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A REVIEW OF 16 PLANNING AND FORECAST METHODOLOGIES

Used in U.S. Army Corps of Engineers Inland Navigation Studies

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This manual is part of a larger R&D effort to develop procedures and guidelines for making consistent and systematic inland waterway traffic projections. The purpose of this manual is to review and assess traffic forecasting methodologies previously employed by project level and national level Corps of Engineers inland navigation studies. Inherent in this effort is the identification of data sources for economic, transportation, and commodity supply and demand forecasts.

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A REVIEW OF 16 PLANNING AND FORECAST METHODOLOGIES USED IN U.S. ARMY CORPS OF ENGINEERS INLAND NAVIGATION STUDIES

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EXECUTIVE SUMMARY

This report is part of a larger R&D effort to develop procedures and guidelines for making consistent and systematic inland waterway traffic projections. The purpose of this report is to review and assess traffic forecasting methodologies previously employed by project level and national level Corps of Engineers inland navigation studies. Inherent in this effort is the identification of data sources for economic, transportation, and commodity supply and demand forecasts.

Each of the 16 inland navigation studies reviewed is in some way unique, because individual waterway projects have unique physical features, geographic locations, traffic mixes and patterns, economic hinterlands, etc., that have to be addressed. However, the studies discussed still exhibit enough similarities to categorize their projection methodologies into four broad groups: (1) the application of independently derived commodity-specific annual growth rates to base year traffic levels; (2) shipper surveys of existing and potential waterway users to determine future plans to ship by barge; (3)statistical analysis using regression and correlation to predict future waterborne traffic based on independent economic variables; and, (4) a detailed long-range commodity supply-demand and modal split analysis incorporating the production and consumption patterns of individual economic regions within the waterway hinterland. The complexity of these methods varies widely, as does the time, effort, and expense invested in each. The general projection methodology and data sources incorporated in each of the reviewed inland navigation studies are summarized in Table 33 in the summary section of this report.

Most analysts would agree that the projection methodologies employed in Corps navigation studies should not be judged solely on the basis of forecasting accuracy for the simple reason that every forecast contains some degree of error. A sound methodology does not necessarily ensure an accurate forecast. Often macroeconomic changes or unpredictable political, fiscal, or meteorological events, for example, can defy all the presumptions of "conventional wisdom." How, then, should these methodologies be judged?

The answer depends on what kind of forecast the analyst requires: long-term or near-term; national, regional, or project-specific; definitive tonnage estimates or projection "envelopes"; needs assessment or benefit calculations; or, investment strategies or in supplementing planning efforts. To develop general guidelines with wide applicability, the most practical methodology appears to be one that uses a consistent set of macroeconomic assumptions in generating international, national, and regional level projections. In turn, these can be adapted by the Corps planners as a basic framework for further modifications derived from local knowledge and expertise, and applied in project level analysis. Credibility would thus be enhanced by the uniformity of national-level traffic totals and assumptions imbedded in individual project forecasts with overlapping time horizons. The development of general forecasting guidelines is most practical if it incorporates a methodology that is easily updatable based on the latest historic and forecast data, is relatively low cost for the project manager to implement, and is adaptable for use on microcomputer in a format available to any Corps planner.

The next phase of the waterway projection R&D effort will be to develop and document a projection methodology and to coordinate a field test at the project level with one or more divisions or districts. The methodology will be an attempt to synthesize national level commodity-driven projections developed for IWR's 1988 Inland Waterway Review with regional economic analysis and localized shipper/receiver data to develop specific forecasts. Also, IWR personnel will review software packages that have been developed for forecasting. Several existing programs enable forecasting to be done with limited data and/or provide techniques for risk analysis. Some of these software forecasting packages will be highlighted in the follow-up report.

ACKNOWLEDGMENTS

This document has been prepared as part of an Institute for Water Resources Research & Development work unit on Planning Methodologies. A Final Report will present guidelines and recommendations for inland navigation transportation forecasts by commodity and waterway in FY1992. The authors for this report were David V. Grier, IWR Navigation Division, and L. Leigh Skaggs, IWR Research Division. The authors gratefully acknowledge valuable assistance in completing this report from Dan Badger, Shipla Patel and Jack Lane of the IWR Navigation Division.

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INTRODUCTION

Inland waterway traffic projections are important elements in the U.S. Army Corps of Engineers' planning process for determining navigation project benefits. With the emphasis on non federal cost sharing resulting from the Water Resources Development Act of 1986, the importance of Nationally consistent traffic demand estimates will increase. At present no consistent set of waterway traffic demand projections are available for use by project managers and water resource planners. Consequently, analysts must devise ad hoc procedures to produce project-specific waterway projections. This has resulted in a wide variety of approaches for traffic demand projections within the Corps, generally producing inconsistent results from one project study to another.

The Institute for Water Resources (IWR) has been directed to study and address the problem of inconsistencies in Corps of Engineers projection methodologies. The objective of the study is to develop procedures and guidelines for making consistent and systematic inland waterway traffic demand projections that fit within a national network of regional production and consumption patterns and which account for traffic projections carried by other modes of transportation. The scope of work calls for developing a methodology for inland waterway traffic demand projections by river reach and by commodity detail, to be reviewed by representatives from Corps divisions and districts.

Component tasks of IWR's research include preparing a report reviewing traffic demand projection methodologies used in recent inland navigation project level and national level Corps reports and identifying sources of information for economic, transportation, and commodity production and consumption forecasts; development of a projection methodology synthesized from an assessment of previous Corps work, regional input/output analysis, and contract forecast services; field review and testing of the projection methodology to develop sample traffic forecasts at the project level; final refinements and enhancements of the methodology incorporating appropriate changes and modifications to techniques and data inputs; generating a final set of general inland waterway traffic projections at the national level, along with waterway and lock level projections for districts participating in the field test; preparing a report/manual documenting the projection methodology and guidelines; and conducting a seminar for all interested field offices to review the approach and practical applications at the field level.

This report reviews and briefly assesses previous Corps forecasting techniques and identifies data sources for commodity demand and supply and economic forecasts used in U.S. Army Corps of Engineers inland navigation studies completed between 1974 and 1990. These studies were conducted by and/or contracted by Corps districts to determine the feasibility of specific inland navigation projects within their jurisdictions. The economic analyses incorporated in many of these feasibility studies were used in the justification of inland navigation projects presently under construction or in preconstruction engineering and design phases. The 16 navigation studies reviewed in this report include:

- Lower Mississippi Region Comprehensive Study
- Comprehensive Master Plan for the Management of the Upper Mississippi River System
- Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980-2040
- Gallipolis Lock and Dam Replacement
- Monongahela River Navigation System, Locks and Dams 7 and 8
- Lower Ohio River Navigation Feasibility: (Mouth to Cumberland River)
- Forecast of Future Ohio River Basin Waterway Traffic: 1986-2050
- Kanawha River Navigation, Winfield Lock Replacement
- Supplement to the Environmental Impact Statement: Tennessee-Tombigbee Waterway
- Operational Forecast for Initial Traffic on the Tennessee-Tombigbee Waterway
- Oliver Lock Replacement
- Bonneville Navigation Lock, Columbia River

- Mississippi River Gulf Outlet New Lock and Connecting Channels
- Montgomery Point Lock and Dam
- The National Waterways Study - A Framework for Decision Making - Final Report
- 1988 Inland Waterway Review

While Corps planning for waterway improvements is centered at the district and division level, the Corps also has undertaken national level navigation studies to provide an integrated system overview and to rank specific project needs for planning, design, construction, and operation of the inland waterways system. Reviews of the projection methodologies incorporated in the National Waterways Study (NWS) and The 1988 Inland Waterway Review, both published by IWR, also are included in this report. Despite the similarity of both studies' national system (versus project-specific) outlooks, the NWS represented a massive multi-year effort addressing waterborne traffic projections for domestic and foreign commerce at both coastal ports and on the inland waterways, and included share analysis for competing modes of transportation (e.g., pipelines and rail). Specific recommendations regarding investment strategies and schedules based on these projections were part of the assessment. The purpose of The 1988 Inland Waterway Review, on the other hand, was to provide useful information on waterway performance, traffic trends, and projections to help supplement the planning efforts of Corps districts and divisions and the Congressionally-mandated Inland Waterways Users Board.

A critical element in the process of determining benefits for a potential navigation project is the estimation of future traffic expected to use the project. In some instances districts have invested considerable time, effort, and expense into developing comprehensive traffic projections for a number of projects. On the other hand, other districts have had to prepare projections under much greater budget and time constraints, and were compelled to draw on existing projections with only minor modifications. Unfortunately, no uniform set of national waterway forecasts has been available on a timely and recurring basis. Compounding this lack of consistency, district planners employ a wide variety of projection methodologies in their individual economic analyses. A review of the 16 Corps inland navigation studies indicates that several unique forecasting procedures were used. While each project always will have unique features to be addressed in developing traffic projections, the use of consistent macroeconomic assumptions will enhance the credibility of all the forecasts.

The individual methodologies from each project report can be grouped into several general categories. One procedure involves multiplying a base year traffic level by commodity-specific annual growth rates. These increases may vary over different time periods, but total traffic in any given year can simply be computed by aggregating the individual commodity traffic levels. Variations on this method were used for projections of waterborne commerce at Winfield Lock (Kanawha River), Oliver Lock (Black Warrior River), Industrial Canal Lock (Gulf Intracoastal Waterway), Bonneville Lock (Columbia River), the Upper Mississippi River Comprehensive Master Plan (Locks and Dam 26, Second Chamber), and the Lower Mississippi Region Comprehensive Study. In addition, both national level reports published by IWR used this type of projection method. The forecasts used in the Winfield Study were both commodity specific and specific to the BEA areas receiving waterborne commodity traffic.

A second group of studies employed a "shipper survey" method in which existing and potential waterway users (utilities, factories, mills, distributors, military installations, exporters, terminal operators, etc.) were interviewed to determine their future plans to ship by barge. Responses then were aggregated to yield total projections. This "bottom-up" approach was used in the Nathan Associates Ohio River Basin Study and the Mobile District's restudy, and in operational forecasts for the Tennessee-Tombigbee Waterway. Other reports (e.g., Monongahela Locks 7 and 8, Ohio Locks 52 and 53, Gallipolis Locks, and Bonneville Lock), while not relying on shipper surveys exclusively, did incorporate survey and interview techniques in establishing future traffic flows.

A third methodology was used the Ohio River Basin Study and the Bonneville Navigation Lock Study. These studies correlated historic waterborne traffic in various commodities to such independent variables as time, population, employment by industry, earnings by industry, and personal income. Regression equations were developed that best "explained" the historic pattern for each commodity group. Future values of the independent variables were obtained from the Bureau of Economic Analysis' OBERS national and regional projections series. These government estimates then were plugged into the regression equations to yield future values for waterborne traffic.

A final method, developed by the consulting firm Robert R. Nathan Associates for the Ohio River Division, provided the basis for several reports, including Monongahela Locks 7 and 8, Ohio Locks 52 and 53, and Gallipolis Locks. This approach included a long-term evaluation of waterway traffic demands based upon an analysis of market demands for waterborne commodities, the Ohio River basin's resource base of these commodities, probable long-term production levels, and a forecast of the transportation modes involved in moving these commodities from production areas to consumption areas.

A brief description of the forecasting methods and commodity projections for each of the reviewed studies is presented in this report. The projections are compared to other studies, if appropriate, and to actual events, that is, how well did the forecasts predict what actually took place. The sources of information for each report's projections also are identified, as well as their usefulness and currency.

REVIEW OF FORECASTS AND METHODS

1. Lower Mississippi Region Comprehensive Study, Appendix J, Navigation, **Lower Mississippi Region Comprehensive Study Coordinating Committee, 1974.**

The purpose of the 1974 Lower Mississippi Region Comprehensive Study was to make a broad determination of the region's navigation needs for the 50-year period, 1970-2020, analyzed under two objectives: national income and regional development. Part of the needs assessment was dependent upon projected waterborne traffic levels through 2020. The study used 1970 base year tonnage data from Waterborne Commerce of the United States. The waterborne share of total commerce moving through the Lower Mississippi Region was assumed to maintain at least its 1970 proportion of total traffic.

Future waterborne commerce in selected commodity categories was projected by applying growth rates to 1970 base year traffic. One set of growth rates was obtained from OBERS indexes of economic growth in selected industries for particular BEA regions. These indices of growth rates by major industry groups (Program A) were used to forecast regional development. Growth rates in agriculture were used to forecast grain traffic; growth rates in mining were used to forecast coal traffic; the average of growth rates in mining and refining were used to forecast petroleum traffic; growth rates in quarrying to forecast aggregates traffic; growth rates in primary metals to forecast iron and steel traffic; and growth rates in chemicals to forecast industrial chemical traffic. Another set of indices (Program B) were developed to reflect a regional growth in employment equal to the national average of 1.4 percent annually. Application of both sets of indexes to base year ton miles provided projections of ton miles by river segment for 1980, 2000, and 2020 (Table 1).

The utility of this study's projections is somewhat weakened by the dated nature of the base year traffic levels and the obsolescence of 1967 OBERS growth indices.

TABLE 1

ACTUAL AND PROJECTED COMMERCE, LOWER MISSISSIPPI RIVER REGION 1970-2020

(Million Ton Miles)

Reach	Actual 1970	Program A 1980	Program A 2000	Program A 2020	Program B 1980	Program B 2000	Program B 2020
				Shallow Draft			
Mouth of Ohio R. to Baton Rouge, La.	49,808	67,645	121,647	229,022	73,689	146,474	301,901
Baton Rouge to New Orleans, La.	6,700	9,089	16,254	31,069	9,959	20.035	41,765
New Orleans, La. to Gulf of Mexico	1,913	2,549	4,365	8,027	2,810	5,364	10,731
Total	58,421	79,283	142,266	268,118	86,458	171,873	354,397
				Oceangoing			
Mouth of Ohio R. to Baton Rouge, La.[1/]	189	282	635	1,398	312	823	2,010
Baton Rouge, La. to New Orleans, La.	2,994	4,011	6,782	12,293	4,325	8,272	16,301
New Orleans, La. to Gulf of Mexico	9,373	12,436	20,819	37,401	13,357	25,357	49,641
Total	12,556	16,729	28,236	51,092	18,163	34,452	67,952

1/ Shallow-draft ocean commerce

SOURCE: Lower Mississippi Region Comprehensive Study. Appendix J. Navigation, 1974 (Table 18)

The projection methodology, while used effectively in several other navigation studies, appear in this case to be too generic. Applying OBERS productivity indexes for various industries to base traffic levels does not necessarily correlate with increased traffic for a given commodity group. Potentially more important determinants of demand for commodities moving on the waterway were not fully considered. Grain, coal, and petroleum products movements, the three major commodity groups on the Lower Mississippi River, are influenced to a great extent by U.S. and world demand for food and energy products than by productivity gains in agriculture, mining, and refining. Use of additional data sources would have enhanced credibility of the projections.

2. **Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A: Navigation and Technical Report, Upper Mississippi River Basin Commission, October 1981.**

This report was written with considerable Corps of Engineers input; in fact, several members of the Commission were Corps personnel. The Corps' economic analysis of Lock and Dam 26 (Second Chamber), located on the Mississippi River above St. Louis, incorporated commodity traffic projections directly from the Comprehensive Master Plan.

The Comprehensive Master Plan study projected commodity and lock traffic on the Upper Mississippi (above St. Louis) and Illinois Rivers through 2040. Although 1980 was used for the base year for commodity movements, the 1980 figures were estimated from National Waterways Study (NWS) projections. Likewise, forecasts were developed using the NWS growth rates (which were finalized in the fall of 1980). Commodity-specific growth rates from NWS were applied to 1980 base year traffic to yield forecasts of traffic tonnages for 1990, 2000, 2010, and 2040. Tables 2-7 from the Comprehensive Master Plan that present the implicit forecast commodity growth rates (assimilated from the National Waterways Study) and forecast tonnages by lock for the Upper Mississippi and Illinois River segments (developed by the Basin Commission) are reproduced here. Some assumptions imbedded in the NWS forecasts are described below.

TABLE 2

NATIONAL WATERWAYS STUDY GROWTH RATES
(Annual Percentages)

GROWTH RATES	FARM PRODUCTS			METALLIC ORES			COAL			CRUDE PETROLEUM			NON METALLIC MINERALS			FOOD & KINDRED PRODUCTS			LUMBER & WOOD		
UPPER MISSISSIPPI*	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L
1977-1990	4.3	0.3	0.5	1.7	1.7	0.0	10.4	5.6	9.7	(0.4)	(0.8)	0	(2.1)	(2.4)	(2.3)	4.5	0.5	(2.2)	3.4	5.1	8.1
1991-2003	3.1	0.3	0.4	1.3	1.3	0.0	3.0	1.9	2.5	0.7	(0.1)	0	(2.0)	(1.1)	(1.6)	2.0	0.5	2.2	0.5	0.6	0.0
1991-2000	3.5	0.3	0.3	1.1	1.2	0.0	3.4	2.1	2.8	0.7	(0.1)	0	(1.5)	(1.0)	(1.3)	1.8	0.5	2.9	0.5	0.7	0.0
2001-2003	2.0	0.3	0.9	1.7	1.3	0.0	1.5	1.0	1.3	0.7	0.1	0	(3.9)	(1.8)	(2.9)	2.8	0.5	0.0	1.6	0.0	0.0
ILLINOIS RIVER																					
1977-1990	2.0	0.0	0.1	0.2	5.5	0.0	3.1	4.5	4.3	(0.8)	(0.8)	0	(1.9)	(1.9)	(1.9)	4.3	0.8	1.6	0.7	1.1	0.0
1991-2003	3.3	0.0	0.1	0.2	2.4	0.0	1.7	2.0	1.6	0.1	0.0	(0.8)	(1.8)	(1.3)	(1.5)	2.0	1.0	0.7	0.3	1.0	0.0
1991-2000	3.7	0.0	0.1	0.1	2.4	0.0	1.9	2.3	1.9	0.0	(0.2)	(1.1)	(1.3)	(1.1)	(1.2)	1.8	1.0	0.9	0.5	1.3	0.0
2001-2003	1.8	0.0	0.0	0.5	2.8	0.0	0.9	1.0	0.8	0.4	0.6	0	(3.4)	(1.7)	(2.4)	2.8	1.1	0.0	0.0	0.0	0.0

GROWTH RATES	PULP PAPER			CHEMICALS			PET & COAL PRODUCTS			STONE CLAY & GLASS PRODUCTS			PRIMARY METALS			WASTE & SCRAP			OTHER		
UPPER MISSISSIPPI	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L	S	R	L
1977-1990	2.4	0.8	0.0	4.0	3.8	3.9	0.0	(0.5)	(0.2)	1.5	1.5	1.5	0.4	2.0	1.7	2.6	2.0	0.0	0.5	0.1	0.2
1991-2003	2.1	0.4	0.0	3.3	3.2	3.2	0.2	(0.1)	0.1	0.6	0.6	0.6	0.5	1.6	1.5	0.2	0.9	0.0	0.7	0.2	0.3
1991-2000	7.2	0.0	0.0	4.4	4.3	4.3	0.2	(0.2)	0.1	0.4	0.5	0.4	0.5	1.6	1.4	0.0	0.0	0.0	0.5	0.3	0.3
2001-2003	0.0	0.0	0.0	0	(.6)	(.5)	0.2	(0.1)	0.1	1.3	1.3	1.3	1.0	1.6	1.7	0.7	14.5	0.0	0.8	0.2	0.4
ILLINOIS RIVER																					
1977-1990	0.0	2.4	2.4	3.1	3.6	3.5	(0.7)	(1.0)	(1.3)	2.2	2.8	2.8	1.2	1.9	1.5	(1.1)	(2.0)	(3.7)	3.8	3.8	3.9
1991-2003	0.0	2.1	2.1	3.1	3.1	3.1	0.0	0.0	(0.5)	1.3	1.8	1.8	1.3	1.5	1.3	(0.9)	(1.3)	(2.9)	3.4	3.4	3.4
1991-2000	0.0	2.1	2.1	3.1	3.4	3.4	0.0	0.0	(0.6)	1.1	1.6	1.6	1.3	1.5	1.3	(1.0)	(1.5)	(3.1)	3.3	3.3	3.3
2001-2003	0.0	2.0	2.0	2.8	2.0	2.0	0.2	0.2	(0.1)	2.0	2.4	2.4	1.4	1.5	1.3	(0.5)	(0.8)	(2.5)	3.9	3.6	3.6

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.5, page 1-14)

S = Shipped; R = Received; L = Local

* NWS disaggregated the Upper Mississippi into two regions. The lower of these two regional growth rates was selected as the more appropriate rate from the NWS baseline scenario.

TABLE 3

UNCONSTRAINED FLOWS BY LOCK AND COMMODITY
YEAR 1980
(Thousands of Tons)

LOCK	FARM PRODUCTS	METALLIC ORES	COAL	CRUDE PETROLEUM	NON-METALLIC MINERALS	FOOD & KINDRED PRODUCTS	LUMBER & WOOD	PULP & PAPER	CHEMICALS	PETROLEUM & COAL PRODUCTS	STONE, CLAY & GLASS PRODUCTS	PRIMARY METALS	WASTE & SCRAP	OTHER	TOTAL
Lockport	1865	9	5329	143	2725	241	76	31	3748	3241	609	2161	302	133	20612
Brandon Rd.	2428	9	5383	143	2419	243	81	31	4159	3725	609	2183	302	268	21982
Dresden Is.	2428	9	5509	155	2743	286	81	31	4585	4542	611	2184	303	483	23949
Marseilles	4256	10	5390	155	1260	286	82	31	5000	5091	611	2194	303	484	25151
Starved Rk.	5810	10	5569	155	1031	286	82	31	5023	5091	612	2194	303	485	26700
Peoria	12140	10	6609	155	899	307	82	31	5359	5334	653	2139	314	481	34511
LaGrange	17097	10	2584	155	909	311	84	31	5237	6242	667	1925	241	486	35976
L&D 1	1017	12	949	0	564	24	0	9	17	95	163	64	19	11	2945
L&D 2	8070	13	2042	512	199	219	0	10	854	1044	172	163	22	341	13662
L&D 3	8070	13	1788	512	199	219	0	10	860	1067	172	163	22	341	13437
L&D 4	8569	13	1804	512	200	247	0	10	860	1067	172	209	22	341	14026
L&D 5	8569	13	1828	512	200	247	0	10	860	1067	172	209	22	341	14049
L&D 5A	8569	13	1828	512	200	247	0	10	860	1067	172	209	22	341	14049
L&D 6	9375	13	1857	512	217	247	0	10	945	1127	172	211	22	341	15050
L&D 7	9375	13	1857	512	217	247	0	10	945	1127	172	211	22	341	15050
L&D 8	9565	13	1810	512	228	247	0	10	947	1127	215	211	22	341	15248
L&D 9	9565	13	2693	512	228	247	0	10	948	1127	215	211	22	341	16132
L&D 10	10654	13	2693	512	251	247	0	10	955	1127	215	221	22	341	17261
L&D 11	10654	13	2989	512	251	247	0	10	955	1127	215	250	22	348	17592
L&D 12	11644	13	3018	512	326	310	0	10	1186	1030	215	250	22	350	18886
L&D 13	11732	13	3018	512	326	310	0	10	1196	1030	215	250	22	352	18987
L&D 14	13195	13	3375	513	742	310	0	10	1586	1038	215	254	22	354	21628
L&D 15	13652	13	3388	513	361	310	0	10	1603	1790	363	258	30	354	22645
L&D 16	15460	13	3543	513	516	398	11	10	1681	1849	420	267	29	352	25063
L&D 17	16311	13	3617	513	505	426	11	10	1764	1849	420	267	29	343	26078
L&D 18	17273	13	3617	513	505	426	11	10	1764	1849	420	267	29	340	27039
L&D 19	19385	14	3621	513	591	426	11	15	1894	1910	420	268	29	340	29437
L&D 20	19605	17	3636	513	594	425	11	15	1901	1917	420	275	29	341	29698
L&D 21	20511	27	3636	513	599	528	11	15	1920	2164	420	284	29	341	30999
L&D 22	20747	27	3639	513	599	528	11	15	1974	2179	503	284	34	341	31395
L&D 24	21025	27	3661	513	600	549	11	15	2119	2179	872	287	34	341	32232
L&D 25	21143	27	3661	513	600	549	11	15	1997	2179	872	287	34	428	32316
L&D 26	41423	37	6353	667	1515	850	112	46	7068	8544	913	2152	210	1166	71115
L&D 27	44576	48	6093	681	1634	1148	120	53	7746	10380	907	[illegible]	291	1307	77381

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.7, page 1-19)

TABLE 4

UNCONSTRAINED FLOWS BY LOCK AND COMMODITY
FORECAST YEAR 1990
(Thousands of Tons)

LOCK	FARM PRODUCTS	METALLIC ORES	COAL	CRUDE PETROLEUM	NON-METALLIC MINERALS	FOOD & KINDRED PRODUCTS	LUMBER & WOOD	PULP & PAPER	CHEMICALS	PETROLEUM & COAL PRODUCTS	STONE, CLAY & GLASS PRODUCTS	PRIMARY METALS	WASTE & SCRAP	OTHER	TOTAL
Lockport	2199	14	8121	132	2249	291	85	39	5273	2934	802	2512	246	193	25092
Brandon Rd.	2844	14	8204	132	1997	293	90	39	5858	3363	802	2539	246	389	26811
Dresden Is.	2844	14	8396	143	2264	340	90	39	6463	4092	805	2540	247	702	28979
Marseilles	5108	16	8216	143	1040	340	91	39	7052	4580	805	2553	247	703	30930
Starved Rk.	7026	16	8488	143	851	340	91	39	7085	4580	805	2553	247	704	32968
Peoria	14745	16	10113	143	742	363	91	39	7563	4820	858	2487	260	699	42936
LaGrange	20787	16	3983	143	750	371	93	39	7395	5650	875	2241	210	706	43258
L&D 1	1521	14	1639	0	447	36	0	10	25	93	190	76	19	13	4082
L&D 2	12182	16	3512	472	157	290	0	11	1242	1005	199	191	22	350	19649
L&D 3	12182	16	3078	472	157	290	0	11	1250	1027	199	191	22	350	19245
L&D 4	12939	16	3105	472	158	332	0	11	1250	1027	199	245	22	350	20126
L&D 5	12939	16	3146	472	158	332	0	11	1250	1027	199	245	22	350	20167
L&D 5A	12939	16	3146	472	158	332	0	11	1250	1027	199	245	22	350	20167
L&D 6	14171	16	3197	472	171	332	0	11	1374	1086	199	247	22	350	21649
L&D 7	14171	16	3197	472	171	332	0	11	1374	1086	199	247	22	350	21649
L&D 8	14461	16	3116	472	179	332	0	11	1376	1086	249	247	22	350	21918
L&D 9	14461	16	4627	472	179	332	0	11	1378	1086	249	247	22	350	23430
L&D 10	16120	16	4627	472	197	332	0	11	1388	1086	249	259	22	350	25130
L&D 11	16120	16	5132	472	197	332	0	11	1388	1086	249	289	22	359	25674
L&D 12	17628	16	5182	472	256	416	0	11	1724	992	249	289	22	362	27618
L&D 13	17721	16	5182	472	256	416	0	11	1739	992	249	289	22	364	27728
L&D 14	19987	16	5794	473	585	416	0	11	2308	1000	249	294	22	366	31521
L&D 15	20572	16	5816	473	283	416	0	11	2332	1735	421	299	30	366	32770
L&D 16	23383	16	6082	473	405	533	17	11	2446	1791	487	310	30	364	36347
L&D 17	24659	16	6208	473	396	562	17	11	2567	1791	487	310	30	354	37882
L&D 18	26144	16	6208	473	396	562	17	11	2567	1791	487	310	30	352	39365
L&D 19	29411	17	6215	473	464	562	17	17	2753	1851	487	311	30	351	42959
L&D 20	29748	21	6240	473	466	561	17	17	2763	1858	487	319	30	352	43352
L&D 21	31123	31	6240	473	470	720	17	17	2791	2100	487	330	30	352	45181
L&D 22	31483	31	6245	473	470	720	17	17	2870	2114	605	330	35	353	45761
L&D 24	31912	31	6288	473	471	750	17	17	3076	2114	1060	333	35	353	46928
L&D 25	32091	31	6288	473	471	750	17	17	2898	2114	1060	333	35	441	47019
L&D 26	57149	48	10466	616	1224	1112	127	56	10058	7889	1113	3523	258	1388	94227
L&D 27	61260	61	10064	620	1319	1355	141	62	11055	9819	1107	2731	285	1575	101460

