VOLUME V OF V

U.S. DEEPWATER PORT STUDY

...ANSPORT AND BENEFIT-COST RELATIO...

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13. ABSTRACT

This report provides an overall appraisal of deep port needs for the United States by means of identification of the factors critical to U. S. deepwater port decision; development of criteria appropriate to the evaluation of engineering, economic and environmental aspects of deep port needs and policies, analysis of the development options available at this time and the critical issues surrounding each and the identification of critical issues which need further analysis. The study emphasizes port requirements for bulk commodities.

Volume I contains the Summary Report
Volume II contains Commodity Studies and Projections
Volume III contains Physical Coast and Port Characteristics, and Selected Deepwater Port Alternatives
Volume IV contains The Environmental and Ecological Aspects of Deepwater Ports
Volume V contains Transport of Bulk Commodities and Benefit-Cost Relationships

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Volume V of V

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Transport and Benefit-Cost Relationships

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CONTENTS

ANNEX E. TRANSPORT OF BULK COMMODITIES

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CONTENTS

I. OCEAN SHIPPING OF BULK COMMODITIES: WORLD SUPPLY AND DEMAND

The Demand for Ocean Shipping of Major Bulk Commodities

The world market for ocean transport of liquid and solid bulk materials is huge. In 1971 over 2.5 billion metric tons of internationally traded cargo of all kinds, of which some 80 percent or more were bulk commodities,1/ were shipped across the world's oceans. Approximately half of that 1971 total tonnage was accounted for by oil; another 10 percent, by iron ore; and the balance, by a wide variety of other commodities, including coal, grain, bauxite and alumina, and phosphate rock (table 1).

Although U.S. participation in that total market cannot readily be determined from available data, in 1969 and 1970 the U.S. share of world seaborne trade in the major bulk commodities covered by this study was estimated at slightly more than 15 percent.2/ However, among these commodities the relative importance of U.S. trade varies widely. Expressed as a percentage of total tonnage in world seaborne trade, the U.S. share in

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1/ The appropriate percentage value depends upon one's definition of "bulk commodity," and on its application to trade flows over time. See the following section on "Changing Technology in Bulk Commodity Shipping."
2/ Because there are two trading partners in every movement, aggregation of every country's world market share would come to 200 percent.

Table 1. Estimated World Seaborne Trade by Major Commodity, 1960-71

(In millions of metric tons)

Commodity	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[a]
<u>Major wet bulk</u>												
Crude oil.....	n.a.	n.a.	366	424	482	552	607	672	768	871	979	1,060
Petroleum products.....	n.a.	n.a.	170	158	170	175	195	193	207	209	214	220
Subtotal.....	--	--	536	582	652	727	802	865	975	1,080	1,193	1,280
<u>Major dry bulk</u>												
Iron ore......	101	98	102	107	134	152	153	164	188	214	247	252
Coal..........	46	48	53	64	60	59	61	67	73	83	101	98
Grain[b]	46	57	53	59	71	70	76	68	65	60	73	70
Bauxite/ alumina......	17	17	18	17	19	21	23	25	26	30	34	c/
Phosphates....	18	19	20	22	24	25	27	28	32	32	33	c/
Subtotal.....	228	239	246	269	308	327	340	352	384	419	488	420[c]
Total, major bulk comm.....	--	--	782	851	960	1,054	1,142	1,217	1,359	1,499	1,681	1,700
Other[d]........	n.a.	n.a.	468	499	550	586	628	643	681	741	759	850
Grand total....	--	--	1,250	1,350	1,510	1,640	1,770	1,860	2,040	2,240	2,440	2,550

n.a. = not available.
a/ Preliminary estimate.
b/ Includes only wheat, corn, barley, rye, and oats.
c/ Data for bauxite, alumina and phosphates unavailable; included in "other."
d/ Includes other bulk as well as nonbulk commodities.

Source: Fearnley & Egers Chartering Co. Ltd., <u>Trades of World Bulk Carriers in 1970</u> (Oslo, November 1971), p. 6, and <u>Review 1971</u> (Oslo, January 1972), p. 8.

recent years has ranged from less than 5 percent for crude oil to somewhat more than 50 percent for bauxite and alumina. The United States has also accounted recently for some 40 percent or more of total world seaborne trade in coal, grain, and petroleum products, and for lower proportions of iron ore and phosphate rock trade (table 2).

