US Army Corps
of Engineers
Vicksburg District

RED RIVER WATERWAY PROJECT
SHREVEPORT, IA TO DAINGERFIELD, TX REACH
REEVALUATION STUDY

**IN-PROGRESS REVIEW
DOCUMENTATION**

REGIONAL ECONOMIC DEVELOPMENT

MAY 1994

Red River Waterway Project
Shreveport, LA, to Daingerfield, TX, Reach
Reevaluation Study In-Progress Review

REGIONAL ECONOMIC DEVELOPMENT

PREFACE

1. In October 1988 (Fiscal Year 1989), the U.S. Army Corps of Engineers, Vicksburg District, was directed by Congress to initiate a reevaluation of the feasibility of the Shreveport, LA, to Daingerfield, TX, reach of the Red River Waterway Project. Subsequent funding was provided by Congress in Fiscal Years 1990-1993.

2. In December 1992, an in-progress review of the feasibility of extending navigation on the Shreveport to Daingerfield reach was completed. The review was a preliminary assessment of project costs, benefits, and environmental impacts. The review revealed that construction of this reach of the project was not economically feasible. The project was also found to result in significant environmental impacts for which mitigation was not considered to be practicable. The reevaluation studies were terminated as a result of the in-progress review.

3. Various documents are available so that the public can better understand the results of the reevaluation study. The documents are:

a. In-Progress Review Documentation prepared in December 1992 for headquarters review.

b. Environmental Summary.

c. Regional Economic Development.

d. Public Involvement.

e. Recreation.

f. Mussel Survey.

g. Historic Watercraft Survey.

h. Geotechnical Investigations.

i. Geomorphic Investigations.

Copies of all these documents have been placed in the local depositories listed in the Public Involvement documentation. Copies can be obtained from the Vicksburg District for the cost of reproduction.

4. The regional economic development study was done by the U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, Fort Belvoir, VA. The purpose of the study was to identify the impact the construction and operation of a navigation project would have on the local/regional economy. Although regional impacts must be considered to fully assess project benefits and costs, these impacts cannot be used in the justification of U.S. Army Corps of Engineers water resource projects.

RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY

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INTRODUCTION

1. The economic growth of most regions is substantially determined by exports of goods and services to areas outside of the region. Water transportation, which reduces transport costs, helps to enhance the growth potential of the exporting sectors and thus stimulates growth in income and employment that might not otherwise occur. The purpose of this report is to summarize the Regional Economic Development (RED) impacts that are related to the construction and operation of the proposed Red River Navigation Channel from Shreveport, Louisiana, to Daingerfield, Texas. The economic impacts estimated and presented in this report are not limited to the economic effects that are induced by project construction activity and the reduction in transportation costs which stem from the proposed project. The economic effects of two alternative development scenarios are also evaluated, for example, low and high growth in the demand for goods services produced in Louisiana and Texas induced by enhanced water transportation opportunities.

THE ROLE OF WATERWAYS IN REGIONAL DEVELOPMENT

2. The Federal Government has long taken an active and leading role in the development of waterways to provide low-cost waterborne transport. An indicator of the success of this role is that the total waterborne tonnage of the U.S. inland waterway system climbed from 579 million short tons in 1947 to

1,037 million short tons in 1986. The reduction in the cost of moving goods because of water transportation has improved economic efficiency, increased incomes, and allowed U.S. companies to compete more successfully in world markets.

3. The development of these waterway projects occurred because the benefits of the waterways to the nation outweighed the construction and maintenance costs for the projects. These benefits, (called primary benefits) consist mainly of transportation cost savings, but also include other benefit categories. Primary benefits represent benefits to the nation and not just to a particular region. Primary benefits have been the cornerstone of project authorization for the U.S. Army Corps of Engineers. However, primary benefits do not include the economic effects or impacts to a particular region because they are considered transfers of fully employed resources.

4. In the past, water resource projects were considered, in most cases, solely a Federal responsibility. With the passage of the Water Resources Development Act of 1986 (Public Law 99-662), local interests have assumed more responsibilities in the process of developing our nation's water resources, including financial participation. Along with the increased participation of local sponsors in the water resources development process, there has been an increased importance placed on the estimation of the local and regional economic impacts. These effects are above and beyond the net benefits to the nation. They can include resource transfers and secondary benefits that accrue to regions, but not necessarily to the nation. As stated by one official within the planning arena, "Hopefully the priority-setting process

(under P.L. 99-662) will not overlook the important public benefits that local and regional projects can produce. ... It will be important to keep in mind the synergistic effects of strong local and regional economies."

5. Local and regional economic impacts are the direct, indirect, and induced effects of (1) construction activity, (2) expansion of existing firms, and (3) entry of new firms in a region. Economic impacts may stem from changes in the demand for local goods and services; or they may stem from changes in the cost of doing business (e.g., due to reduction in transportation rates). They can be measured in various ways, such as by employment, income, or business activity (output).

6. Transportation of all types is a fundamental and critical factor in RED. The transportation of a region often defines how that region can compete, what types of goods will be available as inputs for local industries, and what types of goods and services it will be reasonable for local sectors to produce. An improvement in the transportation system of a region can change the production costs of many goods and services produced in the region and can provide the benefitted region with a competitive advantage in regional, national, and international markets.