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.8, page 1-20)

TABLE 5

UNCONSTRAINED FLOWS BY LOCK AND COMMODITY
FORECAST YEAR 2000
(Thousands of Tons)

LOCK	FARM PRODUCTS	METALLIC ORES	COAL	CRUDE PETROLEUM	NON-METALLIC MINERALS	FOOD & KINDRED PRODUCTS	LUMBER & WOOD	PULP & PAPER	CHEMICALS	PETROLEUM & COAL PRODUCTS	STONE, CLAY & GLASS PRODUCTS	PRIMARY METALS	WASTE & SCRAP	OTHER	TOTAL
Lockport	3009	18	9812	131	1996	331	96	49	7318	2920	939	2868	209	267	29962
Brandon Rd.	3053	18	9912	131	1773	332	102	49	8136	3328	939	2899	209	539	32217
Dresden Is.	3053	18	10143	141	2011	384	102	49	8981	4026	942	2900	210	971	34732
Marseilles	7101	19	9929	141	925	384	103	49	9801	4500	942	2915	210	972	38071
Starved Rk.	9940	19	10258	141	758	384	103	49	9847	4500	943	2915	210	974	41042
Peoria	21095	19	12322	141	662	410	103	49	10515	4776	1002	2839	223	967	55121
LaGrange	29784	19	4934	141	669	420	106	49	10280	5621	1023	2561	187	977	56769
L&D 1	2121	16	2153	0	393	43	0	10	37	93	197	88	19	14	5185
L&D 2	17089	18	4609	467	140	338	0	13	1893	997	207	220	22	363	26375
L&D 3	17089	18	4037	467	140	338	0	13	1905	1020	207	220	22	363	25838
L&D 4	18154	18	4073	467	141	388	0	13	1905	1020	207	281	22	363	27051
L&D 5	18154	18	4118	467	141	388	0	13	1905	1020	207	281	22	363	27096
L&D 5A	18154	18	4118	467	141	388	0	13	1905	1020	207	281	22	363	27096
L&D 6	19896	18	4179	467	153	388	0	13	2094	1079	207	284	22	363	29162
L&D 7	19896	18	4179	467	153	388	0	13	2094	1079	207	284	22	363	29162
L&D 8	20304	18	4073	467	161	388	0	13	2097	1079	259	284	22	363	29527
L&D 9	20304	18	6042	467	161	388	0	13	2100	1079	259	284	22	363	31498
L&D 10	22644	18	6042	467	177	388	0	13	2116	1079	259	298	22	363	33885
L&D 11	22644	18	6707	467	177	388	0	13	2116	1079	259	329	22	375	34594
L&D 12	24771	18	6768	467	230	484	0	13	2625	983	259	329	22	378	37347
L&D 13	24868	18	6768	467	230	484	0	13	2648	983	259	329	22	380	37469
L&D 14	28097	18	7564	469	520	484	0	13	3513	992	259	335	22	382	42667
L&D 15	28828	18	7592	469	255	484	0	13	3550	1733	438	341	30	382	44132
L&D 16	32840	18	7934	469	366	619	18	13	3724	1790	507	353	30	380	49059
L&D 17	34624	18	8097	469	358	650	18	13	3908	1790	507	353	30	370	51203
L&D 18	36734	18	8097	469	358	650	18	13	3908	1790	507	353	30	367	53311
L&D 19	41385	19	8106	469	419	650	18	18	4186	1851	507	354	30	367	58377
L&D 20	41864	23	8137	469	421	649	18	18	4201	1857	507	364	30	368	58924
L&D 21	43797	35	8137	469	425	838	18	18	4244	2101	507	376	30	368	61362
L&D 22	44306	35	8143	469	425	838	18	18	4364	2115	652	376	34	368	62161
L&D 24	44915	35	8201	469	426	873	18	18	4663	2115	1155	379	34	368	63668
L&D 25	45168	35	8201	469	426	873	18	18	4391	2115	1155	379	34	460	63742
L&D 26	81430	55	13445	610	1099	1284	142	67	14343	7889	1218	2895	239	1663	126378
L&D 27	86193	70	12935	624	1181	1606	157	73	15878	9862	1211	3140	267	1810	135006

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.9, page 1-21)

TABLE 6

UNCONSTRAINED FLOW BY LOCK AND COMMODITY
FORECAST YEAR 2010
(Thousands of Tons)

LOCK	FARM PRODUCTS	METALLIC ORES	COAL	CRUDE PETROLEUM	NON-METALLIC MINERALS	FOOD & KINDRED PRODUCTS	LUMBER & WOOD	PULP & PAPER	CHEMICALS	PETROLEUM & COAL PRODUCTS	STONE, CLAY & GLASS PRODUCTS	PRIMARY METALS	WASTE & SCRAP	OTHER	TOTAL
Lockport	3526	23	10631	137	1581	392	96	59	9080	2971	1190	3298	190	381	33555
Brandon Rd.	4496	23	10739	137	1406	394	102	59	10077	3377	1190	3333	190	768	36290
Dresden Is.	4496	23	10990	148	1604	452	102	59	11109	4075	1194	3335	191	1400	39177
Marseilles	8507	25	10759	148	749	452	103	59	12116	4551	1194	3352	191	1401	43607
Starved Rk.	11805	25	11116	148	618	452	103	59	12173	4551	1195	3352	191	1404	47192
Peoria	25164	25	13409	148	545	480	103	59	12987	4850	1267	3268	204	1393	63904
LaGrange	35549	25	5414	148	552	497	106	59	12701	5720	1293	2954	176	1408	66603
L&D 1	2577	19	2446	0	296	57	0	10	36	94	225	102	19	17	5896
L&D 2	20798	21	5235	472	114	417	0	13	1787	995	236	256	22	381	30746
L&D 3	20798	21	4585	472	114	417	0	13	1798	1018	236	256	22	381	30129
L&D 4	22096	21	4624	472	115	484	0	13	1798	1018	236	326	22	381	31605
L&D 5	22096	21	4672	472	115	484	0	13	1798	1018	236	326	22	381	31652
L&D 5A	22096	21	4672	472	115	484	0	13	1798	1018	236	326	22	381	31652
L&D 6	24220	21	4739	472	125	484	0	13	1977	1078	236	329	22	381	34095
L&D 7	24220	21	4739	472	125	484	0	13	1977	1078	236	329	22	381	34095
L&D 8	24718	21	4617	472	131	484	0	13	1980	1078	295	329	22	381	34539
L&D 9	24718	21	6847	472	131	484	0	13	1982	1078	295	329	22	381	36772
L&D 10	27570	21	6847	472	145	484	0	13	1997	1078	295	346	22	381	39669
L&D 11	27570	21	7604	472	145	484	0	13	1997	1078	295	380	22	399	40479
L&D 12	30162	21	7672	472	189	601	0	13	2484	981	295	380	22	402	43694
L&D 13	30269	21	7672	472	189	601	0	13	2505	981	295	380	22	404	43824
L&D 14	34217	21	8573	473	406	601	0	13	3332	990	295	387	22	406	49734
L&D 15	35075	21	8605	473	209	601	0	13	3366	1739	498	394	30	406	51429
L&D 16	39981	21	8989	473	303	768	20	13	3532	1796	577	409	30	404	57315
L&D 17	42150	21	9172	473	298	802	20	13	3703	1796	577	409	30	394	59857
L&D 18	44728	21	9172	473	298	802	20	13	3705	1796	577	409	30	391	62432
L&D 19	50411	22	9182	473	349	802	20	18	3983	1857	577	409	30	390	68522
L&D 20	50995	27	9218	473	350	800	20	18	3998	1863	577	420	30	392	69180
L&D 21	53350	41	9218	473	354	1047	20	18	4038	2110	577	434	30	392	72100
L&D 22	53971	41	9224	473	354	1047	20	18	4150	2123	768	435	34	392	73051
L&D 24	54714	41	9290	473	354	1093	20	18	4482	2123	1376	438	34	392	74849
L&D 25	55023	41	9290	473	354	1093	20	18	4224	2123	1376	438	34	487	74995
L&D 26	98455	67	15082	622	912	1582	144	77	16524	8014	1454	3350	230	2099	140613
L&D 27	104004	83	14518	637	971	1907	159	83	17954	10014	1446	3640	256	2180	157852

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.10, page 1-22)

TABLE 7

UNCONSTRAINED FLOWS BY LOCK AND COMMODITY
FORECAST YEAR 2040
(Thousands of Tons)

LOCK	FARM PRODUCTS	METALLIC ORES	COAL	CRUDE PETROLEUM	NON-METALLIC MINERALS	FOOD & KINDRED PRODUCTS	LUMBER & WOOD	PULP & PAPER	CHEMICALS	PETROLEUM & COAL PRODUCTS	STONE, CLAY & GLASS PRODUCTS	PRIMARY METALS	WASTE & SCRAP	OTHER	TOTAL
Lockport	4091	27	11630	137	1581	455	99	61	11193	3155	1382	3830	190	442	38276
Brandon Rd.	5220	27	11748	137	1406	457	105	61	12422	3585	1382	3871	190	892	41502
Dresden Is.	5220	27	12023	148	1604	525	105	61	13694	4326	1386	3873	191	1625	44808
Marseilles	9070	29	11770	148	749	525	106	61	14936	4832	1386	3892	191	1626	50129
Starved Rk.	13700	29	12161	148	618	525	106	61	15006	4832	1387	3892	191	1630	54294
Peoria	29722	29	14669	148	545	557	106	61	16010	5149	1471	3795	204	1618	73585
LaGrange	41263	29	5923	148	552	577	109	61	15657	6072	1502	3430	176	1634	77153
L&D 1	2922	22	2676	0	296	66	0	11	44	100	261	118	19	19	6623
L&D 2	24153	24	5727	472	114	484	0	13	2203	1056	274	297	22	442	35281
L&D 3	24153	24	5015	472	114	484	0	13	2217	1081	274	297	22	442	34607
L&D 4	25661	24	5059	472	115	562	0	13	2217	1081	274	378	22	442	36318
L&D 5	25661	24	5110	472	115	562	0	13	2217	1081	274	378	22	442	36369
L&D 5A	25661	24	5110	472	115	562	0	13	2217	1081	274	378	22	442	36369
L&D 6	28127	24	5184	472	125	562	0	13	2436	1144	274	382	22	442	29207
L&D 7	28127	24	5184	472	125	562	0	13	2436	1144	274	382	22	442	39207
L&D 8	28705	24	5051	472	131	562	0	13	2440	1144	343	382	22	442	39703
L&D 9	28705	24	7491	472	131	562	0	13	2443	1144	343	382	22	442	42173
L&D 10	32018	24	7491	472	145	562	0	13	2461	1144	343	401	22	442	45536
L&D 11	32018	24	8319	372	145	562	0	13	2461	1144	343	441	22	463	46426
L&D 12	35028	24	8393	472	189	698	0	13	3061	1042	343	441	22	467	50191
L&D 13	35151	24	8393	472	189	698	0	13	3088	1042	343	441	22	469	50343
L&D 14	39735	24	9378	473	406	698	[illegible]	13	4106	1051	343	449	22	471	57170
L&D 15	40732	24	9413	473	209	698	[illegible]	13	4149	1846	578	458	30	471	59094
L&D 16	46430	24	9833	473	303	892	20	13	4353	1906	670	474	30	469	65890
L&D 17	48948	24	10034	473	298	931	20	13	4566	1906	670	474	30	457	68843
L&D 18	51942	24	10034	473	298	931	20	13	4566	1906	670	474	30	454	71834
L&D 19	58542	26	10045	473	349	931	20	19	4909	1971	670	475	30	453	78911
L&D 20	59220	31	10084	473	350	929	20	19	4927	1978	670	487	30	455	79673
L&D 21	61955	47	10084	473	354	1216	20	19	4977	2239	670	504	30	455	83041
L&D 22	62676	47	10091	473	354	1216	20	19	5115	2254	892	504	34	455	84150
L&D 24	63539	47	10162	473	354	1269	20	19	5524	2254	1597	508	34	455	86257
L&D 25	63897	47	10162	473	354	1289	20	19	5206	2254	1597	508	34	565	86408
L&D 26	114336	77	16499	622	912	1837	148	79	20369	8508	1688	3890	230	2437	171632
L&D 27	120779	97	15881	637	971	2214	163	86	22132	10631	1680	4226	256	2531	182283

SOURCE: Comprehensive Master Plan for the Management of the Upper Mississippi River System, Appendix A, (Table 1.11, page 1-23)

Grain traffic, which is in large part a driving force on the Upper Mississippi Basin Navigation system, is heavily influenced by foreign demand for U.S. grains. Approximately 90 percent of grain moving outbound from the region is destined for export. The National Waterways Study forecast that export demand for grain would continue to exhibit strong growth (3 to 4 percent per year through 2003), acres planted would increase, yields per acre would increase, and domestic demand would remain constant. The NWS also predicted that real oil prices would continue to increase by 3.8 percent per year, encouraging the search for alternative energy sources and reducing petroleum's share of total energy consumed. In response, domestic coal demand was expected to triple during the period 1977-2003, while export demand doubled. The NWS also expected steel imports as a percent of total consumption to fall (thereby benefiting domestic producers and raw material suppliers), and for chemical traffic to exhibit slower growth than its historical average.

In comparing the Lock and Dam 26 (L&D 26) projections to actual historic traffic, it appears that the Upper Mississippi Comprehensive Plan projections were too optimistic. Total traffic in 1985 (57.3 million tons) fell short of the "estimated" 1980 base (71.1 million tons). By 1987 actual traffic reached only 69.3 million tons, far short of the 1990 projection of 94.2 million tons. One explanation for the discrepancy between forecasted and actual values is the extent of macroeconomic change in the U.S. economy after 1980 not captured by the NWS projections or other forecasts at the time. A severe world recession, structural changes in the national economy, the collapse of oil prices, and fierce competition for grain export markets were not anticipated when the forecasts for L&D 26 were developed. While forecast values can be compared to history, it is more difficult to evaluate the methodology employed in this study. Apparently the National Waterways Study was relied upon exclusively for projected growth rates by commodity. These projections were in turn dependent upon data and economic models developed by Data Resources, Inc. (DRI), a well-respected economic consulting firm. DRI's methodology is not explained in the Upper Mississippi Comprehensive Plan report. DRI's role in the National Waterways Study, however, is examined subsequently in this document.

A second factor in not realizing the projected traffic was the application of growth rates from NWS rather than tonnages projected by NWS. The NWS growth rates were derived using a 1976 base year and premised on achieving a set tonnage level in the forecast years. Applying these growth rates to a different and much higher base (1980, when grain movements were exceptionally high) disconnects the rates from the economic assumptions in the DRI Model while increasing the magnitude of the forecasts.

3. **Projections of Demand for Waterborne Transportation, Ohio River Basin 1980-2040, Study Summary, Ohio River Division, December 1980.**

Projections of waterborne commerce on the Ohio River and its eight navigable tributaries (the Allegheny, Monongahela, Kanawha, Kentucky, Green, Cumberland, Tennessee, and Clinch Rivers) were produced for ORD by three independent consultants: Robert R. Nathan Associates, CONSAD Research Corporation, and Battelle Columbus Laboratories.

The CONSAD report, completed in January 1979, projected traffic demands through 1990 by correlating the historic waterborne commodity flows on the Ohio River system (obtained from the 1975 Waterborne Commerce reports) with various indicators of regional and national demands for the commodities. The demand variables which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The historic and projected values for the demand variables were based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity.

CONSAD used correlation and regression techniques to try to determine the historical quantitative relationships between national economic indicators and waterway traffic levels. These relationships could then be applied to future economic forecasts to obtain projections of future demand for waterway traffic. The forecast economic indicators, provided by 1972 OBERS Series E, were total earnings, total personal income, per capita income, and population.

A series of regression equations were developed using traffic levels for the eight commodity groups as the dependent variables and time, GNP, national population, national income and earnings, and basin-level income and earnings in various industry groups as the independent variables in individual regression equations. Only variables that had some identifiable economic relationship to the commodities in a particular commodity group were used in the regressions. The criteria employed for retention of a regression equation were goodness of fit (R^2) and "appropriateness" of the projected tonnage (a subjective judgment whether or not the projected value seemed reasonable in light of historic tonnage values). As an example, basinwide traffic in grains was predicted as a function of projected national earnings in manufacture of food and kindred products and projected basinwide earnings in agriculture and wholesale and retail trade. At the individual river level, the analysis was performed by direction (upstream/downstream) and commodity group. Finally, the projection procedures employed for lock and dam projects were similar to those used for individual river projections.

CONSAD's and NATHAN ASSOCIATES' projections of Ohio River System traffic are presented in Table 8. For comparative purposes, 1976 and 1989 actual traffic and IWR's projections from The 1988 Inland Waterway Review also are provided. It should be noted that the IWR study was completed almost 10 years after the other studies; thus, the economic and political conditions were different.

The Battelle report, completed in June 1979, also projected traffic through 1990. Projections were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain from each individual shipper an estimate of his future commodity movements, by specific origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and the responses were then aggregated to yield projected traffic demands.

The Nathan report, completed in November 1980, projected commodity movements into, from, and within the Ohio River Basin using three techniques: commodity resource inventory, market demand analysis, and modal split analysis. The demand for waterway transportation was projected for 15

TABLE 8

OHIO RIVER NAVIGATION SYSTEM TRAFFIC, 1976 AND 1989, AND PROJECTIONS 1980-2040
(Million Tons)

	1976	1980	1985	1989	1990	2000	2020	2040
Total Traffic								
Historic	178.1	179.3	203.9	238.4				
CONSAD	--	211.3	264.8	--	328.1			
Nathan	200.8	222.2	--	--	297.3	334.3	390.8	438.7
IWR (High)					254.2	326.9		
IWR (Low)					232.3	266.8		
Coal Traffic								
Historic	103.0	103.8	117.3	144.6				
CONSAD	--	117.0	146.6	--	182.3			
Nathan	116.5	130.4	--	--	183.5	204.2	228.1	253.7
IWR (High)					159.5	217.9		
IWR (Low)					146.5	176.8		

commodity groups, by origin and destination, through 2040. Point-to-point waterway flows were allocated to 72 operational lock and dams.

Major forecasts of the Nathan report included the projection of traffic growth on the Ohio River System (ORS) from 200.8 million tons in 1976 to 438.7 million tons in 2040 (Table 8). This figure compares to an actual 238.4 million tons in 1989 (historical Corps data) and IWR's projected 327.0 million tons in 2000 (The 1988 Inland Waterway Review, high scenario). Further, the Nathan report forecast the largest absolute increase in commodity traffic for coal and coke and the highest rate of growth for ore and mineral commodities (chiefly due to inbound alumina shipments). Movements of petroleum and petroleum products were forecast to decline, as were regional production and consumption of these products.

As previously mentioned, Nathan incorporated assessments of future market demands (consumption base) and resource inventories (production base) in Ohio River Basin (ORB) BEA regions for 15 commodity groups. An analysis of historical modal splits was also used in projecting future transportation patterns. A summary of Nathan's methodology follows:

(1) BEA regions were identified in the ORB as ultimate origin or destination of waterborne movements.

(2) Historical production and consumption data by BEA region for each commodity were obtained from a variety of sources (e.g., Departments of Interior, Agriculture, Energy, and Transportation, Bureau of Economic Analysis, Bureau of the Census, and state and local governments).

(3) Historical commodity movements to and from BEA regions by rail and water modes were provided by the Corps of Engineers. Truck shipments were estimated to equal total net shipments minus net water and rail shipments.

(4) Factors affecting modal choice were solicited from shippers, receivers, and professional researchers.

(5) Future production and consumption of commodities by BEA region were projected for 1980, 1990, 2000, 2020, and 2040, based on national projections developed by Federal agencies and then disaggregated to BEA levels.

(6) Projected commodity movements and modal splits were based on 1976 traffic patterns and past trends. Trends were adjusted to take into account the opinions of industry experts and the stated intentions of firms.

(7) Projections of waterborne movements were distributed among BEA-to-BEA links on the basis of historical (1976) distributions, again adjusted according to information from interviews.

Traffic projections from The Nathan Report for the Ohio River Basin locks are presented in Table 10 for total tonnage and in Table 11 for coal and coke.

Ohio River navigation system historic (1976 and 1989) and projected waterway traffic demands 1980-2040, are presented in Table 9 from the Nathan Report.

TABLE 9

OHIO RIVER NAVIGATION SYSTEM
HISTORIC AND PROJECTED WATERWAY TRAFFIC DEMANDS BY COMMODITY GROUP
1976-2040

(1,000 Tons)

COMMODITY GROUP	HISTORIC		PROJECTED					PROJECTED GROWTH (%)	
	1976	1989	1980	1990	2000	2020	2040	1976-1990	1976-2040
Coal and Coke	116,533	146,547	130,391	183,496	204,161	228,101	253,657	57.5	117.7
Petroleum Fuels	20,943	12,800	21,166	27,179	28,300	22,627	15,807	29.8	-24.5
Crude Petroleum	665	559	847	827	773	591	344	24.4	-48.3
Aggregates	25,152	27,722	27,554	30,140	31,364	37,092	40,276	19.8	60.1
Grains	5,582	11,023	4,154	4,997	6,043	7,275	8,637	-10.5	54.7
Chemicals & Chem. Fert.	11,364	11,623	12,396	16,534	22,420	37,565	49,195	45.5	333.0
Ores and Minerals	4,451	3,678	5,413	8,491	11,815	20,198	28,405	908	538.2
Iron Ore, Iron and Steel	5,064	6,853	6,365	7,665	9,436	14,324	18,124	51.4	257.9
All Others	11,017	17,565	13,876	17,964	19,997	23,000	24,297	60.8	124.4
Totals	200,771	238,427	222,162	297,293	334,309	390,773	438,742	48.0	118.7

1/ Revised 1976 WCSC Data.

2/ Tonnage in commodity groups 9-15 were aggregated to one group - "All Other", for comparability with other projection studies.

SOURCE: Projected Demand for Waterway Traffic, Ohio River Basin, 1976-2040, Robert R. Nathan Associates, and Waterborne Commerce Statistics Center for 1989 data (Table 11, page 32).

TABLE 10

TOTAL WATERBORNE COMMERCE BY LOCK AND DAM, OHIO RIVER BASIN, 1976 AND PROJECTED 1980-2040, SELECTED YEARS

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL a/	1,070,817	1,167,818	1,603,497	1,895,238	2,383,408	2,820,619
Opekiska L/D	188	208	256	290	324	360
Hildebrand L/D	1,548	1,657	2,009	2,161	2,276	2,397
Morgantown L/D	2,344	2,605	3,358	3,726	4,104	4,376
Point Marion L/D	6,991	7,622	9,300	10,332	11,115	11,808
L/D 7 - Monongahela	8,939	9,689	11,608	12,861	13,856	14,759
Maxwell L/D	18,364	19,734	22,737	25,297	28,365	31,299
L/D 4 - Monongahela	19,351	20,836	23,732	26,302	29,475	32,478
L/D 3 - Monongahela	25,101	27,275	30,876	33,946	37,971	41,436
L/D 2 - Monongahela	22,885	25,846	30,627	34,188	41,314	46,767
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	126	137	104	91	101	107
L/D 5 - Allegheny	1,625	1,773	1,377	1,229	1,374	1,452
L/D 4 - Allegheny	2,145	2,342	2,155	2,157	2,462	2,655
L/D 3 - Allegheny	3,789	4,202	4,786	5,417	6,430	7,140
L/D 2 - Allegheny	4,241	4,677	5,286	5,989	7,137	7,986
Emsworth L/D	25,811	29,119	36,092	41,446	50,144	56,587
Dashields L/D	25,587	28,769	35,428	40,609	49,062	55,324
Montgomery L/D	22,936	26,424	33,314	38,494	48,157	55,155
New Cumberland L/D	26,583	30,380	38,067	43,818	54,603	62,451
Pike Island L/D	27,079	31,411	41,249	48,121	61,610	71,247
Hannibal L/D	31,603	36,054	48,118	56,048	71,884	83,251
Willow Island L/D	33,021	37,844	51,248	60,851	80,830	95,454
Belleville L/D	34,642	40,008	56,175	67,185	88,612	104,338
Racine L/D	36,234	42,156	58,087	68,900	90,105	105,746
London L/D	1,604	1,919	3,035	3,224	3,209	3,196
Marmet L/D	6,619	8,010	12,330	13,215	13,382	13,814
Winfield L/D	11,344	13,553	19,403	21,977	26,483	29,810
Gallipolis L/D	40,794	47,538	64,519	75,000	93,475	107,916
Greenup L/D	32,388	36,041	48,668	59,833	72,473	86,123
Meldahl L/D	28,708	32,162	42,843	52,521	65,961	79,158
Markland L/D	34,160	38,570	53,729	65,690	85,723	103,764
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	542	546	521	471	561	610
L/D 3	542	546	521	471	561	610
L/D 2	542	546	521	471	561	610
L/D 1	542	546	521	471	561	610
McAlpine L/D	40,094	44,493	63,218	78,086	104,179	127,807
Cannelton L/D	42,787	46,495	66,056	81,706	109,698	135,016
Newburgh L/D	39,854	42,247	68,874	84,565	117,194	146,698
L/D 3	58	67	85	134	74	59
L/D 2	12,417	14,062	22,845	25,652	24,829	25,736
L/D 1	12,958	14,685	23,871	26,758	26,650	27,918
Uniontown L/D	47,126	48,519	72,876	87,149	111,715	137,575
L/D 50 - Ohio River	51,895	53,459	79,092	92,955	115,885	140,594
L/D 51 - Ohio River	52,743	54,267	79,950	93,152	116,654	141,783
Smithland L/D	52,913	54,520	80,184	93,407	116,963	142,103

(continued)

TABLE 10 (Continued)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
L/D 52 - Ohio River	61,530	62,460	94,712	116,207	146,489	178,250
L/D 53 - Ohio River	56,110	55,009	75,447	94,522	117,641	143,672
Kentucky - Barkley L/D	24,719	27,405	31,336	33,537	42,648	47,765
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	262	276	351	465	650	707
Cheatham L/D	3,791	3,609	4,476	5,250	6,605	7,410
Watts Bar L/D	378	472	668	830	1,128	1,338
Chickamauga L/D	973	1,438	1,444	1,705	2,213	2,494
Nickajack L/D	4,029	4,173	5,496-	6,447	7,620	8,139
Guntersville L/D	4,544	4,824	6,478	7,798	9,907	11,063
Wheeler L/D	6,996	7,532	10,228	12,835	18,221	22,062
Wilson L/D	7,301	7,895	10,847	13,747	19,887	24,391
Pickwick L/D	8,191	8,850	11,950	15,048	21,760	26,657
Ft. Loudoun L/D	228	312	407	473	514	503
Melton Hill L/D	4	6	9	13	23	31

SOURCE: Robert R. Nathan Associates, Inc. (Table G-1, pages 201-202 of the 1980 Ohio River Basin Study).

a/ Total tonnages from running all locks and dams in the system.
Note: Tonnages may not sum to totals due to rounding.