While U.S. participation in world seaborne trade is very important, Western Europe -- taken as a whole -- plays a substantially larger role. Among individual countries, Japan's influence is especially striking. Reflecting its extraordinarily rapid industrial growth in the last two decades, Japan's share of total world seaborne trade in the same group of commodities increased to approximately 20 percent in 1969 and 22 percent in 1970. That share was particularly large in crude oil, iron ore, and coal (table 3).

Although world seaborne trade in general has grown very fast, trade in major bulk commodities has grown more rapidly. Between 1962 and 1971, estimated seaborne carriage of all commodities in world trade approximately doubled, a compound annual growth rate of 8 percent. The fastest growing of the major commodities of interest in this study was the dominant one, crude oil. Its volume nearly tripled over that 9-year interval, a 12.5-percent annual growth rate. Among the major dry bulk cargoes, the fastest growing were iron ore (which increased 2.5 times), coal, and bauxite/alumina (which approximately doubled). Notable was the relatively slow growth of world seaborne trade in petroleum products. Whereas such products represented nearly one-third of total oil movements in world seaborne trade in 1962, by 1971 they accounted for only 17 percent of the trade (table 1). This development clearly reflects continuation of the historical tendency to locate new petroleum refineries closer to markets than to producing areas.

Trends or changes in distances of haul are an important factor in transport demand, which may influence shipping markets as much as tonnage taken alone. It is therefore useful to consider recent trends in world

Table 2. Estimated U.S. Share of Total World Seaborne Trade in Major Bulk Commodities, 1967-70

Commodity	Total world				Total U.S.				U.S. share			
	1967	1968	1969	1970	1967	1968	1969	1970	1967	1968	1969	1970
	---------- millions of metric tons ----------								----- percent -----			
Dry bulk												
Iron ore..	164.4	187.7	213.8	247.1	27.5	25.0	26.8	28.6	16.7	13.3	12.5	11.6
Grain a/...	68.0	65.1	59.5	73.2	29.7	29.2	23.6	29.7	43.7	44.9	39.7	40.6
Coal......	66.8	72.9	83.2	101.2	31.1	30.8	35.8	47.5	46.6	42.2	43.0	46.9
Bauxite/ alumina..	25.0	26.3	30.0	33.7	14.3	13.8	16.0	17.2	57.2	52.5	53.3	51.0
Phosphate.	27.6	32.4	31.6	33.0	7.3	9.6	9.1	9.6	26.4	29.6	28.8	29.1
Subtotal.	351.8	384.4	418.1	488.2	109.9	108.4	111.3	132.6	31.2	28.2	26.6	27.2
Wet bulk												
Crude oil.	672	768	871	979	n.a.	n.a.	43	32	--	--	4.9	3.3
Petroleum products.	193	207	209	214	n.a.	n.a.	79 b/	92 b/	--	--	37.8	43.0
Subtotal.	865	975	1,080	1,193	--	--	122 b/	124 b/	--	--	11.3	10.4
Total......	1,217	1,359	1,498	1,681	--	--	233	257	--	--	15.3	15.3

n.a. = not available.
a/ Includes only wheat, corn, barley, rye, and oats.
b/ RRNA estimate.

Source: Fearnley & Egers Chartering Co. Ltd., Trades of World Bulk Carriers in 1969 (Oslo, November 1970), pp. 8, 12, 16, 18, 20; Trades of World Bulk Carriers in 1970 (Oslo, November 1971), pp. 10, 14, 18, 20, 24; Large Tankers, January 1971 (Oslo, June 1971), p. 16; and Review 1971 (Oslo, January 1972), p.8.

Table 3. Estimated Japanese Share of Total World Seaborne Trade in Major Bulk Commodities, 1967-70

Commodity	Total Japanese seaborne trade				Japanese share of world seaborne trade			
	1967	1968	1969	1970	1967	1968	1969	1970
	---- mil. of metric tons ---				-------- percent --------			
Dry bulk								
Iron ore........	56.7	68.2	83.2	102.1	34.5	36.3	38.9	41.3
Grain a/.........	4.1	4.1	4.3	n.a.	6.0	6.3	7.2	n.a.
Coal............	26.2	32.5	41.5	50.3	39.2	44.6	49.9	49.7
Bauxite/alumina.	2.2	2.6	3.3	4.0	8.8	9.9	11.0	11.9
Phosphate.......	2.7	3.4	2.9	3.2	9.8	10.5	9.2	9.7
Subtotal.......	91.9	110.8	135.2	163.9 b/	26.1	28.8	32.3	33.6 b/
Wet bulk								
Crude oil.......	103.0	119.3	144.1	172.0	15.3	15.5	16.5	17.6
Petroleum products.......	16.3	19.3	21.6	n.a.	8.4	9.3	10.3	n.a.
Subtotal.......	119.3	138.6	165.7	193.6 c/	13.8	14.2	15.3	16.2 c/
Total...........	211.2	249.4	300.9	357.5 b,c/	17.4	18.4	20.1	21.3 b,c/

