacity of existing bridges is not a limiting factor for traffic volume. As capacity is reached for existing bridges, it is assumed that alterations or additional bridges will be provided to allow for continued growth in traffic volume.

c. Traffic volumes, as tabulated for six reaches of the Trinity River channel from 1966 traffic counts furnished by the Texas Highway Department for each bridge across the Trinity River, are basic data for projecting future traffic loads.

d. Traffic composition, based on the actual counts between trucks and passenger cars for 1966 traffic furnished by the Texas Highway Department, is assumed to remain constant.

e. The additional vehicular unit costs per foot of lift are $0.0004108 for trucks and $0.0000672 for passenger cars. These values were furnished by the Federal Highway Administration, Department of Transportation.

f. Texas Highway Department district highway maps were used to establish area traffic flow patterns and grouping into appropriate reaches of the river.

53. For consistency with the methods of computing transportation savings and benefits for future years, the economic loss from increased cost to vehicular traffic was first computed for base year 1966, assuming the waterway and raised bridges had been in existence at that time. The projections of the base year estimates to the initial waterway project year of 1985 and through the waterway 50-year project life period to 2035 were computed in the same manner as the navigation benefits.

54. The computations and data used to arrive at 1966 base year increased vehicular operating costs are presented in table 11. The six reaches of the Trinity River on which computations were based and the bridge locations are identified in the first 3 columns of the table. The 1966 base year average daily traffic counts, the division between passenger cars and trucks, and the annual traffic count totals are shown in columns 4 through 10. The increased height of each bridge and the

TABLE 11

TRINITY RIVER AND TRIBUTARIES, TEXAS
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REEVALUATION OF NAVIGATION FEATURES

INCREASED VEHICULAR COSTS DUE TO NAVIGATION - 1966

Reach (1)	Bridge (2)	Channel Mile to Channel Mile (3)	Average Daily Traffic (4)[A]	Percent of Trucks (5)[A]	Average Daily Truck Traffic (6)	Average Daily Pass. Car Traffic (7)	Days in Year (8)	Total Yr. Truck Traffic (6 x 8) (9)	Total Yr. Pass. Car Traffic (7 x 8) (10)	Increased Height of Bridge (11)	Total (9 x 11) (12)	Total (10 x 11) (13)	Cost/ft. Lift for Trucks (14)[B]	Cost/ft. Lift for Pass. Cars (15)[B]	Total Increased Truck Costs (12 x 14) (16)	Total Increased Pass. Car Costs (13 x 15) (17)	Total Vehicular Costs (16 + 17) (18)
1		0.00 - 70.00															
	Interstate Highway 10	30.36	10,460	12.7	1,328	9,132	365	484,700	3,333,200	46'	22,296,200	153,327,200	$0.0004108	$0.0000672	$ 9,159	$ 10,304	$ 19,463
	US Highway 90	47.84	7,300	10.0	730	6,570	365	266,400	2,398,000	50'	13,320,000	119,900,000	$0.0004108	$0.0000672	5,472	8,057	13,529
	Farm-to-Market Road 162	62.00	980	10.0	98	882	365	35,800	321,900	37'	1,324,600	11,910,300	$0.0004108	$0.0000672	544	800	1,344
		TOTAL	18,740		2,156	16,584		786,900	6,053,100		36,940,800	285,137,500	$0.0004108	$0.0000672	$15,175	$ 19,161	$ 34,336
2		70.01 - 115.00															
	State Highway 105	75.78	850	12.0	102	748	365	37,200	273,000	51'	1,897,000	13,923,000	$0.0004108	$0.0000672	$ 779	$ 936	$ 1,715
	US Highway 59	91.86	6,040	19.0	1,148	4,892	365	419,000	1,785,600	38'	15,922,000	67,853,000	$0.0004108	$0.0000672	6,541	4,560	11,101
	County Road	98.90	155	15.0	23	132	365	8,395	48,180	62'	520,490	2,987,160	$0.0004108	$0.0000672	200	200	400[C]
	US Highway 190	111.54	1,010	15.0	152	858	365	55,500	313,200	53'	2,942,000	16,600,000	$0.0004108	$0.0000672	1,208	1,116	2,324
		TOTAL	8,055		1,425	6,630		520,095	2,419,980		21,281,490	101,363,160	$0.0004108	$0.0000672	$ 8,728	$ 6,812	$ 15,540
3		115.01 - 255.00															
	State Highway 19	136.15	3,000	8.0	240	2,760	365	87,600	1,007,400	50'	4,380,000	50,370,000	$0.0004108	$0.0000672	$ 1,799	$ 3,385	$ 5,184
	Farm-to-Market Road 3076	160.00	145	10.0	14	131	365	5,110	47,815	52'	265,720	2,486,380	$0.0004108	$0.0000672	100	100	200[C]
	State Highway 21	171.63	1,110	14.0	155	955	365	56,600	348,600	36'	2,038,000	12,550,000	$0.0004108	$0.0000672	837	843	1,680
	State Highway 7	196.68	630	17.0	107	523	365	39,100	190,900	35'	1,369,000	3,847,000	$0.0004108	$0.0000672	562	258	820
	US Highway 79 & 84	220.55	3,000	10.0	300	2,700	365	109,500	985,500	34'	3,723,000	33,507,000	$0.0004108	$0.0000672	1,529	2,252	3,781
	US Highway 287	249.99	990	13.0	129	861	365	47,100	314,300	47'	2,214,000	14,772,000	$0.0004108	$0.0000672	910	993	1,903
		TOTAL	8,875		945	7,930		345,010	2,890,515		13,989,720	117,532,380	$0.0004108	$0.0000672	$ 5,737	$ 7,831	$ 13,568

TABLE 11 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

INCREASED VEHICULAR COSTS DUE TO NAVIGATION - 1966

Reach (1)	Bridge (2)	Channel Mile to Channel Mile (3)	Average Daily Traffic (4)[A]	Percent of Trucks (5)[A]	Average Daily Truck Traffic (6)	Average Daily Pass. Car Traffic (7)	Days in Year (8)	Total Yr. Truck Traffic (6 x 8) (9)	Total Yr. Pass. Car Traffic (7 x 8) (10)	Increased Height of Bridge (11)	Total (9 x 11) (12)	Total (10 x 11) (13)	Cost/ft. Lift for Trucks (14)[B]	Cost/ft. Lift for Pass. Cars (15)[B]	Total Increased Truck Costs (12 x 14) (16)	Total Increased Pass. Car Costs (13 x 15) (17)	Total Vehicular Costs (16 + 17) (18)
4		255.01-305.00															
	State Highway 31	264.52	2,960	10.0	296	2,664	365	108,000	972,400	47'	5,076,000	45,703,000	$0.0004108	$0.0000672	$ 2,085	$ 3,071	$ 5,156
	State Highway 1129	285.60	320	10.0	32	288	365	11,700	105,100	35'	410,000	3,678,000	$0.0004108	$0.0000672	168	247	415
	State Highway 34	298.04	890	8.0	71	819	365	25,900	298,900	34'	881,000	10,163,000	$0.0004108	$0.0000672	362	683	1,045
		TOTAL	4,170		399	3,771		145,600	1,376,400		6,367,000	59,544,000	$0.0004108	$0.0000672	$ 2,615	$ 4,001	$ 6,616
5		305.01 - 326.25															
	Malloy Co. Rd.	312.84	630	6.5	41	589	365	15,000	215,000	29'	435,000	6,235,000	$0.0004108	$0.0000672	$ 179	$ 419	$ 598
	Beltline Rd.	315.57	1,310	6.0	79	1,231	365	28,800	449,300	26'	748,000	11,681,800	$0.0004108	$0.0000672	308	785	1,093
	Dowdy Ferry Rd.	319.92	1,410	6.0	85	1,325	365	31,000	483,600	36'	1,116,000	17,409,600	$0.0004108	$0.0000672	458	1,170	1,628
	Interstate Highway Loop 635	320.00	38,928	5.4	2,102	36,826	365	767,230	13,441,490	52'	39,895,960	698,957,480	$0.0004108	$0.0000672	16,400	47,000	63,400[C]
	State Highway Loop 12	326.19	15,000	5.0	750	14,250	365	273,800	5,201,200	31'	8,487,800	161,237,200	$0.0004108	$0.0000672	3,487	10,835	14,322
		TOTAL	57,278		3,057	54,221		1,115,830	19,790,590		50,682,760	895,521,080	$0.0004108	$0.0000672	$20,832	$60,209	$ 81,041
6		326.26 - 362.75															
	Interstate Highway 45	328.46	27,500	5.4	1,485	26,015	365	542,000	9,495,000	13'	7,046,000	123,435,000	$0.0004108	$0.0000672	$ 2,894	$ 8,295	$ 11,189
	Forest Avenue	330.65	27,000	4.5	1,215	25,785	365	443,000	9,442,000	19'	8,417,000	179,398,000	$0.0004108	$0.0000672	3,458	12,056	15,514
	Corinth Street	331.41	29,000	4.0	1,160	27,840	365	423,000	10,162,000	30'	12,690,000	304,860,000	$0.0004108	$0.0000672	5,213	20,486	25,699
	Cadiz Street	332.22	45,000	5.4	2,430	42,570	365	887,000	15,538,000	30'	26,610,000	466,140,000	$0.0004108	$0.0000672	10,931	31,325	42,256
	Interstate Highway 35E	332.28	45,000	5.4	2,430	42,570	365	887,000	15,538,000	27'	23,949,000	419,526,000	$0.0004108	$0.0000672	9,838	28,192	38,030
	Houston Street	332.61	10,000	5.0	500	9,500	365	183,000	3,468,000	26'	4,758,000	90,168,000	$0.0004108	$0.0000672	1,954	6,059	8,013
	Dallas-Ft. Worth Turnpike	333.12	26,000	6.0	1,560	24,440	365	569,000	8,921,000	23'	13,087,000	205,183,000	$0.0004108	$0.0000672	5,376	13,788	19,164
	Commerce Street	333.50	20,000	5.0	1,000	19,000	365	365,000	6,935,000	25'	9,125,000	173,375,000	$0.0004108	$0.0000672	3,748	11,651	15,399
	Continental Street	333.93	16,000	5.0	800	15,200	365	292,000	5,548,000	25'	7,300,000	138,700,000	$0.0004108	$0.0000672	2,999	9,321	12,320
	Sylvan Avenue	334.89	7,000	5.0	350	6,650	365	128,000	2,427,000	52'	6,656,000	126,204,000	$0.0004108	$0.0000672	2,734	8,481	11,215

TABLE 11 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

INCREASED VEHICULAR COSTS DUE TO NAVIGATION - 1966

Reach (1)	Bridge (2)	Channel Mile to Channel Mile (3)	Average Daily Traffic (4)[A]	Percent of Truck (5)[A]	Average Daily Truck Traffic (6)	Average Daily Pass. Car Traffic (7)	Days in Year (8)	Total Yr. Truck Traffic (6 x 8) (9)	Total Yr. Pass. Car Traffic (7 x 8) (10)	Increased Height of Bridge (11)	Total (9 x 11) (12)	Total (10 x 11) (13)	Cost/ft. Lift for Trucks (14)[B]	Cost/ft Lift for Pass. Cars (15)[B]	Total Increased Truck Costs (12 x 14) (16)	Total Increased Pass. Car Costs (13 x 15) (17)	Total Vehicular Costs (16 + 17) (18)
6 (Cont'd)		326.26 - 362.75															
	Hampton Avenue	336.33	25,000	5.0	1,250	23,750	365	456,000	8,669,000	22'	10,032,000	190,718,000	$0.0004108	$0.0000672	$ 4,121	$12,816	$ 16,937
	Westmoreland Road	337.26	11,000	5.0	550	10,450	365	201,000	3,814,000	47'	9,447,000	179,258,000	$0.0004108	$0.0000672	3,880	12,046	15,926
	State Highway Loop 12	340.39	15,000	4.0	600	14,400	365	219,000	5,256,000	19'	4,161,000	99,864,000	$0.0004108	$0.0000672	1,709	6,711	8,420
	Meyers Road	342.94	2,900	7.0	203	2,697	365	74,000	984,000	47'	3,478,000	46,248,000	$0.0004108	$0.0000672	1,429	3,108	4,537
	Beltline Road	345.25	13,560	5.0	678	12,882	365	247,000	4,702,000	33'	8,151,000	155,166,000	$0.0004108	$0.0000672	3,348	10,427	13,775
	State Highway 360	350.75	9,430	7.0	660	8,770	365	241,000	3,201,000	38'	9,158,000	121,638,000	$0.0004108	$0.0000672	3,762	8,174	11,936
	Farm-to-Market Road 157	354.00	12,200	8.0	976	11,224	365	356,000	4,097,000	41'	14,596,000	167,977,000	$0.0004108	$0.0000672	5,996	11,288	17,284
	Arlington-Bedford Road	357.00	1,600	5.0	80	1,520	365	29,000	555,000	34'	986,000	18,870,000	$0.0004108	$0.0000672	405	1,268	1,673
	Arlington-Smithfield Road	359.95	1,650	5.0	82	1,568	365	30,000	572,000	29'	870,000	16,588,000	$0.0004108	$0.0000672	357	1,115	1,472
	US Highway Loop 820	362.11	22,000	5.0	1,100	20,900	365	402,000	7,628,000	33'	13,266,000	251,724,000	$0.0004108	$0.0000672	5,450	16,916	22,366
	Handley-Ederville Road	362.70	2,910	3.0	87	2,823	365	32,000	1,030,000	43'	1,376,000	44,290,000	$0.0004108	$0.0000672	565	2,976	3,541
		TOTAL	369,750		19,196	350,554		7,006,000	127,982,000		195,159,000	3,519,330,000	$0.0004108	$0.0000672	$80,167	$236,499	$316,666

A Information obtained from Texas Highway Department.

B Costs per foot of lift for trucks and passenger cars was obtained from the Federal Highway Administration, Department of Transportation.

C Estimated 1985 traffic was brought to 1966.

computations to arrive at the base year annual totals for increased vehicular operating costs are shown in the remainder of the tabular columns.

55. Projections of traffic volume over the life of the Trinity River navigation project from 1985 to 2035 were developed by the stepdown correlation method. The national, state and the Trinity River population growth projections were correlated with vehicular registration projected growth to obtain a composite growth factor for vehicular traffic volume. The Resources in America's Future, John Hopkins Press, Baltimore, Md., and the Statistical Abstract of the United States, U. S. Department of Commerce, were used as source material for projecting vehicular traffic growth. Vehicular traffic growth factors for the Trinity River are shown for selected years in table 12.

TABLE 12

ESTIMATED GROWTH FACTORS FOR PROJECTED VEHICULAR TRAFFIC VOLUME

Year	Growth Factor
1966(1)	1.000
1985(2)	2.059
2000	3.642
2010	4.385
2020	5.281
2035	7.109

(1) Base year of project
(2) Beginning year of project

56. These factors of growth were applied to the 1966 base year vehicular traffic for each of the six reaches on the Trinity River to obtain future vehicular traffic volume for 1985, 2000, 2010, 2020, and 2035 for computation of economic losses from increased vehicular operating cost by type vehicle and by area.

57. The estimates of economic losses from increased vehicular operating costs were converted to an average annual equivalent

economic loss for the project life period in accordance with EM 1120-2-118, Appendix II, and Senate Document 97, 87th Congress, using an interest rate of 3.25 percent. The average annual equivalent economic loss from increased vehicular operating costs was estimated at $1,836,000. A summary of the estimates of average annual equivalent costs to vehicular traffic is given in table 19.

58. Recreation.- A complementary study was made of the benefits from general recreation and recreation associated with fish and wildlife resources directly related to the navigation features of the proposed project. The detailed investigation, given in exhibit 4 to this appendix, includes a study of the type of facilities or recreation opportunities provided by the several features comprising the navigation project. Generally, these opportunities are associated with the navigation channel, the slack-water pools created by the navigation dams, and recreational and sight-seeing facilities provided in connection with navigation lock structures. The detailed study also includes an investigation of the increased sport fishing and hunting that would be a direct result of the construction of the project.

59. Benefits evaluated for recreation activities at facilities provided by the navigation features of the project are estimated in accordance with criteria set forth in Senate Document 97, 87th Congress, 2nd Session, "Evaluation Standards for Primary Outdoor Recreation Benefits." The unit values per recreation day contained therein range from $0.50 to $1.50. To evaluate these benefits, the quality of facilities and recreation that would be provided by the project were judged to warrant unit values of $0.75 per day for general recreation and $1.00 per day for primary sport fishing and hunting activities.

60. The estimated average annual equivalent recreation and fish and wildlife benefits creditable to the navigation features of the project are estimated at $3,302,000. The derivation of these benefits is discussed in exhibit 2 and is summarized in table 20 of this appendix.

61. Economic development.- In the report of the Board of Engineers for Rivers and Harbors contained in H. D. 276, 89th Congress, 1st Session, an evaluation was made of the direct effect that construction of the multi-purpose project would have on unemployed labor in ten counties designated as economically depressed areas by the Area Redevelopment Administration (ARA). Subsequent to the transmittal of the Trinity River and Tributaries, Texas report to Congress in 1963, the Public Works and Economic

Development Act was enacted in 1965, and the administration of the development program was assigned to the Economic Development Administration (EDA).

62. For the purposes of reevaluating the navigation economics, a second complementary study of development benefits was made. This study incorporated the most recent data available on counties designated as economically distressed by the Economic Development Administration. The study also includes the determination of the probable economic impact that would occur to these distressed counties because of expenditures from construction, operation and maintenance of the navigation features of the authorized project.

63. The detailed study, conducted in accordance with the provisions of Senate Document 97, is contained in exhibit 5 to this appendix. The economic development analysis presents information on nine counties now designated as depressed areas under the Public Works and Economic Development Act of 1965 and contains an evaluation of the estimated average annual equivalent benefits creditable to the construction, maintenance and operation of the navigation features of the authorized project.

64. The average annual equivalent EDA benefits creditable to the navigation project amount to about $1,565,000 for new construction, $321,000 for maintenance and operation, or a total of about $1,886,000 annually.

COMMERCE

65. Existing commerce.- The only existing commerce on the Trinity River is the traffic moving over the 9 feet deep by 150 feet wide channel to Liberty project authorized under the Rivers and Harbors Act of March 3, 1905, as modified by the Rivers and Harbors Acts of March 2, 1945 and July 24, 1946. This channel is presently maintained to a 6 foot depth.

66. The analyses of savings in cost to waterway transportation presented herein exclude the existing and projected commerce estimated in the report on Trinity River and Tributaries, Texas - Wallisville, contained in House Document 215, 87th Congress, 1st Session. However, in order to provide adequate lock capacity to carry the combined prospective commerce for both the channel to Liberty and the channel to Fort Worth, Texas, at the Wallisville lock, this commerce was included in lock capacity studies accomplished for this purpose.

67. Prospective commerce.- For the purposes of this study, prospective commerce is considered to be the barge adaptable portion of the overall traffic moving in the tributary area by

overland modes of transportation that would be susceptible to routing and movement, either wholly or in part, on the Trinity River waterway at less cost than the present mode of movement, and provided that the degree of potential savings is sufficient to attract the commerce to the waterway.

68. Traffic analysis.- The initial traffic disclosed by the field traffic survey was carefully screened to eliminate all commodity movements that obviously had no potential for being moved as waterway traffic on the Trinity River project. The balance of the potential waterway traffic was then subjected to an analysis of applicable rates and charges to determine the current transportation charges via the existing routes. These rates and charges were then compared with estimated rates and charges for shipments via the proposed Trinity River route. Where portions of the joint land-water hauls could alternatively move via authorized and competing waterways, such as the Arkansas River, with its terminus at Catoosa, Oklahoma, and the Red River, with its terminus at Daingerfield, Texas, constructed rates and transfer charges via the alternative routes were compared with similar data via the Trinity River waterway to determine which route would provide the least costly total transportation charges. The constructed charges and rates applied to the waterway movements reflect the weighted average level for like hauls and distances on other comparable operating waterways and are based on extensive studies of barge operating costs and services on the existing waterways. If, by comparison, the alternative route was found to be less costly, the prospective traffic was assumed to move by the alternate route, and was not further considered as prospective commerce for the Trinity waterway. If the comparison indicated a lesser cost for movement by the Trinity than by the alternative, the traffic was accepted as prospective commerce for the Trinity. In this case, however, the measure of transportation savings, or benefits, was computed as the difference in transportation costs by the two waterways, rather than the difference in Trinity waterway movement costs and the existing land transportation costs for the movement. An example of a comparison of rates for a specific movement is shown below:

Existing movement-Chicago to Dallas
Barge to Houston; Truck to Dallas---------$16.20
Possible movement-Chicago to Dallas via
Arkansas River; Barge to Muskogee, Okla.;
Truck to Dallas---------------------------$15.60
Possible movement-Chicago to Dallas
Via Red River-Barge to Jefferson, Tex.;
Truck to Dallas---------------------------$14.46
Possible movement-Chicago to Dallas
Via Trinity River; Barge only-------------$11.52

The smaller cost via the Trinity ($11.52) as compared to the Arkansas ($15.60) and the Red ($14.46) would indicate that the traffic should be claimed as prospective commerce for the Trinity. The benefits or savings per ton, however, would be the difference between the lowest alternate rate of $14.46 and $11.52, rather than the difference between the existing rate of $16.20 and the Trinity rate of $11.52. Transfer, handling, switching, or trucking charges used where plant locations are not directly accessible to the water routes, reflect the average level of such charges applicable to the same commodities at existing regular interchange points or ports. The field study developed information on the current pattern of transportation of commodities in the area. This information included: origins and destinations of commodities, transportation mode employed, transportation rates, costs of inter-modal transfer for commodities, switching charges, and related information pertaining to actual commerce in the area. Transfer, switching, rates, and handling charges, not developed by the survey teams, were provided by a rate specialist under contract for the purpose. Barge rates for traffic to be transported on the projected waterway were provided by OCE.

69. Accepted waterborne commerce - 1966 conditions.- A field canvass of traffic and special studies of grain, sand, gravel and stone, and iron and steel, as described in paragraph 13, were made in order to evaluate the prospective waterborne commerce. Each of these studies, conducted concurrently in 1967, and discussed in detail in the ensuing paragraphs, includes information on basic data, basis of analysis, estimates of 1966 base-year traffic, and estimates of the traffic accepted as prospective base-year waterborne commerce.

a. Traffic survey.- A total potential of almost 137 million tons of traffic was reported by respondents to the field traffic survey as moving in the tributary area in 1966. As stated in paragraph 15, the raw traffic data were carefully reviewed by Corps of Engineers' transportation specialists to eliminate those commodities and movements obviously not suited to barge movement. The preliminary review left a remaining total potential traffic volume of almost 24 million tons. This traffic was then reviewed on a movement and commodity basis to screen out traffic that would not move on the waterway for one or more specific reasons, including such factors as duplication; not barge adaptable because of special handling requirements; excessive circuity of routing; insufficient total volume shipped or necessity for small frequent shipments; and other incidental reasons such as traffic concentrated at interior points under transit rates, four-way transfer, insufficient data, etc. The detailed screening further reduced the potential commerce to

17.044 million tons accepted for detailed rate analysis. This traffic was then posted to rate analysis sheets, as illustrated in figure 4, for analysis of commodity movements by origin and destination to determine by what route and mode of transport and what transportation cost would govern each movement. With the further eliminations by the detailed rate analysis because of insufficient or no savings, the 1966 base year traffic finally accepted as prospective waterway commerce totaled about 1.932 million tons, exclusive of grain (wheat and grain sorghum) and sand, gravel, and stone.

b. Grain (wheat and grain sorghum).- Detailed information on the field traffic study, market analysis, producing areas, mode of transport and distribution of grain is given in exhibit 1 to this appendix. The available statistics on grain production for past years were reviewed and it was determined that, for various reasons, the use of 1965 data as a representative grain production year for base-year traffic analysis was more appropriate than averaging data for a number of years. Further, the 1965 production year is recent enough to obtain reasonably accurate information on the movement of grain from the tributary area to established markets. Accordingly, 1965 was selected as the base year for estimating prospective grain commerce. The grain study shows that about 31 percent of the wheat and 4 percent of the grain sorghum produced moves into the export market by truck. Also, it was found that only this increment of grain movement is acceptable as prospective commerce for waterway movement. Table 11 of exhibit 1 shows that about 9.841 million tons of wheat and 8.495 million tons of grain sorghum were produced in the tributary area in 1965. Market and transportation pattern studies found 69 percent of the wheat and 96 percent of the grain sorghum was not potential waterborne commerce since this traffic was moving to domestic markets or moving to export by rail and truck and, for a number of reasons, would not change its pattern of movement. The remaining traffic of 4.426 million tons of wheat and 0.308 million tons of grain sorghum was subjected to a detailed rate analysis. Grain traffic eliminated because of no savings, insufficient savings and volume resulted in a total accepted prospective grain commerce of 0.719 million tons of wheat and 0.123 million tons of grain sorghum. All of this prospective traffic is downbound from the producing area via the Trinity River waterway to export points on the Texas Gulf Coast.

c. Sand, gravel and stone.- The analysis of 1966 base-year prospective commerce in sand, gravel and stone, given in detail in the supplement II to exhibit 2, is based on a regional market

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analysis of resources, movement patterns and market demands, as developed by the resource analyst in his sand, gravel and stone study. By his studies, it was found that the primary sources of sand and gravel in the Houston-Galveston Region will be depleted by the year 2000 while the primary sources of sand and gravel in the Dallas-Ft. Worth Region will be depleted by the year 1980. The potential base-year commerce (1966) was estimated on the basis that the existing primary sources did not contribute to supplying the market demands in 1966. Upon depletion of these primary sources, production from alternate sources was estimated by analyzing the future reserves of sand, gravel, stone and shell to determine the distribution of this production that would serve the regional markets. The sand and gravel production, developed from the analysis of future production areas, for base year estimating purposes, is considered as 1966 production from these areas. The distribution of this future production based on 1966 production figures is shown on tables 2, 3, 5 and 6 in supplement II to exhibit 2 for each of the consuming regions. Therefore, from this analysis it was determined that the sand and gravel deposits, located along the Trinity River, will become one of the primary sources of supply for this material in competition with alternate sources of supply, including substitute materials that probably would have supplied the regional markets in the base year 1966. The 6.10 million tons accepted for rate analysis includes 3.10 million tons of sand and gravel moving upbound to the Dallas-Fort Worth Region. This production represents about 48 percent of the former production of the primary sources in this region and is production developed at the Trinity River deposits for this study. The remaining 3.00 million tons moving downbound into the Houston-Galveston Region consists of 0.90 million tons of actual 1966 production and 2.10 million tons of developed sand and gravel production which represents about 30 percent of the former production of the primary sources in this region. The rate analysis eliminated an additional 0.90 million tons because of no savings. The estimated waterway traffic in sand, gravel and stone amounts to 2.1 million tons moving downbound to the Houston-Galveston Region market area concurrently with 3.1 million tons moving upbound to the Dallas-Fort Worth Region market area for a total of 5.2 million tons of 1966 base year prospective commerce in sand, gravel and stone.

d. <u>Iron and steel</u>.- Conventional traffic survey methods of developing estimates of prospective iron and steel traffic were employed as described in paragraph 68. However, as discussed in paragraph 19, because of the relative economic importance of this traffic to the waterway, it was considered appropriate that additional market studies be made to assure reliability of the estimates of this traffic accepted for waterborne movement. A professional market analyst was directed to investigate iron and steel traffic moving into the tributary area from producing areas as a check of the field traffic survey data obtained primarily from consumers. In addition, he was directed to investigate the basic characteristics of the iron and steel business in the tributary area; particularly, with respect to the role that petroleum related steel has in the industry. The analyst has shown in table 31 of exhibit 3 that his base year estimate of iron and steel commerce subject to a detailed rate analysis amounts to 1.345 million tons, which is in reasonable agreement with the 1.267 million tons derived in the field traffic survey; further, he has shown that petroleum related steel is a relatively minor item in the overall regimen of the iron and steel business in the tributary area, with a diminishing importance in future traffic patterns. It should be noted that the analyst uses a different method of projection for estimates of future commerce than the Corps' method used in the traffic analysis presented herein, and variance in the magnitudes of traffic developed by both methods for the 69-year period (1966-2035) covered are attributable to the different projection methods, rather than differences in base year traffic estimates. In view of the minor role of petroleum related iron and steel in the overall traffic in these commodities, this increment of iron and steel traffic was included in the overall analysis of iron and steel commerce and was not analyzed separately.

70. Summary of accepted waterborne commerce - 1966 conditions.- A summary statement by commodities, of all estimated tonnage collected from all sources of information, and tonnages eliminated to derive the 1966 base year commerce accepted for the project channel is given in table 13. An upward adjustment of 10 percent has been made on traffic accepted for waterway movement on the basis of the field traffic survey to allow for traffic undisclosed by the field canvass of traffic. This adjustment was not made for the base year commerce in wheat and grain sorghum and sand, gravel and stone traffic, which were derived by statistical analysis rather than by the field traffic canvass.

TABLE 13

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Farm Products												
Cotton, raw	1,118,648	314,602		314,602				0				0
Barley and rye	130,756	2,640	640				2,000 (1)	0				0
Corn	67,042	45,730	6,320			750	11,660 (1) 14,000 (2)	13,000				13,000
Oats	6,048	1,880	420			500	960 (1)	0				0
Rice, rough, husked, & milled	457,450	17,800	4,800					13,000	13,000			0
Sorghum grain (10)	8,495,000	308,000						308,000	70,000	25,000	15,000 (3)	198,000
Wheat (10)	9,841,000	3,025,000						3,025,000	1,720,000	194,000	6,000 (3)	1,105,000
Soybeans	47,350	7,600			1,200		6,400 (1)	0				0
Oilseeds, not elsewhere classified	9,900	0						0				0
Hay and fodder	15,676	0						0				0
Field crops, not elsewhere classified	135	0						0				0
Fresh fruits and tree nuts, except bananas and plantains	6,783	2,700	2,700					0				0
Coffee, green	95,500	500	500					0				0
Fresh and frozen vegetables	14,859	0						0				0
Animals and animal products not elsewhere classified	1,389	1,301	520			781		0				0
Sub-Total	20,307,736	3,727,753	15,900	314,602	1,200	2,031	35,020	3,359,000	1,803,000	219,000	21,000	1,316,000
Forest Products												
Crude rubber and allied gums	24,280	24,030				30		24,000				24,000
Sub-Total	24,280	24,030				30		24,000				24,000
Fresh Fish and Other Marine Products												
Marine shells, unmanufactured	6,100,000	0						0				0
Sub-Total	6,100,000	0						0				0
Metallic Ores												
Iron ore and concentrates	13,117	0						0				0
Sub-Total	13,117	0						0				0
Coal												
Bituminous coal and lignite	18,000	13,800					1,800 (1) 12,000 (2)	0				0
Sub-Total	18,000	13,800					13,800	0				0

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Crude Petroleum												
Crude petroleum	20,137,656	1,822	1,822					0				0
Sub-Total	20,137,656	1,822	1,822					0				0
Nonmetallic Minerals, Except Fuels												
Limestone flux and calcareous stone	3,425,768	15,378	3,660				3,918 (1)	7,800	7,800			0
Building stone, unworked	1,126	515				515		0				0
Crushed and broken stone	6,590,000	40,000						40,000	40,000			0
Sand and gravel (10)	17,530,000	11,660,000					950,000 (4) 4,610,000 (5)	6,100,000	900,000			5,200,000
Clay, ceramic and refractory materials	1,008,798	18,160	8,920			360	2,880 (1) 6,000 (4)	0				0
Phosphate rock	569,900	169,900	400					169,500	10,000			159,500
Salt	23,610	3,100	2,520			580		0				0
Sulphur, dry	2,750,100	100	100					0				0
Sulphur, liquid	68,500	0						0				0
Gypsum and plaster rock	79,560	37,100	600	36,500				0				0
Nonmetallic minerals, except fuels, not elsewhere classified	177,408	10,367	4,480		3,200	600	1,087 (1)	1,000				1,000
Sub-total	32,224,770	11,954,620	20,680	36,500	3,200	2,055	5,573,885	6,318,300	957,800	0		5,360,500
Food and Kindred Products												
Meat, fresh, chilled, or frozen	43,900	0						0				0
Meat and meat products prepared or preserved, including canned meat products	5,300	500	500					0				0
Animal by-products, not elsewhere classified	8,150	8,150		8,150				0				0
Dairy products, except dried milk and cream	6,610	520				520		0				0
Fish and fish products, prepared or preserved, except shellfish	1,750	1,400	1,400					0				0
Vegetables, canned	1,890	945				945		0				0
Vegetables and preparations, otherwise prepared and preserved	4,930	3,050				50	3,000 (6)	0				0
Fruits, frozen	200	0						0				0
Fruits, canned	870	0						0				0
Fruit and vegetable juices	1,400	600	600					0				0
Wheat flour and semolina	562,712	150,300					138,300 (6) 12,000 (1)	0				0
Prepared animal feeds	1,341,741	102,706	22,350			676	8,680 (1) 12,000 (2)	59,000	24,000			35,000

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Food and Kindred Products (con't)												
Grain mill products, not elsewhere classified	18,197	113,237	4,120		1,500	1,617	14,000 (1) 60,000 (2)	32,000	20,000			12,000
Sugar	1,255,517	3,680	3,680					0				0
Molasses, inedible	178,127	81,590	41,490				1,600 (1)	38,500	8,900			29,600
Alcoholic beverages	57,029	43,727		43,727				0				0
Beverages, nonalcoholic; flavoring syrups and extracts	2,230	160				160		0				0
Vegetable oils, all grades; margarine and shortening	162,390	69,788	16,513			400	2,625 (1)	50,250	45,000			5,250
Animal oils and fats, not elsewhere classified, including marine	9,200	9,200	800					8,400	8,400			0
Coffee, roasted	30,000	0						0				0
Miscellaneous food products	147,782	18,322	16,722		1,250	350		0				0
Sub-Total	4,002,925	607,875	108,175	51,877	2,750	4,718	252,205	188,150	106,300			81,850
Basic Textiles												
Basic textile products, except textile fibers	56,840	13,525	9,760	1,250		1,315	1,200 (1)	0				0
Textile fibers, not elsewhere classified	33,361	27,781	10,796			1,985	15,000 (6)	0				0
Sub-Total	90,201	41,306	20,556	1,250		3,300	16,200	0				0
Lumber and Wood Products												
Timber, posts, poles, piling, and other wood in the rough	227,700	49,900	2,500		7,350			40,050	40,050			0
Pulpwood	293,980	113,740	700					113,040	113,040			0
Lumber	328,361	51,598	40,454		6,120	1,524	1,100 (4) 2,400 (1)	0				0
Veneer, plywood, and other worked wood	25,693	6,762	4,656			1,506	600 (1)	0				0
Wood manufactures, not elsewhere classified	268,304	30,720	13,040		2,080			15,600	15,600			0
Sub-Total	1,144,038	252,720	61,350		15,550	3,030	4,100	168,690	168,690			0
Furniture and Fixtures												
Furniture and fixtures	40,125	200	200					0				0
Sub-Total	40,125	200	200					0				0

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Pulp, Paper and Allied Products												
Pulp	2,500	0						0				0
Standard newsprint paper	402,504	222,834	9,988		23,764	3,185		185,897	103,969			81,928
Paper and paperboard	748,647	429,500	27,620		46,500	2,292	12,000 (1) 3,000 (7)	338,088	317,688			20,400
Pulp, paper and paperboard products not elsewhere classified	542,926	139,070	27,895		12,480	2,855		95,840	95,840			0
Sub-Total	1,696,577	791,404	55,515		82,744	8,332	24,988	619,825	517,497			102,328
Printed Matter												
Printed matter	21,282	2,624	2,624					0				0
Sub-Total	21,282	2,624	2,624					0				0
Chemicals and Related Products												
Sodium hydroxide (caustic soda)	365,209	42,709				129		42,580	10,000			32,580
Crude products from coal tar, petroleum, and natural gas	2,503,540	40	40					0				0
Dyes, organic pigment, dyeing and tanning materials	8,420	1,240	1,000			240		0				0
Alcohols	4,550	1,050				1,050		0				0
Sulphuric acid	247,600	55,200	5,200					50,000				50,000
Benzene	72,000	0						0				0
Basic chemicals and basic chemical products, not elsewhere classified	5,488,157	476,299	33,890	18,000	2,000	5,249	20,000 (6) 26,130 (1)	371,030	215,950			155,080
Plastic materials, regenerated cellulose and synthetic resins, including film, sheeting, and laminates	389,640	90,092	27,592		50,000			12,500				12,500
Synthetic rubber	311,042	21,552	3,480		18,000	72		0				0
Synthetic (man-made) fibers	2,132	1,032	782			250		0				0
Drugs (biological products, medicinal chemicals, botanical products and pharmaceutical preparations)	295	0						0				0
Soap, detergents, and cleaning preparations; perfumes, cosmetics and other toilet preparations	2,650	2,050	1,500			550		0				0
Paints, varnishes, lacquers, enamels, and allied products	57,276	14,890	14,430			460		0				0

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Chemicals and Related Products (Cont'd)												
Gum and wood chemicals	1,182	810				810		0				0
Nitrogenous fertilizer and fertilizer materials, manufactured	225,250	33,450	800			650		32,000	17,000			15,000
Superphosphate	11,000	11,000			2,000		6,000 (2)	3,000	3,000			0
Phosphatic fertilizer and fertilizer materials, not elsewhere classified	151,263	151,263	6,360	12,000			3,000 (2)	129,903	3,000			126,903
Ammonium sulphate, all grades	8,000	8,000					3,000 (2)	5,000				5,000
Insecticides, fungicides, pesticides, and disinfectants	7,231	6,070			6,000	70		0				0
Fertilizers and fertilizer materials, not otherwise classified	364,458	175,725	44,925			740	560 (1) 4,000 (2)	125,500	30,500	10,000		85,000
Miscellaneous chemical products	321,713	186,411	37,115		110,996	94	806 (2) 13,400 (1)	24,000				24,000
Sub-Total	10,542,608	1,278,883	175,614	30,000	188,996	10,364	78,396	795,513	279,450	10,000		506,063
Petroleum and Coal Products												
Gasoline	522,012	0						0				0
Jet Fuel	600	600	600					0				0
Lubricating oils and greases	85,880	13,080	12,480			600		0				0
Naphtha and other petroleum solvents	19,910	7,000						7,000				7,000
Asphalt, tar, and pitches	598,464	67,345	66,500			845		0				0
Liquefied petroleum gases, coal gases, natural gas, and natural gas liquids	385,541	38,060						38,060	38,060			0
Asphalt building materials	160,199	19,800	19,400			400		0				0
Petroleum and coal products, not otherwise classified	23,066,285	7,515	2,280			235	5,000 (6)	0				0
Sub-Total	24,838,891	153,400	100,660			2,680	5,000	45,060	38,060			7,000
Rubber and Miscellaneous Plastics Products												
Rubber and miscellaneous plastic products	95,903	3,525	2,980		500	45		0				0
Sub-Total	95,903	3,525	2,980		500	45		0				0
Leather and Leather Products												
Leather and leather products	928	460	460					0				0
Sub-Total	928	460	460					0				0

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Stone, Clay, and Glass Products												
Glass and glass products	34,244	24,875	180	24,060		635		0				0
Building cement	2,462,451	99,824	600			224		99,000				99,000
Structural clay products, including refractories	591,651	151,538	16,488		7,410	2,200		125,440	125,440			0
Lime	15,600	15,000						15,000	15,000			0
Cut stone and stone products	1,541	15				15		0				0
Miscellaneous nonmetallic mineral products	1,241,412	71,059	1,000	67,100		829	2,130 (2)	0				0
Sub-Total	4,346,899	362,311	18,268	91,160	7,410	3,903	2,130	239,440	140,440			99,000
Primary Metal Products												
Pig iron	23,788	21,360	15,480			680	5,200 (7)	0				0
Slag	21,300	17,500			17,500			0				0
Coke, screenings and breeze	13,353	11,973	2,280		3,800	973	3,120 (2)	1,800	1,800			0
Iron and steel ingots, and other primary forms, including blanks for tube and pipe, and sponge iron	6,240	0						0				0
Iron and steel bars, rods, angles, shapes and sections, including sheet piling	975,749	605,633	49,777			2,571	1,137 (1) 7,100 (2)	545,048	23,090	31,438		490,520
Iron and steel plates and sheets	373,314	216,519	33,811		2,649	133	4,129 (2)	175,797	14,480	9,805		151,512
Iron and steel pipe and tube	1,092,715	148,074	41,904		22,875	1,393	2,100 (1) 15,000 (2) 2,500 (6)	62,302	29,620			32,682
Ferroalloys	20,130	17,130	1,500				15,630 (2)	0				0
Primary iron and steel products, not elsewhere classified, including castings in the rough	5,331,517	462,299	62,218		13,695	4,623	14,339 (1) 88,724 (2) 156,000 (7) 16,500 (8)	106,200				106,200
Nonferrous metals primary smelter products, basic shapes, wire, castings and forgings, except copper, lead, zinc and aluminum	86,143	51,338	24,692		9,100	426		17,120	11,970	2,150		3,000
Copper and copper alloys, whether or not refined, unworked	41,933	17,230	16,330		900			0				0
Lead and zinc including alloys, unworked	115,924	30,069	19,937			820	600 (1)	8,712	7,000			1,712
Aluminum and aluminum alloys, unworked	121,503	73,799	6,309		27,200	790	10,000 (1)	29,500				29,500
Sub-Total	8,223,609	1,672,924	274,238		97,719	12,409	342,079	946,479	87,960	43,393		815,126

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Fabricated Metal Products, except Ordance, Machinery, and Transportation Equipment												
Metal containers	92,424	20,176	8,711		10,000	505	960 (7)	0				0
Cutlery, hand tools, and general hardware	7,432	0						0				0
Plumbing fixtures, heating equipment and sanitary ware	40,223	2,700	2,700					0				0
Miscellaneous fabricated metal products	766,249	84,211	47,629			2,265	9,375 (1) 1,042 (2) 500 (7)	23,400	8,400	15,000		0
Sub-Total	906,328	107,087	59,040		10,000	2,770	11,877	23,400	8,400	15,000		0
Machinery, except Electrical												
Machinery, except electrical	235,081	35,889	3,290		2,750	3,271	4,093 (1) 16,485 (2) 6,000 (8)	0				0
Sub-Total	235,081	35,889	3,290		2,750	3,271	26,578	0				0
Electrical Machinery, Equipment and Supplies												
Electrical machinery, equipment and supplies	34,302	0						0				0
Sub-Total	34,302	0						0				0
Transportation Equipment												
Motor vehicles, parts and equipment	11,707	1,487				387	1,100 (1)	0				0
Aircraft and parts	4,045	250				250		0				0
Ships and boats	25,120	40				40		0				0
Miscellaneous transportation equipment	8,566	0						0				0
Sub-Total	49,438	1,777				677	1,100	0				0
Instruments, Photographic and Optical Goods, Watches and Clocks												
Instruments, photographic and optical goods, watches and clocks	267	0						0				0
Sub-Total	267	0						0				0

TABLE 13 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF TRAFFIC DEVELOPED, SCREENED, ANALYZED, AND ACCEPTED AS PROSPECTIVE TRAFFIC BY COMMODITIES - 1966 COMMERCE
(Tons of 2,000 pounds)

Commodity	Total Reported	Total Developed	Frequency Of Small Shipments	Not Barge Adaptable	Excessive Circuity	Insufficient Volume	Other	Total Accepted For Rate Analysis	No Savings	Insufficient Savings	Other	Total Accepted
Miscellaneous Products of Manufacturing												
Miscellaneous Products of Manufacturing	87,660	81,100	9,600			1,500	70,000 (7)	0				0
Sub-Total	87,660	81,100	9,600			1,500	70,000	0				0
Waste and Scrap Materials												
Iron and steel scrap	1,417,478	364,937	18,800		100,031	524	10,906 (1) 6,976 (2) 300 (7)	227,400	104,400			123,000
Nonferrous metal scrap	100,440	5,480	4,080			500	900 (1)	0				0
Textile waste, scrap, and sweepings	2,400	0						0				0
Paper waste and scrap	238,342	42,934				250	1,500 (7)	41,184	41,184			0
Waste and scrap, not elsewhere classified, including ashes, rubbish, garbage	830	630					630 (2)	0				0
Sub-Total	1,759,490	413,981	22,880		100,031	1,274	21,212	268,584	145,584			123,000
Commodities - N.E.C.												193,187
Sub-Total												193,187
GRAND TOTAL ALL TRAFFIC, WATERWAY TERMINATING AT FORT WORTH, TEXAS	136,942,111	21,529,491	953,852	525,389	512,850	62,389	6,478,570	12,996,441	4,253,181	287,393	21,000	8,628,054 (9)

(1) Insufficient data
(2) Red River traffic
(3) Insufficient tonnage
(4) Creditable to Channel to Liberty
(5) Creditable to Channel to Victoria
(6) Subject to transit rate
(7) Duplication
(8) Arkansas River traffic
(9) An adjustment of 10 percent has been added to the tonnage of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.
(10) Included in the table to show total commodity movements only. The estimated tonnages for these commodities were developed by analytical procedures in the special studies rather than through the field traffic survey.

ESTIMATES OF BENEFITS

71. Navigation benefits.- The rate analysis sheets for each movement of commodities accepted as prospective commerce, as shown in column 13 of table 13, were posted to traffic work sheets of accepted commerce. The work sheets contain the commodity by individual movement, direction of movement, tonnage accepted, savings in transportation costs, and the economic indicator assigned. An example of a traffic work sheet is given in figure 5.

72. The total accepted 1966 annual commerce and savings were aggregated by commodity class, commodity, and direction of movement, to develop the traffic pattern for the base year traffic. The total prospective commerce is shown in table 14.

FIGURE 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

EXAMPLE OF TRAFFIC WORK SHEET

ACCEPTED TRINITY RIVER WATERWAY COMMERCE - 1966

Sheet No.	Commodity	Movement	Tonnage	Savings	Economic Indicator Used
767	Caustic Soda (Liquid)	Up - D	11,000	$50,400	Manufacture
1603	Caustic Soda (Liquid)	Up - D	2,080	10,600	Manufacture
3390	Caustic Soda (Liquid)	Up - D	6,000	27,500	Manufacture
3413	Caustic Soda (Liquid)	Up - FW	3,500	21,700	Manufacture
3413	Caustic Soda (Liquid)	Up - D	6,000	35,300	Manufacture
2129	Sulfuric Acid	FW - Dwn.	50,000	77,000	Manufacture
250	Soda Ash	Up - D	20,500	208,500	Manufacture
1368	Soda Ash	Up - D	6,000	25,400	Manufacture
1368	Soda Ash	Up - D	6,000	21,400	Manufacture
1368	Soda Ash	Up - D	6,000	15,700	Manufacture
1368	Soda Phosphate	D - Dwn.	5,880	14,300	Manufacture
1530	Phosphoric Acid	Up - Tr	60,000	235,200	Farm
1583	Formalin	Up - D	5,000	31,900	Manufacture
1667	Isopropyl Alcohol	Up - D	8,000	33,800	Manufacture
1667	Isopropyl Alcohol	Up - Tr	8,000	4,500	Manufacture
3260	Soda Ash	Up - O	12,000	13,100	Manufacture

TOTALS THIS PAGE FOR EACH INDICATOR:

Farm Products________Tons 60,000
Savings 235,200

Manufacture________Tons 155,960
Savings 591,100

New Construction________Tons 0
Savings________

Population________Tons 0
Savings________

TABLE 14

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ACCEPTED PROSPECTIVE COMMERCE AND SAVINGS IN TRANSPORTATION CHARGES
(1966 commerce)

	UPBOUND		DOWNBOUND		TOTAL	
Commodity	Traffic (Net tons)	Savings (Dollars)	Traffic (Net tons)	Savings (Dollars)	Traffic (Net tons)	Savings (Dollars)
Farm Products						
Corn	13,000	44,300			13,000	44,300
Wheat (1)	-	-	1,105,000	719,000	1,105,000	719,000
Grain Sorghum (1)	-	-	198,000	123,000	198,000	123,000
Subtotal	13,000	$ 44,300	1,303,000	$ 842,000	1,316,000	$ 886,300
Forest Products						
Crude Rubber	24,000	133,900	-	-	24,000	133,900
Subtotal	24,000	$ 133,900	-	-	24,000	$ 133,900
Non-Metallic Minerals						
Perlite	-	-	1,000	2,200	1,000	2,200
Phosphate Rock	159,500	189,500	-	-	159,500	189,500
Sand & Gravel	3,100,000	3,383,000	2,100,000	1,281,000	5,200,000	4,664,000
Subtotal	3,259,500	$3,572,500	2,101,000	$1,283,200	5,360,500	$4,855,700
Food & Kindred Products						
Cottonseed Oil	-	-	5,250	16,000	5,250	16,000
Fish Meal	15,000	11,300	-	-	15,000	11,300
Meal & Feed	15,000	32,100	-	-	15,000	32,100
Molasses, Inedible	29,600	77,900	-	-	29,600	77,900
Rice Feed	5,000	3,600	-	-	5,000	3,600
Soybean Meal	12,000	21,800	-	-	12,000	21,800
Subtotal	76,600	$ 146,700	5,250	$ 16,000	81,850	$ 162,700

TABLE 14 (CONT'D)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ACCEPTED PROSPECTIVE COMMERCE AND SAVINGS IN TRANSPORTATION CHARGES
(1966 commerce)

Commodity	UPBOUND Traffic (Net tons)	UPBOUND Savings (Dollars)	DOWNBOUND Traffic (Net tons)	DOWNBOUND Savings (Dollars)	TOTAL Traffic (Net tons)	TOTAL Savings (Dollars)
Chemicals & Related Products						
Ammonium Phosphate	-	-	104,403	47,000	104,403	47,000
Ammonium Sulfate	5,000	8,500	-	-	5,000	8,500
Caustic Soda	45,280	233,800	-	-	45,280	233,800
Malamin Crystals	3,000	11,900	-	-	3,000	11,900
Phosphate	22,500	105,100	-	-	22,500	105,100
Phosphoric Acid	60,000	235,200	-	-	60,000	235,200
Polyethylene Pellets	7,500	26,000	-	-	7,500	26,000
Polyvinyl Choride Resin Compound	5,000	1,300	-	-	5,000	1,300
Soda Ash	63,500	328,100	-	-	63,500	328,100
Soda Phosphate	-	-	5,880	14,300	5,880	14,300
Sulfuric Acid	-	-	50,000	77,000	50,000	77,000
Misc. Chemical Products	34,000	177,600	-	-	34,000	177,600
Urea Fertilizer	15,000	12,300	85,000	143,000	100,000	155,300
Subtotal	260,780	$1,139,800	245,283	$281,300	506,063	$1,421,100
Pulp, Paper & Allied Products						
Bond Paper	8,400	34,900	-	-	8,400	34,900
Newsprint	77,098	114,300	4,830	6,300	81,928	120,600
Printing Paper	12,000	43,100	-	-	12,000	43,100
Subtotal	97,498	$ 192,300	4,830	$ 6,300	102,328	$ 198,600

TABLE 14 (CONT'D)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ACCEPTED PROSPECTIVE COMMERCE AND SAVINGS IN TRANSPORTATION CHARGES
(1966 commerce)

Commodity	UPBOUND Traffic (Net tons)	UPBOUND Savings (Dollars)	DOWNBOUND Traffic (Net tons)	DOWNBOUND Savings (Dollars)	TOTAL Traffic (Net tons)	TOTAL Savings (Dollars)
Petroleum & Coal Products						
Solvents	7,000	46,000	-	-	7,000	46,000
Subtotal	7,000	$ 46,000	-	-	7,000	$ 46,000
Primary Metal Products						
Lead Ingots	-	-	1,712	5,300	1,712	5,300
Aluminum & Aluminum Alloys	29,500	58,900	-	-	29,500	58,900
Iron & Steel Articles	750,432	1,888,500	800	1,400	751,232	1,889,900
Pipe, Iron & Steel	32,682	161,000	-	-	32,682	161,000
Subtotal	812,614	$2,108,400	2,512	$ 6,700	815,126	$2,115,100
Stone, Clay & Glass Products						
Cement	-	-	99,000	104,900	99,000	104,900
Subtotal	-	-	99,000	$ 104,900	99,000	$ 104,900
Waste & Scrap Materials						
Scrap, Iron & Steel	-	-	123,000	290,200	123,000	290,200
Subtotal	-	-	123,000	$ 290,200	123,000	$ 290,200
Miscellaneous						
Commodities - N.E.C.	145,099	400,100	48,088	70,800	193,187	470,900
Subtotal	145,099	$ 400,100	48,088	$ 70,800	193,187	$ 470,900
Grand Total	4,696,091	$7,784,000	3,931,963	$2,901,400	8,628,054(2)	$10,685,400(2)

(1) 1965 Commerce
(2) An adjustment of 10 percent has been added to the tonnage and savings of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

73. Projection of waterborne commerce.- Estimates of average annual savings to transportation over the 50-year project life are based on projections of base year tonnage and savings to transportation over this period. The projection indicators are based on estimates of economic development within the traffic area that will probably occur over the same period as discussed in paragraphs 33 through 36. Accordingly, individual commodities and savings of the accepted 1966 prospective commerce were allocated to major indicators on the basis of the indicator that most nearly represents the sector of the economy that controls the movement of the specific commodity. The accepted 1966 prospective commerce, as given in table 14, is allocated by commodity, tonnage, and savings for the project channel in table 15.

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TABLE 15

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ALLOCATION OF PROSPECTIVE COMMERCE TO MAJOR INDICES

POPULATION		
COMMODITY	TONS	SAVINGS
Bond Paper	8,400	$ 34,900
Cotton Seed Oil	5,250	16,000
Newsprint	81,928	120,600
Perlite	1,000	2,200
Printing Paper	6,000	18,100
Commodities NEC	10,258	19,200
TOTALS(1)	112,836	$ 211,000

VALUE ADDED BY MANUFACTURE		
COMMODITY	TONS	SAVINGS
Aluminum & Aluminum Alloys	22,000	$ 55,100
Caustic Soda	45,280	233,800
Cement	99,000	104,900
Crude Rubber	24,000	133,900
Lead Ingots	1,712	5,300
Malamin Crystals	3,000	11,900
Misc. Chemical Products	34,000	177,600
Polyvinyl Chloride Resin Compound	5,000	1,300
Polyethylene Pellets	7,500	26,000
Printing Paper	6,000	25,000
Soda Ash	63,500	328,100
Soda Phosphate	5,880	14,300
Solvents	7,000	46,000
Sulfuric Acid	50,000	77,000
Commodities NEC	37,387	124,000
TOTALS(1)	411,259	$1,364,200

SHIPMENTS OF IRON AND STEEL		
COMMODITY	TONS	SAVINGS
Iron & Steel Articles	751,232	$1,889,900
Pipe, Iron & Steel	32,682	161,000
Scrap, Iron & Steel	123,000	290,200
Commodities NEC	90,692	234,100
TOTALS(1)	997,606	$2,575,200

VALUE OF FARM PRODUCTS SOLD		
COMMODITY	TONS	SAVINGS
Ammonium Phosphate	104,403	$ 47,000
Ammonium Sulfate	5,000	8,500
Corn	13,000	44,300
Fish Meal	15,000	11,300
Fertilizer (Urea)	100,000	155,300
Meal & Feed	15,000	32,100
Molasses (Inedible)	29,600	77,900
Phosphate	22,500	105,100
Phosphate Rock	159,500	189,500
Phosphoric Acid	60,000	235,200
Rice Feed	5,000	3,600
Soybean Meal	12,000	21,800
Commodities NEC	54,100	93,200
TOTALS (1)	595,103	$1,024,800

VALUE OF NEW CONSTRUCTION CONTRACTS		
COMMODITY	TONS	SAVINGS
Sand & Gravel	5,200,000	$4,664,000
Aluminum & Aluminum Alloys	7,500	3,800
Commodities NEC	750	400
TOTALS (1)	5,208,250	$4,668,200

EXPORT WHEAT		
COMMODITY	TONS	SAVINGS
Wheat	1,105,000	$ 719,000
TOTALS	1,105,000	$ 719,000

EXPORT GRAIN SORGHUM		
COMMODITY	TONS	SAVINGS
Grain Sorghum	198,000	$ 123,000
TOTALS	198,000	$ 123,000

(1) An adjustment of 10 percent has been added to the accepted tonnage and savings of all commodities except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

74. The projection factors for each economic indicator, as shown in table 8, are used to project the corresponding tonnages and savings of the 1966 prospective commerce accepted for the proposed project as allocated in table 15. The projected tonnages and savings associated with each economic indicator are given for selected years in table 16.

75. Average annual equivalent gross transportation benefits.- The benefits from the reduction in transportation costs must be expressed as an average annual equivalent uniform level of benefits for comparison with uniform level annual charges over the project life. In accordance with procedures given in EM 1120-2-118 and using 3.25 percent compound interest rate, the varying annual savings levels projected in table 16 were reduced to an average annual equivalent level of annual savings to transportation for each indicator. An example of the computations used to derive the average annual equivalent savings to transportation for iron and steel is given in figure 6.

76. A summary of the average annual equivalent benefits by economic indicators and the total average annual equivalent gross navigation benefits is given in table 17.

TABLE 16

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

PROJECTIONS OF COMMERCE AND SAVINGS

Economic Indicators	1966	1985(1)	2000	2010	2020	2035
	TONNAGE (in thousands)					
Population	113	163	215	255	303	406
Value Added by Manufacture	411	1,034	2,123	3,384	5,393	11,041
Shipments of Iron & Steel	998	2,087	3,495	4,930	6,954	11,651
Value of Farm Products Sold	595	733	897	1,127	1,418	1,789
Value of New Construction Contracts (2)	5,208	10,479	19,266	27,474	39,131	66,987
Export Wheat (3)	1,105	1,172	1,277	1,362	1,454	1,567
Export Grain Sorghum (3)	198	247	257	264	271	310
TOTALS (4)	8,628	15,915	27,530	38,796	54,924	93,751
	SAVINGS (in thousands)					
Population	$ 211	$ 304	$ 401	$ 477	$ 566	$ 759
Value Added by Manufacture	1,364	3,430	7,042	11,225	17,889	36,622
Shipments of Iron & Steel	2,575	5,387	9,021	12,727	17,952	30,076
Value of Farm Products Sold	1,025	1,263	1,544	1,941	2,442	3,081
Value of New Construction Contracts (2)	4,668	9,392	16,960	24,186	34,447	58,971
Export Wheat (3)	719	763	831	887	946	1,020
Export Grain Sorghum (3)	123	154	160	164	168	193
TOTALS (4)	$10,685	$20,693	$35,959	$51,607	$74,410	$130,722

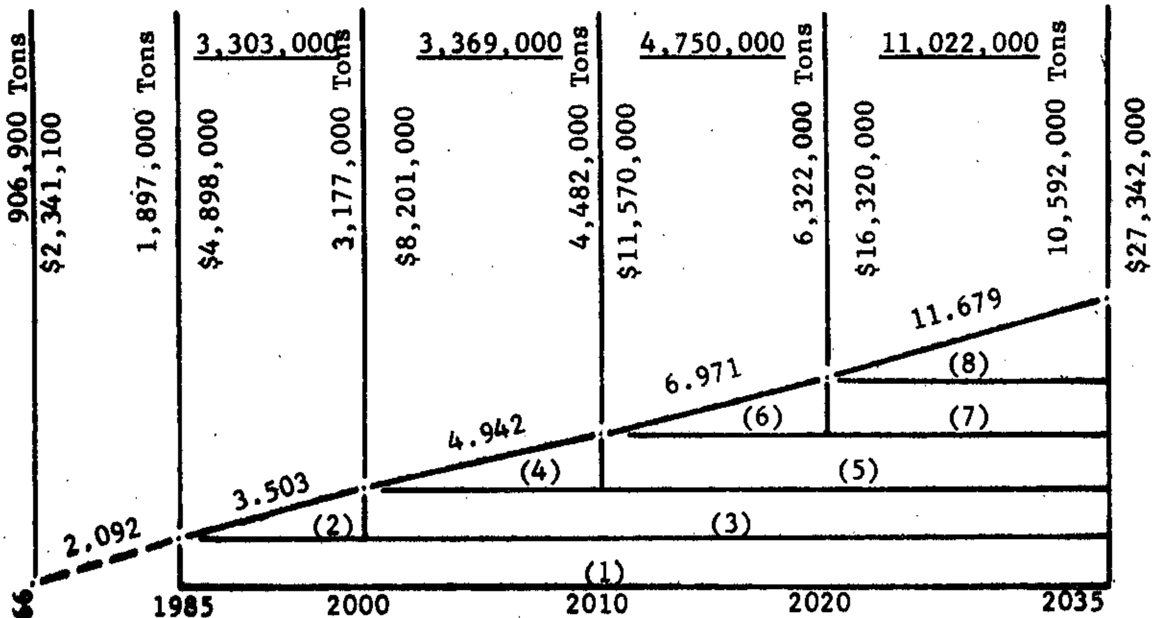
(1) Assumed initial year of project use.
(2) Base year sand & gravel tonnage of 5,200,000 and savings of $4,664,000 were used to compute tonnage and savings to the year 1999 and 5,700,000 tons and $5,021,000 savings were used to compute tonnage and savings from 2000 to 2035.
(3) Base year for wheat and grain sorghum is 1965.
(4) An adjustment of 10 percent has been added to the tonnage and savings of all commodities, except grain sorghum and wheat and sand and gravel, to allow for traffic undisclosed by the field survey.

FIGURE 6

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

EXAMPLE OF AVERAGE ANNUAL EQUIVALENT COMPUTATION

<u>SHIPMENTS OF IRON AND STEEL</u>



(1) BEGINNING YEAR OF THE PROJECT = $ 4,898,000

(2) $\frac{3,303,000}{15}$ = 220,200/yr.

(220,200) x (86.82594)(.04073) = 779,000

(3) (3,303,000) x (20.72389)(.61894)(.04073) = 1,726,000

(4) $\frac{3,369,000}{10}$ = 336,900/yr.

(336,900) x (44.10466)(.61894)(.04073) = 375,000

(5) (3,369,000)(16.93786)(.44952)(.04073) = 1,045,000

(6) $\frac{4,750,000}{10}$ = 475,000/yr.

(475,000)(44.10466)(.44952)(.04073) = 384,000

(7) (4,750,000)(11.72490)(.32647)(.04073) = 741,000

(8) $\frac{11,022,000}{15}$ = 734,800/yr.

(734,800)(86.82594)(.32647)(.04073) = 848,000

Total Average Annual Equivalent Benefits $10,796,000

TABLE 17

SUMMARY OF AVERAGE ANNUAL EQUIVALENT
GROSS NAVIGATION BENEFITS DERIVED FROM SAVINGS
PROJECTED BY THE VARIOUS ECONOMIC INDICATORS

Economic Indicator	Average Annual Equivalent Benefit (in thousands)
Population	$ 447
Value added by manufacture	10,951
Shipments of iron and steel	11,876
Value of farm products sold	1,812
Value of new construction contracts	22,208
Export wheat	858
Export grain sorghum	162
Total average annual gross equivalent navigation benefit	$ 48,314

77. Benefits from extended life of bridges.- The benefits creditable to the navigation features of the authorized project from the extended useful life of existing bridges, given in detail in tables 9 and 10 are summarized in table 18.

TABLE 18

SUMMARY OF BENEFITS FROM EXTENSION OF BRIDGE LIFE

Lower Reach	Average Annual Benefits for Life of the Project
Channel mile 0.00 to Dallas, Texas, terminus	
Highway bridges	$214,160
Railroad bridges	12,950
Average annual equivalent benefits-lower reach	$227,110
Upper Reach	
Dallas, Texas, terminus to Ft. Worth, Texas, terminus	
Highway bridges	$246,570
Railroad bridges	65,640
Average annual equivalent benefits-upper reach	$312,210
Total average annual equivalent benefits	$539,320
Rounded	$539,000

78. Economic losses-vehicular operating costs.- The increased cost to vehicular traffic that would operate over the raised sections of existing bridges that must be altered to provide adequate navigation clearance is taken as an economic loss resulting from construction of the navigation features of the authorized project. Therefore, the average annual equivalent value of this loss is deducted from the gross average annual equivalent navigation benefits.

79. The detailed computation of these costs, given in table 11, is summarized in table 19.

TABLE 19

SUMMARY OF AVERAGE ANNUAL EQUIVALENT ECONOMIC LOSS FROM INCREASED OPERATING COSTS OF VEHICLES

Area	Channel mile to Channel mile	Trucks	Passenger Vehicles	Total
1	0.00-70.00	$ 59,700	$ 75,400	$ 135,100
2	70.01-115.00	34,100	26,800	60,900
3	115.01-255.00	22,400	30,600	53,000
4	255.01-305.00	10,300	15,700	26,000
5	305.01-326.25	81,600	236,300	317,900
6	326.26-362.75	314,700	928,100	1,242,800
	TOTAL	$522,800	$1,312,900	$1,835,700
Total average annual equivalent economic loss =				Rounded: $1,836,000

80. Reduction in benefits-critical lock capacity.- The total port-to-port tonnages given in table 7 were converted to barge-tow requirements at each lock in the proposed navigation system. These requirements provide the basis for time-phase construction of additional facilities at the several locks to provide adequate capacity at the times it is needed. However, these studies also show that with additional capacity, installed locks 12 and 13 again reach capacity in the forty-eighth year of the project life. In view of the two year period remaining of the analysis period, it is considered more practical to discount the average annual equivalent savings in the amount of transportation savings that would be realized on traffic exceeding the capacity of these locks for the remaining two years of project life in lieu of construction of additional facilities in the forty-eighth year of the useful life of the project. Accordingly, the transportation savings creditable to the traffic exceeding the capacity of these locks has been discounted back to present worth, redistributed over the 50-year project analysis period and deducted from the gross navigation benefit. The average annual equivalent value of these discounted savings is computed at $273,000.

81. Summary of net transportation savings.- The total net average annual equivalent benefits creditable to transportation savings on the navigation project are the savings in transportation costs in the amount of $48,314,000, less the $273,000 discounted savings for the last two years of the project life, which results in a net annual transportation savings benefit of $48,041,000.

82. Recreation and fish and wildlife benefits.- A summary of the recreation benefits creditable to the navigation features only, discussed in paragraphs 58 through 60 and presented in detail in table 2 of exhibit 4 of this appendix, is given in table 20.

TABLE 20

SUMMARY OF RECREATION AND FISH AND WILDLIFE BENEFITS CREDITABLE TO NAVIGATION FEATURES

Period	Recreation Type	Recreation Use (1)	Average Annual Equivalent Benefit (2)
1985-1988	General	1,338,000	$ 115,100
	F & W	357,000	40,900
	Subtotal	1,695,000	$ 156,000
1988-2008	General	4,305,000	1,360,100
	F & W	357,000	192,100
	Subtotal	4,662,000	$1,552,200
2008-2035	General	5,643,000	1,470,000
	F & W	357,000	124,000
	Subtotal	6,000,000	$1,594,000
1985-2035	General		2,945,000(3)
	F & W		357,000
	Total 50-year period		$3,302,000

(1) Visitor days
(2) Based on 3.25 percent interest rate.
(3) Rounded to nearest thousand dollars.

83. Economic development benefits.- A summary of the economic development benefits creditable to the construction and maintenance and operation of the navigation features of the authorized project, discussed in paragraphs 54 through 56 and presented in detail in exhibit 5 of this appendix, is given in table 21.

TABLE 21

SUMMARY OF ECONOMIC DEVELOPMENT BENEFITS

Item	Average Annual Equivalent Benefit
Local wages during construction	$1,566,000
Local wages for operation and maintenance	321,000
Total economic development benefits	$1,887,000

84. Summary of benefits.- The total benefits reevaluated for all economic aspects of the navigation only features of the authorized channel from the Houston Ship Channel via the Trinity River to Fort Worth, Texas, are summarized in table 22.

TABLE 22

SUMMARY OF ESTIMATED AVERAGE ANNUAL EQUIVALENT BENEFITS
REEVALUATED FOR CHANNEL TO FORT WORTH

Item	Average Annual Equivalent Benefits
Navigation	
Saving in transportation cost	$48,041,000
Extended life of existing bridges	549,000
Less increased cost to vehicular traffic	- 1,836,000
Subtotal, navigation benefits	$46,754,000
Recreation, Fish and Wildlife	3,302,000
Economic Development Benefits	1,887,000
Subtotal, related benefits	$ 5,189,000
Total benefits	$51,943,000

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

EXHIBIT 1
GRAIN STUDY

EXHIBIT 1
APPENDIX II

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

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TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

SYLLABUS

In connection with reevaluation of the authorized Trinity River navigation project, a field traffic study and market analysis of the Trinity River tributary area was made to establish producing areas, quantities, mode of transportation, and distribution of grain. The data obtained indicated that the only grains of significance to the navigation restudy are export wheat and grain sorghum. About 4 percent of the grain sorghum and 31 percent of the wheat produced in the study area in the year 1965 moved into export market outlets by trucks. Statistical information could not be developed for the allocation of rail movements as potential waterway traffic. Consequently, only truck movements of grain were analyzed in the study.

The navigation benefits that would accrue to the proposed waterway were considered to be the savings to transportation afforded by truck-barge traffic to grain export outlets as compared to existing movements by trucks or truck-barge. The total savings in the grain producing area tributary to the proposed waterway were derived by multiplying the tonnage of the trucked grain moving into export by the estimated savings per ton from each shipping point to export outlets via the proposed waterway.

In 1985, the initial year of the project, the accepted prospective grain tonnages that would move via the Trinity River will be approximately 1,172,000 tons of wheat and 247,000 tons of grain sorghum with an estimated savings in transportation costs of $763,000 and $154,000 respectively. The average annual equivalent benefits over the 50 year project life, using $3\frac{1}{4}$ percent interest rate, were estimated to be $858,000 for wheat and $162,000 for grain sorghum.

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TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

GENERAL

1. Scope of Work.- The Congress, in the fall of 1966, authorized the economic reevaluation of the navigation features of that portion of the comprehensive Trinity River Project extending through the multiple purpose channel from the Houston Ship Channel to Ft. Worth, Texas, for navigation, flood control, and allied purposes. In conjunction with this reevaluation, a study of prospective commerce in grain was conducted, including existing production and shipment of grain in the area of influence of the Trinity River navigation project, projection of future production and shipments, and estimates of the amounts of grain that would be shipped on the proposed waterway. The area of influence or study area of the Trinity River navigation study and the defined grain tributary area are shown in figure 2 of the attached supplemental data. Counties in five states, Texas, Oklahoma, Kansas, New Mexico and Colorado which were examined to determine whether or not they would contribute prospective grain commerce to the waterway comprise the study area. The tributary area, shown in greater detail in figure 3 of the supplemental data, is included in the study area, but is limited to only those counties with accepted grain commerce for the waterway. In the field traffic canvass of all commodities moving in the study area, it was determined that flour and grains other than wheat and grain sorghum were moving only in relatively small volumes and, therefore, were not included in this grain study. However, these commodities will be included in the overall traffic analysis that will be presented in the final report. Specifically, the grain study involved a determination of:

a. The amount of grain produced within each county of the defined tributary traffic area;

b. The approximate percentage amount shipped by each mode of existing transportation, viz. rail, motor carrier and water transportation or a combination thereof;

c. Direction of grain movements from each county, and amounts of grain exported to foreign markets and supplied to domestic needs and requirements;

d. Rates charged by rail and truck for grain transportation from various producing counties in the tributary area to Texas Gulf ports;

e. An estimate of savings that would be available to shippers via the authorized Trinity River waterway, measured as the product of estimated waterway grain traffic and the estimated unit savings realized by waterway movement instead of movement of that traffic by present transportation means. The unit savings will be the difference between freight rates, presently being charged on the alternative transportation means as compared to the estimate of freight rates that would be charged via the improved waterway.

2. Basic Assumptions.- The potential waterborne commerce in wheat and grain sorghum for the Trinity River was developed under the following assumptions:

a. There will be no major wars or national economic depressions;

b. The grain will move from the producing area to foreign and domestic areas of consumption through normal marketing channels;

c. The Arkansas River project is completed to the Port of Catoosa (Tulsa), Oklahoma; the Red River project is completed to the Port of Daingerfield, Texas; and the Central Oklahoma project is not constructed.

3. Sources of Data and Information.- Data and various information for the grain study were obtained from the following sources:

a. Grain acreage, yield, and production data by counties for Texas, Oklahoma, Colorado, Kansas and New Mexico were obtained for the years 1956 through 1965 from United States Department of Agriculture, Statistical Reporting Service.

b. Information on the export grain situation expected over the 50 year life of the Trinity River Project was obtained from United States Department of Agriculture, Economic Research Service, (USDA, ERS) Marketing Economics Division and Agriculture Economics Department, Texas A.&M. University.

c. Statistics on transportation of grain in the Southwestern States published in USDA, ERS Bulletin No. 367, and supplements were used in the determination of grain movement patterns.

d. Estimates of wheat and grain receipts at Gulf ports by rail & truck in recent years were based on information obtained from USDA, ERS, Marketing Economic Division and published statistics in Waterborne Commerce of the United States, Corps of Engineers, U. S. Army.

e. Estimates of expected changes in grain production and grain marketing patterns in the Trinity River traffic area were based on USDA data made available by Texas A.&M. University, Oklahoma State University, and Fort Worth Grain Exchange.

f. Current information on marketing patterns and grain movements in the area of influence of the Trinity River Project for both export and domestic market outlets were obtained from officials of major grain firms located in Houston, Corpus Christi, Fort Worth, Lubbock, Amarillo, Perryton and Dumas, Texas and Alva, Enid and Oklahoma City, Oklahoma.

4. Methods and Procedures.- The calendar year 1965 was selected as being most representative of the average grain production in the study area during recent years and was used as the base year for the grain analysis. For the base year, the amount of grain production in each county moving into the export market in a pattern likely to be converted to use of the waterway was established by a field canvass and a market study of the tributary area. Estimates of regional grain production for the Trinity River area and prospective commerce in grain for the waterway were based on a number of factors, including projections of national grain production, changes in grain production capacity for the tributary area, and changes in domestic and export grain flow and demand.

WHEAT

5. Wheat Production and Markets.- Wheat is produced in many areas of the world, as shown in table 1, and is used primarily for human consumption. The major wheat producing countries are Russia, United States, Canada, France, Australia and Argentina, with the major exporting countries being the United States and Canada. Wheat is an important economic item in international trade and the market for wheat is affected by supply demand relations in the major markets throughout the world. Since 1956, world wheat exports have increased from 31.7 million tons to 62.3 million tons in 1964 and 56.4 million tons in 1965, as shown in table 2. In 1965, the base year for the Trinity River grain restudy, world wheat production was 272.3 million tons, of which the United States produced 39.5 million tons. For this same period, the United States exported 21.6 million tons or about 38.3 percent of total world exports.

6. Wheat and Grain Exports.- Wheat exports from the United States have increased from 10.7 million tons in 1956 to 25.5 million tons in 1964 as shown in table 2. In addition to normal, commercial foreign exchange exports in recent years, United States' wheat has been used to promote friendly foreign relations by exports to countries lacking dollar exchange credit to pay for wheat and to countries suffering from disasters such as drought, flood or earthquake. This has been in accordance with the post - World War II United States Government policy of assisting the economic development of friendly countries. An important part of the assistance has taken the form of wheat sales for local currencies. The major movement of surplus grain into export markets occurs under Federal foreign assistance programs under Public Law 480. The programs provide outright economic grants in the form of commodities, including grain, as well as Federally supported loans for investments for which private financing is not available. Public Law 480 also provides for the sale of surplus agricultural commodities, including grain, through private trade channels in exchange for foreign currencies and some U. S. dollars. Movement of wheat into export under these two programs made up approximately 66 percent of the United States' wheat exports in 1965. The remainder of the United States' exports was sold for cash to principal U. S. dollar markets such as the nations of Western Europe and Japan.

TABLE 1

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

WORLD PRODUCTION OF WHEAT 1956-1965

YEAR	RUSSIA(1)	UNITED STATES	CANADA	FRANCE	ARGENTINA	AUSTRALIA	OTHER	TOTAL(2)
				(Million short tons)				
1956	60.00	30.13	17.19	6.75	7.86	4.05	107.87	233.85
1957	54.00	28.52	11.57	12.22	6.41	2.93	114.15	229.80
1958	69.00	43.85	11.15	10.59	7.35	6.45	112.61	261.00
1959	57.00	33.63	12.41	12.75	6.45	5.96	116.45	244.65
1960	51.00	40.72	15.53	12.15	4.50	8.21	113.44	245.55
1961	57.00	37.04	8.50	10.55	5.70	7.38	110.23	236.40
1962	60.00	32.81	16.97	15.27	5.70	9.21	122.84	262.80
1963	44.10	34.26	21.70	11.30	9.85	9.84	118.40	249.45
1964	63.00	38.72	18.01	15.25	12.45	11.06	121.32	279.81
1965	51.26	39.47	19.47	16.27	6.83	7.79	131.18	272.27

(1) Unofficial Estimates.
(2) Estimated totals include allowances for any missing data for countries shown and for other producing countries not shown.

SOURCE: Foreign Agricultural Circulars. 1959-1966 Inclusive. USDA.

TABLE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

WHEAT EXPORTS BY COUNTRY, 1956-65

YEAR(1)	UNITED STATES(2)	CANADA	AUSTRALIA	ARGENTINA	RUSSIA	OTHER	TOTAL(1)
				(Million short tons)			
1956	10.37	7.55	3.06	3.36	2.21	5.18	31.73
1957	16.46	8.47	3.77	2.97	4.79	3.24	39.70
1958	12.05	9.52	1.85	2.33	4.33	5.66	35.74
1959	13.26	9.01	2.26	3.08	6.61	5.27	39.49
1960	15.27	8.38	3.65	2.33	6.08	5.02	40.73
1961	19.83	10.26	5.50	2.14	5.58	3.99	47.30
1962	21.74	10.96	6.95	2.59	5.57	4.90	52.71
1963	19.21	9.94	5.47	1.99	5.88	5.78	48.27
1964	25.51	16.56	8.56	3.06	1.61	6.96	62.26
1965	21.57	13.03	7.09	4.69	1.66	8.35	56.39

(1) Export year ending 30 June.
(2) Also includes wheat equivalent of products other than flour.

SOURCE: The World Grain Trade, Sep 1966. FAS USDA.

7. Wheat consumption per capita is declining in the highly industrialized countries of Western Europe, including the Common Market countries, and in the United States and Canada. However, the increase in population more than compensates for the decline in per capita consumption in these countries and results in an increasing trend in the demand and consumption of wheat.

8. In many of the low income countries the standard of living is being raised by increased national productivity. The per capita consumption of wheat and other grain is increasing in Asia, Africa, and South American countries except Argentina. Balance of payments problems preclude immediate large wheat purchases by the low income countries except through the United States program of grants in aid and long-term credit. It is in these low income countries, however, where the greatest relative rate of increase both in national productive capacity and in standards of living are expected. These increases in productivity will tend to further increase grain demand and consumption. The low income countries also account for a large part of the world population and have a high population growth compared with other countries of the world. The need for large additional amounts of grain in these countries is unquestioned. Clearly, in recent years, these countries have paid for increased grain imports by increasing their own non-grain exports, production efficiency, and international grants in aid and trade agreements, which have provided the necessary funds. It is recognized that many factors difficult to predict with a high degree of reliability, may affect the volume of food grains exported by the United States in a given period or year. The import needs of many foreign countries are greatly affected by the success or failure of their own crop harvests. The harvests, in turn, can be drastically affected by adverse weather or climatic conditions, insect infestations, or other disasters. Foreign relations or internal political conditions may exert powerful effects. Nevertheless, with all of the uncertainties, two principal conclusions can be drawn with a reasonable degree of certainty. First, that the advanced agricultural technology and the very large agricultural production areas of the United States render large scale crop failures unlikely and, accordingly, the United States can be expected to continue producing food grains in excess of its own needs. Second, that the need for food grains in excess of local production will continue to exist in other parts of the world for the forseeable future. Thus, as the foreign demands for food grains increase, the United States can be expected to supplement these demands with an ever increasing amount of food grain exports.

9. Historical data for total wheat exports from the United States and from selected Gulf ports, as reported by the Corps of Engineers in Waterborne Commerce of the United States, Part 2, are shown in table 3. Wheat exports from the selected Gulf ports for 1965 accounted for 10.0 million tons or approximately 51.2 percent of the total for the United States. For the five-year period, 1961 through 1965, an average of about 58 percent of the total wheat exports from the United States was shipped through Gulf ports. This represents an average of about 11.1 million tons per year for the five-year period.