TABLE 11

TOTAL COAL AND COKE COMMERCE BY LOCK AND DAM, OHIO RIVER BASIN, 1976 AND PROJECTED 1980-2040, SELECTED YEARS

(Thousands of Tons)

Lock and dam	1976	Projected 1980	1990	2000	2020	2040
TOTAL a/	533,241	594,408	872,414	1,000,996	1,235,851	1,480,004
Opekiska L/D	100	108	130	143	151	160
Hildebrand L/D	1,460	1,557	1,883	2,014	2,103	2,197
Morgantown L/D	1,586	1,693	2,050	2,196	2,296	2,401
Point Marion L/D	5,935	6,437	7,672	8,454	9,012	9,616
L/D 7 - Monongahela	7,882	8,503	9,979	10,983	11,753	12,573
Maxwell L/D	17,307	18,547	21,108	23,419	26,266	29,113
L/D 4 - Monongahela	17,530	18,781	21,353	23,687	26,564	29,440
L/D 3 - Monongahela	21,213	22,648	25,291	28,087	31,882	35,622
L/D 2 - Monongahela	17,313	19,350	22,934	25,841	32,239	37,624
L/D 9 - Allegheny	—	—	—	—	—	—
L/D 8 - Allegheny	—	—	—	—	—	—
L/D 7 - Allegheny	—	—	—	—	—	—
L/D 6 - Allegheny	—	—	—	—	—	—
L/D 5 - Allegheny	—	—	—	—	—	—
L/D 4 - Allegheny	208	217	233	265	313	361
L/D 3 - Allegheny	2,012	2,120	2,289	2,567	2,994	3,435
L/D 2 - Allegheny	2,463	2,593	2,786	3,136	3,697	4,277
Emsworth L/D	15,947	17,942	21,465	24,437	31,457	37,454
Dashields L/D	15,947	17,942	21,465	24,437	31,457	37,454
Montgomery L/D	11,500	13,318	16,517	19,236	26,619	32,929
New Cumberland L/D	14,110	16,204	19,862	22,857	30,985	37,772
Pike Island L/D	15,279	17,874	22,891	26,636	37,357	45,892
Hannibal L/D	17,615	20,527	27,820	32,316	44,081	53,452
Willow Island L/D	17,616	20,528	27,826	32,323	44,091	53,464
Belleville L/D	18,290	21,368	30,618	35,658	48,317	58,492
Racine L/D	18,292	21,370	30,622	35,663	48,322	58,497
London L/D	1,265	1,560	2,613	2,811	2,781	2,800
Marmet L/D	5,195	6,335	10,173	11,155	11,219	11,625
Winfield L/D	4,221	5,114	9,133	10,307	11,217	12,310
Gallipolis L/D	22,149	25,941	36,009	47,426	55,791	67,547
Greenup L/D	13,721	14,823	21,779	28,315	35,120	45,176
Meldahl L/D	9,546	10,327	15,203	20,128	27,502	36,536
Markland L/D	11,670	14,041	22,212	27,335	38,059	48,626
L/D 14	—	—	—	—	—	—
L/D 13	—	—	—	—	—	—
L/D 12	—	—	—	—	—	—
L/D 11	—	—	—	—	—	—
L/D 10	—	—	—	—	—	—
L/D 9	—	—	—	—	—	—
L/D 8	—	—	—	—	—	—
L/D 7	—	—	—	—	—	—
L/D 6	—	—	—	—	—	—
L/D 5	—	—	—	—	—	—
L/D 4	—	—	—	—	—	—
L/D 3	—	—	—	—	—	—
L/D 2	—	—	—	—	—	—
L/D 1	—	—	—	—	—	—
McAlpine L/D	18,340	21,759	34,071	41,849	57,471	62,647
Cannelton L/D	20,011	23,723	37,017	45,485	62,448	78,845
Newburgh L/D	15,311	17,733	36,840	44,442	62,272	79,829
L/D 3	58	67	85	134	74	59
L/D 2	12,241	13,904	22,645	25,377	24,517	25,387
L/D 1	12,778	14,523	23,665	26,472	26,318	27,543
Uniontown L/D	19,956	21,991	39,342	43,427	52,466	64,434

(continued)

TABLE 11 (Continued)

Lock and dam	1976	Projected				
		1980	1990	2000	2020	2040
L/D 50 - Ohio River	24,458	26,788	45,359	48,949	56,261	66,975
L/D 51 - Ohio River	24,548	26,868	45,430	49,040	56,380	67,137
Smithland L/D	24,548	26,868	45,430	49,040	56,380	67,137
L/D 52 - Ohio River	19,805	19,668	42,842	50,064	57,546	69,879
L/D 53 - Ohio River	15,167	12,988	24,657	29,152	29,802	36,576
Kentucky - Barkley L/D	11,018	12,653	12,111	9,951	8,897	6,143
Cordell Hull L/D	—	—	—	—	—	—
Old Hickory L/D	—	—	—	—	—	—
Cheatham L/D	—	—	—	—	—	—
Watts Bar L/D	—	—	—	—	—	—
Chickamauga L/D	198	567	271	208	213	112
Nickajack L/D	1,104	968	1,410	1,790	1,951	1,900
Guntersville L/D	1,109	975	1,415	1,794	1,955	1,902
Wheeler L/D	1,577	1,388	1,855	2,235	2,343	2,179
Wilson L/D	1,632	1,434	1,901	2,283	2,385	2,211
Pickwick L/D	2,009	1,776	2,152	2,473	2,529	2,270
Ft. Loudoun L/D	—	—	—	—	—	—
Melton Hill L/D	—	—	—	—	—	—

SOURCE: Robert R. Nathan Associate, Inc. (Table G-2, pages 203 and 204 of the 1980 Ohio River Basin Study).

a/ Total tonnages from running all locks and dams in the system.
Note: Tonnages may not sum to totals due to rounding.

4. <u>Gallipolis Lock and Dam Replacement, Ohio River, Appendix L, Study Area Economic Base and Commodity Flow Analysis</u>, Huntington District, Ohio River Division, April, 1980.

To thoroughly evaluate the existing Gallipolis project and potential improvements for increasing tonnage capacity at the lock, the Huntington District estimated future traffic levels and origin-destination patterns for all Ohio River system traffic. Three independent yet complementary studies of future demands for waterway service were performed for <u>Projections of Demand for Waterborne Transportation , Ohio River Basin 1980-2040</u>: (1) by CONSAD Research Corporation, (2) by Battelle Memorial Institute, and (3) by Robert R. Nathan Associates. The methods, procedures, and resulting forecasts of each of the three studies were reviewed and interpreted by the Huntington District in their economic analysis of the Gallipolis Lock and Dam replacement study. The following is a summary of the Huntington District's analysis and selection of an appropriate projection methodology.

<u>Comparison of Projection Methodologies</u>

The Huntington District summarized future demands for waterway service on the Ohio River navigation system as a function of four major variables: 1) future local, regional, and national demands for products which use commodities moving on the basin's waterways as production inputs; 2) the portion of these demands which will be met by industries suitably located so that the raw material inputs or final products can be transported by barge; 3) the location of supply regions (for raw materials) and markets (for finished goods) for industries located contiguous to the basin's navigable waterways; and 4) the waterways' share among all modes of transportation in moving the raw materials from point of supply to point of production and the final or intermediate goods from point of production to point of consumption.

The first two variables specify the demand for commodities as well as the available supply; the third specifies the demand area-supply area links; and the fourth specifies the waterway tonnage for each of the links. The degree to which these variables are considered, either individually or in aggregate, varies considerably among the three projection studies.

The theoretical approach used by CONSAD is founded on the hypothesis that a direct and quantifiable relationship exists between the rate of economic growth in the Ohio River basin and basin waterway traffic. The regression equations developed for each of the commodity groups and the resulting projections implicitly consider each of the four variables discussed earlier. Future commodity demand indicators were derived from the 1972 OBERS Series E projections of national and regional economic activity endorsed by the Water Resources Council for use in water resources planning. The share of these demands that would be met by waterway-oriented industries and the subsequent modal split were estimated by regression techniques. The regression equations yielded total system traffic demands by major commodity group. These commodity group totals were then distributed to an origin-destination (O-D) matrix format using the historical O-D traffic patterns.

This overall approach yielded what might be considered a "baseline" projection (i.e., a continuation of past trends). It utilized the 1972 OBERS projections as the macroeconomic scenario, essentially assuming that the Ohio River Basin would continue along its historic path, economically, technologically, and socially, and become even more like the nation in the future. It must also be remembered that the 1972 OBERS projections did not take into account significant structural changes in the economy or the regional redistribution of economic activity that took place in later years. The procedures also assumed a continuation of historical modal split patterns and the relationships between production and consumption areas which were implicitly reflected in the historic waterway traffic.

The Battelle Columbus Labs shipper survey approach differed significantly from CONSAD's statistically-based methodology. It could be thought of as a "bottom-up" approach rather than the "top-down" projection by CONSAD. Each of the four variables discussed above were determined by the collective views of the waterway users, as opposed to an independent projection. Since it was probable that the survey participants held highly divergent views of the regional/national economic future as well as its possible impact on commodity demands, it was not possible to quantify how the basin waterway users collectively viewed the future and compare their outlook to the OBERS forecasts.

The users provided estimates of future waterway traffic volumes by individual commodity and origin-destination points. The total system demands then were determined simply by aggregating the individual responses. This bottom-up approach permitted the identification of new traffic links as markets shifted or new facilities were built (e.g., new power plants) as well as the elimination of other links. In essence, the traffic demands and the O-D traffic links were solved simultaneously. In contrast to the statistically-based projections, the shipper survey also reflected each firm's assessment of the portion of its future traffic that would likely move by barge.

The long-range commodity supply-demand and modal split analysis performed by Nathan Associates, Inc. was designed specifically to measure each of the four major factors influencing Ohio River Basin waterway traffic demands listed earlier. It thus represented a much more comprehensive assessment of future traffic demands than the statistical approach or the shipper survey approach. Future commodity demands (consumption) and future available supply (production) for each BEA region within the waterway region were analyzed and projected using broad national and regional models and trends, and, in some cases, the judgment of industry, government, and Nathan commodity specialists.

The models used represented the best estimates of the Department of Energy on energy-related products, the Department of Agriculture on grains and related products, the Bureau of Mines on aggregates, and an industry expert on iron and steel products, ores, and minerals. The other smaller commodity groups were projected using a variety of methods.

The projection of future markets and supply sources for barge-using industries within the waterway region was based on existing markets and sources, discussions with representatives of waterway users as well as other government and industry authorities, and the probable effect of evolving economic, environmental, and technological considerations. The waterways share of the total transportation requirement within the waterway region was projected using the 1976 modal split as the base. This distribution was changed only if specific information existed to indicate it would change. The O-D characteristics of future waterway traffic were estimated by using the 1976 distribution with modifications incorporated through time to reflect known new facilities (e.g., new power plants) and the impact of market shifts and changes in supply sources.

In summary, each of the three projection studies differed in the theoretical approach used. These differences were reflected in the overall macroeconomic scenario assumed, the associated level of economic activity within the Ohio River Basin, markets for basin production and consumption, and the waterways share of the total transportation requirement. In addition, each of these factors were considered in varying levels of detail among the three studies.

The statistical approach used by Nathan inherently assumed a continuation of historical trends for each of these factors and used OBERS as the national/ regional economic scenario. Since this approach did not reflect changes in the structure of the economy or shifts in energy or resource consumption that occurred after 1972 the Huntington District expected the waterway traffic demand projections to be higher than for the other two studies This, in fact, has occurred.

The shipper survey approach, on the other hand, reflected the users views, on each of these factors. Since their mid-1970s perspective was tempered by one of the highest rates of inflation in the history of the United States, with rapidly escalating interest rates and energy costs, the Huntington District expected this approach to yield lower short-term traffic projections than the statistical approach. Again, these expectations were borne out by the projections.

Based upon the methods and assumptions inherent in the Nathan study, it was expected to yield lower growth rates than the statistical approach, principally due to the perceived impact of higher energy costs and potentially slower economic growth. The results agreed with this expectation.

A comparison of the projected 1990 total Ohio River system traffic by commodity group for the three projection methods is summarized in Table 12. The 1990 projections from IWR's The 1988 Inland Waterway Review are included for comparative purposes.

The data in Table 12 indicate that all three of the commodity traffic projections expected continued growth in system traffic demands through 1990 at rates approaching the historical growth rate of 4.2 percent annually. The three projection methodologies yielded estimates of total system traffic in 1990 that varied by only 15 percent. In contrast, IWR's 1988 projections of 1990 traffic were considerably lower than any of the three study estimates; IWR's highest forecast was 17 percent below even the Nathan forecast. All three projections analyzed by the Huntington District now appear overly optimistic with the hindsight of major economic restructuring of the early 1980s. IWR's estimates benefited from having more recent historical data (1986 base year Ohio River system traffic of 222.2 million tons), projecting fewer years into the future, and with the hindsight of the early 1980s recession.

To compare the projections through 2040 (the statistically-based and shipper-survey studies did not forecast beyond 1990), the Huntington District extended the two short-term projections by commodity group using the same rate of increase as the supply-demand (Nathan) analysis on a commodity group basis. All three projection methodologies, therefore, forecast traffic levels in the 1990-2040 period to grow at rates significantly below the recent historical trend.

Although there appeared to be little significant variation in the forecasting results of the three projection methods over the short- or long-term, the supply, demand, and modal split analysis performed by Nathan was

TABLE 12

COMPARISON OF 1990 TRAFFIC PROJECTIONS ON THE OHIO RIVER SYSTEM: STATISTICAL METHODS (CONSAD), SHIPPER SURVEY (BATTELLE), SUPPLY-DEMAND ANALYSIS (NATHAN), AND IWR
(Millions of Tons)

				IWR[a]		1976-1990 AVE. ANNUAL GROWTH RATE		
COMMODITY	CONSAD	BATTELLE	NATHAN	LOW	HIGH	CONSAD	BATT.	NATHAN
Coal & Coke	182.3	217.3	183.5	146.5	159.5	4.1	5.0	3.4
Pet. Fuels	37.3	23.8	27.2	17.3	18.8	5.0	0.9	1.9
Crude Pet.	0.0	0.0	0.8	0.6	0.7	-	-	1.6
Aggregates	39.7	38.3	30.1	28.3	31.3	4.6	3.0	1.3
Grains	5.5	9.6	5.0	15.9	16.6	0.2	3.5	-0.8
Chemicals	22.6	15.7	16.5	13.5	14.7	6.4	2.4	2.8
Ores & Min.	9.7	5.6	8.5	6.7	8.1	7.8	1.8	4.7
Iron & Steel	8.7	6.7	7.7	b/	b/	5.2	1.9	3.0
Other	21.9	24.1	18.0	3.8	4.4	5.2	5.8	3.5
Total	328.1	341.0	297.3	232.3	254.2	4.5	4.1	2.8

a/ The IWR study was completed approximately 10 years after the other three studies.
b/ IWR's projections for iron and steel are included in ores and minerals.

considered a more sophisticated method from the viewpoint of depth and detail of analysis. This methodology was based upon an exhaustive evaluation and projection of the full realm of activities from which aggregate transportation demands are derived as well as the modal shares. In contrast, the other two methods focused only on the waterway mode and its traffic. The activities which generate aggregate transportation demands and the modal shares were addressed in a more simplistic manner. For these reasons the supply-demand analysis performed by Nathan was designated by the Huntington District as the "most probable" future scenario.

The results of the supply-demand analysis for the Ohio River system are presented on a commodity-specific basis in Table 13. Over the entire projection period these estimates were characterized by a growth trend which was increasing at a decreasing rate (2.8 percent average annual growth 1976-1990, 0.8 percent average annual growth 1990-2040). As a result, a large portion of the total traffic growth was forecast to occur by 1990. A brief explanation of each of the commodity groups follows.

Coal and coke was the only commodity group that was expected to grow at or above its historic growth rate. This forecast was related to the expected completion of several new steam-electric generating facilities in the middle and lower Ohio River Basin area. While a large majority (approximately 84 percent in 1990) of future coal and coke traffic was expected to be local traffic moving from production to consumption areas within the basin, a significant increase in inbound coal traffic was anticipated. This increase was accounted for by expected growth in the use of low-sulfur western coal by basin powerplants. The largest relative increase in coal receipts was expected to occur along the lower and middle Ohio Rivers. Receipts of coal along the Tennessee River were expected to decline as TVA phased out its coal-fired electric generating facilities in favor of nuclear plants. As the Pittsburgh area becomes increasingly dependent on external sources of coal due to the depletion of high quality North Appalachian reserves, upbound shipments of coal through Gallipolis were anticipated to increase significantly.

TABLE 13

EXISTING AND PROJECTED OHIO RIVER BASIN WATERWAY TRAFFIC
BY COMMODITY GROUP
(Millions of Tons)

Commodity Group	Existing 1976	% of Total 1976	Projected 1980	Projected 1985[a]	Projected 1990	% Change 1976-1990	Projected 2040	% Change 1990-2040
Coal and Coke	116.5	58.0	130.4	157.0	183.5	+57.5	253.7	+38.3
Petroleum Fuels	20.9	10.4	21.2	24.2	27.2	+30.1	15.8	-41.9
Crude Petroleum	0.7	0.3	0.8	0.8	0.8	+14.3	0.3	-62.5
Aggregates	25.2	12.5	27.6	28.9	30.1	+19.4	40.3	+33.9
Grains	5.6	2.8	4.2	4.6	5.0	-10.3	8.6	+72.0
Chem, Chem Fertilizers	11.4	5.7	12.4	14.5	16.5	+44.7	49.2	+198.2
Ores & Minerals	4.6	2.3	5.4	7.0	8.5	+84.8	28.4	+234.1
Iron & Steel	5.1	2.5	6.4	7.1	7.7	+51.0	18.1	+135.1
All Other	11.0	5.5	13.9	15.8	18.0	+60.9	24.3	+39.5
Totals	200.8	100.0	222.2	259.9	297.3	+47.9	438.7	+47.9

SOURCE: Robert R. Nathan Associates, Projected Demand for Waterway Traffic, Ohio River Basin 1976-2040 (Table 10).

a/ 1985 projections were interpolated to the midpoint between the 1980 and 1990 projections.

Growth in petroleum fuel traffic through 1990 is expected to slow considerably relative to historic traffic trends. Reasons include slower increases in consumption, an excess of basin refining capacity relative to consumption (thus reducing the need for fuel imports), and completion of a new petroleum products pipeline to the Louisville area. The long-term outlook through 2040 projects a rather sharp decline in traffic (-41.8 percent from 1990 levels) as the price of crude petroleum increases and alternative energy sources come into widespread use.

Traffic in aggregates throughout the projection period is expected to grow slowly, at about half the rate of growth for total traffic. Intra-basin shipments are expected to continue to dominate movements in this commodity group, although reduced supplies in the Pittsburgh BEA area are expected to result in increased waterborne imports from the middle and lower Ohio River areas. This will increase upbound aggregate traffic through Gallipolis.

The Nathan forecasts for iron ore, iron, and steel traffic used by the Huntington District were exceptionally optimistic, with growth rates exceeding the 1960-1976 historical average. The only explanation offered for this scenario was that the Ohio basin would continue to consume iron ore, iron, and steel at a faster rate than its ability to produce these commodities. Inbound shipments would increase, especially through Gallipolis to the Pittsburgh area, the basin's major steel production area.

Once the traffic forecasts for the entire Ohio River Basin navigation system were developed, the Huntington District's remaining task was to allocate the projected tonnages to the system lock and dam projects. Using projected origin-destination matrices, tonnages were allocated to specific navigation projects by computer program. Tonnages were assigned to locks along the basin river routes which would have to be traversed in going from an origin to a destination. The end result of this process is a set of traffic demand forecasts for each of the navigation projects in the Ohio River Basin.

Existing and projected commodity traffic demands at the Gallipolis locks are presented in Table 14. Traffic levels at Gallipolis were expected to grow

TABLE 14

EXISTING AND PROJECTED GALLIPOLIS LOCK TRAFFIC BY COMMODITY GRO UP
(Millions of Tons)

Commodity Group	Existing 1976	% of Total 1976	Projected 1980	Projected 1985[a]	Projected 1990	% Change 1976-1990	Projected 2040	% Change 1990-2040
Coal and Coke	22.1	54.2	25.9	31.0	36.0	+62.9	67.5	+87.5
Petroleum Fuels	6.5	15.9	6.9	8.1	9.2	+41.5	4.8	-47.8
Crude Petroleum	0.2	0.5	0.3	0.2	0.1	-50.0	.05	-50.0
Aggregates	2.2	5.4	2.2	3.0	3.7	+68.2	5.6	+51.4
Grains[b]	-	-	-	-	-	-	-	-
Chem, Chem Fertilizers	3.1	7.6	3.3	3.7	4.1	+32.3	11.9	+190.2
Ores & Minerals	1.6	3.9	1.8	2.0	2.2	+37.5	5.2	+136.4
Iron & Steel	3.2	7.8	4.0	4.3	4.6	+43.8	7.7	+67.4
All Other	1.9	4.7	3.0	3.8	4.5	+40.6	5.2	+15.5
Totals	40.8	100.0	47.5	56.1	64.5	+58.1	107.9	+67.3

SOURCE: Robert R. Nathan Associates, Projected Demand for Waterway Traffic, Ohio River Basin, 1976-2040 (Table 13).

[a] *1985 projections were interpolated* to the midpoint between the 1980 and 1990 projections.

[b] Existing and projected grain traffic are less than .01 percent of total existing and projected commodity group.

from 40.8 million tons in 1976 to 64.5 million tons by 1990 and to 107.9 million tons by 2040. In reality traffic amounted to only 39.5 million tons in 1989, declining by an average 1.8 percent annually during the preceding decade. The projected 1990 traffic mix implied no major changes from the 1976 base year situation. For example, coal and coke would still represent over 55 percent of total traffic, the majority destined for upper basin markets. Petroleum fuels follow with about a 15 percent share; however, after 1990, petroleum traffic was expected to drop off sharply due to conservation and development of alternative energy sources. Aggregate and non-metallic mineral traffic increases would result largely from greater shipments to the Pittsburgh BEA area from middle and upper basin sources. Chemical traffic (also moving primarily in an upbound direction) was predicted to double its relative share of total commodity traffic by 2040. Finally, the increases in iron ore, iron, and steel traffic demands would consist primarily of raw materials and intermediate inputs destined for the upper basin area.

Prior Studies

When Huntington District prepared the Gallipolis replacement study in 1980, there were no other prior projections of waterway traffic available for the Ohio River System. However, projections were available for the Ohio River mainstem from the Ohio River Basin Comprehensive Study which was completed in 1968. That study projected that total traffic on the Ohio River would increase at an average annual rate of 3.2 percent between 1964 and 1990 and 2.6 percent for the period 1990-2020. Substantial increases in traffic were projected for each of the major commodity groups. Assuming that the projected 1990 traffic for the mainstem represented about 74 percent of the total system traffic, as it did in 1964, the Huntington District estimated 1990 system traffic projections of about 294 million tons (217.8 divided by 0.74), very close to the 1990 projection under the Nathan analysis of 297 million tons.

Although a slight dampening of the 1964-1990 growth rate was projected for the 1990-2020 period, the rate was significantly higher than the long-term projection from the Nathan study. The Nathan study predicted an increase in total system traffic of only 0.9 percent annually over the 1990-2020 period.

As stated earlier, the comparable ORB Comprehensive projection for the mainstem Ohio was 2.6 percent per year. Thus, the more recent Nathan projections represented a more conservative long-range outlook.

In summary, the Huntington District examined a variety of forecasting techniques to project future movements of traffic through the Gallipolis locks. The choice of theoretical technique employed by the three consulting firms (CONSAD, Battelle, and Nathan) was critical to their final estimates of traffic because of varying assumptions regarding economic activity, shifting production and consumption patterns, and modal shares. The Huntington District's selection of Nathan's supply-demand analysis as the "most probable" scenario was based on a detailed and thorough examination of the methodological strengths and weaknesses of each of the three studies. Published data sources incorporated in the Nathan study were varied and extensive, and interview and expert opinion techniques were employed as well. While the Nathan projections represented the "best estimate" at the time of the Huntington District's analysis, the forecast of future traffic levels turned out to be significantly overestimated due to unanticipated national and international economic conditions. However, the Huntington District's overall effort was exhaustive and competent and reflected prevailing economic trends. All exogeneous macroeconomic variables cannot be captured realistically by any forecasting technique, although alternative assumptions may be used to determine a likely range of possible futures.

5. **Monongahela River Navigation System, Locks and Dams 7 and 8 Feasibility Study, Pittsburgh District, Ohio River Division, January 1984.**

At the time this study was conducted waterborne traffic on the Monongahela River exceeded that of any other component of the Ohio River System except for the Ohio River mainstem itself. The predominant commodity carried is bituminous coal, accounting for 85% of total tonnage. Most of the coal is shipped in a downbound direction and used both to generate electricity at downstream power plants and in the steel-making plants of the Pittsburgh industrial complex. Other commodities transported (in descending order of importance) are aggregates (limestone, phosphate, cement, sand, and gravel), petroleum products, iron and steel products, and chemicals.

The study conducted by the Pittsburgh District relied on commodity flow projections produced by Robert R. Nathan Associates, Projected Demands for Waterway Traffic, Ohio River Navigation System, 1970-2040. The Nathan study used 1976 as the base year for historic data. Projections were developed based on an evaluation of the probable future market demands for waterborne commodities, an analysis of the basin's resource base of these commodities, probable long-term production levels, and a forecast of the modes of transportation involved in moving these commodities from production areas to consumption areas. A more detailed explanation of Nathan's methodology is provided above in the review of the Ohio River Navigation System report.

The Pittsburgh District updated Nathan's 1976 projections in 1981, in collaboration with GAI Consultants, Inc. These "Nathan-adjusted" figures incorporated "local perspectives" in the overall methodology; namely, consultation with local industrial representatives to determine potential variations between local shipping patterns and the basinwide (Ohio River Basin) methodology, and to ascertain near-term plans for specific commodity movements. Emerging market trends accounted for in the Nathan-adjusted projections include increasing export movements, diversification of coal consumption from the steel industry to the energy sector, and the coal requirements for generating the additional electricity to support increased electric-arc steel production.

The Monongahela Locks and Dams 7 and 8 study forecasted increasing waterborne traffic on the Monongahela River to 1990 with growth rates averaging 2.8 percent annually from 1976 through 1990, when traffic was predicted to reach 60 million tons. Thereafter growth would continue at a decreasing rate, averaging 0.8 percent annually through 2040. In reality traffic on the Monongahela declined throughout much of the 1980's after reaching an all-time high of 39.9 million tons in 1976 (adjusted data). Traffic did increase to 38.4 million tons in 1989. The demand for coal from new electricity-generating power plants coming on-line in the 1980s was expected to drive total traffic figures upward. After 1990, however, very slow growth for all energy-related commodities was expected as alternative fuels and energy sources come into play. Table 15 and Figures 1, 2, and 3 depict commodity and lock traffic projections on the Monongahela through 2040.

In summary, Pittsburgh District employed Nathan's supply-demand analysis of future waterborne commerce in the Ohio River Basin to project movements of traffic through Monongahela Locks 7 and 8. Nathan's detailed and methodologically sound investigation made reasonable assumptions about future production and consumption patterns and modal shares they also were selected by the Huntington District in its economic analysis of the Gallipolis Locks and Dam project. Published data sources incorporated in the Nathan study were varied and extensive, and interview and expert opinion techniques were employed as well. Additional interviews conducted by the Pittsburgh District and GAI Consultants insured that local perspectives were incorporated in the forecasts.