n.a. = not available.
a/ Includes only wheat, corn, barley, rye, and oats.
b/ Assumes grain at 1969 level.
c/ Assumes petroleum products at 1969 level.
Source: Same as table 2, plus: UN Yearbook of International Trade Statistics, 1969 (N.Y., 1971) for grain and petroleum products; and RRNA estimates for a small part of petroleum products.

seaborne trade in terms of ton-miles (metric ton-nautical miles). From 1962 to 1971, world seaborne trade in all commodities increased from around 4.4 trillion ton-miles to over 11.1 trillion ton-miles, or an average annual growth rate of nearly 11 percent. Among the major bulk commodities, crude oil and iron ore revealed the most rapid increases in ton-miles over the same 9-year span, each expanding by over 350 percent (table 4).

The faster growth of world seaborne trade in ton-miles than in tonnage of course reflects substantial increases in average distances of movement. For total world seaborne trade in all commodities, average distances of haul increased from just under 3,500 miles to almost 4,400 miles between 1962 and 1971. Average distances for the major bulk commodities covered by this study were greater, expanding from 4,000 tc nearly 5,200 miles over the same period. Differences among specific commodities were notable, however.

Crude oil was typically transported the longest distances in most recent years, averaging nearly 5,800 miles in 1971 as against 4,500 miles in 1962. Among the dry bulks, cereals were consistently carried the longest distances on the average -- approximately 5,200 miles -- but with no tendency since 1960 to increase. Average distances of haul for iron ore, coal, and bauxite/alumina grew very rapidly between 1960 and 1971, amounting in the latter year to around 4,400, 4,800 and 2,900 miles, respectively. The equivalent 1971 figure for petroleum products was 3,500 miles (which was modestly lower than in earlier years), and for phosphates, around 3,500 miles (which was slightly higher than in the early 1960's) (table 5).

Data on the U.S. share of total world seaborne trade expressed in ton-miles are not available and cannot conveniently be estimated. However, most of U.S. major bulk commodity imports have originated in the Caribbean and other parts of the Western Hemisphere, implying relatively short average distances of movement. Typical shipping distances for U.S. major bulk commodity exports are significantly longer, especially for coal and grain, but in general are not believed to exceed

Table 4.—Estimated World Seaborne Trade by Major Commodity, 1960-71

(In billions of ton-miles)

Commodity	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[a]
Major wet bulk												
Crude oil.....	n.a.	n.a.	1,650	1,850	2,150	2,480	2,629	3,400	4,197	4,853	5,536	6,120
Petroleum products.....	n.a.	n.a.	650	600	620	640	700	730	750	760	760	770
Subtotal.....	--	--	2,300	2,450	2,770	3,120	3,329	4,130	4,947	5,613	6,296	6,890
Major dry bulk												
Iron ore......	264	298	314	348	456	527	575	651	775	919	1,093	1,100
Coal..........	145	157	170	202	199	216	226	269	310	385	481	470
Grain[b]	248	283	272	304	378	386	408	380	340	307	393	370
Bauxite/ alumina......	34	35	37	35	39	46	55	62	70	84	99	[c]
Phosphates....	55	60	61	67	74	85	96	103	119	118	116	[c]
Subtotal.....	746	833	854	956	1,146	1,260	1,360	1,465	1,614	1,813	2,182	1,940[c]
Total, major bulk comm.....	--	--	3,154	3,406	3,916	4,380	4,689	5,595	6,561	7,426	8,478	8,830
Other[d]	n.a.	n.a.	1,202	1,298	1,437	1,469	1,549	1,635	1,811	1,948	1,985	2,300[c]
Grand total....	--	--	4,356	4,704	5,353	5,849	6,238	7,230	8,372	9,374	10,463	11,130

n.a. = not available.
a/ Preliminary estimate.
b/ Includes only wheat, corn, barley, rye, and oats.
c/ Data for bauxite, alumina and phosphates unavailable; included in "other."
d/ Includes other bulk as well as nonbulk commodities.