TABLE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

WHEAT EXPORTS FOR SELECTED GULF PORTS COMPARED WITH
TOTAL UNITED STATES EXPORTS 1956-1965

YEAR	Total US Exports (1000 tons)	Port of Galveston (1000 tons)	Percent of Galveston Exports to US	Port of Houston (1000 tons)	Percent of Houston Exports to US	Port of Port Arthur (1000 tons)	Percent of Port Arthur Exports to US	Port of Corpus Christi (1000 tons)	Percent of Corpus Christi Exports to US	Port of Baton Rouge (1000 tons)	Percent of Baton Rouge Exports to US	Port of New Orleans (1000 tons)	Percent of New Orleans Exports to US	Total Exports From Selected Gulf Ports (1000 tons)	Percent of Selected Gulf Ports Exports to US
1956	12,257.5	1,690.3	13.8%	929.2	7.6%	297.4	2.4%	22.3	0.2%	276.6	2.3%	708.0	5.8%	3,923.8	32.0%
1957	12,452.2	1,484.0	11.9%	1,014.9	8.2%	515.8	4.1%	10.7	0.1%	317.0	2.5%	532.7	4.3%	3,875.1	31.1%
1958	9,926.2	1,440.4	14.5%	1,289.6	13.0%	502.9	5.1%	18.5	0.2%	486.4	4.9%	873.6	8.8%	4,611.4	46.5%
1959	10,727.8	1,385.7	12.9%	1,641.6	15.3%	758.2	7.1%	11.1	0.1%	447.7	4.2%	599.3	5.6%	4,843.6	45.2%
1960	15,115.7	2,092.5	13.8%	2,163.1	14.3%	1,111.7	7.4%	117.1	0.8%	1,033.2	6.8%	1,209.9	8.0%	7,727.5	51.1%
1961	18,813.3	3,212.7	17.1%	3,080.5	16.4%	1,428.9	7.6%	296.5	1.6%	1,036.9	5.5%	2,225.2	11.8%	11,280.7	60.0%
1962	15,637.2	2,144.3	13.7%	2,437.2	15.6%	1,060.9	6.8%	218.2	1.4%	1,223.3	7.8%	3,000.7	19.2%	10,084.6	64.5%
1963	19,259.1	1,554.1	8.1%	2,281.3	11.8%	975.4	5.1%	282.9	1.5%	1,120.6	5.8%	3,628.7	18.8%	9,843.0	51.1%
1964	22,732.4	1,949.6	8.6%	4,006.9	17.6%	1,800.9	7.9%	600.3	2.6%	1,456.6	6.4%	4,503.5	19.8%	14,317.8	63.0%
1965	19,568.4	1,486.5	7.6%	4,495.3	23.0%	1,151.3	5.9%	359.0	1.8%	586.1	3.0%	1,947.5	10.0%	10,025.7	51.2%
(1961-) (1965) (Average)	19,202.1	2,069.4	10.8%	3,260.2	17.0%	1,283.5	6.7%	351.4	1.8%	1,084.7	5.6%	3,061.1	15.9%	11,110.3	57.8%

SOURCE: Corps of Engineers "Waterborne Commerce of United States"; Part 2 (1956-1965).

TABLE 4

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

UNITED STATES WHEAT PRODUCTION BY CLASS, 1956-65

YEAR	WINTER WHEAT 1000 Tons	WINTER WHEAT % of Total	DURUM WHEAT(2) 1000 Tons	DURUM WHEAT(2) % of Total	OTHER SPRING WHEAT 1000 Tons	OTHER SPRING WHEAT % of Total	ALL WHEAT 1000 Tons	ALL WHEAT % of Total
1956	22,218	73.7	1,164	3.8	6,780	22.5	30,162	100
1957	21,354	74.5	1,198	4.2	6,120	21.3	28,672	100
1958	35,206	80.5	650	1.5	7,867	18.0	43,723	100
1959	27,533	81.9	606	1.8	5,495	16.3	33,634	100
1960	33,317	81.8	1,024	2.5	6,377	15.7	40,718	100
1961	32,250	87.1	636	1.7	4,157	11.2	37,042	100
1962	24,630	75.1	2,092	6.4	6,088	18.5	32,810	100
1963	27,255	79.5	1,537	4.5	5,468	16.0	34,260	100
1964	30,750	79.4	2,000	5.2	5,969	15.4	38,720	100
1965 (1)	30,722	77.2	2,067	5.2	7,014	17.6	39,802	100
(1956-) (1965) (Average)	28,523.4	79.1	1,297.4	3.6	6,133.6	17.0	35,954.3	100

(1) Preliminary
(2) All but a very small quantity of durum wheat is produced in the states of Minnesota, North Dakota, South Dakota, Montana, and California.

SOURCE: Agricultural Statistics 1966, United States Department of Agriculture.

10. The principal class of wheat produced in the Trinity River grain tributary area is winter wheat. A recent report on the supply and distribution of United States wheat by classes, published by the U.S.D.A., indicated that in 1965, winter wheat accounted for 30.7 million tons or 77.2 percent of the total United States wheat production. The five states of Colorado, Kansas, New Mexico, Oklahoma and Texas, which are tributary to the Trinity River, produced approximately 46.3 percent of the winter wheat in the United States in 1965. Table 4 which was taken from the U.S.D.A. report shows the production of wheat in the United States by class from 1956 through 1965. The distribution of wheat in the United States is shown in figure 1. The concentrated wheat production area tributary to the Trinity River is easily seen in the figure.

11. A summary of total wheat production for selected states in the Trinity tributary area is presented in table 5. These states produced about 14.2 million tons or approximately 36 percent of the total United States wheat grown in 1965. For the ten-year period 1956-1965, wheat production in the five states averaged about 12.4 million tons, of which approximately 6.5 million tons were produced in Kansas. The states, shown in table 5, are surplus production areas, from which wheat is shipped to domestic and export market outlets.

12. Generally, the major portion of the wheat produced in the tributary area is marketed by the grower during and immediately following the principal harvesting months of June and July. On a local county basis, the bulk of the crop moves into the market within a period of about 15 days. Under ideal conditions, harvest operations begin in Texas and move northward through Oklahoma and Kansas into Nebraska and the Dakotas. With ideal conditions of ripening grain and movement of harvesting equipment, transportation, storage and other marketing facilities are planned to provide an orderly movement for the physical flow of the wheat into storage. Often, however, the vagaries of weather, labor shortages, or other factors will disrupt the planned orderly movements. Under these conditions, inadequate storage capacity, inadequate transportation capacity and unfavorable transportation rates may cause a depression of grain prices at harvest time.

13. Wheat and Grain Storage.- Grain storage capacity in the Trinity River tributary area is approximately 13 million tons of which 2.1 million tons is in registered grain warehouses. This is generally adequate for production and carry-over in most crop years. The location and capacity of these country elevators, which are gathering and shipping points, are significant factors in the orderly flow of wheat through marketing channels to domestic and export market outlets. Unless grain is stored in adequate storage facilities, it is a relatively perishable commodity. Ample storage facilities, either registered or private, are generally available in the tributary area for most crop years. If grain production at any point exceeds local market demands and adequate storage facilities are not available, it must be moved to market quickly and depressed prices usually result.

FIGURE I

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

WHEAT PRODUCTION
1960

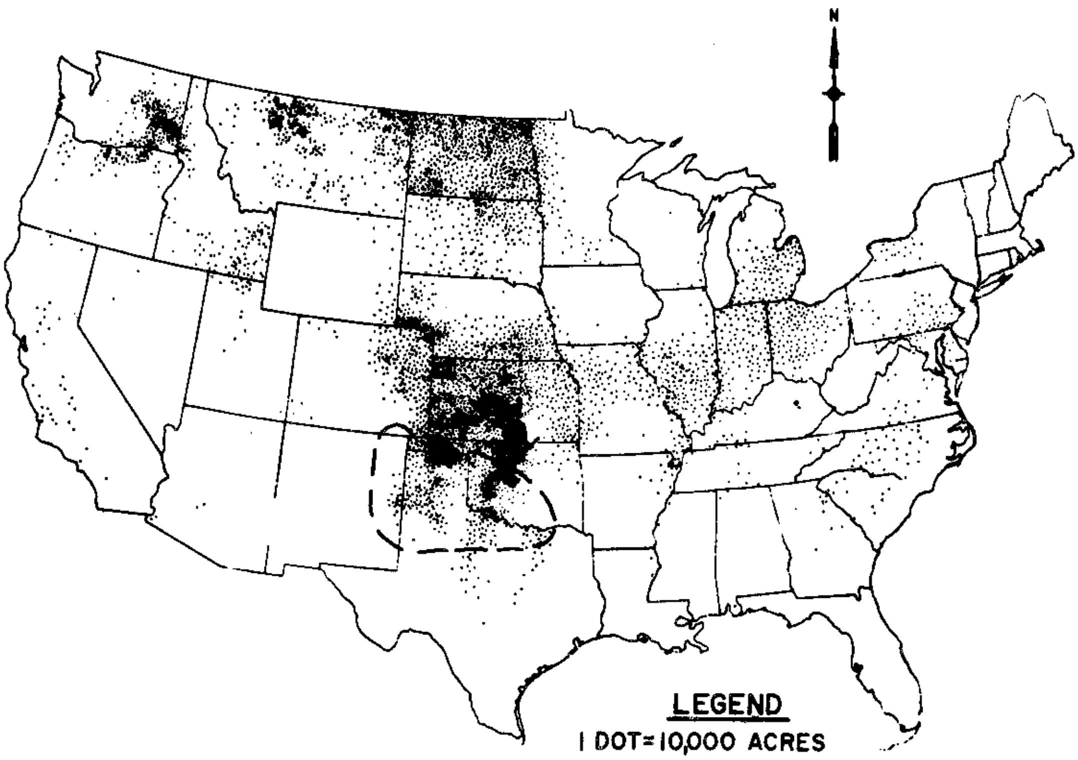


EXHIBIT I
APPENDIX II

TABLE 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

TOTAL WHEAT PRODUCTION FOR THE STATES OF
TEXAS, OKLAHOMA, KANSAS, NEW MEXICO & COLORADO

YEAR	TEXAS 1,000 Tons	OKLAHOMA 1,000 Tons	KANSAS 1,000 Tons	NEW MEXICO 1,000 Tons	COLORADO 1,000 Tons	TOTAL 1,000 Tons
1956	791.6	2,078.0	4,298.5	33.2	529.6	7,730.9
1957	1,010.1	1,290.8	3,003.3	66.1	1,095.7	6,466.0
1958	2,191.2	3,463.2	8,896.4	114.2	2,016.2	16,681.2
1959	1,795.5	2,675.2	6,291.0	115.5	1,636.9	12,514.1
1960	2,364.8	3,638.7	8,831.3	140.4	1,999.4	16,974.6
1961	2,546.1	3,325.0	8,211.5	240.1	1,703.7	16,026.4
1962	1,310.9	2,132.4	6,335.1	127.8	1,100.6	11,006.8
1963	1,288.1	2,262.3	5,564.4	114.0	667.8	9,896.6
1964	1,855.4	2,898.7	6,463.8	83.2	797.5	12,098.6
1965	2,178.9	3,987.5	7,308.7	147.7	624.3	14,247.1
10 YR. AVERAGE	1,733.3	2,775.2	6,520.4	118.2	1,217.1	12,364.2

SOURCE: Agricultural Statistics 1956-1965, Inclusive, United States Department of Agriculture.

14. Wheat and Grain Transportation.- An analysis of grain transportation from country elevators in the tributary area showed, that all other factors being equal, cost based on transportation rates to the shipper, is the dominant factor affecting selection of the mode of transport. Two of the major reasons reported by the elevator managers for the use of trucks to transport grain are the imbalance of the demand and supply of rail cars when needed and the time lag in moving rail cars when loaded. When faced with these conditions, managers usually employ trucks to move the grain in order to meet local price competition and maintain volume. When local storage space is filled and rail cars are not available, there is great need for trucks. When trucks also are in short supply, the nearest available storage that can be located will often be used so that the vehicles can return quickly for reloading. On occasion in the past, when trucks have not been available, wheat has had to be piled upon the ground or diverted to competitors. This type of disorganized marketing has been characteristic of local market conditions during the harvest season rush.

15. In recent years, export grain has been handled mostly through the larger terminal and cooperative grain elevators. Managers of these facilities have used methods for handling export grain similar to those employed in independent country elevators. A considerable amount of export grain is shipped direct to port outlets from the country elevator, thus, by-passing the terminal. When this can be done, it reduces the number of times the wheat is handled and the savings in handling cost is often reflected in both the producer price and the export price. A grain marketing survey in the Trinity River tributary area, conducted by the Galveston District, Corps of Engineers, included interviews with representatives of the major terminal elevator facilities located in the area. The survey indicated that variations in the wheat quality, primarily in the protein content, within the project tributary area, significantly influences the area of procurement by areas and crop years. Such variations tend to determine the quantity of wheat purchased for domestic market mill requirements and storage by the elevators during the harvest season. The terminals located in the tributary area reported that substantial quantities of wheat of high protein content are purchased each season in western Kansas, Oklahoma, and Texas. The high protein wheat is used by the terminal elevators in blending mixtures of wheat to quality specifications needed to meet specific domestic mill and some export market contract orders received during the year.

GRAIN SORGHUM

16. Grain Sorghum Production and Markets.- As compared to wheat, the production of grain sorghum for feed grain in the Great Plains area is the most profitable alternative grain crop. The climatic conditions are favorable

and the land used for wheat production is quite adaptable to the production of grain sorghum. Texas, Kansas, and Oklahoma are the major grain sorghum producing states with Texas producing about 43 percent of the nation's supply. In general, the United States grain sorghum is produced in the concentrated area shown in figure 2, as a complementary crop on farms that produce beef and wheat as primary farm enterprises. Grain sorghum is principally used as a feed in the rations for cattle, swine, and commercial broiler production.

17. Grain Sorghum Exports.- The United States has exported an average of about 3.1 million tons of grain sorghum annually during the 1961-1965 period, as shown in table 6. Of this average total United States grain sorghum exports, the Gulf ports have exported 79.4 percent or about 2.4 million tons. The principal export markets are Japan, Western Europe, and other advanced countries that require grain for livestock feed to supply an increasing demand for meat. The increased demand for meat in these countries is the result of an increase in population and per capita income. Projections, prepared by the U.S.D.A., ERS, indicate that grain sorghum exports will continue to increase in order to supplement the demands of these foreign markets.

18. According to U.S.D.A. agricultural statistics for 1966, grain sorghum production has increased an average of 257 percent over the sixteen-year period, 1949 through 1965. In 1965 total United States grain sorghum produced amounted to 18.6 tons. There are many factors contributing to an increased production of grain sorghums. Agricultural technology; changing population characteristics and attendant changes in market demand; improved grain varieties; agricultural control programs; and increased standards of living in lower income groups are some of the factors contributing to an increased production. Two factors providing major inducements to farmers to increase grain sorghum production are the Agricultural Acreage Control Program and the increasing demand for grain fed beef as a result of population increases and a rising per capita income. Under the Agricultural Acreage Control Program, many farmers can transfer otherwise idle acreage in excess of their wheat acreage allotment to grain sorghum production within their acreage allotment for feed grains thereby bringing as many of their agricultural resources as possible into production. The increased demand for grain fed beef complements the effect of the Agricultural Acreage Control Program in that increased production of the feed grain base of barley, rye, oats and grain sorghums is necessary to support increased beef production. In the feed grain base, grain sorghums are the most profitable alternate grain crop after wheat. In addition to the growing domestic market, demand for export grain sorghums has also grown substantially since the post - World War II period.

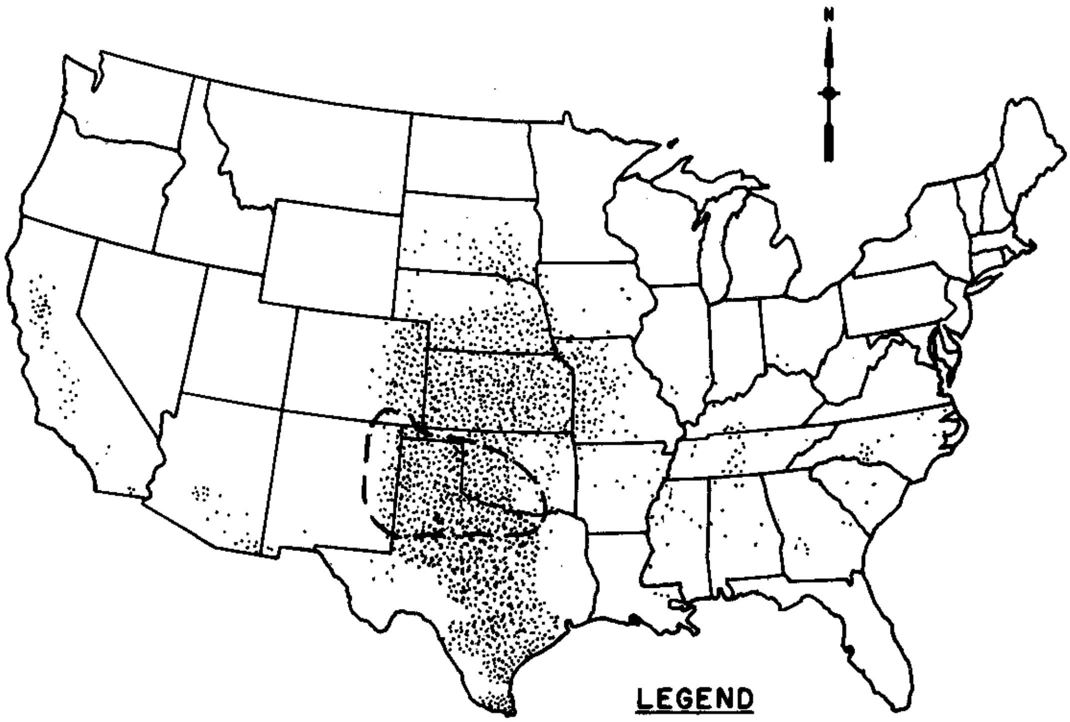
19. Total grain sorghum production for selected states within the study area for the ten-year period, 1956 through 1965, is shown in table 7. In 1965, these states produced about 13.2 million tons or 71 percent of the total United States grain sorghum produced. Approximately, 12.5 million tons were produced in Texas, Oklahoma, and Kansas, of which about 8.5 million tons were grown in the Trinity River tributary area. The above three states are surplus production areas from which grain sorghum is shipped

FIGURE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

GRAIN SORGHUM PRODUCTION 1960



LEGEND
1 DOT = 5,000 ACRES
— — = GRAIN TRIBUTARY AREA

EXHIBIT I
APPENDIX II

TABLE 6

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY
GRAIN SORGHUM EXPORTS FOR SELECTED GULF PORTS COMPARED WITH TOTAL UNITED STATES EXPORTS 1956-1965

YEAR	Total US Exports (1000 tons)	Port of Galveston (1000 tons)	Percent of Galveston Exports to US	Port of Houston (1000 tons)	Percent of Houston Exports to US	Ports on The Sabine Neches Waterway (1000 tons)	Percent of the Sabine Neches Waterway Exports to US	Port of Corpus Christi (1000 tons)	Percent of Corpus Christi Exports to US	Port of Baton Rouge (1000 tons)	Percent of Baton Rouge Exports to US	Port of New Orleans (1000 tons)	Percent of New Orleans Exports to US	Total Exports From Selected Gulf Ports (1000 tons)	Percent of Selected Gulf Ports Exports to US
*1956	1,530.7	460.5	30.1%	289.7	18.9%	344.3	22.5%	382.7	25.0%	---	0	27.8	1.8%	1,505.0	98.3%
*1957	572.8	104.2	18.2%	206.5	36.1%	48.9	8.5%	206.4	36.0%	---	0	6.8	1.2%	572.8	100.0%
1958	2,067.7	531.3	25.7%	569.7	27.6%	360.0	17.4%	512.6	24.8%	---	0	27.6	1.3%	2,001.2	96.8%
1959	2,877.4	539.4	18.7%	833.7	29.0%	349.3	12.1%	1,052.2	36.6%	26.6	0.9%	55.5	1.9%	2,856.7	99.3%
1960	2,627.9	339.7	12.9%	564.3	21.5%	472.9	18.0%	1,055.3	40.2%	38.6	1.5%	142.5	5.4%	2,613.3	99.4%
1961	1,747.3	55.9	3.2%	354.0	20.3%	166.3	9.5%	932.3	53.4%	27.5	1.6%	117.3	6.7%	1,653.3	94.6%
1962	2,999.9	246.7	8.2%	221.1	7.4%	531.1	17.7%	909.5	30.3%	109.5	3.7%	535.7	17.9%	2,553.6	85.1%
1963	3,084.0	302.0	9.8%	267.0	8.7%	225.9	7.3%	1,077.4	34.9%	100.0	3.2%	393.4	12.8%	2,365.7	76.7%
1964	2,762.3	189.9	6.9%	376.0	13.6%	403.6	14.6%	1,046.6	37.9%	89.6	3.2%	270.1	9.8%	2,375.8	86.0%
1965	4,758.8	544.3	11.4%	551.9	11.6%	585.2	12.3%	1,399.0	29.4%	35.0	0.7%	124.1	2.6%	3,239.5	68.1%
(1961-) (1965) (Average)	3,070.5	267.8	8.7%	354.0	11.9%	382.4	12.5%	1,073.0	34.9%	72.3	2.4%	288.1	9.4%	2,437.6	79.4%

SOURCE: Corps of Engineers "Waterborne Commerce of the United States"; Part 2 (1956-1965).
*Categorized as "Other Grains", grain sorghum assumed to represent the largest percentage of tonnage shown.

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TABLE 7

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

TOTAL GRAIN SORGHUM PRODUCTION FOR THE STATES OF TEXAS, OKLAHOMA, KANSAS, NEW MEXICO, & COLORADO

(In 1,000 tons)

YEAR	TEXAS	Texas Percent of Total Production	OKLAHOMA	KANSAS	NEW MEXICO	COLORADO	TOTAL
1956	3,477.7	77.2%	172.6	682.9	97.7	71.7	4,502.6
1957	6,666.7	58.7%	426.0	3,615.6	184.5	459.2	11,352.0
1958	7,645.8	61.9%	516.9	3,611.0	226.4	348.6	12,348.7
1959	7,774.6	60.9%	526.2	3,971.9	237.3	260.2	12,770.2
1960	7,239.5	55.3%	665.3	4,691.2	258.8	244.7	13,099.5
1961	6,429.8	61.1%	472.2	3,127.0	260.7	234.8	10,524.5
1962	5,628.2	54.5%	552.7	3,605.3	284.3	264.7	10,335.2
1963	6,868.7	56.3%	611.2	4,137.6	348.7	230.6	12,196.8
1964	6,044.2	62.4%	412.0	2,749.8	298.6	188.7	9,693.3
1965	8,000.7	60.5%	627.8	3,827.9	409.5	365.8	13,231.7
10 YR. AVERAGE	6,577.6	59.8%	498.3	3,402.0	260.7	266.9	11,005.5

SOURCE: Agricultural Statistics - 1956-1965 inclusive, and United States Department of Agriculture.

to domestic and export market outlets. Generally, the Southern Plains region is a deficit feed grain area; however, the above region contains surplus production areas from which grain sorghum is shipped to domestic and export market outlets.

20. Grain Sorghum Storage.- A production explosion of grain sorghum in the past two decades, accompanied by large increases in carry-over stocks, has taxed facilities for moving, handling, storing and marketing the crop. However, as mentioned previously, grain storage facilities in the Trinity River Study area are considered adequate for production and carry-over in most crop years. The principal storage and functional market points are Wichita and Dodge City, Kansas and Amarillo, Plainview and Lubbock, Texas. The greatest concentration of storage and consequently the dominant supply points are the Amarillo, Plainview and Lubbock areas.

21. Grain Sorghum Transportation.- The analysis of wheat and grain transportation from country elevators in the tributary area as discussed in detail in paragraph 15 is generally applicable to grain sorghum transportation with the exception that for grain sorghum the area of procurement by area and crop year is closely correlated with the livestock industry's feed requirements.

FIELD SURVEY AND MARKET STUDY

22. General.- A field survey was made within the study area of the Trinity River to determine (1) current marketing patterns, (2) projections of production, consumption, and market changes, and (3) base year determination for wheat and grain sorghum production projections. Data were obtained through interviews with representatives of major grain firms, grain brokers, and U.S.D.A. and Agricultural Experiment Station personnel in the major grain marketing centers of Texas, Kansas, and Oklahoma.

23. Current Marketing Patterns.- Data obtained on grain marketing within the study area included the percentage of grain sorghum and wheat moving into the domestic and export markets by truck and rail. This percentage was used in evaluating the amount of each county's total production that is transported to the export market.

24. Investigations into the modes of transporting wheat and grain sorghum to the export market were made to determine and substantiate the allocation of movements between truck and rail as presented in this report.

25. Rail movements were analyzed to determine, if any, the tonnages that would be expected to be diverted to the proposed waterway. However, no statistical data could be obtained either from the contacts made or any other statistical source that would substantiate a specific amount of diversion of rail movements to the proposed project.

26. Data on truck charges from county shipping points to destination points were obtained from major grain firms and grain shippers. An analysis of these data indicated that grain truck rates, unlike general commerce, are unregulated. An official uniform truck rate scale is non-existent, but a general pattern of rates and movements does exist. This pattern provided a basis for the construction of a uniform truck rate scale between origin and destination points within the study area. Officials of major grain firms were provided the constructed truck rate scale and were requested to review and comment thereon. The consensus was that these rates represented an average of the actual charges paid for grain movements throughout the year. Accordingly, the constructed truck rate scale was accepted as a reasonable basis for measuring transportation charges via this transportation mode and is included in table A of the supplemental data.

27. Projections of Production, Consumption, and Market Changes - Wheat.- Information received, by interviews with the industry; from the Economic Research Service (ERS), U.S.D.A.; and Texas A.&M. University, was studied to determine market demands and changes in production methods that may be expected in the present and future production of wheat. This analysis revealed that while production levels are high, per capita consumption of wheat products has declined slightly. This indicates that surplus production is available for the export market. Generally, a portion of the future increases in production are expected to be absorbed by the domestic market as the population increases and may eventually bring per capita consumption back to previous levels. Beyond this point, however, it is estimated that increases in production during the life of the proposed project will be moved to the export market. Future projections of wheat production are discussed in detail in paragraph 49.

28. Projections of Production, Consumption, and Market Changes - Grain Sorghum.- An analysis of similar data on grain sorghum indicates that the domestic and export markets will absorb proportional amounts of the future increases in grain sorghum production. A detailed discussion of future grain sorghum production and exports is discussed in paragraph 53.

29. Base Year Determination.- A detailed investigation was made to determine the base year to be used in the analysis of grain transportation and production projections. Historical data on wheat and grain sorghum production in the five state area of Texas, Oklahoma, Kansas, New Mexico and Colorado for the years 1956 through 1965, were analyzed to determine the production trends of wheat and grain sorghum.

30. Statistics of total wheat production in the five state area, as shown in table 5, were used in developing the production trend for the 10 year period ending in 1965. Figure 3 contains a graphic presentation of total production of wheat by years and the computed trend in production. Examination of figure 3 shows that the 1965 wheat production year lies closest to the computed trend in production. Further, the 1965 production year is recent enough that transportation data on grain movement are probably as complete as can be obtained.

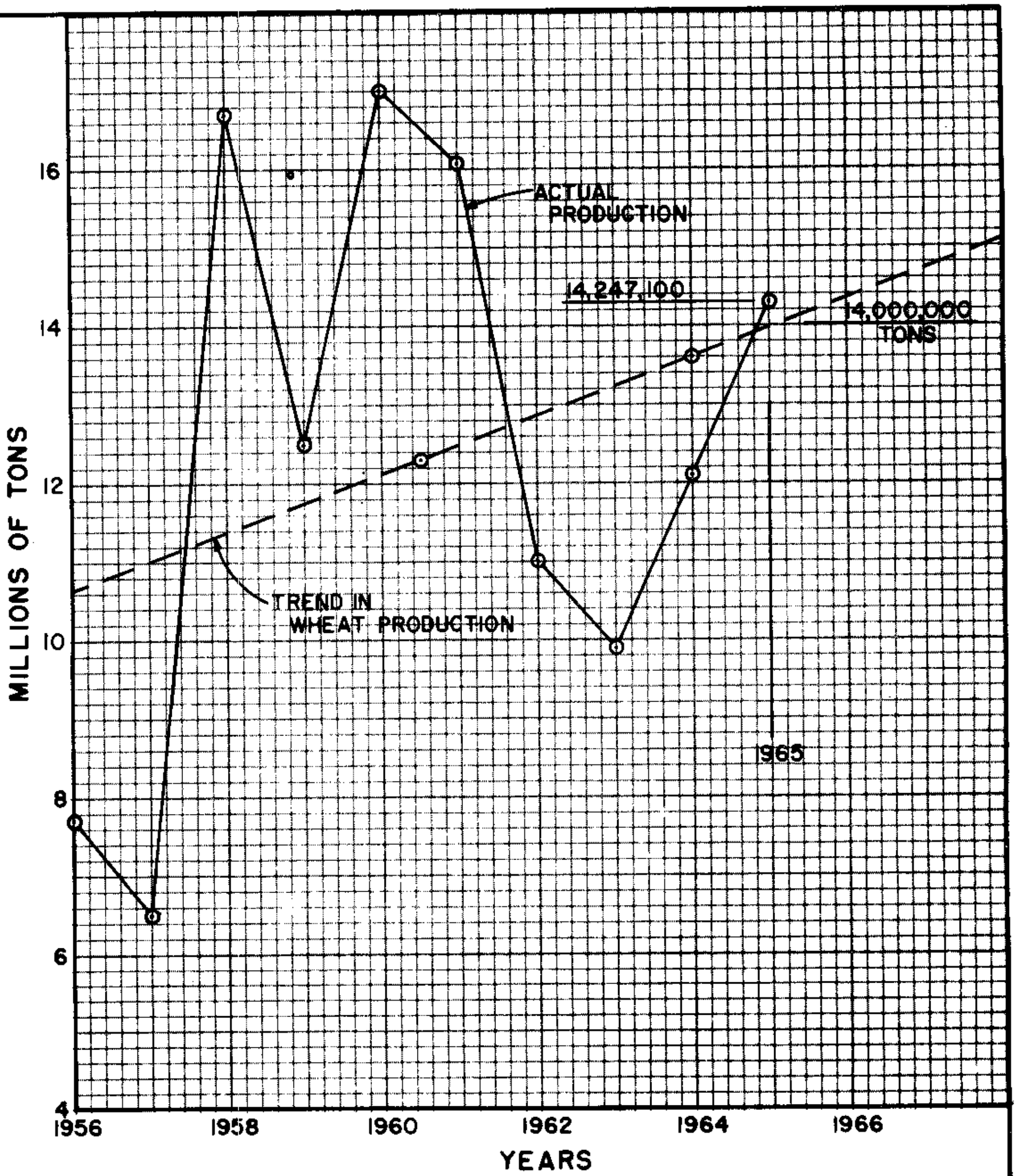

FIGURE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

BASE YEAR DETERMINATION
ANALYSIS FOR WHEAT

EXHIBIT I
APPENDIX II

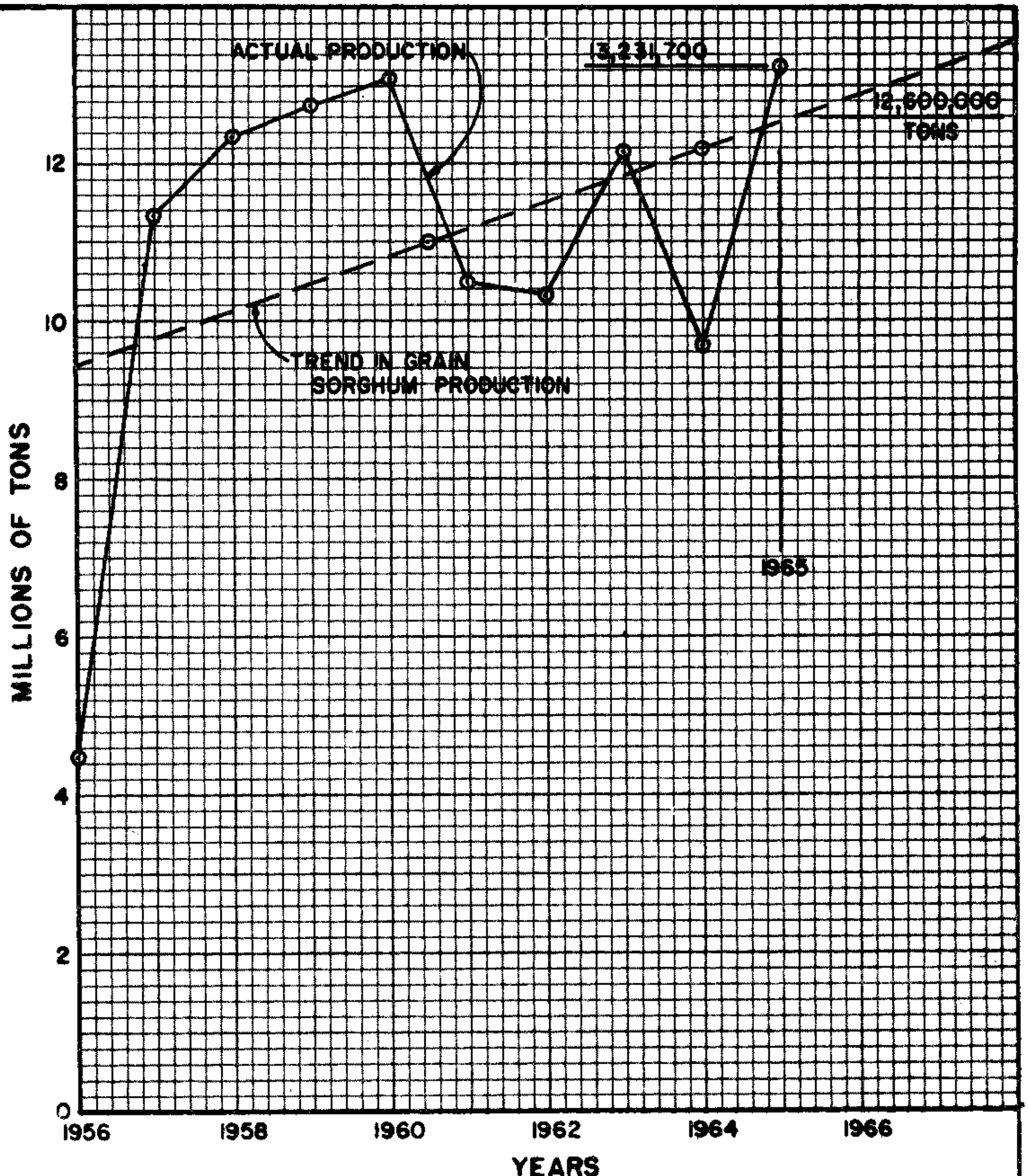

FIGURE 4

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

BASE YEAR DETERMINATION
ANALYSIS FOR GRAIN SORGUM

EXHIBIT I
APPENDIX II

31. A check was made on the reliability of the analysis for the selection of the base year wheat traffic by a study of the 10 year production of wheat to identify those years that appear to be not representative of normal production. Inspection of table 5 shows that the years 1956, 1957, and 1963 may not represent the normal production potential of the producing area. By eliminating these years and averaging the total production for the remaining 7 years, the resulting average production is 14.221 million tons of wheat. This compares favorably with the reported 1965 wheat production of 14.247 million tons.

32. A similar analysis was made of the historical data for grain sorghum production shown in table 7. The analysis of the actual total production and the computed trend in production, as shown in figure 4, discloses that the 1963 production is at the closest proximity to the production trend. However, the total production of grain sorghum in 1965 while not the closest point to the production trend, is congruous with the increasing trend in grain sorghum production and is consistent with the production trend of wheat. Further, as discussed in paragraphs 16 through 21, grain sorghum is the second most valuable grain crop and is complementary to wheat production in the grain producing areas. Increases in per capita income will provide a larger market for beef which will require larger quantities of grain sorghum, the principal feed grain. This condition is a factor that will influence grain sorghum production to rise at a greater rate than is indicated by the computed trend of grain sorghum production shown in figure 4.

33. As a result of these analyses, 1965 was selected, and subsequently confirmed by major grain firms, U.S.D.A. and Agricultural Experiment Station personnel, as the base year to be used in the analysis of grain transportation and production projections for both wheat and grain sorghum.

PRESENT METHODS OF SHIPMENT

34. General.- By comparing historical wheat and grain sorghum production in the study area to grain exports moving through selected Gulf ports for the ten year period, 1956 through 1965, it was determined that about 68% of the wheat production, excluding the study area's domestic consumption, and 24% of the grain sorghum production were available for export. The 9.841 million tons of wheat and 8.495 million tons of grain sorghum, shown in table 12, and discussed in paragraph 45, represents the total production in the study area. Thus, estimates of grain available for export were derived by applying the above percentages to the base year production and projected production, as discussed in paragraphs 49 through 56. Furthermore, based on supplemental information concerning present method of shipments of export grains, it was concluded that only export grain shipments moving by truck were acceptable as potential waterway commerce. Therefore, wheat and grain sorghum tonnages accepted for rate analysis were based on truck movements of export grain, which are estimated to be 45% of wheat and 15% of the grain sorghum

exports. The studies made of the present method of grain shipment are based on information obtained from major grain firms within the grain tributary area and inspected grain receipts on grain moving into selected Gulf ports from the U. S. Department of Agriculture. These data also provide the basis for estimating the quantities of grain that would move by truck and rail transport.

35. Present method of shipment.- Grain that could move on the waterway was identified as export grain moving from the producing area contiguous to the proposed waterway through the nearest deep draft ports. A study of the export wheat from all Gulf ports, shown in table 3, shows that 38.3 percent of total U. S. exports moved through Texas ports in 1965.

36. The deep draft ports in Texas that would serve grain traffic moving over the Trinity waterway are the ports of Houston and Galveston. Statistics obtained from the U. S. Department of Agriculture were examined to determine the amount of wheat and grain sorghum moving through all Texas ports and the mode of transport used.

37. The minor discrepancy between U.S.D.A. data shown in table 8 and Corps of Engineers Waterborne Commerce of the United States shown in table 3 is attributable to different reporting periods in that Corps of Engineers traffic data are reported on a calendar year basis and U. S. Department of Agriculture grain data are based on fiscal year beginning 1 July. However, for this report, the disagreement between sources is not considered significant for the purposes for which these data are used.

38. The U. S. Department of Agriculture statistics given in table 8 indicate that 70 percent of all Texas wheat exports and 36 percent of all Texas grain sorghum exports moved through the ports of Houston and Galveston in 1965. A further breakdown of this traffic was made to determine the average percentage of wheat and grain sorghum moved by rail, barge, and truck through the port of Houston for the four year period 1962-66, which was used to estimate the percentage of production in the producing area tributary to the proposed project that would be potential grain traffic on the proposed waterway. No comparable data were available for the port of Galveston. The statistics given in tables 9 and 10 for wheat and grain sorghums respectively, show that for the 4 year average, 50.4 percent of the wheat and 83.4 percent of the grain sorghum moved through the port by rail. Comparable data on truck movement indicate that 49.6 percent and 16.6 percent of the wheat and grain sorghum, respectively, moved through the port by truck.

39. If these percentages are applied to the base year exports, as developed in the grain projections discussed in paragraphs 49 through 56 and shown in table 12, they will derive an estimate of the amount of these grains that can be expected to move to deep draft ports by truck and rail; however, this grain study shows that there are variable factors in the grain industry, not necessarily related to transportation cost, that affect the mode of shipment. Accordingly, a 10 percent adjustment was made on the statistical percentages to allow for these variations. The adjusted percentage of rail and truck movement of wheat and grain

TABLE 8

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

GRAIN RECEIPTS AT SELECTED GULF PORTS, 1965

Port	Rail 1,000 Tons	Truck 1,000 Tons	Total 1,000 Tons	Truck Percent of Total
		WHEAT		
Port Arthur	831.3	---	831.3	---
Houston	2,797.5	1,955.2	4,752.7	41.1
Galveston	1,858.5	5.2	1,863.7	.003
Corpus Christi	272.6	77.4	350.0	22.0
Beaumont	1,593.2	11.9	1,605.1	.007
Total	7,353.1	2,049.7	9,402.8	21.8
		GRAIN SORGHUM		
Port Arthur	215.0	---	215.0	---
Houston	598.0	201.7	799.7	25.2
Galveston	891.6	2.8	894.4	.003
Corpus Christi	1,343.3	1,163.7	2,507.0	46.4
Beaumont	269.4	10.6	280.0	.04
Total	3,317.3	1,378.8	4,696.1	29.4

SOURCE: Consumer and Marketing Service, Grain Division, United States Department of Agriculture.

TABLE 9

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

WHEAT RECEIPTS AT THE PORT OF HOUSTON

YEAR BEGINNING 1 July	RAIL		TRUCK		TOTAL	
	1,000 TONS	PERCENT OF TOTAL	1,000 TONS	PERCENT OF TOTAL	1,000 TONS	PERCENT OF TOTAL
1962-63	970.7	45.9	1,144.5	54.1	2,115.5	100.0
1963-64	1,194.7	39.5	1,827.1	60.5	3,021.8	100.0
1964-65	1,683.8	50.9	1,626.0	49.1	3,309.8	100.0
1965-66	2,797.5	58.9	1,955.2	41.1	4,752.7	100.0
4 Year Average	1,661.7	50.4	1,638.2	49.6	3,300.0	100.0

SOURCE: Consumer and Marketing Service, Grain Division, United States Department of Agriculture.

TABLE 10

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

GRAIN SORGHUM RECEIPTS AT THE PORT OF HOUSTON

YEAR BEGINNING 1 July	RAIL		TRUCK		TOTAL	
	1,000 TONS	PERCENT OF TOTAL	1,000 TONS	PERCENT OF TOTAL	1,000 TONS	PERCENT OF TOTAL
1962-63	308.8	97.3	8.5	2.7	317.3	100.0
1963-64	288.6	84.5	52.9	15.5	341.5	100.0
1964-65	357.8	88.5	46.6	11.5	404.4	100.0
1965-66	598.0	74.8	201.7	25.2	799.7	100.0
4 Year Average	388.3	83.4	77.4	16.6	465.7	100.0

SOURCE: Consumer and Marketing Service, Grain Division, United States Department of Agriculture.

sorghum, rounded to the nearest percent amounts to 45 percent wheat and 75 percent grain sorghum moved by rail and 45 percent wheat and 15 percent grain sorghum moved by truck. The mode of shipment (truck or rail) for the remaining 10% of wheat and grain sorghum was not determined as discussed in the preceding paragraph. There was a minor movement of wheat by barge through the port of Houston in 1962-63 which is not significant.

40. Transportation Rate Structures.- A detailed investigation of rail and truck rate structures, together with the quantities of grain transported by each mode, was made to determine the amount of wheat and grain sorghum tonnages that could be diverted to the proposed waterway.

41. Rail Rates.- A study of the rail rate structure was made to determine whether grain movements could be diverted to the proposed waterway. Rail movements, however, are based on a complex system of proportional rates which enable carriers, shippers, and the grain industry in general to compete with each other for rail movements of grain and grain products. The study revealed the various reasons why rail transportation moves and will continue to move a certain percentage of all grain to the Gulf ports. The major reasons are: (1) greater financial control, (2) ability to have more tonnage per carload, (3) special "intransit privileges" which allows milling, storage, blending, and cleaning of the grain at intermediate points prior to reshipment, and (4) grain facilities are basically rail orientated.

42. Truck Rates.- A similar study of the truck rate structure disclosed that a uniform truck rate scale for grain is non-existent. However, a general pattern of quantities, distances, and rates does exist. Using this pattern as a base, a uniform truck rate scale was constructed and subsequently confirmed by major grain firms and shippers. This scale, shown in table A of the supplemental data, provides the basis for the rate analyses of grain movements by truck versus the proposed waterway.

43. Information received from representatives of the major grain firms indicates that the percentage of trucked grain sorghum may increase as the Commodity Credit Corporation grain sorghum stocks are reduced to a smaller percentage of the exports. Railroads have moved a large percentage of C. C. C. grain stocks into the Gulf port export outlets in the past, but Agricultural policy is for continuing grain exports through private marketing channels. As the private marketing pattern develops further, the allocation of grain sorghum exports will approach that of wheat (45 percent by truck and 55 percent by rail).

44. Allocation of Grain Shipments.- As a result of these analyses, it was estimated that approximately 45 percent of the wheat and 15 percent of the grain sorghum exports in the study area for the base year 1965, moved to the export market outlets by trucks while the remaining 55 and 85 percent respectively, was shipped by rail and truck to domestic and export market outlets. These percentages were confirmed by representatives

of major grain firms and represent the potential waterborne commerce in grain on the proposed Trinity River Waterway. Accordingly, the analysis of potential traffic in wheat and grain sorghum is based on 45 and 15 percent respectively.

PROSPECTIVE TRAFFIC

45. Estimates of Prospective Grain Traffic.- Prospective grain traffic to be analyzed for possible diversion to the proposed waterway was based on the 1965 base year statistics of wheat and grain sorghum production for counties within the tributary area of the Trinity River. Column 2 of table 11 and columns 6 & 4 of table 12 show that 9.841 million tons of wheat and 8.495 million tons of grain sorghum were produced within the study area in 1965. Of the 9.841 million tons of wheat and 8.495 million tons of grain sorghum produced in the study area, 6.723 million tons of wheat (approximately 68%) and 2.055 million tons of grain sorghum (approximately 24%) moved into export market outlets. Using the allocation of export grain traffic developed in paragraph 44, it was further estimated that 3.025 million tons of wheat (approximately 45%) and 0.308 million tons of estimated grain sorghum (approximately 15%) moved into export market outlets by truck. Accordingly, for the purposes of this report, prospective grain traffic is estimated at 3.025 million tons of wheat and 0.308 million tons of grain sorghum. Detailed estimates of prospective traffic on a county by county basis are given in table B of the supplemental data. A summary of 1965 production statistics for the United States, the Tri-State area of Texas, Kansas, and Oklahoma, and the Study Area is presented in line one of table 12.

ANALYSIS OF BENEFITS - EXISTING TRAFFIC

46. Assumptions.- The analysis of transportation charges is based on the following assumptions:

a. The county "shipping point" is the representative origin in each county in the study area which contains major grain storage and handling facilities.

b. A handling charge of $0.75 per ton is included in the transportation charges when grain is transferred from truck to elevator and from elevator to barge.

c. Unit savings of $0.21 or more per ton in transportation costs will be required to induce grain firms and shippers to divert shipments to the proposed waterway. Therefore, movements with unit savings of $0.20 or less were eliminated for insufficient savings.

d. Movements with total savings of less than $500.00 were eliminated for insufficient tonnage.

TABLE 11

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

SUMMARY OF TONS OF WHEAT AND GRAIN SORGHUM TRAFFIC DEVELOPED, ANALYZED, AND ELIMINATED AS PROSPECTIVE COMMERCE

(2,000 lbs = short ton)

State	State (1) production (thousands of tons)	Study area (2) production (thousands of tons)	Study area (3) quantity shipped export (thousands of tons)	Total (4) eliminated by screening (thousands of tons)	Production accepted for rate analysis (thousands of tons)	Eliminated by Analysis: No savings	Eliminated by Analysis: Insufficient savings	Eliminated by Analysis: Volume	Production accepted as waterway commerce (thousands of tons)	1965 Savings (thousands of dollars)	1985 Savings (thousands of dollars)
WHEAT											
Texas	2,178.9	2,142.0	1,464.0	805.0	659.0	22.0	3.0	5.0	629.0	$ 422.0	$448.0
Oklahoma	3,987.5	3,825.0	2,613.0	1,437.0	1,176.0	587.0	160.0	0.0	429.0	271.0	288.0
Kansas	7,308.7	3,692.0	2,522.0	1,387.0	1,135.0	1,111.0	24.0	0.0	0.0	0.0	0.0
Colorado	624.3	44.0	30.0	17.0	13.0	0.0	7.0	0.0	6.0	3.0	3.0
New Mexico	147.7	138.0	94.0	52.0	42.0	0.0	0.0	1.0	41.0	23.0	24.0
Sub-total	14,247.1	9,841.0	6,723.0	3,698.0	3,025.0	1,720.0	194.0	6.0	1,105.0	$ 719.0	$763.0
GRAIN SORGHUM											
Texas	8,000.7	5,680.0	1,374.0	1,168.0	206.0	14.0	10.0	8.0	174.0	$ 111.0	$139.0
Oklahoma	627.8	555.0	134.0	114.0	20.0	4.0	1.0	5.0	10.0	4.0	5.0
Kansas	3,827.9	1,690.0	409.0	348.0	61.0	52.0	9.0	0.0	0.0	0.0	0.0
Colorado	365.8	230.0	56.0	48.0	8.0	0.0	3.0	1.0	4.0	2.0	2.0
New Mexico	409.5	340.0	82.0	69.0	13.0	0.0	2.0	1.0	10.0	6.0	8.0
Sub-total	13,231.7	8,495.0	2,055.0	1,747.0	308.0	70.0	25.0	15.0	198.0	123.0	154.0
TOTAL	27,478.8	18,336.0	8,778.0	5,445.0	3,333.0	1,790.0	219.0	21.0	1,303.0	842.0	917.0

(1) Total grain produced in the five state area in 1965. Information obtained from Texas, Oklahoma, Kansas, New Mexico, and Colorado, individual state statistics compiled in cooperation with the U.S.D.A. for 1966.
(2) Total grain produced in considered study area in 1965.
(3) Export shipments from the study area amount to 68.32 percent of wheat and 24.2 percent of grain sorghum production.
(4) Rail exports eliminated by screening, 45 percent for wheat, 75 percent for grain sorghum plus additional 10 percent adjustment on each for other variable factors affecting mode of transportation.

TABLE 12

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

PROJECTED GRAIN TONNAGES FOR WHEAT AND GRAIN SORGHUM
(1965-2035)

WHEAT
(In Short Tons)

1	2	3	4	5	6	7	8	9
Year	United States total production	Texas total production	Kansas & Oklahoma total production	Tri-State total production	Trinity River study area total production	Study area movements to export market	Production transported by truck for export (45% Col. 7)	Tons diverted to proposed Trinity River waterway
(1) 1965	39,468,000	2,179,000	11,296,000	13,475,000	9,841,000	6,723,000	(2) 3,025,000	1,105,000
1985	49,013,000	1,947,000	13,316,000	15,263,000	10,441,000	7,133,000	3,210,000	1,172,000
2000	54,557,000	2,128,000	14,822,000	16,950,000	11,376,000	7,772,000	3,497,000	1,277,000
2010	59,085,000	2,273,000	16,052,000	18,325,000	12,138,000	8,289,000	3,730,000	1,362,000
2020	64,030,000	2,433,000	17,396,000	19,829,000	12,951,000	8,847,000	3,981,000	1,454,000
2035	71,133,000	2,662,000	19,325,000	21,987,000	13,955,000	9,533,000	4,289,000	1,567,000

GRAIN SORGHUM
(In Short Tons)

1	2	3	4	5	6	7
Year	United States total production	Texas total production	Trinity River Study area total production	Study area movements to export markets (24.2% Col. 4)	Production transported by truck to export market (15% Col. 5)	Tonnage diverted to proposed waterway
(1) 1965	18,649,700	8,000,700	8,495,000	2,056,000	(2) 308,000	198,000
1985	23,208,000	10,357,000	11,001,000	2,566,000	384,000	247,000
2000	25,540,000	11,471,000	12,182,000	2,671,000	400,000	257,000
2010	27,226,000	12,251,000	13,006,000	2,741,000	411,000	264,000
2020	29,001,000	13,105,000	13,915,000	2,813,000	421,000	271,000
2035	32,825,000	14,993,000	15,920,000	3,222,000	483,000	310,000

(1) Historical Data

(2) Amount used in Rate Analyses (45% and 15% of wheat and grain sorghum exports respectively).

47. Method.- The analysis of grain transportation savings via the Trinity River was computed as the difference between the existing truck and water charges or a combination thereof from county shipping points to existing ports, and the truck charges to Ft. Worth or Dallas and barge charges on the Trinity River thence to existing ports. The benefits were computed by multiplying the unit savings per ton by the prospective grain tonnage in each county. Figure 1 of the supplemental data is an example of a county rate sheet and illustrates the basic method of computing the unit savings, showing the alternate waterways, barge rates and modes of transportation considered in the analysis. A tabular list of the accepted savings and wheat and grain sorghum tonnage moving by truck into the port of Houston for export from each selected county shipping point, within the tributary area is shown in table B of the supplemental data. Figure 2 of the supplemental data shows a map of the grain study and tributary area of the Trinity River. Grain shipments from the counties shown in the study area were analyzed to establish the tributary area. The counties determined to have sufficient savings in grain shipments via the authorized waterway comprise the tributary area and are shown in detail in figure 3 of the supplemental data.

48. Benefits.- Grain production in the study area for the base year 1965, was approximately 9.841 million tons of wheat and 8.495 million tons of grain sorghum. Table 11 shows a summary of the tonnages of wheat and grain sorghum eliminated by screening and traffic analysis. As a result, there are 1.105 million tons of wheat and .198 million tons of grain sorghum with transportation savings of $719,000 and $123,000 respectively, which are accepted as benefits from existing grain traffic that could have been derived from movement of grain over the proposed Trinity River waterway in 1965.

GRAIN PROJECTIONS

49. Wheat Projections.- Wheat projections were developed from data furnished by the Economic Research Service (ERS), Department of Agriculture, through Texas A.&M. University. This information included total projected United States and Texas wheat production for the years 1980, 2000, and 2020. The United States projected wheat production is 47.165 million tons in 1980, 54.557 million tons in 2000, and 64.030 million tons in 2020. Texas projected wheat production is 1.887 million tons in 1980, 2.128 million tons in 2000, and 2.433 million tons in 2020. The estimated U. S. wheat production of 49.013 million tons and Texas wheat production of 1.947 million tons for the beginning year of the project, 1985, were obtained by interpolation from the projected 1980 and 2000 production estimates. Similarly wheat production in 2035 was obtained by extrapolation and is estimated at 71.133 million tons for the U. S. and 2.662 million tons for Texas. Wheat projections were not available for Kansas or Oklahoma; therefore, to acquire these projections,

historical wheat production for these states was first related as a percentage of the total United States production for the years 1957 through 1965. The average of these percentages (27.168 percent) was assumed to remain constant for the years 1980, 2000, and 2020. Projected wheat production for Kansas and Oklahoma was derived by multiplying the assumed 27.168 percent for these states by the projected total United States wheat production for the required projected years. The two state total projected production in 1980 is 12.814 million tons, for 1985 is 13.316 million tons, for 2000 is 14.822 million tons, for 2020 is 17.396 million tons, for 2035 is 19.375 million tons.

50. Based on series 2-B population projections from the U. S. Bureau of Census, the projected population for the three state area was computed for the years 1980, 1985, 2000, 2020, and 2035. Domestic per capita wheat requirements were also computed to be .08595 tons per person from ERS information. To obtain the three state domestic wheat requirements, the projected population was multiplied by the per capita wheat requirements. The difference between the estimated total wheat production and the estimated domestic requirements represents the estimated amount of wheat that is available for export from the three state area. On this basis, the volume of export wheat estimated for specific production years amounts to 13.0 million tons in 1980; 13.4 million tons in 1985; 14.7 million tons in 2000; 16.7 million tons in 2020; and 18.0 million tons in 2035.

51. In order to compute wheat exports via Trinity River, it was necessary to determine the historical relationship between the three state area's actual exports and possible exports. Actual wheat exports from Texas Gulf ports for the years 1957-1965, obtained from the Corps of Engineers - Waterborne Commerce, Part 2 and 5, were taken as a percentage of the computed possible exports. The average of these percentages (68.32 percent) was assumed to remain constant throughout the project life. Thus, by multiplying the assumed 68.32 percent by the possible three state wheat exports, the projected wheat exports obtained were: 8.9 million tons for 1980; 9.2 million tons for 1985; 10.0 million tons for 2000; 11.4 million tons for 2020; and 12.3 million tons for 2035. The projected wheat production for the U. S. and the tri-states throughout the project life are shown in table 12.

52. Wheat projections were obtained for the required counties in New Mexico and Colorado by using the factors of increase as developed for the above three state area. Separate projections for these states were not considered necessary, due to the small quantity of wheat involved and the similarity of the two states' county economics as related to the three state area.

53. Grain Sorghum Projections.- Grain sorghum projections were developed from information furnished by the Economic Research Service through the courtesy of Texas A.&M. University. This information included the total United States and Texas grain sorghum projected production and exports for the years 1980, 2000, and 2020. Further information indicated that Texas produced 43% of the nation's grain

sorghum in 1965 and an average of 59.8% of the total grain sorghum production in the five states within the study area. Thus, Texas production was used as the basis for determining the projection factors for future production and exports of grain sorghum.

54. ERS information projected Texas grain sorghum production in 1980 at 10.016 million tons; in 2000 at 11.471 million tons; and in 2020 at 13.105 million tons. Production figures for the years 1985, the beginning of project life, and 2010, the mid-year of the project, were obtained by interpolation of the projected 1980, 2000, and 2020 production estimates and are 10.357 and 12.251 million tons, respectively. The production figure for the year 2035, the end of the project life, was obtained by extrapolation and is estimated at 14.993 million tons.

55. Similarly, ERS projections of Texas exports were analyzed to determine the estimated tonnages of grain sorghum exports. It is estimated that grain sorghum exports will amount to 2.385 million tons in 1980; 2.417 million tons in 1985; 2.517 million tons in 2000; 2.583 million tons in 2010; 2.650 million tons in 2020; and 3.035 million tons in 2035.

56. Statistical data shown in table 7 indicates that for the 10 year period (1956-1965) Texas has produced an average of 59.8% of the total five state production of grain sorghum. Statistical data on the percentages of Texas production moving to the export market is not available, therefore, it was assumed that the total exports of grain sorghum moving through the Gulf ports, as shown in table 6, represents the total exports from the five state area. It was further assumed that each of the five states would export tonnage in the same relation as its production (Texas was 24.2% export). Thus in 1965, the Gulf ports exported 3.2395 million tons of grain sorghum with Texas exports amounting to 1.9372 million tons (3.2395 million tons x 59.8%). This figure represents 24.2% of Texas grain sorghum production in 1965. The percentages of grain sorghum exports as related to total production as furnished by ERS for the years 1980, 2000, and 2020 are 23.8%, 21.9%, and 20.2%, respectively. Therefore, 1.9372 million tons were used as the 1965 base year, export figure for Texas. The projected tonnages of grain sorghum production throughout the project life for the U. S. and Texas are shown in table 12.

BENEFITS FROM FUTURE GRAIN TRAFFIC

57. Benefits from Future Grain Traffic.- Benefits to be derived from future transportation of wheat and grain sorghum on the proposed waterway are based on the projections of wheat and grain sorghum production as discussed in paragraphs 49 and 53 and summarized in table 12. The factors of growth developed in the grain projections

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were applied to the transportation savings developed in the rate analysis. Table 13 summarizes the estimates of tonnages and savings to be derived during the proposed project life.

58. The total benefits attributable to the proposed project at the beginning of the project life in 1985, as shown in table 13, is estimated to be $917,000. The benefits to be derived from future grain traffic during the 50 year project life from 1985 to 2035, were estimated in accordance with the formula and procedures described in EM 1120-2-118, Appendix II and Senate Document 97, 87th Congress. An interest rate of $3\frac{1}{4}$ percent was used to reduce the total future benefits to an average annual equivalent benefit. The average annual equivalent benefits to be derived from the increment of increasing future transportation savings attributable to the proposed Trinity River Waterway is estimated at $103,000.

59. Summary of Benefits.- The total average annual equivalent benefits attributable to the proposed Trinity River Waterway from savings realized from grain shipments is estimated at $1.020 million as shown in table 14.

TABLE 13

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

SUMMARY OF ESTIMATED GRAIN TONNAGES AND
TRANSPORTATION SAVINGS DURING PROJECT LIFE
(In 1000's)

	WHEAT			GRAIN SORGHUM			TOTALS	
Year	Tonnage diverted to waterway	Transportation savings	Growth factor	Tonnage diverted to waterway	Transportation savings	Growth factor	Tonnage diverted to waterway	Transportation savings
1965(1)	1,105.0	$719.0	1.000	198.0	$123.0	1.000	1,303.0	$842.0
			1.061			1.248		
1985(2)	1,172.0	763.0		247.0	154.0		1,419.0	917.0
			1.156			1.299		
2000	1,277.0	831.0		257.0	160.0		1,534.0	991.0
			1.233			1.333		
2010	1,362.0	887.0		264.0	164.0		1,626.0	1,051.0
			1.316			1.368		
2020	1,454.0	946.0		271.0	168.0		1,725.0	1,114.0
			1.418			1.567		
2035	1,567.0	1,020.0		310.0	193.0		1,877.0	1,213.0

(1) Base year of project
(2) Beginning of project life

TABLE 14

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

SUMMARY OF BENEFITS

	Benefits from Transportation Savings
Beginning of Project Life (1985)	$ 917,000
Increased Future Grain Movements (1986-2035) - Average annual equivalent	103,000
Total Average Annual Equivalent Benefits	$1,020,000

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SUPPLEMENTAL DATA
TO
GRAIN STUDY

BIBLIOGRAPHY

Arbingast, Stanley A., and Kennamer, Lorrin, University of Texas, Bureau of Business Research. Atlas of Texas, Austin, Texas, 1963.

Askew, William R., United States Department of Agriculture, Economic Research Service, Economic and Statistical Analysis Division. Outlook for Wheat in 1966-67; Talk given at 44th Annual Agricultural Outlook Conference, Washington, D.C., 17 November 1966.

Atkins, I. M.; Porter, K. B.; Lahr, Keith; Merkle, Owen G.; and Futrell, M. C.; "Wheat Production in Texas", Texas Agricultural Experiment Station, Bulletin 891, March 1958.

Bonnen, C. A., "Types of Farming in Texas", Texas Agricultural Experiment Station, Bulletin 964, October 1960.

Bullock, Jimmie Bruce, "An Analysis of Interregional Competition In the Wheat and Flour Economics", Oklahoma State University, Stillwater, Oklahoma, May 1964.

Clough, Malcolm, United States Department of Agriculture, Economic Research Service, Economic and Statistical Analysis Division. Outlook for Feed, Talk given at 44th Annual Agricultural Outlook Conference, Washington, D. C., 15 November 1966.

Corps of Egnineers. Waterborne Commerce of the United States, Parts 2 and 5, 1956-1966.

Digest of Papers Presented at Grain Sorghum Research and Utilization Conferences, Amarillo, Texas, 1959-1966.

Green, William A., and Fritshen, John F., United States Department of Agriculture, Economic Research Service, Farm Economics Division. The Supply of Natural Resources For Future Agricultural Production, Texas River Basins, Prepared for delivery before Texas Agricultural Workers Conference, Corpus Christi, Texas, 2 November 1961.

Kincannon, J. A., "A Statistical Analysis of the Sorghum Grain Industry", Texas Agricultural Experiment Station, Bulletin 967, Octobe. 1960.

Larson, Adlowe L., and Yates, Tom W., "Effect of Motor Trucks on Movements of Wheat in Oklahoma", Oklahoma State University Experiment Station, Processed Series P-436, February 1963.

Oil and Gas Journal, 1963.

Southern, John H., "Farm Land Market Situation in the Southwestern States," Texas Agricultural Experiment Station, Bulletin 797, March 1955.

Staten, R. D., and Hodges, R. J., "Soybean Production in Texas," Texas Agricultural Experiment Station, Bulletin 919, November 1958.

Texas A & M University, Water Resources Institute, Texas Agricultural Experiment Station Agricultural Extension Service. Agricultural Resources Related to Water Development in Texas, College Station, Texas, September 1965.

Ulrey, Ivon W., United States Department of Agriculture, Economic Research Service, Marketing Economics Division. Current Problems In Transportation In The Trans-Missouri West, Speech presented at the Workshop on Transportation, Denver, Colorado, 30 November 1965.

United Nations Population Studies, No. 28. New York, New York, 1958.

United States Department of Agriculture. Agricultural Statistics, Washington, D. C., 1965 and 1966.

United States Department of Agriculture, Consumer and Marketing Service, Grain Division. Grain Marketing News, Weekly Summary and Statistics, Hyattsville, Maryland, November 1966-June 1967.

United States Department of Agriculture, Economic Research Service, Economic and Statistical Analysis Division. National Food Situation, NFS-117, Washington, D. C., August 1966.

United States Department of Agriculture, Economic Research Service, Marketing Economic Division. "The Freight Car Situation and Prospects," ERS-331-Reprinted from, The Marketing and Transportation Situation, November 1966.

United States Department of Agriculture, Foreign Agricultural Service. Foreign Agricultural Circulars, Washington, D. C., 1960-1966.

United States Department of Agriculture, Foreign Agricultural Service The World Grain Trade, Washington, D. C., 1956-1966.

United States Department of Agriculture, Marketing Service, Transportation and Facilities Research Division. Grain Transportation Statistics For The North Central Region, Statistical Bulletin No. 268 Washington, D. C., August 1960.

United States Department of Agriculture, Office of Information. Fact Book of United States Agriculture, Washington, D. C., January 1965.

United States Department of Agriculture, Statistical Reporting Service, Colorado Wheat and Grain Sorghum: Acreage, Yield and Production, Denver, Colorado 1956-1966.

United States Department of Agriculture, Statistical Reporting Service, Kansas Wheat and Grain Sorghum: Acreage, Yield and Production, Topeka, Kansas 1956-1966.

United States Department of Agriculture, Statistical Reporting Service, Oklahoma Wheat and Grain Sorghum: Acreage, Yield and Production, Oklahoma City, Oklahoma, 1956-1966.

United States Department of Agriculture, Statistical Reporting Service, New Mexico Crop and Livestock Reporting Service, New Mexico Wheat and Grain Sorghum: Acreage, Yield and Production, Las Cruces, New Mexico 1956-1966.

United States Department of Agriculture, Statistical Reporting Service, Texas Crop and Livestock Reporting Service. Texas Wheat and Grain Sorghum: Acreage, Yield and Production, Austin, Texas 1956-1966.

University of Oklahoma, College of Business Administration, Bureau of Business Research. Statistical Abstract of Oklahoma, Norman, Oklahoma 1964-1966.

U. S. Army Engineer Division, North Central, Corps of Engineers, Grain Traffic Analysis to Accompany Great Lakes Harbors Study, Chicago, Illinois, June 1965.

West, Quentin M., United States Department of Agriculture, Economic Research Service, Foreign Regional Analysis Division. Foreign Supply and Demand Projections; Outlook for U. S. Agricultural Exports, Paper presented at the Annual Meeting of the American Farm Economics Association, College Park, Maryland, 23 August 1966.

White, John C., Texas Department of Agriculture, Texas Grain Warehouses, Austin, Texas 1965.

Wright, Bruce H., United States Department of Agriculture, Economics Research Service, Marketing Economic Division, Transportation and the Grain Industries, Talk given at the Symposium on Structure, Conduct and Performance of the Grain Markets of the United States, University of Nebraska, June 1965.

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TABLE A

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

GRAIN STUDY

CONSTRUCTED TRUCK SCALE FOR WHEAT & GRAIN SORGHUM

MILEAGE	CHARGE/TON	MILEAGE	CHARGE/TON	MILEAGE	CHARGE/TON
0-35	$1.66	201-210	$3.48	521-540	$6.96
36-40	1.71	211-220	3.58	541-560	7.17
41-45	1.76	221-230	3.69	561-580	7.39
46-50	1.82	231-240	3.79	581-600	7.60
51-60	1.92	241-250	3.90	601-620	7.81
61-70	2.02	251-260	4.00	621-640	8.02
71-80	2.13	261-280	4.21	641-660	8.23
81-90	2.23	281-300	4.42	661-680	8.44
91-100	2.34	301-320	4.63	681-700	8.66
101-110	2.44	321-340	4.85	701-720	8.87
111-120	2.54	341-360	5.06	721-740	9.08
121-130	2.65	361-380	5.27	741-760	9.29
131-140	2.75	381-400	5.48	761-780	9.50
141-150	2.86	401-420	5.69	781-800	9.71
151-160	2.96	421-440	5.90	801-820	9.92
161-170	3.06	441-460	6.12	821-840	10.14
171-180	3.17	461-480	6.33	841-860	10.35
181-190	3.27	481-500	6.54	861-880	10.56
191-200	3.3[illegible]	501-520	6.75	881-900	10.77

NOTE: Using actual costs of truck movements, the constructed truck scale was developed from data furnished by grain shippers and truckers.

TABLE B

DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND WHEAT

CARD NO	COUNTY	TONS See Note	ORIGIN	TRANSPORTATION CHARGES VIA LOWEST AVAILABLE ROUTE						TRANSPORTATION CHARGES VIA PROPOSED WATERWAY						SAVING PER TON	TOTAL See Note
				1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	TEXAS																
104	Dallam	10,000	Dalhart	Houston		8.66			8.66	Ft. Worth	Houston	5.90	.75	1.27	7.92	0.74	$ 7,000
105	Sherman	28,000	Stratford	Catoosa	Baton Rouge	5.48	.75	2.35	8.58	" "	"	5.90	.75	1.27	7.92	0.66	18,000
106	Hansford	41,000	Spearman	"	" "	5.06	.75	2.35	8.16	" "	"	5.48	.75	1.27	7.50	0.66	27,000
107	Ochiltree	23,000	Perry	"	" "	4.63	.75	2.35	7.73	" "	"	5.27	.75	1.27	7.29	0.44	10,000
108	Lipscomb	13,000	Lipscomb	"	" "	4.42	.75	2.35	7.52	" "	"	5.06	.75	1.27	7.08	0.44	6,000
109	Hartley	9,000	Hartley	Houston		8.44			8.44	" "	"	5.69	.75	1.27	7.71	0.73	7,000
110	Moore	36,000	Dumas	"		8.23			8.23	" "	"	5.48	.75	1.27	7.50	0.73	26,000
111	Hutchinson	14,000	Borger	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	10,000
112	Roberts	3,000	Miami	Catoosa	Baton Rouge	4.42	.75	2.35	7.52	" "	"	5.06	.75	1.27	7.08	0.44	1,000
113	Hemphill	4,000	Canadian	"	" "	4.42	.75	2.35	7.52	" "	"	4.85	.75	1.27	6.87	0.65	3,000
114	Oldham	5,000	Vega	Houston		8.02			8.02	" "	"	5.27	.75	1.27	7.29	0.73	4,000
115	Potter	3,000	Amarillo	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	2,000
116	Carson	21,000	Panhandle	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	15,000
117	Gray	9,000	Pampa	"		7.39			7.39	" "	"	4.85	.75	1.27	6.87	0.52	5,000
118	Wheeler	3,000	Shamrock	"		7.17			7.17	" "	"	4.42	.75	1.27	6.44	0.73	2,000
119	Deaf Smith	38,000	Hereford	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	28,000
120	Randall	17,000	Canyon	"		7.81			7.81	" "	"	5.27	.75	1.27	7.29	0.52	9,000
121	Armstrong	8,000	Claude	"		7.39			7.39	" "	"	4.63	.75	1.27	6.65	0.74	6,000
122	Donley	2,000	Clarendon	"		7.17			7.17	" "	"	4.42	.75	1.27	6.44	0.73	1,000
123	Collingsworth	3,000	Wellington	"		6.75			6.75	" "	"	4.00	.75	1.27	6.02	0.73	2,000
124	Parmer	42,000	Farwell	"		7.81			7.81	" "	"	5.27	.75	1.27	7.29	0.52	22,000
125	Castro	29,000	Dimmitt	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	21,000
126	Swisher	32,000	Tulia	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	23,000
127	Briscoe	7,000	Silverton	"		7.17			7.17	" "	"	4.42	.75	1.27	6.44	0.73	5,000
128	Hall	1,000	Turkey	"		6.96			6.96	" "	"	4.21	.75	1.27	6.23	0.73	1,000
129	Childress	6,000	Childress	"		6.54			6.54	" "	"	3.69	.75	1.27	5.71	0.83	5,000
130	Bailey	3,000	Muleshoe	"		7.60			7.60	" "	"	5.06	.75	1.27	7.08	0.52	2,000
131	Lamb	2,000	Littlefield	"		7.17			7.17	" "	"	4.85	.75	1.27	6.87	0.30	1,000
132	Hale	17,000	Plainview	"		7.39			7.39	" "	"	4.63	.75	1.27	6.65	0.74	13,000
133	Floyd	20,000	Floydada	"		6.96			6.96	" "	"	4.63	.75	1.27	6.65	0.31	6,000
134	Motley	1,000	Matador	"		6.75			6.75	" "		4.21	.75	1.27	6.23	0.52	1,000
135	Cottle	2,000	Paducah	"		6.54			6.54	" "		3.79	.75	1.27	5.81	0.73	1,000
	TOTALS	452,000													TOTAL		$290,000

NOTE: Tonnages and Savings Rounded to Nearest 1,000

TABLE B
DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND WHEAT

CARD NO	COUNTY	TONS See Note	ORIGIN	TRANSPORTATION CHARGES VIA LOWEST AVAILABLE ROUTE						TRANSPORTATION CHARGES VIA PROPOSED WATERWAY						SAVING PER TON	TOTAL See Note
				1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	TEXAS																
136	Hardeman	9,000	Quanah	Houston		6.12			6.12	Ft. Worth	Houston	3.38	.75	1.27	5.40	0.72	$ 6,000
137	Foard	7,000	Crowell	"		6.12			6.12	" "	"	3.38	.75	1.27	5.40	0.72	5,000
138	Wilbarger	17,000	Vernon	"		5.90			5.90	" "	"	3.06	.75	1.27	5.08	0.82	14,000
139	Wichita	11,000	Wichita Falls	"		5.27			5.27	" "	"	2.54	.75	1.27	4.56	0.71	8,000
140	Cochran	1,000	Morton	"		7.60			7.60	" "	"	5.06	.75	1.27	7.08	0.52	1,000
143	Crosby	6,000	Crosbyton	"		6.96			6.96	" "	"	4.21	.75	1.27	6.23	0.73	4,000
144	Dickens	1,000	Dickens	"		6.54			6.54	" "	"	3.79	.75	1.27	5.81	0.73	1,000
146	Knox	11,000	Gilliland	"		5.90			5.90	" "	"	3.17	.75	1.27	5.19	0.71	8,000
147	Baylor	12,000	Seymour	"		5.48			5.48	" "	"	2.75	.75	1.27	4.77	0.71	9,000
148	Archer	5,000	Archer City	"		5.27			5.27	" "	"	2.44	.75	1.27	4.46	0.81	4,000
149	Clay	5,000	Henrietta	"		5.06			5.06	" "	"	2.34	.75	1.27	4.36	0.70	4,000
151	Cooke	4,000	Gainesville	"		4.63			4.63	Dallas	"	2.02	.75	1.12	3.89	0.74	4,000
152	Grayson	11,000	Sherman	"		4.63			4.63	"	"	1.92	.75	1.12	3.79	0.84	9,000
158	Stonewall	2,000	Aspermont	"		5.90			5.90	Ft. Worth	"	3.38	.75	1.27	5.40	0.50	1,000
159	Haskell	7,000	Haskell	"		5.69			5.69	" "	"	3.27	.75	1.27	5.29	0.40	3,000
160	Throckmorton	6,000	Throckmorton	"		5.48			5.48	" "	"	2.75	.75	1.27	4.77	0.71	4,000
161	Young	8,000	Graham	"		5.06			5.06	" "	"	2.34	.75	1.27	4.36	0.70	6,000
163	Wise	1,000	Decatur	"		4.63			4.63	" "	"	1.76	.75	1.27	3.78	0.85	1,000
164	Denton	6,000	Denton	"		4.63			4.63	" "	"	1.66	.75	1.27	3.68	0.95	6,000
165	Collin	11,000	McKinney	"		4.21			4.21	Dallas	"	1.66	.75	1.12	3.53	0.68	7,000
166	Fannin	5,000	Bonham	"		4.63			4.63	"	"	2.02	.75	1.12	3.89	0.74	4,000
169	Hunt	3,000	Greensville	"		4.21			4.21	"	"	1.76	.75	1.12	3.63	0.58	2,000
172	Rockwall	1,000	Rockwall	"		4.21			4.21	"	"	1.66	.75	1.12	3.53	0.68	1,000
173	Dallas	5,000	Dallas	"		3.90			3.90	"	"	----	.75	1.12	1.87	2.03	10,000
174	Tarrant	1,000	Ft. Worth	"		4.21			4.21	Ft. Worth	"	----	.75	1.27	2.02	2.19	2,000
176	Stephens	1,000	Breckenridge	"		5.27			5.27	" "	"	2.44	.75	1.27	4.46	0.81	1,000
177	Shackelford	2,000	Albany	"		5.48			5.48	" "	"	2.65	.75	1.27	4.67	0.81	2,000
178	Jones	6,000	Anson	"		5.48			5.48	" "	"	3.06	.75	1.27	5.08	0.40	2,000
	TOTALS	165,000													TOTAL		$128,000

NOTE: Tonnages and Savings Rounded to Nearest 1,000

TABLE B

DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND WHEAT

CARD NO	COUNTY	TONS See Note	ORIGIN	Transportation Charges via Lowest Available Route: 1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	Transportation Charges via Proposed Waterway: 1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	SAVING PER TON	TOTAL See Note
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	TEXAS																
179	Fisher	2,000	Roby	Houston		5.69			5.69	Ft. Worth	Houston	3.27	.75	1.27	5.29	0.40	$ 1,000
189	Taylor	7,000	Abilene	"		5.27			5.27	" "	"	2.96	.75	1.27	4.98	0.29	2,000
192	Callahan	3,000	Baird	"		5.06			5.06	" "	"	2.75	.75	1.27	4.77	0.29	1,000
	TOTALS	12,000													TOTALS		$ 4,000
	COLORADO																
63	Baca	5,000	Springfield	Catoosa	Baton Rouge	6.12	.75	2.35	9.22	Ft. Worth	Houston	6.75	.75	1.27	8.77	0.45	$ 2,000
65	Las Animas	1,000	Trinidad	Houston		10.14			10.14	" "	"	7.39	.75	1.27	9.41	0.73	1,000
	TOTALS	6,000													TOTALS		$ 3,000
	NEW MEXICO																
67	Quay	5,000	Tucumcari	"		8.87			8.87	" "	"	6.12	.75	1.27	8.14	0.73	4,000
322	Curry	33,000	Clovis	"		8.02			8.02	" "	"	5.48	.75	1.27	7.50	0.52	17,000
323	Roosevelt	3,000	Portales	"		8.23			8.23	" "	"	5.69	.75	1.27	7.71	0.52	2,000
	TOTALS	41,000													TOTALS		$ 23,000
	OKLAHOMA																
7	Canadian	42,000	El Reno	Catoosa	Baton Rouge	2.86	.75	2.35	5.96	Ft. Worth	Houston	3.48	.75	1.27	5.50	0.46	$ 19,000
13	Cleveland	4,000	Norman	"	" "	2.75	.75	2.35	5.85	Dallas	"	3.38	.75	1.12	5.25	0.60	2,000
14	McClain	4,000	Blanchard	"	" "	2.86	.75	2.35	5.96	Ft. Worth	"	3.27	.75	1.27	5.29	0.67	3,000
19	Texas	36,000	Guymon	"	Baton Rouge	5.06	.75	2.35	8.16	" "	"	5.90	.75	1.27	7.92	0.24	9,000
26	Beckham	11,000	Elk City	"	" "	3.58	.75	2.35	6.68	" "	"	4.42	.75	1.27	6.44	0.24	3,000
27	Garvin	3,000	Paoli	Houston		5.69			5.69	Dallas	"	3.06	.75	1.12	4.93	0.76	2,000
28	Kiowa	47,000	Hobart	"		6.54			6.54	Ft. Worth	"	3.79	.75	1.27	5.81	0.73	34,000
30	Grady	18,000	Chickasha	"		5.90			5.90	" "	"	3.06	.75	1.27	5.08	0.82	15,000
31	Washita	48,000	Bessie	Catoosa	Baton Rouge	3.38	.75	2.35	6.48	" "	"	4.00	.75	1.27	6.02	0.46	22,000
35	Cimarron	10,000	Boise City	"	" "	5.69	.75	2.35	8.79	" "	"	6.33	.75	1.27	8.35	0.44	4,000
37	Caddo	35,000	Anadarko	Houston		6.12			6.12	" "	"	3.27	.75	1.27	5.29	0.83	29,000
38	Roger Mills	7,000	Hammon	Catoosa	Baton Rouge	3.58	.75	2.35	6.68	" "	"	4.42	.75	1.27	6.44	0.24	2,000
40	Harmon	12,000	Gould	Houston		6.54			6.54	" "	"	3.69	.75	1.27	5.71	0.83	10,000
	TOTALS	277,000													TOTAL		$154,000

NOTE: Tonnages and Savings Rounded to Nearest 1,000

TABLE B

DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND WHEAT

CARD NO	COUNTY	TONS See Note	ORIGIN	TRANSPORTATION CHARGES VIA LOWEST AVAILABLE ROUTE						TRANSPORTATION CHARGES VIA PROPOSED WATERWAY						SAVING PER TON	TOTAL See Note
				1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	OKLAHOMA																
41	Greer	14,000	Mangum	Houston		6.54			6.54	Ft. Worth	Houston	3.69	.75	1.27	5.71	0.83	$ 12,000
42	Jackson	30,000	Altus	"		6.33			6.33	" "	"	3.38	.75	1.27	5.40	0.93	28,000
43	Tillman	54,000	Loveland	"		5.69			5.69	" "	"	2.96	.75	1.27	4.98	0.71	38,000
44	Comanche	13,000	Lawton	"		5.90			5.90	" "	"	3.17	.75	1.27	5.19	0.71	9,000
45	Cotton	31,000	Walters	"		5.69			5.69	" "	"	2.96	.75	1.27	4.98	0.71	22,000
46	Stephens	5,000	Duncan	"		5.48			5.48	" "	"	2.75	.75	1.27	4.77	0.71	4,000
47	Jefferson	2,000	Ringling	"		5.48			5.48	" "	"	2.86	.75	1.27	4.88	0.60	1,000
50	Murry	1,000	Davis	"		5.48			5.48	Dallas	"	2.86	.75	1.12	4.73	0.75	1,000
53	Marshall	1,000	Madill	"		5.27			5.27	"	"	2.65	.75	1.12	4.52	0.75	1,000
54	Bryan	1,000	Durant	"		4.85			4.85	"	"	2.34	.75	1.12	4.21	0.64	1,000
	TOTALS	152,000															$117,000
															TOTAL		

SUMMARY OF SHEET TOTALS FOR WHEAT

	Tonnages	Savings
Sheet 1		
Texas	452,000	$290,000
Sheet 2		
Texas	165,000	128,000
Sheet 3		
Texas	12,000	4,000
Colorado	6,000	3,000
New Mexico	41,000	23,000
Oklahoma	277,000	154,000
Sheet 4		
Oklahoma	152,000	$117,000
TOTAL	1,105,000	$719,000

NOTE: Tonnages and Savings Rounded to Nearest 1,000

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TABLE B
DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND GRAIN SORGHUM

				TRANSPORTATION CHARGES VIA LOWEST AVAILABLE ROUTE						TRANSPORTATION CHARGES VIA PROPOSED WATERWAY							
CARD NO	COUNTY	TONS See Note	ORIGIN	1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	SAVING PER TON	TOTAL See Note
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	TEXAS																
104	Dallam	7,000	Dalhart	Houston		8.66			8.66	Ft. Worth	Houston	5.90	.75	1.27	7.92	0.74	$ 5,000
105	Sherman	6,000	Stratford	Catoosa	Baton Rouge	5.48	.75	2.35	8.58	" "	"	5.90	.75	1.27	7.92	0.66	4,000
106	Hansford	9,000	Spearman	"	" "	5.06	.75	2.35	8.16	" "	"	5.48	.75	1.27	7.50	0.66	6,000
107	Ochiltree	2,000	Perryton	"	" "	4.63	.75	2.35	7.73	" "	"	5.27	.75	1.27	7.29	0.44	1,000
109	Hartley	3,000	Hartley	Houston		8.44			8.44	" "	"	5.69	.75	1.27	7.71	0.73	2,000
110	Moore	5,000	Dumas	"		8.23			8.23	" "	"	5.48	.75	1.27	7.50	0.73	4,000
111	Hutchinson	1,000	Borger	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	1,000
114	Oldham	1,000	Vega	"		8.02			8.02	" "	"	5.27	.75	1.27	7.29	0.73	1,000
115	Potter	1,000	Amarillo	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	1,000
116	Carson	4,000	Panhandle	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	3,000
117	Gray	1,000	Pampa	"		7.39			7.39	" "	"	4.85	.75	1.27	6.87	0.52	1,000
118	Wheeler	1,000	Shamrock	"		7.17			7.17	" "	"	4.42	.75	1.27	6.44	0.73	1,000
119	Deaf Smith	12,000	Hereford	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	9,000
120	Randall	4,000	Canyon	"		7.81			7.81	" "	"	5.27	.75	1.27	7.29	0.52	2,000
121	Armstrong	1,000	Claude	"		7.39			7.39	" "	"	4.63	.75	1.27	6.65	0.74	1,000
123	Collingsworth	1,000	Wellington	"		6.75			6.75	" "	"	4.00	.75	1.27	6.02	0.73	1,000
124	Parmer	19,000	Farwell	"		7.81			7.81	" "	"	5.27	.75	1.27	7.29	0.52	10,000
125	Castro	14,000	Dimmitt	"		7.81			7.81	" "	"	5.06	.75	1.27	7.08	0.73	10,000
126	Swisher	12,000	Tulia	"		7.60			7.60	" "	"	4.85	.75	1.27	6.87	0.73	9,000
127	Briscoe	3,000	Silverton	"		7.17			7.17	" "	"	4.42	.75	1.27	6.44	0.73	2,000
128	Hall	1,000	Turkey	"		6.96			6.96	" "	"	4.21	.75	1.27	6.23	0.73	1,000
130	Bailey	6,000	Muleshoe	"		7.60			7.60	" "	"	5.06	.75	1.27	7.08	0.52	3,000
131	Lamb	12,000	Littlefield	"		7.17			7.17	" "	"	4.85	.75	1.27	6.87	0.30	4,000
132	Hale	16,000	Plainview	"		7.39			7.39	" "	"	4.63	.75	1.27	6.65	0.74	12,000
133	Floyd	10,000	Floydada	"		6.96			6.96	" "	"	4.63	.75	1.27	6.65	0.31	3,000
140	Cochran	2,000	Morton	"		7.60			7.60	" "	"	5.06	.75	1.27	7.08	0.52	1,000
142	Lubbock	6,000	Lubbock	"		6.96			6.96	" "	"	4.42	.75	1.27	6.44	0.52	3,000
143	Crosby	4,000	Crosbyton	"		6.96			6.96	" "	"	4.21	.75	1.27	6.23	0.73	3,000
146	Knox	2,000	Gilliland	"		5.90			5.90	" "	"	3.17	.75	1.27	5.19	0.71	1,000
155	Lynn	2,000	Tahoka	"		6.75			6.75	" "	"	4.42	.75	1.27	6.44	0.31	1,000
159	Haskell	2,000	Haskell	"		5.69			5.69	" "	"	3.27	.75	1.27	5.29	0.40	1,000
164	Denton	1,000	Denton	"		4.63			4.63	" "	"	1.66	.75	1.27	3.68	0.95	1,000
	TOTALS	171,000													TOTAL		$108,000

NOTE: Tonnages and Savings Rounded to the Nearest 1,000

TABLE B
DETAILED ANALYSIS OF TRANSPORTATION CHARGES ON PROSPECTIVE TRAFFIC

NAME OF PROJECT TRINITY RIVER RESTUDY

DIRECTION OF TRAFFIC MOVEMENT DOWNBOUND GRAIN SORGHUM

CARD NO	COUNTY	TONS See Note	ORIGIN	TRANSPORTATION CHARGES VIA LOWEST AVAILABLE ROUTE: 1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	TRANSPORTATION CHARGES VIA PROPOSED WATERWAY: 1st PORT	2nd PORT	RATE TO 1st PORT	TRANSFER AND HANDLING AT 1st PORT	BARGE RATE PORT to PORT	TOTAL	SAVING PER TON	TOTAL See Note
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	
	TEXAS																
165	Collin	2,000	McKinney	Houston		4.21			4.21	Dallas	Houston	1.66	.75	1.12	3.53	0.68	$ 1,000
173	Dallas	1,000	Dallas	"		3.90			3.90	"	"	----	.75	1.12	1.87	2.03	2,000
	TOTALS	3,000															$ 3,000
	COLORADO																
63	Baca	4,000	Springfield	Catoosa	Baton Rouge	6.12	.75	2.35	9.22	Ft. Worth	Houston	6.75	.75	1.27	8.77	0.45	$ 2,000
	TOTALS	4,000															$ 2,000
	NEW MEXICO																
67	Quay	1,000	Tucumcari	Houston		8.87			8.87	Ft. Worth	Houston	7.12	.75	1.27	8.14	0.73	$ 1,000
322	Curry	7,000	Clovis	"		8.02			8.02	" "	"	5.48	.75	1.27	7.50	0.52	4,000
323	Roosevelt	2,000	Portales	"		8.23			8.23	" "	"	5.69	.75	1.27	7.71	0.52	1,000
	TOTALS	10,000															$ 6,000
	OKLAHOMA																
19	Texas	5,000	Guymon	Catoosa	Baton Rouge	5.06	.75	2.35	8.16	Ft. Worth	Houston	5.90	.75	1.27	7.92	0.24	$ 1,000
35	Cimarron	3,000	Boise City	"	" "	5.69	.75	2.35	8.79	" "	"	6.33	.75	1.27	8.35	0.44	1,000
37	Caddo	1,000	Anadarko	Houston		6.12			6.12	" "	"	3.27	.75	1.27	5.29	0.83	1,000
43	Tillman	1,000	Loveland	"		5.69			5.69	" "	"	2.96	.75	1.27	4.98	0.71	1,000
	TOTALS	10,000															$ 4,000
															TOTAL		

SUMMARY OF SHEET TOTALS FOR GRAIN SORGHUM

	Tonnages	Savings
Sheet 5		
Texas	171,000	$108,000
Sheet 6		
Texas	3,000	3,000
Colorado	4,000	2,000
New Mexico	10,000	6,000
Oklahoma	10,000	4,000
TOTAL	198,000	$123,000

NOTE: Tonnages and Savings Rounded to the Nearest 1,000

FIGURE 1
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
GRAIN STUDY

COUNTY: POTTER

RATE ANALYSIS SHEET (Sample)

TRAFFIC SURVEY FOR ______________

Commodity: Wheat & Grain Sorghum Annual tonnage: ______________ tons (short tons)

Origin: Amarillo, Texas Destination: Houston, Texas

Plant to dock ______________ Miles Dock to plant ______________ Miles

(1) Existing rate (rail) (~~truck~~) (~~barge~~) $ 8.00 N.T.