This also should have helped to update the Nathan projections, which were based on 1976 base year data. However, while the Nathan projections represented the "best estimate" at the time of Pittsburgh's analysis, their forecast of future traffic levels in the 1980's turned out to be greatly overestimated. Traffic levels have failed to keep pace with predicted growth rates; traffic actually declined from the 1976 base year level of 39.9 million tons. This downward trend should have been evident by the time of Pittsburgh's analysis in 1984. However, the significance and magnitude of the decline was not yet clear and the District did not adjust their forecasts accordingly. Again unpredictable events (in this case, a national recession, structural shifts in the national and regional economies, and foreign competition) have proved elusive to anticipate and to model.

TABLE 15

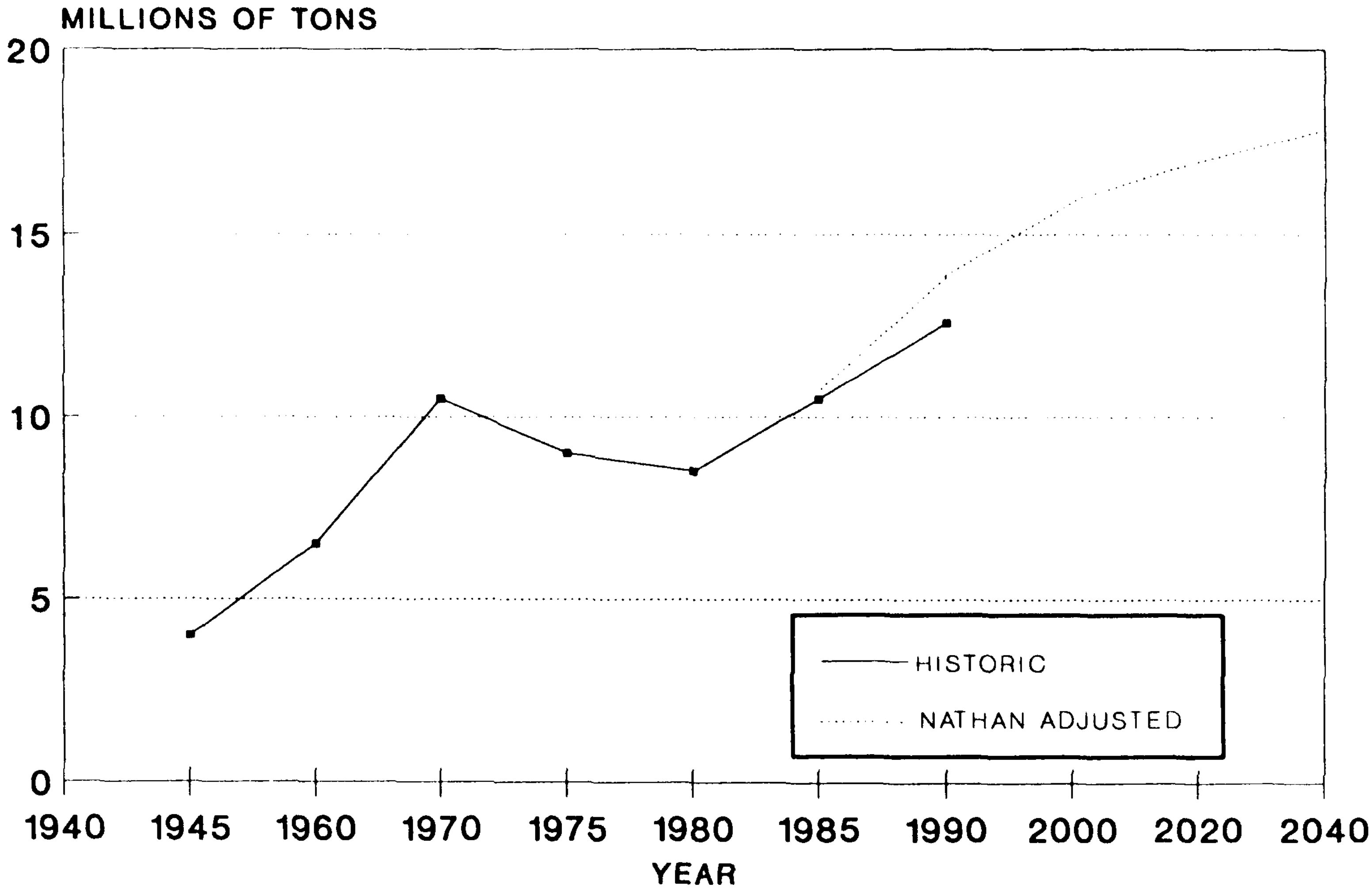
PROJECTED MONONGAHELA RIVER TRAFFIC *
(1,000 Tons)

Commodity	Actual 1976 **	Actual 1989	Projected 1990	Projected 2000	Projected 2040	Average Annual Change 1976-2040
Coal and coke	32,619	34,168	48,860	54,979	75,852	1.2
Petroleum fuels	2,477	1,099	2,974	3,265	1,866	-0.4
Crude petroleum	0	0	0	0	0	--
Aggregates	1,856	1,852	3,620	4,492	5,107	1.6
Grains	0	0	0	0	0	--
Chemicals	341	254	554	761	1,641	2.7
Ores and minerals	499	399	605	699	1,116	1.2
Iron and Steel	1,790	292	2,366	2,550	3,371	1.0
All Others	364	352	775	862	810	1.1
Totals	39,946	38,416	59,754	67,608	89,763	1.2

*Does not include intra-pool traffic.
**Adjusted 1976 Waterborne Commerce Statistics.

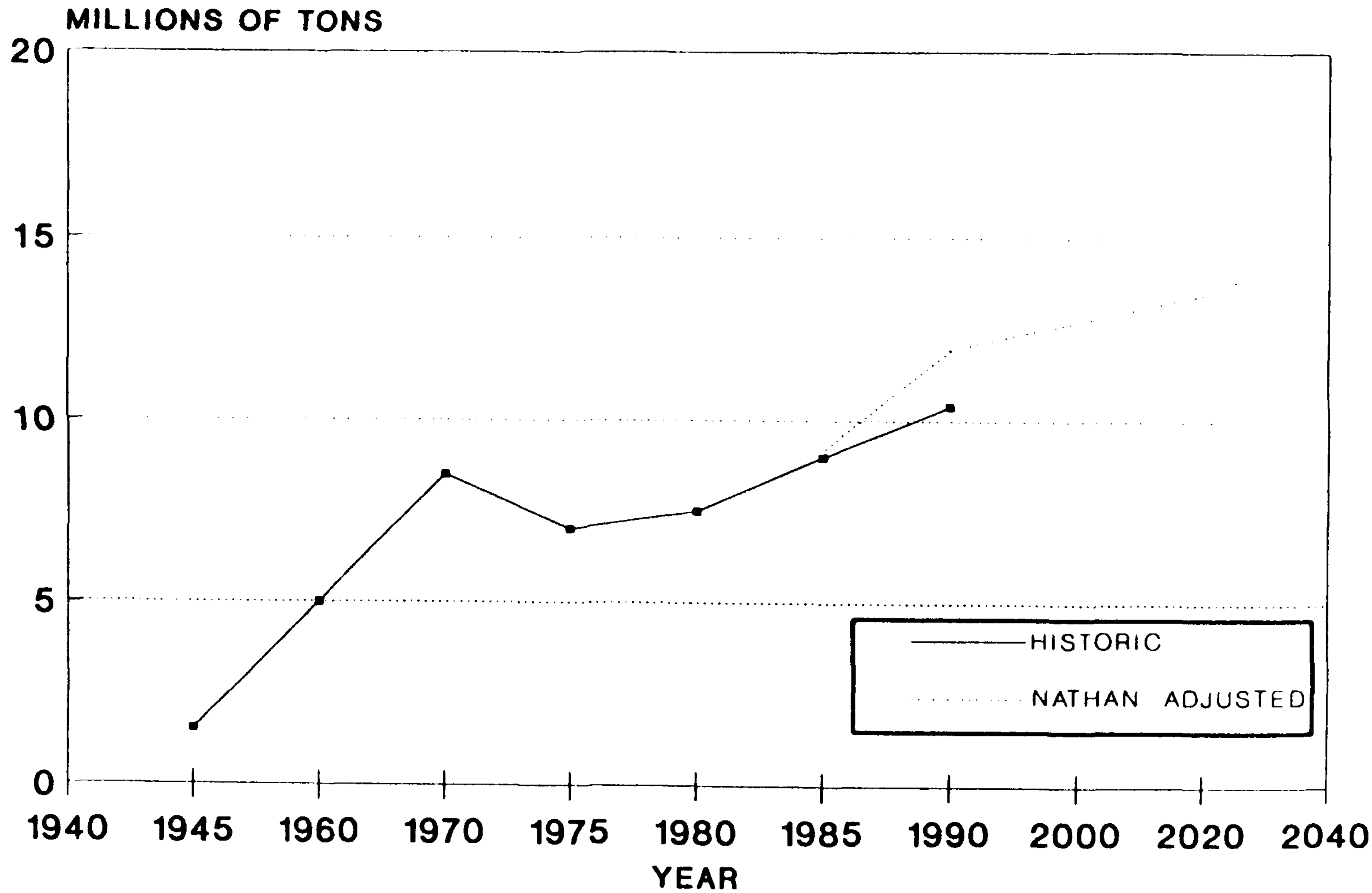
SOURCE: Projections of Demand for Waterborne Transportation, Ohio River Basin, by Robert R. Nathan and Associates with adjustments by GAI Incorporated for the Pittsburgh District (From Page 19 of the Monongahela River Study), and Waterborne Commerce Statistics Center for 1989 data.

FIGURE 1: HISTORIC AND PROJECTED TRAFFIC FOR GRAYS LANDING (L&D 7)



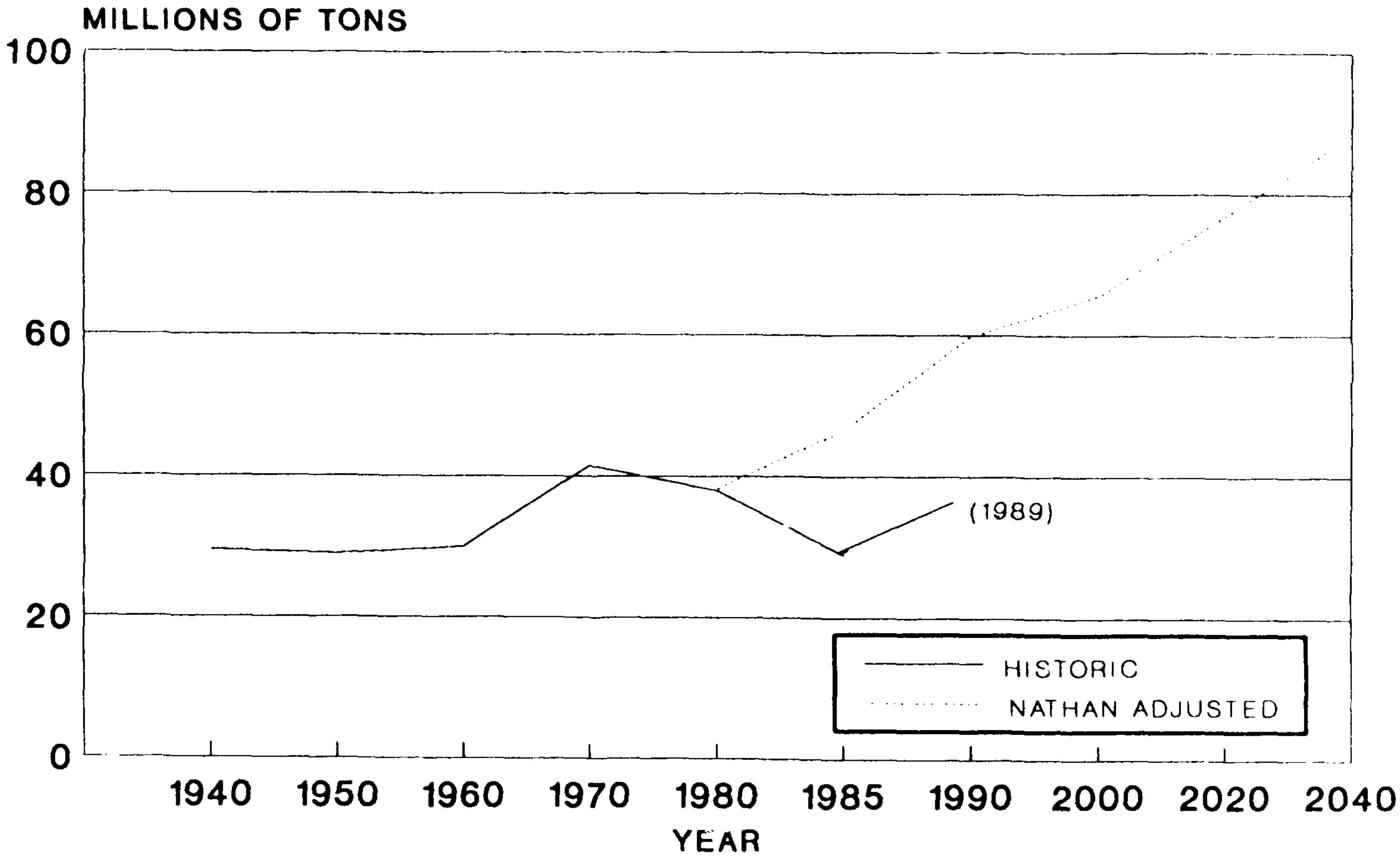
NATHAN ADJUSTED PROJECTIONS

FIGURE 2: HISTORIC AND PROJECTED TRAFFIC FOR POINT MARION (L&D 8)



NATHAN ADJUSTED PROJECTIONS

FIGURE 3: MONONGAHELA RIVER
TRAFFIC PROJECTIONS
NATHAN ADJUSTED



6. **<u>Lower Ohio River Navigation Feasibility Study IL-KY (Mouth to Cumberland River)</u>, Louisville District, Ohio River Division, August 1985, Revised November 1985.**

This report documents the results of a feasibility level study conducted for the purpose of determining the feasibility and the economic and environmental effects of making navigation improvements along this reach of the Ohio River. Part of the economic evaluation involved projecting future traffic flows for Locks & Dams 52 and 53, the existing navigation structures in the study area (Table 16).

The Corps study relied heavily on Robert R. Nathan Associates' comprehensive report, <u>Projections of Demand for Waterborne Transportation, Ohio River Basin, 1976-2040</u> (described earlier). The Nathan study represented a long-term (1976-2040) evaluation of waterway traffic demands founded on an analysis of market demands for waterborne commodities, the basin's resource base of these commodities, probable long-term production levels, and a forecast of the modes of transportation involved in moving these commodities from production areas to consumption areas.

Ohio River Basin waterborne traffic increased nearly fourfold from 1945 to 1980, growing from 51.3 million tons in 1945 to 193.7 million tons in 1980 (Table 17). The Basin is a major "exporter" of coal and grain, while it "imports" petroleum fuels, chemicals, chemical fertilizers, ores, and minerals. In addition, 72% of Ohio River traffic is local to the system.

Over the entire projection period (1976 to 2040) Ohio River System traffic is expected to increase by 119% (Table 9). Growth will occur at a diminishing rate, however, as coal traffic plateaus after 1990. Traffic was expected to increase at an average annual rate of 2.8 percent through 1990, thereafter averaging only 0.8 percent annually.

Because the Nathan projections do not reflect the opening of the Tennessee-Tombigbee Waterway (TTWW) in 1985, traffic projections were obtained for the TTWW from Mobile District and incorporated in this study. Projected

TABLE 16
PROJECTED TRAFFIC DEMAND FOR LOCKS AND DAMS 52 AND 53,
LOWER OHIO RIVER BASIN, 1995-2045
(Thousands of Tons)

Commodity Group	Projected 1995	2015	2045
Locks and Dam 52			
Coal and Coke	43,453	57,298	75,254
Petroleum Fuels	8,177	9,209	8,718
Crude Petroleum	744	592	263
Aggregates	3,506	4,014	4,756
Grains	5,454	6,736	8,556
Chemicals and Chemical Fertilizers	11,169	17,984	26,563
Ores and Minerals	9,130	16,174	27,239
Iron Ore, Iron and Steel	6,602	10,564	15,980
All Others	13,864	15,655	18,929
Totals	102,099	139,279	186,258
Locks and Dam 53			
Coal and Coke	23,904	31,314	40,562
Petroleum Fuels	8,177	9,209	8,718
Crude Petroleum	744	592	263
Aggregates	2,582	2,996	3,453
Grains	5,454	6,736	8,556
Chemicals and Chemical Fertilizers	11,169	17,984	26,563
Ores and Minerals	9,130	16,174	27,239
Iron Ore, Iron and Steel	6,600	10,562	15,977
All Others	13,863	16,654	18,917
Totals	81,623	112,221	150,248

Source: **Tabulation of Tow Cost Model shipment lists.**

LOWER OHIO RIVER NAVIGATION FEASIBILITY STUDY, IL-KY, AUGUST 1985

TABLE 17

OHIO RIVER NAVIGATION SYSTEM
WATERBORNE COMMERCE BY COMMODITY GROUP, 1980

(Millions of Tons)

Group	Total	Percent of Total	Inbound	Outbound	Local
Coal and Coke	117.9	60.9	3.3	12.5	102.1
Petroleum Fuels	17.1	8.8	4.8	2.4	9.9
Crude Petroleum	0.6	0.3	0.3	0.1	0.2
Aggregates	21.8	11.3	0.1	2.4	19.4
Grains	6.8	3.5	2.0	4.6	0.3
Chemicals & Fertilizers	11.8	6.1	8.1	1.0	2.7
Ores and Minerals	3.2	1.7	2.8	0.1	0.3
Iron & Steel	4.0	2.1	1.3	1.7	1.1
All Other	10.4	5.4	25.0	4.9	3.2
Totals	193.7	100.0	25.0	29.7	139.0

SOURCE: Adjusted Waterborne Commerce Statistics Center data.
NOTE: Because of rounding, individual items may not sum to totals.

traffic was screened to eliminate duplicate tonnages. In addition, coal traffic was added (7.4 million tons in 1995 and 13.6 million tons in 2040) as a result of an update to the Nathan projections made by the Pittsburgh District in 1983. These additions reflected new coal markets in the Upper Ohio River Basin since 1976, the base year for the Nathan study.

The Tennessee-Tombigbee Waterway has a dual impact on traffic through the project area. First, there was a small increase in traffic through Locks & Dams 52 and 53 because of new movements between the TTWW and the Mississippi River. Second, the opening of the TTWW enabled Ohio River shipments bound for the eastern Gulf Coast to use the TTWW instead of the Mississippi River.

Louisville District's approach in modifying the Nathan projections with TTWW traffic and additional coal movements was found acceptable and reliable at the time of its publication in 1985. In hindsight, despite lower than forecast initial TTWW tonnages, the Lower Ohio study traffic figures appear close to target based on 1990 PMS tonnage of 99 million at L&D 52, compared with a 1995 forecast of 102 million tons and in view of anticipated continued growth in coal traffic.

7. Kanawha River Navigation Study, Winfield Lock Replacement Interim Feasibility Report, Huntington District, Ohio River Division, September 1986.

Traffic growth on the Kanawha River more than tripled from 1940 to 1980, reaching 14.7 million tons in 1980 and an all-time high of 18.9 million tons by 1989 (Table 18). Virtually all Kanawha traffic transits Winfield Lock and Dam, situated near the mouth of the river below Charleston, WV. Most of the growth in Kanawha River tonnage is attributable to the growth of the coal and chemical industries in the Kanawha Valley (Figures 4 and 5). Increased inbound shipments of aggregates and petroleum fuels for industrial and consumer use were lesser contributors to the overall expansion.

TABLE 18

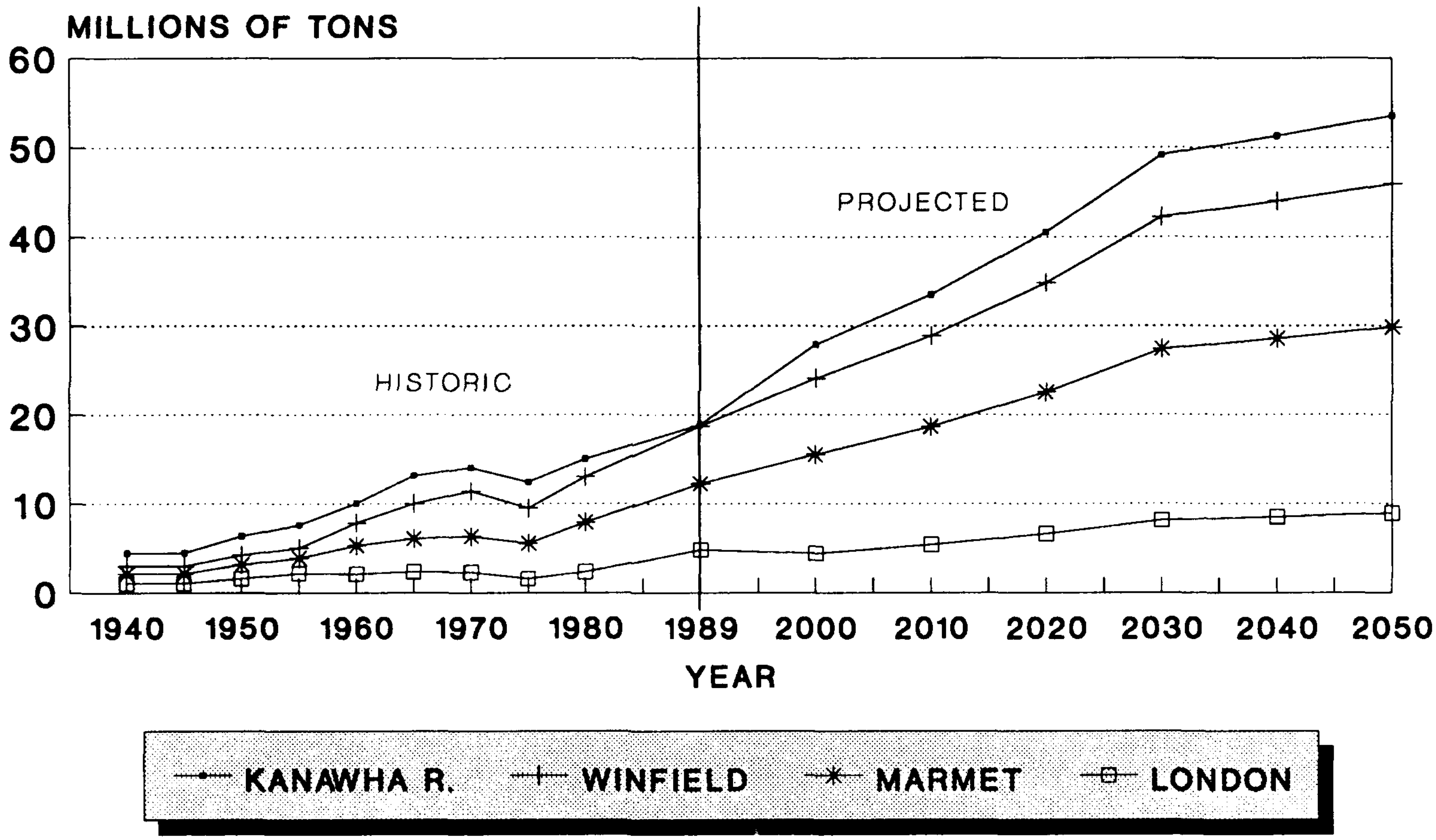
COMMODITY MIX OF PROJECTED KANAWHA RIVER TRAFFIC DEMANDS 1980-2050

(1,000 Tons)

	1980		1990		2000		2010		2020		2030		2040		2050	
Commodity	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
Coal	8,829	59	14,271	63	17,768	64	21,518	64	26,185	65	32,003	65	33,423	65	34,913	65
Petro Fuels	1,040	7	1,155	5	1,181	4	1,213	4	1,245	3	1,279	3	1,286	3	1,293	2
Aggregates	2,192	15	2,808	12	3,247	12	3,724	11	4,319	11	5,060	10	5,241	10	5,431	10
Grains	0	--	0	--	0	--	0	--	0	--	0	--	0	--	0	--
Chemicals	2,381	16	3,626	16	4,684	17	5,830	17	7,257	18	9,035	18	9,468	18	9,923	19
Ores & Minerals	118	1	166	1	207	1	251	1	306	1	375	1	391	1	409	1
Iron & Steel	53	0	76	0	93	0	112	0	135	0	164	0	171	0	178	0
All Other	439	3	601	3	732	3	878	3	1,058	3	1,282	3	1,337	3	1,394	3
Totals	15,051	100	22,703	100	27,913	100	33,525	100	40,506	100	49,197	100	51,318	100	53,541	100

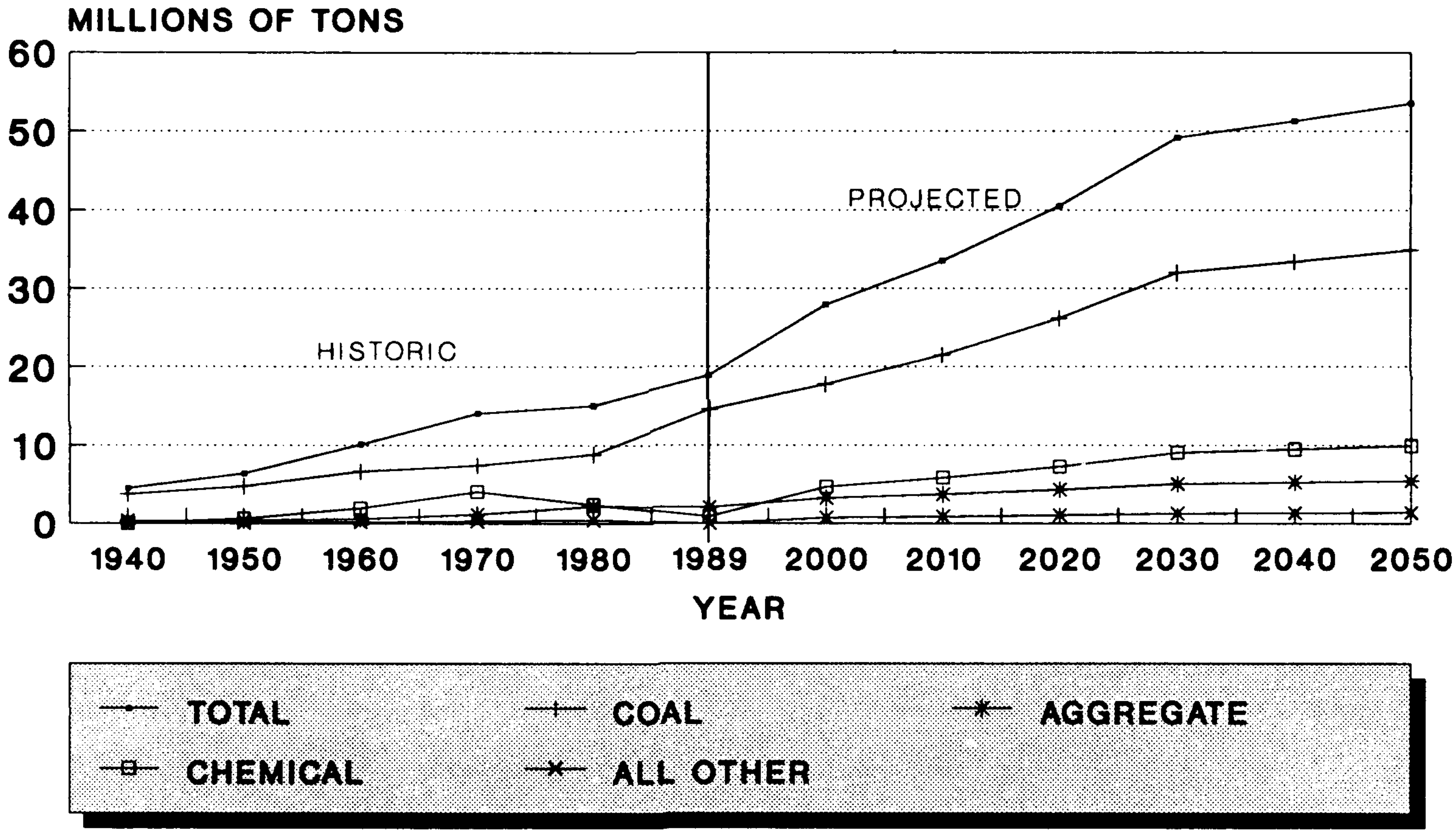
SOURCE: Table 26 (page 69) of the Kanawha River Navigation Study (1986)

FIGURE 4: KANAWHA RIVER SYSTEM LOCK TRAFFIC 1940 - 2050



NOTE: UNABLE TO DISPLAY 1990 PROJECTED DATA

FIGURE 5: KANAWHA RIVER SYSTEM COMMODITY TRAFFIC 1940 - 2050



NOTE: UNABLE TO DISPLAY 1990
PROJECTED DATA

Most Kanawha River tonnage is shipped inbound from or outbound to the Ohio River. This largely external orientation is a function of the types of industries along the river, the resources of the basin, and the location of product supply and market areas for basin industry. Of the four commodity groups that account for 96 percent of Kanawha River traffic, coal moves primarily in a downbound/outbound direction, while chemicals, aggregates, and petroleum move mostly upbound/inbound. Due to the predominance of coal traffic over other commodity traffic, however, slightly more traffic is shipped out of the area (53 percent) than into the area (47 percent).