7. Transportation of goods on the inland waterway system occurs because this mode of transportation provides the lowest cost means of movement for such heavy and bulky goods as grain, grain mill products, lumber, paper products, chemicals, petroleum, coal, stone, iron, and steel. When a new waterway is opened, the reduction in transportation costs reduces the cost of producing

other goods. Reductions in transport costs make indigenous industries more competitive, thereby leading to firm expansions. The firms are able to lower costs and participate in new markets. This helps to increase region output, employment, and income. This can be followed by sectoral expansions as other indigenous industries recognize new market opportunities. In some cases, the expansion may include the opening of undeveloped natural resources to productive recovery. These expansions will lead to further expansions for businesses providing ancillary goods and services in water-related sectors (such as warehousing facilities).

8. Local participants play a major role in the realization of both the primary benefits and the economic impacts. The types, locations, and levels of regional economic impacts are significantly influenced by actions taken by local and regional entities. It has become clear that local participation and initiative are necessary to bring about the synergistic effects. Local representatives and political and business leaders play a key role in fostering success. Their efforts, whether in such things as the provision of required infrastructure (docks, terminals, etc.), the training of workers for the new industries attracted by the waterway, or the introduction of unique and inventive financing schemes for developing resources, can influence the direction and magnitude of potential impacts.

DESCRIPTION OF THE PROJECT

9. The authorized Red River Waterway, Louisiana, Texas; Arkansas, and Oklahoma, project provides for a 9- by 200-foot navigation channel extending

about 310 miles from the Mississippi River through the Old and Red Rivers to the vicinity of Shreveport. The channel then continues through Twelvemile and Cypress Bayous to a turning basin in Lake 0' the Pines (Ferrells Bridge Reservoir)-downstream of the U.S. Highway 259 bridge near Daingerfield. The project also provides for realigning the banks of the Red River from Old River to **Denison Dam** by means of dredging, cutoffs, and training works and for stabilizing its banks by means of revetments, dikes, and other methods. Facilities which will provide recreation opportunities are an integral part of the project. Only data for two barge alternatives were evaluated for this analysis. Similar results would occur for the other alternatives considered as part of the Shreveport to Daingerfield Review Report.

10. Construction of the Red River Navigation Project will extend low cost water transportation into northwest Louisiana and northeast Texas. The expanded water transportation facilities, in turn, are expected to improve the competitive position of Louisiana and Texas for increasing the supply of goods and services to the rapidly growing southeastern regional market. Industries utilizing the waterway can experience reduced costs in the form of lower transportation charges, resulting in lower variable costs and a change in the marginal costs of the firms. Thus, an industry which attempts to maximize profits will increase output to the quantity where marginal costs equal marginal revenues. The competitive advantage gained by the industries utilizing the waterway would also stimulate a shift in the demand schedule facing the firms. Accordingly, the anticipated increases in output can be attributed to a shift in both the supply and demand schedules of the affected industries. The benefits attributable to the increased production induced by

the waterway are measured by estimating employment gains and corresponding gains in regional income.

SUMMARY OF THE ECONOMIC IMPACTS OF THE RED RIVER NAVIGATION PROJECT

11. Nationally, the economic impacts that result as a consequence of project construction activities and transportation cost savings (Table 1) will have a temporal pattern quite similar to the temporal pattern of expenditures and savings. The output impacts due to construction activity are almost three times the size (specifically, a factor of 2.8 larger) of the construction expenditures for every year construction occurs (i.e., from 1995 to 2000). Note, the construction impacts shown in Table 1 include the **onsite** construction activity (e.g., construction receipts, construction workers, and their wages and salaries). Similarly, the output impacts of the transportation cost savings are a factor of 2.2 larger than the savings over time. For each $1 million (1990 prices) spent during the construction phase, the Red River Waterway, Shreveport to Daingerfield, Project is expected to generate 33 **full-**time jobs. Each $1 million (1990 prices) saved in transportation costs generates approximately 18 full-time jobs.

TABLE 1
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
NATIONAL ECONOMIC IMPACTS
(1990 Prices)

Construction Project Impacts				
Year	Construction Expenditures ($ million)	output ($ million)	Income ($ million)	Employment (man-years)
1995	42.4	119.5	32.0	1,381
1996	53.1	149.6	40.1	1,732
1997	84.9	239.2	64.1	2,768
1998	95.5	269.1	72.2	3,113
1999	95.5	269.1	72.2	3,113
2000	53.1	149.6	40.1	1,732
Transportation Cost Savings Impacts				
Year	Savings ($ million)	output ($ million)	Income ($ million)	Employment (man-years)
2001	26.1	58.0	12.6	483
2010	27.2	60.1	12.9	498
2020	28.1	61.8	13.1	510
2030	29.3	64.1	13.5	527
2040	30.5	66.5	13.9	544
2050	31.9	69.0	14.2	563
Future Growth Impacts				
Scenario		Output ($ million)	Income ($ million)	Employment (man-years)
Low Growth		147.3	28.4	1,257
High Growth		704.4	138.0	5,995

12. Potential growth in the demand for goods and services in the Red River area of Louisiana and Texas due to the Shreveport reach'of the Red River Project has been projected in a recent report prepared for the Red River

Waterway Commission (1986). **Low** and high growth scenarios indicate the potential for substantial growth in business and employment opportunities within Louisiana and Texas. Nationally, these opportunities could mean from $150 to $700 million in business expansion (industrial output) and from 1,300 to 6,000 new full-time jobs.