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Houston, Texas	600	*1	$ 7.60
Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge				
Other (specify)				
TOTAL				$ 7.60

______________ ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Ft. Worth, Texas	340		$ 4.85
Port-to-port	(Via Trinity)			1.27
(5) Rate from 2d port	Houston			
Constant factor				
Handling charge				.75
Switching charge				.75
Other (specify)				
TOTAL				$ 6.87

REMARKS: Unit Savings $ 0.73 N.T.

NOTES Total Savings $ ______ *2

*1 See Table A in the Appendix for the appropriate truck charge.

*2 Unit savings multiplied by estimated trucked grain moving into export. (See Table B) = Total savings for each county.

Figure 1 (continued)

COMPARISON OF SHIPMENTS VIA

(Sample)

ALTERNATE PORTS

PORTS	MILES	ROUTE	CARRIER	RATE/TON
Amarillo	362		Truck	5.27
To				
Catoosa, Okla.			W	2.35
To				
Baton Rouge			Handling	.75
				$8.37
Amarillo			Truck	
To				
Daingerfield				N.A.
To				
Baton Rouge			W	
Amarillo	340		Truck	4.85
To				
Ft. Worth			W	1.27
To				
Houston			Handling	.75
				$6.87
Amarillo	366		Truck	5.27
To				
Dallas			W	1.12
To				
Houston			Handling	.75
				$7.14
Amarillo	695		Truck	8.23
To				
Corpus Christi				
				$8.23

BARGE RATES: (Computed by Office, Chief of Engineers)

Daingerfield to Baton Rouge	$1.70
Catoosa to Baton Rouge	2.35
Muskogee to Baton Rouge	2.10
Ft. Smith to Baton Rouge	1.90
Dallas to Houston	1.12
Ft. Worth to Houston	1.27

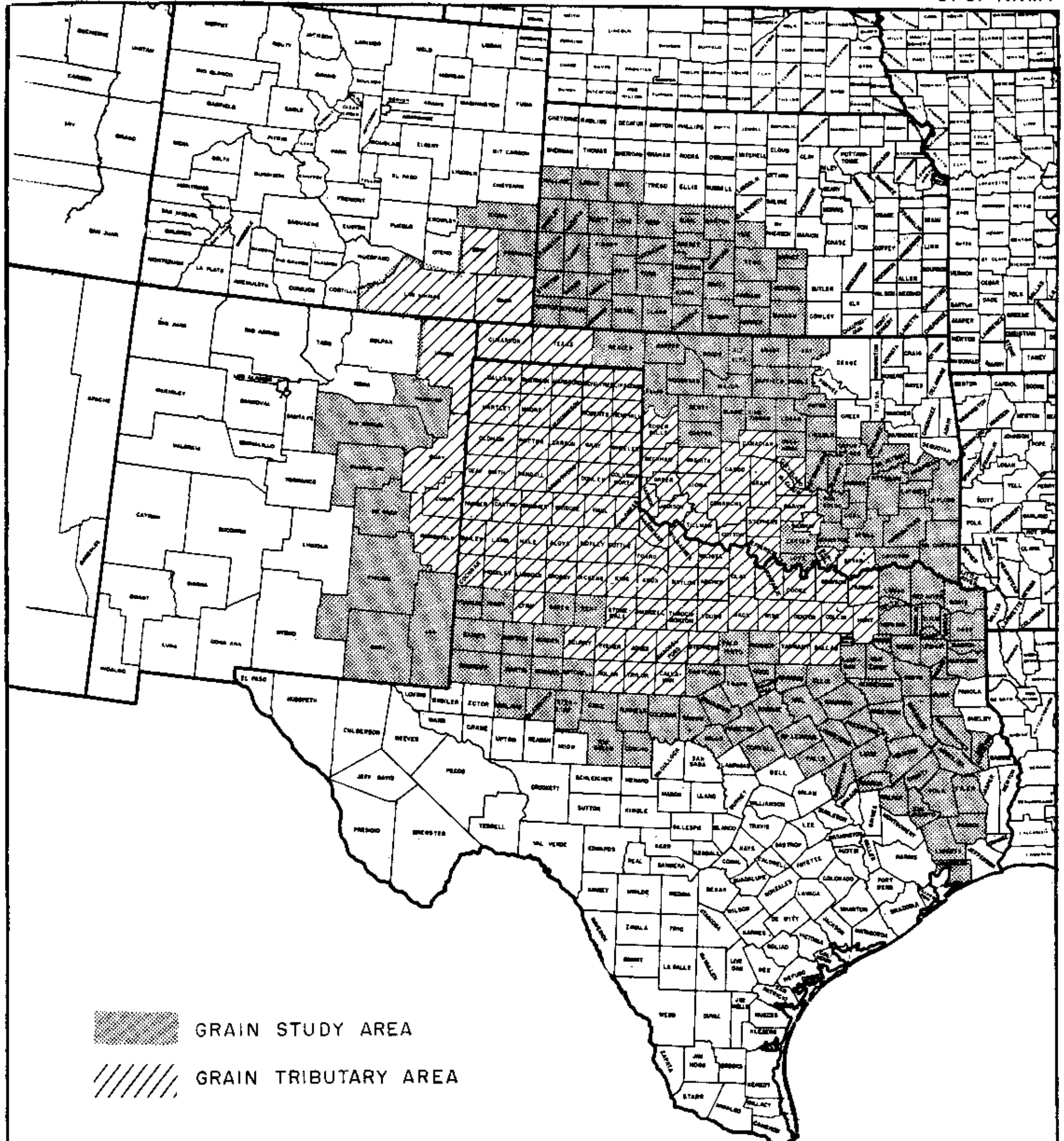

FIGURE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
GRAIN STUDY

VICINITY MAP OF GRAIN STUDY
AND TRIBUTARY AREA

EXHIBIT I
APPENDIX II

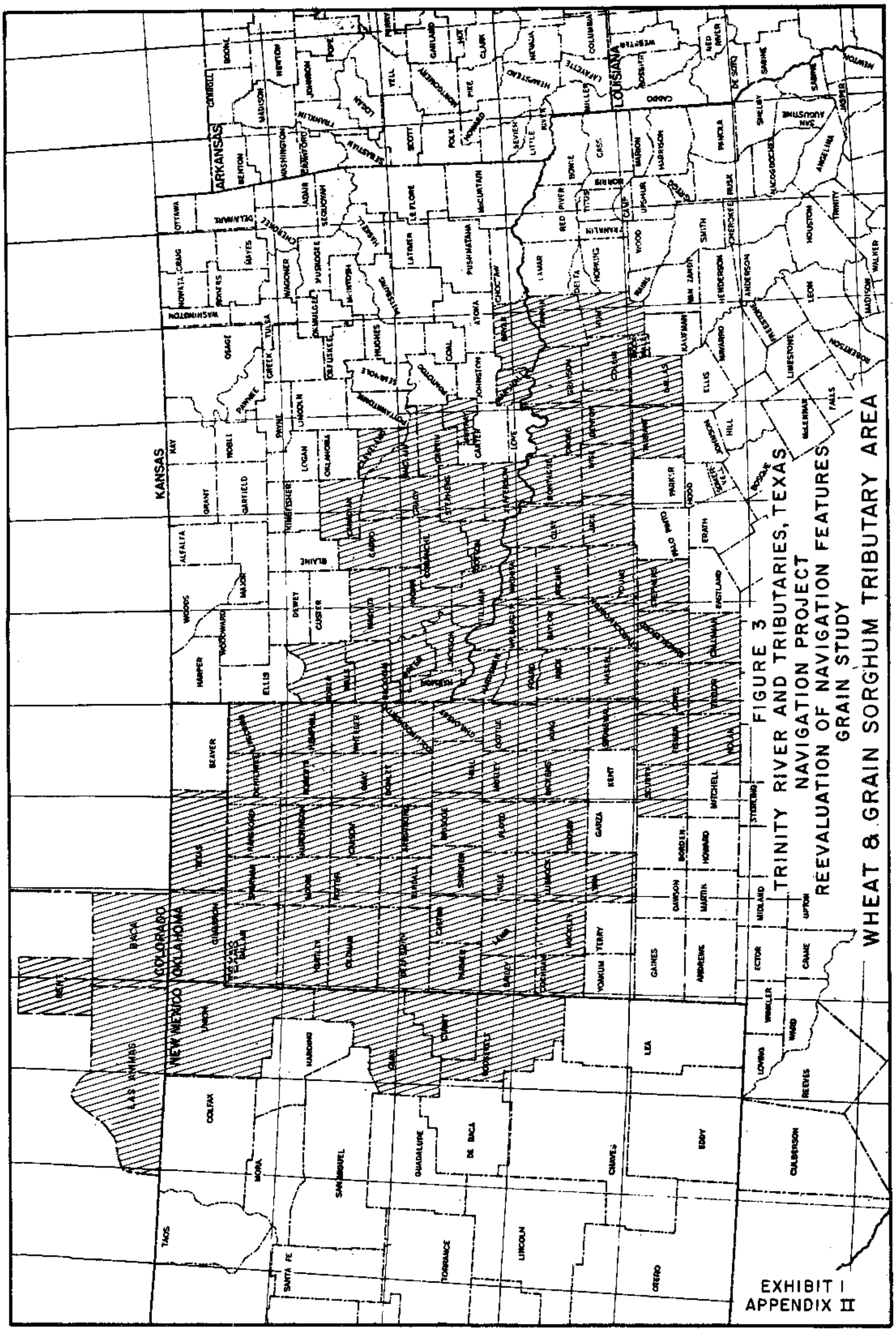

FIGURE 3
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
GRAIN STUDY
WHEAT & GRAIN SORGHUM TRIBUTARY AREA

EXHIBIT I
APPENDIX II

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

EXHIBIT 2
SAND, GRAVEL, AND STONE STUDY

TRINITY RIVER WATERWAY SPECIAL STUDY

SAND - GRAVEL - STONE

William D. Miller

William D. Miller,
Resource Analyst

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

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APPENDIX

SUPPLEMENTAL DATA

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

SCOPE OF WORK

The original work to be accomplished under the contract (DACW 64-67-C-0067) consisted of "performance of a study and preparation of a report of the present movements of sand, gravel, and stone that are consumed in the area of influence of the Trinity River navigation project, and determination of savings in transportation costs of these commodities in lieu of the least-costly alternative transportation mode."

Specifically, the report is to include:

(A) Location, quantity, and quality of sand-gravel-stone aggregates within the area of influence of the Trinity Waterway;

(B) Locations and estimates of quantities of reserves;

(C) Life expectancy of reserves in terms of depletion by market demand, with and without the proposed waterway;

(D) Estimate of proportion and location of reserves that would never move without the waterway;

(E) Present market areas and length of hauls;

(F) Present modes of transportation;

(G) Transportation rates from present sources;

(H) Probable change in transportation modes and traffic patterns due to waterway;

(I) Analysis of costs of production methods of each commodity to determine:

(1) Possibility of change to hydraulic operation adjacent to river bed with transportation to a central collection point;

(2) Likelihood of continuing existing production methods, and potential for producing larger quantities because of waterway movement;

(3) Comparative production unit costs between methods of production.

Statement of Change: Changes in the original contract refer to specific items in Corps contract Appendix A - Sand, Gravel, and Stone Special Study which are shown below.

A. Paragraph 2a of Appendix A, Nature of Report shall be expanded to include the following:

(4) Assume dredging of sand and gravel reserves will not be permitted within the channel and reservoir areas created by locks and dams; therefore, an estimate of reserves so excluded should be made.

(5) Investigate types of industries, located along the coastal area, now using seashell as a base for limestone. Incorporate an estimate of seashell reserves, the locations and reserves of limestone and the possible use of limestone as a substitute for seashell along the Gulf Coast area, if, and when applicable.

B. In addition to the previous requirement stated in Corps paragraph 2a (1), the stone reserves and markets within the influence of the Trinity River waterway shall be treated separately from sand and gravel.

C. The original draft report shall be revised by deleting the following items generally required by Corps paragraph 2b.

(1) Savings based on truck mileage distance scale, and benefits incurred from savings in transportation costs.

(2) Barge charges or rates and savings attributable to the rates.

(3) Savings based on rail rates, and benefits incurred from savings in transportation costs.

D. Paragraph 2c (1) of Appendix A shall be expanded to include the following:

(1) Analysis of production costs of each commodity both by dry-land mining and by hydraulic dredging operation, transportation to an identical collection point.

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

SYLLABUS

Approximately 7,018,000 tons of sand and gravel were produced by the major companies in the Dallas-Fort Worth Region in 1966. Production of sand and gravel in the Houston-Galveston Region approximated 10,505,000 tons.

All the major deposits of sand and gravel in the Dallas-Fort Worth Trinity River flood plain will be depleted by 1971-73. Essentially all the prolific production from Seagoville now supplying the Dallas market will cease before 1985.

Reserves in the present producing localities of the Houston Region approximate 375 million tons. The life expectancy of these reserves are estimated to be between 20 and 25 years.

There are over 5 billion tons of reserves in the Dallas-Houston interarea. Excluding the deposits expected to be covered by the proposed canal and two major reservoirs, the total reserves are estimated at 3.5 to 4.2 billion tons.

Sand and gravel deposits located along the Trinity flood plain between central Navarro-Henderson counties and Walker-Trinity counties will not be developed in the foreseeable future without the proposed waterway. Sand and gravel deposits between central Navarro-Henderson counties and Dallas County will move in the foreseeable future but at a higher cost than possible with the proposed canal. Sand deposits north of the Urbana area of Polk-San Jacinto counties will not be developed to their maxima without the canal. When these deposits are developed it will be at a greater cost without the canal. The low cost factors associated with the proposed canal are due not only to expected transportation savings but also to savings to be realized by hydraulic rather than dry-land production methods.

Comparisons were made between the cost of hydraulic and dry-land methods of production of sand and gravel. According to Dallas producers, hydraulic production can be performed where feasible along the river at an average savings of 29¢ per-ton.

The prevailing least-costly mode of transport for aggregates in Dallas-Fort Worth and between Houston-Dallas is by truck. In the Houston region, shell and sand are transported by barge, and sand, gravel and stone are shipped principally by rail.

There was a minimum of 5,650,000 tons of crushed stone produced in the Dallas-Fort Worth Region in 1966. Shell production in the Houston-Galveston Region approximated 3,704,200 tons for aggregate use and 2,393,933 tons for cement manufacture. The Burnet-Georgetown, New Braunfels and San Antonio areas supplied 800,000 tons of stone to the region.

Stone reserves for cement manufacture in the Dallas, Fort Worth, Waco, and San Antonio areas are unlimited. The life expectancy of the deposits exceeds 100 years. Stone for aggregates is also available in essentially unlimited quantities near Bridgeport-Chico, Wise County, in Palo Pinto and Parker counties, and in the Burnet-Georgetown, New Braunfels, San Antonio region.

In the event shell production from the bays were to be curtailed, or deposits depleted, raw materials for cement manufacture could be supplied from the San Antonio area. Also, cement would be shipped via rail and truck from Waco and San Antonio. With a waterway in operation, cement would be shipped from Dallas-Fort Worth to the Gulf Coast. Gravel from the Colorado and Guadalupe Rivers, and stone from the present sources in the Burnet-Georgetown, New Braunfels, San Antonio region would replace shell for aggregates in the event this material were unavailable.

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TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

INTRODUCTION

1. There are three natural, distinct regions within the Trinity River Basin in terms of market demand and location of reserves. The three regions are centered on Dallas-Fort Worth, Houston-Galveston and the Dallas-Houston interarea (Fig. 1).

2. Dallas-Fort Worth and Houston-Galveston are the major aggregate and cement consuming regions. The interarea is less important in terms of market demand, but extremely important in terms of future sand-gravel reserves.

3. The geographic extent of the two major regional markets is determined by the economics of (1) location of materials, (2) manufacturing costs, and (3) transportation. The radius of the circle-of-influence around the two major markets extends approximately 75 miles.

4. In the Dallas-Fort Worth Region, the location of quality stone deposits extends the radius to 75 miles in a westward and northwestward direction (Parker, Palo Pinto, Wise counties). The radius is extended south of Dallas for 30 miles to the location of sand-gravel reserves in the Seagoville area of Dallas-Kaufman counties (Fig. 1).

5. In the Houston-Galveston Region, the location of quality deposits of gravel extends the radius westward for 75 miles to Colorado County and northward to Madison-Houston counties. The radius-of-influence reaches northeast of Houston to the sand deposits along the San Jacinto and Trinity Rivers. The southward limit terminates at the Gulf bays where shell is dredged. Small quantities of stone for rip-rap, cover stone, etc., are transported about 200 miles from San Antonio, New Braunfels, Georgetown-Burnet to Houston.

6. The interarea of this report includes the region south of Seagoville along the Trinity River flood plain to Austonio in Houston County. In reference to the sand-gravel supplies and reserves, in an east-west direction it includes all counties conterminous with the Trinity River. Stone for cement manufacture and for aggregates extends the sphere-of-influence in a westward direction to the San Antonio, New Braunfels, Georgetown, Waco areas.

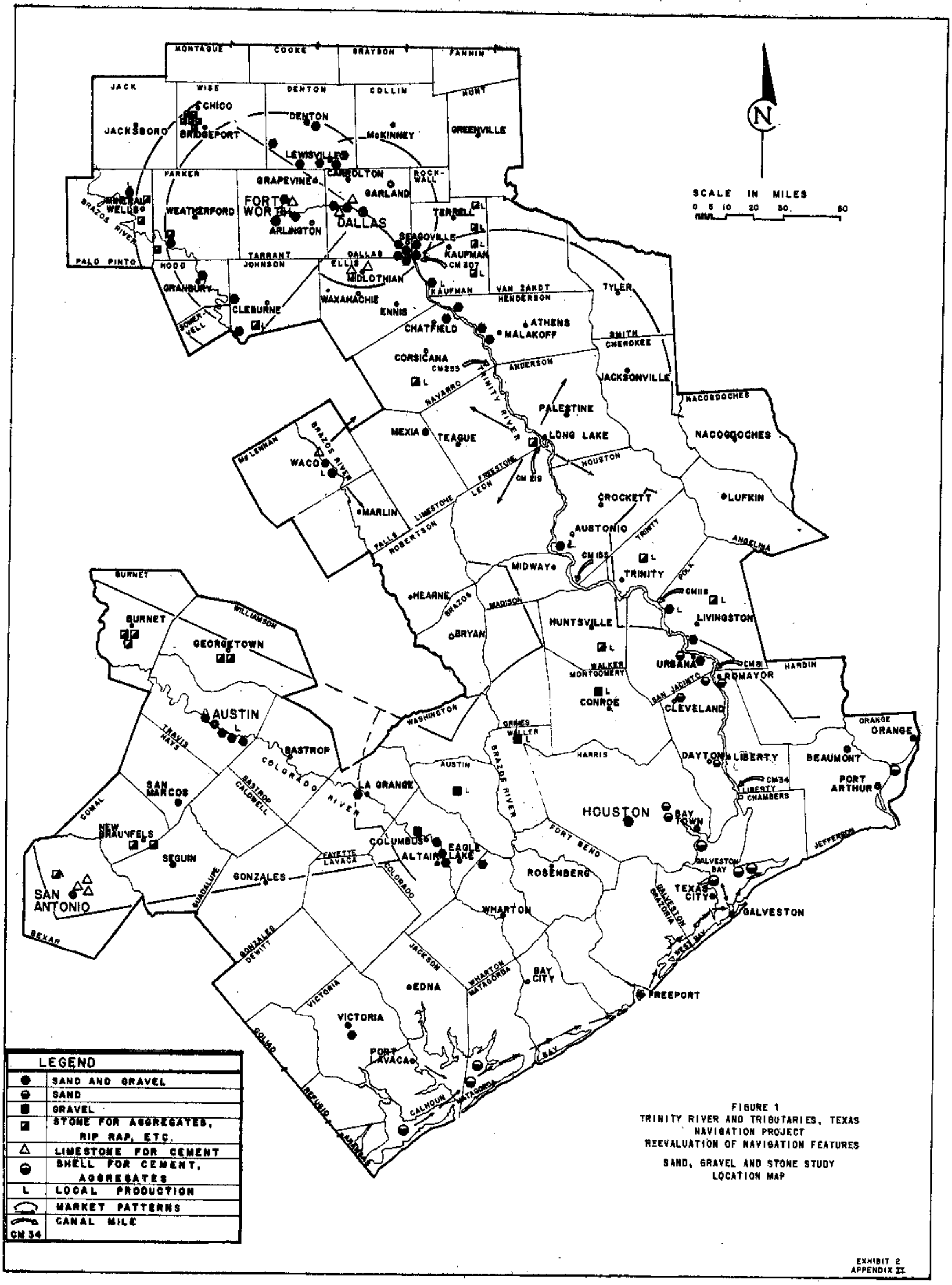

FIGURE 1
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
SAND, GRAVEL AND STONE STUDY
LOCATION MAP

EXHIBIT 2
APPENDIX II

7. Principal information sources considered include (1) all major, and some smaller, producers of sand, gravel, and stone; (2) published and unpublished geological, engineering and economic studies; (3) open file reports of Bureau of Mines, Bureau of Economic Geology, Corps of Engineers, Galveston District, and theses of University Geology Departments; (4) Chambers of Commerce; (5) Texas Highway Department and the District Offices; (6) municipalities, and (7) transportation companies. Pertinent reference sources are shown in the Appendix. Production data and information sources were coordinated with the Bureau of Mines, Dallas (F. F. Netzeband).

8. Production data are for the 1966 year, and reserve figures are estimated as of January, 1967. The original study (draft) was completed in May, 1967. Revision of the original draft was completed November 13, 1967.

9. The report is divided into two parts for purposes of discussion. Part I includes all data on sand and gravel, and Part II includes all data on stone and shell for cement and aggregate use.

PART I: SAND AND GRAVEL STUDY

LOCATION, QUANTITY, AND QUALITY OF SAND AND GRAVEL PRODUCED IN TRINITY RIVER REGION

Dallas-Fort Worth Region

10. Sources of specification-quality (ASTM, AASHO) sand and gravel for constructional use are located (See Fig. 2) along (1) the Trinity River flood plain at Seagoville, Dallas and Kaufman counties; (2) the Trinity River flood plain and tributaries, Dallas, Tarrant, Denton counties; and along (3) the Brazos River in Johnson, Hood, Parker, and Palo Pinto counties. Small operators produced aggregates in Collin, Denton, Hood, Parker, and Palo Pinto counties.

11. The quantity of sand and gravel aggregates produced for consumption in 1966 by the major operators[1] in the region totaled 7,018,000 tons (Table 1). This figure represents an estimated[2] 85% of the total regional sand-gravel requirements for all purposes. The estimated 15% excluded is fill sand, etc., marketed by "non-permanent" producers. Including the 15% figure, the total quantity of sand-gravel produced in the region in 1966 approximated 8,070,700 tons. The significant figure for this study, however, is 7,018,000 tons. Approximately 50% of the sand and gravel was used for concrete aggregate. The remaining quantities were used for fill sand, base materials, cover stone, pre-coat, and other. Aggregates from the sand and gravel deposits were upgraded by washing and screening, particularly by the major producers to meet ASTM and AASHO specifications.

Houston-Galveston Region

12. Sand and gravel for constructional use were produced primarily from localities (Fig. 2) at (1) Columbus-Altair-Eagle Lake, Colorado county; (2) La Grange, Fayette county; and from the (3) San Jacinto and Trinity Rivers in the Urbana, Cleveland areas. Small operators produced (mostly sand) in Houston, Waller, Walker, Grimes, Montgomery, Brazoria, Austin, and Fort Bend counties (locations not shown).

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[1]List of producers in Appendix, Table B.

[2]Averaged estimates by major producers, and by F. F. Netzeband, Bureau of Mines, Dallas.

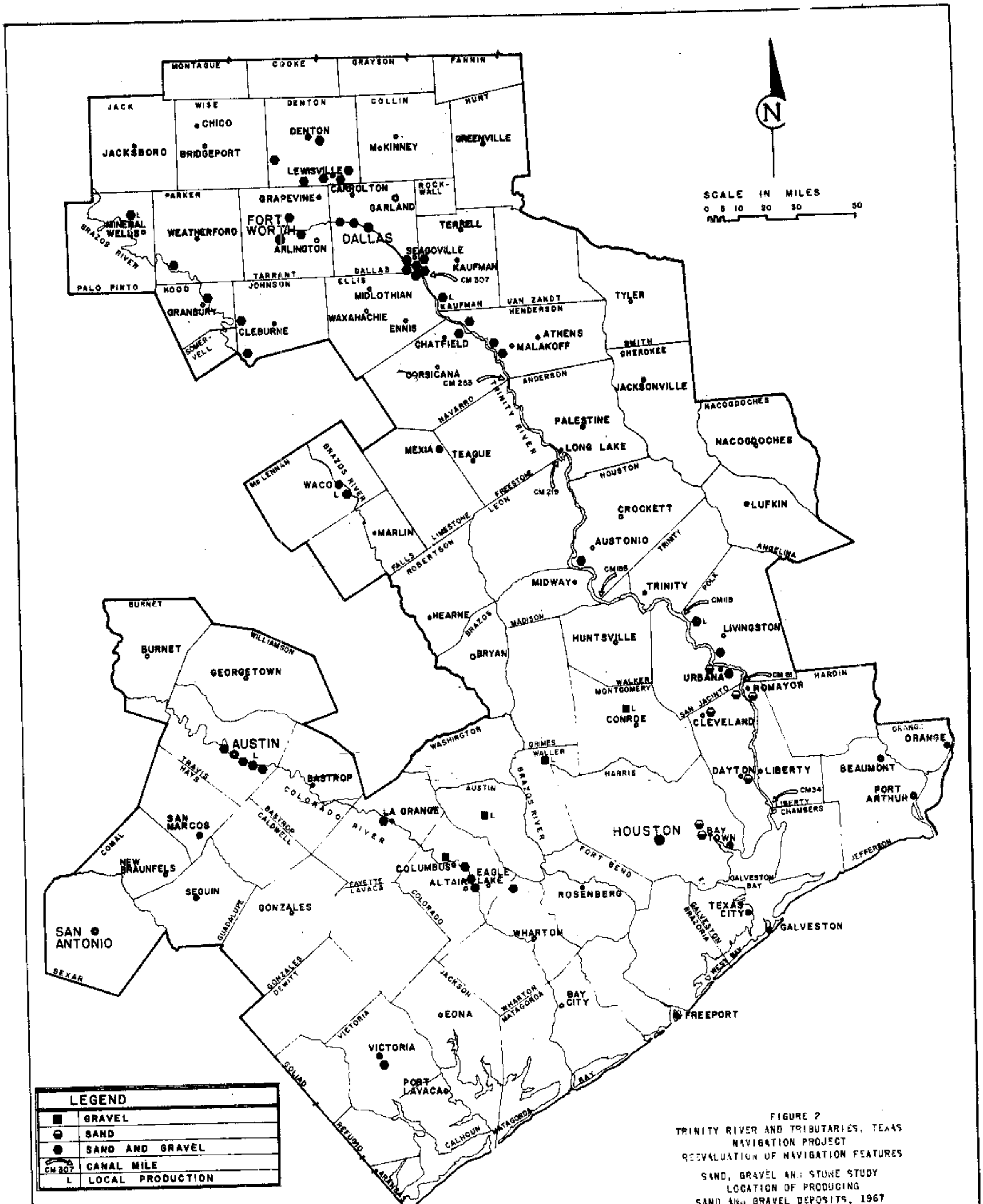

FIGURE 2
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
LOCATION OF PRODUCING
SAND AND GRAVEL DEPOSITS, 1967

EXHIBIT 2
APPENDIX II

TABLE 1

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Sand and Gravel Production for Dallas-Fort Worth Region, 1966[1]

Location[2]	Material		Quantity (short tons)
Trinity River Fort Worth-Dallas	sand, gravel		2,169,000
Seagoville	sand, gravel		4,331,000
Miscellaneous locations, Texas Highway Department[3]	sand, gravel		204,000
Brazos River (Parker, Johnson, Palo Pinto, Hood counties)	sand, gravel		314,000
		TOTAL	7,018,000

[1]List of producers in Appendix, Table B. Itemization of production for specific deposits not given in order to protect confidential information.

[2]See Figure 2 for locations.

[3]Includes usage in Denton, Dallas, Collin, Johnson, Tarrant, Hood, Parker, and Palo Pinto counties. Contractor produced for a specific job by independent operators.

13. The quantity of sand-gravel produced for consumption in 1966 by the major operators[3] in the region totaled 10,505,000 tons (Table 2). This figure represents an estimated[2] 90% of the total aggregate requirements for all purposes. The 10% excluded represents material produced by "non-permanent" operators. Using the estimated figure of 10%, the total sand-gravel consumption for the region approximated 11,555,500 tons in 1966. More than half of the sand-gravel estimate represents sand. The significant figure for this study is the 10.5 million tons. Concrete-quality sand and gravel aggregates were produced in the localities mentioned previously.

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[2]Averaged estimated by major producers, and by F. F. Netzeband, Bureau of Mines, Dallas.

[3]List of producers in Appendix, Table C.

TABLE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Sand and Gravel Production for Houston-Galveston Region, 1966[1]

Location[2]	Material	Quantity (short tons)
Columbus-Altair-Eagle Lake, La Grange	sand, gravel	7,300,000
Cleveland, Urbana, San Jacinto River	sand; sand, gravel	2,567,000
Texas Highway Dept.[3], Independents in Houston and other areas.	sand, gravel	638,000
	TOTAL	10,505,000

[1]List of producers in Appendix, Table C. Itemization of production for specific deposits not given in order to protect confidential information.

[2]See Figure 2 for locations.

[3]Contractor produced for a specific job by independent operators.

Between Dallas and Houston Regions

14. The sand and gravel aggregates produced[4] in this region are consumed within the area. Of course, some small quantities of aggregates produced along the boundaries of the region under consideration are marketed into the adjacent area. Total quantities produced are not accurately estimable for the area because of the prevalence of portable units operating on contractor sites, and small independent Ready Mix operators. Production figures are concealed, where indicated, to protect confidential information.

15. Kaufman and Rockwall Counties.- Data regarding the Seagoville area of Kaufman County are reported under the preceding section entitled: Dallas-Fort Worth Region. No significant quantity of production is known from Rockwall County. Sand and gravel are processed from the Trinity River and East Fork of the Trinity River (Locations, Fig. 2).

16. Most of the gravel produced is less than 3/4-inch in grade size. Washing and screening upgrades the sand and gravel for portland cement and asphaltic concrete usage.

17. Ellis County.- Local companies mined sand and gravel for area consumption. Total quantity of sand and gravel produced is estimated not to exceed 100,000 to 150,000 tons. Most of the production was for jobsite use. There are no major operations in the County.

18. Navarro and Henderson Counties.- Sand and gravel are produced in the Chatfield and Malakoff areas of the Trinity River flood plain (Fig. 2). Sand and gravel production in 1966 in the area approximated 500,000 tons. The deposits average 55-75% sand, and 90-95% will pass a 3/4 inch screen. In some places silt and lignite will average 0.5%. These materials meet THD specifications for cover stone or aggregate for road surfacing.

19. Freestone County[5].- Sand and gravel were produced only for local use. Principal source for quality aggregates is from crushed stone.

20. Leon and Anderson Counties[5].- Aggregates were produced only for local use. What was once a sizeable operation has been discontinued at the Anderson County, Calloway plant located approximately 10 miles south of Long Lake. This deposit averaged 35% gravel. Clay is included which makes the operation marginal under present economic conditions. There are abundant sand deposits in this area but few good gravel deposits with low overburden.

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[4]List of producers in Appendix, Table D. Total production shown in Table 3.

[5]Production information concealed in figures given under section to follow, entitled: Additional Comments.

TABLE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Sand and Gravel Production Between Dallas - Houston Regions, 1966[1]

County[2]	Material		Quantity (short tons)
Ellis	sand, gravel		100,000
Navarro, Henderson	sand, gravel		500,000
Freestone, Leon Anderson, Houston[3]	sand, gravel		1,100,000
		TOTAL	1,700,000

[1]List of producers in Appendix, Table D.

[2]Major Locations, Figure 2.

[3]Production figures combined to conceal confidential information.

21. Iron-ore gravel, soft sandstone, mortar sand, and pea gravel are produced in Leon County. The principal use is in road construction. The sand and gravel deposits are restricted to the Trinity River flood plain. Iron-ore and sandstone are spread over wide areas of the County.

22. Houston County[5].- One sizeable operation for concrete-quality sand and gravel is located southwest of Austonio (Fig. 2). These deposits are produced from the Trinity flood plain.

23. Additional Comments.- All the major production of sand and gravel in this region comes from the Trinity River or its nearby tributaries.

24. The quantity of produced sand and gravel in 1966 accounted for in the region totals 1,700,000 tons.

RESERVES OF SAND-GRAVEL

25. Location, Quantity, Life Expectancy.- Data for reserves were requested in terms of years and tons from the companies and people interviewed. Present volume of tonnage multiplied by the number of years estimated for company reserves were usually used to derive the total quantity figures. Each company estimated the number of years reserves in terms of the present economic situation and the foreseeable demand for the product. None of the companies interviewed would project tonnage figures for future demand beyond 10 years. The projected figures include, where stated, an assumed rate of growth. The assumed rate-of-growth figure was derived from company supplied figures of their previous 10-year period. Companies in business less than 10 years furnished data on their rate of production during the portion covered.

26. Life expectancy figures of deposits now being produced are predicated upon foreseeable future demand. When known, figures are given with and without a waterway in operation.

Dallas-Fort Worth Region

27. Reserves of sand and gravel are located along the flood plain of the Trinity River between and near Dallas-Fort Worth, south of Dallas at Seagoville, and along the Brazos River (Fig. 3).

28. Total reserves of sand and gravel accounted for along the Trinity in the Dallas-Fort Worth area and south of Dallas at Seagoville are estimated at 80,000,000 tons. Approximately 65,000,000 tons are located south of Dallas.

29. Large quantities of "economically marginal" deposits are located along the East Fork of the Trinity River north of Seagoville. These deposits are "economically marginal" because of the high ratio of sand to gravel and contamination by the Austin Chalk. Future demand, plus depletion of deposits closer to Dallas, may permit development of what is "guessed" by a major producer to be 40- to 50- million tons of sand and gravel. The life-expectancy of these deposits is not known.

30. Estimates of reserves (Open file report, Corps of Engineers, Galveston District, dated 15 December 1959) of 60,000,000 tons for Denton County, Lewisville area, cannot be substantiated. Operators at Carrollton and Farmers Branch indicate that sand and gravel are not available in large volumes.

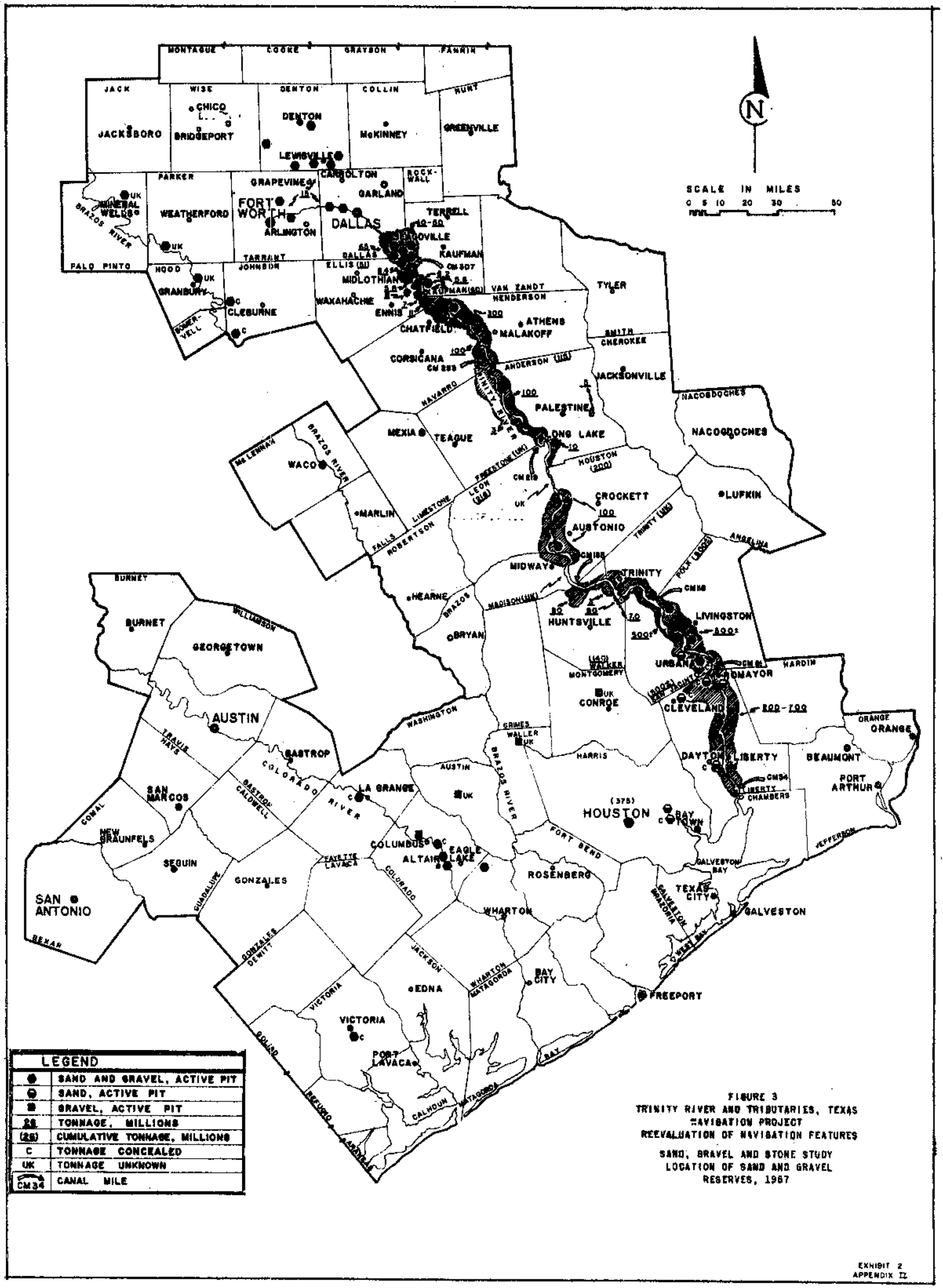

FIGURE 3
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
LOCATION OF SAND AND GRAVEL
RESERVES, 1967

EXHIBIT 2
APPENDIX II

31. Major companies in the region agree that the Trinity River deposits between Dallas and Fort Worth will be essentially depleted within 4 to 6 years. Previous estimates agree with this contention (Trinity River Comprehensive Report, vol. 1, p. 3, 1962). The waterway will never affect the life expectancy of these deposits because they will be depleted before the proposed project can be built. Regardless, the materials will be consumed in the area.

32. Reserves of the various companies producing in the Seagoville area are predicted to last from 2 to 30 years. This estimate is in light of present production of aggregates from other areas. Depletion of the Dallas-Fort Worth Trinity reserves will shift a larger proportion of the market to this area. Therefore, Seagoville will not be a major supplier for the 30-year period because of expected depletion. The area will not be a prolific supplier in 1985 but will be essentially depleted prior to that time.

33. The proposed canal is not expected to significantly affect the life expectancy of the Seagoville deposits. Although some companies do have reserves marked for production in the 1980's, materials from these deposits will not move downriver if they are still present during operation of the canal.

34. Total reserves in the Brazos River flood plain are not known. This area now supplies less than one percent of the sand-gravel requirements for the region. At present usage rates known resources are predicted to last 25 years in areas now in production.

35. The life expectancy of the Brazos River reserves will be affected by the proposed waterway. The two sources of supply for sand and gravel after depletion of the Dallas-Fort Worth Trinity River deposits will be the Brazos River and the areas downriver from Dallas County along the Trinity and its tributaries. When the Dallas-Fort Worth Trinity deposits are gone, the Brazos source will assume a larger proportion of the regional market. If the canal were then built after the Brazos deposits had assumed a larger proportion of the market, the Brazos area would again diminish as a source of supply. The Brazos supply to the Fort Worth market would not enlarge in proportion to the Trinity River supply if the canal were now in operation. The Brazos River deposits will not be moved on the canal because of the Trinity supply

36. In conclusion, it is expected that all reserves of sand and gravel within the Dallas-Fort Worth Region (except the Brazos River) will be essentially depleted prior to 1985. A shortage will develop by 1971-1973, and by 1985 no substantial sources will be available in the present areas of operation (See Fig. 2) along the Trinity River.

37. Major reserves of sand and gravel are located (Fig. 3) in the Columbus-Altair-Eagle Lake area of Colorado County; near La Grange, Fayette County; and Victoria, Victoria County. Reserves of sand are located along the San Jacinto River, and sand, and some gravel, are located along the Trinity.

38. Reserve figures for sand and gravel in the major producing areas are given for all the area in order to protect confidential information of individual companies. Two companies would not release figures for separate localities. Total reserves in the major producing areas (Fig. 3) approximate 375,000,000 tons of sand and gravel. Over 75% of this figure represents sand. In addition, another 200-700 million tons, mostly sand, are estimated for Liberty-Chambers counties.

39. The life expectancy of the deposits in producing localities is 20 to 40 years. Average figures for the areas would be 25 to 30 years. The Trinity canal would not decrease the life expectancy of the gravel reserves west of Houston. Their life expectancy would increase if competitive sources for gravel were developed along the Trinity.

40. The life expectancy of the sand and gravel deposits is also dependent upon shell production from the bays. Shell and sand are mixed in the ratio of 70:30 for road-base construction. Legislation is now pending to restrict removal of oyster shell from Matagorda and Galveston bays due to pollution of live oyster reefs. The outcome at this time is problematical. Should this practice decrease, new demands will be created for coarse base-material to replace the shell (See section entitled: RESERVES OF STONE AND SHELL, HOUSTON-GALVESTON REGION).

41. Sand reserves are also in Wharton, Fort Bend, Brazoria, Galveston, Waller, Austin, Montgomery, and Madison counties. These areas fall within the producing region supplying materials to the Houston market. The total tonnage and life expectancy of reserves away from the Trinity and outside producing areas are not known. These deposits are numerous and are used by on-site contractors. Reserve figures for Walker, Trinity, Polk, and San Jacinto counties are included under the following discussion, except for the present major producing localities in Polk and San Jacinto counties. The reserves of the major producers (only) in Polk and San Jacinto counties are included under the Houston-Galveston reserves.

42. The total quantities of sand-gravel reserves (Table 4) are not as well known in this area as are reserves in the Dallas and Houston regions. The reason for this lack of knowledge is that most of the known deposits in the Dallas and Houston regions are either under lease, or they are now being produced, whereas, there are extensive deposits in the interarea that have not been delineated completely due to the economics of transportation and market demand.

43. Data were not available in detail from one of the major producers of the region. Accordingly, the "known" figures presented in detail are an under estimate of total reserves in the region.

44. Actual life expectancy figures of individual counties are difficult to predict for the Dallas-Houston interarea because market patterns are not well established. Future market patterns are not predictable for the "interior" of the interarea. Life expectancy of deposits depends on future contributions of areas up and down the river. Life expectancy figures given for deposits in individual counties are stated as if the particular locality were the only source of materials. By combining life expectancy data for each county the total life expectancy is predictable for the Trinity River Basin in the Dallas-Houston interarea.

45. Kaufman County.- The major sand and gravel reserves located near Seagoville (Fig. 3) were enumerated previously under the Dallas-Fort Worth discussion. All the exploitable deposits of sand and gravel are located in the Trinity River flood plain and along the East Fork of the Trinity. The total quantity accounted for, exclusive of the Seagoville reserves, approaches 60 million tons (Locations, Fig. 3). The life expectancy of the deposits is unknown.

46. Ellis County.- Sand and gravel reserves are located along the Trinity River (Fig. 3). Incaprera (1959) estimated reserves to be 33,000,000 tons of which 35% is gravel. Reserves of 51,000,000 tons, developed in the study, are believed to be present along the Trinity River. Not all of these reserves will produce 35% gravel.

47. Best estimates by three local producers put life expectancy of the reserves at 25 years. The life expectancy of these reserves would be greatly shortened by the presence of a waterway. The reserve figure quoted would supply the present demand in the Dallas-Fort Worth area for eight years.

48. Navarro and Henderson Counties.- These two counties probably contain as large a supply of proven reserves of sand and gravel along the Trinity as any other locality. Knowledgeable sources report sand and gravel reserves in numerous places along the flood plain between the two counties. Known deposits in the northeastern area

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TABLE 4

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Summary of Sand-Gravel Reserves Between Dallas-Houston Regions

Location[1]	Tonnage (millions)	Life Expectancy[2] (years)
Kaufman	60	Unknown
Ellis	51	10
Navarro, Henderson	400	25
Anderson	115	Unknown
Freestone	(vast)	"
Leon	216	"
Houston	200	18
Walker	140	12
Trinity	Unknown	Unknown
Polk, San Jacinto	1,000	75
TOTAL	2,182	140 years

[1]Locations, Figure 3.

[2]Life expectancy stated as if the particular locality were the only source for materials.

of Navarro County, for about four-tenths of a mile of the upper reaches, cover 6,100 to 7,000 acres. Core testing in one block of 800 acres of this section proved 30,000,000 tons. Estimates of 300,000,000 tons are made for the upper reaches of the river. Another 50 to 100-million tons are believed to be present along the river in areas to the south. Incaprera (1959) estimated reserves of over 475 million tons within the two counties. Reserves now under lease in the area by three major producers exceed the total reserves in the present producing areas supplying the Dallas-Fort Worth Region. In summary, the total reserves exceed 400,000,000 tons.

49. No doubt, the life expectancy of these reserves will be decreased by implementation of the proposed waterway. However, the reserves reported are so vast in these two counties that the life expectancy, in terms of supplying all the Dallas-Fort Worth demands, is over 25 years with the waterway in operation.

50. Anderson County.- Sand (and some gravel) in quantities estimated in excess of 100,000,000 tons (but of no economical value at present) is available in the County.

51. Approximately 10 million tons of sand and gravel (65%:35%) are located near Long Lake (Fig. 3). Reserves of naturally impregnated asphaltic sands are located 10 to 12.5 miles east of Palestine (Fisher, et al, p. 60, 1965) (Fig. 3). Stenzel, et al., (Reported by Fisher, p. 60) estimated reserves of approximately 5,000,000 tons. These deposits have not been exploited.

52. Iron-ore gravel and soft sandstone deposits are estimated at 48,000,000 tons. These materials are widespread at the surface over about 4,000 acres of the County (tonnage is included under stone study).

53. The life expectancy of these deposits depends, at present, upon the waterway. The materials will likely never be depleted under the present transportation conditions. The life expectancy of the sand deposits will not be immediately shortened by the presence of a waterway due to the abundance of such materials nearer major markets. New deposits of sand and gravel that could be developed, due to transportation and production savings, would increase the beneficial life expectancy of these materials.

54. Freestone County.- Reserves of 3,000,000 tons of 30% gravel were reported by Incaprera (1959) to be located in the flood plain near TRM 343. Vast quantities of sand with no commercial use are also available in the county. The total quantity is so vast that no reliable estimates are available. Life expectancy of the deposits is unpredictable because of the great abundance of sand closer to the major consuming areas.

55. Leon County.- Aggregate resources in Leon County are available in two areas. There are sand and gravel deposits in the Trinity River flood plain, and the upland areas contain iron-ore rock and gravel.

56. A detailed study developed reserves of 216,000,000 tons of pit-run sand and gravel along the Trinity in Leon County (Fig. 3). The material contains 15% to 20% gravel of 3/8 inch or smaller diameter. These materials are being used now but in small volume due to transportation factors and market demand. Their life expectancy would be decreased by the waterway.

57. Houston County.- Large volumes of sand and gravel are located along the Trinity River (Fig. 3). Yields of 30,000 tons per acre (30% gravel) are reported. Tests have proven 100 million tons, and estimates of proven and unproven reserves are quoted at 200 million tons.

58. The life expectancy of these deposits will be decreased by canalization of the Trinity. These deposits would move to the Houston market. Reserves of this quantity would supply the total Houston area for about 18 years.

59. Walker County.- Total reserves in the county are conseratively estimated at 140 million tons. These figures include only flood plain deposits. About 40% of this represents small-diameter gravel. Life expectancy of these deposits will be shortened by the development of the canal. These materials will be shipped to the coastal markets. Life expectancy is about 12 years in terms of supplying all the Houston-Galveston market.

60. Trinity County.- No reliable data were developed for Trinity County. Presently, there are no major producers in the County. Total reserves of sand are rather extensive.

61. San Jacinto-Polk Counties.- Major supplies of sand and some gravel for the coastal market are being produced from the southern half of this area (Locations, Fig. 3). Reserves of one billion tons are estimated by two major producers in the Trinity River Basin. These materials are predominantly sand. Minimum life expectancy of these deposits is 75 years.

62. Conclusions.- The total quantity of sand and gravel accounted for along and near the Trinity River in the interarea of this report exceeds 2.182 billion tons (Table 4). This figure represents estimates based on testing by some companies and on best reliable estimates of individuals. Confidential information on detailed locations and tonnage was not permitted from all the major producers. However, it should be said that all the producers who refused confidential information verify that reserves in the Basin do exceed the accountable tonnage.

63. In a letter dated February 3, 1967, Mr. Roy Stanley, Exploration Manager, Gifford-Hill Company, stated that reserves of 6 billion tons of sand and gravel are located along and near the Trinity River from Dallas south to approximately five miles south of Liberty, Texas[2]. These figures are "based on testing" done by the Gifford-Hill Company. Industry personnel acknowledge that Gifford-Hill and its subsidiaries hold the largest reserves in the Trinity River Basin.

64. According to Mr. W. W. Pickens[3], Wesco Materials Corporation, sand and gravel deposits exceed 1 billion tons within 90 miles of the bay. Furthermore, he states that within 75 miles downstream from Dallas there are in excess of 500 million tons of reserves.

65. Mr. Cedric Willson[3] estimated that sand-gravel reserves below CM-91 exceed 200 million tons. In addition, Mr. Willson estimated reserves in excess of 1 billion tons within the Trinity flood plain between CM-91 and CM-125.

66. It is concluded that sand and gravel reserves undeveloped between Dallas and Houston number into the billions of tons. Based on a maximum sand-to-gravel ratio of 2:1, the gravel reserves in the region may approximate one billion tons. Without question, the sand reserves are several billion tons. The "accountable" reserves (in detail) and the "unaccountable" reserves (in toto) are estimated to exceed 5 billion tons. Estimates of reserves detailed in this report are included, at least in part, in the total estimate quoted.

67. The reserves estimated to be coverable by the proposed canal and reservoirs are from 0.871 to 1.466 billion tons. Locations and estimates of tonnage of reserves that would be excluded due to coverage by the proposed canal and reservoirs are discussed in the following section. The reserves (in toto), <u>excluding</u> those coverable by the proposed canal and reservoirs, are estimated to be between 3.534 and 4.129 billion tons.

68. The life expectancy of reserves would be reduced by the waterway. Demands for sand-gravel in the two major consuming areas in 1966 (approximately 20 million tons), reserves in the Dallas-Houston regions, and the "known" reserves in the Dallas-Houston interarea would permit estimation of a life expectancy exceeding 100 years for the deposits between Dallas and Houston (Table 4).

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[2]Addressed to Brigadier General William T. Bradley, Division Engineer, Southwest Division, Corps of Engineers, Dallas.

[3]Bureau of the Budget testimony, dated April 26, 1965.

LOCATION, QUANTITY OF RESERVES WITHIN PROPOSED CHANNEL AND RESERVOIRS

69. In the opinion of the people most knowledgeable about the reserves of sand and gravel along the Trinity, 40 to 50 percent of the flood plain contains a minimum of 12,000 tons/acre to a maximum of 35,000 tons/acre. The average estimate by those canvassed is 21,000 tons per acre. Those data are used as the basis to determine the quantity of sand and gravel expected to be covered by the proposed channel and reservoirs.

70. There are places along the proposed canal where the reserves are known to be limited. Only the areas shown along the canal in Figure 3 (LOCATION OF SAND-GRAVEL RESERVES) are assumed to be critical in arriving at a total tonnage figure for channel coverage.

Dallas-Fort Worth Region

71. Essentially all the major deposits of sand and gravel in this region will be depleted prior to 1985. Some small deposits are reserved for production after this by three major companies. One company has 280,000 tons reserved for production during the 1980's that will be covered by the proposed channel (Fig. 4). The total tonnage possessed by other companies that could be covered by the channel is unknown. The actual tonnage in terms of the total project is insignificant. In conclusion, there are no deposits of consequence expected to be covered by the proposed channel.

Houston-Galveston Region

72. There are no deposits in the producing areas that will be covered by the proposed channel or reservoir. Assuming the channel overlies exploitable reserves all the way from Anahuac to Urbana (Fig. 4), the quantity covered would be on the order of 15 million tons. This figure is a maximum for this zone. Wallisville Reservoir is estimated to cover about 350,000 tons of sand reserves in Chambers and Liberty counties (Fig. 4).

Between Dallas and Houston Regions

73. The area considered in the following discussion extends from the southern Dallas County line along the flood plain to Urbana, in San Jacinto County. The canal distance between these two areas is 216 miles. There are about 190 canal miles delineated as containing appreciable reserves (See Fig. 3). Excluding reservoirs along this zone, the total canal distance is about 112 miles. The

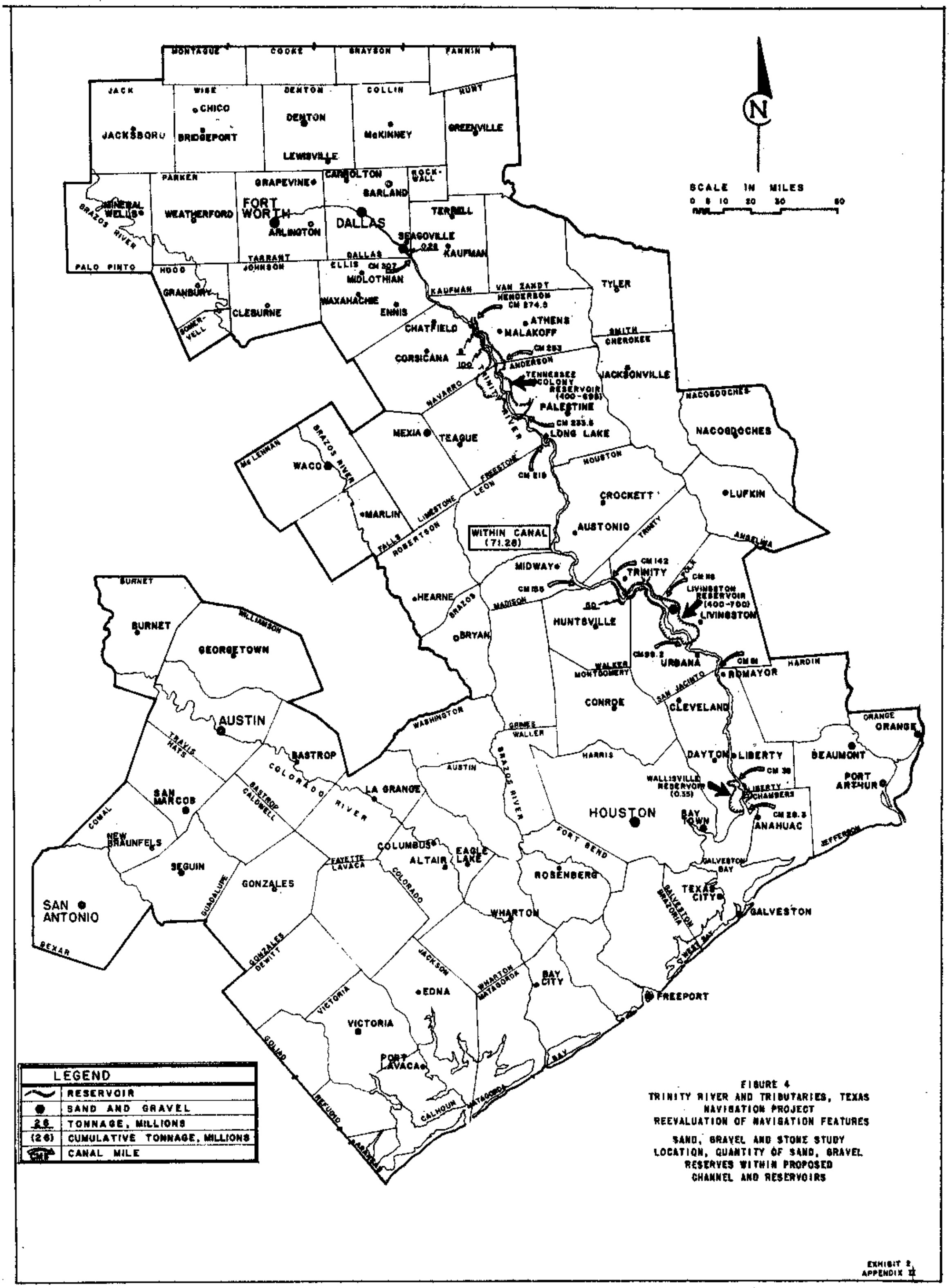

FIGURE 4
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
SAND, GRAVEL AND STONE STUDY
LOCATION, QUANTITY OF SAND, GRAVEL
RESERVES WITHIN PROPOSED
CHANNEL AND RESERVOIRS

aforementioned figure is the proposed canal mileage that will cover appreciable reserves, excluding that in reserviors. At a potential average of 21,000 tons/acre, the total reserves to be covered are approximately 56 million tons. The 21,000 tons/acre figure is conservative because some areas, for example Navarro-Henderson counties, are known to yeild greater than 21,000 tons/acre.

74. There are two reservoirs within the Region that will cover appreciable reserves; these are the Livingston and Tennessee Colony reservoirs (Fig. 4).

75. The Livingston reservoir will cover 75,000 acres at the conservation pool elevation of 129.2', mean sea level. Assuming 45% of the area has a potential yield of 21,000 tons/acre, the total quantity of aggregates to be covered is 700 million tons. Assuming the minimum of 12,000 tons/acre estimated by the major companies, the total reserves could approach 400 million tons.

76. The accountable reserves in San Jacinto and Polk counties, in which a large part of the reservoir will exist, are estimated at one billion tons (See, SAND-GRAVEL RESERVES, Polk-San Jacinto Counties). The reserves coverable by the proposed reservoir are predominantly sand.

77. The Tennessee Colony reservoir will cover 73,540 acres at the conservation pool elevation of 262.5', mean sea level. Assuming 45% of the area has a potential yield of 21,000 tons/acre, the total quanity of aggregates coverable is 695 million tons. Assuming the minimum of 12,000 tons/acre, the total reserves covered approach 400 million tons.

78. The accountable reserves in all but one of the counties (Freestone) in which the reservoir is proposed are estimated at 203-plus million tons. The total reserves in Freestone County are not known but are reported to be so vast that a reasonable estimate is not possible (See, RESERVES OF SAND-GRAVEL, Freestone County).

79. Conclusions.- The total reserves to be covered by the proposed canal between Dallas and Anahuac are estimated at 71,280,000 tons. The total reserves coverable by the two major proposed reservoirs are estimated at a minimum of 800 million tons and a maximum of 1.395 billion tons (Fig. 4). The accountable (in detail) and unaccountable (in toto) reserves are estimated to exceed 5 billion tons. A minimum of 16% of the total reserves are expected to be covered by the reservoirs. The maximum estimated reservoir coverage of reserves is 28%. The quantity of aggregates coverable by the proposed canal are inconsequential in terms of the total quantity of reserves.

LOCATION, QUANTITY OF SAND-GRAVEL RESERVES THAT WILL NEVER MOVE WITHOUT WATERWAY

80. There are no known sand and gravel reserves in the Dallas-Fort Worth Region that would never move without the waterway. All the sand-gravel deposits included in the Houston-Galveston consuming region will also move without the waterway.

81. In general, it is conceded that gravel located along the Trinity between central Navarro-Henderson Counties and the Austonio area of Houston County will not be moved outside the Dallas-Houston interarea in the foreseeable future (Locations, Fig. 5). Also, sand deposits located south of central Navarro-Henderson Counties and north of the Livingston area of Polk County will not move in the foreseeable future without a waterway. One may add, that deposits located between Dallas and Navarro-Henderson Counties, and between Houston-Galveston and Houston, Polk counties, respectively, and south of Trinity, will move, but at a much higher price than possible on a waterway.

82. Specifically, there are over 100 million tons of sand and gravel in southern Navarro-Henderson counties that are not likely to move in the near future. Sand reserves in Freestone County, estimated to be almost limitless, will never move without the waterway. An estimated 100,000,000 tons of sand, 10,000,000 tons of sand-gravel and additional large quantities of sand-gravel located in Anderson County are not likely to move (Locations, Fig. 5). There are over 200,000,000 tons of sand-gravel in Leon County that have no market without the waterway. Perhaps 100 million tons of the 200 million tons estimated for Houston County (See Fig. 5) will not move.

83. There are approximately 140 million tons of sand and gravel in Walker County that are not expected to move for 25 to 50 years from now without a waterway. Sand reserves located between Livingston and Austonio (Fig. 5) are estimated at approximately one billion tons. It is problematical as to how much will never move due to the lack of a waterway, but it is reasonable to assume that 500 million tons would not be moved without adequate transportation and mining facilities.

84. The total tonnage not movable due to lack of mining facilities without a waterway is not known. The only specific deposits discernible are located in Navarro-Henderson Counties. The quantity given was 25 million tons of sand and gravel. There are probably large reserves of sand in almost every County that may never be produced due to dry-land costs of mining (See section entitled: PRODUCTION METHODS AND COSTS OF SAND-GRAVEL).

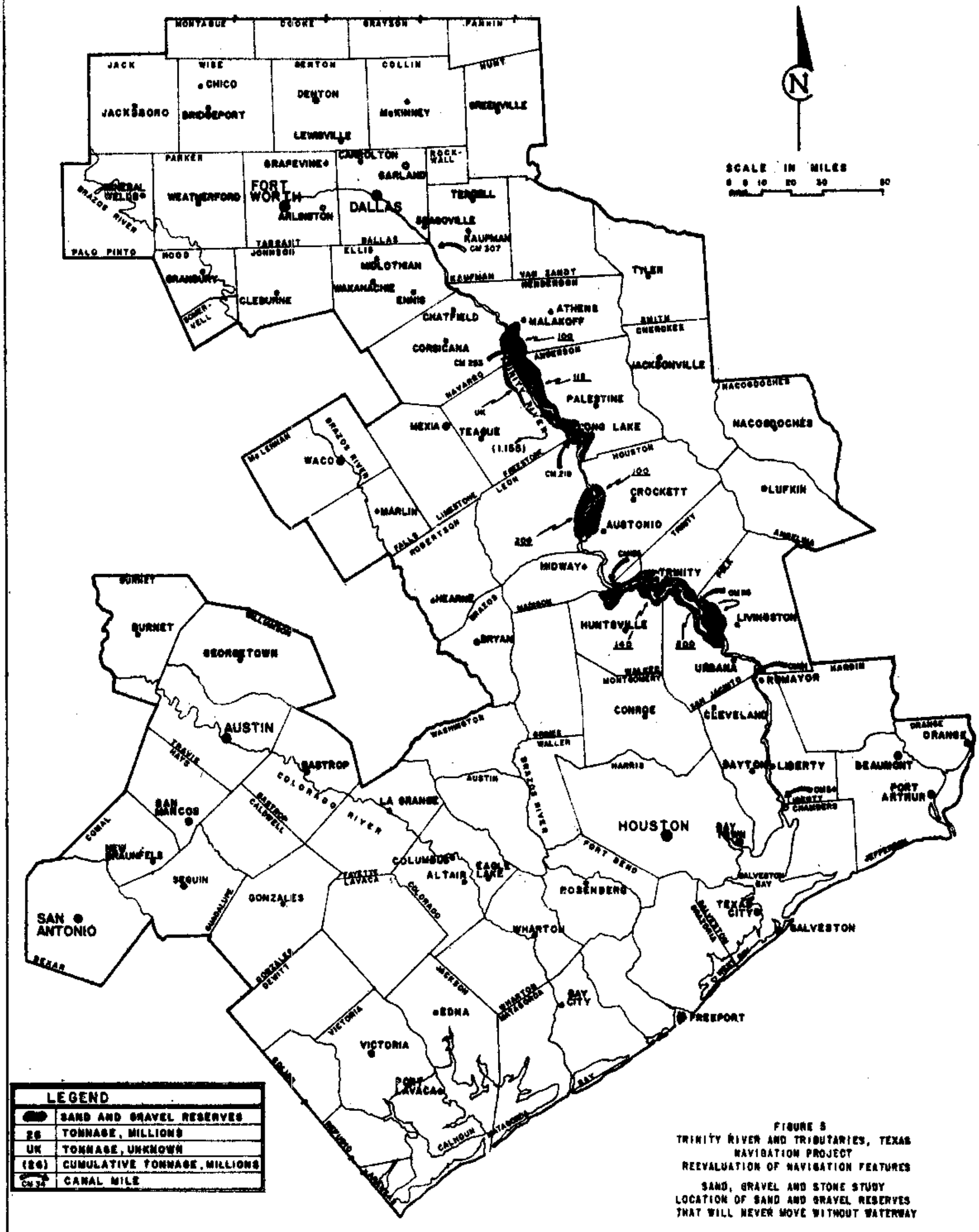

FIGURE 5
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
LOCATION OF SAND AND GRAVEL RESERVES
THAT WILL NEVER MOVE WITHOUT WATERWAY

EXHIBIT 2
APPENDIX II

85. The total quantity of sand and gravel that will never move without a waterway that has been itemized is 1.155 billion tons. In the Dallas-Houston interarea, the total itemized reserves plus reserves undefined in detail (See, RESERVES OF SAND-GRAVEL) are estimated to exceed 5 billion tons. Therefore, it seems plausible that the itemized tonnage attributable to not being moved without a waterway is conservative.

TRANSPORTATION MODES AND TRAFFIC PATTERNS FOR SAND AND GRAVEL

86. Trucking is the transportation mode for sand and gravel in the present producing areas of the Dallas-Fort Worth Region. There are essentially no movements of sand and gravel by rail. Principal movements occur south-to-north from Seagoville to the Dallas area. Traffic patterns for the Trinity River Region are shown diagrammatically in Figure 6.

87. West-to-east and south-to-north movements prevail from the Brazos River deposits to the Fort Worth area. The deposits along the Dallas-Fort Worth Trinity River and tributaries are consumed in the nearby markets.

88. Rail and barge are the prevailing transportation modes in the Houston-Galveston region. Rail movements from the Columbus-Altair-Eagle Lake area account for about 70% of the sand-gravel requirements in the region. Other major movement of sand is by barge from the San Jacinto River, and by rail and truck from the Trinity (Fig. 6). Truck transportation moves the aggregates for distribution from dock and railhead locations.

89. Movements of all sand and gravel in the interarea of this report are by truck. Movements are principally east and west away from the local pits operating along the Trinity and its tributaries.

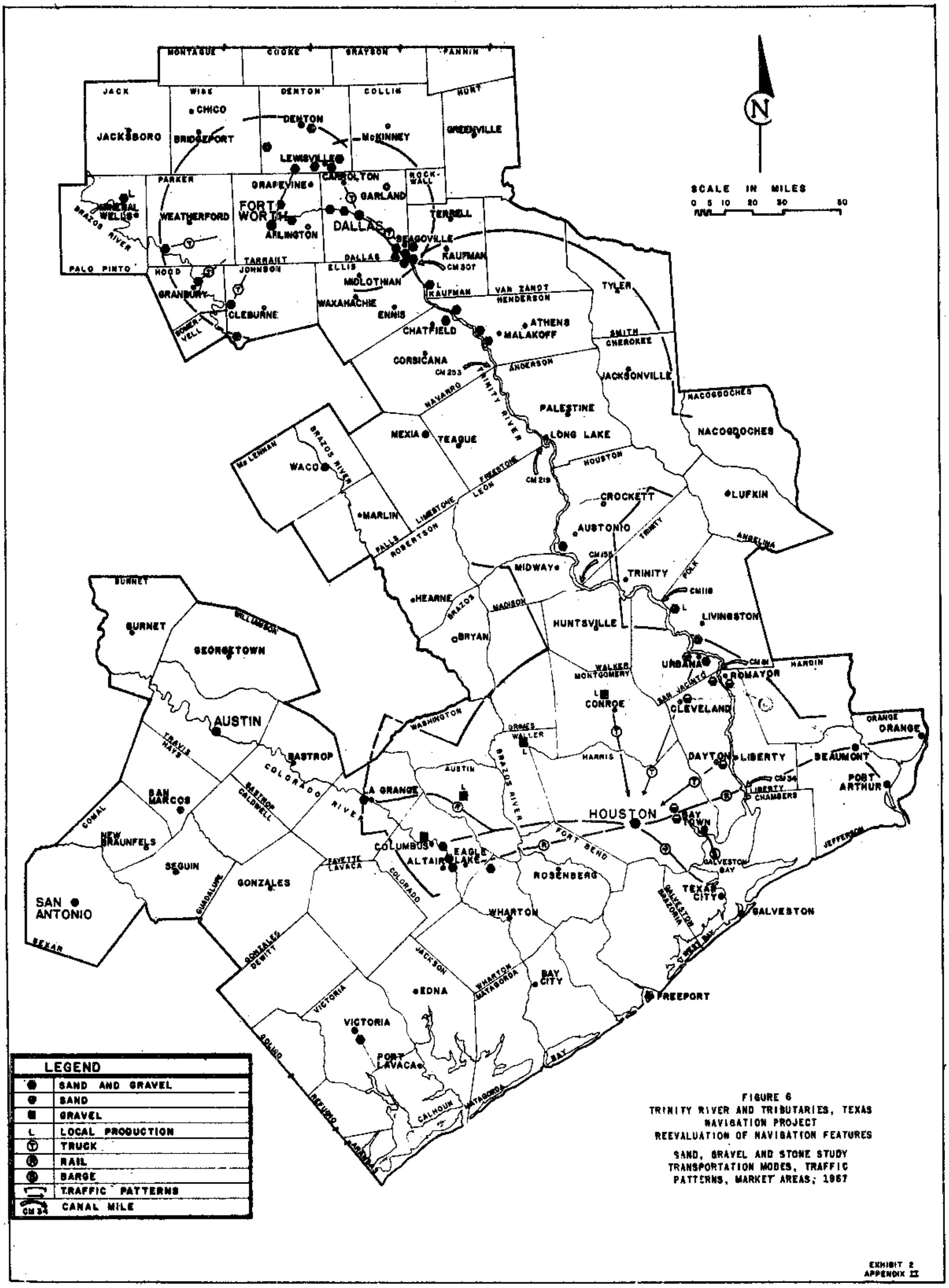

FIGURE 6
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
TRANSPORTATION MODES, TRAFFIC
PATTERNS, MARKET AREAS; 1967

TABLE 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Summary of Sand- Gravel That Will Not Move Without Waterway

Counties[1]	Quantity (short tons) (millions)
Navarro-Henderson	100
Freestone	vast[2]
Anderson	115
Leon	200
Houston	100
Walker	140
Polk, Trinity San Jacinto	500 plus
TOTAL	1,155

[1]Location, Figure 5.

[2]Tonnage not known.

PROBABLE CHANGES IN TRANSPORTATION MODES AND TRAFFIC PATTERNS FOR SAND-GRAVEL DUE TO WATERWAY

90. Trucking is the predominant transportation mode in the Dallas-Fort Worth Region. Major quantities of sand-gravel are moved from south-to-north to the Dallas consuming region, and within the region (Fig. 6). If the proposed waterway is constructed, the predominant transportation mode for sand and gravel for the Dallas-Fort Worth Region will be by barge and will be from south-to-north on the canal. There will be no significant volume of sand and gravel from the Dallas-Fort Worth area moving south past Dallas.

91. All major Trinity River sand and gravel sources now supplying the Dallas-Fort Worth Region are expected to be essentially depleted within 15 years (See section entitled: RESERVES OF SAND-GRAVEL). Thereafter, with the waterway in operation, the major sand and gravel requirements will be met from along the Trinity River south of Dallas. In 1966, the supplies from Seagoville and areas to the north approximated 6,500,000 tons of sand and gravel. Eighteen years from now (1985) the demand could exceed 10 million tons from the Trinity River south of Dallas.

92. As previously stated, approximately 70% of the sand-gravel requirements are moved by rail from west of Houston. Rail traffic patterns west of Houston are not expected to be changed by a waterway in this region. Major producers expect to continue to move the reserves from this area to the Houston market in increasing quantities with or without a waterway, unless competition can succeed from up the Trinity.

93. Sand and small-diameter gravel will be moved south on the channel.

94. According to one major producer, sand and gravel could be barged direct from the Victoria area up the Trinity as far north as competitive rates would permit (canal from Matagorda Bay to Victoria). Sand from the San Jacinto River would already be loaded on barges and could move up the Trinity River to the extent of competitive sources and rates.

95. The conclusion from the study of the Houston Region is that sand and gravel will continue to move by rail from the west to the regional market.[1] None of the Colorado County deposits is expected to move on the canal. Sand from the San Jacinto and Trinity Rivers will be moved up and down the river by barge. Small-diameter gravel will be moved down river to the Houston, Galveston, Port Arthur, Orange areas.

96. Movement of some materials consumed in the Dallas-Houston interarea will be by barge if competitive barge rates and associated costs can beat truck rates. Present traffic patterns are not well enough established to predict with accuracy significant changes within the interarea.

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[1] The only way movement could be diminished would be if gravel could be supplied at a cheaper cost from upriver.

SAND-GRAVEL TRANSPORTATION ANALYSIS: MARKET AREAS, TRUCK-RAIL RATES

97. Two major markets for sand-gravel aggregates exist within the Trinity River Basin; the Dallas-Fort Worth and Houston-Galveston metropolitan regions. The interarea, by comparison is not a major consuming market.