Source: Fearnley & Egers Chartering Co. Ltd., Trades of World Bulk Carriers in 1970 (Oslo, November 1971), p. 6, and Review 1971 (Oslo, January 1972), p. 8.

Table 5. Average Distances of Seaborne Cargo Movements in World Trade, by Major Commodity, 1960-71

(In nautical miles)

Commodity	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971[a]
Major wet bulk												
Crude oil.....	--	--	4,508	4,363	4,461	4,493	4,331	5,060	5,465	5,572	5,655	5,774
Petroleum products.....	--	--	3,824	3,797	3,647	3,657	3,590	3,782	3,623	3,636	3,551	3,500
Weighted sub-total.......	--	--	4,291	4,210	4,248	4,292	4,151	4,775	5,074	5,197	5,277	5,383
Major dry bulk												
Iron ore......	2,614	3,041	3,078	3,252	3,403	3,467	3,758	3,970	4,122	4,294	4,425	4,365
Coal..........	3,152	3,271	3,208	3,156	3,317	3,661	3,705	4,015	4,247	4,639	4,762	4,796
Grain[b]	5,391	4,965	5,132	5,153	5,324	5,514	5,368	5,588	5,231	5,117	5,384	5,286
Bauxite/ alumina......	2,000	2,059	2,056	2,059	2,053	2,190	2,391	2,480	2,692	2,800	2,912	c/
Phosphates....	3,056	3,158	3,050	3,045	3,083	3,400	3,556	3,679	3,719	3,688	3,515	c/
Weighted sub-total.......	3,272	3,485	3,472	3,554	3,721	3,853	4,000	4,162	4,203	4,327	4,471	4,619[c]
Weighted total, major bulk commodities...	--	--	4,033	4,002	4,079	4,156	4,106	4,597	4,828	4,954	5,043	5,194
Other[d]........	--	--	2,568	2,601	2,613	2,507	2,467	2,543	2,659	2,629	2,615	2,706
Weighted grand total.........	--	--	3,485	3,484	3,545	3,566	3,524	3,887	4,104	4,185	4,288	4,365

a/ Preliminary.
b/ Includes only wheat, corn, barley, rye, and oats.
c/ Data for bauxite, alumina and phosphates unavailable; included in "other."
d/ Includes other bulk as well as nonbulk commodities.
Source: Tables 1 and 4.

world averages. Thus, the U.S. share of world seaborne trade in major bulk commodities, expressed in total ton-miles, is probably about the same as, or possibly somewhat lower than, its recent 15.3-percent share of total world tonnage.

In contrast, Japan's bulk commodity trade consists almost entirely of imports which come predominantly from distant origins. As a result, Japan's participation in world shipping of major bulk commodities has been estimated by a leading trade source at some 30 percent of total world ton-miles covered in 1971 (table 6), or substantially higher than its share of total world tonnage.

Underlying determinants of growth or change in worldwide demand for ocean shipment of major bulk commodities are numerous and complex. They reflect dynamic political, economic, technological, and physical factors whose significance varies by specific commodity and trade route. For example, import substitution policies stimulate disproportionately rapid rates of growth in oceanborne movements of some bulk commodities, with corresponding reductions in like movements of the typically nonbulk commodities being substituted. Thus, some current importers of wheat, corn, or soybeans -- all bulk commodities -- at one time imported flour, formula feeds, or meat. The latter are substantially equivalent processed products which are usually not shipped in bulk. Similarly, in their efforts to develop domestic manufacturing activity and employment, some developing countries have built and expanded their pig iron and other steel-producing facilities. This has had the effect of substituting iron ore and coal imports (to the extent they are not locally available) for pig iron and other semiprocessed or final steel products, which are not generally transported in bulk.

On the other hand, some developing countries have successfully overcome deficiencies in domestic food grain production through improved technology, thereby reducing or eliminating import requirements. Similar results may also be achieved by subsidizing domestic agriculture and protecting it from imports, as is done in the European Common Market.