METHODOLOGY OF THE ECONOMIC IMPACT ANALYSIS

13. An industry in one area is interrelated to industries of all regions through a complex system of trade and interindustry relationships. Firms purchase their productive requirements from other firms both locally and in other regions. Waterways contribute to RED and National Economic Development by offering a means of shipping bulky and heavy commodities at low cost. The U.S. Army Corps of Engineers Traffic Survey (Institute of Water Resources, 1980) reveals that a navigable waterway reduces the **cost of** shipping bulky commodities such as grain, gravel, chemicals, steel products, crude petroleum, and coal. Because these commodities are often inputs for other industries manufacturing goods at the early stages of producing goods and services for final consumption, taking advantage of the lower costs of transportation on the waterway can affect the trade and interindustry relationships of the economic system. For example, a change in the cost of delivering commodities affects both the selling and purchasing industries, which will then create repercussions in all industries throughout all regions of the economy. **This** complexity, arising from industrial and regional interdependencies, makes it

difficult to accurately measure the impacts from operating waterway facilities. However, the multiregional input-output analysis is one way to evaluate the impacts of public works projects.

14. A multiregional input-output (MRIO) analysis explicitly considers the interrelationships between industrial sectors and among the regions of an economy. In addition, MRIO analysis examines how these relationships affect the process of economic change throughout the entire national economy. That is, in addition to the production of "new wealth," input-output models trace through the production and consumption of goods and services. In other words, sales by firms are categorized into intermediate and final uses and all industrial sectors of a local economy are dependent upon every other sector. The complex interrelationships between industries and regions have been modeled for some time by such analysts as Isard (1951), Moses (1955), Leontief and Strout (1963), Polenske (1970), and others in the development of MRIO models. The MRIO balancing equation between inputs and outputs, taking into account interregional trading patterns, is:

$$X = TAX + Y \qquad [1]$$

Given R to be the number of regions in the economic system and N to be the number of industrial sectors, X is an (RNx1) vector of industrial and regional output levels, T is an (RNxRN) matrix of multiregional trading patterns, A is an (RNxRN) matrix of regional technical coefficients, and Y is an (RNx1) vector of industrial and. regional final demand purchases (Miller and Blair (1985)).

15. However, nothing in the **MRIO** model or its solution accounts for the economic expansion that can occur as a result of an improved waterway system. That is, the standard MRIO solution is incapable of estimating the economic impacts that can occur because of reductions in transportation costs. A reduction in transportation costs incident to the delivery of commodities by water creates a kind of "substitution" effect which conventional MRIO models fail to capture. This substitution effect plays a critical role in determining the regional technical and trading patterns in the economy and in those relationships found in the MRIO model. These changes will also impact on the output, income, and employment levels of all industrial sectors within each regional economy. Much of these conceptual problems have to do with their inflexibility with respect to price and input cost changes.

16. The restrictive nature of the standard MRIO model can be eased by total differentiation of [1] (i.e., the input-output balancing equation) and then solving for changes in output levels with respect to changes in technological and trading patterns and with respect to changes in final demand values; that is,

[2] $$\Delta X = \Delta TA\ X + TA\ \Delta X + \Delta Y$$

[3] $$\Delta X - TA\ \Delta X = \Delta TA\ X + \Delta Y$$

[4] $$(I - TA)\ \Delta X = \Delta TA\ X + \Delta Y$$

[5] $$\Delta X = (I - TA)^{-1}\ \Delta TA\ X + (I - TA)^{-1}\ \Delta Y$$

VARIABLE **FINAL DEMAND**

where Δ indicates differentiation or small change. Equation [5] is a more general solution to the multiregional input-output model than the standard version. Not only does this solution involve those impact scenarios, generating final demand expenditures, $(I-TA)^{-1} \Delta Y$, but it also indicates how changes in technological and trading relationships can be expected to alter production and subsequent employment and income levels, $(I-TA)^{-1} \Delta TA X$. The first part of the right-hand side of equation [5], the multiregional "variable" input-output (MRVIO) solution, and the second part of the right-hand side of equation [5] may be called the multiregional "final demand" input-output solution.[1]

17. Following the work of Hudson and Jorgenson (1974) and their KLEM model, Liew and Liew (1984 and 1985) developed a practical production function approach that makes changes in the technical coefficients depend on changes in such cost items as transportation costs, wage rates, the service price of capital, and the relative prices of inputs and outputs.[2] This procedure has been implemented on a nationwide basis through a regional input-output modeling system by economists at the U.S. Army Engineer Institute for Water Resources.

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[1] Liew and Liew (1984 and 1985) call these input-output solutions the substitution and income effects, respectively.

[2] Rose (1984) reviews 12 methodologies of incorporating technological change in an input-output framework. These procedures include methods such as ad hoc changes in technical coefficients, mechanical devices like RAS, and explicitly modeled production functions.