Coal traffic (59 percent of total tonnage) is primarily destined for steam-electric generating plants located along the Ohio River and its tributaries. Lesser amounts are destined for the steel plants of the Pittsburgh area. Chemical traffic (16 percent of total tonnage) revolves around the large chemical complex in the Charleston Metropolitan Statistical Area (MSA) and is primarily inbound. Major origins include the Ohio River, the lower Mississippi River, and the petrochemical complexes located along the Gulf Coast. These areas provide basic feedstocks for use in chemical manufacturing as well as intermediate chemical products which require further processing. Aggregates (15 percent of total traffic) are used largely in construction activities around the Charleston area. Petroleum fuels (7 percent of total traffic), consumed by individuals and industry throughout the Kanawha Basin, originate primarily from refining centers located along the Ohio River and the lower Mississippi River near Baton Rouge.

Traffic projections for the Kanawha River were developed by the Navigation Planning Support Center of the Huntington District by relating the existing traffic base to indexes of growth in the specific regions served by the Kanawha River. The <u>1980 OBERS BEA Regional Projections</u> series developed by the Bureau of Economic Analysis (BEA) was selected as the demographic and economic framework for developing regional growth indexes.

In summary, projections for Kanawha River traffic to the year 2050 were developed by applying OBERS growth indices for population and industry earnings by BEA to 1980 base year Waterborne Commerce dock-to-dock commodity movement information. The OBERS index most closely related to the demand for a specific type of commodity was used for that commodity. For example, in determining coal and coke traffic for utility usage, the following indexes were used: population (weighted 33 percent), earnings in wholesale and retail trade and services (weighted 19 percent), and earnings in total manufacturing (weighted 48 percent). For coal and coke traffic for export, an index of earnings in the mining industry was used; for crude petroleum and petroleum fuels traffic, a population index was used; for aggregates, earnings in the construction industry; for grains, earnings in agricultural production (weighted 70 percent) and population (weighted 30 percent); for chemicals, earnings in non-durable manufacturing; and for iron and steel, earnings in durable manufacturing adjusted by a 0.7 dampening factor.

Destination-BEA area indices were used for domestic traffic, (which was considered to be demand driven) while origin-BEA area indices were substituted for export traffic, which had no destination-BEA area associated with it. These indices were applied to 1980 traffic movements at the port equivalent (PE) to port equivalent origin-destination level to arrive at projections through 2030. Thereafter, some commodity growth rates were dampened to 0.7 percent through 2050 to reflect the great uncertainty in making projections that distant in the future. This dampening was to insure that the planning process would not be biased by large out-year numbers and represented a reasonable judgment call by the analyst.

The study projects Kanawha River traffic to triple between 1980 and 2050 to 53.5 million tons (Table 18). By 1990 traffic should reach 22.7 million tons. This translates to a 1.8 percent annual growth rate. Coal traffic will increase as a share of total tonnage due to expanding demands by utility plants. Chemical and aggregates traffic will also increase, although the latter will possess a declining share of total traffic. Petroleum fuels traffic should decrease because of continuing conservation and conversion to alternative energy sources. The major origins of Kanawha River traffic are projected to remain the Charleston, Parkersburg, Wheeling, Huntington, and Columbus BEA areas. Likewise, the major destinations of traffic are projected to remain Charleston, Huntington, Wheeling, Cincinnati, and Pittsburgh BEA areas. Table 18 and Figures 4 and 5 show projected Kanawha River traffic by commodities and locks through 2050.

Although this study's publication date is quite recent, the historical Corps of Engineers (COE) Waterborne Commerce data used to generate projections dates back to 1980. Likewise, the OBERS BEA regional growth indexes also date to 1980. The study's projections of Kanawha River traffic for 1990 (22.7 million tons) now appear to be realistic in light of the fact that 1990 traffic at Winfield L&D was 21.2 million tons. As mentioned earlier, virtually all the Kanawha River traffic moves through the Winfield L&D.

Regarding the projection methodology itself, the applicability of OBERS population and earnings growth indexes to most of the commodity groups appears appropriate. One somewhat ambiguous connection was the relationship between earnings in the mining industry and future coal export traffic. Finally, while no attempt was made to allow for future shifts in modal share, it can be argued that there is no reason to believe that barges would not continue to carry at least their current share of traffic. Future growth rates were therefore presumed to affect all transportation modes uniformly.

8. **Forecast of Future Ohio River Basin Waterway Traffic 1986 - 2050, Volumes I and II, Navigation Planning Center, Huntington District, Ohio River Division, May 1990.**

The purpose of the study, as stated in the introduction to Volume I, was to project probable future levels of demand for waterway transport on the Ohio River Navigation System (ORS). Projections were developed for the entire ORS, each navigable river, and each lock and dam project for the period 1986 - 2050. The projections were estimated to help guide the Corps of Engineers' waterway improvement planning program by indicating which lock and dam projects would be most likely to experience traffic congestion in the future. Through this assessment of future problems, plans then could be developed to improve the flow of waterway traffic.

The ORS includes the Ohio River and the navigable portions of the Allegheny, Monongahela, Kanawha, Big Sandy, Green, Tennessee, Cumberland, and Kentucky Rivers. The ORS serves as a major transportation link for the coal mines and industries located within the Ohio River Basin (ORB) and provides direct access, through the Mississippi River and tributaries, to both the Midwest and the deep-draft ports of the Great Lakes and Gulf Coast. Between 1940 and 1986, total waterway traffic grew from 51.2 million tons to 223.9 million tons, representing an average annual growth rate of 3.3 percent. This growth was not distributed evenly throughout ORB, however. Average annual tonnage increases on the southern tributaries of the Green, Cumberland, and Tennessee Rivers ranged from 10.2 percent to 6.6 percent, while the northern tributaries experienced growth ranging from 3.1 percent on the Kanawha to negative 0.2 percent on the Allegheny River. Traffic increased by an average 4.2 percent annually on the Ohio River mainstem during the 1940-86 period.

Major commodities on the ORS include coal and coke, aggregates, petroleum fuels, chemicals, and grains, which together represent about 88 percent of total tonnage. Coal and coke constitute by far the largest single commodity group moving on the system, accounting for 60 percent of the total 1986 traffic and growing by an average annual 3.1 percent during the 1940 - 1986 period. With the exception of crude petroleum traffic, which dropped sharply with the opening of a crude petroleum pipeline into the Ashland-Huntington area in the early 1970's, all of the major commodity groups exhibited traffic growth since 1940: grains, 10.6 percent annually; chemicals, 7.8 percent per annum; ores, 6.1 percent per year; petroleum fuels, 3.3 percent annually; aggregates, 2.5 percent per year; and steel, 1.9 percent annually. Approximately 63 percent of waterborne commerce in the ORS is internal, meaning that both the waterside origin and the waterside destination are within the ORS. About 24 percent of the traffic is outbound and 13 percent is inbound. While the share of inbound traffic has remained relatively constant since 1970, the share of outbound traffic has doubled.

Forecast Methodologies

While the methodologies used in developing traffic demand forecasts were specific to each individual commodity, two basic methods were used: one for utility related commodities (utility coal, and lime and limestone for desulfurization), and another for the remaining commodities. Some steps were common to both methods: examination and completion of industry forecasts, development of base year traffic flows, and categorizing each receiving dock by geographic and end use market. The development of growth indices to apply to base year traffic levels, however, differed between utility related commodities and all other commodities.

Non-Utility Commodity Forecasts

In Volume I of Forecast of Future Ohio River Basin Waterway Traffic 1986 - 2050, forecasts were developed for each of the ORB industries that generate significant amounts of waterway commodity traffic: petroleum refining, quarrying, construction, agriculture, chemicals, nonferrous metals, steel, and paper industries. Both top-down and bottom-up approaches to forecasting were employed. Top-down techniques begin with national level forecasts which are first disaggregated to the industry/regional level and then to the company/ local level. Bottom-up techniques, on the other hand, originate at the company/ local level and are then aggregated to the regional and national levels. Both approaches are used to insure general consistency between national level forecasts and the unique prospects for individual company operations.

The 1986 - 2050 forecast period has a short-term and a long-term time horizon. The short-term extends to the year 2000 and generally corresponds to the planning horizon of most of the available industry forecasts. The long-term projection extending from 2000 to 2050 relies primarily on 1985 OBERS top-down projections produced by the Bureau of Economic Analysis (BEA). BEA's OBERS forecasts include both employment and earnings by industry. Employment forecasts are based on demographic estimates and projected labor force participation rates. Earnings forecasts are derived from national level earnings forecasts which have been distributed to the various industry sectors through the use of an input/output model. State and county projections are in turn founded on the projection of ratios of state employment growth to national growth, and county ratio of employment to state totals.

Calendar year 1986 was selected as the base year for forecasting purposes. Actual waterway traffic, while serving as a starting point for identifying waterway demands, is but one visible component of demand. Before applying growth indices to the 1986 base level, necessary adjustments were made to insure that 1) reported traffic for the base year was accurate; the year chosen was a representative one; and 3) system constraints were not dampening demands. System constraints act to reduce traffic flows in the affected areas and, if left unaccounted for, would result in understated levels of demand. Two major potential system constraints were identified: the small navigation projects located on the upper Tennessee and the lower Monongahela Rivers.

Formal mail surveys were conducted in both areas. Upper Tennessee River surveys were completed as part of a 1987 reconnaissance-level study of Chickamauga, Watts Bar, and Ft. Loudoun locks and dams. These surveys indicated that 5.7 million tons of additional traffic might move on the river in the absence of constraints on the upper Tennessee. Surveys of potential Monongahela River shippers were conducted in the spring of 1988 as part of the subject study. Surveys were mailed to over 100 firms identified as potential Monongahela River users. Respondents indicated that an additional 7.3 million tons of traffic might move on the river system if constraints on the lower Monongahela were removed.

Major waterway users were contacted in an effort to identify changes in traffic patterns since 1986 or changes expected to occur in the near future. Extensive telephone surveys of major basin shippers were conducted for each of the nine commodity groups. In addition, each of the Ohio River's four Corps Districts and the Tennessee Valley Authority provided further assistance in identifying new waterway traffic flows. As a result of these contacts with current and potential shippers, a number of origin/ destination patterns were altered and some additional traffic was added to the base. Comparisons of historic averages with the base traffic figures also were made to help insure the reasonableness of base traffic levels.

After base traffic levels were determined, the next important step was the identification and categorization of each of the unique origin/ destination commodity movements on the ORS by geographic and end use markets. This involved identifying the shipper, determining the market it best represented, and examining the market(s) the shipper served. Classification of end use markets for some commodity movements was difficult simply through the use of dock name descriptions. When sizeable movements were involved, docks and probable shippers were contacted in an attempt to identify the shipper and classify the particular movement.

The objective in classifying all movements according to appropriate end use market was to determine which of the previously assembled industry and/or CBERS-based forecasts were appropriate in the development of growth indices to apply to the base traffic level for each commodity. Final classifications corresponded to the finest level of detail available from an industry forecast standpoint. For example, in the case of the utility industry, the finest level of detail involved identifying specific utility operating companies; for the construction industry, a particular region of the country; and for the paper industry, the specific type of paper involved.

By associating, or "keying," each movement to a particular market, traffic projections for any one commodity became the product of forecasts for numerous industries representing both end use and geographic markets. In the case of limestone, for example, lime plants, utilities, steel mills, cement plants, water revetment projects, and highway construction projects acted as markets for the different movements. Geographic variation in markets was accounted for in that the industrial make-up of any given geographic area necessarily influences the pattern of flows and prospects for growth in the near-term. Additionally, destination BEA industry forecasts were, in varying degrees, incorporated into the traffic projections for all commodities.

A final procedure was the selection and application of appropriate growth indices. End use classifications for each commodity movement represented determining factors or "keys" in identifying and selecting specific growth indices for each movement in the ORS. Forty market keys were used in developing the traffic projections. The keys most commonly related to industries which acted as the shipper, or consumer, of the commodity in question. In turn, the indices were based on industry market forecasts developed by the industry itself, or by BEA. The BEA forecasts are presented in the form of industry sector variables referred to as OBERS variables. A summary of the industry forecasts and OBERS variables used in developing the traffic projections in each commodity group are presented in Table 19.

Short run indices (1986-2000) relied most heavily on industry forecasts, when available. In some cases the industry forecasts were regionally specific. Separate keys and companion indices reflecting this geographic specificity were created. These same keys were used to select long run (2000-2050) indices as well. Indices used in long run projections were generally tied to a limited set of OBERS-based variables. These variables relate to broad industry sectors and the smaller BEA areas, which are geographic regions tied economically to a central metropolitan area. While only nine OBERS variables were used, (population, manufacturing earnings, durable earnings, nondurable earnings, construction earnings, retail trade earnings, transportation and public utility earnings, mining earnings, and mining employment) they were transformed into as many indices as there were destination BEA's for waterway shipments.

Utility Commodity Forecasts

Utility coal, and lime and limestone for desulfurization, are the waterborne commodities most directly affected by utility forecasts. These three commodities represented roughly 48 percent of total ORS traffic in 1986. The development of coal forecasts is the most critical component for utility commodity projections because the lime and limestone forecasts are generally arrived at by applying constant consumption factors for these inputs to coal consumption forecasts. In addition, utility coal accounts for 99.0 percent of the tonnage in this group.

Projected shipments of coal by utilities were based on projected coal consumption, the current share of coal traffic moving by barge, and the results of industry interviews and surveys. This involved obtaining the

TABLE 19

SUMMARY OF INDUSTRY FORECASTS AND OBERS-BASED VARIABLES USED IN WATERWAY PROJECTIONS

Commodity Groups	Short-term Forecasts	Long-term Forecasts
Coal	Utility Industry Coal Industry Steel Industry	Population Retail Trade Earnings Manufacturing Earnings Mining Earnings Mining Employment Durable Earnings
Petroleum Fuels	Population	Population
Crude Petroleum	Population	Population
Aggregates	Construction Industry Steel Industry Utility Industry	Construction Earnings Nondurable Earnings Durable Earnings Population Retail Trade Earnings Manufacturing Earnings
Grains	US Dept of Agriculture Population	US Dept of Agriculture Population
Chemicals	Aluminum Industry US Dept of Agriculture Population	Aluminum Industry US Dept of Agriculture Population
Ores and Minerals	Nondurable Earnings Construction Industry Zinc Industry US Forest Service Population Steel Industry	Nondurable Earnings Construction Earnings Zinc Industry US Forest Service Population
Iron and Steel	Steel Industry Manufacturing Earnings	Durable Earnings Manufacturing Earnings
All Others	US Dept of Agriculture Population US Forest Service Construction Industry Nondurable Earnings Aluminum Industry Zinc Industry Utility Industry Durable Earnings Steel Industry	US Dept of Agriculture Population US Forest Service Construction Earnings Nondurable Earnings Aluminum Industry Zinc Industry Transportation and Public Utility Earnings Durable Earnings

SOURCE: Forecast of Future Ohio River Basin Waterway Traffic, 1986 - 2050, (Huntington, WV: U.S. Army Engineer District, Huntington, 1990).

short-term electricity demand forecasts developed by each utility and relating these to BEA forecasts of regional population and economic growth. These forecasts were used to develop electricity requirements for each utility involved in ORS coal traffic.

The next step involved converting electricity requirements into generation by fuel type. Projected generating mix was based on each utility's mix of capacity by fuel type and the relative efficiencies of each. Net capacity additions from new plant construction and the retirement of old plants was factored into the analysis. The results of this effort were projections of electric generation by coal-fired plants in the ORS. Electricity generation was then converted into coal consumption based on historic conversion rates for each plant. The link between coal consumption and barge receipts was based on the share of 1986 coal consumption barged to each plant unless otherwise indicated by the utilities.

The coal forecasting methodology pertains to the most probable traffic conditions. These projections were bracketed with high and low forecasts estimated to be 15 percent above the most probable condition for the high forecasts and 15 percent below the most probable condition for the low forecasts. Huntington District bracketed the most probable case by plus or minus 15 percent based on trend line analysis and review of pertinent forecasting literature. Regression analysis was used to fit a trend line to historic traffic observations between 1950 and 1986. The derived regression equation yielded a good fit between the trend line and the observations. Related statistical tests indicated that 95 percent of the historical observations deviating about this trend line were within plus or minus 15 percent of the trend line. Further confirmation for the plus or minus 15 percent technique came from the National Electric Reliability Council. The Council establishes an envelope of high and low forecasts 15 percent above and below its most probable forecast. The Council's convention has significance because of the importance of utilities to ORS waterborne traffic. Utilities represent a large share of the ORS coal and aggregates traffic.

Forecast Results

The projections for total system traffic demand and each of the nine commodity groups are presented in Table 20. Total traffic is expected to increase from 223.9 million tons in 1986 to 315.9 million tons by the year 2000 (an increase of 41 percent); to 437.9 million tons by the year 2030 (96 percent growth); and to 548.7 million tons by 2050 (an increase of 145 percent). Over the 64-year period from 1986 to 2050, total traffic is projected to grow at an average annual rate of 1.4 percent. Figure 6 graphically portrays the level of ORS traffic from 1940 to 1986 and projections from 1986 to 2050.

The Huntington District bracketed the projections in Table 20 with high and low forecasts set at 15 percent above and below the most probable condition. Projected values for total ORS traffic ranged between 268.5 million tons and 363.3 million tons for the year 2000, and between 466.4 and 631.0 million tons in the year 2050. Between 1986 and 2050, traffic demands were projected to increase at an annual rate of 1.2 percent in the low scenario, 1.4 percent in the most probable, and 1.6 percent in the high scenario.

Summary

In summary, the Huntington District employed a variety of techniques in attempting to project future traffic movements on the Ohio River System. Commodities were first aggregated into industry related groups. Each industry was in turn examined and its likely demand for waterborne shipments was forecast. Base year traffic flows for each commodity group were adjusted to account for system constraints and potential shifts in waterway flows. Movements were categorized by the geographic location of the destination and end use market. Various short-term and long-term growth indices, based on industry market forecasts and OBERS population, employment, and earnings variables, were applied to adjusted base traffic levels for each commodity group. Finally, projections were bracketed with high and low forecasts estimated to be 15 percent above and below the most probable condition based or trend line analysis and review of pertinent forecasting literature.

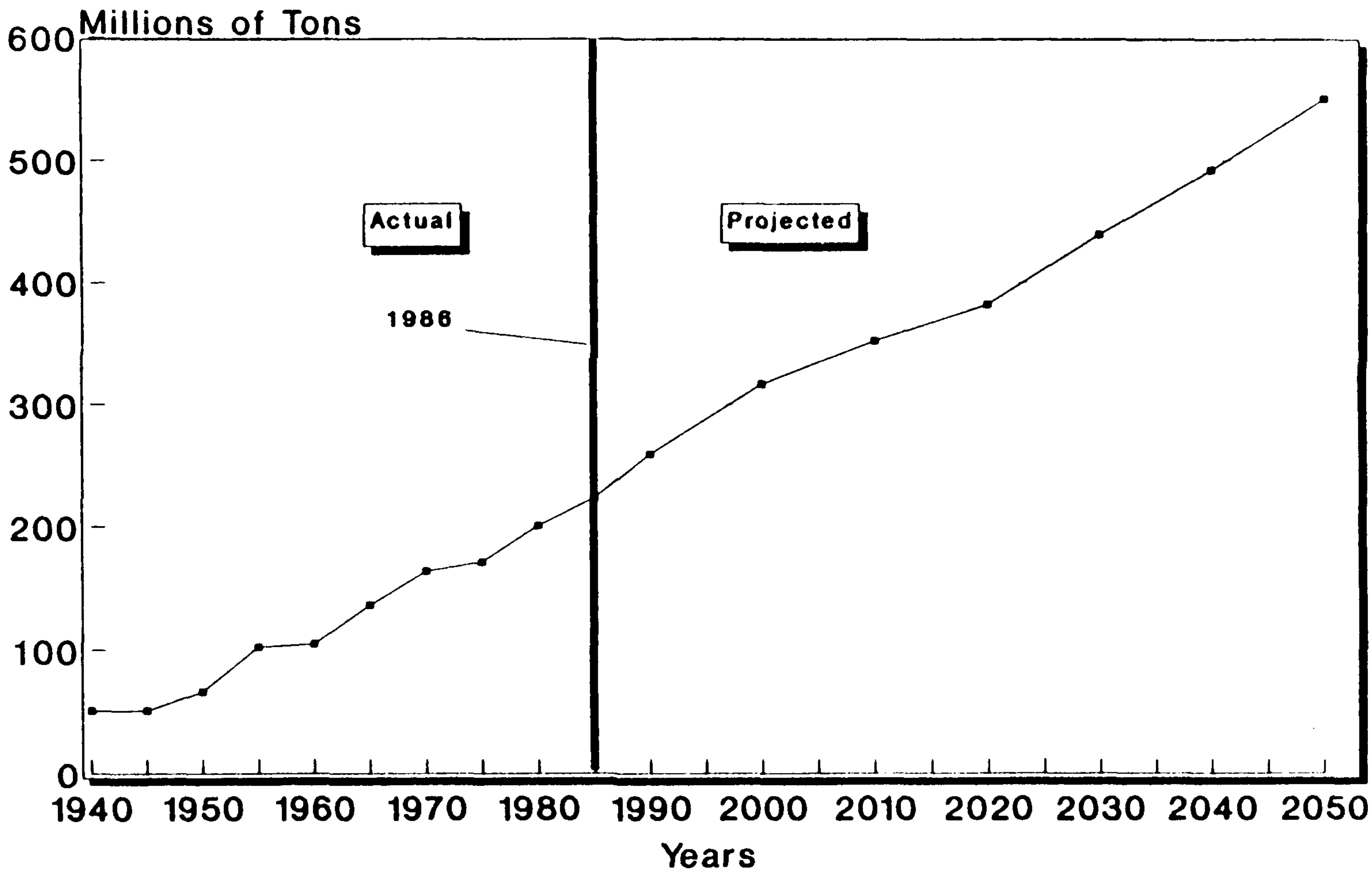
TABLE 20
OHIO RIVER NAVIGATION SYSTEM
PROJECTED COMMODITY TRAFFIC, 1986-2050
(Millions of Tons)

Commodity Group	Actual 1986	Projected 2000	2010	2020	2030	2050	Annual % Change 1986-2050
Coal	135.2	189.6	207.0	216.6	254.4	321.4	1.4
Petro Fuels	12.9	13.3	13.8	14.2	14.4	15.0	0.2
Crude Petro	0.6	0.6	0.6	0.6	0.6	0.7	0.2
Aggregates	28.1	38.2	45.0	54.5	61.6	75.7	1.6
Grains	10.3	19.0	21.8	25.2	29.1	39.2	2.1
Chemicals	12.4	17.9	19.9	21.9	23.8	28.0	1.3
Ores	3.1	4.1	4.7	5.4	6.0	7.8	1.5
Steel	5.8	10.4	11.5	12.5	13.3	15.3	1.5
Misc.	15.5	22.8	26.6	30.3	34.5	45.6	1.7
TOTAL	223.9	315.9	350.9	381.0	437.9	548.7	1.4

SOURCE: Forecast of Future Ohio River Basin Waterway Traffic, 1986 - 2050, (Huntington, WV: USAED Huntington, 1990).

The Huntington District's overall effort was exhaustive and competent. The commodity-specific growth indices selected were based on the characteristics of the commodity, the underlying forces influencing traffic levels for that commodity, and a detailed examination of the commodity's origin/ destination flows. Published data sources were varied and extensive, and the District used interview and expert opinion techniques as well. While the forecast horizon is still too distant to begin to assess the accuracy of the projections, the most recently published data on waterborne commerce indicate that ORS traffic continues to grow and projected probable traffic levels for the year 2000 could well be met. The application of OBERS employment and earnings growth indices to most of the commodity groups appears appropriate for such a long-term planning horizon. Extending a projection envelope above and below the most likely scenario builds some degree of flexibility into the forecasts to capture exogenous macroeconomic variables. The only clear drawback to the Huntington approach might be the cost and time required to develop such projections. While forecasts of this sophistication are always preferable, not all offices can commit resources of this magnitude when budgets are tight.

FIGURE 6 - OHIO RIVER SYSTEM TRAFFIC (Actual and Projected: 1940-2050)



9. Supplement to the Environmental Impact Statement: Tennessee-Tombigbee Waterway , Alabama and Mississippi, Navigation, US Army Engineer Districts Mobile, Alabama, and Nashville, Tennessee, April, 1981.

This report relied on economic data from the 1966 Reevaluation of Project Economics and 1976 Restudy of Project Costs and Benefits, both Mobile District studies. The 1966 report's estimates of future Tennessee-Tombigbee Waterway (TTWW) traffic were drawn from interviews and correspondence with shippers and receivers during the period 1957-1960, and supplemented by a traffic survey conducted during 1964-65. Tonnage of 7.5 million tons was projected on the TTWW for 1966 (had the waterway been operational), increasing to 39.5 million tons by 2026. The four predominant commodities (in roughly equal proportions) were predicted to be petroleum and products, coal, metals and ores, and chemicals.

In 1975 Mobile District contracted with A.T. Kearney, Inc., to perform a navigation benefit study of the TTWW. This effort became the foundation for Mobile's 1976 report. Kearney identified approximately 1000 shippers and receivers in the waterway tributary area. This population yielded over 500 potential commodity movements. These were screened to eliminate movements that wouldn't use the waterway for various reasons, duplicates, and those under 6000 tons per year, leaving approximately 250 potential movements. This group was then subjected to a detailed rate analysis to determine savings per ton, if any, that would be realized by utilization of the TTWW. Transportation savings were determined by comparing the rate per ton for moving a commodity on an alternative route or mode versus the rate to move the commodity on the TTWW. Movements were not included unless savings were at least greater than $0.50/ton versus an alternative mode (rail or truck) or greater than $0.15/ton versus alternative barge routings on another waterway. This process left 121 movements that met the minimum savings per ton criteria and became the basis for project navigation benefits. The Corps updated these 121 movements annually through 1980 by reanalyzing the rates for individual line-haul movements for the TTWW and alternative modes and/or routes. Finally, a 10 percent contingency factor was added to the total tonnage to account for unidentified and small traffic volumes.