Table 6. Estimated Japanese Share of Total World Seaborne Trade in Selected Major Bulk Commodities, in Ton-Miles, 1971

Commodity	Japanese share (percent)
Iron ore................	60
Coal....................	75
Grain[a/]................	20
Oil (crude and product).	20
Other major bulk commodities[b/].............	30
Total.................	30

a/ Includes only wheat, corn, barley, rye, and oats.
b/ Not specifically identified, but probably including bauxite, alumina, phosphate rock, and other cereals and soybeans, among others.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), pp. 4-5.

A relatively new development may exert an important influence on future flows of waterborne bulk commodities. Many major world suppliers of oil, iron ore, bauxite, and some other primary commodities are developing countries. They may increasingly want to expand vertically into at least the first stages of processing from their present mining operations. This has already occurred on a limited scale. To the degree that this "export substitution" approach is successful, it implies more rapid growth for ocean transport of partially processed bulk commodities, such as petroleum products and alumina, at the expense of equivalent raw materials, such as crude oil and bauxite.

Average distances of waterborne movement for bulk commodities in world trade are importantly influenced by similar factors. Thus, where nearby resources are incapable of economic expansion, and/or where newly exploited but distant resources are potentially attractive, an economic incentive to import from the more remote sources may be created. It may be further stimulated by reductions in transfer costs, which can often be achieved through use of larger ocean vessels than had previously been employed.

Average distances of haul are also affected by physical or political constraints governing major waterways. Notable in this respect are the Suez and Panama Canals. The former's closing in 1967 immediately necessitated circuitous journeys for some traffic, particularly for crude oil moving from Persian Gulf origins to major European destinations. However, the existing water depths in both canals preclude efficient use of vessels exceeding certain limited sizes. As indicated by the benefit-cost analysis (Annex F), scale economies in ocean shipping may often justify longer journeys by vessels much larger than could pass through either canal, even if both were open to traffic.

Changing Technology in Bulk Commodity Shipping

Historical developments in markets and transport technology have resulted in profound changes in the ocean shipping of bulk commodities. Today's bulk commodities are so designated because they are essentially raw or semiprocessed materials that can physically be moved and transshipped without any form of packaging -- that is, in bulk. Generally, handling and transport of such commodities in bulk form is significantly easier and more efficient than in a number of barrels, bags, bales or boxes. However, annual volumes must be sufficiently great to warrant the development of necessary specialized terminal facilities, and individual shipments must be sufficiently large to fill, or substantially load, an ocean vessel. Prior to the satisfaction of those conditions, virtually all so-called bulk commodities were packaged and shipped on vessels bearing a variety of merchandise as general cargo.

With expanding world trade in the second half of the 19th century, specialized ocean vessels began to evolve, resulting in three essentially separate trades and related types of vessels: (1) merchant ships serving most of the world's ports on regular schedules and bearing a large number of diverse cargoes in small lots (liner service); (2) tankships for the carriage of bulk oil cargoes; and (3) essentially multi-deck freighters (tramp ships) for the movement of various dry commodities in bulk form. These latter two types of vessels were employed only on those trade routes and served only those ports for which they were specifically engaged.

The three largely distinct markets and related vessels were, however, to some degree interrelated. Increases in lot size permitted growing proportions of some commodities that were previously moved as general cargo in liner vessels to graduate to bulk movement by tramp or tanker ships. In addition, at times when tankers were not fully occupied in the carriage of oil and other liquid cargoes, some would compete for dry bulk traffic (especially cereals), despite the inefficiencies inherent in their design for accommodating it.

In more recent years, and especially since the end of World War II, ocean movements of bulk commodities have exhibited two notable and widely advertised trends: a tremendously rapid growth in traffic, and substantial increases in average vessel size. But of equal importance, the world fleet has become more specialized and diverse. The earlier twofold distinction between tankers and tramp ships no longer reflects fast-changing realities.

Today's fleet consists essentially of:

1. Tankships or tankers, which are specifically designed to carry liquid commodities in bulk, notably crude oil and petroleum products, but many others as well

2. Dry bulk carriers, which are single-deck vessels built to transport one or more types of such commodities as grain, coal, or mineral ores

3. Combined carriers, which are flexibly arranged to permit carriage either of liquid or of dry bulk cargoes.

These three broad vessel types may be further distinguished by special design features. Apart from vessels built to carry oil, there are now specialty tankships for the carriage of such commodities as liquid gases, chemicals, sulfur, asphalt and bitumen, and wine. However, oil tankers are predominant1/ and are the only tankships of interest in this study. Furthermore, the most useful data available on tankships are limited to oil tankers. Therefore, all further references to tankers in this study pertain only to oil tankers, unless otherwise indicated.