THE RED RIVER MRIO MODEL

18. The Red River MRIO Model was compiled from the Jack Faucett Associates (JFA) 1977 Multiregional Input-Output Accounts.[3] The model has a base year of 1977 and is essentially aggregated from the detailed JFA MRIO Accounts. Modifications to the original JFA data base had to be made to ensure that all accounts (use, make, and trade) were consistent with "purchasing" prices and that the accounts balanced and appropriately interconnected.

19. The Red River MRIO Model is spatially configured to delineate the country according to five regions: the States of Arkansas, Louisiana, Oklahoma, and Texas and the rest of the United States. In addition to local interests, this regional configuration is based on an analysis of the interregional trade flows and the interregional patterns of the transportation cost savings estimates.

20. The Red River MRIO Model has an industrial structure consisting of 47 sectors. The industry definitions are shown in Table 2. The particular industrial aggregations chosen for this model were derived by consolidating the agricultural, service, and natural resource industries and most of the nonmanufacturing industries, while preserving the "key" industrial sectors which produce, manufacture, or utilize the commodities and other goods that

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[3] The JFA MRIO Accounts consist of state use, make, and trade accounts for 119 producing sectors and commodities. "Use" accounts show the industrial and final consumption of commodities, "make" accounts present the industrial production of commodities, and "trade" accounts indicate the regional distribution of commodities.

would be transported on the Shreveport to Daingerfield portion of the Red River Navigation Project.

TABLE 2
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
INDUSTRIAL SECTORS

Industrial Sector	Industrial Sector
1 Livestock and Dairy Farm	25 Stone and Clay Products
2 Cotton, Grain, and Tobacco	26 Basic Iron and Steel
3 Other Agricultural Products	27 Basic Nonferrous Metals
4 Iron Ore Mining	28 Structural Metal Products
5 Nonferrous Ore Mining	29 Other Metal Products
6 Coal Mining	30 Nonelectric Machinery and Equipment
7 Crude Petrol and Natural Gas Mining	31 Electric Machinery and Equipment
8 Stone and Clay Quarrying	32 Transportation Equipment
9 Chemical Minerals Mining	33 All Other Manufacturing
10 New Construction	34 Rail Transportation
11 Maintenance and Repair Construction	35 Water Transportation
12 Grain Mill Products	36 Other Transportation
13 Other Food and Kindred Products	37 Communications
14 Apparel and Textile Products	38 Electric Utilities
15 Logging and Lumber	39 Gas Utilities
16 Furniture and Wood Products	40 Water and Sanitary Utilities
17 Paper and Paperboard Products	41 Wholesale and Retail Trade
18 Industrial Chemicals	42 Finance, Insurance, and Real Estate
19 Agricultural Chemicals	43 Eating and Drinking Places
20 Other Chemicals	44 Hotels and Lodging Places
21 Plastics, Rubber, and Leather Goods	45 Personal and Health Services
22 Cosmetic, Cleaning, and Paint Goods	46 Business and Professional Services
23 Petroleum Refining	47 Government Enterprises
24 Glass Products	

BASIC INPUT DATA

21. Planning, design, and construction phases of the Red River Navigation Project are expected to proceed in several stages over the 1995 to 2000 period. The first year of operation of the Red River Navigation Project is planned for 1995. Table 3 shows the schedule of construction expenditures that are expected to occur. The geographic split between activity in Louisiana and Texas is "fifty-fifty" because approximately one-half of the proposed project is in Louisiana and the other one-half is in Texas.

TABLE 3
-RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
ESTIMATED CONSTRUCTION EXPENDITURES

Year	Construction Expenditures	Percent of Total
1995	42.4	10.0
1996 1997	53.1 84.9	12.5 20.0
1998	95.5	22.5
1999	95.5	22.5
2000	53.1	12.5
Total	424.5	100.0

22. Table 4 presents the projected transportation cost savings that are expected to stem from the Red River Navigation Project. These values were determined by the U.S. Army Corps of Engineers, Vicksburg District. The estimates represent the differentials in the rates charged by shippers via the Shreveport to Daingerfield portion of the Red River Navigation Project and the least cost available combination of rail, truck, or alternative waterway.

23. Water resource developments, such as new navigable waterways, add new infrastructure and create opportunities for economic development. The experience of other, similar areas will be analyzed to provide guidance in examining opportunities and probable impacts for the Shreveport to Daingerfield reach of the Red River Waterway Project. Table 5 shows both low and high growth in final demand changes that is expected to occur in Louisiana and Texas due to the proposed project. These estimates are the same as provided by Gulf South Research Institute in their 1986 report prepared for the Red River Waterway Commission. Differences are due to adjustments in prices for the years from 1984 to 1990. The geographic incidence of the final demand changes are based on U.S. Bureau of Economic Analysis OBERS Projections for the year 2035 by sector of the Shreveport metropolitan statistical area in Louisiana and the Longview-Marshall metropolitan statistical area in Texas.