The methodology yielded a forecast of 28.5 million tons of traffic in the first year of operation (expected to be 1987), of which coal comprised 74 percent. Furthermore, "unconstrained" TTWW traffic was expected to reach 111 million tons by 2036, while the expected "projected" traffic would reach 41 million tons by the same year. (The difference between unconstrained and projected can be explained by capacity limitations of the channels and lock and dam dimensions of the TTWW and Black Warrior-Tombigbee Waterways.) A key issue is how Kearney arrived at higher future traffic levels (beyond 1987) when their shipper survey approach identified only movements in the first year or so of operation.

Projections of future TTWW traffic were made by relating each base year commodity movement on the TTWW to a recognized economic indicator that was most closely associated with the commodity's use or demand. Initial tonnage levels were multiplied by OBERS Series E projections of total earnings in the applicable industry and region involved in each particular movement. Usually the demand industry and region OBERS earnings indices were used, unless insufficient information was available, in which case the supply industry and region indices were applied. For example, pulp and paper movements were based on the earnings index for the paper industry in the appropriate demand region. All commodities projections relied on the appropriate OBERS forecast except coal movements for export, which were estimated using the Department of Interior, Bureau of Mines projections for coal exports and projected growth in the foreign steel industry. Five key commodities (coal, farm products, metallic ores, pulp and paper products, and chemicals) were expected to constitute over 90 percent of future traffic. Kearney's projected average annual growth rates for traffic in various TTWW commodities are presented in Table 21.

In summary, the forecast undertaken by Kearney Management Consultants and Mobile District projected initial operational traffic levels using a shipper survey and interview technique. Rate analysis was performed to determine if the TTWW provided a least-cost alternative for potential commerce. Projections of traffic levels in later years generally relied on industry- and region-specific OBERS growth indexes. Initially, this approach

TABLE 21

TENNESSEE-TOMBIGBEE WATERWAY -
TTWW COMMODITY FORECAST

Commodity	Average Annual Growth Rate (Percent)	Forecast Used
Chemicals	1.0 - 3.9	OBERS Series E for total earnings in the applicable industry(s) and region(s) involved in each particular movement.
Clay, Concrete and Stone	2.4	
Coal (Domestic)	2.5 - 3.5	
Fabricated Metals	1.2 - 2.9	
Food Products	2.5 - 2.7	
Marine Products	2.2 - 2.3	
Metallic Ores	1.4 - 3.1	
Miscellaneous	1.4 - 2.2	
Nonmettalic Minerals (Domestic)	1.9 - 2.9	
Petroleum	1.3 - 2.4	
Primary Metals (Domestic)	1.4 - 3.2	
Pump, Paper and Allied Products (Domestic)	2.0 - 2.8	
Forest Products	2.7	
Coal (Export)	2.9	Department of the Interior, Bureau of Mines projections for coal exports and projected growth in the foreign steel industry.
Farm Products (Export)	1.0 - 4.1	OBERS Series E for total earnings in the applicable supply industry and region for each particular movement.
Nonmetallic Minerals (Export)	0.7	
Primary Metals (Export)	1.6 - 1.8	
Pulp, Paper and Allied Products (Export)	2.4 - 2.6	

SOURCE: A. T. Kearney, Inc. Study for 1981 Tenn-Tom Study (Page VI-38, Table VI-10 of Report) would seem methodologically appropriate for forecasting traffic in the immediate future. In contrast to the District's expectations, however, traffic was only 1.4 million tons in 1985; 2.2 million tons in 1986; 3.6 million tons in 1987; 8.8 million tons in 1988 and 4.3 million tons in 1989.

Although the OBERS projections probably represented the best long-term forecasting tools available when the TTWW was being planned, designed, and constructed, fundamental changes in the price of energy, the value of the dollar, competition in foreign agricultural markets, and the structure of the national economy have drastically undermined the validity of the OBERS growth indices dating from the early 1970s. In addition, the Kearney analysis did not appear to fully consider the potential transition time for regional industries to alter transportation practices to utilize the new waterway. Many industries have fixed assets, costs, and contracts associated with a particular transportation mode and may require some time to evaluate and adopt alternatives. The unique character of the project was a further analytical challenge in that there was no historic traffic base. Economic forecasts for new projects require a regional modal split analysis for forecasting shipments and receipts on the waterway, a broader water route-shift methodology and finally, a very complicated input, "waterway-induced" development and traffic.

10. **Operational Forecast for Initial Traffic on the Tennessee-Tombigbee Waterway, Mobile District, South Atlantic Division, August 1985.**

The Mobile District contracted with BHS Economic Research of Knoxville, TN to estimate the freight traffic and volume of commerce that could be expected to move over the Tennessee-Tombigbee Waterway (TTWW) during its initial years of operation. The TTWW opened to commercial traffic in January, 1985. No projections of growth in traffic over the project life were presented.

Traffic forecasts were developed by surveying industries that were using the waterway and those that had the potential to ship on the waterway. All identifiable industries that might have been interested in using the waterway were contacted and requested to provide survey information, including type of commodity, volume in tons, origins and destinations of cargo, plans for expansion, expected traffic, etc. Many of these industries had been identified in A. T. Kearney's 1976 study on Transportation Economics of the Tennessee-Tombigbee Waterway. Others were identified by the Mobile District from chamber of commerce lists, trade associations, and state industrial directories.

Industry traffic estimates were then aggregated to yield 18.4 million tons of "potential" commerce that could use the TTWW in its routing. Duplicate tonnages and commodities that were not suitable for barge movements were eliminated. Potential commerce included two distinct categories: freight which was already moving via the TTWW and commerce moving via an alternative mode or route which could potentially realize a savings in transportation costs if it was diverted to the TTWW. Of the 18.4 million tons 2.5 million tons were designated as "future" traffic (freight that would not use the waterway for several more years).

A comparative rate analysis was conducted to determine if the remaining 15.9 million tons could move at a savings in transportation costs over an alternative routing (or alternative modes). This analysis entailed the development of complete transportation charges for each commodity movement. In most cases the alternative routing was the route currently being used. The alternative could be an all-overland route, a combination of overland and water route, or a competitive all-water route. The rates for overland routes either were quoted by shippers, receivers, and carriers, or published in freight tariffs. Barge rates were constructed using the daily operating costs of towboats and barges published by the Office, Chief of Engineers, Washington, DC. The 2.8 million tons that did not indicate a savings from using the TTWW routing were eliminated, leaving 13.1 million tons of traffic (Table 22). A 10 percent contingency was applied to the total annual base-year (1985) tonnage to account for any industries not surveyed, resulting in an estimated 14.5 million tons of "accepted" commerce that should be available for the TTWW during FY86 or shortly thereafter. The data in Table 22 show the forecast traffic by commodity and by direction of traffic (upbound/downbound).

TABLE 22

FORECAST OF INITIAL (1985) TRAFFIC ON
THE TENNESSEE-TOMBIGBEE WATERWAY

Industrial Group	Upbound	Downbound	Total
01 Agricultural Production	--	203,000	203,000
10 Metal Mining	191,000	20,000	211,000
12 Bituminous Coal	--	7,125,000	7,125,000
14 Mining and Quarring of Non-metallic Minerals (Except Fuels)	53,000	1,250,000	1,303,000
20 Food and Kindred Products	37,000	50,000	87,000
24 Lumber and Wood Products	--	2,232,000	2, 32,000
26 Paper and Allied Products	268,000	--	268,000
28 Chemicals and Allied Products	756,000	171,000	927,000
29 Petroleum Refining and Related Industries	217,000	--	217,000
32 Stone, Clay, Glass and Concrete Products	--	55,000	55,000
33 Primary Metals Industries	398,000	103,000	501,000
50 Wholesale Trade	10,000	--	10,000
Sub-total	1,930,000	11,209,000	13,139,000
Plus 10% for Contingencies	193,000	1,121,000	1,314,000
Grand Total	2,123,000	12,330,000	14,453,000

SOURCE: BHS Economic Research, Knoxville, TN

In summary, the operational forecast undertaken by BHS Economic Research and Mobile District projected near-term traffic levels using a shipper-survey and interview technique. Rate analysis was performed to determine if the TTWW provided a least-cost alternative for potential commerce. Initially, this approach would seem methodologically appropriate for forecasting traffic in the immediate future. In contrast to the District's expectations, however, traffic in 1985 amounted to only 1.4 million tons; in 1986, 2.2 million tons; in 1987, 3.6 million tons; 1988, 8.8 million tons, and 1989, 4.3 million tons. The increase in traffic on the TTWW in 1988 was due to drought conditions on the Mississippi River. Other factors were obviously at work in holding down TTWW traffic levels for several years. Reluctance of shippers and carriers to deviate from established routings, as well as the extra time incurred by tows having to break-up and lock through the TTWW versus the open-river Mississippi channels, played larger roles than expected in adversely affecting projected TTWW traffic levels.

11. Interim Feasibility Report and Environmental Impact Statement for Oliver Lock Replacement, June 1983, and Reevaluation of the Oliver Lock Replacement Project, September 1985, Mobile District, South Atlantic Division.

Although the Mobile District did not generate forecasts for the entire Black Warrior-Tombigbee River System in this study, projections were made for selected locks through 2030 (Table 23). The projections used 1979 Waterborne Commerce (WC) dock-to-dock commodity movements for base year traffic levels. The data was verified and supplemented by shipper interviews. In addition, potential shippers and receivers were contacted from existing WC dock listings, state industrial directories, and Chamber of Commerce lists. Interviews indicated that improvements to Oliver Lock & Dam alone would not induce modal diversion of traffic. Companies in the study area that currently used other modes for all or part of their shipments would continue to move that way even with the replacement of Oliver Lock.

Future traffic projections were based on "the applicable 1980 OBERS BEA region growth rate, considering the type of commodity, its use, and the origin and destination of the movement." In other words base year (1979) traffic was

TABLE 23

PROJECTED TONNAGES FOR SELECTED LOCKS FOR THE BLACK WARRIOR-- TOMBIGBEE RIVER SYSTEM, 1990-2030 (WITH AND WITHOUT PROJECT CONDITIONS)

(1,000 TONS)

LOCK	WITHOUT PROJECT					WITH PROJECT				
	1990	2000	2010	2020	2030	1990	2000	2010	2020	2030
L&D 53	96.6(35) a/	111.2(22)	125.8(46)	125.8(46)	125.8(46)	96.8(35)	110.5(20)	125.9(44)	125.9(44)	125.9(44)
L&D 52	116.5(51)	133.8(61)	151.8(68)	151.8(68)	151.8(68)	116.4(51)	133.1(57)	151.8(60)	151.8(60)	151.8(60)
SMITHLAND	128.1(75)	148.1(85)	166.1(89)	166.1(89)	166.1(89)	127.9(75)	147.9(83)	165.8(90)	165.8(90)	165.8(90)
THNC	24.5(93)	26.5(95)	26.6(94)	28.6(94)	28.6(94)	25.9(96)	26.3(89)	28.3(93)	28.3(93)	28.3(93)
KENT/BARK	69.2(80)	81.0(91)	85.5(94)	85.5(94)	85.5(94)	69.5(80)	80.1(90)	85.4(95)	85.4(95)	85.4(95)
PICKWICK	38.7(29)	45.4(39)	48.4(40)	48.4(40)	48.4(40)	38.8(29)	44.4(39)	48.5(40)	48.5(40)	48.5(40)
CHICKAMAUGA	7.7(74)	9.2(82)	8.4(82)	8.4(82)	8.4(82)	7.6(77)	8.8(96)	6.5(64)	6.5(64)	6.5(64)
WILSON	27.5(83)	32.2(47)	28.5(58)	28.5(58)	28.5(58)	27.5(84)	31.1(44)	26.8(68)	26.8(68)	26.8(68)
BANKHEAD	17.2(26)	[illegible](25)	12.4(18)	12.4(18)	12.4(18)	19.1(31)	21.5(35)	27.2(45)	27.2(45)	27.2(45)
HOLT	18.2(34)	17.8(32)	20.1(34)	20.1(34)	20.1(34)	24.9(54)	28.4(55)	35.8(77)	35.8(77)	35.8(77)
OLIVER	[illegible](96)	18.2(97)	20.6(99)	20.6(99)	20.6(99)	25.5(51)	28.8(53)	36.4(78)	36.4(78)	36.4(78
WARRIOR	18.5(33)	18.5(29)	20.7(32)	20.7(32)	20.7(32)	25.7(47)	29.1(48)	36.4(68)	36.4(68)	36.4(68)
DEMOPOLIS	42.7(75)	49.5(84)	43.9(76)	43.9(76)	43.9(76)	49.6(88)	56.8(96)	57.1(95)	57.1(95)	57.1(95)
COFFEEVILLE	43.2(73)	50.2(81)	44.2(71)	44.2(71)	44.2(71)	50.1(84)	57.5(91)	57.5(89)	57.5(89)	57.5(89)
GAINESVILLE	29.5(53)	37.6(74)	30.9(60)	30.9(60)	30.9(60)	29.6(53)	34.4(69)	26.6(52)	28.6(52)	26.6(52)
BAY SPRINGS	28.9(47)	35.3(57)	28.7(45)	28.7(45)	26.7(45)	28.9(44)	33.2(56)	26.5(41)	26.5(41)	26.5(41)

a/ Values in () are the percent utilization of the available lockage time.

SOURCE: <u>REEVALUATION OF THE OLIVER LOCK REPLACEMENT PROJECT, APPENDIX B, ECONOMICS</u>, SEPT 1985 multiplied by a projection factor. This commodity- and region-specific factor was derived from 1980 OBERS forecasts of population and income growth by BEA region. Additionally, Tennessee-Tombigbee Waterway (TTWW) traffic estimates produced by A.T. Kearney, Inc. were included in forecast years beyond Tenn-Tom's scheduled opening. Traffic projections were then incorporated into the estimation of project benefits using the Tow Cost Model for calculating transportation cost savings at various traffic levels and for various lock and dam improvements.

Considering the dated nature of both the base year data and the use of 1980 (pre-recession) growth factors, as well as the over optimism of estimated TTWW traffic, the reliability of this study's forecast traffic levels is compromised. The report projected that Oliver Lock and Dam traffic would reach 25.5 million tons by 1990. By 1985 traffic through Oliver amounted to only 15.9 million tons and traffic on the entire Black Warrior-Tombigbee Waterway reached only 19.6 million tons in 1989. The general methodology of applying commodity-specific growth rates to base year traffic levels is widely accepted but the results are strengthened by the use of the latest available data. The District's data sources for base year traffic and OBERS indexes by BEA region for commodity growth rates have been used extensively in other Corps navigation studies and were the most current available at the time of analysis. One common drawback to OBERS is that it is updated infrequently.

12. Bonneville Navigation Lock, Columbia River, Oregon/ Washington, General Design Memorandum, Volume 2 of 2, Appendixes, Portland District, North Pacific Division, September, 1984.

The Portland District analyzed eight separate commodity groups moving on the Columbia River. Each investigation included a review of historical traffic movements, which were obtained from the Bonneville lockmaster's reports. The District provided a detailed and thoroughly-researched description of routing patterns for each of the commodities. These movements were identified by shipper and carrier interviews, discussions with knowledgeable resource people, consulting various censuses (e.g., Agriculture, Manufactures), and contacting government, association, and university experts.

The next step in the analysis was a comparison of transportation rates between waterway and rail modes. Freight rates were obtained for rail and barge shipments of commodities in the Pacific Northwest from Interstate Commerce Commission rate manuals. A September 1981 base was selected for all rate and tariff data. Finally, Portland District incorporated a variety of commodity-specific methods in projecting future traffic at Bonneville Lock for the period 1985 to 2040. High, medium, and low projections were made. The methods and projected traffic levels for each commodity group are explained below.

WHEAT & BARLEY: These two grains represent the largest commodity group moving through Bonneville Lock, accounting for over 27 percent of total tonnage. In general, future wheat and barley traffic on the Columbia River is expected to grow with total U.S. wheat and barley exports. First, the Columbia River's market share of U.S. wheat and barley exports was averaged over the period 1976-81. Second, Bonneville Lock's share of Columbia River wheat and barley exports was averaged over the same period. Third, a time series analysis of U.S. wheat and barley exports was made for the period 1960-1982. Future U.S. wheat and barley exports were projected from the linear regression trend line. High and low projections were defined as one standard deviation above and below the regression line. Bonneville tonnages were allocated on the basis of historical Columbia River and Bonneville Lock market shares.

CORN: The Portland District did not project corn shipments to use Bonneville Lock. On the basis of current corn production and transportation patterns, the only producing region expected to use the Columbia River for transportation would be the Columbia Basin agricultural area. Currently, Columbia Basin corn cannot be delivered to East Asian markets at a competitive price. The Basin has a transportation cost advantage over corn of midwestern origins, but this is more than offset by higher production costs related partially to the region's requirement for irrigation.

PETROLEUM: Combination barges on the Columbia River move grain downstream to export terminals and return upstream laden with petroleum products for local markets. Petroleum products are the second largest commodity group moving through Bonneville, accounting for 16 percent of total traffic and 81 percent of all upstream movements. One third of these movements are bound for Pasco, Washington, a major distribution hub for refined petroleum products delivered to the eastern parts of Washington and Oregon and northern Idaho (the "local market" for barged petroleum products). Four major modal flows bring these products to the region: 1. by tanker to Portland, then barged upriver; 2. by pipeline from Puget Sound to Portland, then barged upriver; 3. by pipeline to Pasco and Spokane from Salt Lake City; and, 4. by pipeline to Spokane from Billings, Montana. Barge transportation is the least costly mode (vs. rail and truck) for the first two flows. For the latter two flows, transporting petroleum products by pipeline is actually less expensive than moving it upriver by barge, but the capacity of the pipelines is severely limited. Demand for petroleum products in the local market exceeds the capacity of existing pipelines to deliver it.

In the projections the Portland District first examined the correlations between several independent variables and upbound waterway petroleum products movements. Although correlations (Pearson's r) were estimated for total covered employment, manufacturing employment, total pipeline deliveries, average per capita petroleum consumption, and average automobile fleet mileage efficiency, only manufacturing employment (correlation .909) and pipeline deliveries (correlation -.358) were used in the final regression equation. Future levels of manufacturing employment were obtained from <u>1980 OBERS BEA Regional Projections</u> and future pipeline deliveries were estimated using a SAS forecast procedure. By plugging the projected values for these independent variables into the regression model, future barge movements of petroleum products were predicted.

WOODCHIPS: This commodity has grown rapidly in importance since the first shipments on the Columbia River in 1967. Originally a waste product of the lumber-making process, wood chips are now used as a valuable source of wood fiber for the paper processing industry. Woodchips accounted for 12 percent of all traffic through Bonneville lock in the early 1980s. The demand for woodchips is related to the general level of paper-making activity and the number of mills located along the river. Recent increases in woodchip movements through Bonneville are attributable to increases in demand for paper; a transportation shift to moving chips as a commodity, rather than transporting the pulp logs downriver; and a modal shift from rail to water because barge shipment is more cost-effective.

The method used in forecasting the flow of woodchips in future years was a time series analysis for the period 1967 to 1982. Based on the assumption that changes in woodchip tonnages are basically a function of time and that historical relationships will continue, a regression trend line was derived using ordinary least squares regression analysis. The regression trend line was used as the mid-case scenario while high and low estimates were obtained by computing projections one standard deviation above and below the regression line.

FERTILIZER: Approximately 10 to 15 percent of all fertilizer consumed in Washington, Oregon, and Idaho moves through Bonneville lock; 93 percent of these shipments move upstream.

The first step in projecting future fertilizer traffic was to compile the historical record (from the USDA Statistical Reporting Service) of wheat and barley acreage planted in the "barge-favorable" counties of Washington and Oregon. Fertilizer consumption is inherently related to acreage used in the production of fertilizer-consuming crops, wheat and barley in particular. The continuation of that historical trend into the future serves as the independent variable for the fertilizer projection. Regression analysis was performed to determine the relationship between fertilizer tonnage and wheat and barley acreage planted. Future fertilizer traffic levels were projected using the previously developed trend line for future acreage. Finally, high and low projections were estimated as one standard deviation above and below the regression line.

LOGS: Logs are brought from the production areas to the river by truck, then stored in the river in log booms. The logs are collected in rafts of 250,000 board feet before being pulled downriver 3 or 4 at a time by towboats to the timber processing industries and export terminals of the lower Columbia. Log tonnage on the Columbia has decreased in importance over time, declining to less than 5 percent of total traffic in the 1980s. While traffic levels have fluctuated wildly in any given year, the 20 year totals have been remarkably constant.

Rafted logs are a low priority tow and have to wait for other barged commodities passing through Bonneville. This delay factor increases the transportation cost of logs and hence their final delivered price. For this reason and also because of safety concerns there has been a shift to the movement of logs in barges rather than open rafts.

Several projection methods were attempted in determining future log tonnage through Bonneville and found to be not applicable: trend line, simple regression, and multiple regression. Because no significant relationships could be determined using typical forecasting techniques, log projections were simply estimated by extrapolating the historical average of log tonnages through Bonneville from 1963 to 1981. The arithmetic mean was extended into the future as a constant traffic level. High and low projections were computed as plus and minus one standard deviation above and below the arithmetic mean.

There are several constraints and assumptions affecting both supply and demand which corroborate the constant flow approach used in log projections. First, the export of logs from federal and state lands is prohibited except for minor allowances. Second, the Forest Service expects a fairly constant flow of softwood lumber exports from the U.S. Third, pulp producers are shifting from transportation of pulpwood logs to transporting woodchips. Finally, many public forest lands are shifting from logging to wilderness use. All of these factors mitigate against increasing volumes of traffic.

CONTAINERS: Movement of containers by barge is a fairly recent phenomenon and only a slightly-used practice on the inland waterways of the U.S. On the Columbia River, however, several upstream ports have invested in container handling facilities and nearly 200,000 tons of containerized commodities move by barge annually. Major containerized cargoes on the Columbia include paperboard (downbound), peas and lentils (downbound), and general cargo (upbound and downbound). A very brief description of projection methods for each of these commodities follows:

Paperboard: This product is produced in Lewiston, Idaho, and shipped downriver to Portland for export. The U.S. Forest Service expects exports of paper and board, which have been rising since the 1960s, to continue to increase and double by 2030 because of rising world demand and a favorable supply situation in the U.S. The medium projection of future paperboard tonnage through Bonneville lock is based upon the 6 percent average annual growth rate anticipated by industry sources through 1995. Thereafter tonnage was held constant because of capacity constraints at the production plant. The high and low projections were based on time series analysis of the historical traffic levels. The high projection treated all observations (traffic levels in a given year) equally, while the low projection used exponential smoothing to weight the more recent observations heavier than those in the early part of the time series.

Dry Peas and Lentils: Nearly all of the U.S. production of dry peas and lentils is in the Bonneville region of eastern Washington and Oregon and northern Idaho. Approximately three-quarters of the crop is produced for export. The Portland District's low projection was simply an expectation of the continuation of current traffic levels -- constant domestic/export shares, modal shares, port shares, etc. The medium projection assumed a one percent annual increase in traffic based on expected expansion of wheat acreage (peas and lentils are grown in rotation with wheat). The high projection assumed a two percent annual increase in traffic levels associated with a geographic expansion of production through the use of new varieties of dry peas.

General Cargo: Containerized general cargo moving downstream through Bonneville is generally bound for export to Asia. Portland District projected high, medium, and low scenarios of future traffic based on 10 percent, 7.6 percent, and 5 percent annual growth rates. These growth rates were associated with growth in GNP in Asian economies. Upbound container movements represent very small totals and were projected to grow by 0.7 percent annually, based on OBERS population growth estimates for the BEA regions in the upper Columbia Basin.

MISCELLANEOUS COMMODITIES: This category included all commodities not grouped elsewhere. Because of the heterogeneous nature of this group, projections of future traffic were not based on analyses of demand, production, or other economic factors. Rather, because miscellaneous commodities had historically made up an average of one percent of total traffic passing through Bonneville, this trend was assumed to continue in the future. A trend line through 2040 was developed for total Bonneville traffic, and one percent of this total was allocated to projected miscellaneous commodity tonnages. High and low projections were defined as one standard deviation above and below the trend line.

The Portland District's projections of total future traffic levels expected to use Bonneville Navigation Lock, as well as actual traffic recorded by the Corps' Performance Monitoring System are presented in Table 24. On a positive note, actual traffic did fall within the District's projection envelope, although it was much closer to the low scenario than the medium projection.

Unfortunately for planners trying to predict future movements, traffic on the Columbia River actually peaked in 1976 and 1980 at about 19 million tons; commerce since then has declined, and was 17.2 million tons in 1989. Unforeseen conditions in the grain and lumber industries, which many economists failed to predict, had much to do with the variation between actual and predicted traffic levels. Although traffic through Bonneville has increased somewhat in the late 1980s, by 1989 it had still failed to reach 1981's all-time high. Despite the Portland District's thorough and detailed economic analysis of the industries and modal flows associated with the commodities moving through Bonneville lock, its projections were over optimistic. The effects of exogenous events (e.g., value of the dollar, world economic recession, government trade programs, environmental legislation, etc.) are often difficult to model.

In summary, the Portland District used a variety of forecasting techniques to project future movements of different commodity groups. Each technique was selected based on the characteristics of the commodity, the underlying forces influencing traffic levels for that commodity, and a detailed examination of the commodity's origin-destination flows. Published data sources were varied and extensive, and the District employed interview and survey techniques as well. In terms of accuracy, while future traffic was overestimated, their projection envelope did at least include the level of traffic that actually occurred. The Portland District's overall effort was thorough and sound.

TABLE 24

TOTAL TRAFFIC PROJECTIONS AT BONNEVILLE LOCK, 1985-2010
AND ACTUAL TONNAGE 1985-89

(Millions of Tons)

	1985	1986	1987	1989	1990	2000	2010
Low	7.6	7.9	8.2	--	9.2	13.5	17.8
Medium	10.2	10.6	10.9	--	13.3	17.6	22.1
High	12.8	13.2	13.6	--	19.3	21.9	26.7
Actual	7.7	8.3	8.9	11.6			

SOURCE: Bonneville Navigation Lock, Columbia River, Oregon/Washington (1984).

13. Mississippi River Gulf Outlet New Lock and Connecting Channels, Feasibility Study Draft Report, New Orleans District, Lower Mississippi Valley Division, March, 1989.

A feasibility study examining the problems, needs, and potential solutions relating to shallow-draft navigation channels connecting the Gulf

Intracoastal Waterway (GIWW) to the Industrial Canal in the vicinity of New Orleans was completed at the Corps New Orleans District Office. The purpose of the study was to estimate traffic expected to use a system of GIWW locks through year 2050. The study locks included Industrial Canal, Harvey, Algiers, Port Allen, Bayou Sorrel, and Bayou Boeuf Locks. Traffic projections form an integral part of the economic analysis in evaluating alternative plans to improving and/or replacing the existing lock structures on the Industrial Canal. Due to concerns raised in public hearings over the proposed reconstruction of the Industrial Canal Lock at its present location, reanalysis of this project was initiated in 1990.

Traffic projections were made for 18 commodity groups. These aggregations were chosen on the basis of physical properties of the commodity, uses of the commodity, and its tonnage. Single commodities with sufficiently large tonnages were treated as one group. For example, coal, marine shell, and crude petroleum were projected individually while grain, chemicals, and building materials each were combined as groups.

The commodity growth rates used by New Orleans District were developed by IWR for The 1988 Inland Waterway Review, with the exception of marine shell. IWR's projections of internal waterborne commerce were produced at the national level and subsequently distributed among component waterway segments based on that waterway's 1984-86 historic share of traffic. Growth indexes for various commodity groups identified by IWR were derived from economic projections made by DRI, the WEFA Group, the Department of Energy, and the Fertilizer Institute. The New Orleans District then applied IWR's commodity-specific growth rates to a base traffic level. This base was defined as the 1986-87 average tonnage figure for each commodity group moving through the study locks. Although IWR's projections did not extend beyond year 2000, the District extended the 1995-2000 annual growth rate projected by IWR to year 2050 (based on the need to evaluate the project over its 50-year economic life).