Dallas-Fort Worth Region

98. Sand and gravel for aggregate use are transported by truck from the Brazos River, the Seagoville area of the Trinity River, and the Trinity River flood plain and its tributaries in Dallas, Tarrant, and Denton counties (Fig. 6).

99. Data illustrating average length-of-haul, transportation modes and rates are shown on Table 6. Transportation figures shown do not include loading costs.

100. Truck rates for short-haul distances of 30 miles or less average 3.94¢ per ton-mile. There are no major movements of sand and gravel by rail, therefore the least costly transportation mode is essentially that of trucking.

Houston-Galveston Region

101. Sand and gravel for aggregate use are transported by rail from Columbus-Altair-Eagle Lake, by barge from the San Jacinto River, by rail and truck from the Trinity River northeast of Houston (Fig. 6).

102. Columbus-Altair-Eagle Lake supplies approximately 70% of the sand and gravel for the area. The San Jacinto and Trinity localities supply approximately 20%. Trucks haul from numerous localities within the region. However, the major mode of transport for aggregate materials in this region is rail and barge.

103. Data illustrating average length-of-haul, transportation modes and rates are shown in Table 7. Transportation figures do not include loading and unloading costs.

104. Rail transportation costs average 1.45¢/ton-mile for approximately 70% of the present market supply. Average haul distances are 110 miles.

TABLE 6

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Transportation Analysis of Dallas-Fort Worth Region

Origin[1]	Mode	Destination	Ave. Dist. (miles)	Rate[2]
Brazos River	Truck	Ft. Worth	30	2.9
Seagoville[3]	"	Dallas[3]	25	5.0
"	"	Dallas	25	2.8
"	"	Dallas	25	3.0
"	"	Seagoville	10-15	6.0

[1] Locations, Figure 2.

[2] Rate in cents/ton-mile.

[3] Repetition represents rates from different sources.

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TABLE 7

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Transportation Analysis of Houston-Galveston Region

Origin[1]	Mode	Destination	Ave. Dist (miles)	Rate[2]
Columbus-Altair	Rail	Houston	65	$1.16
Eagle Lake	"	Houston	70	1.23
"	"	Liberty	40	1.46-1.52
"	"	Livingston	75	1.74-1.92
"	"	Beaumont	165	1.75
"	"	Port Arthur	175	1.87
"	"	Orange	177	1.87
"	"	Galveston	118	1.60
"	"	Texas City	118	1.60
"	"	Freeport	100	1.60

[1]Location, Figure 2.

[2]Rate in dollars/ton unless indicated otherwise.

105. Comparison of Hydraulic and Dry-Land Costs.- The costs of dry-land and hydraulic or semi-hydraulic production of sand-gravel depend on many variables. Therefore, several qualitifications are necessary in arriving at cost figures for comparison.

(1) The data presented do not include royalties or taxes on land owned in fee. Royalty costs may vary from 10¢ to 40¢ per cubic yard. Royalties do not directly affect the production (manufacturing) methods or costs for comparative purposes.

(2) The ratio of sand-gravel to overburden and the ratio of sand-to-gravel in deposits are of prime importance in production costs. Sand and gravel are used in an approximate ratio of 40:60 in concrete. In some market situations variations from this result in an im-balance or over production of one commodity, which is usually sand. This im-balance may be corrected in a dredge operation with a corresponding reduction in production costs.

(3) Comparisons to be presented are based on an average production of approximately 59,000 tons per month for the dry-land plant, and pumping of 55,000 tons/month for the hydraulic plant. The dredge plant used as an example would be operated to produce 60% gravel and 40% sand. The total tonnage pumped would be approximately equivalent to the dry-land plant but a portion would be "backwasted" in order to produce only "marketable" products. The quantity of material "backwasted" in the comparison approximates 40%. Thus, in this example the dredge plant would produce 33,000 tons of "marketable" material per month. One major producer estimated that the Trinity deposits are hydraulically producible with 10-15% wastage due to the marketing of sand in larger ratios (to gravel) than 40%:60%. The greater the percentage of material pumped that is marketed, the lower the cost of production. Therefore, the cost figures presented for hydraulic operations are deemed conservative.

(4) Dry-land production includes cost of loading trucks and/or railcars from the stockpile. Hydraulic production costs include loading finished product onto barge along-side plant. The cost of barge-along-side is attributed to transportation. Equal point of delivery is considered to be finished product loaded at plant site.

(5) The hydraulic operation presented represents a 12" dredge requiring approximately 5,000 gallons of water per minute operating in 12' of water.

(6) Equipment costs for such an operation, including screens, are about $200,000. An equivalent dry-land plant with two draglines costs at least $230,000.

(7) The cost of moving a dredge operation as described is estimated at $2,500 to $3,000. The cost of moving a dry-land plant may exceed this figure by a factor of 10.

(8) All the average-cost and detailed-cost data are for the current period. No cost projections are made for 1985.

Dallas-Fort Worth Region

106. Detailed-cost data for hydraulic and dry-land operations were obtained from two major producers. The detailed-cost data represent two active hydraulic plants, and the dry-land data represents an average of several plants in each organization. Data for average-cost of dry-land operations are combined from three of the four major companies in the region.

107. The average cost for dry-land operations producing sand and gravel in the Dallas-Fort Worth region is 74¢ per-ton. The 74¢ per-ton differs from the 79¢ per-ton average presented in the draft report. The 79¢ per-ton represented the average of all producers but two (large and small) in the Basin, whereas, the 74¢ per-ton is a "weighted" average of three major producers in the Dallas-Fort Worth region. The 74¢ per-ton figure is probably more valid because only the major companies are expected to operate fully hydraulic units capable of producing the quantities advocated for comparison.

108. The average cost for hydraulic operations is estimated at 43¢ per-ton. This estimate is from companies with active operations outside the Basin, but they are comparable to operations projected for use in the Basin in the event dredging becomes feasible. The original report of 50¢ per-ton was an average of all producers in the Basin. The average saving projected for this region is 31¢ per-ton for hydraulic production of sand and gravel.

109. Detailed costs (averaged) for dry-land and dredge operations obtained from companies are as follows:

DETAILED-COSTS	DRY-LAND (cents/ton)	DREDGE (cents/ton)
Direct costs; labor, supervision, fringe benefits, ins., workmans comp., etc.	20.1	12.5
Indirect costs; power, fuel, utilities, maintenance supplies and labor, etc.	37.3	18.5
Fixed costs; depreciation, taxes, ins., supervision, clerical, office expenses, etc.	16.5	11.5
TOTAL	73.9	42.5

110. The net savings attributable to hydraulic over dry-land production is 31.4¢ per ton.

Houston-Galveston Region

111. Dry-land costs for producing sand and gravel in the region average 75¢/ton. This represents data from all but one of the major producers. Dredging operations for sand and gravel are estimated to cost an average 55¢/ton. This represents data from all three major dredge operations in the region. The dredging costs are predominantly for sand production.

112. The average saving of dry-land over hydraulic operations is 20¢/ton. No detailed-cost data were obtainable from the operators of this area.

Previous Estimates for the Trinity River Basin

113. Previous estimates of 35¢/ton in savings have been published by Pickens (1965), Willson (1965), and by the Trinity Improvement Association (1962).

114. One of the individuals (personal communication, May, 1967) up-dated his 1965 statement from 35¢/ton to 31¢/ton in savings for dredge operations. The revised estimate is "in light of more accurate figures developed (by him) during the past months." An average of the published estimates and the Houston and Dallas region estimates is 29¢ per ton.

115. The greatest potential for hydraulic production of sand and gravel will be by the major operators in the Dallas-Fort Worth Region and will be from the upper reaches of the river. Therefore, the 29¢ per-ton saving is believed to be conservative. The maximum average-saving to be realized is not expected to exceed the 31¢ per-ton estimated by the companies in the Dallas-Fort Worth Region.

Affect of Waterway on Production Methods of Plant Locations

116. There was only one producer in the Dallas-Fort Worth Region that indicated any probability of changing from a dry-land to a hydraulic operation in the present producing region. The probability for this change depends upon the final position of the canal south of Dallas.

117. All the major producers in the Dallas region indicated that hydraulic operations would be introduced along the Trinity River if sufficient water were made available. These operations would be located south of Dallas County, particularly in Henderson and Navarro counties. Some smaller operators anticipate developing sites down the Trinity principally for barging rather than hydraulic operations.

118. The Houston deposits that supply 70% of the sand-gravel are located far from the Trinity (Fig. 2). There is no possibility of plant relocation. The sand deposits northeast of Houston along the San Jacinto River are now being dredged and barged. The large operators do not now have major total production and reserves situated whereby there is any probability of plant relocation to the Trinity for barge loading or changing production methods. Changes in production and transportation methods would be dependent upon developing the present locations near the Trinity (Fig. 2). In short, there are no benefits to be derived in the San Jacinto, La Grange, Columbus-Altair-Eagle Lake localities that are attributable to production changes or plant relocation.

119. Probability does exist for continuing production methods with a potential for producing larger quantities because of waterway movement. All operators canvassed, except one, indicated a likelihood of increased production due to waterway movement.

120. The quantities of material that will be hydraulically produced and the quantity of increased production due to cheaper transportation is difficult to estimate, according to the companies interviewed. It is obvious that all material economically feasible to produce in the Trinity River Basin will not be located along the canal site. If water is made available in nearby off-canal localities for operation of shallow-water dredges, production savings may be realized for these deposits. Pickens (1962) estimated "more than 50% of the Trinity flood plain deposits can be dredged instead of strip mined." In the same report, Willson estimated a "minimum of 75% of the sand and gravel in the flood plain could be dredged." Some companies indicated essentially all the flood plain

deposits have the potential to be hydraulically produced. In the opinion of the writer, based on (1) conversations with people in the industry, (2) the ratio of channel size to width of the flood plain, (3) location of channel in relation to the present stream, and (4) on location of some of the reserves enumerated in the report, it is not feasible that more than 75% of the total reserves will be dredged unless water is made available for the total dredging process, and dredging is permitted in some of the proposed reservoirs (See section entitled: LOCATION, QUANTITY OF RESERVES WITHIN PROPOSED CHANNEL AND RESERVOIRS).

121. In the revised contract (See, SCOPE OF WORK) the assumption was made that dredging of sand and gravel reserves will not be permitted within the channel and reservoirs created by locks and dams. All the major producers of the Dallas-Fort Worth Region indicated that practically none of the Trinity flood plain deposits could be produced by hydraulic methods if the proposed canal were not available. The total quantity of material to be covered by the canal and two major reservoirs approximated 0.871 to 1.466 billion tons. These materials, under the present assumption, would be excluded from production. Other reserves in the "abandoned" meanders and within the flood plain could be dredged if water were available for hydraulic operations. The potential tonnage to be hydraulically produced in this event would approach in quantity the total flood plain reserves (5 billion tons) minus the reserves in channel and reservoirs.

122. One may assume that with <u>average</u> savings of 29¢ per ton, the hydraulically producible deposits would be eventually developed.

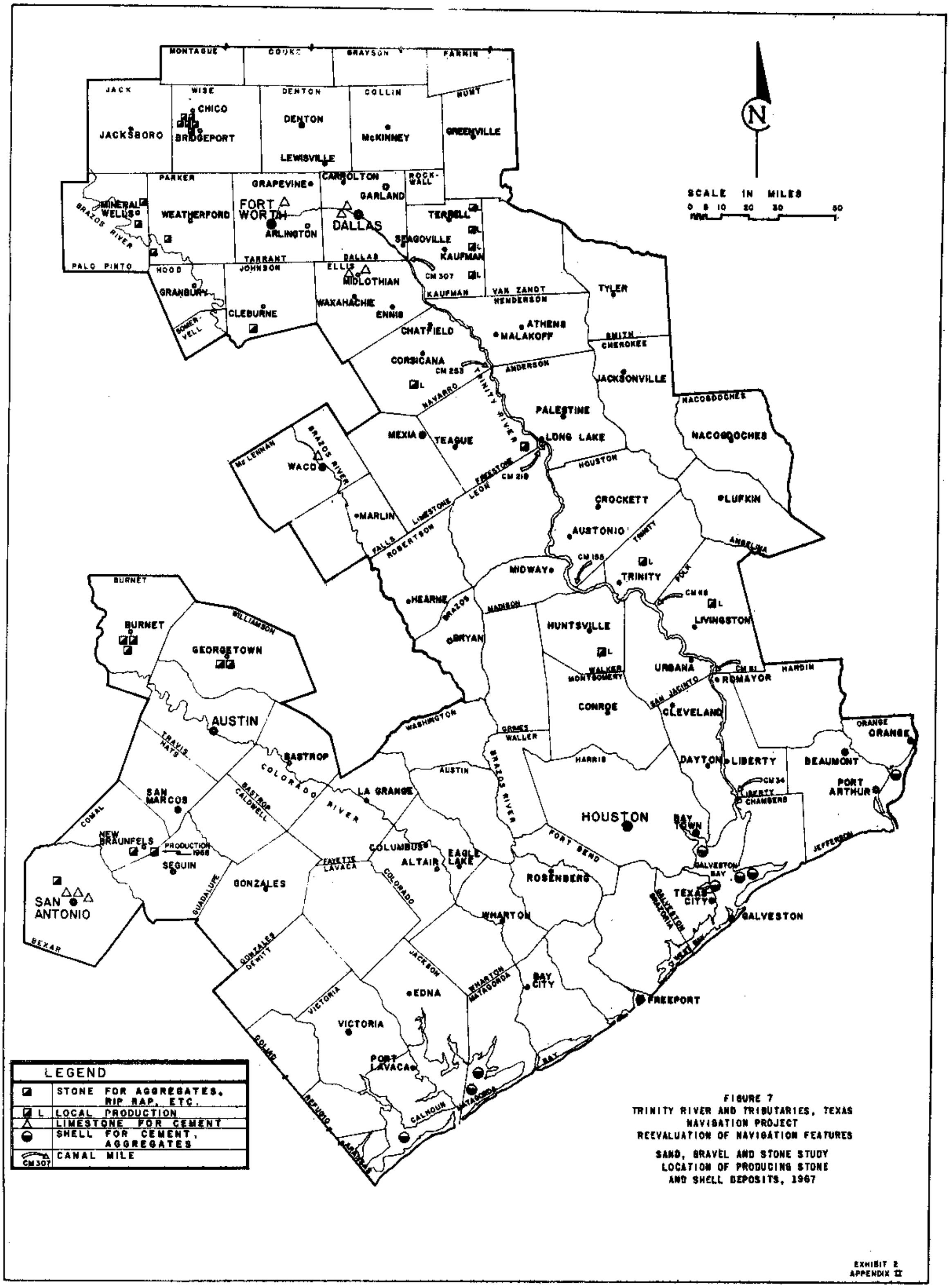

FIGURE 7
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
LOCATION OF PRODUCING STONE
AND SHELL DEPOSITS, 1967

EXHIBIT 2
APPENDIX II

PART II: STONE AND SHELL SPECIAL STUDY

LOCATION, QUANTITY, AND QUALITY OF STONE AND SHELL PRODUCED IN TRINITY RIVER REGION

Dallas-Fort Worth Region

123. Limestone for specification-quality (ASTM, AASHO) aggregates was produced by (1) five manufacturers located near Bridgeport-Chico, Wise County; (2) two in parker County; and, (3) by one operator in Palo Pinto County (Locations, Fig. 7; Producers, Appendix, Table E). The principal source for quality, crushed limestone is in Wise County.

124. Soft, crushed limestone was produced within the area from local rock quarries by on-site contractors and as a bi-product of some manufacturers of lime. These products do not meet specifications for quality concrete aggregate. The soft, crushed limestone was used for base materials in State and county road construction. Production comes from Denton, Dallas, Collin, Hood, Johnson, Palo Pinto, Tarrant, and Parker counties. This production is used locally and would not be moved on a waterway.

125. The total crushed aggregate production for the region approximated 5,650,000 tons (Table 8). The total production accounted for 45% of the total aggregate production in the region. Of the total stone production accounted for in this report, approximately 95% was of concrete-aggregate quality. Crushed stone has gained wide usage due to the quality-control possible with a homogeneous, mono-mineralic rock such as limestone, and to the shortage of quality coarse aggregates.

Houston-Galveston Region

126. There were 6,098,133* tons of shell produced from the coastal bays for cement manufacture and for aggregate use in 1966 (Locations, Fig. 7).

127. Of the total quantity, 2,393,933 tons were attributable to cement manufacture (Table 9). The shell producers supply shell to four major cement manufacturers (Appendix, Table G) in the Houston area. One cement manufacturer operates in Orange, Texas, and another in Corpus Christi, for a total of six in the Gulf Coast area. The Corpus Christi manufacturer does not market cement or aggregates to the Houston region, thus, the location is not considered in the report.

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*Figure reduced below tonnage given in preliminary report due to replication discovered in data from a manufacturer.

128. The other five cement manufacturers do not supply all the cement for the region. Cement produced in Waco and San Antonio (Producers Appendix, Table G, Locations, Fig. 7) is marketed within the region away from the metropolitan area of Houston.

129. The shell for aggregate use was consumed in road construction for flexible and cement-stabilized bases. The total quantity dredged in 1966 was 3,704,200 tons (Table 9).

130. There are no major stone operations for cement use in the region. Approximately 800,000 tons (Table 9)* of stone from the Burnet, Georgetown, San Antonio, and New Braunfels region (locations, Fig. 7) were shipped mostly via rail for use as rip-rap, jetty stone, road materials, and aggregate.

*Figure reduced below tonnage given in preliminary report due to replication discovered in data from a manufacturer.

TABLE 8

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Stone Production for Dallas - Fort Worth Region, 1966[1]

Location[2]	Material	Quantity (short tons)
Bridgeport-Chico	Limestone	3,864,000[3]
Palo Pinto, Parker	Limestone	1,505,000
Texas Highway Department Uses[4], and Independent Contractors	Sandstone	105,000
	Limestone	176,000
	TOTAL	5,650,000

[1]List of producers in Appendix, Table E.

[2]Locations, Figure 7.

[3]Total production was 5,520,000 tons. Estimated 70% to Dallas-Fort Worth Region.

[4]Highway Department usage in Denton, Dallas, Collin, Johnson, Tarrant, Hood, Parker, and Palo Pinto counties. Contractor produced for a specific job by independent operators.

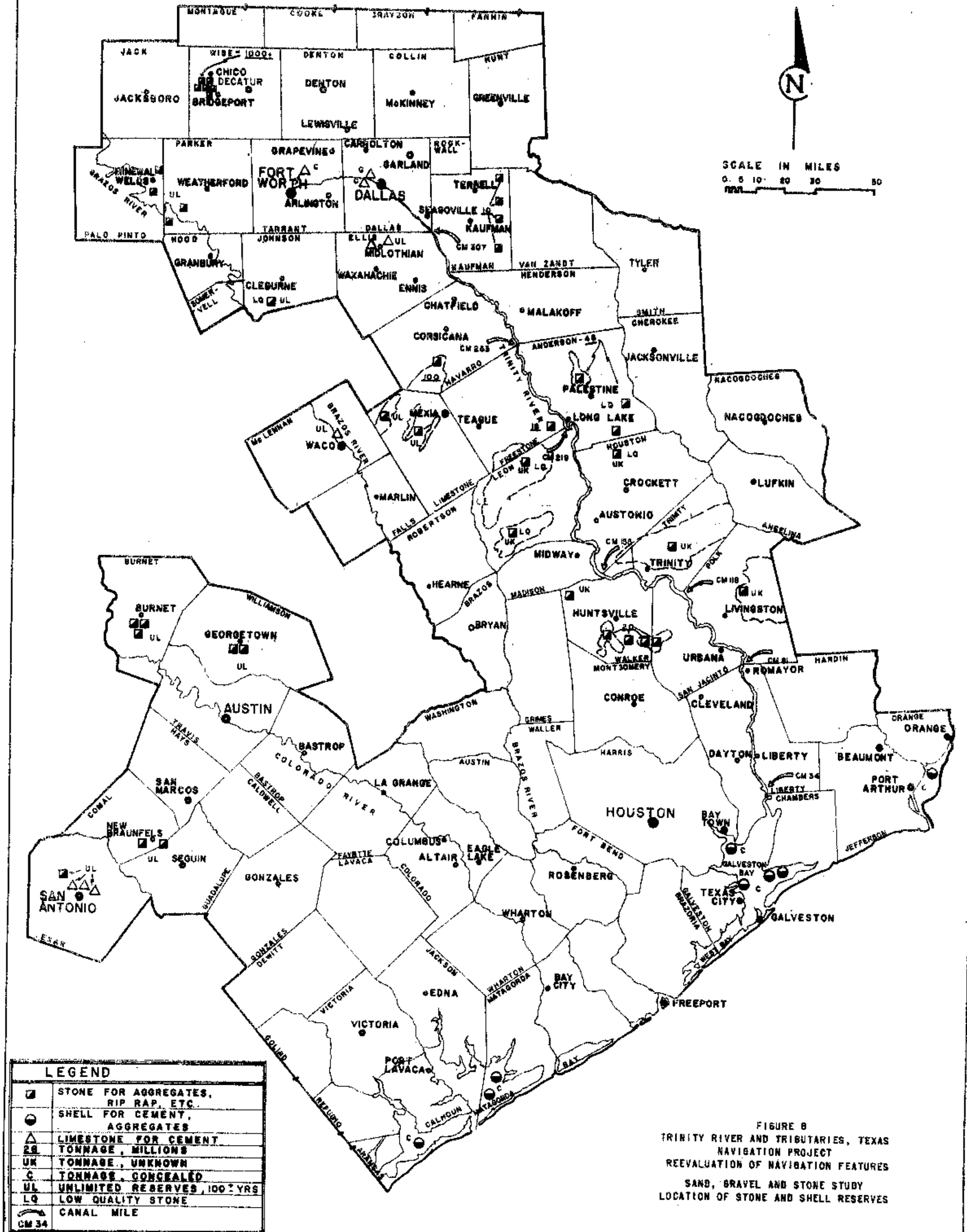

FIGURE 8
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES
SAND, GRAVEL AND STONE STUDY
LOCATION OF STONE AND SHELL RESERVES

TABLE 9

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Stone Production for Houston - Galveston Region, 1966[1]

Location[2]	Material	Quantity (short tons)
Galveston, Trinity Matagorda Bays	shell (aggregate)	3,704,200
	shell (cement)	2,393,933
Texas Highway Dept.[3]	stone (aggregate)	88,000
New Braunfels, Georgetown Burnet, San Antonio	stone (aggregate, etc.)	800,000
	TOTAL	6,986,133

[1]List of producers in Appendix, Table F.

[2]Locations, Figure 7.

[3]Contractor produced for a specific job by independent operators.

Between Dallas-Houston Regions

131. All the stone produced as aggregates was consumed within the region. Total quantities produced are not accurately estimable, however, all significant quantities of production are accounted for.

132. Kaufman and Rockwall Counties.- Crushed limestone for aggregate use was produced from the eastern part of Kaufman County (Fig. 7). The quantity produced was sufficient to supply local needs. Contractors in Kaufman County produced 431,000 tons of crushed limestone in 1966 for use by the Texas Highway Department. Total contractor production in the county in 1965 approximated 272,000 tons (Netzeband, Bureau of Mines, Dallas).

133. The limestone is variable in hardness. Variations exist within deposits, and particularly between localities. The limestone was used for flexible base and for rip-rap on earthen dams.

134. Sandstone was produced in Rockwall County for flexible-base by the Texas Highway Department. Total production in 1966 equaled 170,000 tons.

135. Ellis County.- Soft limestone (Austin Chalk) was crushed for road base-material. Crushed aggregates produced by contractors for the THD in 1966 totaled 88,000 tons.

136. Limestone was also produced for cement manufacture by two plants at Midlothian (Fig. 7).

137. Navarro and Henderson Counties.- Limestone was crushed for aggregates in southcentral Navarro County (Fig. 7). The deposits meet all requirements of State specifications for concrete aggregate or cover stone. These materials are also used for rip-rap. The total production is concealed under the summation to follow. No significant quantity of stone production comes from Henderson County.

138. Freestone and Leon Counties.- Quality sandstone and siltstone were crushed by one operator in Freestone County. The locality is about one-half mile from the Trinity River (Fig. 7). The stone is hard and meets specifications for concrete aggregate in highway and dam construction. Total production concealed in figures given under section to follow. Soft sandstone was produced for road construction in Leon County.

139. Summary.- Crushed limestone and sandstone were marketed within the region. The total quantity of stone produced approximated 1,089,000 tons.

140. Location, Quantity, Life Expectancy.- Data for reserves were requested in terms of years and tons from the companies and people interviewed. Present volume of tonnage multiplied by the number of years estimated for company reserves were usually used to derive the total quantity figures. Each company estimated the number of years reserves in terms of the present economic situation and the foreseeable demand for the product.

Dallas-Fort Worth Region

141. Reserves of stone suitable for specification-quality crushed aggregates are known in this region only from localities now being produced. The areas are located (1) at Bridgeport-Chico, Wise County, and in (2) Parker, Palo Pinto counties (Fig. 8).

142. The five major producers at Bridgeport-Chico (Appendix, Table E) conservatively estimate they now have under control a minimum 50 year supply. The range in company estimates was from 40 to 80 years. Information from geological reports (Raish, 1964; Feray, open file reports) indicates that the limit of availability of stone in the area is controlled mostly by the economics of overburden removal.

143. Several producers estimated that 100 years of production could be sustained if different economic conditions would permit removing additional overburden. At the present rate of production of 5,520,000 tons, an average 50 year supply, and with reserves given by individual companies, the cumulative total is estimated to exceed one billion tons.

144. The only way the proposed canal would decrease the life expectancy of the Wise County deposits would be if new market demands were created down river from Dallas and/or new market demands were created in the Dallas area.

145. The producers of crushed aggregates in Parker, Palo Pinto counties (Appendix, Table E) estimate well over a 100 year supply. Without question, the geographic extent of these deposits are sufficient for long term supply in large volumes. However, under the present economic conditions of producing and hauling, the entire extent of the deposits of quality materials is not available to the market. These deposits would not be appreciably decreased by the proposed waterway.

146. In summary, limestone for crushed aggregates is in abundant supply in the present areas of operation. None of the producers interviewed foresees a shortage of these materials in 50 to 100 years.

Houston-Galveston Region

147. Shell reserves for aggregates and for cement manufacture are located in the Gulf bays (Fig. 8). The life expectancy of the shell deposits is estimated at 20 to 25 years. The presence of a waterway would be expected to reduce the reserve figures by five years. This means that by 1985 about 2 to 7 years of reserves would be left. These would soon be depleted due to the waterway being in operation. The total known quantity of shell reserves in present producing areas is put at 75 million tons by the producers. Based on life expectancy figures (20-25 years) and present tonnage of production (6,000,000 plus) the total probable reserves may be on the order of 150 million tons.

148. Legislation is now pending to restrict removal of oyster shell from Matagorda and Galveston Bays due to pollution of live oyster reefs. The outcome at this time is problematical. Should this practice decrease or cease, new demands would be created for coarse base-materials and for raw materials for cement manufacture.

149. There are no sources in the Houston region for limestone for cement manufacture to replace shell use. In the event a waterway were not present, and shell production were restricted, or reserves were depleted, raw materials for the region would be supplied from the San Antonio area (Fig. 8). Also, cement would likely be shipped from San Antonio and Waco. In the event a canal were present and shell production were restricted, or reserves were depleted, the Dallas, Fort Worth, and Midlothian deposits (Fig 8) could supply cement to the Houston market.

150. Life expectancy of reserves in the Waco and San Antonio areas is estimated at greater than 100 years. The same is also true for the Dallas-Fort Worth region.

151. There are no reserves of quality stone for aggregates known in the Houston-Galveston area. Small quantities, in terms of the total market for concrete-quality aggregates, are marketed to the region from San Antonio, New Braunfels, and the Georgetown-Burnet area (Locations, Fig. 8). These areas also supply rip-rap, jetty stone, cover stone, etc., to the market. There is more than a 100-year supply.

152. In the event shell production were restricted, or reserves depleted, and a waterway were not present, gravel to replace shell would be supplied from the present producing areas in the region. Stone would also be supplied from the San Antonio, New Braunfels, Georgetown areas. Stone reserves are available for aggregate use in Walker, Polk, Trinity, and San Jacinto counties. Gibbs Brothers and Company (Exhibit D, TIA Report, 1962) estimated reserves of 20,000,000 tons of sandstone in San Jacinto and Walker counties.

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Between Dallas-Houston Regions

153. The location of deposits are enumerated in those counties which lay south of Dallas County and north of Trinity-Walker counties. (Fig. 8).

154. Kaufman County.- Reserves of limestone for crushing are located in the eastern part of the County. Approximately 10,000,000 tons of known reserves are within the County (Table 10). Incaprera (Open file report, 1959) estimated limestone reserves in the County at 7,000,000 tons. These materials meet ASTM specifications for flexible base and asphaltic concrete aggregates.

155. The life expectancy of the limestone in terms of present market demand, without the waterway, is estimated at 20 to 30 years. These figures are based on the 1966 usage in the County (about 0.4 million tons) and the estimated reserves. A decrease in life expectancy of the deposits with the waterway is problematical due to trucking distances of 25 miles to the river.

156. Ellis County.- Limestone (Austin Chalk) for crushing is plentiful in the area but the quality of the material is fit only for road base. The Texas Highway Department is the major user of this material for aggregate purposes. The material is used for cement manufacture. Reserves are almost unlimited.

157. Navarro County.- Limestone suitable for concrete aggregate is known in the south central part of Navarro County (Fig. 8). The deposit extends from Richland Creek southward for a distance of 10 miles. There are numerous deposits ranging from zero to 20 feet in depth below the surface over areas as much as 75 to 100 acres in areal extent. The total quantity of reserves is estimated by a major company to be on the order of 100,000,000 tons. The life expectancy of the deposits is problematical due to locations 20-30 miles west of the proposed canal.

158. Leon County.- Aggregate resources in Leon County are available as iron-ore rock and gravel, and as sandstone. The total quantity and life expectancy are unestimable.

159. Freestone County.- Quality sandstone and siltstone are known from only one locality in the County (Fig. 8). The location is approximately one-half mile from the River. Reserves are estimated at 10,000,000 tons of concrete-quality stone and 8,000,000 tons of riprap. The life expectancy of these reserves would be increased if the waterway were built. The deposits that are economically feasible to produce will probably be depleted before implementation of the waterway; however, savings realized by waterway transportation plus new markets along the Coast would make larger volumes of reserves economical to produce.

TABLE 10

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Summary of Stone Reserves Between Dallas-Houston Regions

Location[1]	Tonnage (millions)	Life Expectancy (years)
Kaufman	10	20-30[2]
Navarro	100	Unknown
Leon	Unknown	"
Freestone	18	"
Anderson	48	"
Houston	Unknown	"
TOTAL	176	Unknown

[1]Locations, Figure 8.

[2]Life Expectancy with or without waterway.

160. Anderson County.- Iron-ore gravel and soft sandstone deposits are estimated at 48,000,000 tons. These materials are wide-spread at the surface over about 4,000 acres of the County. The life expectancy of these deposits is unknown. The materials will likely never be depleted under present transportation conditions and quality standards.

161. Houston County.- Reserves of low quality stone are located in the northern part of the county. Total reserves and the life expectancy of the deposits are unknown.

LOCATION, QUANTITY OF STONE AND SHELL RESERVES

THAT WILL NEVER MOVE WITHOUT WATERWAY

162. There are no stone deposits suitable for aggregates or cement in the Dallas-Fort Worth Region that are attributable to never being moved without a waterway.

163. Shell in the Houston-Galveston region will be depleted with or without a waterway. The only stone in the region that may never move without a waterway is located in Walker, Polk, Trinity, and San Jacinto counties (Fig. 8). The total accountable reserves are estimated at 20 million tons. Total tonnage is not known.

164. A portion of the high-quality stone reserves in Freestone County will never move without a waterway. Savings realized by waterway transportation plus new markets along the Coast would permit movement of an estimated one million tons per year. Total reserves depend upon future economics of production and marketing, but they are conservatively estimated at 18 million tons.

165. The Navarro and Kaufman counties deposits (Fig. 8) are questionably attributable to not moving without a waterway. These deposits are 20-30 miles from the river.

166. In conclusion, only stone reserves in Freestone County, and in San Jacinto, Polk, Trinity, and Walker counties are subject to not being moved without waterway transportation.

TRANSPORTATION MODES AND TRAFFIC PATTERNS

FOR STONE AND SHELL

167. In the Dallas-Fort Worth Region the major movement of crushed stone is north-to-south from Wise County, and west-to-east from Parker and Palo Pinto counties (See, Fig. 9). An estimated 80% of the production from Wise County, the major source, is moved by truck, and 20% by rail. Stone is hauled from Palo Pinto and Parker counties by truck.

168. In the Houston-Galveston Region, shell for aggregate use is moved by barge to stock pile and then by truck to site of use. Shell for cement manufacture is also moved by barge. Stone from the New Braunfels, Burnet, Georgetown, and San Antonio areas (Locations, Fig. 9) is moved into the region principally (80%) by rail.

169. Essentially all shipments of stone in the Dallas-Houston interarea are by truck. Materials are shipped 75-100 miles from the major production site, which is in Freestone County.

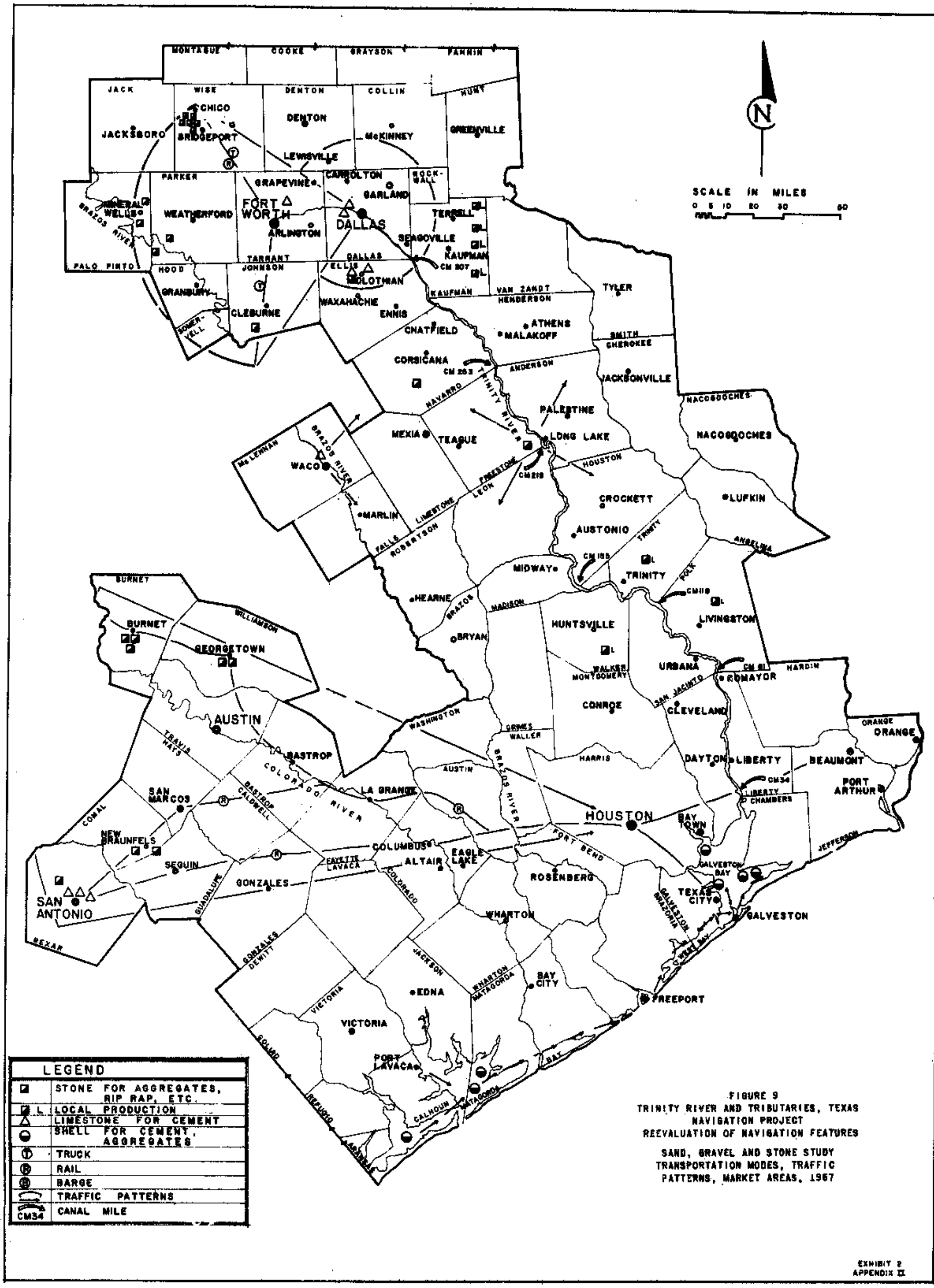

FIGURE 9
TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL AND STONE STUDY
TRANSPORTATION MODES, TRAFFIC
PATTERNS, MARKET AREAS, 1967

PROBABLE CHANGES IN TRANSPORTATION MODES AND TRAFFIC PATTERNS

FOR STONE AND SHELL DUE TO WATERWAY

Dallas-Fort Worth Region

170. Trucking and rail shipments from the present producing localities for stone (Fig. 9) will prevail with the waterway in operation. No large quantity of stone is expected to move to the Dallas-Fort Worth area by barge. However, shipments of stone aggregate from Bridgeport-Chico and from Parker-Palo Pinto counties may bypass the region. If shipments bypass the region, they will be by barge and the movement will be from Fort Worth south past Dallas and on to a final destination. The quantity that would bypass the region on the waterway is unknown. Transportation of major quantities will depend on the demands of new markets.

171. No movements of stone for cement manufacture are anticipated. However, shipments of cement, the finished product, will occur down river.

Houston-Galveston Region

172. Movement of shell in the region is already by barge. Shell is expected to be moved northward on the proposed canal. The material will already be loaded on barges from the processing plant, therefore will be able to readily compete from a transportation standpoint. The quantity of shell that will be moved on the waterway is unestimable by the major operators. Considering the life expectancy of shell deposits, the quantity should diminish by 1990.

173. The stone requirements are met by rail and truck from the New Braunfels, Burnet, Georgetown, and San Antonio areas (Fig. 9). Stone from these areas, when moved, will still be shipped principally by rail.

174. There are stone reserves in Walker, Polk, Trinity, and San Jacinto counties (Fig. 8) that will likely move to the Houston market with a canal in operation. The quantity expected in 1985 is unestimable.

Between Dallas-Houston Regions

175. The present mode for stone movement in the area is principally by truck. The only major source is in Freestone County (Location, Fig. 9). New traffic patterns will develop by barge if the waterway is built. The major movement will principally be south to the Houston

market. The total quantity expected is about one million tons/year in 1985. The duration of the shipments will depend on reserves available (See, RESERVES OF STONE AND SHELL: Freestone County). Transportation of Freestone County stone aggregate via canal to the Dallas market will be minimal because of the closer availability of gravel deposits.

176. The movement of stone from Navarro and Kaufman counties is questionable due to locations 20-30 miles from the proposed canal (Fig. 9). If movement does occur it will likely be down the canal because hauling to the canal then barging to the north would not be competitive with trucking direct to the north. There are no limestone deposits known that would likely be moved for cement manufacture.

STONE AND SHELL TRANSPORTATION ANALYSIS: MARKET AREAS, TRUCK-RAIL RATES

177. Two major markets for stone and shell exist within the Trinity River Basin; the Dallas-Fort Worth and Houston-Galveston metropolitan regions. The interarea, by comparison, is not a major consuming market.

Dallas-Fort Worth Region

178. Crushed stone is transported by truck and rail from Bridgeport-Chico, Wise County, and by truck from Parker, Palo Pinto counties (Locations, Fig. 9). An estimated[1] 80% of the Wise County production is hauled by truck, and the remaining 20% is hauled by rail.

179. Data illustrating average lengths-of-haul, transportation modes, and rates are shown in Table 11. Truck haul-distances for about 95% of the crushed-aggregate market average 72 miles. The average truck rate is 2.36¢/ton-mile.

180. Rail transportation costs average 1.73¢/ton-mile from Wise County to Fort Worth, and 1.63¢/ton-mile to Dallas. The least-costly mode is rail, if the sites of origin and destination of the commodity are situated on a railroad. In this region approximately 90% of the crushed aggregate production moves by truck; therefore, the least-costly transportation is essentially that of trucking.

Houston-Galveston Region

181. There are no movements of stone in this region for cement manufacture. Approximately 800,000 tons of stone for aggregates, rip-rap, cover stone, etc., were shipped via rail from Burnet, Georgetown, New Braunfels, and San Antonio (Locations, Fig. 9). Transportation rates are shown in Table 12.

182. Trucks are used locally within the area for movements of low-quality base materials.

183. Shell is moved by barge from dredging sites in the bays to dock side for unloading. Barge rates are being developed by the Corps of Engineers, Galveston District.

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[1]Percentage derived from producers estimates.

TABLE 11

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Transportation Analysis of Dallas-Fort Worth Region

Product	Origin[1]	Mode	Destination	Ave. Dist	Rate[2]
Crushed limestone	Parker County	Truck	Fort Worth	45	2.2
"	"	"	Dallas	75	2.5
"	"	"	Waxahachie	80	2.0
"	"	"	Corsicana	118	1.9
"	Wise County	"	Fort Worth	55	2.3
"	"	"	Dallas	75	2.5
"	"	"	Dallas	65	2.5
"	"	"	Dallas	60	3.0
"	"	Rail	Fort Worth	55	1.73
"	"	"	Dallas	75	1.63

[1]Locations, Figure 9.

[2]Rate in cents/ton-mile. Repetition of origin-destination data represents different information sources.

Between Dallas-Houston Regions

184. Trucks are used exclusively to transport crushed aggregates. The only location for quality stone-aggregates is in Freestone County (Fig. 9). Rates are established by independent haulers and are variable.

185. Low-quality stone is produced from other locations (Fig. 9), and is hauled by truck within the surrounding area. Again, truck rates are variable.

TABLE 12

TRINITY RIVER AND TRIBUTATIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Transportation Analysis of Houston - Galveston Region

Origin[1]	Destination	Distance (miles)	Rate[2]
New Braunfels	Houston	176	1.92
" " (base mat.)	"	176	1.77
" "	Galveston	222	2.18
" " (aggregate)	Beaumont	265	2.40
" " (base mat.)	"	265	2.27
" "	Port Arthur	285	2.41
" "	Texas City	215	2.08
Georgetown (aggregate)	Houston	190	2.06
" (cover stone)	"	190	1.84
San Antonio	"	200	1.93
"	Galveston	220	2.28
"	Beaumont	289	2.39

[1]Locations, Figure 7.

[2]Rate, Dollars/per ton.

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

APPENDIX

SUPPLEMENTAL DATA

TO

SAND, GRAVEL, AND STONE STUDY

EXHIBIT 2
APPENDIX II

TABLE A

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

List of Companies and the Personnel Interviewed

Alamo Cement Company*

Leroy Oneal
W. R. Erby
San Antonio, Texas

Alpha Portland Cement*

Mr. McQuhae, Plant Manager
San Jacinto Building
Beaumont, Texas

Campbell and Sons Sand and Gravel*

Joseph Campbell
521 Beach Street
Fort Worth, Texas

Capital Cement Company

Carl Strating, Plant Manager
San Antonio, Texas

Centex Cement Corporation

Malcolm Alexander
Box 1200
Corpus Christi, Texas

Crushers Incorporated

John H. Van Amburgh, Executive Vice President
400 Stemmons Tower South
Dallas, Texas

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* Data obtained by personnel of Corps of Engineers, Galveston District.

East Texas Stone Company

R. E. Hable, President
Corsicana, Texas

Gifford-Hill Company, Inc.

Roy Stanley, Mgr. Expl. Dept.
2949 Stemmons Freeway
Dallas, Texas

Gulf Coast Portland Cement*

Neal Peckham
6203 Industrial Way
Houston, Texas

W. D. Haden Company

C. R. Haden, President
2243 Milford
Houston, Texas

Harston Gravel Company, Inc.

R. B. Harston, Jr., President
7000 Midway Road
Fort Worth, Texas

Holsey Bros. Sand & Gravel*

B. J. Holsey
Austonio, Texas

Horton & Horton

George Horton, President
Mr. Hedges, Vice President
Jack Bowen, Sales Manager
621 North Live Oak
Houston, Texas

Ideal Cement*

Mr. Conley, Plant Manager
San Jacinto Building
Houston, Texas

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*Data obtained by personnel of Corps of Engineers, Galveston District.

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Industrial Concrete

Jim Blakeman, General Manager
Ridglea Tower Building
Fort Worth, Texas

Lagow Gravel Company

Mr. Lagow, Owner
Seagoville, Texas

Longhorn Cement Company

Mr. Gaines Voight, Vice President
San Antonio, Texas

McDonough Bros.

Paul Koerner
San Antonio, Texas

Nelson Bros. Gravel Company*

Tom Morton, Bookkeeper
Trinity Mill Road
Carrollton, Texas

Palo Pinto Stone Company

D. C. Hopper, President
Dallas, Texas

Parker Brothers & Company, Inc.

C. T. Parker, President
P. O. Box 107
Houston, Texas

Servtex Corporation

J. G. Rheinlaender
Box 729
New Braunfels, Texas

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* Data obtained by personnel of Corps of Engineers, Galveston District.

Sparkman Gravel Company

Farmers Branch, Texas

Superior Sand & Gravel, Inc.

D. F. Postle, Vice President
P. O. Box 892
Bellaire, Texas

Texas Construction Materials Company*

Gordon Jones, Executive Vice President
3816 West Alabama
Houston, Texas

Texas Industries

Cedric Willson, Vice President Engineering
Arlington, Texas

Texcrete Company*

E. W. Christensen
2202 Nance
Houston, Texas

Tex-O-Line Stone Company

D. F. Mooney, Vice President
Box 218
Weatherford, Texas

Thorstenberg Materials Company

Joe Speer, Traffic Manager
1435 Bank of Southwest
Houston, Texas

Trinity Concrete Products

Cecil Cannon, Treasurer
2800 Republic National Bank Building
Dallas, Texas.

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* Data obtained, in part, by personnel of Corps of Engineers, Galveston, District.

Trinity Portland Division of General Portland

Bank of Southwest
Houston, Texas

Universal Atlas Corporation

Jim Gresham
Waco, Texas

Weatherford Sand & Gravel Company*

Joe Bennett, Manager
403 Ft. Worth Street
Weatherford, Texas

Wesco Materials Corporation

W. W. Pickens, President
Dallas, Texas

Wesco-Wamix, Inc.

T. M. Mallon, Vice President
Norris Northcutt, Geologist
Stemmons Freeway
Dallas, Texas

Other Sources: Texas Highway Department District Offices, other independent operators and sources listed under: Information Sources, Personal Communication; Producers in area between Dallas-Houston, Table D.

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* Data obtained, in part, by personnel of Corps of Engineers, Galveston, District.

TABLE B

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Aggregates in Dallas-Fort Worth Region, 1966

Trinity River, Dallas-Fort Worth;
Seagoville

- Gifford-Hill Company
- Wesco-Wamix
- Trinity Concrete Products
- Texas Industries
- Nelson Brother's Gravel Company
- Harston Brother's Gravel Company, Inc.
- Campbell & Sons Sand & Gravel
- Sparkman Gravel Company
- Lagow Gravel Company

Brazos River, Parker, Palo Pinto, Johnson, Hood Counties

- Trinity Concrete Products
- Texas Highway Department
- Independent Operators

TABLE C

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Aggregates in Houston-Galveston Region, 1966

Columbus-Altair-Eagle Lake, La Grange

Horton & Horton
W. D. Haden
Thorstenberg
Parker Brothers
Superior Sand and Gravel
Texcrete Company

Cleveland, Urbana, Liberty, San Jacinto River

Texas Construction Materials
Thorstenberg
Gifford-Hill Company, Inc.
Horton & Horton
Cleveland Sand and Gravel
Parker Brothers

Texas Highway Department and Independent Operators

TABLE D

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Aggregates Between Dallas-Houston Regions, 1966[1]

Kaufman County

Producers listed under Dallas-Fort Worth Region, Table B

Ellis County

H. R. Burden Gravel Company
Dixon Sand & Gravel Company
Rabe Sand & Gravel
E. W. Hable & Sons (Corsicana, Texas)

Navarro and Henderson Counties

Gifford-Hill Company (Dallas, Texas)
Holsey Bros. (Crockett, Texas)
Turkey Creek Gravel Company (Malakoff, Texas)
Cope Gravel Company (Trinidad, Texas)

Houston County

Gifford-Hill, Holsey Brothers

[1]This list does not include every operator.

TABLE E

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Stone in Dallas-Fort Worth Region, 1966

Bridgeport Chico

- Gifford-Hill Company
- Wesco-Wamix
- Trinity Concrete Products
- Texas Industries
- Crushers Incorporated

Parker County

- Tex-O-Line
- Industrial Concrete

Palo Pinto County

- Palo Pinto Stone Company

Johnson County

- Round Rock Lime Company (low-quality stone)

Texas Highway Department and Independent Operators

TABLE F

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Stone and Shell in Houston-Galveston Region, 1966

Houston-Galveston (shell for cement and aggregate)

Parker Brothers
W. D. Haden
Horton and Horton
Independent Operators

Orange, Texas (shell for cement)

Alpha Portland Cement

San Antonio (stone for cement)

Alamo Cement
Longhorn Cement
Capital Cement

Waco (stone for cement)

Universal Atlas

New Braunfels (stone; aggregate, rip-rap, etc.)

Servtex Corporation

San Antonio (stone; aggregate, rip-rap, etc.)

McDonough Brothers

Georgetown-Burnet (stone; aggregate, rip-rap, etc.)

Texas Construction Materials
Texas Crushed Stone Company

TABLE G

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Manufacturers of Cement in Houston-Galveston Region, 1966

Houston-Galveston

- Trinity Portland Cement
- Lone Star Cement
- Ideal Cement Company
- Gulf Coast Portland Cement
- Alpha Portland Cement (Orange, Texas)

Waco

- Universal Atlas Cement

San Antonio

- Alamo Cement
- Longhorn Cement
- Capital Cement

TABLE H

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY

Producers of Stone Between Dallas-Houston Regions, 1966[1]

Kaufman County

Joe Davidson (Terrell, Texas)
Buckner Contractors (Cleburne, Texas)
Wesco Materials (Dallas, Texas)
R. W. McKinney (Nacogdoches, Texas)
Billy McKnight (Commerce, Texas)
R. N. Adams (Kaufman, Texas)
E. W. Hable (Corsicana, Texas)
Fred Hall and Sons (Waco, Texas)
M. C. Winters, Inc. (Johnson City, Texas)

Ellis County

E. W. Hable & Sons (Corsicana, Texas)
Three Brothers Equipment Corp. (San Antonio, Texas)
Hustin Construction Co. (Dallas, Texas)
Downing Bros. (Waco, Texas)

Rockwall County

R. N. Adams Construction Co. (Kaufman, Texas)
M. C. Winters, Inc. (Johnson City, Texas)

Navarro and Henderson Counties

D. P. Frost Construction Company (Wortham, Texas)
East Texas Stone Company (Corsicana, Texas)

Freestone County

East Texas Stone Company

[1]This list does not include every operator..

PERSONAL COMMUNICATION, 1967

Alexander, Malcolm, Centex Cement Corporation, Corpus Christi, Texas.

Barrington, S. M., Public Relations, Sam Houston Electric Cooperative, Inc., Livingston, Texas.

Blakeman, Jim., Gen. Mgr., Industrial Concrete Company, Fort Worth, Texas.

Cabaniss, L. D., Dist. Engr., Dist. 1, Texas Highway Department Paris, Texas.

Cannon, Cecil, Treasurer, Trinity Concrete Products, Dallas, Texas.

Chapline, Lee P., Mgr., Athens Chamber of Commerce, Athens, Texas.

Cook, Glenn J., Mgr. Houston County Development Foundation, Crockett, Texas.

Crook. R. W., Dist. Engr., Dist. 2, Texas Highway Department, Fort Worth, Texas.

DeBerry, B. L., Dist. Engr., Dist. 18, Texas Highway Deaprtment, Dallas, Texas.

Eastman, A. W., Materials & Test. Engr., Texas Highway Department, Austin, Texas.

Feray, Dan E., Goescience Professor, Texas Technological College, Lubbock, Texas.

Gresham, Jim, Universal Atlas Corporation, Waco, Texas

Hable, R. E., President, East Texas Stone Company, Corsicana, Texas.

Hamilton, Lamar W., Palestine, Texas.

Harlan, H. V., Jr., Dist. Design Engr., Dist. 11, Texas Highway Department, Lufkin, Texas.

Harston, R. B., Jr., President, Harston Brothers Gravel Company, Inc., Fort Worth, Texas.

Herrington, Harry, Palestine Ready Mix Concrete Company, Palestine, Texas.

Hopper, D. C., President, Palo Pinto Stone Company, Dallas, Texas.

Horton, George; Hedges; and Bowers, Jack, Horton & Horton, Houston Texas.

Jones, Gordon, Executive Vice President, Texas Construction Materials, Houston, Texas.

Keller, John, G., Dist. Engr., Dist. 20, Texas Highway Department, Beaumont, Texas.

Koerner, Paul, McDonough Bros., San Antonio, Texas.

Long, Robert E., Supvr. Lab. Engr., Dist. 17, Texas Highway Department, Bryan, Texas.

McKay, Jack, Mgr., Ennis Chamber of Commerce, Ennis, Texas.

Mooney, D. F., Vice President, Tex-O-Line Company, Weatherford, Texas.

Mowlam, William V., Registered Civil Engineer and Public Surveyor, (and Butler, Joe E.), 307 State National Bank Building Corsicana, Texas.

Munson, George P., Jr., Asst. Dist. Engr., Dist. 12, Texas Highway Department, Houston, Texas.

Nash, Edward, President, Farmers & Merchants National Bank, Kaufman, Texas.

Netzeband, F. F., Mining Engineer, Bureau of Mines, Rm. 1908, Federal Building, Dallas, Texas.

Northcutt, Norris, Geologist, Wesco-Wamix, Inc., Dallas, Texas.

Parker, C. T., President, Parker Brothers, Houston, Texas.

Pickens, W. W., President, Wesco Materials Corporation, Dallas, Texas.

Postle, D. F., Vice President, Superior Sand and Gravel, Inc., Bellaire, Texas.

Potter, W. W., Dist. Engr., Dist. 10, Texas Highway Department, Tyler, Texas.

Rheinlaender, J. G., Servtex Corporation, New Braunfels, Texas.

Speer, Joe, Traffic Mgr., Thorstenberg Materials Company, Houston, Texas.

Stanley, Roy, Mgr. Expl. Dept., Gifford-Hill Company, Dallas, Texas.

Strating, Carl, Plant Mgr., Capital Cement Company, San Antonio, Texas.

Turner, Maurice E., Executive Vice President, Chamber of Commerce, Walker County, Huntsville, Texas.

Van Amburgh, John H., Executive Vice President, Crushers, Inc., Dallas, Texas.

Voight, Gaines, Vice President, Longhorn Cement Company, San Antonio, Texas.

Wakefield, Julian, County Commissioner, Leon County, Centerville, Texas.

Willson, Cedric, Vice President of Engr., Texas Industries, Arlington, Texas.

REFERENCE SOURCES: PUBLISHED AND UNPUBLISHED

Fisher, W. L., 1965, Texas Minerals: Trends in Production, Circular 654, Bureau of Economic Geology, Austin, Texas.

Fisher, W. L., _et al._, 1967, Rock and Mineral Resources of East Texas, Report of Investigations No. 54, Bureau of Economic Geology, Austin, Texas.

Garner, L. E., 1967, Sand Resources of Texas Gulf Coast, Report of Investigations No. 60, Bureau of Economic Geology, Austin, Texas.

Girard, Roselle M., 1965, Texas Mineral Producers, Bureau of Economic Geology, Austin, Texas.

Godfrey, Charlie B., 1957, the Geology of the Seagoville Quadrangle, Dallas and Kaufman Counties, Texas, Unpublished Master Thesis, Department of Geological Sciences, SMU, Dallas, Texas.

Incaprera, Frank G., 1959, Open-file report, Corps of Engineers, Galveston District, Galveston, Texas.

Netzeband, F. F., and Girard, Roselle M., 1966, the Mineral Industry of Texas in 1965, Mineral Resource Circular No. 48, Bureau of Economic Geology, Austin, Texas.

Raish, Dean, 1964, Petrology of a Limestone Bank in the Winchell Formation (Upper Pennsylvania) of Wise County, Texas, Unpublished Master Thesis, Geology Department, T.C.U., Fort Worth, Texas.

Rodda, Peter U., _et al._, 1966, Limestone and Dolomite Resources, Lower Cretaceous Rocks, Texas, Report of Investigations No. 56, Bureau of Economic Geology, Austin, Texas.

Stanford Research Institute, 1959, Potential Water Use in the Trinity River Basin, Texas.

Trinity Improvement Association, 1957, Economic Survey of the Trinity River, Texas.

Trinity Improvement Association, 1962, Trinity River, Texas, Comprehensive Survey Report, 5 vols., Fort Worth, Texas.

Trinity River and Tributaries, Texas, 1965, Corps of Engineers, House Document No. 276, 5 vols.

Publications of the Bureau of Economic Geology: The following publications were reviewed.

Geological Circular 65-2. Texas Mineral Resources: Problems and Predictions, Peter T. Flawn.

Bulletin 62. Road Materials of Texas, Jas. P. Nash.

Bulletin 1758. Geological Conditions near Bridgeport and Chico, Wise County, Emil Bose.

Bulletin 1818. The Geology of Dallas County, E. W. Shuler.

Bulletin 1869. The Geology of East Texas, E. T. Dumble.

Bulletin 1931. The Geology of Tarrant County, W. M. Winton and W. S. Adkins.

Bulletin 2229. The Geology of Johnson County, W. M. Winton and Gayle Scott.

Bulletin 2544. The Geology of Denton County, W. M. Winton.

Bulletin 2710. The Geology of Cooke County, Texas, H. P. Bybee and F. M. Bullard. Petroleum Developments in Cooke County, E. M. Hawtof.

Bulletin 3224. The Geology of Wise County, Texas,Gayle Scott and J. M. Armstrong.

Publication 3818. The Geology of Leon County, Texas, H. B. Stenzel.

Publication 4246. Building Stones of Central Texas, V. E. Barnes, R. F. Dawson, and G. A. Parkinson.

Publication 4824. Geological Resources of the Trinity River Tributary Area in Oklahoma and Texas, H. B. Stenzel, A. E. Weissenborn, and others.

Publication 5724. Geology of Parker County, Texas, Leo Hendricks.

Publication 5905. Symposium on Edwards Limestone in Central Texas, in Part.

Mineral Resource Series:

No. 9. Glass Sands in Leon County, Texas, H. B. Stenzel.

No. 29. Index to Mineral Resources of Texas by Counties, E. H. Sellars and G. L. Evans.

No. 7. Report on Road Metals Investigation as a Part of a Mineral Resource Survey in Limestone County, Texas, I. J. Broman.

No. 10. Report on the Building Stone Deposits in Burnet County, Texas, V. E. Barnes.

No. 21. Preliminary Report on the Mineral Resources of Freestone County, Texas, Bruce Whitcomb.

No. 23. Report on the Mineral Resources of Leon County, Texas, Davis Crow.

No. 24. Report on the Gravel Resources of Henderson County, Texas, G. L. Evans.

No. 25. Report on the Mineral Resources of Houston County, Texas, Horrace Harrington.

No. 44. Report on Fluxing Limestone at Palestine Salt Dome, Anderson County, Texas, J. H. McCammon.

Theses bibliographies of SMU, TCU, University of Texas, Baylor University, and University of Houston.

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LETTERS OF COMMUNICATION

TEXAS INDUSTRIES, INC.
P. O. BOX 400 • ARLINGTON, TEXAS 76011 • DALLAS TA • 4111 • FORT WORTH GL 1-6311

April 26, 1965

Statement Made by Cedric Willson at Washington Meeting Concerning Trinity River Canal Project. April 22, 1965.

I am Cedric Willson of Dallas, Vice-President of Engineering for Texas Industries, Inc. I have been in the portland cement and concrete business for over 35 years, 25 of which have been in Texas. This time has been about equally divided between the Gulf Coast and North Central Texas. Texas Industries, Inc. is engaged in every phase of the concrete business. We have very substantial operations in the Dallas-Fort Worth area, as well as a number of other large cities in Texas, Louisiana and five other states farther inland.

We produce, use, sell and purchase a large volume of sand, gravel and crushed stone. The availability of these aggregates in specification quality at a low cost is of major importance to the concrete industry and the entire construction business.

The practical sand and gravel man, whether he be producer, purchaser, or perhaps both, is primarily interested in the cost of specification aggregates delivered at the point of use... the concrete batching plant or job site. He is not concerned with the transportation cost per se, but rather the combined cost of production and transportation which are of equal importance to him since together they determine the delivered selling price. Sand and gravel are probably the only commodities whose production cost as well as transporation will be influenced by construction of the canal, and failure to take this into account is completely unrealistic.

We produce sand and gravel in both dry-land plants and by pumping with shallow water dredge equipment. Construction of the canal would make possible hydraulic production operations for a minimum of 75% of the sand and gravel in the flood plain of the river at a savings of approximately one-half over a dry-land plant. Our records indicate this would amount to about 35 cents per ton, a savings which must be credited to the canal if a true picture is to be developed.

The cost of transporting up-bound sand and gravel into the Dallas-Fort Worth area is not complete from the standpoint of producer or purchaser until all transportation costs involved in delivering these aggregates to the point of use have been considered. In a majority of cases he cannot stop with the delivery of a barge to the dock or rail car to the switching yards or a team track. It must be realized the only meaningful figure to him is the total delivery cost of these heavy low-value materials to the concrete plant or job site.

I have estimated the up-bound towing charge at 7 mils per ton mile which takes into account delays in moving through locks. The possible delivery combinations and average estimated cost of each based on an 80 mile haul by barge, rail or truck into Dallas or Tarrant Counties are:

Basic Costs Used For Estimating

Motor truck	80 miles at 2.75¢ per ton mile	220 cents
Barge tow	80 miles at 0.70¢ per ton mile	56 cents
Rail	80 miles (single line)	123 cents
Unload barge to truck		15 cents
Unload rail car to truck		10 cents
Average truck haul to plant or job from dock or track	10 miles at 3.00¢ per ton mile	30 cents

Point of Use Is:	Basic Delivery, Cents Per Ton By: Truck	Rail	Barge	Savings, Cents Per Ton For Barge Movement Over: Truck	Rail
off water - off rail	220	163	101	119	62
off water - on rail	220	123	101	119	22
on water - off rail	220	163	71	149	92
on water - on rail	220	123	71	149	52

Based on their locations and the facilities at existing batching plants, together with projections of major concrete marketing areas, I estimate average savings in transportation to the point of use for the 80 mile movement to be 65 cents per ton. In order to determine the true savings in delivered cost at points of use which properly should be credited to the canal, the savings in production cost of 35 cents per ton due to a hydraulic rather than a land operation must be added to the transportation savings. Most of the sand-gravel within the flood plain of the Trinity south of Dallas can be produced by the hydraulic operation.

The Corps of Engineers traffic study for the canal indicated no further down-bound movement of sand and gravel after approximately 71,000,000 tons had moved into the Houston-Galveston area through 1988, 30 years after the base year of 1958. Since their construction index showed an increasingly greater potential market each year through the end of the study in 2070, we must conclude this 71 million tons was their estimate of the total reserves between Liberty and CM 91, the most northerly point shown for the down-bound movement.

Our investigations show this to be a most conservative figure and that the sand-gravel reserves below CM 91 exceed 200,000,000 tons. Further, between CM 125 and CM 91 there is a virtual unlimited supply, specifically in excess of one billion tons within the flood plain of the river.

A reasonable estimate of the down-bound towing cost from CM 125 to Houston is 5 mils per ton mile since there would be very little lockage delay. The 160 mile tow would cost 80 cents per ton~~-mile~~ and the delivered cost should reflect the difference in production cost of a hydraulic operation as compared to a plant on land which I have estimated to be a savings of 35 cents per ton.

The construction of the canal will assure both the Dallas-Fort Worth and Houston-Galveston areas a long-time future supply of lower cost, high quality concrete aggregates. Low cost concrete has great influence on low cost construction which is so important in the continued industrial and commercial growth of both areas.

Cedric Willson

STATEMENT BY: Mr. Roy Stanley
Gifford-Hill Company

February 3, 1967

Brig. General William T. Bradley
Division Engineer, Southwest Division
U. S. Army Corp of Engineers
1114 Commerce Street
Dallas, Texas 75202

Dear General:

Re: Canalization of Trinity River in Texas

I am Roy Stanley, Manager Exploration and Testing Department of Gifford-Hill & Company, Inc., having been with this Company for the past twenty (20) years, with twenty (20) years prior to this with other companies operating sand and gravel and crushed stone facilities on and near the Trinity River. I have tested lands along the Trinity River from Fort Worth to approximately seven (7) miles South of the City of Liberty, Texas.

It is my responsibility to test and evaluate sand, gravel, stone deposits for acquisition by Gifford-Hill & Co., Inc.

We produce, use, sell or otherwise dispose of sand, gravel, crushed stone to the construction industry and are at the present time operating production facilities in Texas, Arkansas and Louisiana, producing washed, screened, crushed and prepared to specifications aggregates for the industry.

It is also my responsibility to locate and acquire at the most available and economical source materials for the market. In this scope we are familiar with freight rates by rail, trucks, and water.

It is my opinion that a canal along the Trinity River Basin would be the most economical method of transportation for the deposits of aggregates undeveloped along its course. I say this because rail facilities are not available at reasonable distances from these deposits. The St. Louis-Southwestern Railroad Crossing the Trinity at Trinidad, Texas; The Missouri-Pacific Crossing at Long Lake, Texas, and Trinity, Texas; Southern Pacific at Urbana, Texas; The G. C. & S. F. Railroad near Rye, Texas; and Liberty, Texas, and many of the better sources of these materials are located between these crossing points. In the event the Trinity River is canalized, all the transportation problems to the sand and gravel industry would be solved and the Federal, State, and local government, in addition to the general population, would be greatly benefited through the transportation savings thereby effected by such barge transportation. Sand and gravel is now being moved into Houston from a distance of 80 miles at a freight rate of $1.23 per ton. This same materials could be moved from the Trinity River Basin from a distance of 168 miles at the same cost. Estimating, we would say that in the 168 miles from Houston, North, aggregate would be had for transportation to Houston in excess of three (3) billion tons, with a like amount moving North to the Dallas, Fort Worth market. We base these figures on testing we have done along the Trinity River from Dallas South to approximately five (5) miles South of Liberty, Texas.

We know that practically all Trinity River deposits between Dallas and Fort Worth have or will be exhausted within the next five years; therefore, the major portion of the construction materials will move up river from South of Dallas, Texas to the Dallas-Fort Worth area. We of the industry are well aware that sand and gravel deposits lying south of Dallas along the Trinity River will eventually move to the Dallas-Fort Worth metropolitan area regardless of whether or not the canal is built. However, with the canal we have estimated below the savings that would be effected by such a waterway. In estimating the savings by water barge transportation over other methods, we give you the following for comparison:

Motor Truck	100 mi. - @ 3¢ per ton mile	300 cents
Barge tow water	100 mi. - @ 5 mills per ton mile	50 cents
Rail	100 mi. - @ published rate	138 cents

Actual transportation savings by different carriers over water barge cost -

Motor Truck	100 miles	300 cents
Water (barge)	100 miles	50 cents
Savings to Consumer -		250 cents
Rail	100 miles published rate	138 cents
Water (barge)	100 miles	50 cents
Savings to Consumer		88 cents

This will give you the estimated savings to the consumer, which amount in dollars based on 1/2 the tonnage estimated moveable on a barge canal to Houston, in excess of $1,200,000,000 and a like savings for materials moving to Dallas and Fort Worth. This sounds unrealistic, but with a savings of 88 cents per ton on a 100 mile haul - is very realistic.

I should mention also that lakes to be built along the waterway will inundate a portion of sand and gravel deposits that occur along the Trinity watershed and that the Corp of Engineers should allow dredging to be done along the edges of such lakes to remove sand and gravel therefrom.

I mention this because sand and gravel is not now or doubtful if materials will be deposited again along this stream. All deposits of sand and gravel in Texas and Louisiana are alluvial in nature and such deposits when depleted or made inaccessible to producers by building lakes, takes away forever the materials needed for the construction industry and will not be replaced without a catastrophe or the same conditions that caused the original deposits again occurs.

Therefore, the construction and maintenance of the Trinity River Canal will serve the Southwest and South Central Texas for generations to come and will make construction aggregates available, which is essential to growth economy of our major cities and effect great savings to our population.

Yours very truly,

Roy Stanley - Manager
Land Exploration Department
GIFFORD-HILL & COMPANY, INC.

RS:nch

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SUPPLEMENT I TO EXHIBIT 2
SAND, GRAVEL, AND STONE STUDY

Supplement I EXHIBIT 2
APPENDIX II

SUPPLEMENT

TO

TRINITY RIVER WATERWAY SPECIAL STUDY

SAND - GRAVEL - STONE

William D. Miller
WILLIAM D. MILLER,
Resource Analyst

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TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

SCOPE OF WORK

The original work to be accomplished under contract DACW-64-67-C-0067 is outlined in Exhibit II, pp. i-ii. Additional work proposed under the same contract is as follows:

(A) Guadalupe River Sand and Gravel Reserves. To the extent practicable and without field surveys or soil explorations, obtain and furnish information on the location of sand and gravel deposits in the Guadalupe River basin from approximately 10 miles south of Victoria, Texas, upstream to the vicinity of Hochheim, Texas. The information shall cover deposits suitable for mining commercially under present market prices, shall include estimates of quantities in the deposits, and an assessment of quality of materials in the deposits related to use for concrete aggregate, road subbase materials, etc.

(B) Supply Sources of Houston-Galveston Regional Market Without Trinity Waterway. Based on the previously developed information and the additional information to be developed for the Guadalupe River reserves, forecast the probable supply pattern of the Houston-Galveston market through the year 2035, assuming the Trinity Waterway is not constructed. This forecast should take into account the known deposits on the Colorado River above Columbus, the Trinity River deposits above Cleveland, and the market demands of the Victoria, Corpus Christi, and Rio Grande areas with respect to the Guadalupe River deposits. In this analysis, the influence of barge transportation from the Victoria area via the Guadalupe River, channel to Victoria, and the Gulf Intracoastal Waterway to Galveston-Houston, Corpus Christi, and the Rio Grande area should be taken into account. In the event there are no appreciable supply sources on the Colorado River above La Grange, possible additional sources on the Brazos River or on the Guadalupe River above Hochheim should be investigated.

(C) Role of Seagoville and Other Nearby Sand Deposits in Future Sand Market of Dallas-Fort Worth Area. Information should be developed to determine the future market role that the remaining sand will have in supply to the Dallas-Fort Worth market. This determination should be made separately under the assumption that the Trinity Waterway will be constructed by 1985 and under the assumption that the waterway will not be constructed. If it is found under either or both assumptions that the Seagoville sand will not supply the sand market, the pattern of supply through the year 2035 should be identified and the reasons for non-use of the Seagoville sand should be set forth. If it is found that both sand and gravel would move by barge from the same Trinity River deposits with the waterway constructed, the ratio of sand-to-gravel movement should be estimated and discussed.

(D) Chico-Bridgeport Manufactured Aggregate. Information should be developed to demonstrate what percentage the Chico-Bridgeport crushed aggregate, in the absence of the Trinity Waterway, would capture in the future aggregate market of the Dallas-Fort Worth area, when present supply sources of natural aggregates are depleted.

(E) Use of Crushed Aggregates vs Natural Aggregates Related to Product Needs. Information should be developed to indicate the factors influencing the choice of natural or crushed aggregates in their various uses, and, assuming price equality, identification of specific uses that could best be served by both types of aggregates.

(F) Crushed Stone vs Natural Aggregates Related to Cost of Production and to Market Prices of Finished

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Products. (1) Information should be developed on the factors entering into the costs of production of both crushed stone and natural aggregates to the point that a meaningful comparison can be made. (2) Information should also be developed on the factors entering into the prices of concrete, the primary product of the companies, and (3) relationship between the various factors influencing these prices, including cost of production, cost of transportation, profit considerations, competitive relationships, and others.

TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

LIST OF FIGURES AND TABLES

APPENDIX

INTRODUCTION

This report constitutes a supplement to the original sand, gravel, and stone study prepared in 1967. Additional information was developed to revise the reserve estimates for the Victoria area, and for the area between La Grange and Columbus, and north of La Grange.

The study includes a discussion of the 1967 production, market patterns, and the reserve estimate for sand and gravel along the Gulf Coast from Victoria to Brownsville.

More definitive data are presented on sand reserves and supply patterns for the Dallas-Fort Worth area, and on the economics of the sand, gravel, and stone market.

The supplemental report was initiated and completed in March and April of 1968.

RESERVES OF SAND AND GRAVEL ALONG GUADALUPE RIVER FROM BLOOMINGTON TO HOCHHEIM, TEXAS

Contract requirements include the area from about 10 miles south of Victoria (Bloomington) to Hochheim, Texas. For purposes of discussion the Guadalupe deposits are divided into three geographic areas. The areas are from Bloomington to Victoria, Victoria to Cuero, and from Cuero to Hochheim (See Fig. 1).

Bloomington to Victoria (South)

Commercial deposits of sand and gravel are situated along the Guadalupe River from Victoria to the north side of the Victoria channel harbor. There is one major producer that entered into production in 1968 on the north side of the channel harbor which is located about five miles south of Victoria. Another major producer is expected to be operating near the harbor before the end of 1968.

The deposits south of Victoria and around the city of Victoria yield sand and gravel in ratios varying from 30% gravel-70% sand to 70% gravel-30% sand. Deposits with the high gravel-sand ratios are found around Victoria. South of the Victoria harbor toward Bloomington the deposits have high sand percentages and will not be worked. Based on previous production history and exploratory work of several operators, the

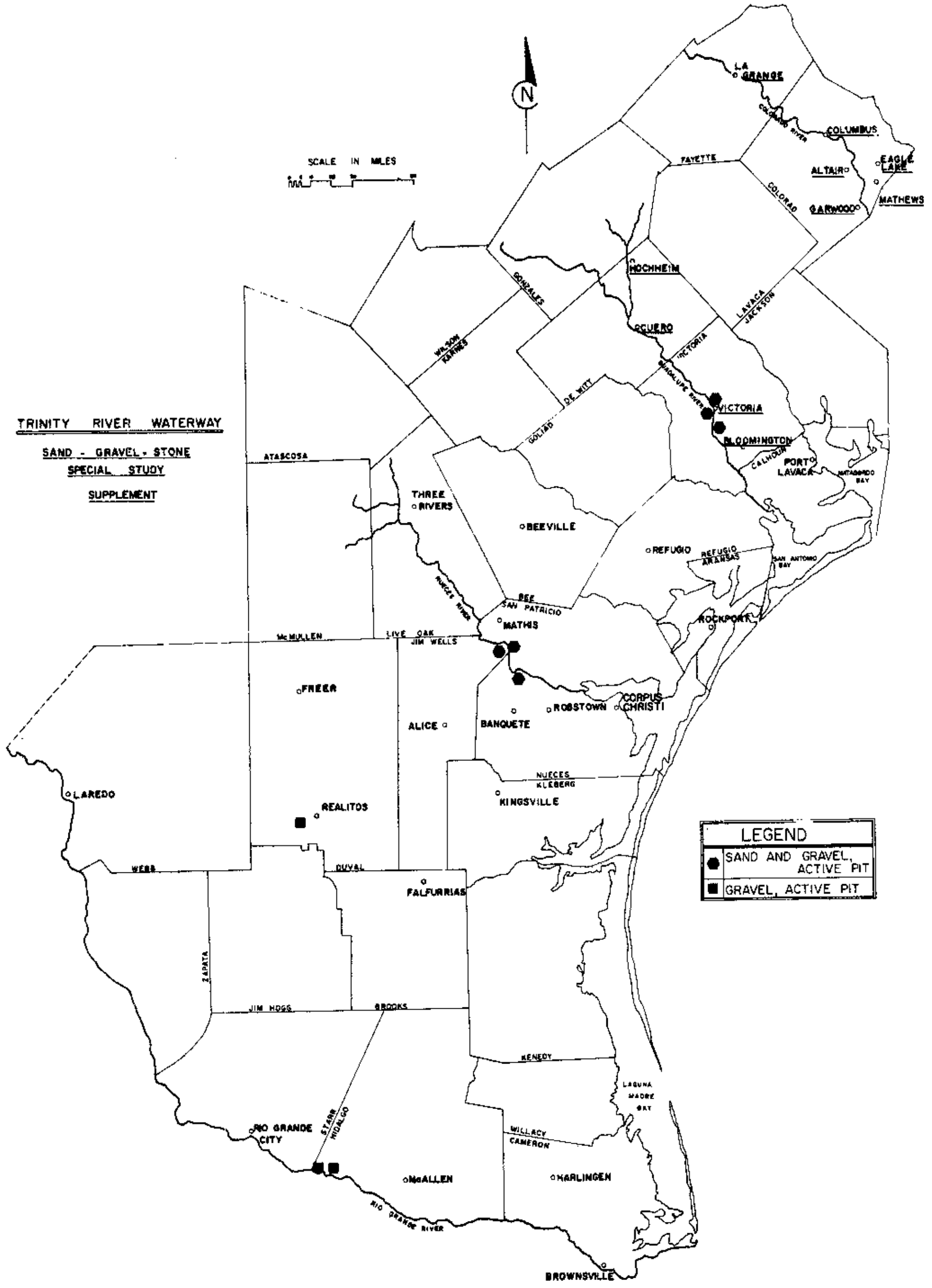

FIGURE I: LOCATION OF PRODUCING SAND AND GRAVEL DEPOSITS, 1968 deposits south of Victoria to the channel harbor are expected to yield up to 40,000 tons of recoverable and salable aggregates per acre. The workable deposits in the area between the channel harbor and Victoria have an average 16' of overburden and 20' of sand-gravel. Total quantity of reserves that are economically producible under present-day market prices are concealed in the reserve figures presented under the following Victoria-Cuero discussion. Concrete-quality sand and gravel in all size grades are produced from the Guadalupe deposits.

Victoria (North) to Cuero

There are two major producers in the area immediately north of Victoria (Fig. 1). One of the producers is expected to move operations south of Victoria in 1968 in order to take advantage of barge transportation.

The commercially worked deposits north of Victoria yield sand and gravel up to ratios of 70% gravel-30% sand. This high gravel-sand ratio north of Victoria is consistent for the area within a 4-mile radius. The working deposits north of Victoria yield an average 34,000 tons/acre. Overburden averages about 12' in thickness, and the sand and gravel averages about 16'.

The following estimate of reserves, economically producible under present market prices, includes the reserve estimate for the Bloomington-Victoria (South) area, and only those reserves within near proximity to the north of Victoria. The accountable reserves are estimated at 125,000,000 tons.

Beyond the present producing localities and the associated reserve deposits, a large quantity of commercial sand and gravel occurs as far north as Cuero. These deposits are not economical to market outside the Victoria area under present conditions due to competitive transportation of closer deposits via the Victoria channel and Intracoastal Waterway. These deposits are also not produced locally because of the Victoria production.

The location and tonnage of reserves in detail between Victoria and Cuero are admittedly known by one company. This information was received in confidence by the consultant. The reserves are accounted for in the projected supply pattern for the Houston-Galveston Region. Concrete-quality sand and gravel in all size grades are available in this zone.

Cuero to Hochheim

There are no major producers with experience in this area. Some small operators have produced only for local consumption and, therefore, widespread detailed data are not known. According to Texas Highway Department engineers at Victoria and Yoakum, the deposits are generally of low quality and in short supply for major production. Pit-run material has been used for base and sub-base materials. As far as could be determined, reserves are minimal for this area in comparison to the region south of Cuero.

Conclusion

Reserves of concrete-quality sand and gravel known around Victoria and south to the harbor are estimated at 125,000,000 tons. Considering only present demands for sand and gravel aggregates for the Victoria, Corpus Christi, and Rio Grande Valley markets (See next section to follow), production could be sustained for well over 75 years from deposits in the Victoria vicinity. This life expectancy figure does not include the deposits between Victoria and Cuero that are outside the Victoria "production-reserve" locations.

Demands will be imposed upon Victoria reserves for the Houston-Galveston market in 1968 and beyond. Therefore, the life expectancy of the deposits will be greatly shortened (See section entitled, Future Supply Pattern of Sand and Gravel for Houston-Galveston Market to Year 2035, Without Trinity River Waterway).

SAND AND GRAVEL PRODUCTION IN VICTORIA, CORPUS CHRISTI, AND RIO GRANDE VALLEY REGION

Location, Quantity, Quality of Sand and Gravel

Sources of specification-quality sand and gravel are located (1) near Victoria, (2) along the Nueces River northwest of Corpus Christi, and (3) in the Rio Grande Valley (See Fig. 1). The locations identified represent the source for about 98% of the sand and gravel production for the region.

The quantity of sand and gravel aggregates produced in 1967 in the region totaled 2,325,300 tons (Table 1). Victoria production averaged 30%-40% sand and 60%-70% gravel, and Nueces production averaged 20% gravel and 80% sand. The 1967 production for the Rio Grande Valley averaged 80% gravel and 20% sand. The Victoria deposits may be considered as a major source for gravel and sand, the Nueces deposits as a main source for sand, and the Valley deposits are essentially gravel.

All size grades of gravel are produced at the Victoria and Nueces locations, with the greatest percentage of gravel being produced at Victoria. The Rio Grande Valley is quantitatively deficient in sand, and produces all size-grades of gravel. Concrete-quality aggregates are produced in all three areas.