TABLE 4
RED RIVER WATERWAY PROJECT
SHREVEPORT, LWISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
TRANSPORTATION COST SAVINGS
(1990 Prices)
($000)

Commodity	Origin	Destination	2001	2010	2020	2030	2040	2050
Grain	Rest of USA	Texts	4,925.8	5,353.4	5,814.8	6,319.5	6,864.7	7,457.7
Coal	Rest of USA	Texts	3,766.9	3,766.9	3,766.9	3,766.9	3,766.9	3,766.9
Stone	Louisiana	Texts	141.0	148.5	156.0	163.5	174.8	184.2
Grtin Mill Products	Rest of USA	Texts	1,797.0	1,951.1	2,120.3	2,308.3	2,503.8	2,719.9
Textile Products	Louisiana	Texas	27.3	28.2	30.1	31.0	32.9	34.8
Logging and Lunber	Louisitnt	Texas	243.4	257.5	271.6	290.4	311.1	330.8
Logging and Lumber	Texas	Louisiana	897.6	946.4	997.2	1,059.2	1,134.4	1,202.1
Refined Petroleun	Louisiant	Texas	17.9	18.8	19.7	20.7	22.6	23.5
Iron and Steel	Texas	Louisitnt	2,491.5	2,491.5	2,491.5	2,491.5	2,491.5	2,491.5
Structural Metals	Louisiana	Texas	2,795.1	2,888.2	2,923.9	3,016.0	3,100.6	3,191.7
Structure1 Metals	Texas	Louisiana	1,834.6	1,914.5	1,953.9	2,027.3	2,094.9	2,170.1
Structure1 Metals	Texas	Texas	1,500.9	1,553.6	1,574.2	1,625.9	1,672.9	1,722.7
Structural Metals	Texas	Rest of USA	673.9	710.5	731.2	766.0	796.1	829.9
Structural Metals	Rest of USA	Texas	4,166.4	4,337.4	4,421.1	4,605.3	4,734.0	4,898.5
Other Metals	Louisiana	Texas	812.0	821.4	814.8	827.1	838.3	849.6
Total			26,091.3	27,187.9	28,087.2	29,318.6	30,539.f	31,873.9

TABLE 5
RED RIVER WATERWAY PROJECT
SHREVEPORT, LCUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
FINAL DEMAND CHANGES DUE TO PROJECT
(1990 Dollars)
($ million)

Sector	Low Growth		High Growth	
	Louisiana	Texas	Louisiana	Texas
02 Cotton, Grain, and Tobacco	4.20	7.90	16.80	31.60
13 Grain Mill Products	0.50	0.50	2.30	2.30
15 Logging and Lumber	1.20	3.00	6.30	14.80
17 Paper and Paperboard Products	5.45	5.45	27.25	27.25
18 Industrial Chemicals	2.40	2.40	12.10	12.10
23 Petroleum Refining	1.80	1.80	9.10	9.10
25 Stone and Clay Products	0.10	0.30	0.50	1.30
26 Basic Iron and Steel	0.90	2.10	4.50	10.60
28 Structural Metal Products	4.00	9.30	19.80	46.80
30 Nonelectrical Machinery and Equipment	2.30	5.30	11.30	26.60

ECONOMIC IMPACT ANALYSIS PROCEDURES

24. Equation [5] provides the mechanism for estimating the economic impacts induced by both the construction expenditures and the transportation cost savings. A procedural step for deflating the construction expenditures and transportation cost savings estimates was incorporated to make them consistent with the base year of the Red River MRIO Model (1977 dollars). This was done to avoid price distortions and overestimating the employment impacts. Likewise, the output, income, and value added impacts were inflated to current prices (i.e., 1990 dollars). The price indexes for the price adjustments were

compiled using the price indexes in the U.S. Bureau of Labor Statistics Time Series on Output, Prices, and Employment.

25. The economic impacts induced by construction expenditures are estimated by using the multiregional "final demand" input-output solution of equation [5], $(I-TA)^{-1}$ AY. Construction expenditures for each year- of the construction phase of the Red River Navigation Project (Table 3) are converted into changes in final demand, AY, by the following procedure. The construction expenditures are distributed industrially by using the U.S. Army Corps of Engineers Materiel and Labor Requirements for Civil Works Construction by Industry (Liew and Liew, 1985b, page 93), which has been updated to 1990 prices. Construction wage payments are adjusted for savings and taxes[4], and the resulting construction worker expenditures are distributed industrially by using the personal consumption expenditure distribution derived from The Detailed Input-Output Structure of the U.S. Economy, 1982, which has also been updated to 1990 prices. Table 6 provides the construction and worker percentage expenditure distributions and the 1990/1977 BLS sector price indexes. The industrial expenditures are distributed spatially using the trade coefficient matrixes (T) from the Red River MRIO Model. The resulting expenditures, distributed by industry and region, are multiplied by the Leontief inverse of the Red River MRIO Model, $(I-TA)^{-1}$, to estimate the direct and indirect output requirements of the economic system that are induced by the construction activity.

[4]We assumed that construction workers spend approximately 75 percent of their pay.