For marine shell, which accounted for almost 3 million tons of GIWW commerce in 1986, the New Orleans District projected future traffic levels based on known reserves of both clam and oyster shell deposits in Lake Ponchartrain and Atchafalaya Bay. High, medium, and low projections were developed assuming current, gradually declining, and immediately declining rates of production throughout the remaining reserve life of the marine shell beds. This translated into average annual growth rates varying from zero (constant traffic levels) to -13.7 percent.

Some potential areas of concern emerge from the New Orleans District's analysis. The District relied almost exclusively on projected growth rates produced at another Corps office (IWR), which were made for a national-level, "priorities" assessment study, not for specific project justification. Lock-specific forecasts could be enhanced through interviews with shippers and carriers and investigation of local markets and industries.

Disaggregating national level commodity-specific growth rates down to individual locks introduces forecasting risks which have been noted elsewhere in this report. In addition, the growth rates developed by IWR were based on a weighted 1984-86 average of historical data. Applying these growth rates to a different base year also introduces another element of uncertainty and weakens the relationship with the information upon which the growth rates were based originally. Assuming growth rates remain constant over a 50-year forecast horizon is also risky in that the commodity growth rates used were derived based on much nearer term (through 2000) macro-economic assumptions. The longer term reliability of these growth rate assumptions would need to be reassessed from the original sources to be applied in a realistic sense much beyond 2000. Lastly, the District study could be improved by clearly explaining how IWR's Gulf Intracoastal Waterway (GIWW) traffic forecasts were allocated among various locks on the GIWW.

14. Montgomery Point Lock and Dam Feasibility Study, McClellan-Kerr Arkansas River Navigation System, Little Rock District, 1990

The purpose of this study was to project tonnages moving on the White River (part of the McClellan-Kerr Arkansas River Navigation System) for the period 1995-2045. Baseline tonnage estimates were developed using Waterborne Commerce Statistics Center (WCSC) data and results from the 1989 Shippers Survey. Three and five year averages were developed by combining WCSC and survey data. Sand, gravel and rock movements, which are mostly internal, were not included in the study. Baseline tonnage was calculated by taking the average of tonnage for 1986 and 1987 from WCSC data and for 1988 from the 1989 Shippers Survey. These figures were then used to estimate projected tonnages for project year 1 (1995) by using various indices, including IWR data and OBERS projections. One exception to the above three year averages was that coal tonnages were based on a five year average to smooth out the annual fluctuations.

Baseline tonnage was forecast to be 6.7 million tons in 1995 (excluding sand, gravel, and rock), up from the three year averaged 6.0 million tons for 1986-88. The largest tonnage increases are expected to be in grains, fertilizer, and primary steel products.

Mode split analysis was used to analyze the mode split for traffic originating and terminating on the M-K Arkansas River Navigation System. The commercial data base, Transearch, was used to analyze the modal splits. This data base combines shipment data from 10 sources. The analysis indicated that barge is a very important mode of transportation for the Arkansas River BEA's, particularly for outbound movements of farm products and inbound movements of chemicals and petroleum products.

Baseline tonnage figures were projected for the period 1995-2045 for use in calculating benefits for the with and without-project scenarios. Growth rate projections are based on IWR material, OBERS projections, and local knowledge, based on the survey effort and discussions with local officials. Low, medium, and high scenario projections were developed. Most of the commodity projections are based on IWR estimates prepared for the 1988 Inland Waterway Review. For the middle (medium) scenario, total tonnages for 13 major categories were projected to increase as follows: 6.7 million tons in 1995, 7.3 million tons in 2000; 7.9 million tons in 2005; 8.6 million tons in 2010; 9.3 million tons in 2015; 10.2 million tons in 2025; 11.1 million tons in 2035; and, 12.1 million tons in 2045. The latter represents a doubling of tonnage over the 1986-88 base period tonnage.

The 2045 projection for the low scenario was 9.9 million tons; and for the high scenario, the projected tonnage was 15.3 million tons for 2045.

15. The National Waterways Study - A Framework for Decision Making - Final Report, U.S. Army Engineer Water Resources Support Center, Institute for Water Resources, Report No. NWS-83-1, January 1983.

The National Waterways Study (NWS) was authorized by Congress through the Water Resources Development Act of 1976. The objective of the study was to provide a national overview of the inland waterway system in response to steady increases in traffic, congestion and delays at certain locks, and the mounting need for replacement or rehabilitation at many aging structures on the system. It was the first comprehensive assessment of the nation's inland, coastal, and Great Lakes waterways since the National Waterways Commission study in 1908.

The study was extensive in scope, covering an examination of current and projected waterborne commerce (foreign and domestic), an assessment of the ability of the current system to handle this traffic, and an evaluation of alternative strategies for adding capacity and maintaining the reliability of the system, particularly with respect to both the inland and Great Lakes waterways. The multi-year study involved three principal contractors (DRI, A.T. Kearney, Louis Berger) and representatives from OCE BERH, and each Corps Civil Works Division, in addition to IWR staff. Besides IWR's Final Report, other products included 10 contractor technical reports, a 24-map set of the waterway system and major commodity flows, a wide variety of historical papers and presentations, and documentation of an extensive public involvement program. The contractor technical reports focused on a comprehensive range of waterway topics including: traffic projections; the waterway shipper and carrier industries; alternative rail, pipeline and truck modes; other demands for water resources such as hydropower, recreation, flood control, and water supply; waterway engineering and technology; and an evaluation and recommendations.

Traffic projections used in the National Waterways Study (NWS) were generated by Data Resources, Inc. (DRI). Projections were developed under four alternative macroeconomic scenarios and under three sensitivity analyses. The projections were generated for 14 commodity groups and for 22 geographic regions. They included traffic class details for internal (inland), coastal, Great Lakes, and foreign trade. In general, the alternative scenarios reflected both economic and institutional changes that may occur over the forecast period. An attempt was made "to incorporate a wide range of possible future events to allow planners to assess a number of contingencies associated with future waterborne traffic growth." The four NWS scenarios--"Baseline", "High Transportation Use", "Low Transportation Use", and "Bad Energy"--were based on three DRI U.S. macroeconomic forecasts of the economy. The three sensitivities examined the impacts of alternative futures not covered directly in the scenarios--"Defense", "High Coal Export", and "Miscellaneous".

Different model assumptions were embodied in each set of forecasts. Assumptions about the likely trends in U.S. population growth were based on the latest U.S. Bureau of the Census data and were the same for all scenarios. A detailed analysis was performed of each of the major industries which significantly affect water transportation tonnage. These analyses used both field interviews and ongoing DRI industry studies and models. Industry forecasts were then disaggregated by region to estimate future production and consumption in specific geographic areas. These projections were based in part upon analysis of historical industry data. Each industry's logistics decision process was analyzed to identify the likely transportation decisions which would be made. Subsequent waterborne projections were based in part upon correlations between broad economic and industry factors and the waterborne flows for 1969 to 1977, as well as on full consideration of likely shifts in logistics systems by industry due to new plant locations or new product introductions. The industry analysis, production and consumption regions, and logistics decision process for each industry were adjusted to reflect the effects of the individual scenario assumptions.

The "Baseline" scenario was largely an extrapolation of historical waterborne traffic trends, although some adjustments were made to the 1977 base year data to take into account the 1979 oil price hike and modified agricultural yields. DRI's "Trendlong" macroeconomic forecast for the U.S. economy was used in this baseline.

The "High Transportation Use" scenario also used DRI's "Trendlong" macroeconomic assumptions, but it incorporated higher estimates for waterborne coal traffic, coal exports, and domestic coal consumption. Further, more relaxed environmental restrictions allow for the expansion of coal use. Phosphate exports were held constant after 1985, compared to a decrease under the baseline scenario.

The "Low Transportation Use" scenario incorporated DRI's "LargeGovt" macroeconomic model, reflecting a combination of economic events and government policy that tend to depress the demand in industries which are major [illegible]ers of water transportation. Assumptions imbedded in this scenario include lower grain yields (than baseline) and reduced grain exports from Great Lakes ports, substantially lower crude oil imports, lower phosphate exports, and growing import penetration of the domestic steel market (to 26% from 15% baseline).

The "Bad Energy" scenario used DRI's "BadEnergy2003" model and hypothesized an energy crises in the mid-1980's with resulting effects on the national economy The scenario predicted that oil imports would drop precipitously, coal exports would grow, and although additional synfuel plants would be constructed to receive coal by water, the traffic would be partially offset by the construction of seven coal slurry pipelines.

The three sensitivity analyses were performed to look at the impact of certain alternative assumptions in the four primary forecast scenarios. The "Defense" analysis reflected the impact on waterborne traffic of U.S. involvement in a five-year conventional war. "High Coal Exports" focused on the effects of dramatically higher coal exports (300 million tons by 2003) on coastal ports and inland waterways. Finally, the "Miscellaneous" sensitivity analysis incorporated a number of specific adjustments to individual river segment forecasts to account for underreporting of base year traffic and to eliminate disparities with locally-prepared navigation studies. The various assumptions employed by the different scenarios are highlighted in Table 25.

The resulting seven sets of forecasts of potential waterborne commodity flows were developed using base year 1977 data from Waterborne Commerce for 14 commodity groups and 22 geographic regions. These forecasts were "unconstrained" by any shortfall in the waterway capability to handle the traffic and represented the probable cargo levels available for water transportation under each of the sets of assumptions. Projected total traffic levels by waterway segments for the four major scenarios are shown in Tables 26-29.

Unfortunately, the National Waterways Study forecast traffic levels are not comparable to either The 1988 Inland Waterway Review projections or historical tonnages in Waterborne Commerce of the U.S. because of differences in both waterway segment definitions and in the types of traffic counted. For example, the NWS Illinois River, Warrior River System, and Gulf Coast West segments included domestic traffic figures from the ports of Chicago, Mobile, and Houston, respectively, which were not included in Illinois Waterway, Black Warrior-Tombigbee Waterway, or Gulf Intracoastal Waterway traffic totals in either Waterborne Commerce or the Review. Furthermore, the NWS also lumped all inland, Great Lakes, local, and coastwise domestic traffic together while the Review deals only with internal barge traffic and Waterborne Commerce lists each of the water modes separately. For these two reasons, most forecasts in the NWS are not easily verified by analogous historic data or more recent traffic projections.

TABLE 25

THE NATIONAL WATERWAYS STUDY PRINCIPAL ASSUMPTIONS FOR NWS SCENARIOS[1]

Principal Assumptions	Baseline	High Use	Low Use	Bad Energy	Defense	High Coal Exports
1. Macroeconomic	Trendlong	Trendlong	Larger Government	Bad Energy	Wartime Economy[2]	Trendlong
2. Corn Yields by 2003 (Bushels per Acre)	121	121	110	121	121	121
3. West Coast Share of Farm Products Exports (Percent)	14	14	14[3]	14	Overall Decline During Conflict	14
4. Phosphate Exports	Decrease After 1985	Constant After 1985	Decrease After 1985	Decrease After 1985	Constant After 1985	Constant After 1985
5. Steel Imports (Percent of Total Consumption)	Decrease After 1990 from 17 to 15	Decrease After 1990 from 17 to 15	Increase to 26 by 2003	Decrease After 1990 from 17 to 15	Decline Sharply During Conflict	Decrease After 1990 from 17 to 15
6. Crude Oil Prices (Average Annual Price Increase-Percent)	3.8	3.8	3.8	4.8	3.8	3.8
7. Crude Oil Imports by 2003 (Millions of Tons)	290	290	240	200	Decline of 100 Million Tons per Year During Conflict	290
8. Coal Exports by 2003 (Millions of Tons)[4]	107	156	107	156	156	290[5]
9. Gulf Coast Share of Total Coal Exports in 2003 (Percent)[4]	19	23	11	23	23	35
10. Domestic Coal Consumption by 2003 (Millions of Tons)	1,794	2,360	1,625	1,728	2,360	2,360
11. Synfuel Plants on Water (Coal Consumption in Millions of Tons by 2003)	10 (50)[6]	11 (61)	6 (30)[6]	15 (81)	11 (61)	11 (61)
12. Coal Slurry Pipelines	None	None	None	7[7]	None	None
13. Eastern Coal Use (Lake Erie Loadings of Coal by 2003 in Millions of Tons)	Present Technology and Regulations (20)	Present Technology and Regulations (22)	Increased Use in Great Lakes Area (24)	Present Technology and Regulations (20)	Present Technology and Regulations (22)	Present Technology and Regulations (22)

1. The Miscellaneous scenario incorporates all the assumptions of the High Use scenario. The adjustments are made to account for data base errors (Ohio and Gulf Coast-East reaches) or to introduce alternative regional forecasts (Arkansas and Columbia-Snake Waterway reaches).
2. Based on Federal Emergency Management Agency forecast.
3. Great Lakes share drops 10 percent.
4. Overseas and Canadian destinations.
5. Based on National Coal Association high forecast and modified by Data Resources, Inc. (DRI).
6. An additional demonstration plant (not included in these numbers) on the Monongahela River is assumed in operation from 1983 to 1990 and consumes 3,000,000 to 6,000,000 tons of coal each year. However, after 1990, it is discontinued.
7. One of these seven pipelines (ETSI) will divert 4.5 million tons of coal from the waterways by 2003.

SOURCE: THE NATIONAL WATERWAYS STUDY, 1983 (TABLE IV-6, PAGE IV-62)

TABLE 26

WATERBORNE PROJECTED USE FOR ALL COMMODITIES
MISSISSIPPI RIVER SYSTEM/GREAT LAKES
DOMESTIC TRAFFIC INBOUND, OUTBOUND, LOCAL, AND THROUGH: 1977 AND 1989 ACTUAL TONNAGE
AND PROJECTIONS FOR 1980-2003: BASELINE SCENARIO
(Millions of Tons)

SEGMENT	ACTUAL		PROJECTIONS						% GROWTH	
	1977	1989	1980	1985	1990	1995	2000	2003	77 - 90	90 - 03
Upper Mississippi	30.874	NA	39.495	44.675	48.924	56.881	63.453	65.980	3.6	2.3
Lower Upper Mississippi	77.493	NA	90.012	101.862	113.324	134.164	153.511	161.975	3.0	2.8
Lower Mississippi	123.598	181.802	138.223	155.519	157.500	185.170	210.325	222.277	1.9	2.7
Baton Rouge to Gulf	187.253	NA	210.646	224.257	232.997	261.273	291.088	303.242	1.7	2.0
Illinois River	54.342	NA	60.927	67.239	70.301	79.660	87.856	91.768	2.0	2.1
Missouri River	6.735	5.352	7.255	7.399	7.316	7.425	7.733	7.817	0.6	0.5
Ohio River	172.509	202.670	179.451	212.225	229.135	262.578	292.505	307.482	2.2	2.3
Tennessee River	26.462	43.062	26.899	27.305	40.884	52.122	61.473	66.922	3.4	3.9
Arkansas River	9.396	7.927	9.670	9.968	11.342	12.808	14.048	14.437	1.5	1.9
Gulf Coast West	168.762	NA	180.838	162.063	167.831	172.774	179.307	186.578	0.0	0.8
Gulf Coast East	69.429	NA	69.166	76.784	91.910	103.377	114.816	116.691	2.2	1.9
Warrior River System	30.006	NA	30.719	33.538	56.166	66.749	76.501	82.651	4.9	3.0
Great Lakes	126.882	NA	169.175	184.320	200.893	223.663	247.829	263.507	3.6	2.1

NA Not Available

SOURCE: The National Waterways Study, Appendix A: Evaluation of the Present Navigation System (Page 727), 1982.

TABLE 27

WATERBORNE PROJECTED USE FOR ALL COMMODITIES
MISSISSIPPI RIVER SYSTEM/GREAT LAKES
DOMESTIC TRAFFIC INBOUND, OUTBOUND, LOCAL, AND THROUGH: 1977 AND 1989 ACTUAL TONNAGE
AND PROJECTIONS FOR 1980-2003: HIGH USE SCENARIO
(Millions of Tons)

	ACTUAL		PROJECTIONS						% GROWTH	
SEGMENT	1977	1989	1980	1985	1990	1995	2000	2003	77 - 90	90 - 03
Upper Mississippi	30.874	NA	39.526	44.647	49.685	57.356	66.010	68.739	3.7	2.5
Lower Upper Mississippi	77.493	NA	90.186	101.847	115.054	135.734	158.489	167.281	3.1	2.9
Lower Mississippi	123.598	181.802	138.418	155.220	160.205	188.715	218.526	231.039	2.0	2.9
Baton Rouge to Gulf	187.253	NA	210.815	223.927	235.422	264.224	297.990	310.908	1.8	2.2
Illinois River	54.342	NA	61.119	67.230	71.250	80.378	90.230	94.623	2.1	2.2
Missouri River	6.735	5.352	7.255	7.399	7.316	7.425	7.733	7.818	0.6	0.5
Ohio River	172.509	202.670	180.400	212.673	248.533	282.361	331.126	345.163	2.8	2.6
Tennessee River	26.462	43.062	27.065	27.944	44.291	58.094	74.089	79.453	4.0	4.6
Arkansas River	9.396	7.927	9.680	9.937	11.512	13.017	14.578	15.020	1.6	2.1
Gulf Coast West	168.762	NA	180.838	162.063	167.831	172.774	179.307	186.578	0.0	0.8
Gulf Coast East	69.429	NA	69.203	76.939	93.855	105.770	120.086	121.805	2.3	2.0
Warrior River System	30.006	NA	30.808	32.940	59.864	71.995	87.731	95.176	5.5	3.6
Great Lakes	126.882	NA	170.656	184.608	205.062	227.807	253.594	271.150	3.8	2.2

NA Not Available

SOURCE: The National Waterways Study, Appendix A: Evaluation of the Present Navigation System (Page 739), 1982.

TABLE 28

WATERBORNE PROJECTED USE FOR ALL COMMODITIES
MISSISSIPPI RIVER SYSTEM/GREAT LAKES
DOMESTIC TRAFFIC INBOUND, OUTBOUND, LOCAL, AND THROUGH: 1977 AND 1989 ACTUAL TONNAGE
AND PROJECTIONS FOR 1980-2003: LOW USE SCENARIO
(Millions of Tons)

	ACTUAL		PROJECTIONS						% GROWTH	
SEGMENT	1977	1989	1980	1985	1990	1995	2000	2003	77 - 90	90 - 03
Upper Mississippi	30.874	NA	39.620	44.346	47.253	52.994	57.119	58.80[illegible]	3.3	1.7
Lower Upper Mississippi	77.493	NA	90.470	101.668	110.431	126.797	140.721	147.740	2.8	2.3
Lower Mississippi	123.598	181.802	138.925	154.180	148.346	166.330	181.331	190.744	1.4	2.0
Baton Rouge to Gulf	187.253	NA	216.644	229.000	230.461	251.002	273.146	284.178	1.6	1.6
Illinois River	54.342	NA	60.991	66.872	68.442	75.371	81.497	84.589	1.8	1.6
Missouri River	6.735	5.352	7.285	7.359	7.158	7.262	7.369	7.444	0.5	0.3
Ohio River	172.509	202.670	177.389	207.148	221.865	245.784	268.839	280.272	2.0	1.8
Tennessee River	26.462	43.062	24.234	24.908	38.598	49.352	57.216	61.680	3.8	3.7
Arkansas River	9.396	7.927	9.661	9.700	9.844	10.296	10.698	10.838	0.4	0.7
Gulf Coast West	168.762	NA	188.020	169.231	172.532	176.940	184.051	192.469	0.2	0.8
Gulf Coast East	69.429	NA	69.003	74.626	88.838	97.088	107.461	107.877	1.9	1.5
Warrior River System	30.006	NA	31.097	33.529	56.064	64.081	72.471	78.002	4.9	2.6
Great Lakes	126.832	NA	168.345	183.701	186.291	200.132	218.156	230.338	3.0	1.6

NA Not Available

SOURCE: The National Waterways Study, Appendix A: Evaluation of the Present Navigation System (Page 733), 1982.

TABLE 29

WATERBORNE PROJECTED USE FOR ALL COMMODITIES
MISSISSIPPI RIVER SYSTEM/GREAT LAKES
DOMESTIC TRAFFIC INBOUND, OUTBOUND, LOCAL, AND THROUGH: 1977 AND 1989 ACTUAL TONNAGE
AND PROJECTIONS FOR 1980-2003: BAD ENERGY SCENARIO
(Millions of Tons)

SEGMENT	ACTUAL 1977	ACTUAL 1989	PROJECTIONS 1980	PROJECTIONS 1985	PROJECTIONS 1990	PROJECTIONS 1995	PROJECTIONS 2000	PROJECTIONS 2003	% GROWTH 77 - 90	% GROWTH 90 - 03
Upper Mississippi	30.874	NA	40.118	48.060	55.241	58.210	60.114	67.914	4.6	1.6
Lower Upper Mississippi	77.493	NA	91.549	109.200	125.832	135.484	143.720	163.294	3.8	2.0
Lower Mississippi	123.598	181.802	140.476	163.809	176.971	196.304	207.045	235.891	2.8	2.2
Baton Rouge to Gulf	187.253	NA	216.312	240.711	265.920	286.586	301.492	335.034	2.7	1.8
Illinois River	54.342	NA	61.523	70.335	77.081	81.309	85.901	95.819	2.7	1.7
Missouri River	6.735	5.352	7.297	7.396	7.402	7.300	7.137	7.006	0.7	-0.4
Ohio River	172.509	202.670	179.643	210.305	245.250	279.582	308.104	324.521	2.7	2.2
Tennessee River	26.462	43.062	26.925	27.335	41.488	53.565	62.253	67.305	3.5	3.8
Arkansas River	9.396	7.927	9.699	10.002	12.208	14.373	15.451	16.492	2.0	2.3
Gulf Coast West	168.762	NA	188.532	170.080	183.100	190.044	198.883	207.894	0.6	1.0
Gulf Coast East	69.429	NA	69.158	76.531	90.096	98.101	105.390	109.161	2.0	1.5
Warrior River System	30.006	NA	31.123	33.127	56.425	65.621	73.621	80.389	5.0	2.8
Great Lakes	126.882	NA	168.439	182.098	196.028	215.955	238.389	253.110	3.4	2.0

NA Not Available

SOURCE: The National Waterways Study, Appendix A: Evaluation of the Present Navigation System (Page 745), 1982.

With these caveats in mind, forecasts from the NWS Baseline scenario closely approximate the medium scenario forecasts from The 1988 Inland Waterways Review for the Lower Mississippi and Missouri River traffic and parallel the high scenario forecasts for the Arkansas, Tennessee, and Ohio Rivers.

16. 1988 Inland Waterway Review, IWR Report 88-R-7, U.S. Army Engineer Institute for Water Resources, November 1988.

This report developed projections of inland waterway traffic at the national and waterway segment levels using a "top-down" approach based on individual commodity groups and historic traffic shares. National level commodity analyses were based on "off-the-shelf" information from major forecasting services, such as Data Resources, Inc. (DRI) and the WEFA Group, Federal agencies, and trade associations. Segment level projections were derived from each segment's historic share of a given commodity group. Traffic for 1975 through 1986 was tabulated and aggregated by commodity group and waterway. Ten aggregated commodity groups were selected:

1. Farm Products
2. Metallic Ores, Products and Scrap
3. Coal
4. Crude Petroleum
5. Nonmetallic Minerals/Products
6. Forest Products
7. Industrial Chemicals
8. Agricultural Chemicals
9. Petroleum Products
10. All Other

Data for these commodity groups were aggregated at the national level and for the following individual waterways:

1. Upper Mississippi
2. Middle Mississippi
3. Missouri
4. Lower Mississippi
5. Arkansas
6. Illinois
7. Ohio
8. Monongahela
9. Kanawha
10. Cumberland
11. Tennessee
12. Gulf Intracoastal Waterway
13. Black Warrior-Tombigbee WW
14. Atlantic Intracoastal Waterway
15. Columbia

Both levels of projections are discussed in more detail below.

National Level Projections

Projections of internal waterborne commerce were developed at the national level by IWR from a variety of sources, depending upon the commodity group. Wherever possible, growth indices were derived from government or private entities with generally accepted expertise with respect to a given commodity group. At least three growth rates were obtained for each commodity to generate "high", "medium" and "low" forecasts for the years 1990, 1995 and 2000. Once derived, growth rates were applied to a weighted average base using 1984-86 data from Waterborne Commerce of the United States for each commodity group to arrive at projected traffic. The data were weighted more heavily for 1986 (3 times 1986, 2 times 1985 and 1 times 1984 divided by 6) than for earlier years for most commodity groups, with two exceptions: farm products and coal. For farm products a simple average of the three years' actual tonnage (1984-86) was used due to abnormally depressed traffic levels in 1985 and 1986. It was felt giving additional weight to these low tonnage years would skew the projections toward the low side. For coal a 1986 historic base was used to capture rapid increases in tonnage for this commodity group. It was felt that using the weighted multiple-year base for coal generated near term (1990) projections that were unrealistically low (i.e., below actual 1986 tonnage). The 1986 actual data and the low, medium and high projections for 1990,1995, and 2000 are shown in Table 30.

As noted, growth rates were derived from a variety of existing sources. In December 1987 DRI prepared waterborne commerce projections for 1990, 1995 and 2000 for each of the ten major commodity categories analyzed in the 1988 Inland Waterway Review, (DRI Inc., Waterway Outlook, December 1987). IWR chose to apply DRI's growth rates rather than the actual tonnages projected by DRI because their forecasts started with a 1985 base, an exceptionally low tonnage year, and did not reflect the recovery in actual traffic tonnage recorded in 1986. This approach admittedly weakens the relationship between the projected growth rates and the underlying macroeconomic assumptions developed by DRI. However, the original DRI forecasts for 1990 were already being exceeded by observed inland waterway coal traffic in the late 1980s. The growth rates projected by DRI provided one set of forecasts for all of the

TABLE 30

U.S. INLAND WATERWAY TRAFFIC
1986 ACTUAL TONNAGE AND PROJECTIONS OF COMMODITY MOVEMENTS, 1990-2000
(Millions of Tons)

Commodity Group	ACTUAL 1986	1990			1995			2000			ANL % TO 2000		
		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
Farm Products	67.6	81.6	83.1	86.9	87.9	93.1	99.3	94.7	102.3	112.0	2.4	3.0	3.7
Metallic Ore/Prod/Scrap	14.9	14.1	15.2	17.2	13.8	14.7	17.0	13.5	13.9	17.0	-0.7	-0.5	0.9
Coal	163.1	175.9	180.2	184.8	193.2	204.0	216.0	212.3	231.1	252.5	1.9	2.5	3.2
Crude Petroleum	43.9	35.4	37.2	39.7	28.8	33.7	37.0	26.3	32.7	34.5	-3.6	-2.1	-1.7
Nonmetallic Min/Prod	75.2	69.9	76.0	77.5	68.3	77.9	79.9	69.4	79.9	81.9	-0.6	0.4	0.6
Forest Products	20.1	20.6	21.4	24.4	21.4	23.3	24.8	22.7	24.9	26.1	0.9	1.5	1.9
Industrial Chemicals	32.9	33.3	34.7	35.7	36.2	39.9	42.4	39.4	45.8	50.3	1.3	2.4	3.1
Agricultural Chemicals	12.8	12.3	12.9	14.4	14.2	15.0	17.2	15.7	17.4	20.1	1.5	2.2	3.3
Petroleum Products	107.5	107.6	113.0	116.8	108.3	115.4	122.2	108.7	117.8	127.1	0.1	0.7	1.2
All Other	22.5	22.0	23.2	24.9	19.5	21.9	25.8	17.4	20.8	26.7	-1.8	-0.6	1.2
Total	560.5	572.7	596.7	622.3	591.6	638.9	681.6	620.1	686.6	748.2	0.7	1.5	2.1

SOURCE: 1988 Inland Waterway Review, IWR (1988) commodity groups except coal, but whether they were the "high", "medium" or "low" depended upon the other growth rates developed for a given commodity (Table 31).