Published information does not seem to illuminate the question of oil tanker suitability for carriage of

1/ Non-oil tankers of all types represented only about 4.5 million d.w.t., or less than 3 percent of the world tanker fleet of 2,000 gross tons or more, at the end of 1970. See Sun Oil Company, Analysis of World Tank Ship Fleet, December 31, 1970 (Sun Oil Company, Philadelphia, August 1971), p. 17.

the various specific commodities within the general petroleum family. Generally, however, we have been given to understand by trade sources that a tanker designed to move crude oil could also often be used to transport most petroleum products and vice versa, although the need would probably not often arise.

While tankships designed to carry oil may occasionally carry dry bulk commodities such as grain, they are classified as tankers rather than as dry bulk carriers or as combined carriers as long as they continue to be used for their originally intended purposes.

The historic practice of tanker switching to dry cargo markets at times of slack demand in the oil markets has apparently been declining in significance, at least in relation to grain (table 7). This undoubtedly reflects the high cost of cleaning the tanks and of somewhat inefficient product loading or unloading. More commonly, many old tankers have been permanently modified to facilitate efficient handling of dry bulk commodities (which usually require large hatch openings, unlike oil). In this event they would normally be reclassified as dry bulk carriers.

Before 1955 the term "bulk carrier" had no special meaning in shipping. Bulk commodities were simply included among the many nonbulk dry cargoes carried in merchant ships or else transported in general-purpose freighters. In the early 1950's, world demand expanded so rapidly that new capacity tonnage increasingly took the form of more efficient and specialized vessels to serve particular types of dry bulk cargo. In shipping circles, these new ships generally became known as bulk carriers. Some single-deck freighters which operated prior to that time were later incorporated as bulk carriers, including ore, grain, and coal ships.

Dry bulk carriers can thus be distinguished by specialty roles. Most important is their ability to efficiently accommodate commodities having entirely different density characteristics. In general, a carrier in this group is built either to carry full loads of

Table 7. Estimated Seaborne Movements of Grain in World Trade in Tankers, 1961-70

(In millions of metric tons)

Year	U.S. grain exports	World grain exports
1961.......	6.8	n.a.
1962.......	5.3	n.a.
1963.......	4.3	6.3
1964.......	5.8	9.4
1965.......	n.a.	13.8
1966.......	7.5	12.5
1967.......	3.2	6.2
1968.......	2.5	4.1
1969.......	1.8	2.9
1970.......	2.1	2.9
1971.......	n.a.	1.5[a/]

n.a. = not available.
a/ Preliminary.

Source: U.S. Department of Commerce, Bureau of the Census, Waterborne Exports and General Imports, FT 985, selected years; and Fearnley & Egers Chartering Co., Ltd., Review 1971 (Oslo, January 1972), p. 14.

low-density commodities, such as coal, grain, or phosphate rock, or to carry full loads of high-density commodities, such as iron ore. Vessels within either of these two broad groups may also have special features for highly efficient movement or handling of one particular commodity, although in most instances they can also effectively carry other commodities of similar density characteristics. However, fundamental differences in vessel design generally preclude the economic use of iron ore ships for the carriage of low-density cargoes, or of other dry bulk vessels for the movement of high-density ores.

The capacity of an iron ore carrier is basically determined by the cargo weight that results in the vessel's reaching its maximum permissible draft. Because of that ore's high density (about 14 to 18 cubic feet per long ton), only a small proportion of the vessel's total cubic space need be used before the vessel attains full deadweight. The ore is stowed in holds which are reinforced to support the relatively great stresses imposed by their highly dense cargoes. Although the cargo holds could be fully loaded with a light-density good (typically ranging between 40 to 55 cubic feet per long ton), that would only permit use of some one-third of the vessel's capacity in tonnage, which is usually uneconomic.

The cargo capacity of a (low-density) bulk vessel is basically determined by the total cubic space of its holds. Loading the holds of such a vessel with iron ore would create serious problems. All holds could be partially loaded, or some holds could be filled and others left empty. However, either approach would be exceedingly dangerous, subjecting the vessel to stresses and motions which it is not designed to resist.1/

This dilemma has been substantially overcome in the design of "multiple stowage factor" dry bulk vessels. Some of their holds are designed to accommodate ores, and others to stow lighter commodities. Normally only

1/ United Nations, Economic Commission for Europe, The World Market for Iron Ore (New York, 1968), p. 101.

one type of commodity would be carried on a single journey. The greater flexibility of this design concept permits improved vessel utilization on those particular trade links providing relevant opportunities.