TABLE 6
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
PERCENT EXPENDITURE DISTRIBUTIONS-CONSTRUCTION AND WORKERS
AND 1990/1977 PRICE INDEXES

Sector	Percent Distribution		1990/1977 Price Index	Sector	Percent Distribution		1990/1977 Price Index
	Construction	Worker			Construction	Worker	
01 LIVESTOCK	.000	.1582	1.523	25 S&C PRD	.000	.0818	1.762
02 CASH CROPS	.000	.0281	1.377	26 IRON & STEEL	3.789	.0008	1.764
03 OTHER AGR	.074	.5482	1.583	27 NOFER MET	2.608	.0037	1.837
04 IRON MIN	.000	.0000	1.329	28 STR MET	4.785	.0273	1.764
05 NONFER MIN	.000	.0000	1.329	29 OTHER MET	.000	.2024	1.726
06 COAL MIN	.000	.0100	1.122	30 NELECT PRD	10.202	.0034	1.147
07 PETROL MIN	.000	.0000	.620	31 ELECT PRD	1.360	1.2739	1.529
08 STONE MIN	19.165	.0016	1.898	32 TRN PRD	2.052	4.1418	1.868
09 CHEM MIN	.000	.0002	1.898	33 OTHER MFG	.024	2.1509	1.863
10 NEW CONST	.000	.0000	1.962	34 RAIL TRN	.920	.2274	1.669
11 M&R CONST	.000	.0000	1.927	35 WATER TRN	.606	.1430	1.846
12 GRAIN PRD	.000	.3747	1.352	36 OTHER TRN	4.792	1.2713	2.160
13 OTHER FOOD	.000	8.5834	1.801	37 COMMUN	.184	1.6447	1.749
14 APPAREL	.000	2.4947	1.501	38 ELECT UTL	.082	2.2068	2.067
15 LOG/LUMBER	.369	.0000	1.591	39 GAS UTL	.043	1.0313	2.219
16 WOOD PRD	.000	.6947	1.722	40 W&S UTL	.000	.4956	2.512
17 PAPER PRD	.000	.4428	1.947	41 TRADE	9.273	16.2076	1.761
18 IND CHEM	.000	.0072	1.959	42 FIRE	1.461	22.6424	2.218
19 AGR CHEM	.000	.0180	1.530	43 EAT & DRK	.000	5.7262	2.052
20 OTHER CHEM	.000	.0609	1.962	44 LODGING	.000	.9893	2.809
21 PR&L PRD	.331	.1468	1.758	45 PER SRV	.149	16.9959	2.304
22 CHEM PRD	.238	1.4615	2.068	46 BUS SRV	1.203	3.8065	2.342
23 PETROL REF	1.507	3.0454	1.908	47 GOVT ENT	.033	.5858	2.260
24 GLAS PRD	.000	.0637	1.858	LABOR	34.750		

26. The economic impacts due to transportation cost savings are estimated by using the MRVIO solution of equation [5], $(I-TA)^{-1} \Delta TA$ X. To estimate the economic impacts of the transportation cost savings (Table 4), one enters the transportation cost savings into the computer code for the MRVIO program by origin region, destination region, and commodity classification.[5] The model then converts the transportation cost savings estimates into rates of transportation cost savings by dividing the savings by the total transportation traffic flowing between the origin region and destination region for the commodity affected by the savings. These rates of transportation cost savings, along with the input elasticities of the model, determine the equilibrium price changes that are consistent with the rates of transportation cost savings. The changes in the relative prices of inputs and outputs then alter the technical and trade relationships of the Red River MRIO Model (ΔTA) which, as a consequence, results in a new equilibration of the output levels produced by the industrial sectors in each region (X). These changes in equilibrium output levels, when multiplied by the Leontief inverse for the model, $(I-TA)^{-1}$, to estimate the changes in the direct and indirect output requirements of the economic system that are induced by the transportation cost savings.

27. The economic impacts induced by future growth are estimated, as for construction expenditures, by using the multiregional "final demand" input-output solution to equation [5], $(I-TA)^{-1}$ ΔY. Change in final demand (ΔY)

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[5]The computer code for the MRVIO program used to carry out the analysis described here is on a computer located at the U.S. Army Construction Engineering Laboratory in Champaign, Illinois.

related to the low and high growth scenarios (Table 3) are multiplied by the Leontief inverse of the model, $(I-TA)^{-1}$, to estimate the direct and indirect output requirements of the economic system that are induced by the growth scenarios.-

28. Hence, the output impacts are computed. The industrial output impacts of each region are converted into value added, income, and employment impacts by applying appropriate factors relating these variables to output for each industrial sector of each region. The analysis of these results is only summarized by region in the discussion below.

CONSTRUCTION ACTIVITY IMPACTS

29. Construction contractors use materials and supplies and hire workers to construct the Red River Navigation Project. The construction expenditures that stem from the project will cause the affected industries and households to purchase more goods and services. The multiregional "final demand" input-output solution of equation [5] traces the economic impacts of the construction expenditures in terms of output, value added, wage and salary income, and employment. The regional impact results due to construction activities are shown in Table 7.