TABLE 1

TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

Sand-Gravel Production for Victoria,

Corpus Christi, and Rio Grande Valley Region, 1967[1]

Location[2]	Material	Quantity (short tons)
Victoria, Nueces River[3]	gravel, sand sand, gravel	1,573,300
Rio Grande Valley	gravel, sand	752,000
	TOTAL	2,325,300

[1]List of producers in Appendix, Table B.

[2]See Figure 1 for locations.

[3]Areas combined to protect confidential information.

Market Demand and Supply Pattern, 1967

The market demand for sand and gravel approximated 2,325,300 tons during 1967 for the area under consideration (Table 1).

The Victoria market (50 mile radius) and areas to the east consumed 596,300 tons of sand and gravel in the ratio of 60% gravel and 40% sand. The Corpus Christi area consumed* 1,017,000 tons of sand and gravel in a ratio of about 60% gravel and 40% sand. The Rio Grande Valley market from Laredo to Brownsville consumed 712,000 tons of sand and gravel in a ratio of 60% gravel and 40% sand.

Major movements of sand and gravel in the Victoria market (50 mile radius) were by truck, and a small volume was moved by rail to the area east of the Victoria market (Fig. 2). Future movements will occur in large volume by barge to the Houston-Galveston region during and after 1968. Sand and gravel were moved by rail (40%) and truck (60%) from Victoria to the Corpus Christi area. The ratio of sand-to-gravel movement to Corpus Christi was about 15% sand and 85% gravel. The gravel was used with sand from the Nueces deposits. The total tonnage is not given in order to protect confidential data, however, the quantity (and shell also) is considered in the report when evaluating the probable supply pattern for the Houston-Galveston Region.

*Approximately 725,000 tons of shell were also produced for aggregates.

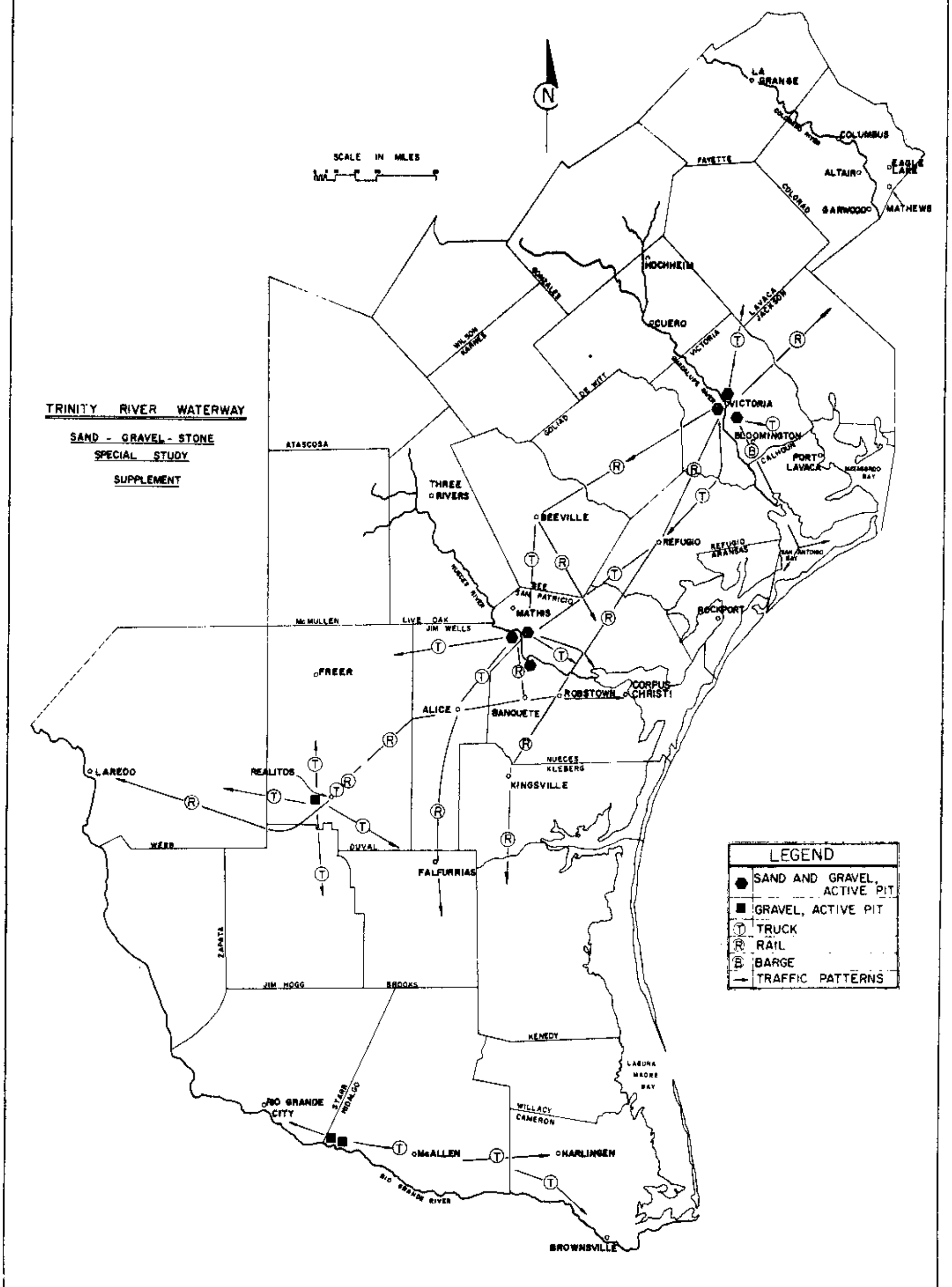

FIGURE 2 SAND AND GRAVEL TRANSPORTATION MODES, TRAFFIC PATTERNS, MARKET AREAS, 1968

Sand was shipped principally via rail to the Rio Grande Valley from the Nueces deposits. The sand requirement satisfied the use with gravel produced in the Valley. Gravel was moved via rail and truck from Realitos (Fig. 2) to the Corpus Christi market to be used with sand from the Nueces deposits.

Reserves of Sand and Gravel

Reserves of sand on the Nueces River are estimated at 30-35 million tons from the present localities to the dam at Mathis. From Mathis to Three Rivers, another 20-25 million tons are available (Fig. 2). There are no deposits of value known above Three Rivers. Future leased reserves in the area are in short supply. If the total estimated reserves are produced, the supply will be depleted by 1985 to 1990.

Reserves of gravel in the Rio Grande Valley are sufficient to last well beyond the year 2035. None of the Valley deposits will be marketed east of Corpus Christi in the foreseeable future.

PROBABLE SUPPLY PATTERN OF HOUSTON-GALVESTON SAND AND GRAVEL MARKET THROUGH THE YEAR 2035

A review of present sand and gravel reserves, production, and supply pattern in the region is presented as a background to developing the future supply pattern. A portion of the information to follow was developed in the 1967 Trinity River Waterway Sand, Gravel, and Stone Study.

Reserves East of Houston: San Jacinto and Trinity Rivers

Production east of Houston is essentially sand. The San Jacinto sand is fine and is used in concrete as an admixture with the sand and gravel shipped from west of Houston, and is mixed with Gulf Coast shell for road-base material. The Trinity River sand and gravel are used in concrete and for road-base material.

Based upon the sand production in 1966 and information on reserves obtained from the producers, 15-to 30-years of reserves are estimated to be in present producing localities (Exhibit 2, p. 298, par. 39).

Additional sand reserves are known along the Trinity River (Exhibit 2, Fig. 3, P. 296), but at present are noncompetitive with transportation and production costs in producing areas. According to three companies, sufficient sand reserves are located in the producing areas and to the north of Cleveland to supply the demand to the year 2035.

Colorado River Reserves

For purposes of discussion the Colorado River reserves are divided into three geographic areas. These areas are Columbus-Altair-Eagle Lake, Columbus to La Grange, and North of La Grange. Producing localities along the Colorado River were grouped under the title Columbus-Altair-Eagle Lake and La Grange in the original study.

Columbus-Altair-Eagle Lake. All the present producing localities near Columbus and south of Altair-Eagle Lake are included in this area. Sand and gravel occurs south to Garwood (Fig. 1) but beyond, the overburden becomes a problem in mining costs.

The reserves located in the Altair-Eagle Lake area and at Columbus are estimated to last for 25- to 30-years of production. This includes the foreseeable demands anticipated by the producers. Production in 1966 was estimated at 7,300,000 tons, which included La Grange.

Columbus to La Grange. Substantial reserves are known north of Columbus but the future availability of the deposits depends upon the pending Lower Colorado River Authority dam above Columbus. Substantial reserves are also known around La Grange. It is estimated that another 20 years of production beyond the 25- to 30-years predicted for the Columbus-Altair-Eagle Lake area could be sustained in the Columbus to La Grange region. Production is not possible now beyond the producing localities north of Columbus and at

La Grange. The reason is due to deposits closer to rail transportation. The materials will be produced at some future date if transportation facilities are available. The 1966 production at La Grange is concealed in the Columbus total.

North of La Grange. There are no major producers operating north of the La Grange vicinity due to lack of competitive transportation facilities. The only information that could be developed on reserves is that large deposits are available to the north but the tonnages are unknown.

Victoria Reserves

Reserves are estimated at 125,000,000 tons at Victoria and south to the channel harbor (See section entitled, Reserves of Sand and Gravel along Guadalupe River). Large volumes of reserves are known north of the sand-gravel production around Victoria and up to Cuero. The tonnage of these reserve are concealed, and they are considered important to the total supply from this area.

Supply Pattern of Sand and Gravel for Houston-Galveston Market, 1966

The Houston-Galveston market used 10,510,000 tons of sand and gravel in 1966. Approximately 70% was moved west-to-east from Columbus-Altair-Eagle Lake to Houston and points beyond.

The other 30% was produced around Houston and areas to

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the east. A large percentage of this was used north and east of Houston.

There has been no large quantity of gravel and sand from Victoria marketed to the east of the Victoria market (50 mile radius) prior to 1968. In 1968, the Victoria deposits will supply gravel and sand to the Houston-Galveston market via the Victoria channel and Intracoastal Waterway.

<u>Future Supply Pattern of Sand and Gravel for Houston-Galveston Market to Year 2035, Without Trinity River Waterway</u>

The following factors and contingencies must be considered in developing the supply pattern through 2035.

(1) Demands on the Victoria deposits to supply a market in the vicinity, and in the Corpus Christi area.

(2) Reserves around Victoria (125,000,000 tons).

(3) Reserves between Victoria and Cuero (Concealed).

(4) Reserves on Nueces River (50-60 million tons), and in the Rio Grande Valley Region (available beyond 2035).

(5) Reserves in the Columbus-Altair-Eagle Lake area (∠275,000,000 tons, including production location at La Grange).

(6) Reserves between Columbus and La Grange (20 year supply).

(7) Substantial reserves north of La Grange.

(8) Reserves of sand east of Houston (available through year 2035).

(9) Shell production for aggregates (4.5 million tons/year, Galveston-Houston-Corpus Christi area).

(10) Possible stone supplies from New Braunfels area (reserves beyond 2035).

Total reserves accounted for between the Victoria channel harbor and Cuero, and from Altair-Eagle Lake area to La Grange are estimated at £700,000,000 tons. This includes the known reserves that have been delineated plus the concealed reserves. This figure is minimal because it does not consider the undetermined quantity of reserves north of La Grange.

Additional reserves in the form of stone in the New Braunfels Region are available to supplement and/or replace these quality gravel deposits. Considering the stone reserves plus the gravel, sand, and shell reserves, it is established that coarse aggregate will be available to the Gulf Coast market through the year 2035. Should shell be depleted or restrictions imposed, the stone deposits would assure a supply of aggregates through the year 2035.

In considering only the gravel and sand deposits, if stone were not used, reserves are not sufficient to supply the Houston-Galveston and Victoria-Corpus Christi sand and gravel market through the year 2035 without going outside the localities delineated in this study along the Colorado and Guadalupe Rivers. The total area delineated in the report will be depleted, without the use of stone, around 2000 to 2005. Due to increasing transportation costs, stone will acquire a portion of the gravel market.

Since Victoria and Columbus-Altair-Eagle Lake will be the major sources for coarse aggregate production in the future, the life expectancy of these two areas are dependent upon one another. As indicated previously, producers in the Columbus-Altair-Eagle Lake area claim sufficient reserves for 25 to 30 years of supply. Considering the additional reserves north of Columbus and at La Grange, and future supply from Victoria, the predicted 25- to 30-year production is completely plausible. The percentage of the market that Columbus will maintain will depend upon increasing costs that will occur in hauling materials that are farther away from debarkation points to Houston. Victoria will be competitive in the Gulf Coast concrete market during 1968 and for some time beyond. This would indicate that Columbus-Altair-Eagle Lake will not capture a greater than present ratio of the aggregate market (which is in supply-demand balance), but will decrease its percentage in the near future.

Considering the delineated reserves of $\not\leq$400,000,000 tons (excludes concealed reserves) in the 1968 producing areas (La Grange, Columbus-Eagle Lake, Victoria), and demands for aggregates from Corpus Christi to Beaumont-Port Arthur, these areas are completely capable of supplying the market beyond 1985.

Producers at Victoria expect to capture about 10% of the sand-gravel market by 1970. Beyond 1970 to 1985, 10% to 30% of the market is allocated to Victoria. This is a very conservative figure according to the Victoria producers, and is optimistic according to the Colorado River producers.

Assuming the Victoria market captures 30% of the Houston-Galveston market, and sustains the projected demands for the Victoria and Corpus Christi markets, the production-reserve locations around Victoria will be productive beyond 1985. With 30% of the future Houston-Galveston market, to 1985, allocated to the Victoria deposits, Columbus-Altair-Eagle Lake, La Grange will also be productive beyond 1985. At this point in time, the Victoria vicinity and Columbus-Altair-Eagle Lake, La Grange area should have at least

150,000,000 tons remaining. The remaining 150,000,000 tons of reserves for both areas should be depleted in the early 1990's. This still leaves reserves located between Cuero and Victoria, part of the reserves between La Grange-Columbus, and north of Columbus. Reserves between Columbus and La Grange are so far removed from existing rail heads that stone from the New Braunfels Region will capture some of market in the 1980's.

As a basis for establishing the projections for stone, a review of comparative transportation costs for sand, gravel, and stone is considered. Sand and gravel are shipped via rail from the Colorado River to Houston for $1.16 to $1.23 per ton. Shipments to Galveston and vicinity are $1.60 per ton (Exhibit 2, p. 316).

Stone is shipped via rail from New Braunfels, Georgetown, and San Antonio to Houston for $1.77 to $2.06 per ton. Shipments to the Galveston vicinity cost $2.08 to $2.28 per ton (Exhibit 2, p. 343).

The transportation advantage for natural aggregates is 61¢ to 83¢ per ton to Houston, and 17¢ to 68¢ per ton for the Galveston vicinity. Some of the deposits between Columbus and La Grange are 10-15 miles from the nearest railroads. Deposits just north of La Grange are an average 5 miles from the nearest rail facility. Short-haul trucking costs of 6¢/ton-mile would make stone competitive with many of the sand and gravel deposits along the Colorado River.

To summarize to this point in the discussion, it is conceived that aggregates from the Guadalupe and Colorado river deposits are in sufficient supply and can be competitively marketed into the 1990's. By this time, crushed stone will have acquired a substantial portion of the market. During the 1980's to the early 1990's, the market will be divided between Victoria, Colorado River, New Braunfels Region, and the Trinity River. Due to increasing costs to market Colorado River gravel, the Victoria area will undoubtedly capture a steadily increasing percentage of the market up to 1985-1990. The maximum sustained percentage is limited by the reserves that are readily accessible to the Victoria Channel.

Reserves of gravel and sand between Cuero and Victoria will have to supply the Victoria market, Corpus Christi market, and continue to substitute for the Nueces sand that is expected to be depleted in the 1980's. If the area supplies Houston-Galveston, it will have to compete by rail and/or truck-barge combinations.

The remaining Colorado River deposits would have to compete by truck and/or extended rail shipments to the Houston-Galveston markets. The stone market would be supplied via rail. The Colorado and Guadalupe deposits, plus stone deposits, would also substitute for shell if and when it is depleted (1985-1990) (Exhibit 2, p. 331, par. 147).

Looking collectively at the total delineated sand and gravel reserves, the stone market will be very competitive with the predicted reserves remaining beyond the 1990's. This could extend the life expectancy of sand-gravel reserves. The predicted demand for aggregates will be so great, however, that natural aggregates will not be available to 2035. Without the stone, all sand and gravel reserves enumerated would be depleted between 2000 and 2005. The next major source would be from north of La Grange. The market pattern is so speculative during this period that no distribution pattern is suggested. One must conclude that stone will share a large part of the 2000-2035 market due to ever increasing transportation costs for natural aggregates.

Seagoville Deposits

Previous study (Consultants Trinity River Waterway Sand-Gravel-Stone Study, Exhibit 2) indicated that Trinity River sand (and gravel) deposits west and north of Dallas will be essentially depleted by 1971-1973 (p. 297, par. 31). Additionally, prolific sand (and gravel) production at Seagoville is expected to decline by 1985 (p. 297, par. 32).

No evidence in the previous study (Exhibit 2) or in the survey made as a part of this supplemental study has been developed to indicate that a "large" volume of sand will remain after the available gravel has been depleted. The maximum cumulative tonnage that will be stockpiled in excess of the marketed gravel is estimated at 5 million tons.

In explanation, Trinity River aggregates average 15% to 30% gravel (plus #4 sieve) with a maximum abundant grade-size of 3/4-inch material. All Trinity River deposits consist of sand-<u>and</u>-gravel, however, the deposits are predominantly sand.

A concrete market, as Dallas and Fort Worth, requires about 60% coarse aggregate and 40% fine material (minus #4 sieve). Large grade-sizes are required for construction concrete ($\leq$1 1/2-inch) and for paving ($\leq$2 1/2-inch). Therefore, the deposits cannot supply the necessary quantity of larger grade-sizes nor the necessary ratio of sand-to-gravel. The coarse grade-size requirements and additional volumes of coarse aggregate are supplied from Chico and Palo Pinto crushed stone. The sand requirements are met essentially from the Trinity River deposits. No "large" volumes of excess sand are produced to obtain gravel, on the contrary, Trinity River deposits are produced for the sand and gravel. This situation has not always existed but exists now and will for the foreseeable future.

In conclusion, all marketable sand (and gravel) will be produced at Seagoville with or without a waterway.

Because reserves at Seagoville and areas along the Trinity River to the north cannot supply all future sand requirements, other sources will be developed. Sand will be moved from south-to-north, with or without a waterway, from along the Trinity River south of Seagoville. Reserves are known along the boundary of Ellis and Kaufman Counties (Exhibit 2, Fig. 3, p. 296).

Brazos River Deposits

Sand (and gravel) will be moved from the Brazos to the Fort Worth-Dallas market in increasing quantities within the next few years. Brazos deposits average 40%-60% sand. By the time the Seagoville deposits are depleted, and without a waterway, the Brazos is expected to capture up to 25% of the total aggregate market.

Supply Pattern of Sand for the Dallas-Fort Worth Market to Year 2035

Sand will continue to be moved from the Seagoville deposits up to time of depletion (≠1985). After this, sand will be moved from along the Trinity River in Ellis-Kaufman counties and Navarro-Henderson counties.

By 1971-1973, the Brazos will have assumed a substantial portion of the market. By 1980-1985, the Brazos will have obtained about 25% of the total aggregate market, of which 40%-60% will be sand. Without a waterway, the natural aggregate market will be split about evenly between the Brazos and Trinity Rivers. No Dallas-Fort Worth producer is knowledge enough to predict the total recoverable reserves along the Brazos but most do feel that marketable reserves will be limited in production after the middle 1980's. This is due to transportation and to lack of reserves.

Total reserves accounted for in Ellis-Kaufman counties approximate 110,000,000 tons (Exhibit 2, p. 300). These reserves are sufficient to supply the sand market for a period of only 8-10 years beyond 1985. It is projected that beyond 1995 the Navarro-Henderson counties deposits would be the closest, economical source for sand along the Trinity River.

In comparing present net costs of producing and delivering sand and crushed stone, and if all other factors could be equalized, sand could be transported, without a waterway, for distances of about 80 miles and still be competitive. This would permit development of sand and gravel deposits as far south as central Navarro-Henderson counties.

The demand for sand in the year 1995 may be on the order of 12,000,000 tons per year. The Trinity will be the main economical source for natural sand at this time. However, accountable reserves are not sufficient in Navarro-Henderson counties to supply the demand to the year 2035. Beyond this time, the three sources would be from farther down the Trinity and Brazos Rivers, and from crushed stone.

Ratio of Sand-to-Gravel Movement on a Trinity River Waterway

Trinity River deposits downstream will yield from 15%-25% gravel and 75%-85% sand. The ratio of sand-to-gravel movement will not exceed this on the proposed waterway. The expected sand-gravel movement is estimated to be not less than 75% sand and probably on the order of 80% sand and 20% gravel. The reasons for this conclusion are:

(1) The ratio of sand-to-gravel in Trinity River deposits.

(2) The unavailability of coarse gravel.

(3) Due to some gravel being required for the East Texas market.

Specific Uses Best Served by Gravel and Crushed Stone

Gravel is preferred in some constructional concrete because of its workability. The finishing is better and easier due to the smooth faces on natural aggregate.

Stone is best used in specifications requiring crushed faces. Stone also best serves requirements for strength, less impurities, cleanliness, size-grades, and particle control, and in some lower weight per volume advantages.

Factors Influencing Use of Gravel or Crushed Stone in Dallas-Fort Worth Market

No significant quantity of sand is manufactured from stone to substitute for natural sand because of the cost factor, and the nearby sand deposits of the Trinity River. The "screenings" obtained from the crushing process are marketed for filler in hot mix and concrete, for agricultural lime, sub-grade, blocks, etc. The fine grade-size is a by-product of the production of coarse aggregate.

In the Dallas-Fort Worth market the primary reason for the use of crushed stone is the lack of gravel in coarse grade-sizes from 3/4-inch to 2 1/2-inch or larger, and the low quality of the fine grade-sizes of gravel, 1/8-inch to 3/4-inch, that are available. The gravel is soft, flat (high length-width to thickness ratios), and may have adhering films of secondary calcium carbonate.

Availability of specific size-grades and location of material in relation to ultimate destination often determines which aggregate is used.

Assuming both materials are available, specifications may dictate the type of aggregate. Crushed aggregates are required in some of the Texas Highway Department flexible paving specifications. Uses include pre-coated surface treatment (type B & D aggregates), and flexible base (Class 1, type A & B). Another use for crushed aggregates, which for Dallas-Fort Worth is crushed stone, is in hot mix and hot-mix, cold-laid asphaltic concrete paving.

Chico stone is also widely used in grades #1 and #2 for concrete structures along highways. Concrete paving and constructional concrete aggregates often include crushed stone.

In addition to institutional specifications, engineers and technologists may prefer one material or the other, particularly in finishing concrete. If the specifications can be met with both materials, and they are available, the cost factor will usually favor gravel.

Future Role of Chico Crushed Stone

Chico stone is crushed and shipped to the Dallas-Fort Worth market to meet size and quality specifications lacking in Trinity River aggregates. The Trinity River deposits in the producing areas (1968) are deficient in quality of gravel and in coarse grade-sizes of gravel (>3/4-inch).

In the absence of a Trinity River Waterway, not all the future total aggregate market will be captured by stone. Sand cannot be produced from stone and compete with Trinity and Brazos sand deposits located near present producing localities. Therefore, the portion captured is essentially that which will replace gravel not available from the Trinity and Brazos Rivers. The 1966 Chico stone production represented $\nleq$35% of the <u>total</u> aggregate market and $\nleq$70% of the total <u>coarse-aggregate</u> market.

Without a waterway, the stone market is expected to increase due to increasing transportation costs for gravel. The maximum increase in the near future would not exceed the demand for coarse aggregates ($\nleq$60% of total market). The maximum increase that would occur represents about an additional 25% of the total aggregate market or $\nleq$30% of the coarse-aggregate market. The major producers feel that in reality, the coarse-aggregate market will not all be replaced by stone because of the Brazos River deposits and the preference of gravel in some concrete uses.

With a waterway, the stone market is not expected to decline due to the continued requirement for large size-grades of quality, coarse aggregate. Future increases in sand and gravel demands from along the Trinity River will be due essentially only to growth factors. Stone demands will also increase due to growth demands but should maintain approximately the same ratio of the present market.

In conclusion, without a waterway, Chico stone will not capture all the aggregate market when present producing localities are depleted. Stone will capture a larger percentage of the coarse-aggregate market, without a waterway, due to increased transportation costs from deposits farther away from present localities. At some future time when the Trinity and Brazos rivers cannot economically supply sand and gravel, a portion of the sand market and most of the gravel market may be captured by crushed stone (See section entitled, Supply Pattern of Sand for Dallas-Fort Worth Market to Year 2035).

CRUSHED STONE VS GRAVEL AS RELATED TO PRODUCTION COSTS AND TO MARKET PRICES OF FINISHED PRODUCT

The factors entering into production costs are restricted in this discussion to those costs necessary to produce the material ready for market at the plant location. It should be understood that a great variation exists in production costs for sand and gravel because of the variation in the geology of the deposits. On the other hand, average production costs for stone are more comparable for all the producers at Chico because they are mining from the same deposit under similar situations. Production costs for stone, and sand and gravel are inversely related to volume. In comparing cost per-ton of stone, to sand and gravel, the volumes produced by a single operation are so different that meaningful costs are difficult.

Another major consideration is equipment costs. The basic cost of crushing equipment and plant (crushers, conveyors, screens, and washers), excluding shovels and haul units, may vary from $500,000 to over $2,000,000. The lower costs are for small operations and the higher costs are for operations as they are in the Chico area. An average cost-factor presented for a plant is $1.6 times annual tonnage of production. The average produc-

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tion of four operators in the region was about 1,000,000 tons per year for 1966.

Plant costs for sand and gravel were presented previously at more than $230,000 for a dry-land operation comparable to what is now being used in the Dallas-Fort Worth region (Exhibit 2, pp.317-320). The immediate significance indicated is that plants for stone operations are considerably higher than for sand-gravel operations.

Factors to Consider in Production Costs of Sand, Gravel, and Crushed Stone

The following factors are to be considered:

(1) Stripping of overburden

(2) Removal of sand, gravel or stone

(3) Loading and hauling to processing plant

(4) Plant processing

(5) Stockpiling and loading

Stripping Cost-Factors. Comparative cost-factors to consider for stone operations at Chico are essentially that of depth of overburden. The type of materials are approximately the same for all the operators.

Significant cost-factors for sand and gravel are related to type of overburden, thickness, relation of overburden to water table, and ratio of overburden-to-ore.

As an example of significant cost variations, a deposit with a 1:1 ratio of overburden to sand and gravel is cheaper to produce at 5' than at 10' below the surface.

Mining Cost-Factors. Factors in mining costs of stone include drilling, blasting, water problems, depth to stone, and thickness. Important considerations for sand and gravel include depth, thickness of sand-gravel, and position of water table.

Loading and Hauling Cost-Factors. Significant factors to consider in loading and hauling of stone, sand, and gravel include cost of shovels, draglines, haul units, and distances between plant and pits.

Plant Processing Cost-Factors. A significant factor is that of primary and secondary crushing operations for stone that are not necessary for sand and gravel operations in the Dallas-Fort Worth area. A great variety of size-grades are producible from stone whereas gravel sizing is controlled essentially by nature. As mentioned previously, volumes produced also greatly influence production unit costs.

Stockpiling and Loading Cost-Factors. These cost-factors depend upon whether conveyors or haul units, or direct loading is used.

Obviously, all cost-factors have not been mentioned because of the myriad variation in production procedures

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and the geologic occurrence of raw materials.

Production Cost of Sand and Gravel, and Crushed Stone

Production costs for sand and gravel as presented in Exhibit 2, pp.317-320, average 74¢/ton for three of the four major producers in the Dallas-Fort Worth Region. Production costs may vary by ±20% or more.

Production costs for crushed stone are presented as an average obtained from four of the five companies producing in the Chico area. The average production cost for crushed stone is $1.00/ton. Approximately 25%-35% of this cost is for stripping, blasting, and mining; 10%-20% for loading and hauling; and 45%-65% for plant processing, ready for shipment.

The significance is that on the average, stone is a higher cost item than sand and gravel. Average differences are presented as about 26¢/ton. One must realize, however, that some stone is produced cheaper than gravel, and vis-a-versa. These data are presented only as guidelines and are not absolute for specific situations or for individual companies.

Cost of Making Concrete

To effect a meaningful cost for concrete, a basis must be established for cost of aggregates, cement, batching, technology, transportation, and for other direct and indirect costs.

Aggregate Costs. To determine an average cost for concrete, the following combination of plant price of aggregates, transportation, and delivered price of aggregates is considered.

Material	Plant Price[a] $/ton	Transportation $/ton	Del. Price $/ton
Stone	1.30[b](1.25-1.35)[c]	1.70	3.00 (2.95-3.05)
Gravel	1.80 (1.45-2.15)	(.75-1.00)	2.80 (2.20-3.15)
Sand	1.28 (1.00-1.43)	(.75-1.00)	1.60 (1.20-2.00)

[a]Prices may be discounted 20¢/ton upon payment by 10th of the month.

[b]Data outside parentheses represent straight averages or weighted averages.

[c]Data in parentheses represent minimum and maximum prices quoted.

Cement Cost. The quoted price for cement is $3.65/bbl. This price is standard when cement alone is considered.

Cost of Concrete. The batching requirements vary for concrete depending upon the characteristics and quality specifications desired. Use of additives, ratios of sand to gravel and/or stone, ratios of stone to gravel, and ratios of cement to aggregates and additives are among considerations in developing a cost for concrete. Generally, an average concrete for the Dallas market is 5-sack.

Materials and unit costs representative for concrete are as follows:

Material	Del. Cost	Quantity		Unit Cost $/yd concrete
Stone	$3.00/ton	0.9 tons		$ 2.70
Sand	$1.60/ton	0.67 tons		$ 1.07
Cement	$3.65/bbl	1.25 bbls		$ 4.56
			TOTAL	$ 8.33
Gravel	$2.80/ton	0.9 tons		$ 2.52
Sand	$2.28/ton	0.67 tons		$ 1.07
Cement	$3.65/bbl	1.25 bbls		$ 4.56
			TOTAL	$ 8.15

The costs presented for an average yard of concrete do not include batching, transportation, nor associated direct and indirect costs. These costs plus aggregate-cement costs do result in a delivered cost for redi-mix concrete that may exceed the selling price.

Relationship between Cost and Selling Prices of Aggregates, Cement, and Concrete

The average quoted price for concrete is $14.00/yd. The actual going rate is somewhere near $12.00-$12.50/yd. Because delivered costs for concrete may exceed the selling price, it is obvious that profit considerations are associated with competition in a vertically integrated aggregate-cement-concrete market.

Production costs for sand, gravel, and stone have been discussed previously, and it is to be understood that production costs vary considerably, especially for sand and gravel.

The plant price of sand, plus delivery cost commonly exceed the delivered price. The production cost of 74¢/ton plus average transportation cost of 75¢-$1.00 approximate the average delivered price of sand ($1.60). It is obvious that sand is not an item that when marketed alone results in a profitable operation. In short, sand may be sold at little or no margin when marketed with other products.

The plant price of gravel, plus delivery cost are in line with quoted delivered prices. Also, the average production cost of gravel (74¢/ton) plus average transportation cost are lower than the average delivered price. The supply and demand factor for gravel accounts for this favorable balance in the gravel market.

The same relationship between plant price and delivered price also holds true for stone as well as for gravel. The profit consideration in the average stone market is on the difference between production cost and plant price. Stone is produced in the same locality, under similar conditions, and is transported equivalent distances by all the major companies. The real advantages in the stone market are gained through volume, location of delivered product and in other competitive advantages.

Sand and gravel are produced in various locations and under many dissimilar situations. Production costs and transportation are prime considerations in obtaining a competitive advantage. In comparing aggregate costs and concrete prices, it is also evident that a vertically integrated situation is necessary in order for the aggregate-concrete market to exist.

In pricing delivered concrete or delivered products for batching concrete, the profit considerations may be in sand, gravel, stone, and/or cement. Depending on the situation, it is not uncommon for a company to rely on the competitive position in one or more items to compensate for a non-competitive situation in one or more of the other items.

In summary, the following advantage-factors are of prime importance in the concrete market of Dallas and Fort Worth.

(1) Production costs of sand and gravel.

(2) Relative distance between point of sand and gravel production and point of delivery.

(3) Availability of materials.

(4) Cement prices and costs.

(5) Delivered cost of crushed stone.

(6) Batching and transportation costs for concrete.

(7) Volume.

TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

APPENDIX

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

TABLE A

TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

List of Companies and the Personnel Interviewed

Heldenfels Brothers

Jim Heldenfels
521 McBride
Corpus Christi, Texas

M. P. Wright, Jr., and
Wright Brothers Materials

M. C. Truesdale
Banquete Plant
Corpus Christi, Texas

Texas Highway Department

Pat Keefe
Resident Engineer
Victoria, Texas

Vernon Matusek
Engineer
Yoakum, Texas

The Fordyce Company

Ed Lee
Belden St.
Corpus Christi, Texas

Other Contacts include:

All major producers of sand and gravel in the Dallas-Fort Worth area, and all in the Houston-Region, except Texas Construction Materials Company, that are listed in Table A, pp.346-350, of the original study.

TABLE B

TRINITY RIVER AND TRIBUTARIES, TEXAS NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE SUPPLEMENTAL STUDY

Producers of Aggregates in Victoria, Corpus Christi, and Rio Grande Valley Region, 1967

Victoria

- Corpus Christi Shell (shell)
- General Dredging (shell for cement)
- Heldenfels Brothers (sand, gravel, shell)
- Horton & Horton (1968)
- The Fordyce Company

Nueces River

- Heldenfels Brothers
- M. P. Wright, Jr.
- The Fordyce Company

Rio Grande Valley

- Crow Gravel Company
- The Fordyce Company
- Wright Brothers Materials

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

TRAFFIC ANALYSIS

SUPPLEMENT II TO EXHIBIT 2
SAND, GRAVEL, AND STONE STUDY

Supplement II EXHIBIT 2 *
APPENDIX II

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

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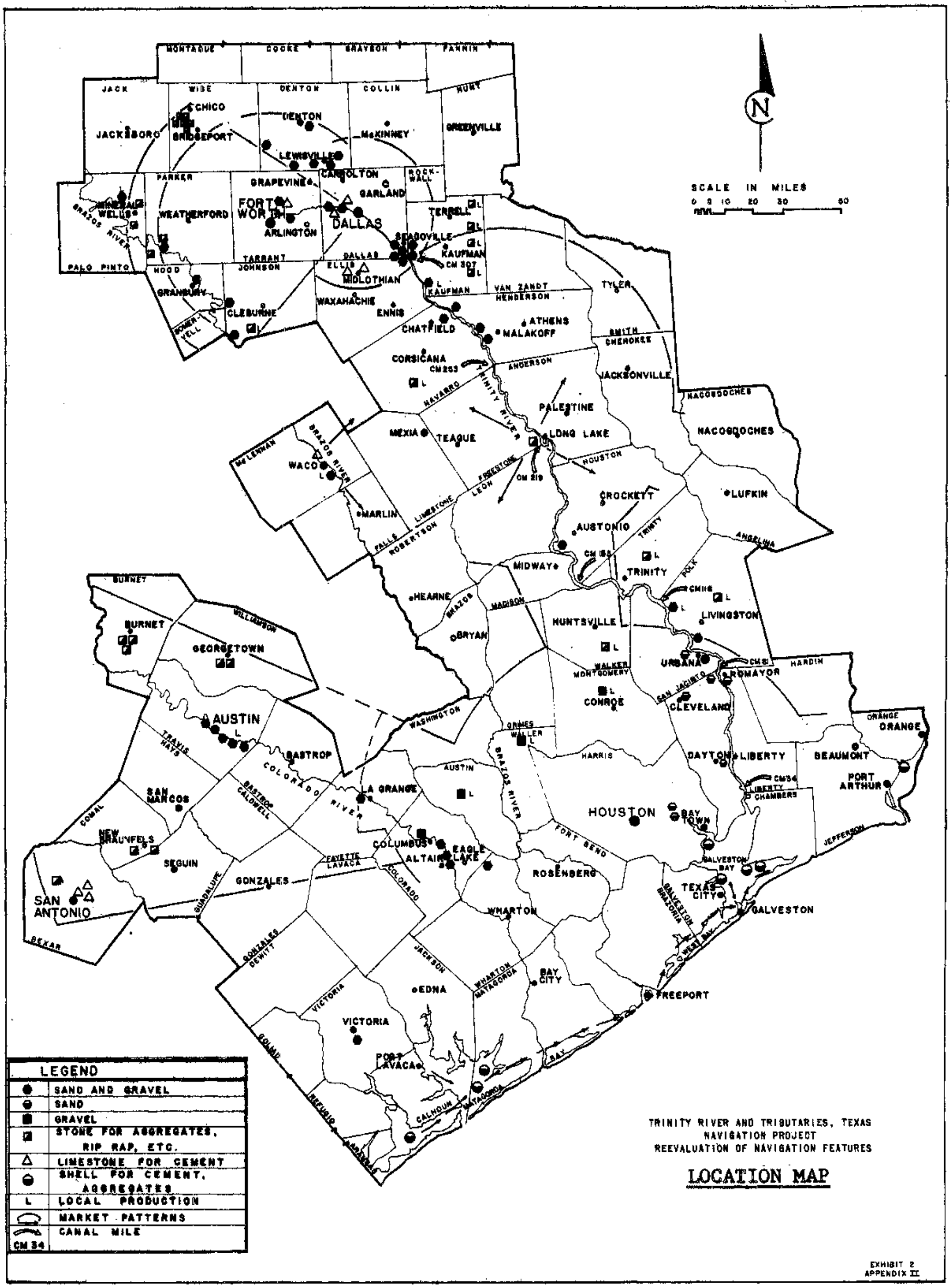
SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

REGIONAL MARKETS

1. General.- Prospective commerce in sand and gravel represents a very important element in the Trinity River reevaluation study. In recognition of the importance of these commodities, a thorough investigation was undertaken to establish the existing supply-market relationships for the principal areas of consumption, and the probable changes in these relationships during the economic life of the Trinity River waterway. Dr. William D. Miller, a faculty geologist of Texas Technological University, is an eminently well qualified resource analyst, thoroughly familiar with resource deposits and industry practices in Texas. Dr. Miller was retained as a consultant to make a special study of the resources supplying the Dallas-Fort Worth and the Houston-Galveston market areas and the probable patterns of future supply from both existing and known deposits that will be worked in the future. The study included assessment of quantities, quality, substitute materials, mining practices, and determinations of the expected life of existing deposits related to forecast market demands. Additionally, much valuable information was obtained from responsible officials of the industry and excellent correlation was noted between the information furnished by the industry and that obtained by Dr. Miller. The regional analysis concept established in the sand and gravel consultant's study provides the basis for the regional market analysis presented herein. As presented in the consultant's report, there are two major regional markets, the geographic extent being determined by the economics of (1) location of materials, (2) manufacturing costs, and (3) transportation. The two major market areas are the Dallas-Fort Worth Region of the upper Trinity watershed and the Houston-Galveston Region adjacent to the lower watershed, with the circle-of-influence radius of the two major markets extending approximately 75 miles. Each of these areas was analyzed separately to determine present consumption of sand, gravel, stone and shell, the present location and life of deposits, future consumption and reserves in relation to present and future methods of movement into the marketing areas to derive estimates of prospective traffic and transportation savings that would be creditable to the authorized waterway. Figure 1 is a location map showing the two regional market areas and the locations of resource deposits in production and serving these areas in 1966-67. Figure 2 shows the locations of the sand and gravel deposits only serving the areas in 1966-67.

FIGURE 1


LEGEND
SAND AND GRAVEL
SAND
GRAVEL
STONE FOR AGGREGATES, RIP RAP, ETC.
LIMESTONE FOR CEMENT
SHELL FOR CEMENT, AGGREGATES
L LOCAL PRODUCTION
MARKET PATTERNS
CANAL MILE
CM 34
SCALE IN MILES
0 5 10 20 30 50
N
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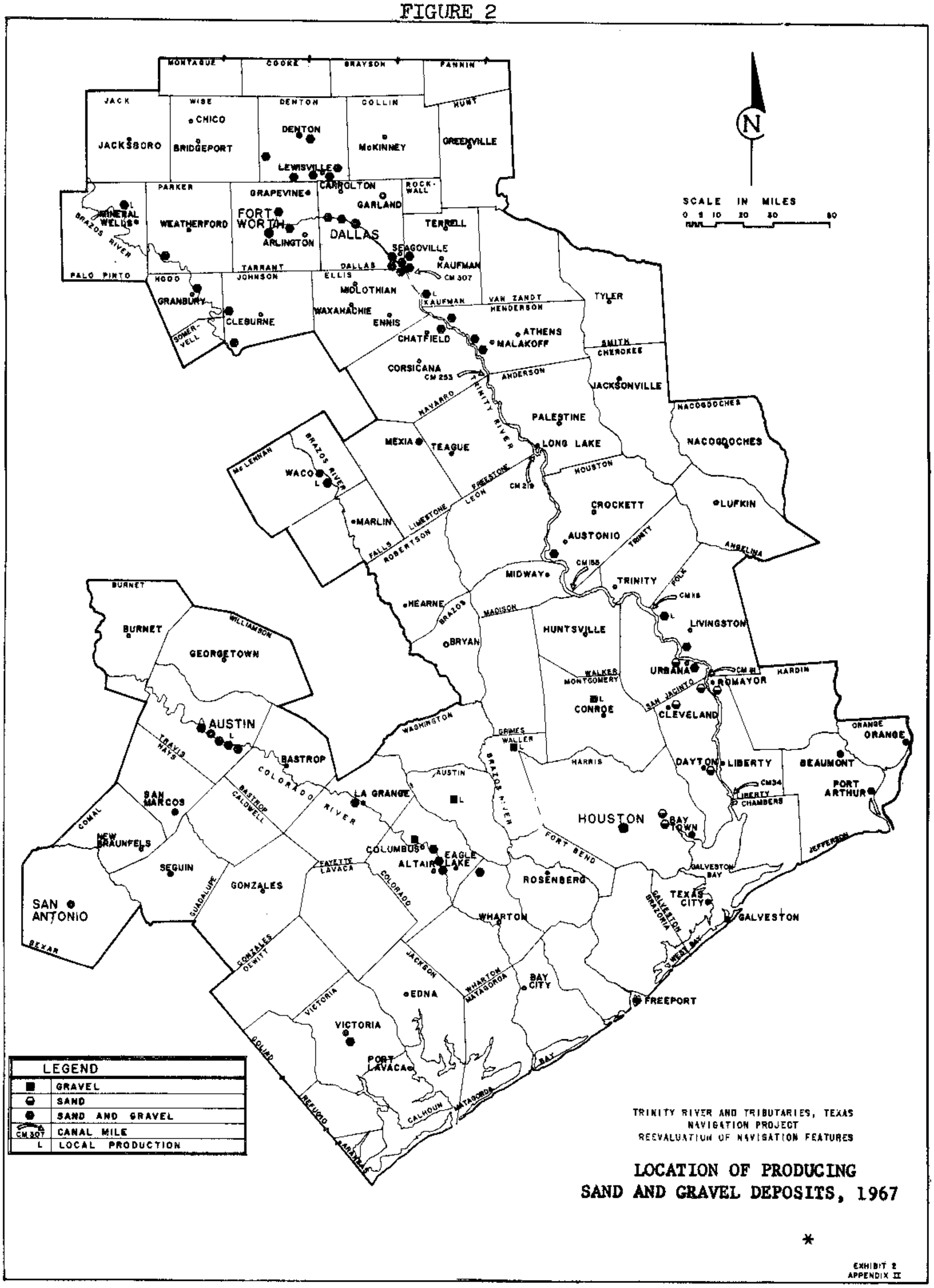
COOKE
GRAYSON
FANNIN
JACK
WISE
DENTON
COLLIN
HUNT
CHICO
JACKSBORO
BRIDGEPORT
DENTON
McKINNEY
GREENVILLE
LEWISVILLE
CARROLTON
ROCKWALL
GRAPEVINE
GARLAND
PARKER
MINERAL WELLS
WEATHERFORD
FORT WORTH
ARLINGTON
DALLAS
TERRELL
SEAGOVILLE
KAUFMAN
TARRANT
JOHNSON
ELLIS
PALO PINTO
HOOD
MIDLOTHIAN
GRANBURY
CLEBURNE
WAXAHACHIE
ENNIS
VAN ZANDT
HENDERSON
TYLER
ATHENS
MALAKOFF
CHATFIELD
SMITH
CHEROKEE
CORSICANA
ANDERSON
JACKSONVILLE
NAVARRO
PALESTINE
NACOGDOCHES
McLENNAN
MEXIA
TEAGUE
LONG LAKE
WACO
TRINITY RIVER
HOUSTON
CROCKETT
LUFKIN
MARLIN
LIMESTONE
FREESTONE
LEON
FALLS
ROBERTSON
AUSTONIO
TRINITY
ANGELINA
MIDWAY
POLK
HEARNE
BRAZOS
MADISON
LIVINGSTON
BURNET
WILLIAMSON
HUNTSVILLE
BRYAN
GEORGETOWN
WALKER
MONTGOMERY
URBANA
ROMAYOR
HARDIN
SAN JACINTO
CONROE
CLEVELAND
WASHINGTON
AUSTIN
ORANGE
GRIMES
WALLER
TRAVIS
HAYS
BASTROP
HARRIS
DAYTON
LIBERTY
BEAUMONT
COLORADO RIVER
PORT ARTHUR
SAN MARCOS
CALDWELL
LA GRANGE
BRAZOS RIVER
CHAMBERS
COMAL
HOUSTON
BAY TOWN
NEW BRAUNFELS
FORT BEND
JEFFERSON
COLUMBUS
EAGLE LAKE
ALTAIR
SEGUIN
FAYETTE
LAVACA
GALVESTON BAY
GONZALES
ROSENBERG
TEXAS CITY
SAN ANTONIO
GALVESTON
BRAZORIA
WHARTON
BEXAR
DEWITT
JACKSON
MATAGORDA
BAY CITY
EDNA
FREEPORT
VICTORIA
PORT LAVACA
CALHOUN
REFUGIO
ARANSAS

FIGURE 2



LOCATION OF PRODUCING SAND AND GRAVEL DEPOSITS, 1967

2. In some respects, the methods used to estimate prospective traffic and transportation savings for sand, gravel and stone differ from those used for other commodities in the Trinity River restudy. Estimates of prospective traffic for sand, gravel, and stone are based on a detailed analysis of resource-market relationships in each region. These analyses determined how the overall market demand for these materials can be most economically supplied from existing or new sources of these materials over the project life. The market demand for each of these commodities was analyzed on the basis of conditions expected to prevail both with, and without, the waterway. Savings attributable to the waterway were derived from a comparison of transportation charges from the most economical alternate sources of these materials with the estimated transportation charges from sources located on the Trinity River waterway. Estimates of the chronological sequence of production from various sources of sand, gravel, stone and shell were developed in order to indicate the pattern of supply of the lowest cost marketable material to meet quality market demands throughout the project life. For consistency with the method used to estimate future prospective traffic and transportation savings for other commodities on the authorized waterway, estimates of prospective traffic in sand and gravel are related to estimated potential commerce for the base year 1966, if the waterway had been in existence at that time. Estimates for all years subsequent to 1966 are related to the base year potential by appropriate indicators of future economic activity.

3. The problem in estimating potential base year (1966) waterway commerce in sand and gravel is complicated by the impending depletion of the existing primary sources of supply for both the Houston-Galveston and Dallas-Ft. Worth market regions within the next 30 years. In the base year 1966, the markets in both areas would have been largely satisfied from existing supply sources and only minor amounts of Trinity River deposits could have been classed as potential waterborne commerce, even had the waterway been in existence at that time.

4. All indications point to depletion of virtually all of the existing sources of supply of sand and gravel for the Dallas-Fort Worth Region prior to 1985, the estimated initial year of the waterway project. To estimate the potential base year 1966 commerce for the waterway, synthetic supply patterns were developed for 1966 on the basis that no contributions were made by existing sand and gravel sources in that year. The synthetic supply patterns were developed to reflect supply from the most economical alternate sources, including substitute materials where applicable. To provide a basis for evaluating waterway benefits, supply patterns were developed both with and without the waterway.

5. The present sources supplying sand and gravel to Houston-Galveston Region have sufficient reserves to meet the total concrete aggregate demand through the year 2000. At about that time, extensive changes in supply sources should occur with or without the waterway project. Further, the

use of substitute materials, such as crushed limestone for large sized gravel can be expected, as the gravel production moves to more distant sources. This shift in production and material is discussed in detail in paragraphs 15 through 26 herein. The potential waterway commerce for this region was estimated by considering the Trinity River deposits as a source of supply in competition with the existing sources of supply through the year 2000 and the most economic alternate sources beyond to 2035.

HOUSTON-GALVESTON REGION (H-GR)

6. General.- The consultant's report states that in 1966 the H-GR consumed 17.5 million tons of sand, gravel, shell and stone. Table 1 shows the 1966 production of each supply source for the H-GR and the percent of the 1966 production that each source represented.

TABLE 1

SOURCES OF MATERIAL CONSUMED IN (H-GR) IN 1966
(In Tons of 2000 Pounds)

Location of Deposit	1966 Production	Percent of Total	Totals	Percent of Total
Limestone				
Local Regional Deposits	100,000	10.1%		
Georgetown-San Antonio Area				
New Braunfels, Georgetown, Burnet, San Antonio	800,000	89.9%		
	900,000	100.0%	0.90M.T.	5.1%
Shell				
Galveston, Trinity, Matagorda Bays	3,700,000(1)	60.7%		
	2,400,000(2)	39.3%		
	6,100,000Tons	100.0%	6.10M.T.	34.9%
Sand and Gravel				
Colorado River				
Columbus, Altair, Eagle Lake, La Grange	7,300,000	69.5%		
San Jacinto & Trinity River (Sand)				
Baytown, Liberty, Urbana	2,600,000	24.8%		
Houston Local Area	600,000	5.7%		
	10,500,000	100.0%	10.50M.T.	60.0%
			17.50M.T.	100.0%

(1) Used as road base material
(2) Used in cement production

7. Limestone.- Table 1 shows that the H-GR used 0.900 million tons of limestone in 1966. Of this amount, 0.800 million tons were produced in the Georgetown-San Antonio Area and shipped to the H-GR by rail for use as rip-rap, jetty stone, road materials, and aggregate. Limestone is also used in the production of cement, but with the availability of low cost shell, its use in cement production currently is limited. The location of these deposits, shown on figure 1, precludes the transportation of limestone via the Trinity River.

8. Shell.- The H-GR used 6.1 million tons of shell in 1966. This market consisted of 2.4 million tons used in the production of cement and 3.7 million tons used in road construction for flexible and cement-stabilized sub-base. Shell reserves for road base material and for cement manufacture are located in the Texas Gulf bays and are shown on figure 1. Based on the present rate of production, these reserves are estimated to be depleted by 1985. Legislation is pending to restrict removal of oyster shell from Matagorda and Galveston Bays to prevent damage to live oyster reefs. Should shell dredging be restricted, the demands for coarse-base-material and raw materials for cement manufacture would create additional markets for sand, gravel and limestone. The increasing price of oyster shell in recent years has already resulted in considerable use of substitute materials for road construction. Shell is now transported by barge from the shell deposits in the bays to processing sites in the bay areas. The shell traffic is not expected to move on the Trinity waterway.

9. There are no sources in the H-GR for limestone for cement manufacture to replace shell use. If shell production should be drastically curtailed, raw materials or cement for the region would be supplied, most likely, from the Georgetown-San Antonio Area. However, if the Trinity River waterway were in operation, it is possible that transportation savings would permit shipment of cement from the Dallas-Ft. Worth Region to the Houston-Galveston Region for marketing at fully competitive or even reduced prices. The development of this traffic is highly speculative and was not considered as potential waterway commerce for this study.

10. Sand and Gravel-general.- In 1966, the H-GR consumed 10.50 million tons of sand and gravel. Figure 2 shows the location of producing sand and gravel deposits supplying the region while table 1 shows the 1966 production of each and the percent of the 1966 production that each source represented.

11. Colorado River deposits.- The deposits located at Columbus, Eagle Lake, Altair, and La Grange are presently the primary sources of sand and gravel of sufficient quality to meet all gradation requirements for concrete aggregate in this region. In 1966 these deposits supplied almost

70 percent of the total sand and gravel requirements of the Houston-Galveston Region as shown in table 1. The 7.3 million tons produced were shipped by rail within the region to Houston, Galveston, Beaumont, Port Arthur and Orange, Texas, with the Houston-Galveston metropolitan area consuming approximately 85 percent of the total. As discussed in the following paragraph, the recent opening of the Guadalupe River, channel to Victoria, navigation project has generated a movement of Guadalupe River sand and gravel into the H-GR in competition with the Colorado River deposits. It is likely that by 1970 the Guadalupe deposits will supply a significant portion of the Houston market and the importance of the Colorado River deposits will diminish somewhat as the primary source of these materials.

12. Guadalupe River deposits.- These deposits, located primarily in the area from about seven miles south of Victoria north to Cuero, did not contribute sand and gravel production to the Houston-Galveston Regional market in 1966, but were the primary sources of sand and gravel for the Victoria-Corpus Christi Regional market. The consultant's Supplement No. 1 to his Sand, Gravel and Stone Study shows that a significant production and shipment of sand and gravel to the Houston-Galveston Region has resulted from the availability of low cost barge transportation via the Channel to Victoria and the G.I.W.W. A major producer in the area has begun a gradual shift in sand and gravel production from the Colorado River deposits to those along the Guadalupe River. Shipments of sand and gravel from these deposits are expected to contribute about 17% of the total sand and gravel market to the H-GR region in 1970. This production represents 25% of the 1966 Colorado River deposits production. The Guadalupe River deposits will assimilate a larger percentage of the Colorado River production as the latter deposits become depleted. Together, however, the Colorado and Guadalupe River deposits will continue to supply about 70% of the total H-GR sand and gravel market. To adjust the actual 1966 supply data so that the present and future role of the Guadalupe River deposits would be taken into account, an appropriate adjustment of the Colorado River production for that year was made to indicate supply from the Guadalupe deposits as it would have occurred if the channel to Victoria navigation project had been open in 1966. Table 1-A shows the 1966 production of these deposits, adjusted as described above.

TABLE 1-A

ADJUSTED 1966 PRODUCTION SUPPLYING
THE HOUSTON-GALVESTON REGION
(Adjusted to reflect role of
Guadalupe River deposits, after
opening of channel to
Victoria Navigation Project in 1967)
(In Tons of 2000 Pounds)

Location of Deposit	Production	Percent of total	Totals	Percent of total
Limestone				
Local Regional Deposits	100,000	11.1%		
Georgetown-San Antonio Area				
New Braunfels, Georgetown, Burnet, San Antonio	800,000	88.9%		
	900,000	100.0%	0.90M.T.	5.1%
Shell				
Galveston, Trinity,	3,700,000(1)	60.7%		
Matagorda Bays	2,400,000(2)	39.3%		
	6,100,000	100.0%	6.10M.T.	34.9%
Sand and Gravel				
Colorado River				
Columbus, Altair, Eagle Lake, La Grange	5,500,000	52.4%		
Guadalupe River				
Victoria	1,800,000	17.1%		
San Jacinto and Trinity River (Sand)				
Baytown, Liberty, Urbana	2,600,000	24.8%		
Houston Local Area	600,000	5.7%		
	10,500,000	100.0%	10.50M.T.	60.0%
			17.50M.T.	100.0%

(1) Used as road base material
(2) Used in cement production

13. San Jacinto-Trinity River deposits.- The deposits located along the San Jacinto and Trinity Rivers supplied about 25% of the total 1966 sand and gravel requirement for the Houston-Galveston Region. The production at these sites consists primarily of sand. The Urbana-Romayor area along the Trinity River supplied about 900,000 tons of concrete quality sand and the San Jacinto River deposits supplied about 800,000 tons of low quality sand. Other deposits located in the Liberty-Dayton area on the lower Trinity River supplied the remaining 900,000 tons of 1966 production. The sand produced in the Urbana-Romayor area was transported by rail and truck to the Beaumont-Port Arthur-Orange metropolitan area. The 0.9 million tons of this material from the Liberty-Dayton area are located within the tributary area of the previously authorized Channel to Liberty, Texas, navigation project and, therefore, is not considered as potential traffic on the Trinity River Waterway.

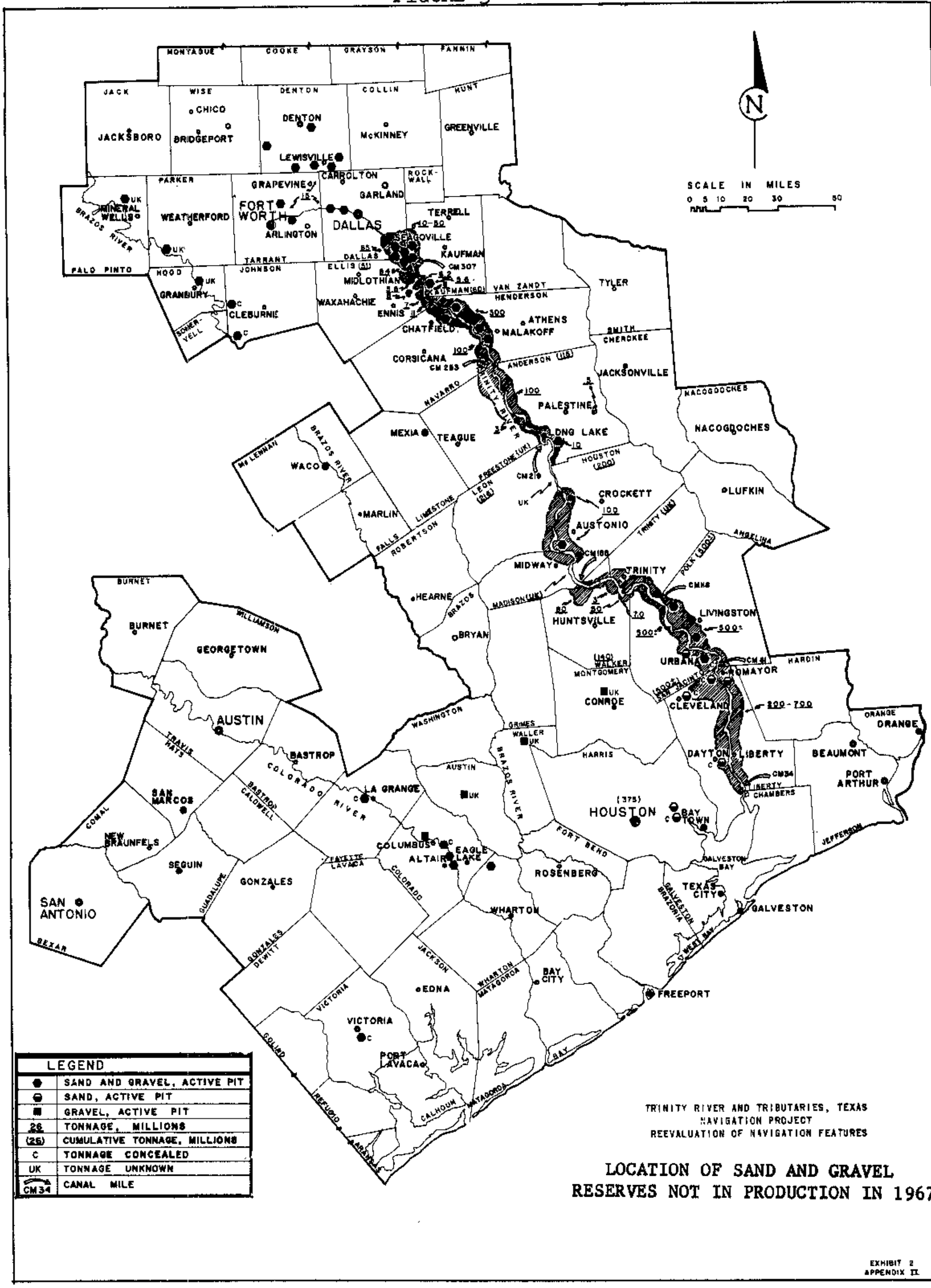
14. Houston local area.- The remaining 6 percent of the total 1966 production comprised low quality sand and was produced by independent operators in local areas in and around the city of Houston in limited quantities as needed. The total reserves for these deposits are limited and considered insignificant for the purpose of this study.

FUTURE RESERVES FOR USE IN H-GR WITHOUT THE TRINITY RIVER WATERWAY

SAND, GRAVEL, AND STONE

15. General.- The estimated pattern of supply for meeting the future market demands for the H-GR until the year 2035 is based on (1) projection of market demands related to the new construction index, (2) estimates of reserves from each of the producing areas for each material, (3) the quality of substitute materials and sources and (4) transportation costs of moving these materials to the major consuming area. The following figure 3 shows the locations of sand and gravel reserves not in production in 1967 but that will be of significance to future supply of the two major market regions. Figure 4 shows similar data for stone and shell reserves. The data pertinent to these reserves were obtained by the consultant and largely confirmed by industry sources. No exploration borings were made in connection with this study, but the data are considered to be the best obtainable short of such field exploration measures.

FIGURE 3


LEGEND
SAND AND GRAVEL, ACTIVE PIT
SAND, ACTIVE PIT
GRAVEL, ACTIVE PIT
26 TONNAGE, MILLIONS
(26) CUMULATIVE TONNAGE, MILLIONS
C TONNAGE CONCEALED
UK TONNAGE UNKNOWN
CM34 CANAL MILE
SCALE IN MILES
0 5 10 20 30 50
N
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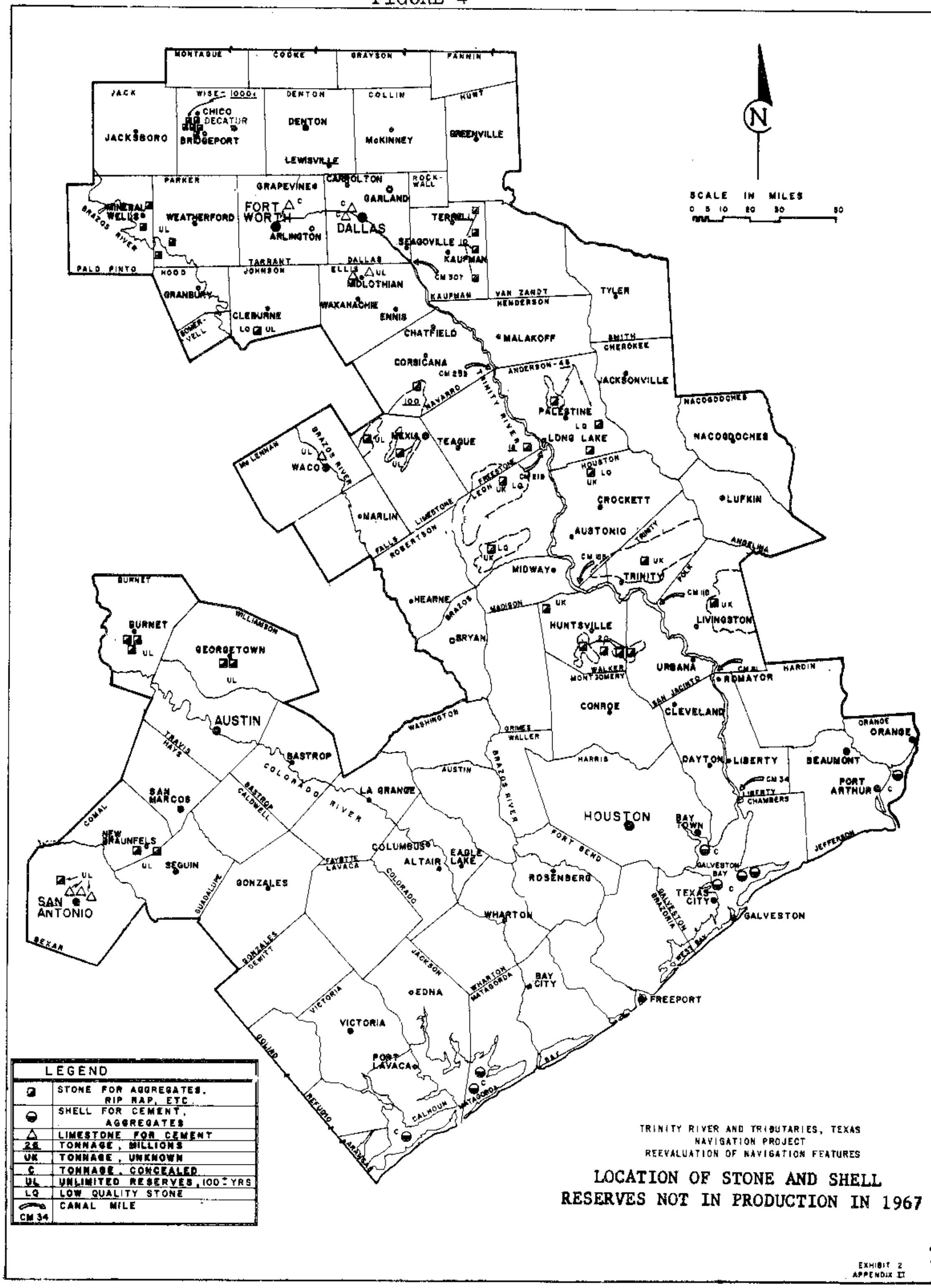
HOUSTON
AUSTIN
SAN ANTONIO
GALVESTON
BEAUMONT
PORT ARTHUR
ORANGE
FREEPORT
WACO
CORSICANA
PALESTINE
LONG LAKE
CROCKETT
HUNTSVILLE
LIVINGSTON
LIBERTY
DAYTON
CLEVELAND
CONROE
VICTORIA
PORT LAVACA
BAY CITY
WHARTON
ROSENBERG
COLUMBUS
LA GRANGE
BASTROP
SAN MARCOS
NEW BRAUNFELS
SEGUIN
GONZALES
EDNA
TEXAS CITY
BAYTOWN
LUFKIN
NACOGDOCHES
JACKSONVILLE
TYLER
ATHENS
MALAKOFF
KAUFMAN
TERRELL
GARLAND
DENTON
McKINNEY
GREENVILLE
LEWISVILLE
CARROLTON
GRAPEVINE
ARLINGTON
WEATHERFORD
GRANBURY
CLEBURNE
WAXAHACHIE
MIDLOTHIAN
ENNIS
CHATFIELD
MEXIA
TEAGUE
MARLIN
HEARNE
BRYAN
GEORGETOWN
BURNET
JACKSBORO
BRIDGEPORT
CHICO
MINERAL WELLS
TRINITY RIVER
BRAZOS RIVER
COLORADO RIVER

FIGURE 4



LOCATION OF STONE AND SHELL RESERVES NOT IN PRODUCTION IN 1967

16. The Colorado and Guadalupe River deposits, which presently supply about 70% of the H-GR's total sand and gravel requirement, have reserves estimated at about 600 million tons. At the present rate of supply (70%) and based on projection of market demands related to the new construction index of the future growth of this region, these reserves will be depleted by about the year 2000. Beyond this point, sand and gravel producers will seek alternate sources of sand and gravel or substitute materials which will economically provide for the region's construction needs. Each of the existing or new sources of sand and gravel or substitute materials that will supply the future needs of the region are discussed in detail in the following paragraphs.

17. Colorado and Guadalupe River deposits.- The deposits located at Columbus, Eagle Lake, Altair and La Grange on the Colorado River and deposits located on the Guadalupe River from seven miles south of Victoria northward to Cuero will be the primary sources of concrete quality coarse and fine aggregates for the Houston-Galveston Region. The total reserves for these deposits which could supply the region are estimated at 600 million tons. The estimates are the best obtainable by the sand and gravel consultant and from industry sources. They have not been verified by core boring data. From the standpoint of the overall traffic analysis of the Trinity waterway, however, the life of these deposits is not a significant factor. As discussed in paragraph 61, an assumption of unlimited reserves for these deposits would reduce the estimated benefits for the waterway by about $167,000, or less than one percent of the benefits from sand and gravel commerce alone.

18. It is expected that production from the Colorado River deposits will gradually diminish, as the deposits presently being worked become depleted and producers are forced to shift operations to more distant reserves northward along the Colorado or to sand and gravel deposits along the Guadalupe River. This shift in production has begun, as evidenced by the operations recently initiated on the Guadalupe River. Together, the Colorado River deposits northward to La Grange and the Guadalupe River deposits northward to Cuero can supply the total market demand of the H-GR and the additional markets of the Guadalupe River production for concrete quality sand and gravel until the year 2000. Even though some of the deposits have an excess of sand over that produced for the combined gravel-sand market, the mining practices do not conserve the sand excess and the sand excess is generally not commercially recoverable after the gravel mining has ceased. Beyond the year 2000, production will shift to alternate sources for both coarse and fine aggregates.

19. San Antonio-Georgetown area.- This area supplied the region with 800,000 tons of limestone in 1966 as discussed in paragraph 7. The deposits in this area have an estimated life of at least 100 years and could supply the H-GR with quality crushed stone in almost unlimited amounts. Upon depletion of the Guadalupe and Colorado River reserves in the year 2000, the deposits of limestone in this area will become competitive

in transportation costs with the more distant reserves on the Colorado north of La Grange and on the Guadalupe north of Cuero and will be in a competitive position to assimilate a major portion of the region's coarse aggregate market. An analysis of transportation charges for the San Antonio-Georgetown area and possible sources on the Colorado River north of La Grange and on the Guadalupe River north of Cuero, indicates that with the existing transportation network and competitive transportation costs, the San Antonio-Georgetown area will be the preferred source of concrete quality crushed coarse aggregates.

20. These limestone deposits will also become the major source of raw material for cement manufacture. Presently, oyster shell is used as a primary raw material in the production of cement in this region. As discussed in paragraph 8, reserves of oyster shell are sufficient to last until 1985 unless legislation further curtails production in the interim. With depletion of the shell reserves in 1985, a new source of raw materials will be required for cement manufacturing. The source of these raw materials is expected to be the limestone deposits in the San Antonio-Georgetown area. However, in lieu of shipments of limestone to the existing cement manufacturing plants, it is expected that cement production will shift to this area and cement will be shipped to the market region. Therefore, in 1985, the limestone equivalent of the 2.4 million tons (1966 production figure) of shell used in cement manufacture is allocated to the San Antonio-Georgetown area.

21. San Jacinto and Trinity River deposits.- The supply pattern for these deposits will remain generally unchanged until the year 2000. At this time there will be a substantial demand for concrete quality sand as a result of depletion of the Colorado River sand and gravel reserves south of La Grange and those of the Guadalupe River south of Cuero and the shift to crushed aggregate from the San Antonio-Georgetown area.

22. Deposits of sand on the San Jacinto River near Baytown and the lower Trinity near Liberty are not of suitable quality for concrete specifications and are used primarily as fill and road materials and as admixtures to high quality sand for some lower specification concrete construction. Sand deposits in these areas are unlimited in quantity, but low in quality.

23. Quality sand and gravel is located on the Trinity River north from the Urbana-Romayor area to Oakwood-Long Lake. Reserves are estimated at about 2.5 billion tons, 15% of which is gravel. Because of the high sand to gravel ratio, the recovery of this gravel is, for commercial purposes, marginal. The sand, however, is of high quality and the deposits located on Trinity River in the Urbana-Romayor area will be the primary source of concrete quality sand upon depletion of the sand and gravel reserves of the Guadalupe and Colorado Rivers. It is estimated that in the year 2000, the Urbana-Romayor deposits will assimilate 100% or 2.6 million tons (adjusted base year 1966 amount) of the fine aggregate market previously supplied by the Guadalupe and Colorado River deposits.

FUTURE PRODUCTION OF SAND AND GRAVEL FOR USE IN H-GR WITH THE TRINITY WATERWAY IN OPERATION

24. General.- The cumulative total market demand of the Houston-Galveston Region during the economic life period of the Trinity waterway (1985-2035) will require transportation of billions of tons of sand, gravel, stone and/or shell from the sources discussed in the preceding paragraphs. The construction of the Trinity River waterway will make available to the H-GR low-cost transportation for a portion of these materials. As previously discussed, shell is presently transported by barge to the region and is not expected to use the proposed waterway. Also, the location of the limestone deposits precludes transportation of this material via the Trinity waterway. Sand and gravel presently produced for the H-GR on the Guadalupe River is shipped to the region by barge via the Channel to Victoria and the Gulf Intracoastal Waterway and will not utilize the Trinity River waterway. The waterway will, however, make available to the H-GR substantial amount of fine aggregate reserves located along the Trinity River and these reserves will serve a portion of the H-GR sand market.

25. Trinity River deposits.- The Trinity deposits located in the Urbana-Romayor area are presently in production supplying the Orange, Beaumont and Port Arthur markets, with concrete quality sand and small size gravel. With the Trinity waterway in place, the concrete quality sand and small gravel can be shipped to the H-GR by barge at a substantial savings in lieu of the comparable quality materials that otherwise would be supplied by the Colorado River deposits south of La Grange and the Guadalupe River deposits south of Cuero. The Trinity River deposits, however, do not contain appreciable amounts of gravel above 3/4-inch size, and the larger size gravel required for quality concrete specifications would continue to be supplied from the Colorado and Guadalupe River deposits.

26. The portion of the market satisfied with low-quality sand will not be affected by the waterway, since this material can be supplied in unlimited quantities from the nearby San Jacinto River and from the Dayton-Liberty deposits on the lower Trinity, which are tributary to the previously authorized channel to Liberty project. The market pattern for the quality sand and gravel, with the waterway constructed, is forecast for the basis of providing the region with the lowest-cost suitable materials for concrete use. The sand and gravel reserves of the Guadalupe River south of Cuero and the Colorado River reserves south of La Grange are sufficient to satisfy the total demand of the region for large gravel and some sand until the year 2000. When the Trinity waterway is constructed, however, a substantial part of the quality sand and some small gravel will be supplied from the Urbana deposits because of the transportation savings. With the progressively increasing cost of sand and gravel production on the Guadalupe and Colorado Rivers in the future as the production moves farther to the north, the Trinity deposit at Urbana is expected to become

the primary source of concrete quality sand and small gravel. The Colorado and Guadalupe River deposits would retain the large aggregate production and some sand and small gravel production which would be produced incidentally, or as a by-product, with the large gravel production. It is estimated that about 0.5 million tons (base year 1966) or about 20 percent of the quality sand and small gravel market would be supplied from this production until the year 2000. The effect of this production, if continued throughout the project life, is discussed in paragraph 61. As the production of oyster shell in the coastal bays diminishes, the Colorado and Guadalupe sand and gravel deposits will furnish substitute materials for the portion of the shell production that was previously used as aggregate in road base construction and cement stabilized sub-bases; while the San Antonio-Georgetown area limestone will substitute for the shell production which previously was used in the manufacturing of cement. This is the estimated pattern of supply for the market from about 1985 to the year 2000. Beyond that year, with the economically marketable sand and gravel reserves along the Colorado south of La Grange and the Guadalupe south of Cuero essentially depleted, the limestone deposits located in the San Antonio-Georgetown area then will become the primary source of coarse aggregate, while the Trinity River deposits in the Urbana-Romayor area will be the primary source of sand and small gravel. Thus the combination of these two sources, both with unlimited reserves, will provide the H-GR with unlimited amounts of high quality concrete aggregates throughout the remaining project life. Table 2 and 3 show the percentage of distribution of base year 1966 market demands as they would be satisfied by the respective supply patterns estimated for the years 1985 and 2000.

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TABLE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

DISTRIBUTION OF PRODUCTION WITH THE PROJECT CHANNEL IN OPERATION BASED ON 1966 PRODUCTION FIGURES
(H-GR)

Location of Deposit	1966 Production (Tons)	Percent of total	Totals	Percent of total
SUPPLY PATTERN FOR YEAR: 1985				
Limestone				
Local Regional Deposits	100,000	3.0%		
Georgetown-San Antonio Area				
New Braunfels, Georgetown, Burnet, San Antonio	3,200,000	97.0%		
	3,300,000	100.0%	3.30M.T.	18.9%
Sand and Small Gravel				
San Jacinto-Trinity River Deposits				
Baytown, Liberty	1,700,000	31.5%		
Urbana and Romayor	3,000,000	55.6%		
Colorado & Guadalupe Rivers	500,000	9.3%		
Local Regional Deposits	200,000	3.6%		
	5,400,000	100.0%	5.40M.T.	30.9%
Gravel				
Colorado-Guadalupe River Deposits				
La Grange to Columbus-Victoria to Cuero	8,400,000	95.5%		
Local Regional Deposits	400,000	4.5%		
	8,800,000	100.0%	8.80M.T.	50.2%
			17.50M.T.	100.0%

TABLE 3

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

DISTRIBUTION OF PRODUCTION WITH THE PROJECT CHANNEL IN OPERATION BASED ON 1966 PRODUCTION FIGURES
(H-GR)

Location of Deposit	1966 Production (Tons)	Percent of total	Totals	Percent of total
SUPPLY PATTERN FOR YEAR: 2000				
Limestone				
Local Regional Deposits	100,000	00.9%		
Georgetown-San Antonio Area				
New Braunfels, Georgetown, Burnet, San Antonio	11,000,000	99.1%		
	11,100,000	100.0%	11.10M.T.	63.4%
Sand and Small Gravel				
San Jacinto-Trinity River Deposits				
Baytown, Liberty	1,700,000	31.5%		
Urbana-Romayor	3,500,000	64.8%		
Local Regional Deposits	200,000	3.7%		
	5,400,000	100.0%	5.40M.T.	30.9%
Gravel				
Local Regional Deposits	1,000,000	100.0%		
	1,000,000	100.0%	1.00M.T.	5.7%
			17.50M.T.	100.0%

POTENTIAL TRINITY RIVER WATERWAY COMMERCE (H-GR)

27. General.- As discussed in the preceding paragraphs, the role of the Trinity River deposits of quality sand and small gravel are expected to compete in the H-GR market with sources located on the Colorado River south of La Grange and on the Guadalupe River between Victoria and Cuero in the initial year of the project, 1985. This competitive situation is expected to prevail until about the year 2000 when the reserves of large gravel on the Colorado River south of La Grange and on the Guadalupe south of Cuero are economically depleted. The Trinity deposits will then become the principal remaining source of quality sand and small gravel, with the need for larger aggregates being supplied by crushed limestone from the Georgetown-San Antonio area. Low grade sand will be supplied from the San Jacinto River near Baytown and the lower Trinity River near Liberty throughout the period.

28. Thus, for the initial year of the project 1985, the potential traffic accepted for rate analysis as prospective commerce for the Trinity River navigation project is represented by the 3.0 million tons of base year 1966 potential from the Urbana-Romayor sand and small gravel deposits along the Trinity River. This total includes 0.9 million tons of actual 1966 production at the Urbana deposits that moved mostly by rail to the Beaumont-Port Arthur-Orange area market. The remaining 2.1 million tons is the sand and small gravel production developed from the analysis of future production areas and, for base year estimating purposes, is considered as equivalent to 1966 production at the Trinity River deposits. As shown in table 3, the estimated potential waterway commerce from these deposits would be increased to 3.5 million tons (on base year 1966 potential) in about the year 2000 when the deposits containing large gravel on the Guadalupe River south of Cuero and those on the Colorado River south of La Grange become depleted and would no longer be worked for sand.

DALLAS-FORT WORTH REGION (D-FWR)

29. General.- The consultant's report states that in 1966 the Dallas-Fort Worth Region consumed 12.70 million tons of sand, gravel and stone. Figure 1 shows the location of the resource deposits in production and supplying the D-FWR in 1966-67, while figure 2 shows the locations of the sand and gravel deposits only serving the area in 1966-67. Table 4 shows the 1966 production of each resource deposit and the percent of the 1966 production that each source represented.

TABLE 4

SOURCES OF MATERIAL CONSUMED IN (D-FWR) IN 1966

Location of Deposit	1966 Production	Percent of total	Totals	Percent of total
Limestone				
Chico-Bridgeport Area	3,900,000	68.2%		
Palo Pinto & Parker County Areas	1,500,000	26.7%		
Local Regional Deposits	300,000	5.1%		
	5,700,000	100.0%	5.70M.T.	44.6%
Sand And Gravel				
Dallas-Ft. Worth-Seagoville Area	6,500,000	92.6%		
Brazos River Area	300,000	4.4%		
Local Regional Deposits	200,000	3.0%		
	7,000,000	100.0%	7.00M.T.	55.4%
			12.70M.T.	100.0%

1966 PRODUCTION AND METHOD OF SHIPMENT

30. Limestone.- Table 4 shows that the D-FWR used 5.70 million tons of limestone in 1966. This production consists of 3.90 million tons of hard limestone produced in the Chico-Bridgeport area and 1.50 million tons produced in the Palo Pinto-Parker County areas. The remaining 0.30 million tons consisted of soft limestone and sandstone produced by independent contractors at various small sites for the Texas Highway Department. About 3.00 million tons of hard limestone were processed into large size crushed aggregates and used to supplement the locally produced sand and gravel, in order to bring its quality up to required concrete specifications. The remaining 2.4 million tons of hard limestone were for non-concrete uses, including agricultural lime, asphaltic paving, blast furnace flux, etc. The limestone was transported to the market region by truck and the location of the deposits precludes transportation via the Trinity River.