The third major group of ships for the ocean transport of bulk commodities is designed to carry either liquid or dry bulk cargoes. Among numerous foreign and domestic sources, different and sometimes confusing references are applied to these vessels. In this report they are known generally as "combined" carriers, corresponding to terminology used by at least two of the leading trade and statistical sources.1/ Although it would be equally logical to relate them closely to tankers, combined carriers are here considered as a subcategory within the broad group of bulk carriers, which also includes ore ships and other dry bulk carriers, to reflect prevailing statistical classifications.

The earliest combined carriers originated from the physical circumstances of specialized ore ships and from emerging new market opportunities. A large proportion of these vessels' total cubic space not used for stowage of iron ore consists of side or wing tanks used for ballast on return voyages. This led to the idea of adapting them for petroleum or other liquid cargo on alternate journeys where market conditions would permit. Such vessels were designated as ore/oil (O/O) carriers.2/ In terms of function, they are alternately ore carriers or oil tankers, although other dry bulk cargo may sometimes be carried in one direction, and other liquid cargo in the other.

The ore/oil ship thus has the advantage of greater flexibility in use than the special-purpose ore ship, and it is relatively simple to operate. It offers the opportunity both to obtain return freight on ore

1/ Fearnley & Egers Chartering Company Ltd. of Oslo, and John I. Jacobs & Company Ltd. of London.
2/ United Nations, Economic Commission for Europe, loc. cit.

runs, and to shift major attention from ore to oil markets on short notice where market conditions warrant. However, there is also a disadvantage, apart from somewhat higher costs: only with high-density ores can full ship capacity be obtained. For lower density oil (comparable to the lighter dry bulk commodities), cubic space is insufficient to permit full use of available deadweight.1/

Since the early 1960's, the flexible design concepts of the multiple stowage factor dry bulk vessel and of the ore/oil vessel have been further refined. Thus, some ships were designed to carry either low-density dry bulk or oil on different journeys, and are known as bulk/oil carriers. To enhance opportunities for convertibility among the different commodity groups, the ore/oil and bulk/oil designs were then integrated, producing the well-known ore/bulk/oil (O/B/O) carrier. The O/B/O is generally designed to carry full, or very substantial, loads of any of the various bulk commodities.2/ Since opportunities for obtaining very large shipments of crude petroleum on many trade routes are much greater than for dry bulk, O/B/O designs are more likely to be optimized for the carriage of oil. Viewed essentially as tankers, they would require only modest volumes of dry bulk cargoes on alternate journeys to become more attractive investments than conventional tankers (see chapter III).

The World Vessel Supply

Recent Size and Age Characteristics

At the beginning of 1971, the entire world fleet of oil tankers was estimated at 159 million d.w.t., of which over 149 million d.w.t. were accounted for by commercial vessels exceeding 10,000 d.w.t. The total world fleet of bulk carriers at that time was around 83 million d.w.t., of which some 76 million d.w.t. were accounted

1/ "The Combination Bulk Carrier," in Surveyor (Quarterly Publication of the American Bureau of Shipping), August 1970, pp. 16-24.
2/ Ibid.

for by commercial ships above 10,000 d.w.t. (table 8). Thus, noncommercial vessels and vessels of less than 10,000 d.w.t. are of minor quantitative significance in the total world supply. Since the smaller ships tend to be used heavily on short distance routes and in coastal or other domestic trades, they are of even less significance in world trade of bulk commodities. Furthermore, the most useful data sources generally exclude them. Accordingly, all further presentation of world fleet data in this report are limited to commercial tankers and bulk carriers over 10,000 d.w.t. unless otherwise indicated.

At 1970 year end, the world's 149 million d.w.t. of tanker capacity was provided by 3,102 vessels of widely ranging sizes. Of these, 704 exceeded 60,000 d.w.t. and collectively accounted for over half the total capacity. Within that group, 275 tankers exceeded 100,000 d.w.t. and provided nearly one-third of world tanker capacity. There were 14 ships over 250,000 d.w.t., and another 117 of 200,000 to 250,000 d.w.t. (table 9).