TABLE 7
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO **DAINGERFIELD**, TEXAS, REACH
REEVALUATION STUDY
REGIONAL CONSTRUCTION PROJECT IMPACTS
(1990 Prices)

Year	Region	Construction Projects	**Output** ($ million)	Income ($ million)	Employment (man-years)
1995	Total Impacts	42.4	119.5	32.0	1,381
	Arkansas		1.1	0.2	10
	Louisiana		36.3	10.1	461
	Oklahoma		0.9	0.2	9
	Texas		46.9	12.7	569
	Rest of USA		34.3	8.8	332
1996	Total Impacts	53.1	149.6	40.1	1,732
	Arkansas		1.3	0.3	12
	Louisiana		45.5	12.6	579
	Oklahoma		1.1	0.3	11
	Texas		58.7	15.9	714
	Rest of USA		43.0	11.0	416
1997	Total Impacts	84.9	239.2	64.1	2,768
	Arkansas		2.1	0.5	19
	Louisiana		72.7	20.2	926
	Oklahoma		1.7	0.4	18
	Texas		94.0	25.4	1,140
	Rest of USA		68.7	17.6	665
1998	Total Impacts	95.5	269.1	72.2	3,113
	Arkansas		2.4	0.5	21
	Louisiana		81.7	22.8	1,041
	Oklahoma		2.0	0.5	20
	Texas		105.7	28.6	1,283
	Rest of USA		77.3	19.8	748
1999	Total Impacts	95.5	269.1	72.2	3,113
	Arkansas		2.4	0.5	21
	Louisiana		81.7	22.8	1,041
	Oklahoma		2.0	0.5	20
	Texas		105.7	28.6	1,283
	Rest of USA		77.3	19.8	748
2000	Total Impacts	53.1	149.6	40.1	1,732
	Arkansas		1.3	0.3	12
	Louisiana		45.5	12.6	579
	Oklahoma		1.1	0.3	11
	Texas		58.7	15.9	714
	Rest of USA		43.0	11.0	416

30. During the 6 years of anticipated construction, the first 2 and last years of construction activity are relatively more modest when compared with the 3 middle years. As expected, the years which have smaller construction expenditures yield smaller subsequent economic impacts (see Table 7). For example, in 1995 (the first year of construction), $42.4 million in construction spending creates 1,380 full-time jobs nationally, while during the 1998 and 1999 period, $95.5 million in construction activity generates over 3,000 full-time jobs.

31. Over the entire construction period (1995-2000), Louisiana is expected to receive approximately 30 percent of the direct and indirect economic impact in terms of output, 32 percent in terms of wage and salary income, and 33 percent in terms of full-time employment. Texas is expected to receive approximately 39 percent of the direct and indirect economic impact in terms of output, 40 percent in terms of wage and salary income and 41 percent in terms of full-time employment. Arkansas and Oklahoma are expected to receive a minor portion of the construction activity impacts. Approximately one-fourth of the construction impact will fall outside of the four-state Red River area.

TRANSPORTATION SAVINGS IMPACTS

32. Navigation impacts are those direct and indirect economic effects that result from the efficiencies created in the economic system from improving transportation facilities. Water transportation improvements on the Red River are'expected to lower the cost of transporting such bulky and heavy commodities as sand and gravel, coal, lumber and wood, refined petroleum products,

and iron and steel products. The MRVIO solution of equation [5] is used to analyze the economic impact of these transportation cost savings throughout the entire economic system, both by region and by industry. Table 8 provides the regional economic impacts of the transportation cost savings analysis of the proposed Red River Navigation Project.

TABLE 8
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
REGIONAL TRANSPORTATION COST SAVINGS IMPACTS
(1990 Prices)

Year	Region	Construction Projects	output ($ million)	Income ($ million)	Employment (man-years)
2001	Total Impacts	26.1	58.0	12.6	483
	Arkansas		0.1	0.0	0
	Louisiana		9.5	2.4	92
	Oklahoma		-0.5	-0.1	-6
	Texas		29.0	6.3	237
	Rest of USA		19.8	4.1	159
2010	Total Impacts	27.2	60.1	12.9	498
	Arkansas		0.1	0.0	0
	Louisiana		9.9	2.4	95
	Oklahoma		-0.5	-0.1	-6
	Texas		29.8	6.4	242
	Rest of USA		20.8	4.2	166
2020	Total Impacts	28.1	61.8	13.1	510
	Arkansas		0.1	0.0	0
	Louisiana		10.1	2.5	97
	Oklahoma		-0.5	-0.1	-6
	Texas		30.5	6.4	246
	Rest of USA		21.6	4.3	172
2030	Total Impacts	29.3	64.1	13.5	527
	Arkansas		0.1	0.0	0
	Louisiana		10.4	2.6	101
	Oklahoma		-0.5	-0.1	-6
	Texas		31.3	6.5	251
	Rest of USA		22.7	4.5	181

TABLE 8 (Cont)

Year	Region	Construction Projects	output ($ million)	Income ($ million)	Employment (man-years)
2040	Total Impacts	30.5	66.5	13.9	544
	Arkansas		0.1	0.0	0
	Louisiana		10.8	2.7	104
	Oklahoma		-0.5	-0.1	-6
	Texas		32.2	6.5	257
	Rest of USA		23.8	4.7	189
2050	Total Impacts	31.9	69.0	14.2	563
	Arkansas		0.1	0.0	0
	Louisiana		11.2	2.8	108
	Oklahoma		-0.5	-0.1	-6
	Texas		33.2	6.7	263
	Rest of USA		25.0	4.9	197

33. The Red River Navigation Project is expected to generate transportation cost savings that increase over time (Table 4), which will result in increasing economic impacts (Table 8). At the national level, transportation cost savings and economic impacts are expected to increase from $26.1 million during 2001 to $31.9 million during and after 2050. Nationally, output should increase subsequently from $58 million to $69 million, income should increase from $12.6 million to $14.2 million, and employment should increase from 480 to 560 full-time jobs.