31. Sand and gravel-general.- Practically all of the sand and gravel used in the Dallas-Fort Worth Region has been produced from nearby sources along the Trinity River. In recent years, with depletion of many of the local deposits, some sand and gravel has been trucked to the Fort Worth vicinity from the Brazos River basin north of Waco. Most of the up-river Trinity sand and gravel deposits contain a mixture of good quality sand and gravel, with the gravel comprising 15 to 30 percent of the total. The gravel is somewhat larger than that in the lower river deposits, with abundant grade sizes up to 3/4-inch material. The concrete market requires generally about 40 percent fine material, or sand, (defined as passing a #4 sieve) and about 60 percent of coarse aggregate. The coarse aggregate may be material grading in size from that retained on a #4 sieve (5 millimeter grain size) upward to about $2\frac{1}{2}$ inches. Most building construction concrete requires coarse aggregate sizes ranging upward to about $1\frac{1}{2}$ to 2 inches. The hard limestone of the Chico-Bridgeport area and Parker-Palo Pinto counties is crushed to meet coarse aggregate size specifications, with virtually all requirements for material larger than 3/4-inch being provided from this source. The Trinity River deposits provide the D-FWR with most of its sand and large amounts of gravel for coarse aggregate ranging downward from 3/4-inch size. Generally, the sand and gravel is shipped from the deposits on a basis of about 35 percent gravel and 65 percent sand.

32. Dallas-Ft. Worth-Seagoville area.- This area is, at present, the primary source of sand and gravel for the D-FWR and supplied 92.6 percent of its 1966 total sand and gravel requirement. The gravel produced in the area between Dallas and Fort Worth was used mostly in the production of concrete or was sold to independent contractors. The sand was used not only for production of concrete, but for a variety of non-concrete uses. The material produced in the Seagoville area was transported to the region by truck.

33. Brazos River area.- In 1966 this area supplied the D-FWR with only 4.4 percent of its total sand and gravel requirement. The 0.30 million tons produced was transported to the region by truck from the Granbury area. Figure 2 shows the location of existing deposits on the Brazos River.

34. Local regional deposits.- The remaining 3 percent of the total 1966 production shown on table 4 was produced in areas in and around the Dallas-Fort Worth Region in limited quantities by independent contractors. These reserves are generally in small deposits, with areas of use limited to the vicinity of the deposits. These materials were not considered as potential waterway commerce.

FUTURE RESERVES FOR USE WITHOUT THE TRINITY RIVER WATERWAY

SAND, GRAVEL, AND STONE

35. General.- Without the Trinity River waterway, the deposits of sand, gravel, and limestone shown in table 4, except for those located in the Dallas-Fort Worth-Seagoville area would continue to supply the D-FWR with these materials in the future.

36. The Dallas-Ft. Worth-Seagoville area deposits, which supplied the region with 92.6 percent of its total sand and gravel requirement in 1966, have reserves estimated at about 109 million tons, including all marketable sand. Based on a projection of market demands related to the new construction index of the future growth of this region, these reserves are expected to be depleted in about 1980, five years prior to the beginning of project life. Beyond this point, sand and gravel producers will seek alternate sources of sand and gravel or suitable substitute materials in the combinations that will most economically satisfy the region's future requirements.

37. The probable supply pattern for meeting market demands expected to exist in 1980, upon depletion of the Dallas-Ft. Worth-Seagoville area deposits, was developed by analyzing the various uses of sand, gravel, and stone, the production costs of each, and the transportation costs of moving the materials to market outlets. As discussed in paragraphs 3 and 4, a synthetic base year 1966 supply pattern was developed for this market, based on 1966 production figures, and the supply pattern expected to exist following depletion of the Dallas-Fort Worth-Seagoville area deposits in about 1980.

38. The market demand as presented in this study is based on data obtained from industry officials as to the various uses and requirements of sand, gravel and stone. Of the 12.7 million tons of sand, gravel and stone produced in 1966, approximately 60 percent or 7.70 million tons were used in the production of concrete or concrete products, while the remaining 40 percent or 5.00 million tons were used as sub-base materials, in asphalt paving, as fill material, and in other non-concrete uses.

39. Uses of sand, gravel and stone.- The production of concrete generally requires that about 40 percent of the total aggregate consist of sand, while the remaining 60 percent is coarse aggregate. Thus, in 1966 concrete production in the D-FWR required about 3.0 million tons of sand and 4.7 million tons of coarse aggregate. The larger part of the coarse aggregate was furnished by crushed limestone. For quality concrete production, the primary problem of the major producers in this region is the location of low-cost concrete quality sand. The 5.0 million tons

required in 1966 for non-concrete uses consisted of approximately 30 percent or 1.5 million tons of sand and 70 percent or 3.5 million tons of coarse aggregates.

40. Market supply pattern for the D-FWR after 1980.- Upon depletion of the Dallas-Ft. Worth-Seagoville area sand and gravel deposits in about 1980, the most economical source of coarse aggregate will be the limestone deposits located at Chico-Bridgeport, Palo Pinto and Parker County areas, while the Brazos River deposits and Trinity River deposits south of Seagoville will be the most economical source of sand. As with the Trinity deposits now being worked, the deposits south of Seagoville and those of the Brazos basin contain 15 to 30 percent gravel ranging up to 3/4-inch size and 70 to 85 percent good quality sand. With the prime requirement for producing 4.5 million tons of sand, about 1.2 million tons of gravel will also be produced from these deposits, based on 1966 production amounts. Thus, the supply pattern after 1980 would require a total of about 8.2 million tons of coarse aggregate, including 7.0 million tons supplied from the major limestone deposits and 1.2 million tons of gravel produced with the 4.5 million tons of sand from the natural aggregate deposits of the Trinity south of Seagoville and those of the Brazos River north of Waco. Each of the new or existing sources of sand, gravel and stone that would be expected to supply the future needs of this region after 1980 without the Trinity waterway are discussed in the following paragraphs.

41. Trinity River deposits.- The consultant's report presents estimates of sand and gravel located within the Trinity River flood plain. Estimates of sand and gravel, south from Kaufman County to the Long Lake area, range from 2.0 to 3.0 billion tons, with "known" reserves estimated at 1.0 billion tons. These reserves consist primarily of concrete quality sand and gravel limited in size to 3/4". The Trinity River deposits represent a substantial source of these materials and will become a primary source of sand and gravel 3/4" or less in size. Without the waterway these deposits should absorb approximately 40 percent of the market previously supplied by the Dallas-Ft. Worth-Seagoville area deposits. The location and extent of these deposits is shown on figure 3, while table 5 shows the distribution of amounts equivalent to 1966 production that would be expected in a supply pattern of 1980 without the waterway.

42. Chico-Bridgeport area.- The consultant, in his report, estimates the limestone reserves in this area at over 1 billion tons, which, with respect to the economic life of the Trinity waterway project, represents an unlimited supply of limestone. This area will continue to supply the D-FWR with limestone in the future. With the depletion of the present primary source of sand and gravel (Dallas-Fort Worth-Seagoville) in 1980, the limestone production is expected to increase in order to provide quality aggregate to compensate for the decrease of gravel production from Trinity River deposits. As shown in table 4, the total 1966 production of the Dallas-

Fort Worth-Seagoville deposits was 6.5 million tons of sand and gravel, including about 2.3 million tons of gravel. The Chico-Bridgeport limestone deposits are expected to absorb about 55 percent of the gravel market previously supplied by the Dallas-Fort Worth-Seagoville area deposits. The location of this area is shown on figures 1 and 4 and the distribution of production in 1980 is shown in table 5.

43. Brazos River area.- Five existing deposits of sand and gravel along the Brazos River, southward from Mineral Wells to Cleburne are shown on figure 2. Although the total reserves of this portion of the river are not known, the best estimates of industry officials indicate a maximum of 200 to 220 million tons. There are other deposits located south of Cleburne to Waco (not shown), wherein known reserves are estimated at 220 million tons. It is assumed that sufficient marketable reserves of sand and gravel exist to support production through the year 2035. With the depletion of the Dallas-Fort Worth-Seagoville sand and gravel in 1980, and without the Trinity River waterway, the Brazos River deposits are expected to absorb about 28 percent of the aggregate market previously supplied by those deposits. About 80 percent of this production would be in the reach from Mineral Wells to Cleburne, while the remainder would be southward of Cleburne. Table 5 shows the estimated distrubution of production in 1980.

44. Local production in region.- Upon depletion of the primary source of sand and gravel in 1980, the smaller producers of sand and gravel throughout the region can be expected to increase production in order to fill the increased demand. This increase is estimated to be about 12 percent of the 1966 sand and gravel market previously supplied by the Dallas-Fort Worth-Seagoville area. This production would be approximately the same with or without the waterway.

TABLE 5

DISTRIBUTION OF 1966 SAND, GRAVEL AND STONE PRODUCTION IN D-FWR
UPON DEPLETION OF DALLAS-FORT WORTH-SEAGOVILLE
SAND AND GRAVEL DEPOSITS IN 1980
(WITHOUT TRINITY RIVER WATERWAY)

(Millions of tons)

	Limestone		Gravel		Sand	
Source	1966	1980	1966	1980	1966	1980
Limestone						
Chico-Bridgeport	3.9	5.2	-	-	-	-
Palo Pinto-Parker	1.5	1.5	-	-	-	-
Local Regional	0.3	0.3	-	-	-	-
Sand and Gravel						
Brazos River	-	-	0.1	0.3	0.2	1.8
Local Regional	-	-	0.1	0.4	0.1	0.6
Dallas-Ft. Worth Seagoville	-	-	2.3	-	4.2	-
Trinity River south of Seagoville	-	-	-	0.5	-	2.1
TOTALS	5.7	7.0	2.5	1.2	4.5	4.5

FUTURE PRODUCTION OF SAND AND GRAVEL FOR USE IN D-FWR
WITH THE PROJECT CHANNEL IN OPERATION

45. General.- The construction of the Trinity River waterway will make available to the D-FWR low cost transportation for a portion of the future reserves discussed in the preceding paragraphs. Sand and gravel from deposits located in the Brazos River basin or stone production from the Chico-Bridgeport area would not be moved via the Trinity River. With the Brazos River reserves between Mineral Wells and Cleburne being located relatively close to Fort Worth and the Western portion of the D-FWR, it is expected that these reserves will continue to serve an appreciable portion of the market, even with the Trinity waterway constructed. The waterway will, however, make available to the D-FWR substantial transportation

savings for the sand and gravel reserves located along the Trinity River and for the portion of the market served by the Brazos River deposits southward of Cleburne. It is expected that a major part of the sand and gravel market supplied by these deposits will shift to the Trinity deposits when the waterway is constructed.

46. Trinity River deposits.- Based on a comparison of transportation costs, it is estimated that the Trinity River deposits will assimilate about 25 percent of the 1980 Brazos River market shown in table 5. Thus, the Trinity River deposits will absorb about 24 percent of the total base year 1966 aggregate demand of 12.7 million tons and 48 percent of the 6.5 million tons supplied by the Dallas-Fort Worth-Seagoville area deposits prior to 1980. The remaining 76 percent of the total demand and 52 percent of the former market of the Dallas-Fort Worth-Seagoville deposits will be served by the Brazos River, Chico-Bridgeport, and local deposits in the region. Transportation of the sand, gravel, and stone into the D-FWR from these sources would be by rail and truck.

47. With the waterway constructed, the expected production in 1985 (based on 1966 market requirements) from the various deposits is summarized in table 6.

TABLE 6

DISTRIBUTION OF 1966 SAND, GRAVEL AND STONE PRODUCTION IN D-FWR UPON DEPLETION OF DALLAS-FORT WORTH-SEAGOVILLE SAND AND GRAVEL DEPOSITS IN 1980 (WITH TRINITY RIVER WATERWAY - 1985)

(Million of tons)

Source	Limestone		Gravel		Sand	
	1966	1980	1966	1980	1966	1980
Limestone						
Chico-Bridgeport	3.9	5.2	-	-	-	-
Palo Pinto-Parker	1.5	1.5	-	-	-	-
Local Regional	0.3	0.3	-	-	-	-
Sand and Gravel						
Brazos River	-	-	0.1	0.2	0.2	1.4
Local Regional	-	-	0.1	0.4	0.1	0.6
Dallas-Ft. Worth-Seagoville	-	-	2.3	-	4.2	-
Trinity River south of Seagoville	-	-	-	0.6	-	2.5
TOTALS	5.7	7.0	2.5	1.2	4.5	4.5

POTENTIAL TRINITY RIVER WATERWAY COMMERCE (D-FWR)

48. As shown in table 6, the potential waterborne commerce in sand and gravel from the Trinity River deposits totals 3.1 million tons of base year 1966 production. In order to obtain representative transportation charges and savings for the Trinity River deposits attributable to the proposed project, the probable port areas that would serve the various production sites over the life of the project were determined. The locations of the port areas (Trinidad-Chatfield, Cayuga, and Oakwood-Long Lake) with respect to the D-FWR market area were used as a basis to estimate the amounts of production that each deposit would supply to the market area. Based on 1966 production amounts, with the waterway in operation, it was estimated that the Trinidad-Chatfield area would produce 1.82 million tons of sand and gravel plus an additional 0.35 million tons assimilated Brazos River production. The Cayuga area would assume production of 0.15 million tons for the Brazos River deposits and the Oakwood-Long Lake area would produce 0.78 million tons. Table 7 presents a summary of potential waterway sand and gravel commerce accepted for rate analysis.

TABLE 7

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF POTENTIAL WATERWAY COMMERCE (D-FWR)

Location	Commodity	1966 Production (tons)
Trinidad-Chatfield	Sand & Gravel	1,820,000
Trinidad-Chatfield	Sand & Gravel	350,000
Cayuga	Sand & Gravel	150,000
Oakwood-Long Lake	Sand & Gravel	780,000
	TOTAL	3,100,000

TRAFFIC ANALYSIS-TRANSPORTATION CHARGES

49. Destination points.- A central destination point was established for each regional market, Sims Bayou on the Houston Ship Channel for the Houston-Galveston Region and Grand Prairie for the Dallas-Fort Worth Region.

50. Houston-Galveston Region.- Five major producers for the Houston-Galveston region were interviewed to establish the prospective waterway traffic pattern for sand and gravel movements into the Houston-Galveston regional market. Presently, these producers supply 90 percent of the total sand and gravel requirement for the regional market. These producers have storage, handling and permanent concrete processing facilities on, or closely connected with, the Houston Ship Channel, where the materials are stockpiled prior to processing and/or distribution to various market outlets. All of the producers stated that sand and gravel downbound movements on the Trinity River Navigation Channel by barge would be stockpiled, processed and distributed from these facilities. The producers have adequate storage space and facilities to handle increased volumes of this traffic throughout the project life. All producers interviewed stated that sand and gravel would be stockpiled at their present sites to avoid additional transportation charges which would be incurred by stockpiling sand and gravel at other than terminal sites. The plants of three of the producers are located on the barge channel extension of the Houston Ship Channel upstream of the Houston turning basin, with the upper plant being about 4 miles from the turning basin. The other two plants are located on the ship channel at points about 2 and 7 miles, respectively, downstream from the turning basin. The distance to the Galveston area for Trinity River traffic would be about 25 miles less than the distance to the Houston turning basin. However, the proportion of traffic to this area would also be much less. The actual destinations for waterway movement of sand and gravel would be to the several plant locations. However, for estimating purposes, and to avoid computations involving specific plant locations, a point on the Houston Ship Channel near Sims Bayou, about 4 miles downstream from the turning basin, was selected as a point that would represent the average water transportation distance for termination of traffic to all of the plants and was used as the destination point for traffic analysis of the Houston-Galveston regional market.

51. Dallas-Fort Worth Region.- The prospective traffic pattern for waterway movements into the Dallas-Fort Worth regional market was established from information obtained from officials of the Dallas-Fort Worth sand and gravel industry.

52. With the exception of one plant on the Brazos River southwest of Fort Worth near Granbury, the major producers, who produce about 95 percent of the sand and gravel for this region, have storage and handling and permanent concrete processing facilities located on the Trinity River, between

Dallas and Fort Worth at distances ranging from 15 to 37 miles west of Dallas. Two of the plants are located near Grand Prairie, about 23 miles west of Dallas. These facilities would be further developed and enlarged for stockpiling of material received on the waterway as demand increases. In a manner similar to that used to select Sims Bayou on the Houston Ship Channel as a central destination point for computing an average transportation distance to the various plant locations, the central destination point of Grand Prairie was established as a point for analysis of traffic to these facilities for the Dallas-Fort Worth Region.

53. Truck rates.- A uniform truck rate scale for sand and gravel is nonexistent. However, truck rates were established by analyzing all truck movements and costs shown on the Corps sand and gravel consultant's contact sheets. This information provided actual truck costs from which two types of truck rates were developed; i.e. one a truck rate based on charges per ton for a specific range of miles; the other, a truck rate based on charges per ton mile.

54. Direct contacts with major sand and gravel producers and trucking firms produced truck rate scales which were in general agreement with those developed by the Corps. Adjustments were made in both scales (per ton and per ton mile) as deemed necessary to have reasonable comparability with specific rates or costs for truck haul in the sand and gravel industry. Further investigations established that the truck rate scale, which was constructed on a rate per ton mile basis, provided lower truck costs and is more representative of the actual rates paid by the industry. This truck rate scale, used in the traffic analysis, is shown in table 8.

TABLE 8

CONSTRUCTED TRUCK RATE SCALE FOR SAND, GRAVEL, AND STONE

Mileage	Rate/Ton Mile	Total charge per ton
0-16	Min. Rate	$.50
17-30	$.03	$.51-$.90
31-36		$.90
37-75	$.025	$.93-$1.88

55. The average break-point from truck movement to rail movement of sand and gravel was found to be 70-75 miles. This was developed from industry contact sheets furnished by the consultant and direct contacts by Corps' personnel with major producers and trucking firms. The sand and gravel producers and trucking firms verified the break-point between the two modes of transportation.

56. Rail rates.- Contact sheets from the consultant and direct contacts made by Corps' personnel with the industry also provided information on the present rail transportation movement patterns and charges for sand and gravel. The rail transportation rate information was correlated with truck transportation rate information to establish probable modes and costs of movement for selected origin and destination points based on existing and potential deposits of sand and gravel. There are no existing rail movements from the assumed origins to the destination points; therefore, the rail rates which the Corps' overland rate contractor provided are constructed rates. The rates developed are joint line rates into the regional market area and are the lowest available for multi-car movements of sand and gravel with a minimum car capacity of 90,000 pounds. These rates are shown on table 9 herein.

57. Barge rates.- Information on the location of major sand and gravel deposits along the Trinity River as developed in the consultant's report provided the basis for establishing ports of origin from which sand and gravel would move to the regional markets of Dallas-Fort Worth and Houston-Galveston. The shipping ports on the waterway would be Urbana, Cayuga, Oakwood, and Trinidad. In the analysis of barge movements, an average ten mile truck haul from the producing point to the nearest river port was assumed. This movement provides a representative estimate of total costs required for each movement.

58. Barge charges for sand and gravel were developed by the Corps of Engineers. The charges used in the traffic analysis of sand and gravel are shown in table 10.

59. Handling charges.- Sand and gravel producers and shippers through interviews with the consultant and Corps of Engineers' personnel, indicated that a handling charge is added to all rail and truck movements of sand and gravel. This handling charge amounts to $0.10 per ton for loading and $0.10 per ton for unloading for a total charge of $0.20/ton. For this traffic analysis an additional charge of $0.10/ton was added for the transfer of sand and gravel from truck to barge, and from truck to rail. Therefore, the total handling charge for these movements is $0.30/ton.

TABLE 9

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

CONSTRUCTED RAIL CHARGES FOR SAND, GRAVEL, & LIMESTONE

Origin	Destination	Rate	Minimum Weight (Pounds)
Urbana	Sims Bayou H. S. C.	$1.28 N. T.	90,000
Midway	" " " " "	$1.75 N. T.	90,000
Oakwood	" " " " "	$1.97 N. T.	90,000
Victoria	" " " " "	$1.60 N. T.	90,000
Cuero	" " " " "	$1.79 N. T.	90,000
Hochheim*	" " " " "	$1.83 N. T.	90,000
Gonzales	" " " " "	$1.79 N. T.	90,000
Seguin	" " " " "	$1.83 N. T.	90,000
La Grange	" " " " "	$1.60 N. T.	90,000
Bastrop	" " " " "	$1.88 N. T.	90,000
Austin	" " " " "	$2.02 N. T.	90,000
Marlin	" " " " "	$1.97 N. T.	90,000
Hearne	" " " " "	$1.60 N. T.	90,000
Riverside	" " " " "	$1.23 N. T.	90,000
Trinidad	Grand Prairie	$1.52 N. T.	90,000
Oakwood	" "	$2.11 N. T.	90,000
Waco	" "	$1.46 N. T.	90,000
Laguna Park*	" "	$1.96 N. T.	90,000
Morgan	" "	$1.96 N. T.	90,000
Granbury	" "	$1.28 N. T.	90,000
Santo	" "	$1.31 N. T.	90,000
Mineral Wells	" "	$1.23 N. T.	90,000
Cayuga	" "	$1.60 N. T.	90,000

* No rail service at present time rates are constructed.

NOTE: Tariff Authority for all rates shown is TLFB 84-1 Item 480.

SOURCE: Rate contractor for The Corps of Engineers.

TABLE 10

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

BARGE CHARGES FOR SAND AND GRAVEL

UPBOUND

Origin		Destination	Rate
Trinidad	to	Grand Prairie	$.55
Oakwood	to	Grand Prairie	$.64
Midway	to	Grand Priarie	$.79
Urbana	to	Grand Prairie	$.94
Cayuga	to	Grand Prairie	$.59
Cayuga	to	Dallas	$.53

DOWNBOUND

Origin		Destination	Rate
Trinidad	to	Houston	$.95
Oakwood	to	Houston	$.85
Midway	to	Houston	$.74
Urbana	to	Houston	$.55
Victoria	to	Houston	$1.15
Urbana	to	Beaumont	$1.15

SOURCE: U. S. Army, Corps of Engineers

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ANALYSIS OF BENEFITS

60. Analysis criteria.- The analysis of transportation savings is based on the following:

a. The regional "destination point" is the representative storage area for the major sand and gravel producers in each region.

b. A handling charge of $0.20 is included on all truck and rail movements to cover loading and unloading costs. An additional $0.10 is included in truck-barge and truck-rail movements to cover the cost of the additional handling.

c. A $0.50 transportation charge was added to all rail, truck, and barge movements to cover the costs of an average 10 mile truck haul from the producing point to the nearest rail head or port.

d. In order to determine the minimum savings that would be required to induce sand and gravel producers to divert operations to the Trinity River deposits, the major producers in each region were interviewed. The concensus of the industry representatives was that several factors must be considered prior to diverting operations to a new production site. These factors include the various combinations of transportation and production costs and the capital costs involved in the physical relocation of the plant. An analysis of each deposit would be required in order to determine the production costs and whether these costs, in combination with transportation costs, would result in competitive market prices for the material produced at a particular site. The industry personnel indicated that assuming equal production costs at each site, a transportation savings of about $0.50 per ton would be required to defray the capital costs involved in the actual relocation of the producing plant. Therefore, for this analysis, truck-barge movement with unit savings of less than $0.50 were eliminated for insufficient savings.

61. Method.- The analysis of sand and gravel transportation savings via the Trinity River was the computed difference between the total transportation costs of existing transportation modes and the transportation costs of truck-barge transportation from producing points to distribution points in the H-GR and D-FWR. Where there is no existing transportation mode, a comparison was made on the basis of the most logical alternate without water transportation. Transportation costs by appropriate modes were developed for alternate sources of sand and gravel throughout the region to determine the lowest-cost source of these materials to the markets, to serve as a basis for estimating waterway commerce from Trinity River deposits. For the commerce finally accepted as prospective for the waterway, benefits were computed by multiplying the unit savings per ton by the prospective

tonnage at each port of movement to obtain the total savings creditable to the waterway for the base year (1966) traffic. The method used in determining the transportation savings creditable to the waterway is illustrated in figure 5. In applying this method to the individual deposits along the Trinity, savings ranging from $0.61 to $0.97 per ton were found in waterway movement from deposits in four port areas. The movements of sand and gravel from the Trinidad-Chatfield deposits to Grand Prairie were found to have a waterway movement savings of $0.97 per ton while movements for the Cayuga area to Grand Prairie were found to have savings of $0.87 per ton, when compared to a rail movement from deposits in the Brazos basin south of Cleburne. The movement of gravel from the Urbana-Romayor area to Houston was found to have a waterway movement savings of $0.61 per ton, compared with rail from Colorado River deposits as an alternate source. The estimated barge rate from Victoria to Houston would indicate a savings of only $0.60 per ton for the waterway movement from Urbana. However, since the barge rate from Victoria is a constructed rate, it is considered more appropriate to use the actual and published rate for the Columbus-Eagle Lake rail movement as an alternate. Accordingly the $0.61 savings was used to compute benefits from waterway transportation from the initial year of the project 1985 through the year 2000, when the Colorado River deposits south of La Grange are estimated to be depleted. At that time the least costly alternative would be truck transportation from the Trinity River Urbana deposit. Accordingly, from the year 2000 to the end of the project life in 2035, a waterway movement savings of $0.63 per ton compared with truck from the Urbana deposit was used to compute savings. Computation of savings by this method is predicated upon economic depletion of the Guadalupe reserves south of Cuero and those of the Colorado south of La Grange in the year 2000. It is possible, of course, that the actual depletion date could be extended if the Guadalupe and Colorado reserves have been underestimated. To determine the effect that this might have on the economic analysis, a computation was made assuming unlimited reserves on both the Guadalupe and Colorado, which would limit transportation savings on the Urbana sand and small gravel movement to $0.61 per ton throughout the project life. The total effect of this assumption would reduce the average annual equivalent benefits by about $167,000, which is considered negligible. Prospective commerce was accepted for the latter four movements, since the estimated savings exceeded the $0.50 per ton criterion required to attract the movements to the waterway.

62. Benefits.- Table 11 shows a summary of the tonnages of sand and gravel accepted as prospective commerce, the unit and total savings by waterway transportation, and the least costly alternate source and/or mode. The base year 1966 prospective commerce totals 5.2 million tons of sand and gravel, with total estimated benefits of $4,664,000.

TABLE 11

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SUMMARY OF 1966 BASE YEAR BENEFITS

Movement		Prospective commerce (tons)	Unit savings	Total savings	Alternate source and/or mode
To H-GR (Sims Bayou)					
From:	Urbana	2,100,000	$0.61	$1,281,000	Colorado River-rail
To D-FWR (Grand Prairie)					
From:	Trinidad	2,170,000	0.97	2,105,000	Truck-rail
	Cayuga	150,000	0.87	131,000	Brazos River/ truck-rail
	Oakwood	780,000	1.47	1,147,000	Truck-rail
	Totals	5,200,000		$4,664,000	

Figure 5

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET
TRAFFIC SURVEY FOR TRINITY RIVER RESTUDY

Commodity: Sand **Annual tonnage:** 2,100,000 **tons** **(short tons)**

Origin: Urbana-Romayor Area **Destination:** Houston (Sims Bayou)

Plant to dock 10 Miles **Dock to plant** 0 **Miles**

(1) Existing rate ~~(rail)~~ (truck) ~~(pipeline)~~ *71 $ 1.78 N.T.

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Columbus-Eagle Lake Area		T	$ 0.50
Port-to-port	(Via)		R	1.16
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.96

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Urbana-Romayor Area	10	T	$ 0.50
Port-to-port	(Via)		B	0.55
(5) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3 @ $0.10			0.30
Switching charge				
Other (specify)				
TOTAL				$ 1.35

REMARKS: **Unit Savings** $ 0.61 **N.T.**

Authority for rates: **Total Savings $** 1,281,000

(1) *Includes aver. 10 mile truck haul

COLORADO RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Columbus-Eagle Lake	10	T	0.50
(2) Port-to-port	(Via)		R	1.16
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.96

GUADALUPE RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Victoria Area	10	T	.50
(2) Port-to-port	(Via)		B	1.15
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.95

TRINITY ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Urbana-Romayor Area			
(2) Port-to-port	(Via)		T	1.78
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 1.98

Figure 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET Sheet 2 of 6
TRAFFIC SURVEY FOR TRINITY RIVER RESTUDY

Commodity: Sand **Annual tonnage:** 2,600,000 **tons** **(short tons)**

Origin: Urbana-Romayor Area **Destination:** Houston, Tex (Sims Bayou)

Plant to dock 10 **Miles** **Dock to plant** 0 **Miles**

(1) Existing rate ~~(rail)~~ **(truck)** ~~(pipeline)~~ *71 $ 1.78 N.T.

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Urbana			$
Port-to-port	(Via)	71	T	1.78
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 1.98

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Urbana-Romayor Area	10	T	$ 0.50
Port-to-port	(Via)		B	0.55
(5) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.35

REMARKS: **Unit Savings $** .63 **N.T.**

Total Savings $ 1,638,000 *

Authority for rates:
*Includes aver. 10 mile truck haul
(1)

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Urbana	10	T	.50
(2) Port-to-port	(Via)		R	1.28
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.08

COLORADO RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	La Grange	10	T	0.50
(2) Port-to-port	(Via)		R	1.60
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.40

GUADALUPE RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Cuero, Texas	10	T	.50
(2) Port-to-port	(Via)		R	1.79
(3) Rate from 2d port	Houston (Sims Bayou)			
Constant factor				
Handling charge	3@ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.59

Figure 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET
TRAFFIC SURVEY FOR TRINITY RIVER

Commodity: Sand and Gravel **Annual tonnage:** 1,820,000 **tons** **(short tons)**

Origin: Trinidad-Chatfield Area **Destination:** Grand Prairie

Plant to dock 10 **Miles** **Dock to plant** 0 **Miles**

(1) Existing rate ~~(rail)~~ **(truck)** ~~(pipeline)~~ *89 $ 2.23 N.T.

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Trinidad	10	T	$ .50
Port-to-port	(Via)		R	1.52
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.32

TRINITY RIVER **ROUTE**

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Trinidad	10	T	$ .50
Port-to-port	(Via Trinity)		B	.55
(5) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.35

REMARKS: **Unit Savings** $ .97 N.T.

Authority for rates: **Total Savings** $ 1,765,000

*Includes aver. 10 mile truck haul

(1)

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Trinidad			
(2) Port-to-port	(Via)	*89	T	$2.23
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 2.43

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port				
(2) Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge				
Other (specify)				
TOTAL				$

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port				
(2) Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge				
Other (specify)				
TOTAL				$

Figure 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET
TRAFFIC SURVEY FOR TRINITY RIVER

Commodity: Sand and Gravel **Annual tonnage:** 350,000 **tons (short tons)**

Origin: Trinidad-Chatfield Area **Destination:** Grand Prairie

Plant to dock 10 **Miles** **Dock to plant** 0 **Miles**

(1) Existing rate ~~(rail)~~ **(truck)** ~~(pipeline)~~ *89 Miles $ 2.23 **N.T.**
Rail Rate: 1.52

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Trinidad-Chatfield Area	10	T	$ .50
Port-to-port	(Via)		R	1.52
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.32

TRINITY RIVER **ROUTE**

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Trinidad, Tex	10	T	$ .50
Port-to-port	(Via Trinity)		B	.55
(5) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.35

REMARKS: **Unit Savings** $ .97 **N.T.**

Authority for rates: **Total Savings $** 340,000

(1) *Includes aver. 10 mile truck haul

BRAZOS RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Morgan, Tex	10	T	.50
(2) Port-to-port	(Via)		R	1.96
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.76

BRAZOS RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Morgan, Texas			
(2) Port-to-port	(Via)	* 92	T	2.30
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 2.50

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Trinidad	10	T	.50
(2) Port-to-port	(Via)		R	1.52
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.32

Figure 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET Sheet 5 of 6

TRAFFIC SURVEY FOR TRINITY RIVER

Commodity: Sand and Gravel **Annual tonnage:** 150,000 **tons (short tons)**

Origin: Cayuga, Texas Area **Destination:** Grand Prairie

Plant to dock 10 **Miles** **Dock to plant** 0 **Miles**

(1) Existing rate ~~(rail)~~ **(truck)** ~~(pipeline)~~ Mileage *111 $ 2.78 **N.T.**
Rail Rate: 1.60

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Waco, Tex	10	T	$ .50
Port-to-port	(Via)		R	1.46
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.26

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Cayuga, Texas	10	T	$ .50
Port-to-port	(Via)		B	.59
(5) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.39

REMARKS: **Unit Savings** $ .87 **N.T.**

Authority for rates: **Total Savings** $ 131,000

*Includes aver. 10 mile truck haul

(1)

BRAZOS RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Waco	10	T	.50
(2) Port-to-port	(Via)		R	1.46
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.26

BRAZOS RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Waco	116	T	
(2) Port-to-port	(Via)			2.90
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 3.10

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Cayuga, Tex	10	T	.50
(2) Port-to-port	(Via)		R	1.60
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.40

Figure 5 (Cont'd)

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

SAND, GRAVEL, AND STONE STUDY
TRAFFIC ANALYSIS

RATE ANALYSIS SHEET
TRAFFIC SURVEY FOR TRINITY RIVER

Commodity: Sand and Gravel Annual tonnage: 780,000 tons (short tons)

Origin: Oakwood-Long Lake Area Destination: Grand Prairie

Plent to dock 10 Miles Dock to plant 0 Miles

(1) Existing rate ~~(rail)~~ (truck) ~~(pipeline)~~ *135 Miles $ 3.38 N.T.
Rail Rate: 2.11

LOWEST AVAILABLE ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(2) Rate to 1st port	Oakwood	10	T	$ .50
Port-to-port	(Via)		R	2.11
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 2.91

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(4) Rate to 1st port	Oakwood	10	T	$ .50
Port-to-port	(Via)		B	.64
(5) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	3 @ $0.10			.30
Switching charge				
Other (specify)				
TOTAL				$ 1.44

REMARKS: Unit Savings $ 1.47 N.T.

Authority for rates: Total Savings $ 1,149,000

*Includes aver. 10 mile truck haul

(1)

TRINITY RIVER ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port	Oakwood			
(2) Port-to-port	(Via)	*135	T	3.38
(3) Rate from 2d port	Grand Prairie			
Constant factor				
Handling charge	2 @ $0.10			.20
Switching charge				
Other (specify)				
TOTAL				$ 3.58

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port				
(2) Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge				
Other (specify)				
TOTAL				$

ROUTE

Item	Port	Miles	Carrier	Rate per N.T.
(1) Rate to 1st port				
(2) Port-to-port	(Via)			
(3) Rate from 2d port				
Constant factor				
Handling charge				
Switching charge				
Other (specify)				
TOTAL				$

63. Projected requirements for sand and gravel.- The projected requirements for sand and gravel in the major consuming regions within the Trinity River tributary area are based on the predicted performance of the index of value of new construction contracts. The predicted growth factors were used to estimate the total sand and gravel requirements of each region throughout the 50-year project life. Table 12 summarizes the estimates of annual tonnages and transportation savings to be derived from movement of sand and gravel on the waterway for selected years during the project life.

TABLE 12

SUMMARY OF ESTIMATED SAND & GRAVEL ANNUAL TONNAGES AND SAVINGS FOR SELECTED YEARS DURING PROJECT LIFE

Year	Prospective waterway commerce (in thousands)	Transportation savings (in thousands)	Base year growth factor
1966	5,200.0 (1)	$ 4,664.0 (1)	1.000
1985	10,462.0	9,384.0	2.012
2000	19,238.0	16,946.0	3.375
2010	27,434.0	24,166.0	4.813
2020	39,074.0	34,419.0	6.855
2035	66,890.0	58,921.0	11.735

(1) Base year tonnage of 5,200,000 and savings of $4,664,000 were used to compute tonnage and savings to the year 2000 and 5,700,000 tons and $5,021,000 savings were used to compute tonnage and savings from 2000 to 2035. (See par. 28).

64. The total benefits attributable to the waterway project at the beginning of project life in 1985, as shown in table 13 are estimated to be $8,859,000. The benefits to be derived from future sand and gravel traffic during the 50-year project life from 1985 to 2035, were estimated in accordance with the formula and procedures described in EM 1120-2-118, Appendix II and Senate Document 97, 87th Congress. An interest rate of 3.25 percent was used to reduce the total future benefits to an average annual equivalent benefit of $12,804,000 for the project life period.

97-086 O-68—31

65. <u>Summary of benefits</u>.- The total average annual equivalent benefits attributable to the Trinity River waterway from savings realized from sand and gravel shipments is estimated at $22,188,000 as shown in table 13.

TABLE 13

SUMMARY OF BENEFITS

		Benefits from Transportation Savings
Beginning of Project Life 1985		$ 9,384,000
Future Sand & Gravel Movements		$12,804,000
	Total Average Annual Equivalent Benefits	$22,188,000

66. These benefits are based on the total accepted tonnage of 5.2 million tons of sand and gravel with transportation savings of $4,664,000 in the base year 1966. Of this 5.2 million tons, 2.1 million tons would be transported downbound to the Houston-Galveston Region concurrently with 3.1 million tons transported upbound to the Dallas-Fort Worth Region.

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

EXHIBIT 3
IRON AND STEEL STUDY

EXHIBIT 3
APPENDIX II

IRON AND STEEL COMMODITY

ORIGINS, TRAFFIC AND MARKETS

ACCESSIBLE

VIA

THE PROPOSED TRINITY RIVER

NAVIGATION PROJECT

Iron and Steel Special Study
Trinity River Waterway
Texas

Prepared For

U. S. Army Engineer District
Galveston
Corps of Engineers
Galveston, Texas
(Contract No. DACW64-67-C-0060)

by

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November 1967

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I. SUMMARY - CONCLUSIONS

In summary and conclusion, in terms of potential iron-and steel-related commodities that would develop as traffic on a multi-purpose Channelized Trinity, this study has demonstrated the following:

1. The Trinity Economic Impact Area is one of the nation's fastest developing regions and, lest this growth be stifled, the area will require increasing transportation facilities to accommodate and move her goods.

2. The Study Area is now a major iron and steel production and market axis and promises to more than double in these activities within the next twenty years.

3. That although oil field iron and steel equipment and supplies will constitute an important segment of Trinity Waterway Traffic this category is not now, nor ever will be, as important as iron and steel for construction, contractors' goods and manufacturers' needs. These latter are the real bases for much of the iron and steel tonnage that will move on the channelized Trinity.

4. The primary steel industries of the Trinity Economic Impact Area are already impressive and these will double within the next five to ten years; and, of all the iron and steel commodities, scrap holds the promise of greatest tonnage.

5. The total of present-day iron and steel commodities that could be expected to move on a channelized Trinity is 1,344,512 net tons. By 1985 this corresponding figure will be 2,858,610. By the year 2000, this figure will be 4,196,111; and by 2035 the figure will be 8,366,618 net tons.

6. The chief iron and steel commodities in terms of future volume will be: (1) iron and steel for manufacturing; (2) scrap (ferrous); and, (3) construction and contractors' iron and steel (see Table 31-A).

7. Total iron and steel tonnage projected for a channelized Trinity are:

1965	--	1,376,048
1985	--	2,789,106
2000	--	4,073,737
2035	--	8,467,547

8. The impact area of a channelized Trinity is in reality all of the Southwest, especially to include Houston. But for purposes of this study the area has been delimited as shown on Map 5.

II. SCOPE OF WORK OR PREFACE

This report is a study of the present movements of iron and steel and their products that are consumed in the area of influence of the Trinity River navigation project, and determination of transportation modes of these commodities that would be developed in the event that a channelized Trinity River might become a reality. However, especially in regard to iron and steel products, the criteria of least transportation cost does not usually dictate how these commodities will be moved.

In fact, the latter factor is sufficiently acute that most iron and steel producers are in favor of the status quo. Significantly, however, most of the great numbers of their customers, and therefore, in turn, the ultimate consumers of iron and steel items are more likely to benefit, cost-wise, from lower transportation costs. Obviously, these factors must be presented in setting the stage for an understanding study of possible movements of iron and steel products on a channelized Trinity River.

The logic behind iron and steel mills' (the basic producers--not users) resistance to additional water transportation is based on two main factors. First, and the most obvious, land-locked mills, or those not in a position to use water navigation dislike seeing their competitors with a cost advantage. Second, and probably of far greater importance, is the equalization factor. Equalization is deeply imbedded in the philosophy of the steel industry. The mechanics in principle are simple. Under the system, iron and steel prices at any given delivery point are uniform--regardless of where the iron and/or steel are "shipped from." In practice, however, primarily in the area of transportation costs, the system can become complex and difficult for the outsider to understand. This is especially true today when some mills ship via one mode of transportation and equalize against another. In addition, secondary competition forces the equalization of small-lot shipments against high-volume minimum weights.

To illustrate this latter problem, Dallas, Texas, is currently controlled by Lone Star Steel Company of Daingerfield, Texas, on pipe. This pipe has a mill base of approximately $220 per ton plus a mark-up of $10.00 per ton, plus truck freight of $9.10 per ton, minimum 30,000 pounds.[1] A barge rate from the Pittsburgh area of anything less than $19.10 would make Eastern Mills plus the barge rate controlling (the current 600-ton barge rate to Houston

[1]Railroad Commission of Texas 6-H, IT 220 (137.8 miles).

is $10.07[2] and to Corpus Christi, $11.85[3]--this latter might reasonably be expected to apply to Dallas). Pittsburgh area truck rates on iron and steel are prohibitive; the corresponding rail rate to Dallas is $24.00[4] ($1.20 per C. W. T., minimum 70,000 pounds). Thus, all mills now must sell in 30,000 pound quantities at a total price of $239 per ton. If barge rates were established at $11.85, all mills would sell at $231.85 regardless of how it was shipped to the customer--barge, rail, or truck--or how much it cost to produce.

Thus, the problem evolves into a simple matter of economics; iron and steel prices are based on the lowest of mill price, plus mark-up (if any), plus the lowest cost method of transportation from the low-cost mill. Secondary competition has forced small-lot deliveries on high-volume rates with actual movement via higher-cost carriage. In actual practice, a steel company equalizes against itself and secondary competition in many instances. As a result, steel companies are not interested in lower cost transportation which, in turn, costs them in added absorptions.

In contrast, and in opposition, are the great numbers of iron and steel mill customers in the Trinity River area of influence and, in turn, their even greater numbers of customers, who when buying from a limited number of producers, a homogeneous product from an oligopolistic industry with administered prices, are anxious to enlarge their markets through the medium of lower-cost transportation.

The significance of these two contrasting groups in regard to this study has been two-fold: (1) excellent cooperation on the part of interested iron and steel users, and (2) a paucity of cooperation and data on the producers of iron and steel. In total, however, the report has engendered sufficient data to provide meaningful projections and the findings are presented in the summary-conclusion section of The Report.

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[2]Item 4360, Federal Barge Line, Inc. Tariff 229-N, E. H. Streble, ICC-88.

[3]*Ibid.*, Item 4325.

[4]Southwestern Lines Tariff.

III. THE REPORT

A. Introduction

The organization of the main body of this report is based on the provisions listed in Appendix A - Iron and Steel Special Study. Essentially, the report consists of two main sections: (1) Iron and Steel Products Relative to the Proposed Trinity River Development; and (2) Iron and Steel Production Relative to the Proposed Project. Within each section are sub-sections dealing with: (a) interview information; (b) present sources of supply of iron and steel products and/or raw materials; and (c) projections of future traffic. And, within the section on iron and steel products, there is a sub-section dealing with the relative use of iron and steel products in the oil and gas industry as compared with other categories of iron and steel consumers, such as construction and/or fabricators. In addition, each of the two main sections contain introductory background material and summary sub-sections on savings in transportation costs to be obtained in iron and steel commodity movements using the proposed waterway as compared with alternative routes and rates.

B. Iron and Steel Products Relative to a Trinity River Navigation Channel

Background. An important part of this study is to ascertain and identify the manufacturers using iron and steel in the Trinity River area of influence, their customers and ultimate users of their manufactured goods and their sources of supply. And, at the same time, to identify those industries and people in the Trinity River Area having an interest in the development of a channelized Trinity in terms of the area's iron and steel economy. The data presented in Table 1 indicates that the iron and steel oriented industrial plants account for 34.9 per cent of manufacturing employment in all of Texas and 29.8 per cent of all value added by manufacturing within the state.

The significance of the above percentages is further enhanced by the fact that two-thirds of the nearly 3500 iron and steel oriented plants in Texas are aligned in close proximity to the Trinity or connecting Intracoastal arteries. Indeed, more than 50 per cent are in the Harris, Tarrant and Dallas Counties--located at either terminous of the proposed Trinity River Channel.

In terms of growth, both categories reflected an 80 per cent increase over the same set of data as reported in the 1954 census totals. In terms of manufacturing employment, the iron and steel related classifications contain five times the number employed in the "Petroleum Refining and Related Industries." (See Table 3).

The 1963 Census of Manufacturing reflected an 80 per cent increase in the Houston-Dallas Standard Metropolitan Statistical Areas in value added by manufacturing over the 1954 census totals. Even after allowing for inflationary and price trends this is a most impressive figure and indicates the sizeable and basic stature of the iron and steel industries at either end and along the proposed Trinity route.

Water transportation is a principal channel of supply because of significant cost advantages inherent in Houston's access to some 60 per cent of the population of continental United States by the inland waterway system and/or major deep-sea port. Economy of water transportation extends to all-rail movements from the East in water-compelled rail rates that for the most part give Houston much lower transportation costs than apply from the East to interior Southwestern points.[5]

Domestic mills operate their own deepsea vessels for coastwise movements and utilize proprietary and for-hire barge movements over the inland waterways. Foreign steel movements into Port of Houston have increased substantially in recent years.

Importance of import, inbound coastwise and inbound barge tonnages to the growing status of Port of Houston as a general-cargo port is indicated in Table 4: Whereas the eight-year span (1957-1964 inclusive) saw total port tonnage increase by 7.7 per cent, total foreign tonnage increased by 18.2 per cent, import foreign tonnage jumped 78.1 per cent, inbound coastwise tonnage increased 57.3 per cent and inbound barge tonnage over the Inland Waterways increased 73.3 per cent. Preliminary data for 1965 and 1966 continue these trends.

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[5] ICC Docket No. Mc-C-1891, July 28, 1966.

TABLE 1

SIGNIFICANCE OF IRON AND STEEL

IN THE

ECONOMY OF THE TRINITY RIVER AREA

	Employment	Per Cent	Value Added by Manufacturing	Per Cent
Industrial Plants--all Texas	508,539	100.0	$7,053,797,000	100.0
SIC[1]				
Primary Metals	27,906	5.5	381,757,000	5.4
Fabricated Metal Products (except ordnance, machinery & Transportation equipment)	33,180	6.5	312,763,000	4.4
Machinery (except electrical)	41,281	8.1	501,640,000	7.1
Electrical & Electronic Machinery, Equipment and Supplies	25,454	5.0	295,649,000	4.1
Transportation Equipment	49,868	9.8	609,822,000	8.6
Total Iron and Steel Oriented Industries in Texas	177,689	34.9	$2,101,631,000	29.6

SOURCE: Escott, Florence. 1965 Industrial Atlas of Texas; Bureau of Business Research, University of Texas, Austin, Texas, 1965.

[1]For purposes of offering a conservative picture of the place of iron and steel relative to all industrial plants such categories as professional, scientific, and controlling instruments; photographic and optical goods; watches and clocks and miscellaneous manufacturing industries, including ordnance and accessories have been omitted.

TABLE 2

PERCENTAGE OF IRON AND STEEL ORIENTED INDUSTRIAL PLANTS

IN ALL OF TEXAS WHICH ARE IN COUNTIES

RIPARIAN TO THE TRINITY RIVER OR INTRACOASTAL CANAL

Industrial (SIC) Category	Total No. in All of Texas	No. in Tarrant, Dallas and Harris Counties	Per Cent	No. in Riparian or SMSA Counties	Per Cent
Primary Metal	222	119	53.6	145	65.3
Fabricated Metal Products, except ordnance, machinery & Transportation Equipment	1,404	710	50.1	850	60.5
Machinery, except Electrical	1,188	619	52.1	722	60.8
Electrical & Electronic Machinery, Equipment and Supplies	298	190	63.8	211	70.8
Transportation Equipment	381	172	45.1	223	58.5
Totals	3,493	1,810	51.8	2,151	61.6

SOURCE: Escott, Florence. 1965 Industrial Atlas of Texas; Bureau of Business Research, University of Texas, Austin, Texas, 1965.

TABLE 3

PER CENT OF IRON AND STEEL ORIENTED EMPLOYEES

AND

VALUE ADDED IN TEXAS, 1965

	S.I.C. Group		No. of Employees	Value Added By Manufacture
1.	S.I.C. 20	Food and Kindred Products	74,971	$ 923,362,000
2.	22	Textile Mill Products	6,461	37,089,000
3.	23	Apparel and Other Fabric Products	40,150	208,611,000
4.	24	Lumber & Wood Products (Except Furniture)	17,515	105,617,000
5.	25	Furniture and Fixtures	10,662	76,392,000
6.	26	Paper and Allied Products	11,506	148,740,000
7.	27	Printing and Allied Industries	30,154	286,840,000
8.	28	Chemicals and Allied Products	44,037	1,653,810,000
9.	29	Petroleum Refining & Related Industries	35,587	956,140,000
10.	30	Rubber and Misc. Plastic Products	6,839	97,695,000
11.	31	Leather and Leather Products	not available	not available
12.	32	Stone, Shell, Clay and Glass Products	25,078	301,392,000
13.	33	Primary Metal Industries	27,906	381,757,000
14.	34	Fabricated Metal Products	33,180	312,763,000
15.	35	Machinery	41,281	501,640,000
16.	36	Electrical & Electronic Machinery	25,454	295,649,000
17.	37	Transportation Equipment	49,868	609,822,000
18.	38	Professional, Scientific Instruments, etc.	4,784	50,077,000
19.	39	Miscellaneous Manufacturing, including ordnance and Accessories	not available	not available
20.	Total 33, 34, 35, 36, 37 S.I.C.		177,689	2,101,631,000
21.	State Totals		508,539[1]	$7,053,797,000[1]

SOURCE: *Ibid.*, Table 2, and *Directory of Texas Manufacturers*, 1965. [1]Not equal to sum of items listed.

TABLE 4

PORT OF HOUSTON TONNAGE (NET TONS)

	1957	1960	1964	1965
Port total	54,945,531	57,132,659	59,152,653	not available
Foreign	10,987,953	9,901,299	12,985,786	
Import Foreign	2,130,291	2,929,500	3,794,205	
Inbound domestic deepsea coastwise	887,534	1,318,416	1,395,861	
Inbound domestic internal (barge)	4,371,081	5,726,534	7,575,978	

SOURCE: Waterborne Commerce of the United States, Calendar Year, 1957, 1960, 1964 (Part 2); Department of the Army, Corps of Engineers

Specifically as to iron and steel products, the three categories of inbound water receipts (barge, coastwise and foreign) are tabulated in Table 5 on a five-year comparison, 1960 vs. 1964, and by the three main categories of product descriptions (semi-finished products, finished products, pipe). Nineteen hundred and fifty-seven figures cannot be compared because Corps of Engineers statistics for that year do not have a specific break-out of only pipe tonnages. Pipe receipts are shown only for general information and to indicate the sharp decline in their relative importance in the Trinity influence area; and, at the same time, the sharp increase in other iron and steel categories.

Growth of Houston's inbound waterborne tonnages of the steel here involved may be quickly observed from Table 5, noting that principal increases occurred in the coastwise and foreign receipts. Finished steel products coastwise rose 40 per cent and foreign 33 per cent, totaling some 680,000 tons in 1964. Barge finished products declined 10 per cent to a 1964 total of just over 380,000 tons or a combined total of finished products of about 1,060,000 tons. Semi-finished products received in 1964 more than doubled, to some 173,000 tons.

The only segment of decline in this set of data is the drop in rolled, finished steel mill products arriving in Houston ex Domestic Internal Barge, and a comparable drop in Iron and Steel Pipe. There are several events which account for this drop in barge movements and make it clear that there was no drop in the area's total need for iron and steel products (see Tables 17 and 18).

TABLE 5

HOUSTON STEEL RECEIPTS BY WATER, IN NET TONS

	1960	1964	1965
Domestic Internal (barge)			
Iron & Steel semi-finished products	31,930	68,892	not available
Rolled, finished steel mill products	426,721	383,050	
Iron & Steel pipe	311,754	181,071	
Domestic Deepsea Coastwise			
Iron & Steel semi-finished products	3,960	16,358	
Rolled, finished steel mill products	126,190	176,477	
Iron & Steel pipe	7,091	26,250	
Foreign			
Iron & Steel semi-finished products	48,179	88,316	
Rolled, finished steel mill products	378,947	504,612	
Iron & Steel Pipe	94,205	126,234	

SOURCE: Waterborne Commerce of the United States, Calendar Year 1960, 1964 (Part 2); Department of the Army, Corps of Engineers.

Some of the decline was due to an enormous increase in imported iron and steel beginning in 1960 and 1961 (see Tables 16 and 17). National imports jumped from 3.4 million tons in 1960 to 6.4 millions in 1964[6] and as Houston's share of this nationwide increase in iron and steel imports (12,747,627 net tons in 1966[7]) was approximately

[6]American Iron and Steel Institute, Charting Steel's Progress, 1962, p. 38 and 1966, p. 38.

[7]American Iron and Steel Institute, Annual Statistical Report, 1966, p. 42.

10 per cent (1,202,640 net tons in 1966[8]) this percentage applied to 1960 and 1964 represents an increase of imports of some 300,000 net tons--certainly sufficient to depress Domestic Internal Barge traffic inbound into Houston. A sizeable share of this 300,000 tons, in 1964 plus a large share of the flood of imports in 1965, 1966 and 1967, would likely move to interior points by barge, especially the Ft. Worth-Dallas areas, if a Trinity Channel were in existence.

In addition to the sudden surge in imports in the 1960-61 period at about the same time Bethlehem began volume coastwise movements of iron and steel products from Sparrows Point, Maryland, to Houston (and other Gulf Coast Points) preempted barge movements from Bethlehem's inland mills to the Houston Port. Although there is no published data on this movement it is significant and in excess of 250,000 net tons yearly.[9]

Then to further affect barge movements of iron and steel during this period was a shift in the marketing techniques used by U. S. Steel. During this period U. S. Steel took a 4 per cent ($8 to $9 per ton) mark-up off of their Oil Country Tubular stocks. This then made it cheaper to buy from stocks in 30,000 pound lots rather than from the producing mill in 600 ton, or larger, quantities. Thus, the new smaller, quantities ordered, lend themselves to rail and/or truck transportation rather than barge. In addition, even those large firms which had formerly ordered large shipments (such as the major oil companies) now draw from a fewer number of stock points along the Gulf Coast other than Houston and from such inland points as Hobbs, New Mexico; Odessa, Texas; or Oklahoma City, Oklahoma, rather than maintain their own inventories.

Still other technical factors reinforced the decline in barge traffic. Some of these, such as the jump in multiple-well completions, are relatively minor in and of themselves, but collectively work to help explain the drop in Domestic Internal Barge tonnage received in Houston from 1960 to 1964.

<u>But, emphatically, the total market for Iron and Steel products reaching the Houston terminous of the proposed Trinity Waterway continued to rise sharply (see Tables 17 and 18) during this period.</u>

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[8]*Ibid.*, p. 47.

[9]This tonnage consisted of 120,290 for the first five months of 1966. Harris County-Houston Navigation District preliminary figure for 1966.

Nineteen hundred and sixty-five port figures are available but not yet in Corps of Engineers classifications. Records of the Statistical Section, Harris County Houston Ship Channel Navigation District reveal that in calendar year 1965 the port unloaded steel tonnages (including pipe) totaling 1,060,346 net tons. For 1966, the corresponding port total for Houston was, as pointed out above, 1,202,640 net tons.

High per-capita consumption of steel is a characteristic of the Houston and Dallas-Ft. Worth area, especially the former with its heavy-industry economy. Steel is a basic material for the Trinity influence area's capital-intensive industries--natural gas, non-electrical machinery, construction, petroleum and coal tar products, air conditioning equipment, chemicals and allied products. Also, both industrial and non-residential construction have combined to keep Houston third in the nation in recent years in value of construction activity. Dallas and Ft. Worth are not far behind. Most of the area's steel is utilized in manufacturing, by hundreds of firms in scores of industry classifications. To illustrate this diversity, Table 6 shows typical representative industry-group users of steel and the number of Trinity-area firms in some of the categories, grouped by Standard Industrial Classification (S.I.C.) codes observed by the Bureau of the Census. Obviously, the 500-600 firms shown do not comprise the entire business community, but indicate the wide range of categories of steel-using industry groups.

The City of Houston's population on January 1, 1966, was 1,142,000; population of Harris County was 1,544,000 and of the five-county Standard Metropolitan Statistical Area, 1,765,000. Houston, sixth largest city in the nation, is the fastest-growing major city, and is more than doubling its population every twenty years.[10] Its economy is significantly steel-oriented.

The Dallas-Ft. Worth area-wide population on January, 1964, was 1,821,468.[11] Thus, counting the 300,000 people along the Trinity route, there are nearly four million people immediately affected by the Trinity project--especially as the project, in turn, affects the cost of such basic items as iron and steel.

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[10] Houston Chamber of Commerce, Population Estimation Committee.

[11] Dallas-Ft. Worth, Regional Transportation Study, U. S. Department of Commerce and Texas Highway Department, p. 8.

TABLE 6

SOME REPRESENTATIVE HOUSTON AREA INDUSTRY-GROUP USERS OF STEEL

No. of Firms	S.I.C. Code	Industry Group	Typical Products
8	3731	Ship building & repairing	ships, barges
13	3391	Iron & Steel Forgings	flanges, forgings
28	3441	Fabricated Structural Steel	structurals
66	3443	Fab. plate work-boiler shops	boilers, towers, vessels
11	3552	Farm machinery & eqpt.	shredders, machinery
18	3461	Metal stampings	signs, stampings
10	3713	Truck & bus bodies	dump bodies, trailers
57	3444	Sheet metal work	carports, ducts
70	3449	Architectural & Misc. metal work	steel bldgs., reinf. steel
30	3481	Misc. Fab. Wire Products	fencing, mesh, ties
8	3531	Construction machinery	draglines, blades, tampers
4	3493	Steel springs	vehicle springs
43	3494	Valves, pipe fittings	hangers, valves
28	3561	Pumps, compressors, eqpt.	air compressors; pumps
96	3533	Oil field mach. & eqpt.	oilfield equipment
25	3499	Fabricated Metal Products NEC	cotton ties, skids
4	3537	Industrial trucks, tractors, etc.	lift trucks; trailers
7	3491	Metal shipping barrels, etc.	steel drums
19	3498	Fabricated pipe; fittings	nipples, tubing
5	3536	Hoists, industrial cranes, etc.	overhead cranes
16	3321	Foundries gray iron	R.R. brake shoes;
	3322	malleable iron, steel	castings; manhole
	3323	foundries	covers; grate bars
4	3411	Metal cans	metal containers
10	3452	Bolts, nuts, etc.	studs, threaded bars

SOURCE: Manufacturers' Directory, 1965-66; Houston Chamber of Commerce, copyright, 1965.

Houston, as supplier of steel to much of the Southwest, sells and delivers structurals, reinforcement and other construction steel, and finished fabricated components to many kinds of projects in the area that would be served by the Trinity Channel. Locks and dams on river flood control-navigation projects; manufacturing plants in rural areas; highway construction projects; electric power generating plants;

public works projects; public and private airports or landing strips; rural school building, and construction of defense installations are representative of current construction activities requiring quantity deliveries of iron and steel products.

Particularizing for illustration: Houston firms have supplied and are supplying many thousands of tons of steel to various lock-and-dam site locations on the Arkansas Verdigris River project including the White River, and similar materials are now being procured locally for construction on the Toledo Bend Reservoir project in Louisiana and Texas. These continuing shipments obviously bear no relationship to oilfield materials so that, as pointed out above, much of the recent growth in iron and steel activities in the Proposed Trinity influence area is not tied to the future of the petroleum per se.[12]

Still another reason for a decline in barge iron and steel traffic is the Transportation Act of 1958[13] which, in effect, allows rail carriers to set mill-to-point prices without consideration of competing carriers (even though the Interstate Commerce Commission is still charged with determining what is a reasonable rate).[14] At the same time, the data of Table 5 shows the strong upsurge in shipments of semi-finished iron and steel and continuing strong movements of other iron and steel categories. And, especially heavy increases are shown in the amount of iron and steel reaching the Southern Terminous of the proposed Trinity River route by Domestic Deepsea Coastwise and from Foreign sources. Collectively, these categories have doubled in tonnage in the short span from 1960 to 1964--the period in which Houston has emerged as one of the nation's important iron and steel centers.

Again, Table 6 reflects the wide range of iron and steel user categories in the Trinity area and its hinterland. Here again, with the immediate past and expected continuing decline in oilfield iron and steel shipments, it is significant to note that there are categories not related to oilfield activities. For the most part, these other categories are related more directly to population (than to the oilfields *per se*). In fact, many of the market research experts of the major iron and steel producers consider population in-mass as "the" important measure of estimating an area's market

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[12] *Op. cit.*, ICC Docket.

[13] Transportation Act of 1958 (Sec. 5, adding a new par. (3) to Sec. 15a of the Basic Transportation Act).

[14] *Ibid.*

potential for their products.[15] In this regard, the burgeoning populations of both Houston and the Dallas-Ft. Worth areas are growing at a rate which places them fourth and sixth, respectively, in the nation (See Table 7). And, based upon this rule of thumb, that iron and steel markets and population growth coincide, iron and steel markets in these two respective termini points on the proposed Trinity Channel are growing at an annual corresponding rate of approximately 4.42 per cent, and 3.83 per cent, respectively. When averaged with the overall population average rates of growth of 2.2, it is assumed that the population of the Trinity area of influence will be something in excess of 2.2 per cent.

In summary of this discussion setting the background for a study of what iron and steel commodities might move on a channelized Trinity River, it is clear that a vast and burgeoning iron and steel industry and market already exists; and, it is equally clear, that the Trinity Influence Area is one of the fastest growing basic economies in the entire country. Thus, in light of the kaleidoscopic expansion of both iron and steel needs, as will be developed later in the study, and growth in production capabilities, (both in terms of volume and in kinds of iron and steel products) estimated projections based on the present and past experiences of iron and steel movements within the area, are by necessity most conservative.

C. Present Trinity River Area Iron and Steel Commodity Origins, Traffic, and Markets.

<u>Present Movements of Iron and Steel Products</u>. A survey of 230 iron and steel-oriented firms in the Trinity influence area reported commodity movements of 4,518,902 tons[16] by all modes of transportation. And, of this total, the shippers interviewed expressed an interest in possibly moving 1,186,312 (combine totals in Tables 9 and 12) tons via a channelized Trinity Waterway--of this tonnage, 945,592 would be upbound cargoes, 240,720 would be downbound.

That there already exists a keen interest in barge service on iron and steel goods at the Houston terminous of the Trinity Route is indicated by the barge receipts and shipment data shown in Table 8. A combined total of shipments and receipts of 625,760 tons moved

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[15] Interview, Lawrence B. Jones, Chairman of the Board, Mosher Steel Company, March 30, 1967.

[16] Corps of Engineers, Galveston, Texas, survey of 230 firms using or selling iron and steel in the economic influence area of the Proposed Channelized Trinity Waterway.

TABLE 7

RELATIVE RATES OF GROWTH

DALLAS AND HOUSTON METROPOLITAN AREAS

METROPOLITAN AREAS	Population Rank	1960 Population	1950 Population	Increase	Percent Increase	Incr. Rank
Miami, Florida	25	935,047	495,084	439,963	88.9	1
San Diego, Calif.	23	1,033,011	556,808	476,203	85.5	2
L.A.-Long Beach, Calif.	2	6,742,696	4,367,911	2,374,785	54.4	3
Houston, Texas	16	1,243,158	806,701	436,457	54.1	4
Denver, Colorado	26	929,383	612,128	317,255	51.8	5
Dallas, Texas	20	1,083,601	743,501	340,100	45.7	6
Atlanta, Georgia	24	1,017,188	726,989	290,199	39.9	7
Washington, D.C.-Md.-Va.	10	2,001,897	1,464,089	537,808	36.7	8
Patterson-Clifton, N.J.	18	1,186,873	876,232	310,641	35.5	9
Seattle, Washington	19	1,107,213	844,572	262,641	31.1	10
Kansas City, Mo.-Kans.	22	1,039,493	814,357	225,136	27.6	11
Mpls.-St. Paul, Minn.	14	1,482,030	1,151,053	330,977	28.8	12
Milwaukee, Wis.	17	1,194,290	956,948	237,342	24.8	13
Detroit, Michigan	5	3,762,360	3,016,197	746,163	24.7	14
San Fran.-Oakland, Calif.	6	2,783,359	2,240,767	542,592	24.2	15
Baltimore, Md.	12	1,727,023	1,405,399	321,624	22.9	16
Cleveland, Ohio	11	1,796,595	1,465,511	331,084	22.6	17
Chicago, Illinois	3	6,220,913	5,177,868	1,043,045	20.1	18
Buffalo, N. Y.	15	1,306,957	1,089,230	217,727	20.0	19
St. Louis, Mo.-Ill.	9	2,060,103	1,719,288	340,815	19.8	20
Cincinnati, Ohio-Ky.	21	1,071,624	904,402	167,222	18.5	21
Philadelphia, Pa.-N.J.	4	4,342,897	3,671,048	671,849	18.3	22
Newark, N.J.	13	1,689,420	1,468,458	220,962	15.0	23
New York, N.Y.	1	10,694,633	9,555,943	1,138,690	11.9	24
Pittsburgh, Pa.	8	2,405,435	2,213,236	192,199	8.7	25
Boston, Mass.	7	2,589,301	2,410,572	178,729	7.4	26

SOURCE: U. S. Department of Commerce, Bureau of the Census.

TABLE 8

BARGE MOVEMENT OF STEEL PRODUCTS

HOUSTON SHIP CHANNEL

1962-1966

In short tons

YEAR	RECEIPTS[1]	SHIPMENTS[2]
1962	639,669	89,463
1963	629,867	132,648
1964	637,126	179,913
1965	509,057	238,751
1966	460,760[3]	165,000

[1]The principal products moved were steel plates and shapes, and steel tubular goods.

[2]Including small local (intra-channel) shipments.

[3]The reasons for this decrease under 1965 levels have already been discussed on pages and

SOURCE: Port of Houston, Harris County, Houston Ship Channel Navigation District, Mr. Vince Williams, Administrative Assistant, Interview, May 1, 1967.

in 1966 alone. For the most part these tonnages consisted of plates, shapes and tubular goods.

In analyzing the potential traffic for a channelized Trinity, Table 9 shows the total "Up-Bound Tonnage by Origin Areas" as seen feasible by the shippers surveyed. Houston's position as the preeminent supplier of much of the iron and steel moving into the Dallas-Ft. Worth area is reflected in this table--425,363 tons currently originates there. Logically, much of this tonnage could move by water. The Pittsburgh-West Virginia and Chicago-Gary Producing Districts are the next origin areas in terms of volume of tonnage that might feasibly reach destinations via a Trinity Waterway.

TABLE 9

RECAP OF FEASIBLE UPBOUND TONNAGE
BY ORIGIN AREAS

ORIGIN AREA	Total Net Tons
Alabama	30,267
Pittsburgh-Ohio-West Virginia	282,224
St. Louis-Granite City	45,045
East Coast	56,288
Chicago-Gary	89,685
Houston	425,363
Miscellaneous	16,720
Total Net Tonnage	945,592

See footnote no. 16, p. 499.

These areas are followed in order of tonnage by East Coast points, St. Louis-Granite City, and Alabama points. Alabama origins are relatively small in terms of the total tonnage that shippers are available to generate for water movement to the Upper Trinity area. Similarly, there are a few other miscellaneous points of origin for commodities that could feasibly move into the Dallas and Ft. Worth areas by water. A further breakdown on Up-bound Commodity Origins for the Trinity Project are shown in Tables 10-A through 10-G. Others are suggested by the volume and kinds of imports--moving chiefly through Houston (and thus for purposes of this study are shown as having a Houston origin).

TABLE 10-A

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY FROM ORIGINS IN HOUSTON

DESTINATION CITY	NET TONS
Oklahoma	268
Ennis	2,170
Burleson	1,250
Wichita Falls	600
Paris	1,500
Tyler	1,200
Grand Prairie	1,800
Dallas	295,241
Ft. Worth	69,264
Hurst	6,000
Garland	4,200
Centerville, Texas	3,650
Lubbock	6,420
Euless	750
Grapevine, Texas	1,200
Gainsville, Texas	450
Carrollton, Texas	12,000
Denton	4,800
Arlington	12,600
TOTAL	425,363

COMMODITY	NET TONS
Rail	400
Plate	58,474
Coil	11,320
Sheet Steel	31,945
Wire Rods	5,500
Pipe	44,382
Tubing	1,000
Structural Steel	125,353
Bars	27,630
Forgings	2,665
Rebars	600
Wire	2,170
Rods	12,500
Chain Link	1,500
Steel Shapes	42,250
Steel Coils	42,724
Steel Castings	450
Angles	6,000
Buckets	2,500
Pipe Scrap	6,000
TOTAL	425,363

See footnote no. 16, p. 499.

TABLE 10-B

FEASIBLE UPBOUND TONNAGE BY COMMODITY AND DESTINATION FROM ORIGINS IN PITTSBURGH-OHIO-WEST VIRGINIA

DESTINATION CITY		NET TONS
Dallas		14,274
Ft. Worth		204,450
Grapevine, Texas		1,000
Arlington, Texas		48,700
Lubbock		3,000
Oklahoma		1,000
Waxahachie		1,600
Burleson		100
Paris		5,000
Grand Prairie		3,100
	TOTAL	282,224

COMMODITY		NET TONS
Steel Sheets		9,711
Pipe		12,030
Plate		33,650
Structural Steel		190,583
Bar		4,000
Coil		2,500
Steel Shapes		2,550
Angles		24,000
Tin Plate		1,200
Tubing		2,000
	TOTAL	282,224

See footnote no. 16, p. 499.

TABLE 10-C

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY
FROM ORIGINS IN CHICAGO-GARY AREA

DESTINATION CITY	NET TONS
Dallas	28,028
Garland	5,760
Ft. Worth	44,047
Carrollton	1,500
Waxahachie	1,600
Burleson	3,200
Paris	1,500
Kaufman	2,400
Grand Prairie	1,050
Tyler	600
TOTAL	89,685

COMMODITY	NET TONS
Structural	21,640
Bars	6,960
Plate	20,450
Steel Sheets	11,402
Coil	18,233
Steel Shapes	6,750
Forging	2,000
Tin Plate	1,200
Pipe	1,050
TOTAL	89,685

See footnote no. 16, p. 499.

TABLE 10-D

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY FROM ORIGINS IN EAST COAST AREAS

DESTINATION CITY		NET TONS
Arlington		3,300
Ft. Worth		20,393
Dallas		10,515
Grapevine, Texas		3,080
Waxahachie		600
Carrollton		7,500
Ennis		4,000
Mineral Wells		2,500
Kaufman		1,800
Grand Prairie		2,600
	TOTAL	56,228

COMMODITY		NET TONS
Tin Sheets		3,300
Pipe		2,550
Plate		12,534
Structural Steel		11,868
Steel Shapes		6,180
Steel Sheets		3,816
Coil		560
Steel Plate		6,980
Forging		1,000
Steel Tubing		7,500
	TOTAL	56,228

See footnote no. 16, p. 499.

TABLE 10-E

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY FROM ORIGINS IN ST. LOUIS-GRANITE CITY AREA

DESTINATION CITY		NET TONS
Ft. Worth		15,500
Dallas		23,875
Carrollton		1,800
Grapevine, Texas		1,200
Ennis		2,170
Grand Prairie		500
	TOTAL	45,045

COMMODITY		NET TONS
Plate		8,000
Steel Sheet		4,875
Coils		6,860
Structural Steel		1,500
Steel Shapes		1,200
Bars		15,000
Pig Iron		5,200
Steel Plate		240
Wire		2,170
	TOTAL	45,045

See footnote no. 16, p. 499.

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TABLE 10-F

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY FROM ORIGINS IN ALABAMA POINTS

DESTINATION CITY		NET TONS
Arlington		6,500
Dallas		11,867
Carrollton		1,500
Grapevine, Texas		2,400
Ft. Worth		6,200
Grand Prairie		600
Tyler		1,200
	TOTAL	30,267

COMMODITY		NET TONS
Tin Sheets		6,500
Bars		1,200
Steel Sheets		7,663
Steel Shapes		3,400
Pig Iron		5,200
Tin Plates		5,470
Structural Steel		834
	TOTAL	30,267

See footnote no. 16, p. 499.

TABLE 10-G

FEASIBLE UPBOUND TONNAGE BY DESTINATION AND COMMODITY FROM MISCELLANEOUS ORIGINS

DESTINATION CITY		NET TONS
Dallas		6,420
Grand Prairie		300
Paris		10,000
	TOTAL	16,720

COMMODITY		NET TONS
Coil		1,110
Water Heaters		2,700
Pumps and Compressors		1,610
Forging		1,000
Tubing		10,000
Steel Sheets		300
	TOTAL	16,720

See footnote no. 16, p. 499.

TABLE 11

RECAP OF FEASIBLE UPBOUND TONNAGE BY COMMODITY

Origins: Alabama, Pittsburgh-Ohio-West Virginia, St. Louis-Granite City, East Coast, Chicago-Gary, Houston, Miscellaneous Points

COMMODITY	NET TONS
Angles	30,000
Bars	54,790
Buckets	2,500
Chain Link	1,500
Coil	83,307
Forgings	6,665
Pig Iron	10,400
Pig Scrap	------
Pipe	60,012
Plates	140,328
Pumps and Compressors	1,610
Rail	400
Rebars	600
Rods	18,000
Steel Castings	450
Steel Shapes	62,330
Steel Sheets	69,712
Structural Steel	351,778
Tin Plate	7,870
Tin Sheets	9,800
Tubing	20,500
Water Heaters	2,700
Wire	4,340
Pipe Scrap	6,000
TOTAL	945,592

See footnote no. 16, p. 499.

The kinds of iron and steel cargoes that are most likely to move upbound on the Trinity are shown in Table 11. Structural steel is first with 351,778 tons; plate is second with 140,328 tons. Coils and sheets with tonnages of 83,307 and 69,712 tons, respectively, are in third and fourth place followed by steel shapes with 62,330 in fifth place and pipe in sixth place with 60,012 tons.

The predominance of Dallas and Ft. Worth as up-bound destinations for Trinity-barged iron and steel products is also shown in Table 9; and, except for a relatively few scattered and isolated industrial plants in an arch from Lubbock on the west to Texarkana on the east, most of the Trinity's area of influence is concentrated in the Dallas-Ft. Worth area. Indeed, the opening of water traffic into Tulsa's port will help to reinforce a dependence on local mills in most of the Oklahoma City and Tulsa iron and steel markets, and, in time, to eastern mills (or to the Pueblo, Colorado, mill).

Similarly, the survey showed that most of the down-bound Trinity barge traffic will be destined for Houston--in fact, over 75 per cent will be consigned either to Houston industries (see Table 12), or for possible export (see Table 13). Still other shipments will enter international trade through other gateways than Houston.

Other down-bound destinations are listed in Table 12.

The chief down-bound commodity is scrap. Approximately 75 per cent or 162,200 tons, of the total 240,720 tons of all surveyed commodities that could be shipped downstream, falls in this category. Pipe, in terms of total tonnage, is a relatively poor second with only 26,020 tons moving toward Houston. In third place, tonnagewise, is structural steel totaling 20,700 tons. Most of this is basic structural forms for ultimate use in construction.

Within the 1,186,312 tons for which shippers have indicated an interest in the Trinity, are additional potential tonnages--mostly downbound tonnages. These are potential downbound traffic movements and fall chiefly in the categories of oil-field goods and scrap. Scrap will be considered further under the major heading of this study entitled "Iron and Steel Production." The other category, oil-field related iron and steel, has long been an important iron and steel commodity moving in the industrial traffic of the southwest. That this, in a relative way, is no longer the case becomes an important consideration of this study and is discussed next.

TABLE 12

FEASIBLE DOWNBOUND TONNAGE BY DESTINATION AND COMMODITY
Origins: Amarillo, Arlington, Daingerfield, Dallas, Ft. Worth, Sand Springs, Oklahoma, Enid, Oklahoma

DESTINATIONS	NET TONS
Houston	220,096
Chicago	5,480
Detroit	2,000
Kansas City	4,200
Cincinnati	480
St. Louis	500
Birmingham	2,000
Gulf Coast Points	5,964
TOTAL	240,720

COMMODITY	NET TONS
Structural Steel	20,700
Scrap Iron and Steel	162,200
Pipe	26,020
Contact Steel	800
Steel Containers	396
Steel Castings	1,560
Fabricated Steel	15,480
Well-Drilling Equipment	6,000
Non-Ferrous Metals	1,200
Steel Shelving	400
Steel Vessels	5,964
TOTAL	240,720

See footnote no. 16, p. 499.

TABLE 13

FEASIBLE TONNAGE OF EXPORTS BY DESTINATION AND COMMODITY

DESTINATION		NET TONS
Unknown Destination		6,800
Mexico		104,400
Japan		2,000
	TOTAL	113,200

COMMODITY		NET TONS
Well-Drilling Equipment		6,000
Scrap Iron and Steel		-----
Undifferential Scrap		106,400
Sheet Steel		800
	TOTAL	113,200

See footnote no. 16, p. 499.

1. <u>Relative Use of Iron and Steel Products in the Oil and Gas Industry</u>. In the past perhaps no economic indicator would have been more symbolic of the Trinity's future tonnage than crude oil demand and production (see Table 14). The Trinity area's reliance on the industry is a national legend and supplying oil-field equipment and know-how are major employment categories in the Dallas-Ft. Worth and Houston Trinity Waterway Terminous areas. The legendary importance of petroleum production to a Trinity project's success, as this success relates to the movement of iron and steel products, colors and even clouds projections of future iron and steel tonnages likely to move on this proposed waterway.

In fact, oil country goods is now, and long has been, a relatively declining factor in the total burgeoning Iron and Steel markets of the Southwest. That a continued relatively high level of exploration and production of petroleum is a significant factor in iron and steel projections cannot be denied. On the other hand, and as was pointed out in the previous discussions of feasible Trinity Waterway traffic, and as will be further developed in the next sub-

TABLE 13-A

FEASIBLE TONNAGE OF IMPORTS BY DESTINATION AND COMMODITY

DESTINATION CITY		NET TONS
Ft. Worth		1,750
Dallas		36,900
Garland		2,000
Grand Prairie		600
Galveston		1,000
Denton		4,800
Bryan		2,170
Houston		54,545
	TOTAL	103,765

COMMODITY		NET TONS
Structural Steel		57,195
Steel Coil		12,400
Pipe		2,000
Rebars		2,000
Sheet Steel		600
Bars (Steel)		500
Structural Shapes		12,000
Tubing		1,000
Wire Rods		5,500
Steel Plate		8,400
Wire		2,170
	TOTAL	103,765

See footnote no. 16, p. 499.

TABLE 14

PETROLEUM[1] DEMAND IN THE UNITED STATES AND PRODUCTION IN THE UNITED STATES, WEST SOUTH CENTRAL REGION,[2] AND TEXAS, 1900-1959, and PROJECTED 1960-2020[3]

(Millions of barrels)

Year	United States Domestic Demand	Production		
		United States	West South Central Region	Texas
1900	---	64	1	1
1905	---	135	45	28
1910	---	210	68	9
1915	---	281	142	25
1920	457	452	244	98
1925	727	791	435	150
1930	927	951	630	302
1935	984	1,036	662	405
1940	1,327	1,409	814	515
1945	1,773	1,826	1,131	807
1950	2,375	2,156[4]	1,366	923
1955	3,088	2,766	1,795	1,212
1959	3,439	2,891	1,788	1,151
1960	3,532	2,901 (2,915[4])	1,776	1,094
1965	---	---	---	1,081
1970	4,747	3,560 (3,207[5])	1,734	1,068
1980	6,380	3,317	1,520	936
1985	---	---	---	887
1990	7,777	3,091	1,333	821
2000	9,480	2,880	1,169	720
2010	11,560	2,683	974	600
2020	14,090	2,500	812	500
2030	19,000	2,300	720	420
2035	26,000	2,150	660	390

[1]Crude Oil and natural gas liquids.

[2]Texas, Louisiana, Oklahoma, and Arkansas.

[3]Reproduced from C. P. Blair; Economic Growth Projections For the Dallas, Ft. Worth and Houston Trading Areas. Bureau of Business Research, The University of Texas, Austin, 1961 with additions as noted under 4, below.

[4]Statistical Abstract of the United States, p. 716.

[5]1964 Data which corroborates Blair's projection through that year. Thus, gives credence and confidence in the total projections to date.

SOURCES: 1900-1955, U. S. Bureau of Mines. The 1959 and 1960 estimates are based on data from The Oil and Gas Journal, LVIII (January 25, 1960), pp. 143, 157, 179; LVIII (October 31, 1960), p. 56; and World Oil, CLI (October 1960), p. 26.

sections of the study dealing with construction and manufacturing, it is now clear that oil field activities no longer are the dominant control of the bulk of iron and steel movements in the Dallas-Ft. Worth and Houston Trading Areas. And, indeed, oil field needs in the southwest appear destined to be even less of a relative force in tomorrow's iron and steel movements.

Even so, and although Texas' proportion of national production of U. S. crude oil production has declined from 44.2 per cent in 1947 to 35.5 per cent in 1964, when gas field operations are added Texas still accounts for almost one-half (46.6 per cent)[17] of the nation's total.

A composite index of oil country iron and steel goods serves to highlight a continuing important volume of iron and steel moving into the area to serve the oil fields of the area (see Table 15). As this table indicates, there has been a relative falling-off of Texas bound oil country oriented iron and steel with the national index standing at 111 and the Texas index of 86 from 1947-49 average levels. However, these figures do not reflect imported pipe and other oil country goods and, as was pointed out earlier, these exceeded 125,000 net tons in 1964 (see Table 5) and are reported to be at more than double that level for the years 1965 and 1966.[18] Thus, if corrected to reflect the imports of oil country related iron and steel products of the last three years, the index would be changed from 86 to at least 101.