Additional DRI forecasts were adapted by using growth rates projected for certain industries as a whole and applying these to waterborne commerce (DRI, Interindustry Review, Spring 1986, DRI Industry Review, Fall 1987, and DRI Long Term Review, Winter 87/88). This approach made the assumption that there would be a direct correlation between overall growth in these industries and waterway movement of commodities related to these industries. Such DRI industry indices were used for farm products, metallic ores and products, nonmetallic minerals and products, forest products, and industrial chemicals.

Publications by the WEFA Group (formerly Wharton Econometrics and Chase Econometrics) provided similar industry forecasts which IWR then related to waterway traffic using historic ratios. The WEFA publications included: U.S. Food and Agriculture Long Term Forecast and Analysis, No. 2, 1987; Global Steel Analysis End 87 Update; U.S. Long Term Economic Outlook, 1st Qtr. 1988; and U.S. and World Fertilizer Service, 1987. From the WEFA data one or more national level growth rate scenarios were developed for farm products, metallic ores, products and scrap, forest products, and agricultural chemicals.

Government agencies provided another source for projections. The U.S. Department of Energy published projections of coal, crude petroleum and petroleum products (DOE, Energy Information Administration, Annual Energy Outlook March 1988). These DOE national forecasts included low, medium and high scenarios and were used to generate waterway projections for these commodities based on historic ratios of waterborne share and, in the case of coal, on alternative assumptions about the future waterborne share. Growth rates published by the U.S. Department of Agriculture for grain exports and for demand for forest products were reviewed for consistency with industry forecasts, but were not applied directly (USDA, Economic Research Service, Farmline, April 1987, and USDA, Forest Service, The South's Fourth Forest, Alternatives for the Future (Review Draft), March 1987).

TABLE 31

GROWTH RATES USED FOR PROJECTIONS OF WATERWAYS TRAFFIC
BY COMMODITY GROUP, FOR INLAND WATERWAY SYSTEM

COMMODITY/SCENARIO		GROWTH RATE/PERIOD/SOURCE	TYPE OF INDICATOR
FARM PRODUCTS			
LOW:	3.4% 86-89.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	1.5% 90-2000.	DRI Industry Review Fall 87	(Food grain productivity.)
MED:	3.4% 86-90.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	2.3% 91-95.	Same source.	
	1.9% 96-2000.	Same source.	
HIGH:	4.6% 86-90.	WEFA Group, US Food & Ag. Long Term Forecast and Analysis, No. 2 1987.	(Ratio of waterway traffic to projected exports of wheat, corn & soybeans.)
	2.6% 91-2000.	Same source.	
METALLIC ORES, PRODUCTS & SCRAP			
LOW:	-0.3% 86-90.	WEFA Group, Global Steel Analysis, End 87 Update.	(Ratio US steel production to waterway metal traffic.)
	-0.4% 91-2000.	Same source.	
MED:	1.5% 86-90.	DRI Waterway Outlook Dec 87	(Waterway traffic.)
	-0.7% 91-95.	Same source.	
	-1.1% 96-2000.	Same source.	
HIGH:	4.7% 86-90.	DRI Long Term Review Winter 87/88.	(Growth rate for primary metals industry.)
	-0.2% 91-95.	Same source.	
	0.0% 96-2000.	Same source.	
COAL			
LOW:	1.9% 86-2000.	DOE Annual Energy Outlook March 88. Low Case.	(Ratio coal production to waterway traffic and assumptions on waterway traffic share.)
MED:	2.5% 86-2000.	DOE, Annual Energy Outlook March 88. Base Case.	(Ratio coal production to waterway traffic and assumptions on waterway traffic share.)
HIGH:	3.2% 86-2000.	DOE, Annual Energy Outlook March 88. High Case.	(Ratio coal production to waterway traffic and assumptions on waterway traffic share.)

TABLE 31 (Continued)

CRUDE PETROLEUM

LOW:	-4.0%	86-95.	DOE, Annual Energy Outlook March 88. High Case.	(Ratio US oil production to waterway traffic.)
	-1.8%	96-2000.	Same source.	
MED:	-3.0%	86-90.	DOE Annual Energy Outlook March 88. Low Case.	(Ratio US oil production to waterway traffic.)
	-2.0%	91-95.	Same source.	
	-0.6%	96-2000.	Same source.	
HIGH:	-1.4%	86-2000.	DRI Waterway Outlook Dec 87	(Waterway traffic.)

NONMETALLIC MINERALS AND PRODUCTS

LOW:	-1.6%	86-91.	DRI, Waterborne Traffic Outlook, Dec. 86.	(Waterway traffic.)
	0.3%	92-2000.	DRI, Interindustry Review Spring 86.	(Growth rate for public works projects.)
MED:	0.5%	86-2000.	IWR, National Waterways Study, 1983, Medium case.	(Waterway traffic.)
HIGH:	1.0%	86-90.	IWR, National Waterways Study, 1983, High case.	(Waterway traffic.)
	0.5%	91-2000.	Same source.	

FOREST PRODUCTS

LOW:	1.9%	86-90.	DRI, US Long Term Review Winter 87/88.	(Growth index for lumber and wood products.)
	0.8%	91-95.	Same source.	
	1.2%	96-2000.	Same source.	
MED:	2.7%	86-92.	WEFA Group, US Long Term Economic Outlk 1st Qtr 88.	(Growth index for logging and lumber.)
	1.3%	93-2000.	Same source.	
HIGH:	6.3%	86-90.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	0.3%	91-95.	Same source.	
	1.1%	96-2000.	Same source.	

INDUSTRIAL CHEMICALS

LOW:	1.7%	86-2000.	DRI Waterborne Traffic Outlook, Dec. 86.	(Waterway traffic.)
MED:	2.8%	86-2000.	IWR, National Waterways Study, 1983.	(Waterway traffic.)
HIGH:	3.5%	86-2000.	DRI, Interindustry Review Spring 86.	(Growth index for chemical industry.)

TABLE 31 (Continued)

AGRICULTURAL CHEMICALS

LOW:	0.3% 86-90.	WEFA Group, US & World Fertilizer Service, 1987.	(Growth rate for farm fertilizer use.)
	2.8% 91-95.	Same source.	
	2.1% 96-2000.	Same source.	
MED:	1.5% 86-90.	Fertilizer Institute, Long Range Future of North American Fertilizer May 87.	(Growth rate for fertilizer consumption.)
	3.0% 91-2000.	Same source.	
HIGH:	4.2% 86-92.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	3.1% 93-2000.	Same source.	

PETROLEUM PRODUCTS

LOW:	0.7% 86-90.	DOE Annual Energy Outlook, March 88. Low Case.	(Ratio of US consumption to waterway traffic.)
	0.1% 91-2000.	Same source.	
MED:	2.0% 86-90.	DRI Waterway Outlk Dec 87.	(Waterway traffic.)
	0.4% 91-2000.	Same source.	
HIGH:	2.8% 86-90.	DOE Annual Energy Outlook, March 88. High Case.	(Ratio of US consumption to waterway traffic.)
	0.9% 91-95.	Same source.	
	0.8% 96-2000.	Same source.	

ALL OTHER COMMODITIES

LOW:	-2.4% 86-2000.	Historic rate.	(Average 1975-1985.)
MED:	-1.1% 86-2000.	DRI Waterborne Traffic Outlook, Dec 86.	(Waterway traffic.)
HIGH:	0.7% 86-2000.	Historic rate and NWS.	(Average 1978-1985.)

SOURCE: 1988 INLAND WATERWAY REVIEW, IWR

Research done for a trade association was also used. A consultant to the Fertilizer Institute provided a growth rate for fertilizer usage that IWR adapted for waterborne traffic in agricultural chemicals (Douglas Associates, The Long Range Future of North American Fertilizer, May 1987).

Finally, when necessary to obtain second and/or third growth rates for a given commodity group, the rates generated for the IWR series of reports in the National Waterways Study ("Evaluation of the Present Navigation System, Appendix A," March 1982) were used. These waterborne forecast growth rates included nonmetallic minerals and products, industrial chemicals, and "all other commodities".

The direct or indirect source for the growth rates used in the 1988 Inland Waterway Review are presented in Table 31 The national level projections by commodity are shown in Table 30.

Waterway Segment Level Projections

The national level projections by commodity group that were derived from the above growth rates were disaggregated to individual waterways by using each waterway's weighted average share of total waterborne commerce for each commodity in the 1984-86 period. The exceptions, as at the national level, were for farm products and coal. Each waterway's simple average of 1984-86 farm products traffic was used to determine that waterway's projected traffic, while for coal each waterway's 1986 volume was used to apportion its future share of coal traffic. Projections of traffic by commodity for each waterway then were summed to arrive at total traffic for each waterway and the resulting growth rate was calculated.

This commodity-driven approach to projecting traffic for individual waterways was refined further to overcome perceived drawbacks for waterways that are highly dependent on one or two principal commodities. Linear trend analysis was performed for each waterway using its 1965-1986 total tonnage data. For waterways exhibiting a significant linear trend, the projected trend line was then calculated to 2000. If the projected trend line fell significantly outside the low-high commodity projection envelope, the trend line was adopted as an alternative boundary, producing a wider projection envelope. Waterways for which a trend line projection was adopted as a forecast envelope boundary included the Upper Mississippi, Middle Mississippi, Lower Mississippi, Arkansas, Cumberland, and Columbia Rivers.

Several smaller waterways had historic traffic levels that varied dramatically and did not lend themselves to linear projection techniques. To capture the magnitude of these historic fluctuations, the standard deviation about the mean of the historic data was calculated. The mean value (between low and high) of the year 2000 commodity-based projection was derived. Subsequently, a new projection envelope was developed that ranged two standard deviations about this year 2000 mean value, which again widened the envelope. However, the original high/low values were retained if the numbers generated by this standard deviation approach still fell within or closely approximated the original projection envelope. Intermediate 1990 and 1995 projections were then interpolated between these new year 2000 high and low values and the 1986 historic tonnage. Waterways that incorporated the $\pm$ two standard deviation range as forecast envelope boundaries included the Missouri River, Gulf Intracoastal Waterway, and Atlantic Intracoastal Waterway.

Traffic projections by waterway used in the 1988 Inland Waterway Review are shown in Table 32. The growth rates shown by waterway in this table are related to total traffic only and are based on the average annual growth rate to achieve the projected tonnages shown, using 1986 actual tonnage as a starting point. Note that these displayed growth rates were not used to generate the total traffic; they are simply a calculation from the projected totals, which in turn were generated by adding the individually projected commodities.

Lock Level Projections

The historic share allocation approach used to generate individual waterway projections also was used to generate the lock level projections. However, the lock projections have been made for total traffic only and were not included in the 1988 Inland Waterway Review. Each lock's weighted 1984-86 average share of total segment traffic was calculated and then this share was applied to segment forecasts to determine projections for individual locks. For a few locks the data years used to develop the weighted average were adjusted due to lack of complete annual data in some years.

Deficiencies of "Top-Down" Projection Methodology

Waterway segment and lock level projections developed by IWR using the above methodology were reviewed by the Divisions and Districts in August 1987 and between September and November 1988. A number of concerns were expressed with respect to the top-down approach and perceived shortcomings in this methodology. IWR refined the projections further at the segment level in consultation with several Divisions and Districts, incorporating linear regression, standard deviation of historic data, and shifting share analysis. Generally, the result was to create a wider traffic projection envelope. Some of the main concerns expressed by the field with respect to the top-down approach follow and a discussion of the issue developed by Huntington District in the course of reviewing this report follows at the end of this section.

Static Shares. The projection approach used by IWR holds each waterway's 1984-86 weighted average share of traffic in a given commodity group constant throughout the forecast horizon. Thus any apparent trends toward an increasing or decreasing share of total traffic in a particular commodity were not reflected beyond the share achieved by 1984-86. The use of some larger waterway segments, such as the entire Ohio River, also masks emerging changes in commodity movement patterns on any given portion of the river.

Local Movements. Localized shifts in traffic patterns, such as would result from the opening/closing of a large facility on a given waterway, have not been addressed in the projections. While such micro-scale changes might not have a significant impact on national traffic projections (or possibly even segment projections), they could affect dramatically the projections at individual locks.

TABLE 32

U.S. INLAND WATERWAY TRAFFIC
1986 ACTUAL TONNAGE AND PROJECTIONS OF COMMODITY MOVEMENTS, 1990-2000
(Millions of Tons)

Commodity Group	ACTUAL 1986	1990			1995			2000			ANL % TO 2000		
		LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH	LOW	MED	HIGH
Upper Mississippi	73.7	82.5	85.3	92.0	87.6	93.6	102.1	93.3	101.9	112.4	1.7	2.3	3.1
Middle Mississippi	97.7	106.3	109.8	117.4	112.9	120.6	130.3	120.3	131.5	144.8	1.5	2.1	2.9
Missouri	7.0	6.8	7.1	7.6	6.5	7.4	8.5	6.2	7.8	9.4	-0.9	0.8	2.1
Lower Mississippi	156.2	168.5	174.4	187.8	178.3	190.9	209.6	189.5	207.8	234.0	1.4	2.1	2.9
Arkansas	8.4	8.9	9.1	11.5	9.1	9.9	13.5	9.6	10.6	15.5	1.0	1.7	4.5
Illinois Waterway	42.3	44.5	46.2	49.9	47.2	50.5	54.9	50.1	54.8	60.1	1.2	1.9	2.5
Ohio River System	222.2	232.3	240.8	254.2	248.2	265.5	288.1	266.8	292.9	326.9	1.3	2.0	2.8
Ohio River-Mainstem	195.6	204.0	211.5	224.3	217.7	232.9	253.9	233.7	256.6	287.7	1.3	2.0	2.8
Monongahela	29.5	38.5	39.5	42.1	40.5	42.0	48.6	43.1	47.0	56.2	2.7	3.4	4.7
Kanawha	16.8	18.1	18.7	21.4	19.5	20.9	24.6	21.2	23.3	28.4	1.7	2.4	3.8
Cumberland*	14.2	15.7	16.4	18.0	16.2	17.6	20.8	17.0	18.9	23.7	1.2	1.9	2.6
Tennessee	39.6	41.3	42.8	44.4	44.0	47.1	50.1	47.1	51.7	56.6	1.2	1.9	2.6
Gulf Intracoastal WW	105.7	102.0	107.2	112.4	99.9	110.8	121.3	101.7	116.2	131.0	-0.3	0.7	1.5
Black Warrior/Tombig	17.9	22.1	22.9	24.1	23.6	25.2	26.9	25.3	27.7	30.2	2.5	3.2	3.8
Atlantic Intracoastal	4.4	4.7	4.8	5.2	5.2	6.4	6.5	5.7	7.0	8.1	1.9	3.4	4.5
Columbia	14.1	15.8	16.3	21.5	16.4	17.8	22.6	17.3	19.0	24.7	1.5	2.2	4.1

SOURCE: 1988 Inland Waterway Review, US Army Engineer Institute for Water Resources, Ft. Belvoir, VA, Nov. 88.

*1985 Data for Cumberland. 1986 Data skewed by Closure of Kentucky Lock on Tennessee R.

Diverted and Induced Waterway Traffic. The projection methodology used by IWR does not have a mechanism to address the diversion of traffic from/to other modes or induced traffic resulting from changes in the system, such as major lock rehabilitation or added locking capacity.

Division/District Input to Modify Projections. Several field offices (FOAs) provided support to IWR to refine the segment level projections to help overcome some of the deficiencies noted above. The divisions and districts are in a position to have local knowledge of new plants, facilities and transfer terminals, closures, changes in operating patterns at a particular lock, and relevant characteristics of area shippers and waterway operators. The localized effects of these factors were evaluated to determine changing traffic shares by commodity on a given segment and at individual locks. Each segment was further evaluated through linear regression analysis and calculation of standard deviation of historic data. The result was to modify the forecast envelope for a number of segments using the linear trend line or the historic variation in traffic about a mean value implied by the standard deviation.

Concluding Remarks on IWR Projections

The projections developed by IWR for the 1988 Inland Waterway Review provide a broad based look at alternative futures for traffic on the nation's waterway system. The "top-down" approach is an effort to capture trends by commodity at the national level, as projected by major commercial forecasting services. Indeed, a major strength of this method is its considerable assessment of production and consumption trends in various sectors of the national economy that use waterborne transportation. The national traffic projections thus derived are probably far more realistic than a summation of projections generated for individual lock and dam projects. Unfortunately, the ability to predict traffic levels becomes weaker as these forecasts are disaggregated down to the segment and lock level using an historic weighted average approach. Some of this weakness is mitigated at the segment level by refinements developed with Division and District support. However, the projection methodology is too generalized to be applied at the lock level without considerable degradation of reliability. For project-level analysis, the projections developed in the 1988 Inland Waterway Review provide a national framework that can be used as a starting point. Project analysts need to refine these projections further through local and regional analysis, perhaps applying origin/ destination studies to determine likely future patterns at individual projects and along localized river reaches.

Huntington District, in its comments on this Review of Planning and Forecast Methodologies, summarized basic concerns from a project level perspective on deficiencies of the top-down approach:

> "With the passage of the Acid Rain Legislation, we are witnessing major and unforeseen changes in coal shipment patterns, some of which are temporary fixes and some of which are permanent. With respect to coal transportation, we are in the midst of a period of adjustment which will continue for the next decade. The usefulness of the top-down forecasting approach described, in this type of an environment, is questionable on the system level and particularly questionable at the project level. Under these circumstances, the major source of useful information will probably prove to be shipper surveys.
>
> "The purpose of making these long-term commodity traffic demand forecasts is for the economic analysis of individual projects and yet the forecasting methodology described is most accurate at the national level, less accurate at the system level, less accurate still at the individual waterway level, and least accurate at the project level. The methodology is undermined by a lack of regional variation in commodity traffic growth rates, a lack of company-level input.
>
> "The report suggests that the forecasts produced will serve as a "framework" for use in producing project-level traffic demand forecasts, and that districts will make micro-level adjustments to make the forecasts useable in project economic analyses. The danger in this approach is that in their unadjusted form, the overall forecasts will be so generalized that they will be entirely unusable at the project level.
>
> "The "leap" from the national-level forecasts to project level forecasts is a highly-complex leap. The forecasts could look good and reasonable at one project in a system, but entirely off-base at another project. Micro-level information is often critical at the project level, and rather than simply adjusting the national-level forecast, what may be required is a complete "re-do" of the forecast. Whatever adjustments are made at the district level, whether minor or major, the likelihood of conflict and confusion is high." (ORH-PD-C, 20 September 1991)

The issues raised by Huntington District are valid and highlight the need for appropriate local and regional input to refine projections in a top-down framework for project level analysis. These refinements can be based on shipper and carrier surveys, localized origin/destination analysis, anticipated modal diversions or new traffic, etc. Ideally, the techniques used to refine the projections at the project level should be well documented, defensible, and adaptable by others performing a similar analysis.

SUMMARY

This report is part of a larger R&D effort to develop suggested procedures and guidelines for making consistent and systematic inland waterway traffic projections. The purpose of this report is to review and assess traffic forecasting methodologies previously employed by project level and national level Corps of Engineers inland navigation studies. Inherent in this effort is the identification of data sources for economic, transportation, and commodity supply and demand forecasts.

Each of the 16 inland navigation studies reviewed is in some way unique, because individual waterway projects have unique physical features, geographic locations, traffic mixes and patterns, economic hinterlands, etc., that have to be addressed. However, the studies discussed still exhibit enough similarities to categorize their projection methodologies into four broad groups: (1) the application of independently derived commodity-specific annual growth rates to base year traffic levels; (2) shipper surveys of existing and potential waterway users to determine future plans to ship by barge; (3)statistical analysis using regression and correlation to predict future waterborne traffic based on independent economic variables; and, (4) a detailed long-range commodity supply-demand and modal split analysis incorporating the production and consumption patterns of individual economic regions within the waterway hinterland. The complexity of these methods varies widely, as does the time, effort, and expense invested in each. The general projection methodology and data sources incorporated in each of the reviewed inland navigation studies are summarized in Table 33.

Most analysts would agree that the projection methodologies employed in Corps navigation studies should not be judged solely on the basis of forecasting accuracy for the simple reason that every forecast contains some degree of error. A sound methodology does not necessarily ensure an accurate forecast. Often macroeconomic changes or unpredictable political, fiscal, or meteorological events, for example, can defy all the presumptions of "conventional wisdom." How, then, should these methodologies be judged?

TABLE 33

GENERAL PROJECTION METHODOLOGY AND DATA SOURCES
FOR THE 16 INLAND WATER STUDIES

STUDY NAME & YEAR	PROJECTION METHODOLOGY	DATA SOURCES
Lower Mississippi Region Comprehensive Study (1974)	Base year traffic multiplied by commodity-specific growth rates	-1970 Waterborne Comm. -1967 OBERS industry indices
Master Plan for Upper Mississippi River System (1981)	Base year traffic multiplied by commodity-specific growth rates	-National Waterways Study, 1983
Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980-2040 (1980)	CONSAD: statistical methods (correlation & regression)	-1972 OBERS Series E Regional Projection -1976 Waterborne Comm.
	Battelle: shipper survey	-surveys and interviews of Ohio River basin waterway users
	Nathan: market demand, resource inventory, and modal split analysis	-1976 Waterborne Comm. -U.S. Depts of Interior, Agriculture, Energy, and Transportation -Bureaus of Economic Analysis and Census
Gallipolis Locks and Dam (1980)	Evaluated CONSAD, Battelle, and Nathan studies; selected Nathan	-see Nathan sources
Monongahela River, Locks & Dams 7 & 8 (1984)	Nathan's market demand, resource inventory, and modal split analysis, then updated in 1981 with interviews, surveys	-Ohio River Basin Study, 1980
Lower Ohio River Navigation Study Mouth to Cumberland River (1985)	Nathan study updated with Tenn-Tom estimates	-see Nathan sources

TABLE 33 (Continued)

STUDY NAME & YEAR	PROJECTION METHODOLOGY	DATA SOURCES
Kanawha River, Winfield Lock Replacement (1986)	Base year traffic multiplied by commodity-specific growth rates	-1980 Waterborne Comm. -1980 OBERS Series E Regional Projections
Forecast of Future Ohio River Basin Waterway Traffic (1986-2050)	Industry analyses performed, base year traffic adjusted through shipper surveys, movements categorized by geographic area and end use market, commodity-specific OBERS and industry growth indices applied to base traffic levels	-1986 Waterborne Comm. -Bureau of Econ. Anal. -U.S. Dept of Ag. -U.S. Forest Service -National Electric Reliability Comm. -Industry Forecasts
Supplement To The Environmental Inpact Statement:Tennessee-Tombigbee Waterway: (1981)	Shipper survey and interviews (base year)	-potential shippers identified from commodity movements from Interstate Commerce Commission (rail), Bureau of Census (truck), and Corps (marine)
	Base year traffic multiplied by commodity-specific growth rates	-1972 OBERS Series E Regional Projections
Operational Forecast for the Tennessee - Tombigbee Waterway (1985)	Shipper survey and interviews	-state industrial directories, trade associations, chamber of commerce lists
Interim Feasibility Report and Environmental Impact Statement for Oliver Lock Replacement (1985)	Base year traffic multiplied by commodity-specific growth rates	-1979 Waterborne Comm. -1980 OBERS Regional Projections
Bonneville Navigation Lock (1984)	-Statistical methods -Shipper surveys -Base year multiplied by commodity-specific growth rates	-1960-81 Lockmaster reports -US Dept Agriculture, US Forest Service -1980 OBERS Regional Projections

TABLE 33 (Continued)

STUDY NAME & YEAR	PROJECTION METHODOLOGY	DATA SOURCES
Mississippi River Gulf Outlet (Industrial Canal Lock) (1989)	Base year traffic multiplied by commodity-specific growth rates	-1986-87 Waterborne Commerce -1988 Inland Waterway Review
Montgomery Point Lock and Dam (1990)	Base year traffic multiplied by IWR and OBERS indices	-1989 Shippers Survey -1989 Waterborne Comm.
National Waterways Study (1983)	Base year traffic multiplied by commodity-specific growth rates	-1977 Waterborne Comm. -Data Resources, Inc.
1988 Inland Waterway Review (1988)	Base year traffic multiplied by commodity-specific growth rates supplemented by statistical methods	-1986 Waterborne Comm. -Data Resources, WEFA Group, US Dept Energy, Fertilizer Institute -Review by Corps districts, divisions

The answer depends on what kind of forecast the analyst requires: long-term or near-term; national, regional, or project-specific; definitive tonnage estimates or projection "envelopes"; needs assessment or benefit calculations; or, investment strategies or in supplementing planning efforts. To develop general guidelines with wide applicability, the most practical methodology appears to be one that uses a consistent set of macroeconomic assumptions in generating international, national, and regional level projections, which in turn can be adapted by Corps planners as a basic framework for further modifications derived from local knowledge and expertise that can be applied in project level analysis. Credibility would thus be enhanced by the uniformity of national-level traffic totals and assumptions imbedded in individual project report forecasts with overlapping time horizons. The development of general forecasting guidelines is more practical if it incorporates a methodology that is easily updatable based on the latest historic and forecast data, is relatively low cost for the project manager to implement, and is adaptable for use on microcomputer in a format available to any Corps planner.

The methodology incorporating commodity-specific growth rates applied to one or more base years(s) traffic levels appears to best meet the criteria outlined above. This technique was used by the Huntington, Mobile, New Orleans, Portland, and St. Louis districts for inland navigation projects in their districts, as well as the Institute for Water Resources in The 1988 Inland Waterway Review. These publically available and independently derived commodity forecasts reflect sophisticated macroeconomic models and informed judgments of academic, government, and industry experts with respect to given commodity groups.

The shipper survey method tends to build in an optimistic bias and does not sufficiently address long-term forecast issues, while the statistically-based regression and correlation methods inherently assume a continuation of past trends. Finally, a long-term evaluation of regional market demands, resource bases, production levels, and transportaion modes -- while detailed, extensive, and methodologically defensible -- is unfortunately the type of massive forecasting effort that is not easily updated and may be impractical for smaller staffs facing urgent time and budget constraints in project analysis.

As explained in the text, IWR developed inland waterway traffic projections using a "top-down" approach in an effort to capture trends by commodity at the national level as projected by major commercial forecasting services. A strength of this method is its considerable assessment of production and consumption trends in various sectors of the national economy that use waterborne transportation. A weakness is that the projection methodology is too general to be disaggregated down to the lock level without serious loss of reliability. This forecast methodology therefore can be used to provide a consistent national framework that can be refined in a project level analysis by planners equipped with knowledge that can be refined in a project level analysis by planners equipped with knowledge of local industry, markets, and transportation patterns and any anticipated changes in these elements. IWR's national framework forecasts can and will be updated as new economic and traffic data become available from the Waterborne Commerce Statistics Centers, DRI, SCI, the WEFA Group, the U.S. Departments of Energy and Agriculture, and other commercially or publicly available forecast sources. Finally, the databases and forecasting calculations produced by IWR are easily installed on microcomputers.

As noted earlier, this review of past Corps forecasting methodologies is part of an effort to develop and document waterway traffic forecasting guidelines which will include a field test at the project level with one or more divisions or districts. The methodology will be an attempt to synthesize national level commodity-driven projections developed for IWR's 1988 Inland Waterway Review with regional economic analysis and localized shipper/receiver data to develop specific forecasts applicable for project level analysis.

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