34. Transportation savings impacts have a somewhat different spatial pattern than do the construction impacts. Generally, Louisiana will receive approximately 20 percent of the output, income, and employment impacts; Texas will experience 50 percent; and the area outside of the four-state Red River area will get about one-third. Interestingly, over time Texas' share of the impacts should decline slightly, while the share of the impact dispersing to the rest of the country should increase.

ALTERNATIVE DEVELOPMENT SCENARIOS

35. The process begun by new navigable waterways can lead to further development beyond the efficiency impacts of transportation cost savings. The primary benefits of navigation projects are the reductions in transport costs which make indigenous industries more competitive, thereby leading to firm expansions. This can be followed by expansions of economic opportunities not directly captured by the indigenous industries. That is, the subsequent reduction in production cost structure brought about by the transportation improvements can lead to such things as the entry of new firms. In some cases, the expansion may include the opening of undeveloped natural resources.

36. The economic impacts that stem from alternative development scenarios associated with the waterway improvements will cause the affected industries and households to purchase more goods and services. The multiregional "final demand" input-output solution of equation [5] traces the economic impacts of the alternative development scenarios in terms of output, value added, wage and salary income, and employment. Two future growth scenarios (low and high growth) are evaluated in this report. The regional impact results due to these alternative development scenarios are shown in Table 9.

TABLE 9
RED RIVER WATERWAY PROJECT
SHREVEPORT, LOUISIANA, TO DAINGERFIELD, TEXAS, REACH
REEVALUATION STUDY
ALTERNATIVE DEVELOPMENT SCENARIOS
(1990 Prices)

Alternative	Region	output ($ million)	Income ($ million)	Employment (man-years)
Low Growth	Total Impact	147.3	28.4	1,257
	Arkansas	1.1	0.2	8
	Louisiana	37.3	6.2	270
	Oklahoma	0.8	0.2	8
	Texas	69.7	12.9	630
	Rest of USA	38.3	9.0	341
High Growth	Total Impact	704.4	138.0	5,995
	Arkansas	5.2	0.9	40
	Louisiana	178.3	30.2	1,290
	Oklahoma	3.9	0.8	38
	Texas	330.7	62.2	2,971
	Rest of USA	186.4	43.9	1,657

37. Potential growth in the demand for goods and services in the Red River area of Louisiana and Texas due to waterway enhancement has been projected in a recent report prepared for the Red River Waterway Commission (1986). Low and high growth scenarios indicate the potential for substantial improvements in business and employment opportunities within Louisiana and Texas. Nationally, these opportunities could mean from $150 to $700 million in business expansion (industrial output) and from 1,300 to 6,000 new full-time jobs. The geographic dispersion of the impacts of the alternative development scenarios is interesting. Under the low and high growth scenarios, approximately 22 percent of the output, income, and employment impacts reside in Louisiana, 46 percent in Texas, and 27 percent in those states outside of the four-state Red River area.

38. A word of caution is warranted here. Although these effects can be substantial, they do not automatically appear because they require a regional effort beyond the placement or improvement of a waterway. The Red River Waterway Project can be a catalytic agent for major economic growth if it is used as a rallying point for the implementation of a regional growth strategy. The appropriate design and implementation of such a strategy depends on the cooperation and active participation of many individuals. Public officials, planning commissions, business groups, and the public have to'come together with a vision and resources in order to make use of opportunities that waterway improvements can provide.

SUMMARY AND CONCLUSIONS

39. This paper reports the results of an economic impact analysis of the segment of the Red River between Shreveport and Daingerfield. This project will generate construction activity that is estimated at about $424.5 million (1990 prices) by the Corps of Engineers. This will accrue during the construction period of 1995 to 2000. A Red River MRIO Model of the project area was compiled and calibrated during the evaluation process. The economic impacts of the project construction expenditures were estimated by the Red River MRIO Model, and the impacts generated by construction activity, transportation cost savings, and alternative development scenarios which stem from the project were estimated using the MRVIO mode, a "state-of-the-art" methodology.

40. During the 6 years of anticipated construction activity, the first 2 and last years of construction have relatively small levels of expenditures as compared with the 3 middle years (Table 1 or Table 7). For example, in 1995 (the first-year of construction), $42.4 million in construction spending creates 1,380 full-time jobs nationally, while during the 1998 and 1999 period, $95.5 million in construction activity generates over 3,000 full-time jobs.

41. During the operation of the Red River Navigation Project, it is estimated in terms of 1990 dollars that the generation of transportation cost savings will be $26.1 million in the year 2001 and increase to $31.9 million by the year 2050. Nationally, output associated with these savings should increase subsequently from $58 million to $69 million, income should increase from $12.6 million to $14.2 million, and employment should increase from 480 to 560 full-time jobs (Table 1 or Table 8).

42. Potential low and high growth scenarios indicate the potential for substantial improvements in business and employment opportunities within Louisiana and Texas. Nationally, these opportunities could mean from $150 to $700 million in business expansion (industrial output) and from 1,300 to 6,000 new full-time jobs.for the low and high growth scenarios (respectively).

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