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[17] In 1966, Texas produced 35.3 per cent of the nation's crude, 52.1 per cent of its gas and 52.4 of its LPG products. Petroleum Facts and Figures, pp. 40-42.

[18] Vincent Williams, Houston-Harris County Navigation District, Interview, March 30, 1967.

TABLE 15

INDEX OF
STEEL FOR THE OIL AND GAS INDUSTRY
of
THE TRINITY RIVER INFLUENCE AREA

1947-49 Average of 3,980,000 net tons = 100

Year	U. S. Total[1]	U. S. Index	Texas Per Cent of U. S. Total	Texas Total[2]	Texas Index
1947			44.1		
1948	3.98	100	43.6	1.74	100
1949			43.1		
1950	5.34	134	42.6	2.27	130
1951	5.19	130	42.1	2.18	125
1952	4.51	113	41.6	1.88	108
1953	5.45	137	41.1	2.24	129
1954	4.70	118	40.6	1.91	110
1955	5.44	137	40.1	2.18	125
1956	5.58	140	39.6	2.21	127
1957	6.49	163	39.1	2.54	146
1958	3.41	85	37.3	1.27	73
1959	4.69	118	36.8	1.73	99
1960	3.90	97	35.9	1.40	80
1961	3.90	97	35.2	1.37	79
1962	3.90	97	35.4	1.38	79
1963	3.70	93	34.9	1.29	74
1964	4.20	106	34.3	1.44	83
1965	4.20	106	34.7	1.46	84
1966	4.40	111	34.0	1.50	86

[1]In millions of net tons. Source: American Iron and Steel Institute's Charting Steel's Progress During 1956-1966.

[2]Percentage used 1947 to 1958 based on retrograde projection of 57 to 66 data. From 1957 to present based on the Formula developed in Appendix B.

In turn, the data in Appendix B reflects Texas' percentage of the national total of oil country-oriented iron and steel products and the data was calculated as follows:

By year $\frac{\text{Texas Crude Production } (C^T)}{\text{National Crude Production } (C^N)} = Q^1$

plus $\frac{\text{Texas Gas Production } (G^T)}{\text{National Gas Production } (G^N)} = Q^2$

plus $\frac{\text{Texas LPG Production } (L^T)}{\text{National LPG Production } (L^N)} = Q^3$

$$\frac{Q^1 + Q^2 + Q^3}{3} = P^1$$

plus $\frac{\text{Texas Well Completions } (W^T)}{\text{National Well Completions } (W^N)} = P^2$

plus $\frac{\text{Texas Crude Oil Run by Refineries } (R^T)}{\text{National Crude Oil Run by Refineries } (R^N)} = P^3$

$$\frac{P1 + P2 + P3}{3} = P^T$$

$P^T =$ Percentage of Texas share, which was developed as shown in Appendix B and applied to determination of the composite Index shown in Table 15.

Any real estimate of iron and steel movements in the study area must be based on all kinds of iron and steel products. It has already been shown that the area has developed a sophisticated, complex iron and steel industry to supply over 26 S.I.C. categories and over 500 firms. Table 16 develops an index for all iron and steel products, nationwide. This index stands at 141.0 with imports. The comparable index for Texas is 169.4 (Table 17) and 121.4 for the Trinity River Area of Influence (Table 18).

Table 18 provides an index of net tonnages for all kinds of iron and steel moving into the area tributary to the Trinity Channel Project. This is the logical basis for tonnage projections after additions and/or allowances for such other categories as scrap imports and exports have been made. Thus, when national growth factors are used in making this, so as to preclude possibility that the unusually high Trinity River Influence Area growth <u>might</u> <u>not</u> hold up for the long-point-of-view, then these national growth factors must be considered to be conservative and the projections developed through them are minimum bench-mark calculations.

TABLE 16

NATIONWIDE SHIPMENTS
of
ALL IRON AND STEEL PRODUCTS

1960-1966[1]

Year	Net Tons	Imported Iron & Steel Net Tons[3]	Index[2]
1960	68,865,052	3,400,000	101.7
1961	64,972,009	3,200,000	95.9
1962	69,359,977	4,100,000	102.4
1963	74,516,370	5,400,000	110.0
1964	82,102,380	6,400,000	121.2
1965	91,719,276	10,400,000	135.4
1966	88,302,651	10,800,000	130.4
(with imports added)			
1960	69,205,052		98.5
1961	68,172,009		97.0
1962	73,459,977		104.5
1963	79,916,370		113.7
1964	88,502,380		125.9
1965	102,119,276		145.3
1966	99,102,651		141.0

[1]Source: AIS 14 reports of the American Iron and Steel Institute.

[2]1960-62 average of 67,732,346 net tons = 100 and with imports added 1960-62 average of 70,279,013 = 100.

[3]Source: American Iron and Steel Institute, Charting Steel's Progress 1960-1966.

TABLE 17

TEXAS SHIPMENTS
OF
ALL U. S. IRON AND STEEL PRODUCTS

1960-1966[1]

Year	Net Tons	Index	With Imports Added[3]	Index[4]
1960	2,758,936	98.4	3,262,936	98.6
1961	2,892,091	103.2	3,388,091	102.4
1962	2,759,032	98.4	3,273,032	98.9
1963	2,834,575	101.4	3,457,575	104.5
1964	3,459,745	123.4	4,409,745	133.3
1965	3,463,918	123.6	5,213,918	157.6
1966	3,354,009	119.6	5,604,009	169.4

[1]Source: AIS 14 reports of the American Iron and Steel Institute.

[2]1960-62 average of 2,803,353 net tons = 100.

[3]Estimated iron and steel imports through Houston, Texas City and Galveston based on Houston-Harris County Navigation District data, interviewed with Mr. Vincent Williams, March 30, 1967.

[4]1960-62 average of 3,308,019 net tons = 100.

TABLE 18

TEXAS AND OKLAHOMA DESTINED
IRON AND STEEL PRODUCTS LIKELY TO MOVE INTO
TRINITY WATERWAY AREA OF INFLUENCE

Year	Total Texas I & S Domestic Market[1]		Total Oklahoma I & S Domestic Market[1]		Total	Trinity River Influence Area Domestic I & S Market[2]	Index[4]
1960	2,758,936	+	464,236	=	3,223,172	670,420[5]	97.2
1961	2,892,091	+	532,711	=	3,424,802	712,359	103.3
1962	2,759,032	+	537,807	=	3,296,839	685,743	99.5
1963	2,834,575	+	491,289	=	3,325,864	691,780	100.3
1964	3,459,745[3]	+	612,296	=	4,072,041	846,985	122.8
1965	3,463,918	+	640,435	=	4,104,553	853,747	123.8
1966	3,354,009	+	671,656	=	4,025,665	837,338	121.4

[1]Source: AIS 14 Reports of the American Iron and Steel Institute.

[2]20.8 per cent of Texas and Oklahoma total. The 20.8 per cent figure was calculated by using the Trinity River Influence Area Iron and Steel Market area net tonnage as determined from American Iron and Steel Institute as prepared for Mr. Lawrence B. Jones of the Mosher Steel Co.

This figure, 857,312 net tons is 20.8 (rounded) per cent of the total AISI reporting Member's Iron and Steel Shipments to Texas and Oklahoma for the same year (1965).

[3]Based on expansion of 9-month figure for the year, 1964.

[4]Index based on average of 1960-62, or 689,507 net tons.

[5]As AISI reporting members account for only 85 per cent of iron and steel shipments in this area data are conservative and can be increased accordingly.

Although Texas' proportion of national production has declined from 44.2 per cent of total U. S. crude oil production in 1947 to 35.5 per cent in 1964 (see Table 14), oil field iron and steel equipment and supplies continue to loom as important cargos on the Trinity due to: (a) petroleum import quotas, (b) relative decline in competition of other fuels; (c) decline in stocks; and (d) stabilization of, and improvement in, demand.

(a) Petroleum Import Quotas. A major factor arresting the decline in oil-field activity has been the progress made in ameliorating the petroleum import situation. Although the level of petroleum imports is not expected to decline, an improved balance between domestic production and demand and imports is already in evidence. For example, in 1947 imports of foreign crude oil and products constituted 7.4 per cent of total U. S. demand; by 1964 this ratio had increased to 20.4 per cent.[19] The growth in petroleum imports was so great and rapid that mandatory quotas were imposed in 1959. Since 1959, imports have increased but 27.3 per cent whereas in the previous five-year period (1954-1959) imports had increased 69.2 per cent.[20] Even with the relative improvement, these petroleum imports are in strong measure responsible for Texas' decline from a level of 21,460 new wells in 1956 to 13,152 in 1964 (see Table 19). However, even these data presented in Table 19 reflect a slight recovery in 1964 over 1963.

(b) Relative Decline in Competitive Position of Other Fuels. A second factor which will help check further declines in petroleum, both in actual production and statistically, is the expectation that competitive fuels and improvements in refinery techniques have had their effect on statistics and have run their course in limiting oil-field activity. For example, now all of the major U. S. markets have been exposed to natural gas, and supposedly the bulk of the users who will change over from oil to gas have done so. Also, most of the impact of the compact automobile has been felt and petroleum statistics should not be so adversely affected by additional increased percentages of the small car ownership in total car registrations. Similarly, the diesel-jet revolutions have swept the transportation industry, and it appears that there will be a respite, however brief, in changes within these segments

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[19]American Petroleum Institute, Petroleum Facts and Figures, 1965, p. 35.

[20]Houston Planning Commission, Metropolitan Houston Long-Range Economic Study Industry Report, No. 102, Houston, Texas, December 1966, p. 8.

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TABLE 19

TOTAL WELLS DRILLED IN TEXAS AND ALLOWABLE PRODUCING DAYS BY YEARS

Year	Number of Wells Drilled[a]	Number of Producing Days[b]
1947	9,283	324
1948	12,172	366
1949	13,619	238
1950	16,509	230
1951	16,615	276
1952	16,812	259
1953	16,948	236
1954	18,843	194
1955	19,970	194
1956	21,460	190
1957	21,173	171
1958	17,721	122
1959	18,123	123
1960	15,174	104
1961	14,259	101
1962	14,297	97
1963	12,900	102
1964	13,152	103
1965	12,741	---
1966	11,109	---

[a]Excludes service wells.

[b]Number of days during the year that prorated wells are allowed to produce.

DATA SOURCE: The Railroad Commission of Texas, <u>Annual Reports of the Oil and Gas Division</u> and American Petroleum Institute, <u>Petroleum Facts and Figures</u>.

TABLE SOURCE: Houston Planning Commission, Metropolitan Houston Long-Range Economic Study, Industry Report 102, Table 9.

of the petroleum market. And, the present refinery techniques which allow the refiner to convert 100 barrels of crude into 102.2 barrels of products (as compared with an average product yield of 100 barrels in 1950) are not likely to further depress future petroleum demands nor statistics.

(c) Reduction in Stocks Accomplished. A third factor which caused the sharp break in petroleum production in the middle fifties was the reduction in the amount of crude oil stored as refinery feed stocks. In the 1930's, refineries maintained on the average a five-months' supply of crude in tanks and pipelines; by 1940 this inventory had dropped to 74 days and in 1950, to 42 days. Today, crude stocks are down to a 20-to-25-day supply.[21] As this stock has been used, it amounted to a sizable loss in production.

(d) Stabilization and Relative Improvement in Demand. A fourth reason for a leveling of petroleum production rather than a continued decline is the stabilization and relative improvement in demand. In terms of prices the average wellhead price of gas has increased from 6.5 cents per million cubic feet in 1950 to 15.9 cents per Mcf in 1954, or an increase of 144.6%; and, the price of crude oil per barrel for the same period has increased 13.6 per cent ($2.57 to $2.92).[22]

Thus, the combined impact of these factors on Trinity Area iron and steel shipments is to help hold them at, or close to or slightly declining from, present levels through the year 2035, rather than the much sharper decline in effect from the middle fifties to the early sixties. By 2020 production is expected to hold close to 2.5 billion barrels which will represent 18 per cent of demand, with the rest being satisfied by imports, shale oil and synthetic fuels.[23]

Overshadowing these factors, in terms of the Trinity's future iron and steel movements, will be the aforementioned impact of offshore developments and, due to a continuing dominant role in domestic production, the total output of the Inland Texas, Gulf-Coast and Inland Louisiana-Arkansas fields--many iron and steel needs of

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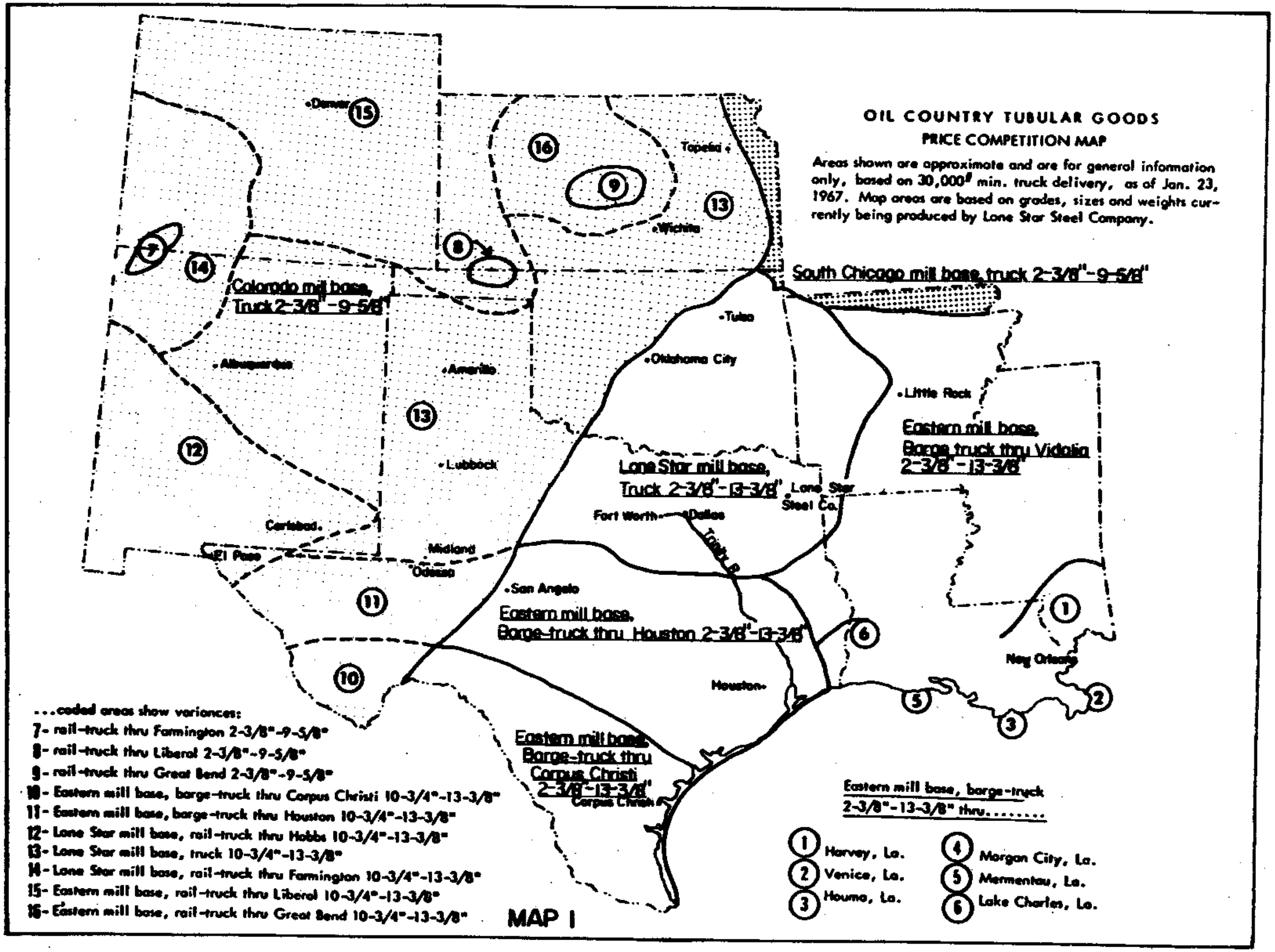
[21] Ibid., p. 6.

[22] Ibid., p. 9.

[23] Resources for The Future, Inc., The Future Supply of Oil and Gas, The John Hopkins Press, Baltimore, 1958, pp. 7-63.


OIL COUNTRY TUBULAR GOODS
PRICE COMPETITION MAP
Areas shown are approximate and are for general information only, based on 30,000# min. truck delivery, as of Jan. 23, 1967. Map areas are based on grades, sizes and weights currently being produced by Lone Star Steel Company.
Denver
Topeka
Wichita
Tulsa
Oklahoma City
Little Rock
Albuquerque
Amarillo
Lubbock
Carlsbad
Midland
Odessa
El Paso
San Angelo
Fort Worth
Dallas
Houston
Corpus Christi
New Orleans
Lone Star Steel Co.
South Chicago mill base, truck 2-3/8"-9-5/8"
Colorado mill base, Truck 2-3/8"-9-5/8"
Lone Star mill base, Truck 2-3/8"-13-3/8"
Eastern mill base, Barge truck thru Vidalia 2-3/8"-13-3/8"
Eastern mill base, Barge-truck thru Houston 2-3/8"-13-3/8"
Eastern mill base, Barge-truck thru Corpus Christi 2-3/8"-13-3/8"
...coded areas show variances:
7- rail-truck thru Farmington 2-3/8"-9-5/8"
8- rail-truck thru Liberal 2-3/8"-9-5/8"
9- rail-truck thru Great Bend 2-3/8"-9-5/8"
10- Eastern mill base, barge-truck thru Corpus Christi 10-3/4"-13-3/8"
11- Eastern mill base, barge-truck thru Houston 10-3/4"-13-3/8"
12- Lone Star mill base, rail-truck thru Hobbs 10-3/4"-13-3/8"
13- Lone Star mill base, truck 10-3/4"-13-3/8"
14- Lone Star mill base, rail-truck thru Farmington 10-3/4"-13-3/8"
15- Eastern mill base, rail-truck thru Liberal 10-3/4"-13-3/8"
16- Eastern mill base, rail-truck thru Great Bend 10-3/4"-13-3/8"
Eastern mill base, barge-truck 2-3/8"-13-3/8" thru........
1 Harvey, La.
2 Venice, La.
3 Houma, La.
4 Morgan City, La.
5 Mermentau, La.
6 Lake Charles, La.
MAP I

these fields are served by the oil-field manufacturers and suppliers of the Dallas-Ft. Worth and Houston areas. The total demand in the U. S. is expected to increase at a compound rate of about 4 per cent. This compares to an annual compound rate of 4.1 per cent for the period 1947 to 1964.[24] In turn, to identify these compound growth rates with specific Trinity area iron and steel production is unrealistic. Oil-field goods come into the area from mills all over the country, some of that coming in is new, but much is used. It comes in by, and goes out by, truck, rail, barge, deep water, and in the case of drill bits and other specialized equipment, even by air. These goods move by private, contract and common carriage. No records are adequate to realistically relate petroleum production with barge shipments of iron and steel. But, based on experience and the above data, logic suggests that oil-field iron and steel needs are likely to equal or approach petroleum demand, except for short periods when a new product may be introduced. In projecting oil-field related iron and steel shipments the index developed in Table 18 constitutes a sound record of activities to date. In any event, the amount of oil field related iron and steel that is to move on the Trinity is likely to remain a function of the present level of specialties and capabilities of oil field iron and steel producers and users in the proposed Trinity Waterway service area.

These specialties and capabilities are, in turn, most likely to remain a function of petroleum production in Texas;[25] thus, if the 1965 volume of oil country goods in the Trinity Influence Area was 176,100 net tons (see Table 20) then this figure is the logical take-off point to develop the data shown in Table 20 for each of the bench mark years as stipulated in projecting potential oil country related iron and steel volumes for this study.

2. <u>Relative Use of Iron and Steel Products in the Construction Industry (of the Trinity's Economic Impact Area)</u>. Construction is a major branch of economic activity, paying more than a billion dollars in personal income in Texas. Nearly 45 per cent of this is concentrated in the Dallas-Ft. Worth and Houston Terminals of the proposed Waterway. Construction is a major factor supporting the state's economy. Construction in the Trinity area cities is heavily weighted by the development of new industrial plants. Over one-fourth of all Texas' non-residential building permits are given in

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[24]Houston Planning Commission, op. cit., p. 41.

[25]Interivew with J. E. Ubben, Oil Country Iron and Steel Statistician, American Petroleum Institute, Dallas, Texas, October 20, 1967.

TABLE 20

PROJECTION OF OIL FIELD IRON AND STEEL TRAFFIC

WHICH SHIPPERS HAVE STATED LIKELY WOULD

MOVE ON THE PROPOSED TRINITY WATERWAY

Year	Volume in Net Tons
1965	176,100[1]
1970	173,977[2]
1980	152,474[2]
1985	144,492[2]
1990	133,741[2]
2000	117,288[2]
2010	97,740[2]
2020	81,450[2]
2030	68,418[2]
2035	65,160[2]

[1] Letter quoting American Iron and Steel Institute dated 9 December 1966 provided a total of 149,707 tons. However, this represented only an estimated 85 per cent of the total oil country iron and steel goods for the area--the remaining 15 per cent would be accounted for by the non-American Iron and Steel Institute members and/or non-reporting A. I. S. I. members. Thus, if 149,707 tons represents 85 per cent, 176,100 approximates 100 per cent. (See Appendix C.)

[2] Using 176,100 net tons as the tonnage of oil country related iron and steel products and the Texas production column in Table 14, and assuming that the volume of oil country iron and steel products will be a function of production, the proportion for 1970 or

$\frac{176,100}{1081}$ or $162.9 = \frac{x}{\text{production for year n}}$, the above values were

calculated by, for example 1980, $\frac{176,100}{1081} = \frac{x}{936}$ or $x = 162.9 \times 936$

or x = 152,474 tons.

Houston; another 18 per cent are given in the Dallas-Ft. Worth area. Highway construction radiating from these two centers, civic centers, new airports, freeway construction, utilities work in recently annexed areas all add to the potential market. Houston alone expects to add over 60 million square feet in highrise office buildings by 1985; Dallas-Ft. Worth will add about 60 per cent of this amount, or over 36 million square feet. Based on conservative rule of thumb estimates of 20,000 tons for every 1 million square feet, this amounts to 1,440 bargeloads of steel for this construction category, not to mention myriads of other needs. For example, there is approximately 1 1/2 tons of iron and/or steel in every home and 1 ton in every apartment. And, new transit systems are under consideration in each of the Trinity's major terminal cities.

Construction throughout the entire state is high. The index of construction tables (Table 21) is based on building permits issued. That these are vast and likely to require structural iron and steel in bargeload quantities is shown in Table 22. These figures are closely related to construction put in place if allowance is made for a lag in performing the work. In any event, construction authorized is a leading index of what structural iron and steel will be moving on the Trinity.

In 1966 structural iron and steel up-bound tonnage was by survey 351,778 tons: down-bound was 20,700 tons.[26] In view of the change in index of over 40 points in the last ten years, this tonnage can conservatively be expected to exceed 492,489 tons annually by 1985 with little or no foreseeable decline in the rate of growth in the long-range so that by the year 2000 there would be a minimum of some 900,000 tons annually that could feasibly be barged on the Trinity. That these figures are impressive is clear when it is considered that these tonnages are only for "structural steel" and do not include reinforcing bars or plates--many of which are used in construction.

Highway construction is another major use category of steel well suited to waterway movements. Of some $185 million annually spent in Texas[27] on highway construction, nearly 12 per cent is spent on iron and steel products (see Table 23). Assuming that

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[26]Corps of Engineers Survey of Shippers in Trinity Economic Impact Area.

[27]Apportionment of Federal-Aid Highway Funds and Allocation of other Funds administered by the Bureau of Public Roads (1967 Highway Report) shows $184,926,924 for fiscal 1966, and $196,187,447 during calendar year 1964.

TABLE 21

TOTAL CONSTRUCTION AUTHORIZED
IN TEXAS
(1957-1959 = 100)

Year	Annual Average Index
1950	74.9
1951	59.1
1952	59.0
1953	59.9
1954	81.4
1955	87.2
1956	78.4
1957	86.8
1958	104.1
1959	109.6
1960	105.5
1961	112.1
1962	124.2
1963	121.3
1964	130.6
1965	129.0

SOURCE: Chart Book of Texas Business, Bureau of Business Research, The University of Texas, Austin, 1964, p. 28.

TABLE 22

CONSTRUCTION AUTHORIZED IN THE
PROPOSED TRINITY WATERWAY TERMINAL CITIES

	High Year	Construction Value Authorized
Dallas	1962	$246,286,818
Ft. Worth	1959	58,386,105
Houston	1962	337,782,338

SOURCE: Chart Book of Texas Business, Bureau of Business Research, The University of Texas, Austin, 1964.

TABLE 23

FEDERAL HIGHWAY DATA

PERCENTAGE DISTRIBUTION OF THE COSTS OF MATERIALS AND SUPPLIES, LABOR, EQUIPMENT OWNERSHIP, OVERHEAD AND PROFIT FEDERAL-AID PRIMARY PROJECTS REPORTED AS COMPLETED

Calendar Year 1964

Table PT-2A
Issued 1965

ELEMENTS	FEDERAL-AID PRIMARY SYSTEM: INTERSTATE Rural Percent	INTERSTATE Urban Percent	INTERSTATE Total Percent	NONINTERSTATE Rural Percent	NONINTERSTATE Urban Percent	NONINTERSTATE Total Percent	ALL PRIMARY Rural Percent	ALL PRIMARY Urban Percent	ALL PRIMARY Total Percent
Cement[1]	5.7	3.2	4.8	4.3	3.4	3.9	5.2	3.3	4.4
Aggregates Purchased[2]	10.9	6.2	9.1	12.0	7.4	9.8	11.2	6.7	9.4
Bitumens[3]	1.5	0.2	1.0	3.1	0.8	2.0	2.0	0.5	1.4
Lumber	0.6	1.0	0.7	0.3	1.0	0.7	0.5	1.0	0.7
Timber Piling	0.1	0.3	0.2	0.1	0.2	0.1	0.1	0.2	0.2
Corrugated Steel Culvert Pipe	0.9	0.3	0.7	1.2	0.5	0.9	1.0	0.4	0.8
Reinforcing Steel[4]	4.7	5.8	5.1	2.6	4.6	3.6	4.0	5.3	4.5
Structural Steel	4.0	9.2	5.9	1.6	5.0	3.2	3.2	7.4	4.9
Ready-mix Concrete	3.8	6.2	4.7	2.7	6.7	4.6	3.4	6.5	4.7
Premixed Bituminous Paving Materials	2.6	1.6	2.2	4.7	3.2	4.0	3.3	2.3	2.9
Concrete Culvert Pipe	1.2	1.3	1.3	1.4	2.4	1.9	1.3	1.8	1.5
Clay Pipe	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1
Miscellaneous Steel	1.0	2.3	1.5	0.7	1.5	1.1	0.9	2.0	1.3
Fencing	0.8	0.2	0.6	0.4	0.2	0.3	0.7	0.2	0.5
Guardrail	1.0	0.7	0.9	0.9	0.6	0.7	0.9	0.6	0.8
Bridge Rail	0.4	0.5	0.4	0.2	0.5	0.3	0.3	0.5	0.4
Petroleum Products[5]	4.8	2.3	3.9	5.3	2.6	4.0	4.9	2.5	3.9
Explosives	1.3	0.2	0.9	0.9	0.3	0.6	1.2	0.2	0.8
Materials not reported	4.0	12.1	6.9	6.5	8.6	7.5	5.0	10.4	7.2
Total Materials	49.5	53.7	51.0	49.0	49.6	49.3	49.3	51.9	50.4
Labor	24.9	26.8	25.6	25.5	28.3	26.8	25.1	27.4	26.1
Equipment ownership, overhead and profit	25.6	19.5	23.4	25.5	22.1	23.9	25.6	20.7	23.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Does not include cement in ready-mix concrete or in concrete culvert pipe.

[2] Does not include aggregates in ready-mix concrete, pre-mixed bituminous paving materials or concrete culvert pipe. The cost of producing aggregates by contractors in addition to "aggregates purchased" is distributed in "petroleum products," "labor" and "equipment, overhead and profit."

[3] Does not include bitumens in pre-mixed bituminous paving materials.

[4] Does not include reinforcing steel in concrete culvert pipe.

[5] Fuels and lubricants for equipment and trucks.

SOURCE: Highway Statistics, 1964.

these products cost an average of $250 per ton,[28] the highway program alone in Texas would use 740,000 tons of steel annually. Of this tonnage, some one-fifth, in terms both of the kinds of products and the spatial relationships involved, could be transported on a channelized Trinity.[29] Translated to 1,000 ton bargeloads this is some 148 bargeloads.

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[28]Interview, B. J. Davis, Assistant Traffic Manager, Republic Steel Corporation, February 13, 1967, Quoted as a rule of thumb value per ton on this type of iron and steel commodity--includes all costs to ultimate consumer including transportation.

[29]This is based on a generalized assumption that 20 per cent of Texas highway construction will take place in the Dallas-Ft. Worth hinterland areas. The logic behind this assumption is based on population and area. In any event these data do not enter into the calculation of the final projection but they do lend support to the projections made.

In Texas, a conservative estimate is that of sums spent on residential construction some 9 per cent is for iron and steel products; and, if the average value in Texas residential construction holds (see Table 24), then $700,000,000 in value of residential construction will produce a demand for $63,000,000 in iron and steel production. At $300 a ton,[30] this sum represents 210,000 tons. Because of product nature and spatial relationships in regard to new residential construction, only a fraction of this is likely to be moved by barge. In contrast, however, the construction and contractor's steel for non-residential construction is more likely to be barged. In Texas the ratio of new residential to non-residential construction, as a percentage of total new construction is in the order of 45 per cent new residential and 55 per cent non-residential (see Table 25). Thus, to the 210,000 tons above, approximately 257,000 tons of construction and contractor's steel for non-residential construction would have to be added. Thus, 467,000 tons of steel in these categories would be used annually in Texas. Of the total, about one-third is produced as contractors' steel and,[31] as will be pointed-up in the next section, Dallas is a heavy user of these basic materials. Dallas is a main supplier of these products not only throughout Texas but to the entire Southwest and in the case of certain products, such as air conditioning equipment, the entire nation. Probably as much as 20 per cent of the 467,000 tons would lend itself to water movement. This would be approximately 93,400 tons.

In any event, the construction and contractors' category of steel products consumed in the proposed Trinity Waterway impact area for industrial plants; commercial, residential and public buildings; bridges; stadiums; dams; and highways constitutes a major iron and steel market. When such contractor's products, such as plumbing, central heating and central air conditioning equipment, doors and windows (using steel components) are added, the Trinity route could constitute an important savings that, because of the nature of these products, reach a broad segment of population. And with the wave of population that is reaching the family-forming age category, this will be especially critical in the years ahead.

Another set of factors are of significance. Texas' population is growing at an average annual increase of 2.2 per cent for the years 1950-1965, one of the highest rates in the nation.[32] So this figure's

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[30] Davis, op. cit.

[31] American Iron and Steel Institute. Charting Steel's Progress During 1965, p. 28.

[32] Statistical Abstract of the United States, 1966, p. 11.

TABLE 24

TEXAS RESIDENTIAL CONSTRUCTION

(Values in thousands of dollars)

Year	One-family units		Two-family units		Apartment units		Grand total	
	Value	Number	Value	Number	Value	Number	Value	Number
1958	$669,226	61,558	$ 7,568	1,250	$ 53,695	9,827	$730,489	72,635
1959	677,690	60,134	7,970	1,324	41,671	7,716	727,331	69,174
1960	544,195	47,040	6,080	989	35,430	7,109	585,705	55,138
1961	585,190	49,581	8,224	1,066	80,041	13,390	673,455	64,037
1962	587,057	47,075	8,519	1,250	187,856	32,986	783,432	81,311
1963	558,218	42,010	13,534	1,809	239,760	39,213	811,512	83,032
1964	563,858	40,931	14,808	1,982	209,584	32,829	788,250	75,742
1965	557,218	38,370	16,908	2,159	138,227	21,233	712,353	61,762
1966	474,632	30,794	12,082	1,376	136,573	20,970	623,287	53,140

(Nine-year average, $695,090)

SOURCE: Stanley A. Arbingast, Texas Industrial Expansion, 1966, Texas Business Review, Bureau of Business Research, The University of Texas, February 1967, p. 42.

TABLE 25

NEW RESIDENTIAL AND NONRESIDENTIAL CONSTRUCTION AS PERCENTAGE OF TOTAL NEW CONSTRUCTION, TEXAS, 1957-1966

Year	New residential	New nonresidential
	(per cent of total new construction)	
1957	57.4	42.6
1958	65.0	35.0
1959	63.0	37.0
1960	54.1	45.9
1961	57.6	42.4
1962	59.3	40.7
1963	62.2	37.8
1964	56.2	43.8
1965	52.1	47.9
1966	45.1	54.9

SOURCE: Stanley A. Arbingast, Texas Industrial Expansion, 1966, _Texas Business Review_, Bureau of Business Research, The University of Texas, February 1967, p. 42.

use in projecting construction and contractor's iron and steel consumption and, in turn, waterway use is conservative. That construction is at higher than normal levels in terms of population is suggested by the fact that the per cent of total employment in the Southwest (mostly in the Trinity Influence Area) is considerably higher than is the construction share of employment for the entire United States (see Table 26).

Collectively, construction and contractors' iron and steel demands support the contention that the volume of tonnage determined by the survey that was available for barge movement in 1966 was both reasonable and, again, perhaps somewhat conservative. Based upon population growth, the lowest rate of growth factor that can be applied to the 1966 survey-developed tonnage data in the projection of future waterway volumes is 2.2 percent.

3. Relative Use of Iron and Steel Products in the Manufacturing Industry. The relationship of the proposed Trinity Water Route to the manufacturing industries of the area of influence is shown on the accompanying map of Texas: Value Added by Manufacture by County: 1963 (Map 2) sets the stage for this section of study. The overwhelming dominance of the entire region's manufacturing activities with the Dallas-Ft. Worth area at one end of the proposed Waterway and the Greater Houston-Intracoastal Canal area at the other end reflects the strategic orientation of the Trinity to serve the iron and steel users in these key industrial complexes of southwestern United States.

The definition which is given to iron and steel products using manufacturing industries in the area are: 34-Fabricated Metal Products; 35-Non-electrical Machinery; 36-Electrical Machinery; 37-Transportation Equipment; and, 38-Instruments. So defined, this group of industries, when combined with primary metals, constitutes the largest segment in the Texas economy. For example, in Dallas alone more than one-half of all plants and nearly three-fourths of all manufacturing employees are in this category; and, as shown in Table 3, out of 508,539 employed statewide in manufacturing in 1965, 177,689 were in these metal-using categories. Similarly, in terms of value added by manufacture, these categories are high and exceed even the chemicals and allied products category by some $463 million during the 1958-63 period ($2,108 million for iron and steel product oriented industries to $1,645 million for the chemical and allied products). In brief, the metals industries of the Trinity influence are relatively large and basic to the present and future economy of the entire Southwest.

TABLE 26

DISTRIBUTION OF EMPLOYMENT BY MAJOR INDUSTRY DIVISION, SOUTHWEST AND UNITED STATES, 1920-1960

(Percent of total employment)

Year/area		Agriculture; forestry; fisheries	Mining	Con-struction	Manu-facturing	All other	Total*	Absolute total (thousands)
1920:	S.W.	48.5	2.4	-------15.7-------		33.4	100.0	3,838
	U.S.	26.3	2.6	-------30.8-------		40.3	100.0	41,614
1930:	S.W.	41.1	2.1	-------16.8-------		40.0	100.0	4,661
	U.S.	21.9	2.0	-------28.9-------		47.2	100.0	48,830
1940:	S.W.	34.3	3.0	4.7	10.1	47.9	100.0	4,267
	U.S.	18.9	2.0	4.6	23.7	50.8	100.0	45,070
1950:	S.W.	19.5	3.3	8.2	13.1	55.9	100.0	5,210
	U.S.	12.4	1.6	6.1	26.0	53.9	100.0	56,435
1960:	S.W.	9.5	3.3	7.6	15.7	63.9	100.0	5,966
	U.S.	6.7	1.0	5.9	27.1	59.3	100.0	64,639

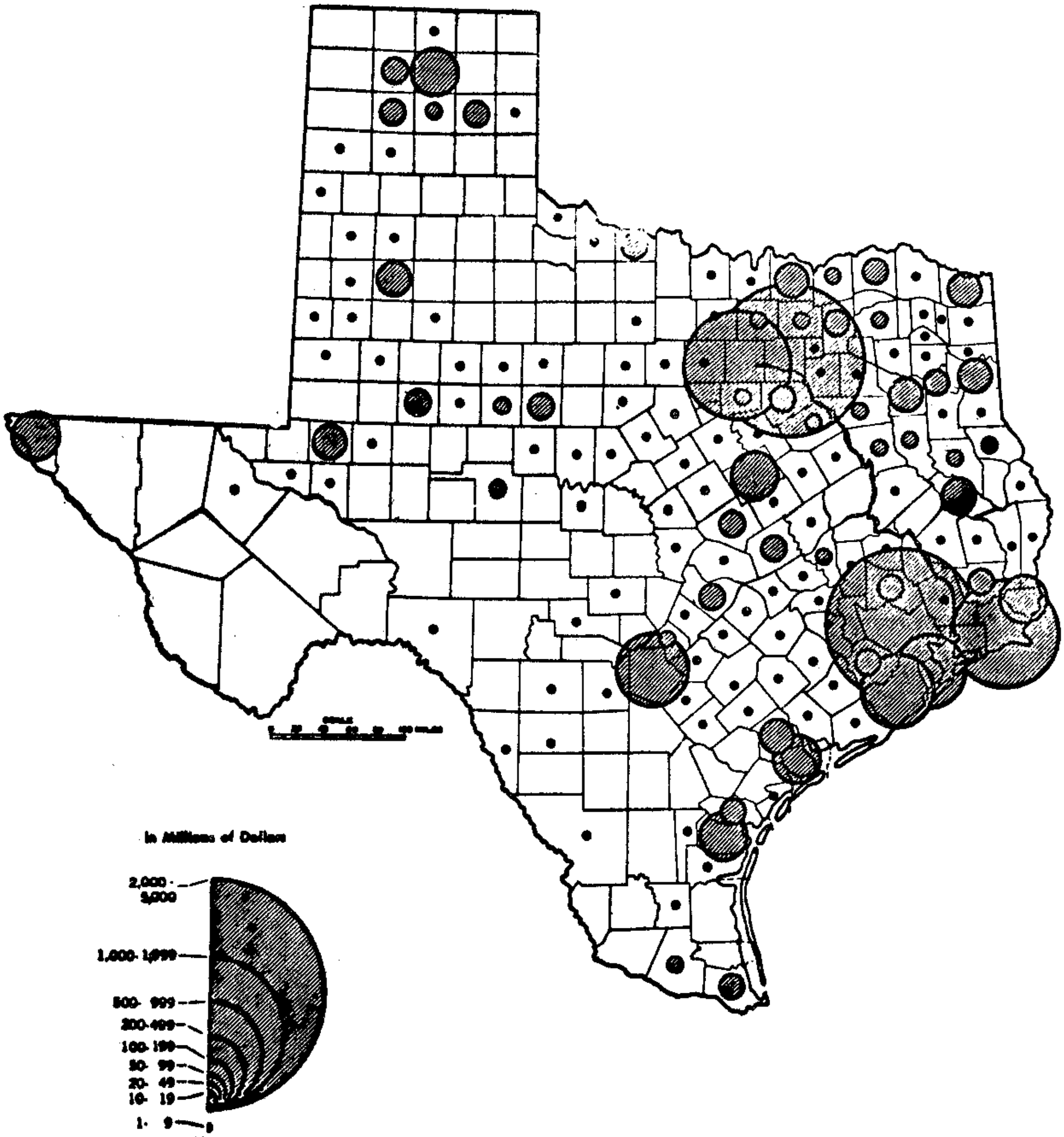
*Detail may not add to 100.0 due to rounding.

*For 1920 and 1930, the total is persons 10 years or older gainfully employed; for the other years, the total is persons employed.

SOURCES: Census of Population, 1920, 1930, 1960.

SOURCE OF TABLE: Stephen L. McDonald, "Economic Development and Change in the Structure of Employment and Income Sources in the Southwestern States Since 1920." Texas Business Review, December, 1965.

TEXAS
Value Added by Manufacture by County: 1963



MAP 2

U.S. Department of Commerce, Bureau of the Census

The Primary Iron and Steel Production Industry will be the subject of the next section of this study, but it is significant to emphasize that to date Texas metal-consuming industries have greatly outrun the primary metallurgical industries, large as they are. The metal economy of the proposed Trinity route is one of iron and steel use, rather than basic production.

There are a large number of foundries in the proposed Trinity Waterway's expected impact area. While some of these are small, older grey-iron foundries without special skills, others are large and well-organized undertakings, as are, for instance, the two large foundries in Lufkin, just 40 miles from the Trinity. These two are Lufkin Foundry and Machine Company (a national manufacturer of pumping equipment and large gear trains) and Texas Foundries (primarily a pearlitic malleable iron producer). Other Trinity area foundries are licensed producers of spheroidal graphite iron castings and others specialize in steel castings, non-ferrous castings, die-castings and centrifugal castings.

In regard to the corresponding strength on the primary fabrication side, such as the conversion of ingots and other large sections to slabs, billets and so on, a different picture becomes clear. Outside of the two primary steel mills, such capacity hardly exists at all in the Trinity's impact area. Thus, water traffic might well prove to have a special attraction for those industries requiring "the-next-step-basic iron and steel forms."

On the steel side, however, capacity to make large wrought shapes does exist outside of the Armco and Lone Star Steel Companies. Firms such as Cameron Iron Works and LeTourneau, have very large-size equipment and several of the main out-of-state steel producers have subsidiary operations in the Trinity area for the fabrication of plates into large pipes and for structural engineering, including ship building. Also, it should be pointed out that the Dallas-Ft. Worth section of the Trinity area has some of the largest undertakings in the aerospace field. Of these, special mention should be made of the Convair plant of General Dynamics, the Chance-Vought plant of Lin-Temco-Vought, and the Bell Helicopter plant. In addition, there is the very large firm of Texas Instruments with a plant at each end of the proposed Trinity artery. And, although all of these plants may not use water shipments directly, they are among the world's most sophisticated users of iron and steel products, and, representing the apex of the metallurgical age, as they do, their mention serves to emphasize that the Trinity area is a unique iron and steel-using complex that in consumption runs the gauntlet from the most basic iron and steel forms to include the most refined and close tolerances to be found in the industry. The number and sizes of these firms were presented in an earlier section of the study under the heading of "Background."

In predicting future barge movements of iron and steel on the proposed Trinity Waterway, especially in view of the basic nature and dominant role of the Trinity area's iron and steel industries, are value added by manufacturing and employment.

Value added by manufacture.--Value added by manufacture is projected to multiply 6.89 times in Texas (from $6,783 million in 1962 to $46,600 million in 1990). This growth for Texas compares impressively with the 4.45 rate projected for the United States (from $189,072 million to $840,760 million). The higher growth in Texas is a result of two forces which combine to determine the projected figure. First, the growth in manufacturing productivity in Texas from 1950 to 1963 was greater than that in the United States. In fact, not only was the growth rate greater, but the[33] absolute level of productivity in Texas in 1963 (the latest census year) was 21 per cent higher than that of the United States.

Manufacturing employment.--The Trinity area compares even more favorably with the United States in expected growth in manufacturing employment. From 1964 to 1990 the projection is that Texas manufacturing employment will grow in excess of 115 per cent, while the nation's manufacturing employment is expected to grow 51 per cent (see Table 27). (On the other hand, employment in other sectors--agriculture, mining, and forestry--is expected to continue a relative decline in both Texas and the nation).[34]

From these two sets of data it is clear that a rate of growth that will quadruple present levels by 1990 is conservative indeed. This rate would be especially conservative in view of the findings of Bruce and others that by 1990 the value added by primary metals production in Texas will be 13 times the 1962 figure.[35] Thus, in terms of iron and steel that will be needed by the Trinity area manufacturers, based on value added, will increase six fold by 1990 (see chart next page) and based on employment will increase four fold.

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33 Grady B. Bruce, "The Future of Texas: An Overview," Texas Business Review, 1966, p. 134.

34 Ibid.

35 Ibid., p. 135.

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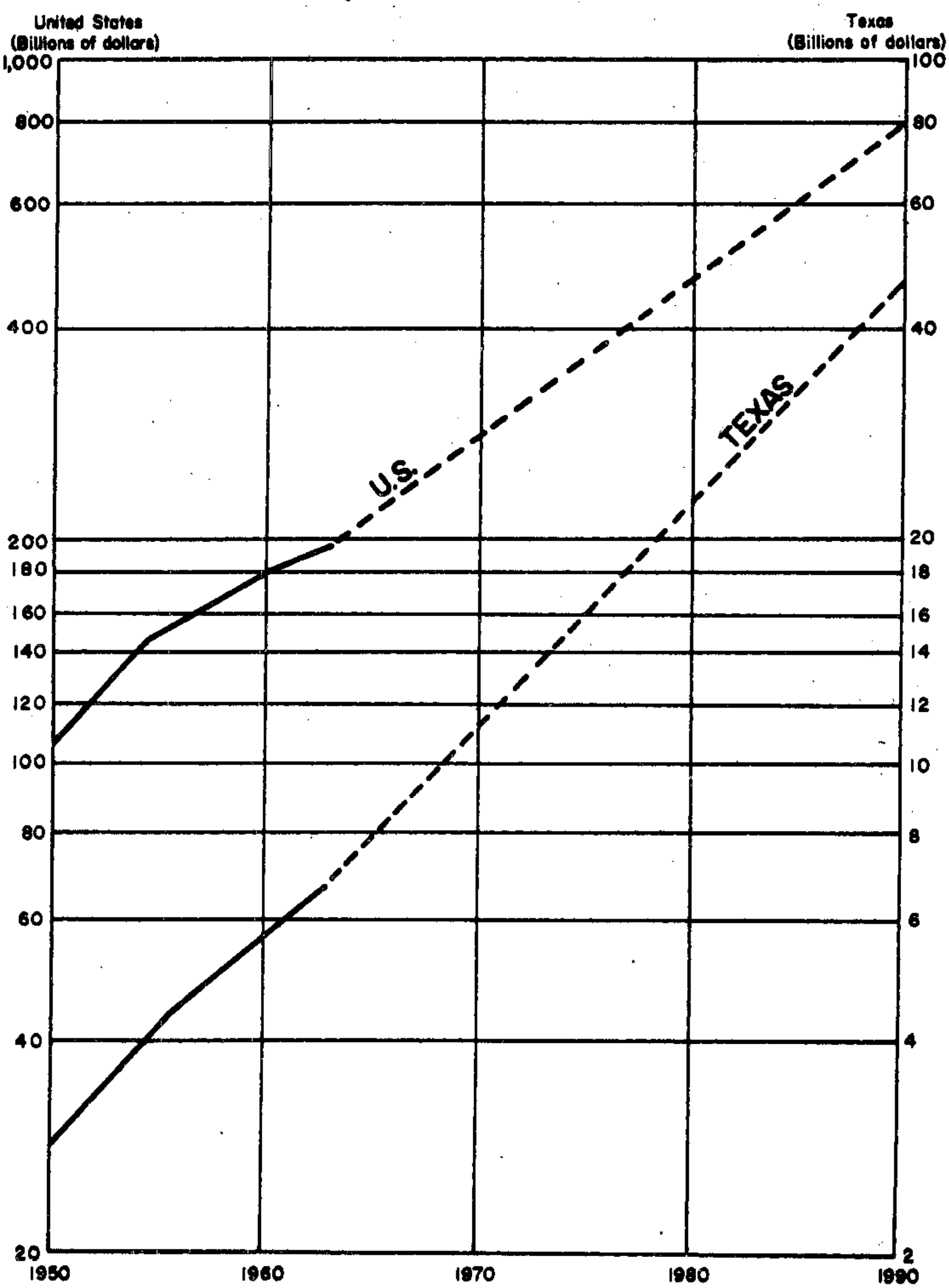
CHART 1

VALUE ADDED BY MANUFACTURE, U.S. AND TEXAS 1950-1963, WITH PROJECTIONS TO 1990 (In 1957-59 dollars)



Source: Blair, op. cit.

TABLE 27

MANUFACTURING EMPLOYMENT, UNITED STATES AND TEXAS, 1939-1964, WITH PROJECTIONS TO 1990

(In thousands of persons)

Year	United States	Texas
1939	10,278	179
1947	15,545	297
1955	16,882	446
1960	16,796	490
1964	17,272	538
1970	18,999	642
1975	20,571	745
1980	22,281	863
1985	24,112	1,001
1990	26,107	1,160

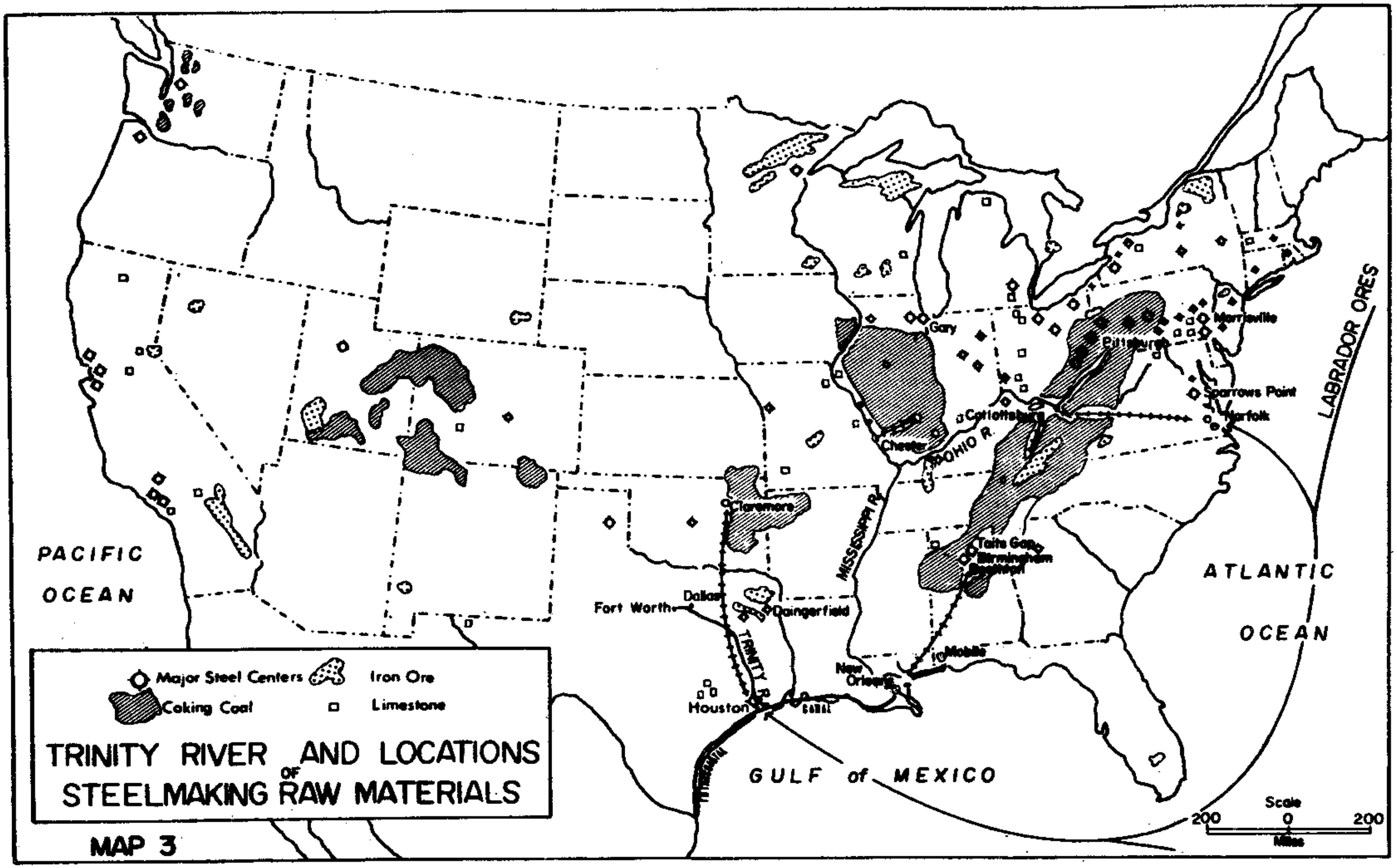
SOURCE OF DATA: 1939-1964, United States, Bureau of Labor Statistics, U. S. Department of Labor; 1939-1947, Texas, U. S. Census of Manufactures; 1955-1964, Texas, Texas Employment Commission.

D. Trinity Area Primary Iron and Steel Production

Although the present rated steel capacity of the Trinity Impact Area is small when compared with the Youngstown-Pittsburgh area or the South Chicago-Gary region, the area is among the top ten producing regions in the nation and is spectacular for its rate of growth. Thirty years ago the rated capacity was under 5,000 tons; by 1959 the capacity had risen to 2,381,450 tons with two main plants: Armco Steel Corporation, in Houston, and the Lone Star Steel Company, in Daingerfield, rated at 1,108,000 and 550,000 tons, respectively. Today, each of these two plants approaches 2 million tons annually and there is new construction underway which will enable the two plants to exceed these annual tonnages. In addition, announcements by U. S. Steel, Des Moines-Pittsburgh and other firms of new plant construction within the Trinity influence area will approximately double present capacities within the next five years. Thus, in discussing tonnages from primary metal plants as these relate to the proposed Trinity project, all production figures could be doubled as that capability will be realized before the Trinity could possibly be opened to traffic.

The larger of the two integrated steel plants, that of the Armco Steel Corporation, was set up as a result of a survey undertaken in 1936 which emphasized the market demand in Texas for steel plates and structural shapes and also the abundance in the State of steel-making scrap. The first idea was to lay down only a steel mill, but with the development of an emergency situation in 1941 the Federal government encouraged the building of coke ovens and a 25-foot hearth diameter blast furnace. The first steel was teemed in 1942 and the first hot metal in 1944. By that stage, $40 million had been expended on the plant, but continued additions have since been made, e.g., the five open-hearth furnaces have been increased to eight, and much has been added by way of rolling mill equipment. The plant, which is the largest steel plant west of the Mississippi, occupies a 650-acre site with a 1-mile frontage on the Ship Channel sixteen miles from downtown Houston. It receives coking coal by rail and/or barge from Oklahoma, Arkansas, Alabama and West Virginia (and formerly by boat from Eastern coalfields); pelletized iron ore comes by boat from Seven Islands, Canada (see Map 3) fields and from Durango, Mexico and by ship from South America (Brazil, Chile, etc.); limestone is available from Texas quarries, but at times has been substituted by oyster shell dredged from the Gulf; fuel, in the forms of oil and natural gas, is drawn by pipeline from Texas fields. The blast furnace is normally operated on pelletized ores blended with the foreign ores with a 60+ per cent iron content. Soon only pelletized ores will be used.

The plant in 1961 comprised 62 coke ovens, one blast furnace with four stoves, eight 105-ton open-hearth furnaces, one 36-inch blooming mill, one 26-inch billet mill, one 24-inch structural mill, one 14-inch merchant mill, one 13-inch plate mill, together with wire drawing facilities, nail machines, etc.; adjacent is the plant of a joint subsidiary with the A. O. Smith Corporation for the fabrication of pipe. An expansion scheme since carried out has embraced a new unit which includes two 100-ton electric furnaces, 16 soaking pits, a 150-ton per hour slab heating furnace, a 160-inch combination slab and plate mill, capable of rolling plates 12-feet wide and 50-feet long, and a plate heat-treatment line, which is 450 feet in length and



TRINITY RIVER AND LOCATIONS OF STEELMAKING RAW MATERIALS

MAP 3

allows both hardening and tempering as continuous operations, and is essential to the production of the proprietary high tensile steel SSS-100 which has a minimum yield point of 100,000 psi, and a tensile strength of 115,000 to 135,000 psi. As well as supplying plate to the pipe mill, the Houston plant produces bars, plates, structurals, wire, rods, fences, and reinforcing bars. A specialty is dished ends for pressure vessels. About 10 per cent of Sheffield Division's production is in special and alloy steels. Two subsidiaries are the National Supply Division, a major source of supply for the petroleum industry, and Southwest Steel Products, which fabricates requirements of the construction industry.[36]

Although located at a disadvantage in regard to the Proposed Trinity Waterway, especially if a Red River Channel is completed, a second plant is important because of its influence and impact on area-wide iron and steel movements.

The establishment of a plant at Lone Star near Daingerfield in Morris County was a wartime measure financed by the Federal Government. An ore beneficiation plant, coke ovens and a 1,200-ton-per-day blast furnace had been built, but had not become operational, when World War II came to an end. At the end of the war, the Lone Star Steel Company was set up to take over the plant and operate it as a specialized project for the Texas petroleum industry, as well as acquiring the ore lands and Oklahoma coal mines. It took over in January, 1948. Proposals to add steelmaking facilities were shelved and, in fact, the addition was not made until 1953.

The company owns or leases 53,000 acres of ore-bearing land within 30 miles of the plant, where limonite and siderite ores occur within 30 feet of the surface. At the neighboring beneficiation plant the ore is crushed, washed, gravity separated, dried, when it has about 45 per cent iron, and calcined in a 300-foot long kiln. Fines are sintered. Oklahoma coal feeds a battery of 78 Koppers-Becker ovens and yields 1,200 tons of metallurgical coke a day, which serves to smelt the iron ore in an efficient operation. The blast furnace is tapped 4 times a day; the record day yielded 1,407 tons of hot metal. A part of the hot metal is diverted to a centrifugal cast iron pipe foundry which produces 80,000 tons a year of non-oil field 4- to 12-inch i.d. pipe. The remainder, together with steel scrap, feeds five open-hearth furnaces which handle 250-ton charges in 8 to 12 hours, and yield in aggregate 800,000 tons of ingots a year. The ingots are broken down on a two-high reversing mill to slabs 4- to 7-inch thick

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[36] Eric H. Bucknall, "Texas Metals, Metal Industries and Metallurgy," Texas Business Review, The University of Texas, 1965, p. 9.

and further rolled to skelp from 1/8- to 1/2-inch thick on a four-hill mill. Skelp constitutes the feed of pipe mills, where it is levelled and side-trimmed before entering the roll-forming stands and being welded longitudinally. All pipe is normalized before inspection and finishing. The plant includes a stretch-reducing mill which is capable of reducing pipe from 6 7/8- to 1/2 inch nominal, with automatic control over wall thickness. Apart from the specialized products referred to, the Lone Star plant produces some reinforcing bar from the side and end trimmings of slabs, plates and skelp. The plant is valued at more than $160 million and employs about 3,000 workers when operating at capacity.[37]

In addition to these two major steel mills there is additional production at other Trinity area firms, such as Texas Steel in Ft. Worth, among others. Most are foundries with electric furnaces, and all of these firms consume thier own product except for LeTourneau at Longview which from time to time sells some of its 100,000 tons annual output.

Adding to this already impressive production level is United States Steel Corporation announcement that their firm is to begin construction in 1967 of a major steel-producing facility on an 8500-acre site at Cedar Point in Chambers County. The site has access to the proposed Trinity Waterway and the Houston Ship Channel. Both access channels will have to be dredged. Initially, the plant will consist of two electric furnaces, a 160-inch plate mill and auxiliary features. Ingots from the electric furnaces are produced, primarily using scrap. Heat-treating facilities and continuous casting equipment are expected to add to a wide range of products. In describing the new Houston-area plant, President Leslie B. Worthington's news releases said, "We expect this to become one of the great steel-producing complexes in the nation... if not the world." Based on this statement, the size of the site, and an initial investment in excess of $150 million, this plant should eventually double basic iron and steel production in the Trinity area.

And, to these impressive totals are announcements of other new iron and steel plants: Armco is starting construction of its third electric furnace and new wider rollers are to be added early in 1968. Ultimately their plant is expected to attain an output of 4,500,000 tons annually.[38] Of special significance to the barging of iron and steel

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[37] Ibid., p. 10.

[38] Houston Post, June 15, 1965.

is Armco's current installation of a new barge unloading and shipping facility, separate from the present deep-water dock.[39]

The Pittsburgh-Des Moines Steel Company has announced that they have purchased a site at Liberty, on the Trinity, for a major facility. Details have not, as yet, been announced.[40] Similarly, Bethlehem Steel Corporation has begun construction of a new $1,500,000 steel-fabrication plant for the production of reinforcing bars. This new plant is 15 miles east of Houston and accessible to barge traffic.[41] All of these announcements are but recognitions of the Trinity Area as a focal point for primary metal operations.

In regard to the production of basic iron and steel, water transportation is limited to the movements of: (1) iron ore; (2) coal; (3) fluxing materials; (4) scrap; (5) pig iron; and (6) steel mill products.

1. Iron ore. Iron ore from Armco is now coming in pelletized form from Seven Islands, Canada. This Labrador ore is nearly 65 per cent iron content. At present, some South American ore is mixed, after sintering, if necessary. But, in the immediate future, Armco expects to rely entirely on pelletized Labrador ore; thus, no barging appears likely.[42] Similarly, the new U. S. Steel and other recently announced mills are expected to use scrap or South American ores and thus generate little or no inland water traffic.

The Lone Star mill does use pelletized Texas ore, of which there are sizable reserves (see Map 3). However, this ore occurs as siderite and limonite materials and reserves are estimated at 200 million tons,[43] and, typically, the beneficiation of these ores takes place at the northern end of the field, most distant from the proposed Trinity. Thus, there is little hope for present and future barge requirements.

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[39] Houston Magazine, April, 1966.

[40] Stanley A. Arbingast, "Texas Industrial Expansion, 1966," Texas Business Review, University of Texas, Austin, February, 1967, p. 38.

[41] Stanley A. Arbingast; Graham Blackstock; Betty Sue Hoch; Texas Industrial Expansion, 1967, Bureau of Business Research, University of Texas, Vol. XVII, No. 4, April, 1967, p. 6.

[42] Interview with Mr. Joe E. Maddok, Assistant Manager, Blast Furnace, Armco Steel Company, May 4, 1967.

[43] Bucknall, op. cit., p. 3.

Other ore deposits, such as the Llano and Iron Mountain magnetities, are too distant to give serious consideration to as a source of Trinity barge traffic, at least in the foreseeable future.

2. Coal. Coking coal has been, and still is, the chief deterent to primary iron and steel production in the Trinity influence area. At present Armco's coking coal comes from the Claremore, Oklahoma-Ft. Smith, Arkansas area (see Map 3) which, in turn, is enriched with higher grade coking coals from the Tait's Gap, Alabama and Huntington, West Virginia areas. Coal from the later two sources reaches Houston ex-barge, and the Alabama coals are being phased-out in favor of the West Virginia coals from Armco-owned mines. The problem of obtaining high quality coke is serious in the Trinity area and at least one firm uses rail from the St. Louis, Missouri area.[44] A barge rate of $3.25 a ton is in effect from Huntington, West Virginia to Houston. The same rate would be logical for a St. Louis-Ft. Worth shipment via a channelized Trinity River. Thus, it is conceivable that some coke would become Trinity Waterway traffic. At one time, some coke did reach Houston coastwise via the Chesapeake and Ohio and Norfolk and Western docks in the Newport News and Norfolk, Virginia area. It is doubtful that this traffic will be revived in competition with the extremely low, rail-barge, rates now in existence from the Southern Illinois, West Virginia, Kentucky and Alabama fields.

Because of the coke situation, it is most likely that electric furnaces, natural gas processes, H-iron or residual H-processes and such other techniques as the use of an iron-powder catalyst all will be studies and/or tried for application in the Trinity area. None of these different processes will add to the volume of heat sources (coal or coke) being barged.

3. Fluxing Materials. Texas limestones and dolomites are used as flux along with boiler scale and in-plant scrap. By weight this flux is about one-third that of coke required (in the blast furnaces) and the relatively short rail-haul from the near Austin, Texas area suggest that little or no barging of these materials is feasible. Similarly, fluorspar does not warrant barging and what little that is needed for the open hearth furnaces will be railed in from Mexico. However, in the event of international friction, the fact that the main domestic sources of fluorspar are close to the Ohio River in Southern Illinois and Kentucky, might in an emergency produce an occasional bargeload.

4. Scrap. Scrap iron and steel (and other metals as well) promises to become one of the major commodities likely to be barged on

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[44] McKinley Iron Works, Ft. Worth, Texas.

a channelized Trinity. Right now Armco is using from 50,000 to 60,000 tons of iron and steel scrap a month. Most of it comes from within a 100-mile radius, nearly all from within 250 miles. However, the new U. S. Steel facility will treble this requirement and enlarge the territory required to generate such a volume of scrap. Compounding the effects of this development are the heavy overseas movements and multi-needs of the numerous aforementioned primary iron and steel plants.

Of importance in a study of possible movements of scrap on the proposed Trinity are the following definitions of the major grade categories.[45]

(1) No. 1 heavy melting steel. This may be not larger than 5 feet by 2 feet by at least one-quarter inch thick. This type of purchased scrap, usually of obsolete material, is obtained from heavy capital goods such as structural shapes, tank plates, ship sides, boilers, and bars.

(2) No. 2 heavy melting steel. This is essentially the same as No. 1 except that it can be as thin as one-eighth inch. This class is subdivided into two size groups, one up to 5 feet by 2 feet, the other up to 3 feet by 1 1/2 feet. Automotive slab (see item 7 below), a recently developed form into which old automobiles are processed, is often classified in this category.

(3) No. busheling. This consists of loose light material, mostly new but including some obsolete (except old auto body and fender stock), which may not exceed 1 foot in any dimension.

(4) No. 1 bundles. These are made up principally of prompt industrial scrap, and consist of sheet clippings compressed mechanically into bales or bundles weighing not less than 75 pounds per cubic foot. This is a premium scrap because it is made up of new material of known composition, free from contaminants and usually free of rust.

(5) No. 2 bundles. These consitute a less expensive item and are made up of old black and galvanized material, often auto bodies, compressed to a density of not less than 75 pounds per cubic foot. Tin or lead coated material or enameled stock may not be included. Although the auto body sheet material is of good quality steel, a problem arises from contamination resulting from incomplete removal of parts in which nonferrous metals or nonmetallic materials are present. The term No. 2 bundles will be used in this report as inclusive of both No. 2 bundles and bundled No. 2 steel, an essentially similar material, which is described in the following paragraph.

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[45]U. S. Department of Commerce, Iron and Steel Scrap Consumption Problems, Superintendent of Documents, U. S. Government Priniting Office, Washington, D. C., March, 1966, p. 5-6.

(6) Bundled No. 2 steel. This is a comparatively new and growing type of steel scrap, a variant of the No. 2 bundle. It is an automobile bundle including the frame. As compared with the No. 2 bundle, it tends to be higher in metallic return and lower in contaminants, because the frame is lower in contaminants than the body.

(7) No. 2 automotive slab. This is another comparatively new type of steel scrap--often classified as a form of No. 2 heavy melting steel scrap--into which old automobiles are increasingly being processed. The method of processing is to partially compress the stripped automobile, and then to slice it with a shear into a number of slabs. In contrast with No. 2 bundles, much of the nonmetallic dirt is eliminated by this process. Furthermore, the smaller size of the pieces makes it physically more acceptable for use in electric furnaces than No. 2 bundles.

(8) Shredded (or fragmented) scrap. This is a new type of scrap which has not yet been included in the commonly used specification lists. It consists of small pieces of chopped up automobile bodies and similar materials, from which dirt, other nonmetallic materials, and nonferrous metals have been largely removed. These pieces generally range from one-half inch up to 8 inches in length or width, although a small proportion (less than 10 per cent) may range up to 12 inches. The thickness is dependent on the nature of the part of the car from which cut.

Qualitywise, shredded scrap is much superior to most No. 2 bundles, bundled No. 2 steel, or automotive slab, the other forms in which this type of scrap material is processed. As yet it is produced by only a few companies, and consumed by only a few iron and steel producers. The annual production of shredded scrap is well over 1 million tons, most of which is accounted for by one large producer. It is particularly well adapted for use in electric furnaces, where virtually all of the current supply is utilized.

(9) Steel turning and iron borings. These are the residue from various machining and fabricating operations in converting iron and steel into capital and consumer goods. They are primarily used in blast furnaces. However, sometimes borings are briquetted for charging into gray iron foundry cupolas. A method was recently developed for using borings in sintering.

(10) Several grades of steel and cast iron used primarily by iron and steel foundries: crops (ends) from billets, blooms, bars,

and forged material; structural shapes and plates; cast steel (includes broken car wheels); hard steel (auto rear ends, crankshafts, front axles, springs, and gears); cupola cast (broken motor blocks and similar cast-iron material); charging box scrap; and heavy breakable cast.

Not all available scrap is consumed, principally because of the presence of certain nonferrous metal and other impurities, which, if too large in amount, give undesirable characteristics to the resultant steel and foundry products.[46] Most grades of scrap can be used with care but "No. 2 bundles." This category of scrap includes automobiles undercoatings, door handles, paint, copper fuel lines and other car accessories. Some steelmakers will not use No. 2 bundles under any conditions. New hammer mills may change this in the near future; and, if such a mill is put on the Trinity in the Ft. Worth-Dallas area, this could generate a sizable barge volume.[47]

When viewed with these categories and user requirements in mind, it becomes clear why much usable scrap "stays at home." That is, it, is consumed within its originating territory (see Map 4). In the territories shown the following generalizations apply:

Colorado Fuel and Iron (Pueblo)	30-40% scrap
Border Steel (El Paso)	100% scrap
Armco (Kansas City)	100% scrap
Laclede (Alton)	100% scrap
Granite City Steel (Granite City)	20-30% scrap
Armco (Tulsa)	100% scrap
Armco (Houston)	30-40% scrap soon less than 25-30% scrap
Lone Star Steel (Daingerfield)	20-30% scrap
Texas Steel (Ft. Worth)	100% scrap

Most of these plants use from 10,000 to 12,000 tons of scrap a month. Little is shipped great distances except for export when scrap is scarce.

In the past the only water movement out of the Trinity area of influence was to Laclede Steel, Alton, Illinois; and, then this moved only during periods when scrap was scarce. Houston seldom goes beyond Waco and Madisonville to the north, the Saline on the east, and

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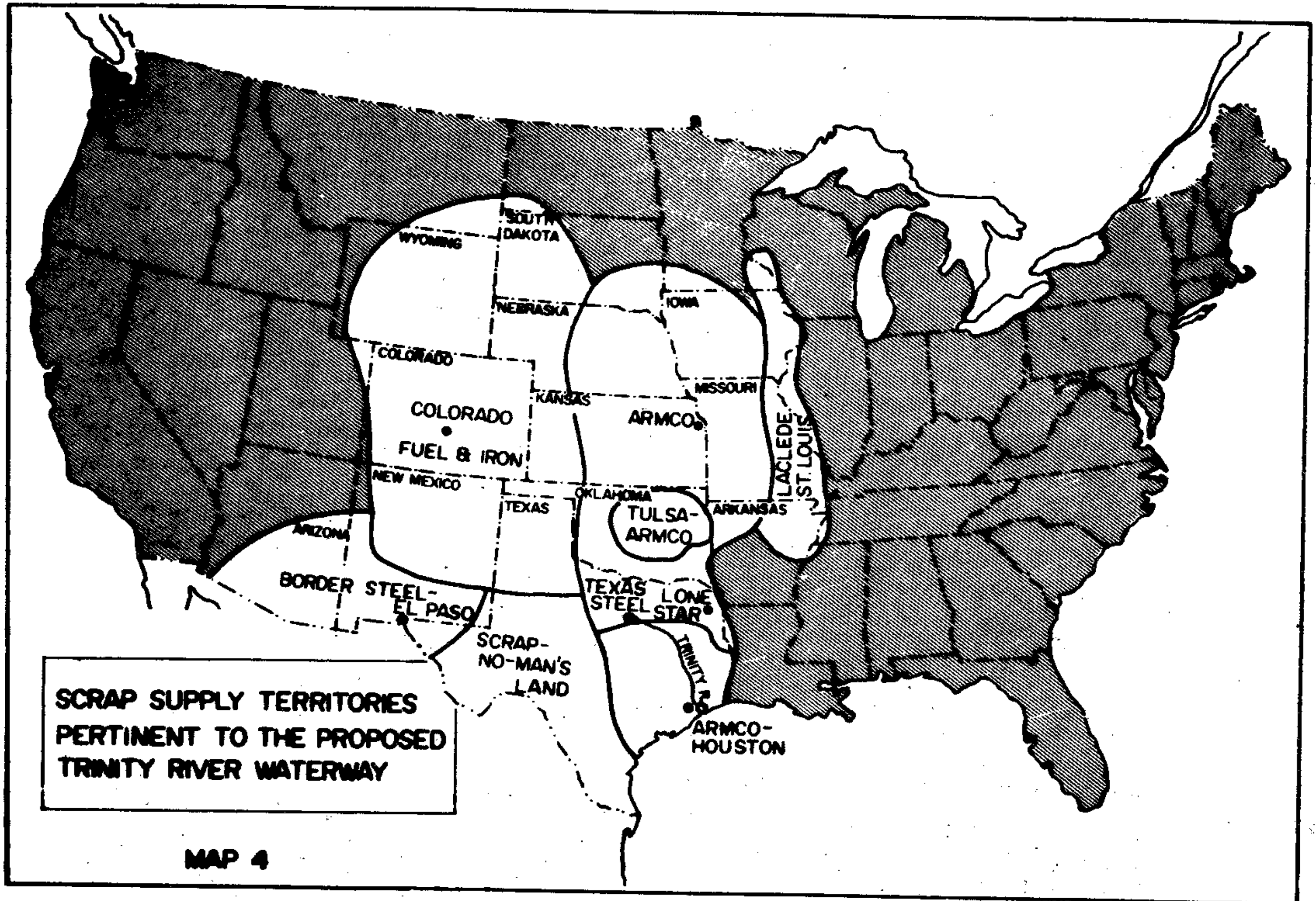
[46] Op. cit., pp. 9-10.

[47] Interview, Mr. Philip Aronaff, Stelmet Corporation, Houston, Texas, May 17, 1967.



SCRAP SUPPLY TERRITORIES PERTINENT TO THE PROPOSED TRINITY RIVER WATERWAY

MAP 4

San Antonio toward the west. (Thus, most of Houston's scrap hinterland is not oriented to the Trinity.) At times, scrap has come to Houston from such distant points as Oklahoma City.

However, the new U. S. Steel plant and a Trinity Waterway would reshape much of the scrap marketing patterns throughout the entire Southwest. And, if as suggested earlier, a hammer mill to upgrade No. 2 bundles is established in the Ft. Worth-Dallas (on the Trinity) then, indeed, the volume of scrap barged would be a most significant part of that waterway's traffic,[48] especially downbound. And, an increased use of automobile bodies for such conservation uses as fish spawning grounds in the Gulf, or to stem beach or stream-bank erosion would add to the total tonnage to move by barge.

In any event, there is already a heavy movement of scrap to Houston for export, some 162,200 tons of potential downbound traffic was reported in the industry survey, (see Table 12). Significantly, no upbound scrap possibilities were found in the survey. In fact, as most tonnage potential is upbound items, scrap would be an ideal backhaul commodity.

One large hammer mill on the Trinity alone would produce some 336,000 tons of No. 2 bundles, 80 pounds to the cubic foot annually.[49] This amount when added to the present 162,200 tons in which shippers have indicated an interest in barge traffic, plus a 2.2 per cent (based on population growth rate) annual growth increment will produce 586,650 net tons by 1985 and 683,374 by the end of the century (see Table 28). Without a large hammer mill on the Trinity, the comparable figures will be 250,650 and 347,374 tons, respectively.

5. Billets and Pig Iron. In the Trinity influence area billets, for the most part, are processed integral to the mills in which they are produced. Little barging of billets is expected on the Trinity. There is little, if any, billet traffic into Houston at present. That there might be some in the future is conceivable, depending on the construction of rolling facilities at processing warehouses in the Ft. Worth-Dallas area.

On the other hand, some pig iron is likely to move by barge. In fact, 21,600 tons of pig iron were listed by industries as possible Trinity traffic (see Tables 11 and 12). And, still other firms suggested that they, too, would be interested in bringing in pig iron if low-cost water transport were made available.[50] With the advent of new mills,

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[48] Op. cit.

[49] Op. cit.

[50] A Ft. Worth, Texas Iron Works.

processors and concentration on pelletized iron ore, more and more pig iron is likely to become amenable to barging (see Table 29).

TABLE 28

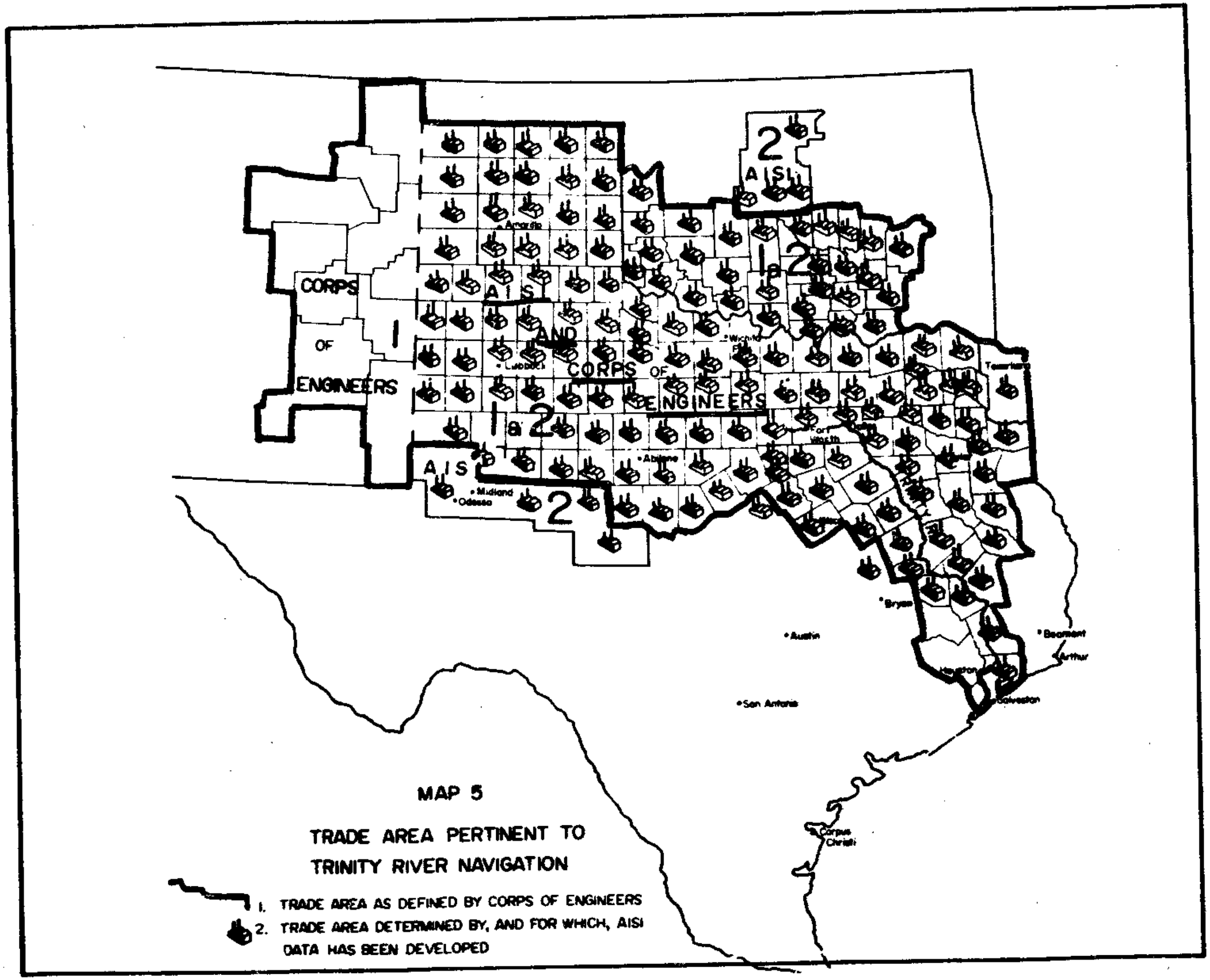
PROJECTIONS OF POTENTIAL (SOUTH [DOWN]-BOUND) FERROUS-SCRAP TRAFFIC ON A CHANNELIZED TRINITY: 1966-2035

Year	Based on Present Interests	Rounded to Nearest 1000 tons	With a Large Riparian Hammer Mill on the Trinity (336,000 ton annual ton capacity)	Rounded to Nearest 1000 tons
1965	158,646 tons	159	(Not yet constructed)	
1966	162,200	162		
1970	176,951	177	512,951 tons	513
1975	197,292	197	533,292	533
1980	219,969	220	555,969	556
1985	245,254	245	581,254	581
1990	273,446	273	609,446	609
2000	339,923	340	675,923	676
2020	525,288	525	861,288	861
2035	728,050	728	1,064,050	1,064

Figure determined by Corps of Engineers Survey of 1966 movements projected backward to 1965 using the 2.2 per cent growth-rate. Compound interest rate applied of 2.2 per cent annually. Bases of growth-rate--population rate-of-growth.

6. <u>Steel mill products (other than billets and pig iron)</u>. Due to problems of equalizing prices against lower transportation costs, competition and a conviction that lower-cost transportation on the Trinity is not in their best interest, data on steel products moving into the upper Trinity Area from the mill companies, per se, is difficult to detail.

The American Iron and Steel Institute provided the Trinity River Improvement Association a total figure of 857,312 net tons for shipments of steel mill products in 1965 into the market area delimited on Map 5. Of this amount, 149,707 tons was oil field goods leaving a balance of 707,605 net tons. The Corps of Engineers survey listed a total upbound net tonnage of 945,592 (see Table 9).



MAP 5

TRADE AREA PERTINENT TO TRINITY RIVER NAVIGATION

1. TRADE AREA AS DEFINED BY CORPS OF ENGINEERS
2. TRADE AREA DETERMINED BY, AND FOR WHICH, AISI DATA HAS BEEN DEVELOPED

Of the nine mills reporting 85 per cent of the AISI tonnage, the Corps of Engineers identified 245,105 tons which were shipped into the Trinity Impact Area and for which shippers had expressed an interest in moving these products by water.[51] These 245,105 net tons are close to 35 per cent of the tonnage shipped into the market area shown on Map 5. Taking into consideration the 300 to 600 ton bargeload minimums required for water movement and a need to move many shipments faster than is possible by water and the fact that most shippers are not immediately on water, this 35 per cent figure takes on real significance as an indication of the number of shippers interested in having a channelized Trinity. That indicates this tonnage will grow at a rate relatively faster than the population growth rate of the area has already been discussed. And, that the steel mills, too, recognize a growth situation is evident in the already announced new plants to be built and the updating and expansion of present facilities.

Thus, in summary of this section, insofar as the Trinity's future is related to iron and steel, there is a conservative 245,105 tons of mill product moving into the Trinity Impact Area,[52] which could be expected to move by water. Then, if this sum is expanded at the growth rate of 2.2 per cent[53] by the time that such a project could be completed (1985) there would be the market demand for 487,706 tons or more than a bargeload per day of mill shipments that could, if the rate structure permits, move up the Trinity (see Table 29).

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[51]The nine steel companies listed are: Armco Steel Corporation, Bethlehem Steel Company, Granite City Steel Company, Inland Steel Company, Jones-Laughlin Steel Corporation, Northwestern Steel and Wire Company, Republic Steel Corporation, U. S. Steel Corporation, and Youngstown Sheet and Tube Company.

[52]Based on the AISI statement that 227,147 net tons which the Corps of Engineers survey determined moved into the Market area on Map 5 was but 85 per cent of the total of all mill products moving into the area which could then be considered as reasonably adaptable to barge shipment.

[53]<u>Charting Steel's Progress During 1965</u>, American Iron and Steel Institute, p. 13.

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E. Summary Estimating Future Levels of Probable Iron and Steel Traffic Using a Channelized Trinity.

In summary, the total future of iron and steel in the Trinity River Economic Impact area is expected to increase at a rate above the national current average 3.7 for steel ingot production and even exceed the 5.4 per cent rate of growth for shipments of steel mill products.[54] Rates of growth used in this study were intentionally conservative and in review are:

Iron and Steel Category	Average Annual Growth Rate Used
Oil Field Related Iron & Steel	Based on production projections
Iron and Steel Products for the Manufacturing and Construction Industries	2.2
Ferrous Scrap	2.2
Mill Products	Rate varies as follows: 3.5 per cent through 1985; 3.0, 1985-2000; 2.2, 2000 to 2035.

[54] U. S. Department of Commerce, Business and Defense Services Administration, U. S. Industrial Outlook, 1967, U. S. Government Printing Office, Washington, D. C., December, 1966, p. 100.

TABLE 29

PROJECTION OF STEEL MILLS' PRODUCTS SUITABLE FOR MOVING BY BARGE ON A CHANNELIZED TRINITY[1]

Year		Volume	Volume Rounded to Nearest 1000 tons
	NOTE: 1965 total actually exceeds		
1965	1966 as actually surveyed based	252,380 net tons	252
1966	on the following calculations:	245,105	245
1970	$\frac{245{,}105^{2}}{89{,}995^{3}} = \frac{x^{4}}{92{,}666^{5}}$	281,264	281
1975		334,052	334
1980		396,750	397
1985	[2]From 1966 survey	471,214	471
1990	[3]AISI Table 13, Net shipments of	546,266	546
2000	steel products--all grades, 1966	734,137	734
2020	[4]1965 equivalent of 1966 survey	1,134,473	1,134
2035	data	1,572,379	1,572
	[5]1965 data as explained in footnote 3, above		

[1]For source of these data see text discussion and footnotes 52 and 53 p. 72 . (Per cent increase compounded annually--again see text previous paragraph.)

The total tonnage surveyed and found to be of interest to iron and steel shippers in terms of moving them on the Trinity is calculated at 1,185,888. Conservative growth factors to be applied to project these tonnages have been developed throughout the study and are footnoted (see Table 30). Based on the factors developed in this study, various segments of the economy will grow at different rates. The projections presented here are recommended for use in calculating cost and engineering factors on the proposed waterway and indexes for the proposed rates of growth are shown in Table 31.

In brief, the iron and steel economy of the Trinity Impact Area is so sound and brisk that today there are some 1,207,927 net tons that would move on a channelized Trinity. Most conservatively by 1985 this total will be 2,108,588; by 2000, 2,790,867; and, by 2035, it will be 5,349,548.

TABLE 30

PROJECTIONS OF IRON AND STEEL TRAFFIC VOLUMES
FOR A CHANNELIZED TRINITY RIVER

Year	Oil Field Goods[1]	Scrap[3]	Mill Products[4] in 1965 Survey	All Others[5]	Total Projected Volume
1965	176,100	158,646	252,380	620,801[6]	1,207,927
1966	175,676[2]	162,200	245,105	602,907	1,185,888
1970	173,977	512,951	281,264	657,740	1,625,932
1980	152,474	555,969	396,750	817,642	1,922,835
1985*	144,492	581,254	471,214	911,628	2,108,588
1990	133,741	609,446	546,266	1,016,418	2,305,871
2000	117,288	675,923	734,137	1,263,519	2,790,867
2020	81,450	861,288	1,134,473	1,910,504	3,987,715
2035*	65,160	1,064,050	1,572,379	2,647,959	5,349,548

*Project Years.

[1]Based on Tables 14, 15 and 20. This traffic is approximately 90 per cent upbound.

[2]Estimated as one-fifth of the decline from 1965 to 1970.

[3]Based on Table 28. This traffic is 100 per cent downbound.

[4]Based on Table 29. This traffic is at least 95 per cent upbound.

[5]Based on Galveston District, Corps of Engineers, 1966 Survey of Trinity River Area Inventory. See Tables 9, 10, 11, 12, and 13. "All Other" tonnages were projected based on a long-range population growth of 2.2 per cent compounded annually. For an explanation of "All Other" category see footnote 4 of Table 31. That this is conservative and can be supported see text accompanying Tables 21, 22, 23, 24, 25, 26, and 27. This traffic is approximately 80 per cent (79.6 per cent) upbound.

[6]Calculated as follows:

$$\frac{602{,}907}{\text{1966 AISI Net Shipments of Steel Products (89,995 thousands of net tons)}^{7}} = \frac{\text{X (1965 share in this category)}}{\text{1965 AISI Net Shipments of Steel Products (92,666 thousands of net tons)}^{7}}$$

[7]AISI Annual Statistical Report, 1966, Table 13.

TABLE 30-A

PROJECTION INDEXES OF IRON AND STEEL TRAFFIC VOLUMES
FOR A CHANNELIZED TRINITY RIVER

Year	Oil Field Goods	Scrap	All Mill Products Less Oil Field Goods	All Others	Total Projected Volume
1965	100.0	100.0	100.0	100.0	100.0
1970	98.8	323.3	111.4	105.9	134.6
1980	86.6	350.4	157.2	131.7	159.2
1985	82.0	366.4	186.7	146.8	174.6
1990	75.9	384.2	216.4	163.7	190.9
2000	66.6	426.0	290.1	203.5	231.0
2020	46.2	542.9	449.5	307.7	330.1
2035	37.0	670.7	623.0	426.5	442.9

But, as this report is an attempt to produce logical projections a most conservative approach is not necessarily the best available projection. Conversely, it would serve no useful purpose to calculate projections on the high-side. Obviously a compromise is preferred--but even this should for reasons of defensibility and possible argument be on the low side. Such a project is shown in Tables 31 and 31-A. These figures are the ultimate conclusion of this study and their adoption, for the reasons and logic developed within the study, are urged for incorporation within the fuel study. A recap of these projections is shown in Chapter I, Summary-Conclusions of the study.

TABLE 31

PROJECTIONS OF IRON AND STEEL TRAFFIC VOLUMES FOR A CHANNELIZED TRINITY RIVER
SHOWING ALL MILL PRODUCTS AS REFLECTING RATES OF GROWTH
IN EXCESS OF POPULATION GROWTH RATES

Year	Oil Field Goods[1]	Scrap[2]	All Mill Products[3]	All Mill Products Less Oil Field Goods	All Others[4]	Total Projected Volume
1965	176,100	158,646	(981,096)[5]	804,996[5]	236,306[5]	1,376,048
1966	175,676	162,200	(952,817)	777,141	229,495	1,344,512
1970	173,977	512,951	(1,093,380)	919,403	259,653	1,865,984
1980	152,474	555,969	(1,542,322)	1,389,848	332,377	2,430,668
1985*	144,492	581,254	(1,831,799)	1,687,307	376,053	2,789,106*
1990	133,741	609,446	(2,123,558)	1,989,817	425,468	3,158,472
2000	117,288	675,923	(2,853,178)	2,735,890	544,636	4,073,737
2020	81,450	861,288	(4,409,067)	4,327,617	892,448	6,162,803
2035*	65,160	1,064,050	(6,110,968)	6,045,808	1,292,529	8,467,547*

[1]See footnote 1, Table 30.

[2]See footnote 2, Table 30.

[3]All mill products surveyed and inventories as follows, but less oil field related: Upbound--angles, 30,000 net tons; bars, 54,790; coil, 83,307; pig, 10,400; pipe, 60,012; plates, 140,328; rebars, 600; rods, 18,000; shapes, 62,330; sheets, 69,712; structural, 351,778; tubing, 20,500; and, wire, 4,340. Downbound--structural, 20,700; and, pipe, 26,020. Projected at 3.5 per cent compounded annually, 1965-1985; 3.0 per cent 1985-2000; and 2.2 per cent, 2000 to 2035. Ninety-five per cent of this total is upbound.

[4]Other than mill-type products includes processed, shaped or manufactured items beyond the basic mill form which the Corps of Engineer surveyed and inventoried which might, or might not, increase at rates above the metropolitan population growth rate, but which definitely will move at or in excess of statewide population growth levels. Hence, 2.5 per cent, compounded annually is arbitrarily assumed to be a compromise between the 3.5 rate developed in the text dealing with employment and value added, and the more conservative, minimum, population projections of 2.2 per cent compounded annually.

[5]For method of calculation see footnote 6 of Table 30.

*Project years.

TABLE 31-A

INDEXES FOR PROJECTIONS OF IRON AND STEEL TRAFFIC VOLUMES FOR A CHANNELIZED TRINITY RIVER

SHOWING ALL MILL PRODUCTS AS REFLECTING RATES OF GROWTH

IN EXCESS OF POPULATION GROWTH RATES

Year	Oil Field Goods	Scrap	All Mill Products	All Mill Products Less Oil Field Goods	All Others	Total Projected Volume
1965	100.0	100.0		100.0	100.0	100.0
1970	98.8	323.3		114.2	109.9	135.6
1980	86.6	350.4		172.6	140.6	176.6
1985*	82.0	366.4		209.6	159.1	202.7
1990	75.9	384.2		247.2	180.0	229.5
2000	66.6	426.0		339.9	230.5	296.0
2020	46.2	542.9		537.6	377.7	447.9
2035*	37.0	670.7		751.0	547.0	615.5

*Project Years.

IV. IMPACT OF A RED RIVER CHANNEL ON POSSIBLE TRINITY NAVIGATION

The only obvious impact that the proposed Red River Navigation Channel will have on a Trinity River Shipments will relate to the Lone Star Mill operations at Daingerfield. First of all, the plant is practically on the Red and, secondly, much of Lone Star's market for their N-80, a special grade of tubular goods made especially for deeper wells, is located off of the Louisiana coast.

While Texas production of crude oil has declined relatively, production in other states of significance to future iron and steel traffic on the Trinity, notably Louisiana, has increased both absolutely and relatively. In 1947 Louisiana produced 8.6 per cent of the national total; by 1964 this ratio had increased to 19.8 per cent.[55] Much of the increased Louisiana activity is in relatively deep offshore drilling (see Tables 32 and 33).

The real significance in this Louisiana offshore activity to the Trinity projects lies in the desire on the part of the Lone Star Steel Company at Daingerfield, Texas to be competitive in the offshore servicing centers aligned for the most part along the Intracoastal Waterway (see Map 1). The Lone Star Steel Company now specializes in the production of oil-field goods--well tubing, line pipe, and cast iron pressure pipe--and (toward the end of 1967) the company plans to distribute a special well drilling steel for deep holes known as N-80. The logical market for this product is the Louisiana offshore area. In fact, the company now trucks to pipe stock points at Venice, Houma and Vidalia, Louisiana and to Houston and Corpus Christi, Texas. Lone Star sells in this market because of product rather than price or transportation advantage (see Map 1). The present truck rate of 59.5 cents per ton on a 30,000 pounds minimum and 39.0 cents on a 42,000 pounds minimum, plus a mark-up of $10 a ton over Eastern Mills limits the price-competitive area as shown (see Map 1). However, if a riparian terminal, say on the Red River were to permit barging of Lone Star's deep-well goods and accompanying materials to aforementioned pipe stock points accessible via the Red and Intracoastal Waterway, there to be unloaded or transferred with equipment already at the offshore-drilling supply points listed, then some 70,000 to 100,000 tons of traffic annually in iron and steel oil-field goods might profitably move on the proposed Red Waterway rather than move to the Dallas-Ennis stretch of the Trinity and thence by barge on that waterway to Intracoastal canal points.

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[55] American Petroleum Institute, Petroleum Facts and Figures, 1965, p. 36.

TABLE 32

U. S., TEXAS, AND LOUISIANA CRUDE OIL PRODUCTION
AND PERCENT OF U. S. PRODUCTION
(Thousands of Barrels)

Year	Production			Texas as % of U. S.	Louisiana as % of U. S.
	U. S.	Texas	Louisiana		
1947	1,856,987	820,210	160,128	44.2	8.6
1948	2,020,185	903,498	181,458	44.7	9.0
1949	1,841,940	744,834	190,826	40.4	10.4
1950	1,973,574	829,874	208,965	42.0	10.6
1951	2,247,711	1,010,270	232,281	44.9	10.3
1952	2,289,836	1,022,139	243,929	44.6	10.7
1953	2,357,082	1,019,164	256,632	43.2	10.9
1954	2,314,988	974,275	246,558	42.1	10.7
1955	2,484,428	1,053,297	271,010	42.4	10.9
1956	2,617,283	1,107,808	299,421	42.3	11.4
1957	2,616,901	1,073,867	329,896	41.0	12.6
1958	2,449,016	940,166	313,891	38.4	12.8
1959	2,574,590	971,978	362,666	37.8	14.0
1960	2,574,933	927,479	400,832	36.0	15.6
1961	2,621,758	939,191	424,962	35.8	16.2
1962	2,676,189	943,328	477,153	35.2	17.8
1963	2,752,723	977,835	515,057	35.5	18.7
1964	2,786,822	989,525	549,698	35.5	19.8

SOURCE OF DATA: American Petroleum Institute, <u>Petroleum Facts and Figures</u>.

SOURCE OF TABLE: Houston City Planning Commission, <u>Metropolitan Houston Long-Range Economic Study</u>, Research Paper No. 12, Houston, Texas, December 1966.

TABLE 33

OFFSHORE DRILLING ACTIVITY

LOUISIANA AND TEXAS

1958-1962

Year	Total Wells		Total Footage	
	Louisiana	Texas	Louisiana	Texas
1958	487	19	4,702,522	170,796
1959	475	6	4,868,223	49,612
1960	505	10	5,173,068	94,783
1961	496	7	5,146,476	74,750
1962	725	6	7,535,567	72,139

SOURCE: American Petroleum Institute, Petroleum Facts and Figures, 1963, p. 35.

V. REASONS WHY IRON AND STEEL SHIPPERS WILL USE THE TRINITY WATERWAY

The advantages of a Trinity Waterway to its hinterland iron and steel shippers are both direct and indirect. One of the most direct benefits to iron and steel shippers in both supply and market areas is freight savings. However, and as was pointed out, due to marketing techniques, iron and steel mills may have to absorb these savings in terms of the total price charged; however, in terms of the many, many users, these are real savings that can, and probably will, aid in the area's total economic development.

In addition, the Waterway will serve riparian construction sites, such as bridges, dams, industrial plants with a means of obtaining deliveries of iron and steel at relatively low cost. And, in terms of advantages to iron and steel producers are the following:

1. Chain-rolls from the mills lend themselves to barge mills.

2. Intra-corporate movements of iron and steel are most likely to be considered as an advantage to mills, and other shippers, rather than intercorporate movements where the lower cost water transport means, due to equalization in the marketing technique, that savings must be past on to the ultimate consumer through absorption.

3. It provides a lower rate-ceiling on iron and steel products area-wide.

4. It provides opportunities in-transit storage.

5. It provides ingress and egress for import and export iron and steel.

6. It provides a means of moving "over-sized" commodities.

7. It adds a needed mix to the other modes present in the area.

8. It saves on scarce and valuable industrial land that might otherwise have to be used for rail switching or truck terminals.

9. It will provide a means of moving in-volume scrap and old cars (for fish spawning grounds and coastal storm protection facilities).

10. It will permit some companies to extend their water related markets and/or sources of raw materials and supplies.

APPENDIX A

SERVICE CONTRACT OUTLINING STUDY TO BE MADE

THIS CONTRACT, entered into this 15th day of February 19 67, by the United States of America (hereinafter referred to as the Government) represented by the Contracting Officer executing this contract and Dr. J. Edwin Becht an individually owned organization trading as Dr. J. Edwin Becht, Industrial Location and Market Analyst, in the City of Houston in the State of Texas (hereinafter referred to as the Contractor)

WITNESSETH THAT:

WHEREAS, the accomplishment of the work and services hereinafter described in the manner contemplated herein is authorized by law and

WHEREAS, the Contractor acting personally is specially qualified to perform such work and services and

WHEREAS, it is deemed to be in the best interest of the Government to obtain the assistance of the Contractor in connection with said work and services

NOW, THEREFORE, the parties hereto do mutually agree as follows:

ARTICLE I. Character and Extent of Services. The Contractor shall furnish the following work and services:

For performance of a study and preparation of a report of present movements of iron and steel and their products in area of influence of Trinity River Navigation project and determination of transportation savings realized by use of Trinity River Waterway in lieu of least costly alternative transportation mode as described in appendix "A" attached hereto and made a part hereof.

ARTICLE 2. Changes. - The Contracting Officer may at any time, by a written order, make any changes within the general scope of this contract which may either increase or decrease the work and services hereunder. If such change causes an increase or decrease in the cost of or the time required for performance of this contract, an equitable adjustment shall be made and the contract shall be modified in writing accordingly. Any claim by the Contractor for adjustment under this Article must be asserted within 30 days from the date of receipt by the contractor of the notification of change; Provided, however, that the Contracting Officer, if he decides that the facts justify such action, may receive and act upon any such claim asserted at any time prior to final payment under this contract. Failure to agree to any adjustment shall be a dispute concerning a question of fact within the meaning of the clause of this contract entitled "Disputes." However, nothing in this clause shall excuse the contractor from proceeding with the contract as changed.

ARTICLE 3. Period of Services. The Contractor shall complete all work required under the terms of the contract as follows:

(a) The study and draft of the report shall be completed within 70 calendar days from date of receipt of executed contract.

(b) Based on the approved draft of the report and written notice of approval thereof, the report shall be completed within 14 calendar days.

ARTICLE 4. Compensation to the Contractor. For and in consideration of the services furnished by the Contractor under the provisions of Article 1 of this contract, the Government agrees to pay the Contractor the lump sum of Five thousand, Two hundred, fifty dollars ($5,250.00).

ARTICLE 5. Method of Payment.

(a) Estimates shall be made of the amount and value of work and services performed by the Contractor under this contract of separable end items determined in accordance with Article 1 hereof.

(b) Upon approval of such estimates by the Contracting Officer payment upon properly certified vouchers shall be made to the Contractor as soon as practicable of 90% of the amount as determined above, less all previous payments.

(c) Upon satisfactory completion by the Contractor and acceptance by the Contracting Officer of all work, the Contractor will be paid the unpaid balance of any money due for work under said Article including retained percentages relating to the work.

ARTICLE 6. Requirements for Registration of Designers. The design of architectural, structural, mechanical, electrical, civil or other engineering features of the work shall be accomplished and/or reviewed and approved by architects or engineers registered to practice in the particular professional field involved in a State or possession of the United States or in the District of Columbia.

ARTICLE 7. Drawings and Other Data to Become Property of the Government.-

(a) The contractor agrees that all notes, designs, drawings, specifications and other technical data produced in the performance of this contract shall be the sole property of the Government including all rights therein of whatever kind and whether arising from the common or civil law, equity, or the statutes of the United States of any State thereof.

(b) The contractor agrees that duly authorized representatives of the Government shall have access, at all reasonable time, to inspect and make copies of all notes, designs, drawings, specifications or other technical data pertaining to the work to be performed under this contract.

ARTICLE 8. Contracting Officer's Decisions.- The extent and character of the work and services to be performed by the contractor shall be subject to the general supervision, direction, control and approval of the contracting officer to whom the contractor shall report and be responsible. In the event that there shall be any dispute with regard to the extent and character of the work to be done, the decision of the contracting officer shall govern, but the contractor shall have the right of appeal as provided in Article 9.

ARTICLE 9. Disputes (JAN 1958) (ASPR 7-103.12)

(a) Except as otherwise provided in this contract, any dispute concerning a question of fact arising under this contract which is not disposed of by agreement shall be decided by the Contracting Officer, who shall reduce his decision to writing and mail or otherwise furnish a copy thereof to the Contractor. The decision of the Contracting Officer shall be final and conclusive unless, within 30 days from the date of receipt of such copy, the Contractor mails or otherwise furnishes to the Contracting Officer a written appeal addressed to the Secretary. The decision of the Secretary or his duly authorized representative for the determination of such appeals shall be final and conclusive unless determined by a court of competent jurisdiction to have been fraudulent, or capricious, or arbitrary, or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence. In connection with any appeal proceeding under this clause, the Contractor shall be afforded an opportunity to be heard and to offer evidence in support of his appeal. Pending final decision of a dispute hereunder, the Contractor shall proceed diligently with the performance of the contract and in accordance with the Contracting Officer's decision.

(b) This "Disputes" clause does not preclude consideration of law questions in connection with decisions provided for in paragraph (a) above; Provided, That nothing in this contract shall be construed as making final the decision of any administrative official, representative, or board on a question of law.

ARTICLE 10. Termination.-

(a) The Government may terminate this contract at any time and for any cause by notice in writing from the Contracting Officer to the Contractor. Upon receipt of such notice the Contractor shall, unless the notice directs otherwise, immediately discontinue all work and services.

(b) If the contract is terminated for the convenience of the Government, payment to the Contractor will be made promptly for that proportion of the work and services required under the contract which the work and services actually performed bear to the total work and services required under the contract, less any payment previously made.

(c) If this contract is terminated because of the failure on the part of the Contractor to fulfill his undertakings under this contract, the Government may take over the work and services and prosecute the same to completion by contract or otherwise, and the Contractor shall be liable to the Government for any excess cost occasioned to the Government thereby.

ARTICLE 11. Officials not to Benefit.- (Jul 49) (ASPR 7-103.19)

No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this contract if made with a corporation for its general benefit.

ARTICLE 12. Covenant against Contingent Fees (Jan 58) (ASPR 7-103.20)

The Contractor warrants that no person or selling agency has been employed or retained to solicit or secure this contract upon an agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bonafide established commercial or selling agencies maintained by the Contractor for the purpose of securing business. For breach or violation of this warranty the Government shall have the right to annul this contract without liability or in its discretion to deduct from the contract price or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage or contingent fee.

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ARTICLE 14. Convict Labor.- (March 1949) (ASPR 12-203)

In connection with the performance of work under this contract, the Contractor agrees not to employ any person undergoing sentence of imprisonment at hard labor.

ARTICLE 15. Assignment of Claims.- (Feb 62) (ASPR 7-103.8)

(a) Pursuant to the provisions of the Assignment of Claims Act of 1940, as amended (31 U.S.C. 203, 41 U.S.C. 15), if this contract provides for payment aggregating $1,000 or more, claims for monies due or to become due the Contractor from the Government under this contract may be assigned to a bank, trust company, or other financing institution, including any Federal lending agency, and may thereafter be further assigned and reassigned to any such institution. Any such assignment or reassignment shall cover all amounts payable under this contract and not already paid, and shall not be made to more than one party, except that any such assignment or reassingment may be made to one party as agent or trustee for two or more parties participating in such financing. Unless otherwise provided in this contract, payments to an assignee of any monies due or to become due under this contract shall not, to the extent provided in said Act, as amended, be subject to reduction or set-off.

(b) In no event shall copies of this contract or of any plans, specifications, or other similar documents relating to work under this contract, if marked "Top Secret," "Secret," or "Confidnetial," be furnished to any assignee of any claim arising under this contract or to any other person not entitled to receive the same. However, a copy of any part or all of this contract so marked may be furnished, or any information contained therein may be disclosed, to such assignee upon the prior written authorization of the Contracting Officer.

ARTICLE 16. Interest (May 1963) (ASPR App. E-620)

Notwithstanding any other provision of this contract, unless paid within 30 days all amounts that become payable by the Contractor to the Government under this contract (net of any applicable tax credit under the Internal Revenue Code) shall bear interest at the rate of six percent per annum from the date due until paid and shall be subject to adjustments as provided by Part 6 of Appendix E of the Armed Services Procurement Regulation, as in effect on the date of this contract. Amounts shall be due upon the earliest one of (i) the date fixed pursuant to this contract, (ii) the date of the first written demand for payment, consistent with this contract, (iii) the date of transmittal by the Government to the Contractor of a proposed supplemental agreement to confirm completed negotiations fixing the amount, or (iv) if this contract provides for revision of prices, the date of written notice to the Contractor stating the amount of refund payable in connection with a pricing proposal or in connection with a negotiated pricing agreement not confirmed by contract supplement.

ARTICLE 17. Definitions.- (Apr. 65) (ECI 7-070 and ASPR 7-602.1)

(a) The term "Head of the Agency" or "Secretary" as used herein means the Secretary of the Army; and the term "his duly Authorized Representative" means the Chief of Engineers, Department of the Army, or an individual or board designated by him.

(b) The term "Contracting Officer" as used herein means the person executing this contract on behalf of the Government and includes a duly appointed successor or authorized representative.

ARTICLE 18. Examination of Records.- (FEB 62) (ASPR 7-104.15)

(a) The Contractor agrees that the Comptroller General of the United States or any of his duly authorized representatives shall, until the expiration of three years after final payment under this contract, have access to and the right to examine any directly pertinent books, documents, papers and records of the Contractor involving transactions related to this contract.

(b) The Contractor further agrees to include in all his subcontracts hereunder a provision to the effect that the subcontractor agrees that the Comptroller General of the United States or any of his duly authorized representatives shall until the expiration of three years after final payment under the subcontract have access to and the right to examine any directly pertinent books, documents, papers, and records of such subcontractor, involving transactions related to the subcontract. The term "subcontract" as used in this clause excludes (i) purchase orders not exceeding $2,500 and (ii) subcontracts or purchase orders for public utility services at rates established for uniform applicability to the general public.

ARTICLE 19. Gratuities.- (MAR 1952) (ASPR 7-104.16)

(a) The Government may, by written notice to the Contractor, terminate the right of the Contractor to proceed under this contract if it is found, after notice and hearing by the Secretary or his duly authorized representative, that gratuities (in the form of entertainment, gifts or otherwise) were offered or given by the Contractor, or any agent or representative of the Contractor, to any officer or employee of the Government with a view toward securing a contract or securing favorable treatment with respect to the awarding or amending or the making of any determinations with respect to the performing of such contract, Provided, that the existence of the facts upon which the Secretary or his duly authorized representative makes such findings shall be in issue and may be reviewed in any competent court.

(b) In the event this contract is terminated as provided in paragraph (a) hereof, the Government shall be entitled (i) to pursue the same remedies against the Contractor as it could pursue in the event of a breach of the contract by the Contractor, and (ii) as a penalty in addition to any other damages to which it may be entitled by law, to exemplary damages in an amount (as determined by the Secretary or his duly authorized representative) which shall be not less than three nor more than ten times the costs incurred by the Contractor in providing any such gratuities to any officer or employee.

(c) The rights and remedies of the Government provided in this clause shall not be exclusive and are in addition to any other rights and remedies provided by law or under this contract.

ARTICLE 21. Renegotiation.-(Oct 59)(ASPR 1-703.13)

(a) To the extent required by law, this contract is subject to the Renegotiation Act of 1951 (50 USC App. 1211, et seq), as amended, and to any subsequent act of Congress providing for the renegotiation of contracts. Nothing contained in this clause shall impose any renegotiation obligation with respect to this contract or any subcontract hereunder which is not imposed by an act of Congress heretofore or hereafter enacted. Subject to the foregoing. this contract shall be deemed to contain all the provisions required by Section 104 of the Renegotiation Act of 1951, and by any such other act, without subsequent contract amendment specifically incorporating such provisions.

(b) The Contractor agrees to insert the provisions of this clause, including this paragraph (b) in all subcontracts, as that term is defined in Section 103g of the Renegotiation Act of 1951, as amended.

ARTICLE 22. Alterations in Contract.-(Jul 49)(ASPR 7-105.1)

The following alterations have been made in provisions of this contract:

ARTICLE 13. Equal Opportunity was deleted.

ARTICLE 20. Accident Prevention was deleted.

IN WITNESS WHEREOF, the parties hereto have executed this contract as of the day and year first above written.

THE UNITED STATES OF AMERICA

BY ____________________
(Contracting Officer)
JOHN A. BRIGANCE
Contracting Officer

WITNESSES:

____________________ DR. J. EDWIN BECHT, INDUSTRIAL AND
(Contractor) MARKET ANALYST

____________________ By ____________________
(Address)

____________________ Title Owner

____________________ ____________________
(Address) (Address)

I, ____________________, certify that I am the secretary of the corporation named as Contractor herein; that ____________________ who signed this contract on behalf of the Contractor; was then ____________________ of said corporation; that said contract was duly signed for and on behalf of said corporation by authority of its governing body, and is within the scope of its corporate powers.

(CORPORATE SEAL)

____
(Secretary)

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1

1. AMENDMENT/MODIFICATION NO.	P001
2. EFFECTIVE DATE	25 Oct 1967
3. REQUISITION/PURCHASE REQUEST NO.	
4. PROJECT NO. (If applicable)	
5. ISSUED BY CODE	Department of the Army Galveston District, Corps of Engineers P. O. Box 1229 Galveston, Texas 77550
6. ADMINISTERED BY (If other than block 5) CODE	
7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) CODE / FACILITY CODE	Dr. J. Edwin Becht 815 South Pearl Macomb, Illinois 61455
8.	☐ AMENDMENT OF SOLICITATION NO. ____ DATED ____ (See block 9) ☒ MODIFICATION OF CONTRACT/ORDER NO. DACW64-67-C-0060 DATED 15 Feb 1967 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

96X3122 Construction General, Corps of Engineers, Civil

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ____

The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of 10 U. S. C. 2304 (a) (4)

It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

This Contract for Iron and Steel Special Study, Trinity River Waterway, Texas, is modified as follows:

1. Statement of Change: The Contractor shall accomplish the following changes in strict accordance with the basic contract as modified and as directed by the Contracting Officer:

(1.) Appendix "A"

a. Paragraph 2a.(1). The following paragraph shall be added:

"(d) An appropriate special projection indicator will be developed, and fully discussed, for projecting oil-related steel used, produced, or fabricated in the Trinity River trade area. A draft of this study will be furnished the Contracting Officer for review prior to insertion in the basic report for completion."

b. Paragraph 2a.(2). The following paragraph shall be added:

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN the original COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR Dr. J. Edwin Becht BY J. Edwin Becht (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY John A. Brigance (Signature of Contracting Officer)
15. NAME AND TITLE OF SIGNER (Type or print) J. E. BECHT	18. NAME OF CONTRACTING OFFICER (Type or print) JOHN A. BRIGANCE Contracting Officer
16. DATE SIGNED 11/1/67	19. DATE SIGNED 17 Nov 67

30-101-01

Modification No. P001 to
Contract No. DACW64-67-C-0060

"(c) The Red River channel to Daingerfield, Texas, shall be considered an alternate route to the Trinity River. Traffic moving via this route shall be evaluated and fully discussed."

(2.) The report shall be revised by deleting the following items required in Appendix "A" of the contract:

a. Paragraph 1. Scope of Work. In the fourth line, place a period after the word "project," and delete the remainder of the paragraph.

b. Paragraph 2. Nature of Work. Subparagraph 2a.(2)(b) shall be deleted.

c. Paragraph 2. Nature of Work. Subparagraph 2b.(2)(b) shall be deleted.

2. As a result of this modification, the amount of the Contract is increased in the amount of $2,225.00.

3. Additional time will be allowed for the work required under this modification, establishing the completion time under Article 3(b) as on or before 20 November 1967.

Attached to and made a part of
Contract No. DACW64-67-C-0060

APPENDIX A

IRON AND STEEL SPECIAL STUDY

1. Scope of Work.-

The work to be accomplished under the contract consists of performance of a study and preparation of a report of the present movements of iron and steel and their products that are consumed in the area of influence of the Trinity River navigation project, and determination of savings in transportation costs of these commodities that would be realized by use of a navigation channel in the Trinity River in lieu of the least costly alternative transportation mode.

2. Nature of Report.-

a. Iron and Steel Products.- The study will develop separately the data on iron and steel products used in the oil and gas industry and those used in the construction and related industry. In support of the data presented in the report, the study shall include the following items:

(1) Information obtained by interview with industry representatives and from published sources regarding:

(a) Present sources of supply of iron and steel products including approximate quantities from each source;

(b) Relative use of iron and steel products in the oil and gas industry and construction and related industry;

(c) A discussion of appropriate methods of estimating future levels of consumptive use of iron and steel products in the oil and gas industry, including correlation, if any, with the production of oil and gas from present reserves.

(2) Analyses showing:

(a) Transportation rates for movements from present sources and modes of transportation used;

(b) Savings in transportation costs to be obtained in these movements by use of the proposed waterway in transporting these materials.

b. Iron and Steel Production.- In support of the data presented in the report, the study shall include the following items:

(1) Information obtained by interview with industry representatives and from published sources regarding: present sources of raw materials including ore, coking coal, fluxing materials, scrap, and iron and steel billets or pigs.

(2) Analyses showing:

(a) Transportation rates for movements from present sources and modes of transportation used;

(b) Savings in transportation costs to be obtained in these movements by use of the proposed waterway in transporting these materials. (3) Analyses of Corps of Engineer data.

3. Submission of Report.

The report resulting from the studies described herein shall be submitted as follows:

a. Three typewritten draft copies, containing bibliography and source reference notations will be submitted for review;

b. Final copy will be in typewritten form suitable for reproduction by photographic copying;

c. Any plates and tables included in the report will be suitable for reproduction by photographic copying;

d. All materials and finished products to be furnished under this contract will be delivered f.o.b., District Engineer, Galveston District, Corps of Engineers, P. O. Box 1229, Galveston, Texas, 77550, ATTN: Project Evaluation Section.

4. Review and Acceptance of Report.-

a. The draft report specified above shall be reviewed by the Contracting Officer prior to acceptance by the Government.

b. The final report will be submitted for acceptance by the Government after necessary corrections disclosed by review of the draft have been made and additions required by the Contracting Officer have been included in the report.

APPENDIX B

COMPUTATION OF TEXAS' SHARE PERCENTAGE OF OIL COUNTRY IRON AND STEEL PRODUCTS

1966

Texas

Production:

Crude	Texas / Nation	1,073,295[1] / 3,038,999	= 35.3%	
Gas	Texas / Nation	10,250,137 / 19,682,722	= 52.1%	
LPG	Texas / Nation	6,359,870 / 12,134,294	= 52.4%	
Production Average				= 46.6%

Drilling Activity:

Wells Completed	Texas / Nation	11,109 / 37,881	= 29.3%
Crude Oil Run by Refineries	Inland / Gulf	921,619,000 / 3,447,193,000	= 26.2%

AISI (oil country) 1,413,023[2] 480,428[3] $\frac{1021}{3}$ = 34.0%

[1]American Petroleum Institute Biannual Facts and Figures 1965 (and by telephone call with Griskvitch and Edland of the API's New York office for 1965 and 1966 data).

[2]Annual Statistical Report. American Petroleum Institute, 1966.

[3]Texas share of AISI oil country products in net tons.

1965[1]

Texas

Production:

Crude	Texas / Nation	1,000,749 / 2,848,514	= 35.1%		
Gas	Texas / Nation	9,629,072 / 18,545,337	= 51.9%		
LPG	Texas / Nation	5,847,601 / 11,257,267	= 51.9%		
Production Average				=	46.3%

Drilling Activity:

Wells Completed	Texas / Nation	12,741 / 41,432	=	30.8%
Crude Oil Run	Inland / Gulf	889,679,000 / 3,300,842,000	=	27.0%

AISI (oil country)	1,573,696	546,073	1041 / 3	=	34.7%

[1]See 1966 for detailed footnotes.

1964

Texas

Production:

Crude	Texas / Nation	989,525 / 2,786,822	= 35.4%	
Gas	Texas / Nation	9,001,407 / 17,634,367	= 51.0%	
LPG	Texas / Nation	5,461,252 / 10,619,309	= 51.4%	
Production Average				= 46.0%

Drilling Activity:

Wells Completed	Texas / Nation	13,152 / 45,286	= 29.1%		
Crude Oil Run by Refineries	Inland / Gulf	898,023 / 3,241,632	= 27.7%		
AISI (oil country)	1,636,508	561,322	1028 / 3	= 34.3%	

1963

Texas

Production:

Crude	Texas / Nation	977,835 / 2,752,723	= 35.5%	
Gas	Texas / Nation	3,320,416 / 6,534,967	= 50.8%	
LPG	Texas / Nation	5,366,831 / 10,302,250	= 52.0%	
Production Average				= 46.1%

Drilling Activity:

Wells Completed	Texas / Nation	12,900 / 41,386	= 31.1%	
Crude Oil Run by Refineries	Inland / Gulf	876,529 / 3,170,652	= 27.6%	
AISI (oil country)	1,494,493	521,578	1048 / 3	= 34.9%

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1962

Texas

Production:

Crude	Texas / Nation	943,328 / 2,676,189	= 34.2%
Gas	Texas / Nation	3,205,517 / 6,244,522	= 51.3%
LPG	Texas / Nation	5,012,291 / 9,409,083	= 53.3%

Production Average = 46.3%

Drilling Activity:

Wells Completed	Texas / Nation	14,297 / 43,779	= 32.7%	
Crude Oil Run by Refineries	Inland / Gulf	837,820 / 3,069,631	= 27.3%	
AISI (oil country)	1,502,736	531,969	1063 / 3	= 35.4%

1961

Texas

Production:

Crude	Texas / Nation	939,191 / 2,621,758	= 35.8%		
Gas	Texas / Nation	3,111,427 / 6,105,463	= 51.0%		
LPG	Texas / Nation	4,768,222 / 9,085,465	= 52.5%		
Production Average				= 46.4%	

Drilling Activity:

Wells Completed	Texas / Nation	14,259 / 43,871	= 32.5%		
Crude Oil Run by Refineries	Inland / Gulf	798,914 / 2,987,158	= 26.7%		
AISI (oil country)	1,521,701	535,639	1056 / 3	= 35.2%	

1960

Texas

Production:

Crude	Texas / Nation	927,479 / 2,574,933	= 36.0%	
Gas	Texas / Nation	2,880,906 / 5,842,507	= 49.3%	
LPG	Texas / Nation	4,476,142 / 8,444,074	= 53.0%	
Production Average				= 46.1%

Drilling Activity:

Wells Completed	Texas / Nation	15,174 / 44,018	= 34.5%		
Crude Oil Run by Refineries	Inland / Gulf	801,775 / 2,952,534	= 27.2%		
AISI (oil country)	1,197,134	429,771	1078 / 3	= 35.9%	

1959

Texas

Production:

Crude	Texas / Nation	971,978 / 2,574,590	= 37.8%	
Gas	Texas / Nation	2,790,155 / 5,597,102	= 49.8%	
LPG	Texas / Nation	4,353,368 / 7,874,706	= 55.3%	
Production Average				= 47.6%

Drilling Activity:

Wells Completed	Texas / Nation	18,123 / 50,094	= 36.2%
Crude Oil Run by Refineries	Inland / Gulf	777,758 / 2,917,661	= 26.7%

AISI (oil country)	2,066,661	760,531	1105 / 3	= 36.8%

1958

Texas

Production:

Crude	Texas / Nation	940,166 / 2,449,016	= 38.4%	
Gas	Texas / Nation	2,871,589 / 5,596,458	= 51.3%	
LPG	Texas / Nation	3,786,575 / 6,783,000	= 55.8%	
Production Average				= 48.5%

Drilling Activity

Wells Completed	Texas / Nation	17,721 / 47,758	= 37.1%
Crude Oil Run by Refineries	Inland / Gulf	735,839 / 2,789,404	= 26.4%

AISI (oil country)	1,158,116	431,977	$\frac{1120}{3}$	= 37.3%

1957

Texas

Production:

Crude	Texas / Nation	1,073,867 / 2,616,701	= 41.0%
Gas	Texas / Nation	2,944,381 / 5,734,307	= 51.3%
LPG	Texas / Nation	3,831,664 / 6,655,282	= 57.6%

Production Average = 50.0%

Drilling Activity:

Wells Completed	Texas / Nation	21,173 / 52,777	= 40.1%
Crude Oil Run by Refineries	Inland / Gulf	786,851 / 2,890,436	= 27.2%
AISI (oil country)	2,822,854	1,103,736	$\frac{1173}{3}$ = 39.1%

APPENDIX C

SHIPMENTS OF STEEL MILL PRODUCTS IN 1965 INTO A SELECTED AREA IN TEXAS AND OKLAHOMA, ALL GRADES, NET TONS

Shipments of Steel Mill Products in 1965
Into a Selected Area* in Texas and Oklahoma,
All Grades, Net Tons[1]

Gross Shipments into Area:	Net Tons
All Grades	
Oil Country Goods	149,707
All Other Steel Mill Products	707,605
Total	857,312

*Note: Counties included in area are listed on attachment.

[1]SOURCE: Letter from Lawrence B. Jones, Chairman of the Board, Mosher Steel Company addressed to Colonel John Unverferth, District Engineer, Galveston District, Corps of Engineers, Post Office Box 1229, Galveston, Texas 77550, dated April 13, 1967.

TRINITY RIVER TRADE AREA BY COUNTIES - TEXAS

Anderson
Andrews
Angelina
Archer
Armstrong
Bailey
Baylor
Borden
Bosque
Bowie
Briscoe
Brown
Callahan
Camp
Carson
Cass
Castro
Chambers
Cherokee
Childress
Clay
Cochran
Coke
Coleman
Collin
Collingsworth
Comanche
Concho
Cooke
Coryell
Cottle
Crosby
Dallam
Dallas
Dawson
Deaf Smith
Delta
Denton
Dickens
Donley
Eastland
Ellis
Erath
Falls
Fannin
Fisher
Floyd
Foard
Franklin
Freestone
Gaines
Garza
Glasscock
Gray
Grayson
Gregg
Hale
Hall
Hamilton
Hansford
Hardeman
Hardin
Harrison
Hartley
Haskell
Hemphill
Henderson
Hill
Hockley
Hood
Hopkins
Houston
Howard
Hunt
Hutchinson
Jack
Johnson
Jones
Kaufman
Kent
King
Knox
Lamar
Lamb
Leon
Liberty
Limestone
Lipscomb
Lubbock
Lynn
McLennan
Madison
Marion
Martin
Midland
Mills
Mitchell
Montague
Moore
Morris
Motley
Nacogdoches
Navarro
Nolan
Ochiltree
Oldham
Palo Pinto
Parker
Parmer
Polk
Potter
Rains
Randall
Red River
Roberts
Robertson
Rockwall
Runnels
Rusk
San Jacinto
Scurry
Shakelford
Sherman
Smith
Somervell
Stephens
Sterling
Stonewall
Swisher
Tarrant
Taylor
Terry
Throckmorton
Titus
Tom Green
Trinity
Tyler
Upshur
Van Zandt
Walker
Wheeler
Wichita
Wilbarger
Wise
Wood
Yoakum
Young

TRINITY RIVER TRADE AREA BY COUNTIES - OKLAHOMA

Atoka
Beckham
Blaine
Bryan
Caddo
Carter
Choctaw
Coal
Comanche
Cotton
Custer
Dewey
Ellis
Garvin
Grady
Greer
Harmon
Jackson
Jefferson
Johnston
Kiowa
Love
Marshall
McClain
Murray
Pontotoc
Roger Mills
Stephens
Tillman
Washita

BIBLIOGRAPHY

A. BOOKS AND PERIODICALS

Adams, Walter. The Structure of American Industry. New York: The MacMillan Company, 1964.

American Iron and Steel Institute. Charting Steel's Progress During 1957-66. New York, New York, July, 1966.

American Iron and Steel Institute--Market Reports.

__________. Steel's Competitive Challenge. New York, New York, 1961.

American Petroleum Institute Facts and Figures 1957-1965 (Biannually).

The American Waterways Operators, Incorporated. Inland-Water Borne Commerce Statistics. Washington, D. C., 1966.

Arbingast, Stanley A. "Texas Industrial Expansion, 1966," Texas Business Review. Austin, Texas, February, 1967.

__________, and others. Texas Industrial Expansion, 1967. Bureau of Business Research. Austin, Texas: University of Texas, April, 1967.

Armco Steel Corporation. Armco Today. Middletown, Ohio, 1967.

Baytown Sun. "Armco Houston Story Thrilling." January 23, 1967.

Becht, J. Edwin. "The Fulshear Line," Business Review. Houston, Texas: University of Houston, Summer, 1966.

Blough, Roger M. "United States Steel To Build New Mill Off Ship Channel," Houston Magazine. Houston, February, 1966.

Bruce, Grady B. "The Future Texas Economy: An Overview," Texas Business Review, Bureau of Business Research. Austin, Texas: University of Texas, May 1966.

Bucknall, Eric H. "Texas Metals, Metal Industries and Metallurgy," Notes on The Industrialization of Texas, Series 11. Bureau of Business Research. Austin, Texas: The University of Texas, 1965.

Bureau of Business Research. Water For the Future, Vol. I-IV. Austin, Texas: Bureau of Business Research, University of Texas, August 1, 1956.

Business Week. Special Report. "Homebuilding's Happy Future," May 6, 1967.

Egger, Gerald. "U. S. Steel to Add to Site For Plant," Houston Post, Houston, Texas, February 22, 1966.

Escott, Florence. 1965 Industrial Atlas of Texas. Bureau of Business Research. Austin, Texas: University of Texas, 1965.

Fish, Sydney. "Steel Firms Investing Millions in New Plants, The Journal of Commerce. New York: January 24, 1966.

Hartman, Fred. "Armco Steel Plans $25 Million Expansion in Houston by 1968," Houston Post. Houston, Texas: February 18, 1966.

Houston Chronicle. "Armco Steel to Install Third Electric Furnace." January 18, 1967.

Houston City Planning Commission. Industry Reports No. 102, Metropolitan Houston Long-Range Economic Study. Houston, Texas: December, 1966.

Interstate Commerce Commission. Seventy-Eighth Annual Report on Transport Statistics in the United States, 1964 and 1965. Washington, D. C.: Superintendent of Documents, U. S. Government Printing Office, 1965 and 1966.

Ledbetter, Jack W. "Governmental Construction Projects in Texas," Notes on the Industrialization of Texas, Series 9, Bureau of Business Research. Austin, Texas: University of Texas, 1963.

McDonald, Stephen L. "Recent Economic Development and Change in the Structure of Manufacturing Employment in the Southwestern States," Texas Business Review, Bureau of Business Research. Austin, Texas: University of Texas, April, 1966.

Mitchell, A. Cameron. "Setting the Texas Allowables," Series No. 10, Notes on the Industrialization of Texas. Bureau of Business Research. Austin, Texas: University of Texas, 1964.

Port of Houston. Foreign Trade Statistics, 1958-1966. Houston, Texas: 1966.

Powers, Hugh. "U. S. Steel to Build Huge Plant on the Trinity," Houston Chronicle. December 7, 1965.

Robertson, Donald E. "Texas Building Construction in December 1966," Texas Business Review, Bureau of Business Research. Austin, Texas: University of Texas, February, 1967.

Rogers, Wesley A. Waterways Freight Bureau, Freight Tariff No. 3-B. November 1, 1964.

Stockton, John R. 1963 Chartbook of Texas Business, Bureau of Business Research. Austin, Texas: University of Texas, 1964.

Texas Almanac. 1966-1967.

Texas Highway Department and United States Department of Commerce, Bureau of Public Roads. Dallas-Ft. Worth Regional Transportation Study, 1964, Vol. I. Austin, Texas: 1964.

Texas Research League. Texas State Highway Needs, 1956-1975. Austin, Texas: 1957.

Weiner, Sam. "Armco Growth to Cost Millions, Add 500 Jobs," Houston Post. February 18, 1966.

__________. "Second Blast Furnace at Armco Mill Charted," Houston Post. February 26, 1967.

Whitman, Robert A. Iron and Steel. Reprint from the 1965 Bureau of Mines, Minerals Yearbook, United States Department of Interior. Washington, D. C.: United States Government Printing Office, 1966.

Williamson, Robert B. "Texas Foreign Trade," Texas Business Review, Bureau of Business Research. Austin, Texas: University of Texas, January, 1967.

United States Department of Commerce. The Biennial Supplement to the Survey of Current Business, Business Statistics. Washington, D. C.: United States Government Printing Office.

__________. Growth Patterns in Employment by County, 1940-1950 and 1950-1960, Volume 6 Southwest. Washington, D. C.: United States Government Printing Office, 1965.

__________. *Industrial Scrap Generation, Iron and Steel, Copper, Aluminum.* Washington, D. C.: United States Government Printing Office, 1957.

__________. *Iron and Steel Scrap Consumption Problems.* Washington, D. C.: United States Government Printing Office, 1966.

__________. *U. S. Industrial Outlook.* Washington, D. C.: United States Government Printing Office, 1966.

__________, Bureau of the Census. *1963 Census of Manufacturers, Texas,* Washington, D. C.: United States Government Printing Office, November, 1966.

B. INTERVIEWS

Archer, Marvin. General Traffic Manager, Mosher Steel Company, Houston, Texas.

Aronoff, Herbert R. Former Manager, Luria Bros. and Company, Incorporated, Houston, Texas.

Arnoff, Philip. Assistant to the President, Steelmet (Scrap Exporters), Houston, Texas.

Barrilleaux, Mel A. Transportation Consultant, Houston, Texas.

Brewer, Robert. Director of Industrial Development, Chamber of Commerce, Houston, Texas.

Byer, Sid. President and owner, Houston Compressed Steel Company and Byer's Barge Terminal, Houston, Texas.

Carlisle, Gordon. Traffic Manager, Dixie Carriers, Inc., Houston, Texas.

Carpenter, Ben. President, Trinity River Improvement Association, Dallas, Texas.

Chapman, James. Public Relations Department, Humble Oil and Refining Company, Houston, Texas.

Cirillo, J. F., Sr. Rate Clerk, Republic Steel Corporation, Houston, Texas.

Colwell, Harry E. Traffic Manager, Texaco, Incorporated, Houston, Texas.

Davis, B. J. Assistant Traffic Manager, Republic Steel Corporation, Cleveland, Ohio.

Davis, L. N., Assistant Chief, Iron and Steel Section, Department of Commerce, Washington, D. C.

Fincher, W. E. General Manager, Houston Port Bureau, Houston, Texas.

Graves, Guy D. Manager, Houston Barge Terminal, Houston, Texas.

Hill, Gifford. Traffic Manager, American Manufacturing Company, Houston, Texas.

Jones, Lawrence B. Chairman of the Board, Mosher Steel Company, Dallas, Texas.

Kelly, Merle. D. F. and P. A., Southern Pacific Company, Houston, Texas.

Kenfield, Frank B. Manager, Transportation Department, Houston Chamber of Commerce, Houston, Texas.

Layton, John B. Rate Clerk, National Supply Division, Armco Steel Company, Houston, Texas.

Maddox, Joe E. Assistant Manager, Blast Furnace, Armco Steel Corporation, Houston, Texas.

Martin, Howard. Director of Research, Chamber of Commerce, Houston, Texas.

Newton, Robert. Assistant Traffic Manager, United States Steel Corporation, Houston, Texas.

Peterson, R. D. Chief, Iron and Steel Section, Department of Commerce, Washington, D. C.

Powell, Ernest M. S. W. District Traffic Manager, Republic Steel Corporation, Houston, Texas.

Reed, . Manager Sales, Houston Office, Lone Star Steel Company, Houston, Texas.

Rogers, Wesley A. Chairman, Waterways Freight Bureau, Washington, D. C.

Slotwinski, Edwin F. Manager, Traffic and Transportation, Armco Steel Company, Houston, Texas.

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TRINITY RIVER AND TRIBUTARIES, TEXAS

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REEVALUATION OF NAVIGATION FEATURES

EXHIBIT 4
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INTRODUCTION

1. Purpose.- The purpose of this study is to reevaluate the benefits from the recreation and fish and wildlife features associated with the navigation increment of the authorized multiple-purpose channel on the Trinity River, as described in House Document No. 276, 89th Congress, 1st Session.

2. Scope.- All recreation and fish and wildlife features of the authorized multiple-purpose channel were not reevaluated. Pertinent information presented in H. D. 276/89/1 has been utilized with modifications in consonance with the present plan of improvement. Variations included in the study are listed as follows:

a. The increased channel and lock sizes as discussed in paragraph 4b.

b. Elimination of certain locks as discussed in paragraph 4c.

c. The navigation features of the plan have been considered operational by 1985, in lieu of 1975.

d. The economic life of the project is based on 50 years amortization period, in lieu of a 100-year period.

In accordance with the above changes, the reevaluation is presented to show the recreation and fish and wildlife net benefits for the multiple-purpose channel with and without the navigation feature.

3. Nature of Investigation and Source of Data.- Information and data contained in volume V, House Document No. 276/89/1 have been reevaluated in consonance with more current information and data. Additional data also were utilized including material contained in appendix D, supplemental to the General Design Memorandum for the Tennessee-Tombigbee Waterway, prepared by the Mobile District in 1966, results of recreation user surveys conducted at Corps projects in the Southwestern Division, including the Fort Worth

District, during the years 1963 through 1966, pertinent project data from Galveston District files, and information and data obtained from representatives of the Bureau of Sport Fisheries and Wildlife Bureau of Outdoor Recreation, and the Texas Parks and Wildlife Department.

4. Project Document Plan and Proposed Departures Therefrom.-

a. The authorized project provides for a multiple-purpose channel for navigation, flood control, recreation and fish and wildlife purposes extending from the Houston Ship Channel along the general course of the Trinity River to Fort Worth, Texas. The channel would have minimum navigable dimensions of 12 feet deep by 150 feet wide and provide for future enlargement to a minimum navigation channel width of 200 feet. The authorized plan provides for 19 locks below Dallas, each having dimensions of 84 feet wide by 600 feet long, and 4 locks between Dallas and Fort Worth each 56 feet wide by 400 feet long. There would also be two turning basins each 400 feet square, at Dallas and Fort Worth.

b. As a result of restudy of the navigation feature, it is now proposed that the minimum channel width be increased to 200 feet, with provisions for future enlargement to 270 feet. The four locks between Dallas and Fort Worth will be increased from 56 feet wide to 84 feet wide by 400 feet long.

c. As a further result of the restudy of the navigation features, it is proposed to eliminate locks numbers 2, 8, and 15 from the navigation channel below Dallas, with appropriate changes in the design and location of the 16 remaining locks below Dallas. This would result in a total of 20 locks for the proposed navigation channel. Recreation visitors and recreation benefits will not be appreciably affected by deletion of locks 2, 8, and 15 because the shoreline, water area, and access thereto will remain unchanged for all practical purposes. The general public desiring to visit lock sites will still be able to do so, since there will be ample access to the proposed remaining locks.

RECREATION RESOURCES OF THE NAVIGATION CHANNEL

5. General.- The plan of operation of the 370-mile waterway would provide for a minimum channel width of 200 feet and a minimum depth of 12 feet. The channel would pass through three reservoir projects; namely, Wallisville, Livingston, and Tennessee Colony, all on the main stem of the Trinity River. Twenty locks and 18 navigation dams, exclusive of the Wallisville, Livingston, and Tennessee Colony Dams, would be constructed on the multiple-purpose channel. These navigation dams would be constructed at the upper end of each river cutoff where the course of the existing

river would be changed due to construction of the multiple-purpose channel. Many of these river cut-offs, especially below the proposed Tennessee Colony Dam, 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. About 10,700 surface acres of water would be provided in the channel at the tops of the normal operating pools for navigation purposes. Furthermore, about 6,600 additional acres would be inundated in the cut-offs between the locks and dams numbered 1 through 12 when water in the completed multiple-purpose channel is at its normal operating levels for navigation purposes. It is proposed to fill all the cut-offs upstream from lock and dam number 13 with spoil material resulting from excavation of the 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 17,300 surface acres of impounded water are not expected to attract as many visitors for recreation activities as a similar size reservoir project. However, it is expected that within 23 years (2008) the channel will attract 6,000,000 visitors annually desiring to observe the passage of floating equipment through the locks, to navigate the channel for sport and pleasure, and to fish. At the present time water in the river channel between Fort Worth and Dallas and for some distance below Dallas is not of suitable quality for recreational purposes. The comprehensive Trinity River improvement plan authorized by Congress includes measures for improvement of water quality through recirculation of water from Tennessee Colony Reservoir to the river in the vicinity of Fort Worth. The State of Texas is now developing an overall state water plan involving interbasin transfers of water, which may involve a portion of the Trinity and require some modification of the water quality improvement measures of the authorized comprehensive improvement plan for the Trinity Basin. However, with the current emphasis at national, state, and local levels concerning the necessity for controlling pollution and achieving suitable quality in all major streams, there can be little doubt that water quality suitable for recreation will prevail in the Trinity during the project life period of the navigation project. The navigation project, in itself, will not degrade water quality. Conversely, some improvement could be expected from the project because of the improved hydraulic characteristics of the stream and the transport of water along the stream during low flow periods through lockage of vessels. Appropriate facilities will be developed along the channel to provide for the recreational use described above, including access roads, parking areas, picnicking, camping, boat launching, boat storage, and other commercial services and goods. For planning purposes, facilities located on or adjacent to the channel for the storage and servicing of pleasure craft, as well as providing needed services for the general public such as fuel, food, drinks, etc. should be spaced at about 30-mile intervals.

6. Fish and Wildlife.- In January 1963, the Fish and Wildlife Service prepared a supplement to its report which is included in House

Document No. 276/89/1. In this supplement, it was concluded that construction of the navigation channel would benefit sport fishing, and navigation features of the project would not result in significant changes to other fish and wildlife values. Based on subsequent discussions with representatives of the Service, it has been concluded that operation of the navigation channel would more than compensate for possible losses to sport fishing that might result from construction and operation of the single-purpose flood control channel. On the basis of these discussions and information contained in the above report and assuming suitable water quality as discussed above, it is estimated that a net average increase of approximately 357,000 man-days of sport fishing annually will occur in the multiple-purpose navigation channel.

7. Highway Access.-The proposed waterway in the Trinity River Basin will be served by a network of major highways in the Dallas-Fort Worth metropolitan area. State Highways, farm-to-market highways, and county roads connect agricultural and rural areas and provide access to local towns. In House Document No. 276/89/1 it is stated that 48 existing bridges cross the Trinity River, and that by the year 1985, there would be 12 additional crossings. In addition to existing highway, county road, and city street crossings, which will provide access to the navigation channel, access roads will be constructed to all proposed lock sites.

RECREATION RESOURCES OF IMPROVED CHANNEL FOR FLOOD CONTROL

8. General.- In order to evaluate the recreational benefits associated with features exclusively for navigation, it was necessary to compare the benefits estimated for the multiple-purpose channel with those estimated for a single-purpose flood control channel, with any difference being attributed to the navigation features. In this comparison, and in consonance with the legislation authorizing the multiple-purpose project, it was considered that a single-purpose flood control channel would follow the same alignment as the authorized navigation channel. Thus, the benefits attributable to the single-purpose flood control channel would be those accruing from the improved channel alignment as opposed to the existing natural river channel alignment. There would be no normal pool elevation suitable for public recreational use, as evidenced from the tabulation of flood occurrences and duration of flooding, presented in Table 1 below. It is estimated that the operating discharge below the various flood control reservoirs, ranging from about 12,000 cfs to 35,000 cfs, will occur on an average of about 28 days per year. This is not conducive to recreational use. Based entirely upon flood control operating procedures, the normal flow in the channel would vary from 200 cfs in the Fort Worth to Dallas reach to about 600 cfs in the lower reaches. It is not presently proposed to construct recreational facilities for use by the general public due to the limited recreation potential of the channel. Highway crossings now provide access to the existing Trinity River channel and they will likewise provide access to the improved flood control channel.

TABLE 1

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

RECREATION AND FISH AND WILDLIFE STUDY

Frequency of Duration of Flooding in Flood Control Channel

Location	Operating discharge (cfs)	No. of times operating discharge is equaled or exceeded per 100 years	Recurrence interval (years)	Average no. of days per occurrence that operating discharge is equaled or exceeded	Channel bottom width	Channel depth	Top width	Reach (down stream) miles
West Fork Trinity								
Ft. Worth gage	12,000	22	4.6	10	200	23.4	294	31.8
Grand Prairie gage	12,000	16	6.2	18	200	27.9	312	11.8
Trinity River								
Dallas gage	20,000	20	5.0	13	150	26.3	255	37.1
Rosser gage	25,000	20	5.0	29	125	28.9	241	81.8
Oakwood gage	35,000	1	100.0	36	150	36.8	297	93.9
Romayor gage	35,000	7	14.3	90	150	37.4	300	31.3
Liberty gage	35,000	7	14.3	90	250	30.5	372	25.9
Mouth	35,000	7	14.3	90	300	27.0	408	25.9

9. Net Estimated Attendance and Benefits.- In the existing natural river channel, the water resulting in the flows of 200 cfs and 600 cfs discussed above would tend to move more slowly and remain in the channel for longer periods of time. Under these conditions, there would be little or no attractive recreation potential. Under either the natural river condition or the improved single-purpose flood control project condition, the recreational use would be largely limited to the sightseers who would visit the project to observe the high water conditions during large floods. This use would be limited to the time the high flood stages prevailed. The Fish and Wildlife Service believes the construction of a flood control channel will not enhance the benefits of sport fishing and hunting. Based on the above information, it is concluded that no increase in annual visitation and, thus, no recreation or fish and wildlife benefits would accrue to an improved single-purpose channel for flood control.

FACTORS INFLUENCING RECREATIONAL DEVELOPMENT

10. General.- A general improvement in the economic levels of the population throughout both adjacent and surrounding territory, together with the widening of the gap between demand and adequate supply, have increased the pressure to augment all types of outdoor recreational facilities. Water is a key factor of recreational development and serves as a magnet, since the populace in both urban and rural areas show a strong desire for water-oriented recreation. The navigation channel will fulfill an essential requirement for water-oriented recreation activities.

11. Recreation Trends.- One of the major trends in present day living is toward more outdoor recreation activity. The national trend of water-oriented recreational demands and activities is reflected in the Trinity River Basin. There is little doubt that wholesome recreation of many varieties will be demanded of all agencies concerned with use and management of outdoor recreation areas. It is considered essential that the navigation channel of the Trinity River be developed to its full potential of recreational activities to the extent consistent with other authorized uses.

12. Population Projections.- As stated in the project document, the principal area of influence would be comprised of 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 population, indicated in millions, for these 39 counties is as follows:

Year	1960	1980	1985	2000	2020	2035
Population	3.886	6.342	7.049	9.676	14.034	18.548

These projections were based on series B. U. S. Census, revised jointly by Galveston and Fort Worth Districts and coordinated by the Southwestern Division on 25 March 1966.

PROPOSED DEVELOPMENT FOR MULTIPLE-PURPOSE CHANNEL

13. General.- Since the land acquisition policy changed in 1962, and fee lands are now purchased below a blocked-out line encompassing the upper guide contour, it is not proposed to buy additional land solely for recreation in connection with the multiple-purpose navigation channel. However, the estimates of cost of lands which were used in the project document were updated to the 1966 price level. The project document plan provides for lands and facilities to secure an observation point, picnicking area, and access to the navigation channel at each of the 21 lock sites. However, these services and facilities are now proposed for only 18 lock sites, since three locks have been deleted, and tandem locks 5B and 10B are located in the embankment sections of Livingston and Tennessee Colony Dams, respectively. In addition, the plan provides for picnicking, camping, boat launching, boat storage, and concession sites to serve the needs of the public at about 30-mile intervals along the 370 miles of the navigation channel. Under this restudy, it is not proposed to increase the facilities requirements for initial development which are presented in the project document.

14. Estimated Attendance.- A study of attendance records for reservoir projects in the Fort Worth District was made to establish a basis for an estimate of the visits per capita in the primary zone of influence that could be anticipated for the navigation project channel. For the purpose of estimating attendance, the channel was divided into the upstream area, the intermediate area, and the downstream area. On this basis, it was estimated in the project document that the multiple-purpose channel would have an initial attendance of 1,350,000 visitors in 1970, an average annual attendance of 5,000,000 visitors, and an optimum annual visitation of 6,000,000 visitors.

15. Project Visitation.- In reevaluating the number of annual recreation visits that would be made to this project, it has been assumed that the project would be physically complete by 1985 in lieu of 1970. In the project document it was estimated that the multiple-purpose channel would receive 10.4 percent of the total annual visitors initially, 19.2 percent of the average annual visitation, and 17.4 percent of the optimum annual visitation. This was based on 4 visits per capita, and further study of existing navigation projects indicates that the canal portion of this project should not be expected to receive the same degree of visitation as major reservoirs. In the Tennessee-Tombigbee report, the attendance

factor for the canal portion of the project was estimated to be 1.5 visits per capita. In 1965, the Fort Worth District made a visitation study on four existing reservoirs in the upper Trinity River Basin. The study was based on actual count at these projects versus the estimated population within the primary zone of influence. This study indicated that there were about 4.5 visits per capita. On the basis of studies at existing navigation projects, it is concluded that a factor of 4.5 visits per capita for the navigation channel is high, but it is also considered that 1.5 visits per capita is low. Because of the nature of this project and the water-oriented recreation activities proposed, it has been concluded that an average of these two studies should form a reasonable basis for estimating per capita visitation. Based on the above conclusion, a visitation factor of 3 visits per capita in the primary zone of influence has been used in this report. On this basis, the initial and optimum annual net visitation would be as follows:

a. Initial Visitation.- The initial annual visitation for the first three years after 1985 is estimated to be 1,695,000, based on the same percentage of total population usage adjusted for change in time and in proportion to rate per capita.

b. Optimum Annual Visitation.- Based on the population projection on the 50-year life of the project and the continued future development of recreation facilities, it is estimated that visitation to the project will continue at an increasing rate and reach its optimum capacity of 6,000,000 visitors in the year 2008. After the year 2008, it is considered that the project visitation will be limited by the optimum project capacity and visitation will level off.

16. Recreation Benefits.- Benefits resulting from the development of the recreation resources of the multiple-purpose navigation channel are based on unit values prescribed in Supplement No. 1 to Senate Document No. 97, 87th Congress, 2d Session: "Evaluation Standards for Primary Outdoor Recreation Benefits." The criteria established therein supports a general recreation-day unit value ranging from $0.50 to $1.50. On the basis of facilities to be provided that will permit various types of water-oriented recreation activities, it is concluded that a unit value of $0.75 would be appropriate for general recreation,including casual and incidental fishing, and $1.00 for primary sport fishing and hunting activities. For this report, it is estimated that average annual equivalent benefits for general recreation will amount to $2,945,000. Also, it was estimated by the Bureau of Sport Fisheries and Wildlife that 357,000 net average annual primary sport fisherman-days will occur with an annual equivalent benefit of $357,000. Man-days of sport fishing

as a primary activity amount to about 7 percent of total estimated annual visitation. From Corps and State records, over 30 percent of the total recreational visitors participate in sport fishing activities either primarily, casually, or incidentally. Therefore, casual and incidental type fisherman-days have been included in the estimates for general recreation activities. A summary of the recreation benefits is presented in table 2.

17. Summary of Benefits.- The average annual equivalent benefits, shown in table 2 and creditable to the plans described in paragraphs 2 and 4, for the navigation channel to Ft. Worth are estimated at $3,302,000.

TABLE 2

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

RECREATION AND FISH AND WILDLIFE STUDY

Benefits Creditable to Navigation Channel

Period	Recreation type	Recreation use	Unit value	Benefits	Average annual equivalent benefit (1)
1985-1988	General	1,338,000	$0.75	$1,003,500	$ 115,100
	F & W	357,000	$1.00	357,000	40,900
	Subtotal	1,695,000		$1,360,500	$ 156,000
1988-2008	General	4,305,000	$0.75	3,228,750	1,360,100
	F & W	357,000	$1.00	357,000	192,100
	Subtotal	4,662,000		$3,585,750	$1,552,200
2008-2035	General	5,643,000	$0.75	4,232,300	1,470,000
	F & W	357,000	$1.00	357,000	124,000
	Subtotal	6,000,000		$4,589,300	$1,594,000
1985-2035	General				2,945,000 (2)
	F & W				357,000
	Total 50-year period				$3,302,000

(1) Based on 3.250 percent interest rate.

(2) Rounded to nearest thousand dollars.

TRINITY RIVER AND TRIBUTARIES, TEXAS

NAVIGATION PROJECT

REEVALUATION OF NAVIGATION FEATURES

EXHIBIT 5
ECONOMIC DEVELOPMENT STUDY

EXHIBIT 5
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ECONOMIC DEVELOPMENT STUDY

SYLLABUS

This exhibit is concerned with evaluation of economic development benefits that would be realized for construction of the authorized Trinity River navigation project. The Economic Development Administration (EDA) publishes lists of all counties in Texas that have been designated as economically underdeveloped. Based on this information, it has been determined that construction as well as operation and maintenance expenditures on the Trinity River project will stimulate the economy of nine underdeveloped counties in Texas.

Economic development benefits that would accrue from construction of the proposed waterway have been estimated on the basis of wages paid to local labor for both actual construction and project operation and maintenance. Total labor costs for construction of the navigation features located within or adjacent to the nine depressed counties are estimated at $35,700,000 of which $30,702,000 represents wages that would be earned by local employees. Annual operation and maintenance labor costs after completion of the project are estimated to be $937,000. The average annual equivalent benefits over the 50-year project life, using a 3.250 percent interest rate, have been estimated at $1,566,000 for construction and $321,000 for operation and maintenance, for a total of $1,887,000.

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ECONOMIC DEVELOPMENT STUDY

INTRODUCTION

1. Purpose and scope.- The purpose of this study is to evaluate development benefits in those counties designated as underdeveloped by the Economic Development Administration (EDA) under Title IV of the Public Works and Development Act of 1965, Public Law 89-136, as a result of the expenditure of funds for construction, operation and maintenance of the navigation features of the authorized project for Trinity River and Tributaries, Texas. Underdeveloped counties are defined as counties with chronic and persistent unemployment and underemployment. Senate Document 97 of the 87th Congress provides that benefits may be derived from wages paid to local labor during actual construction and project operation and maintenance. However, these benefits are limited to only those wages paid to labor living in or within commuting distance of the designated counties. Another limitation is that area employment in project operation and maintenance must be based on a straight line reduction in potential project employables to terminate at the end of 20 years from the date of project completion.

2. Basic assumptions.- The economic development benefits attributable to the Trinity River project were developed under the following assumptions:

(a) Contractors on public works construction in counties designated as economically distressed are expected to hire as much available local labor as possible.

(b) Estimated labor requirements are classified as follows: 40 percent skilled workers, 30 percent semi-skilled workers, and 30 percent unskilled labor.

(c) The estimated daily wage scales are: skilled labor, $32.50, semi-skilled, $22.00, and unskilled, $16.00.

(d) Eighty percent of the skilled workers and 90 percent of the semi-skilled and unskilled workers will be recruited locally.

(e) Although the number of workers to be recruited locally may be in excess of the number of registered unemployed, the area will be able to absorb the demand for workers because local recruitment will include the underemployed as well as the unemployed. (The project will provide an opportunity for underemployed workers to increase their total employment activities). Authorities recognize that a very high rate of underemployment probably exists among rural workers. These workers do not have as many employment opportunities as do urban workers, but this factor is not considered in non-farm jobs to supplement their farm income. If a farm operator loses his non-farm job, labor force surveys still consider him as employed on the basis of his farm work, even though he may be looking for another non-farm job.

(f) The navigation portion of the comprehensive Trinity River plan of improvement accounts for about 2/3 of the estimated total construction costs of the project. The estimated construction costs for project features other than navigation in the 9 depressed counties have been considered, and it has been determined that these counties have an adequate supply of manpower resources to meet all the requirements for local labor on the entire project.

(g) Wages earned by local employees have been estimated to be 86 percent of the total contract labor costs in or near the depressed area.

(h) The time required to complete the construction planned within or near the nine depressed counties is estimated at 5 years. The estimated construction period for the entire navigation project is 10 years.

ANALYSIS OF BENEFITS

3. Benefit area.- Nine of the Texas counties, designated as economically distressed by EDA, will either contain Trinity River navigation features to be constructed or have a substantial portion of their area within reasonable commuting distance, (35 miles one-way). These counties include: Freestone, Grimes, Houston, Leon, Limestone, Madison, Polk, San Jacinto, and Trinity. The locations of these counties are shown in the figure on page 627.

4. Economic development benefits.- The total on-site labor costs for construction of navigation features located within or adjacent to the nine depressed counties are estimated at $35,700,000.

Of this amount, 86 percent, or $30,702,000, represents the wages that would be earned by local labor. Using a compound interest rate of 3.250 percent and the project life period of 50 years, the estimated average annual equivalent benefits to be derived from construction wages amount to $1,566,000.

5. The annual operation and maintenance labor costs for navigation features within the 9-county distressed area are estimated to be $937,000. It has been assumed that the need for economic stimuli for the 9-county area should progressively decrease during a 20-year developmental period, following the operational opening of the project. Accordingly, the effective benefit from the annual operation and maintenance labor costs has been reduced by linear regression to zero after 20 years from the beginning of project operation. Using a compound interest rate of 3.250 percent and the project life period of 50 years, the average annual equivalent value for operation and maintenance labor costs is estimated at $321,000.

6. Computations of the economic development benefits estimated for the navigation features of the authorized project are presented in detail in the following table.

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

TABLE OF
COMPUTATION OF DEVELOPMENT AVERAGE ANNUAL EQUIVALENT BENEFITS

New Construction

a.	Total wage costs for navigation features located within or close to the nine depressed counties	$35,700,000
b.	Eighty-six percent of the total wage costs assigned to the depressed counties	$30,702,000
c.	Construction period (Assumed 1975-1980)	5 years
d.	Value per year $\frac{(\$30,702,000)}{5}$	$ 6,140,400
e.	Value of wage component at end of first five years (1980) ($6,140,400 x 5.33574) (1)	$32,763,578
f.	End of construction period to beginning of project life (1980-1985)	5 years
g.	Value of wage component at start of project life ($32,763,578 x 1.17341) (2)	$38,445,110
h.	Average annual equivalent benefit of value of wage compenent during project life ($38,445,110 x .04073) (3)	$ 1,566,000 (4)

TRINITY RIVER AND TRIBUTARIES, TEXAS
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REEVALUATION OF NAVIGATION FEATURES

TABLE OF
COMPUTATION OF DEVELOPMENT AVERAGE ANNUAL EQUIVALENT BENEFITS
(CONT'D)

Operation and Maintenance

a. Annual wage costs for operation and maintenance, within or near the depressed counties	$ 937,000
b. Annual amount of linear decrease during the twenty-year period ($937,000 / 20)	$ 46,850
c. Present worth for decreasing capital investment ($46,850 x 168.02011) (20-year period, 3.25 percent)	$7,871,742
d. Average Annual Equivalent Value for O & M ($7,871,742 x .04073) (3)	$ 321,000 (4)

TOTAL DEVELOPMENT AVERAGE ANNUAL EQUIVALENT BENEFITS

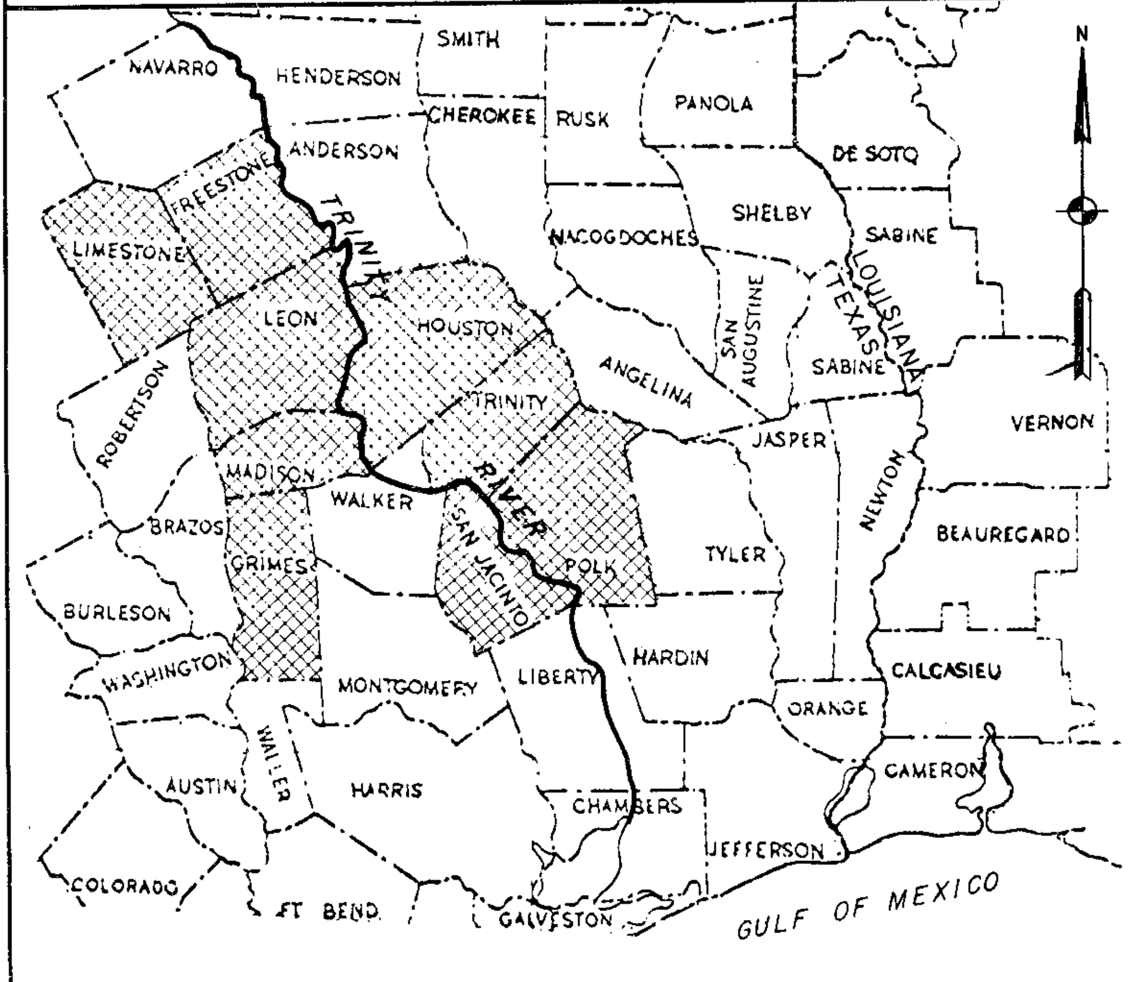
New Construction	$1,566,000
O & M	$ 321,000
TOTAL	$1,887,000

(1) Computed as value of ordinary annuity at 3.25 percent.
(2) Compounded amount - 5 years at 3.25 percent.
(3) Average annual equivalent factor - 50-year period, 3.25 percent.
(4) Rounded to nearest 1000.

FIGURE

TRINITY RIVER AND TRIBUTARIES, TEXAS
NAVIGATION PROJECT
REEVALUATION OF NAVIGATION FEATURES

ECONOMIC DEVELOPMENT STUDY
COUNTIES EVALUATED FOR BENEFITS



LEGEND
= DEVELOPMENT AREA

EXHIBIT 5
APPENDIX II

BIBLIOGRAPHY

U. S. Department of Labor, Manpower Administration, Manpower Report, Washington, D. C., 1967.

Departments of Commerce and Agriculture, Current Population Reports, Farm Population, Series Census-ERS,,p. 27, No. 37, Washington, D. C., April 1967.

Department of Commerce, Economic Development Administration, Maximum Grant Rates for Public Works Grants in Qualified Areas, Washington, D. C., July 1967.

Department of Commerce, Bureau of the Census, United States Population Census, 1960, Washington, D. C., 1960.

United States Department of Labor, Bureau of Labor Statistics, "Labor Requirements for Various Types of Construction," Washington, D. C., March 1966.

United States Department of Labor, Bureau of Labor Statistics, "Labor and Material Requirements for Civil Works Construction by the Corps of Engineers," Bulletin 1390, Washington, D. C., March 1964.

United States Department of Commerce, Economic Development Administration, Directory of Approved Projects, Washington, D. C., September 1967.