At the same point in time, 2,352 bulk carriers provided the world fleet's 76 million d.w.t. capacity, of which 12 percent were ore carriers; 20 percent, combined carriers; and 68 percent, other dry bulk carriers. Only 49 of these ships exceeded 100,000 d.w.t., two-thirds of them combined carriers accounting for less than 8 percent of the world's bulk carrier tonnage. Most of the world's total bulk carrier tonnage was fairly evenly distributed among the different size groups between 10,000 and 80,000 d.w.t. However, combined carriers were heavily concentrated in size groups above 60,000 d.w.t., and non-ore dry bulk carriers, in size groups under 60,000 d.w.t. (table 10).

The world tanker and bulk carrier fleet is very young, reflecting its rapid growth. At the end of 1970, half of all tankers over 10,000 d.w.t. had been built between 1966 and 1970, and only a third of them in 1960 or earlier. Tankers over 60,000 d.w.t. -- representing more than half the total tonnage -- were significantly newer on average: 43 percent of them had been delivered

Table 8. Total World Fleet of Oil Tankers and Bulk Carriers as of January 1, 1971

Fleet	Tonnage (000 d.w.t.)
Oil tankers	
Over 10,000 d.w.t.:	
Commercial..................	149,225
Government..................	2,330
Miscellaneous...............	157
Subtotal..................	151,712
2,000-10,000 d.w.t...........	3,527
100 g.r.t.[a]-2,000 d.w.t.....	3,711[b]
Total.......................	158,950
Bulk carriers	
Over 10,000 d.w.t. (commercial)................	76,086
6,000 g.r.t.[a]-10,000 d.w.t. and noncommercial...........	7,025[c]
Total.......................	83,111

a/ Gross registered tons (somewhat greater than d.w.t. equivalent).
b/ Estimated by interpolation from July 1, 1970, and July 1, 1971, data.
c/ Estimated on basis of July 1, 1971, data.

Source: Tankers over 2,000 d.w.t. -- John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), pp. 1-13. Tankers over 100 g.r.t. -- Lloyd's, Register of Shipping Statistical Tables, 1 July 1970 and 1 July 1971 (London, November 1970 and 1971), table 7. Commercial bulk carriers over 10,000 d.w.t. -- Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 4. Other bulk carriers -- Lloyd's, Register of Shipping Statistical Tables, 1 July 1971 (London, November 1971), table 9; and Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, July 1971 (Oslo, August 1971).

Table 9. Size Distribution of World Tankers as of December 31, 1970

Vessel size group (in 000's d.w.t.)	Number	Pct. of total	Total d.w.t. (000's)	Pct. of total
10-17........	407	13.1	5,820	3.9
17-25........	848	27.3	16,996	11.4
25-40........	658	21.2	21,113	14.1
40-60........	485	15.6	23,872	16.0
Subtotal....	2,398	77.3	67,801	45.4
60-80........	257	8.3	17,923	12.0
80-100.......	172	5.5	15,450	10.4
100-125......	86	2.8	9,480	6.4
125-150......	24	0.8	3,293	2.2
150-200......	34	1.1	6,010	4.0
200-250......	117	3.8	25,257	16.9
250-300......	8	0.3	2,051	1.4
Over 300.....	6	0.2	1,960	1.3
Subtotal....	704	22.7	81,424	54.6
Total........	3,102	100.0	149,225	100.0

Source: John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 5.

Table 10. Size Distribution of World Bulk Carriers as of January 1, 1971

Vessel size group (in 000's of d.w.t.)	Ore carriers		Combined car.		Other bulk car.		Total	
	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)
10-18......	85	1,278	12	170	502	7,487	599	8,935
18-25......	60	1,225	21	480	517	10,974	598	12,679
25-30......	25	668	6	173	278	7,421	309	8,262
30-40......	33	1,159	10	348	240	8,342	283	9,849
40-50......	7	329	14	654	142	6,276	163	7,259
50-60......	33	1,799	22	1,237	106	5,954	161	8,790
60-80......	16	1,131	59	4,232	62	4,310	137	9,673
80-100.....	3	260	45	4,099	5	411	53	4,770
Over 100...	10	1,098	32	3,945	7	826	49	5,869
Total.....	272	8,947	221	15,338	1,859	51,801	2,352	76,086

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 9.

during 1969 and 1970; another third from 1966 to 1968; and less than 3 percent prior to 1961 (table 11). In January 1971, the average age of this large tanker fleet was only 3.3 years per d.w.t.1/

At the start of 1971, nearly five-eighths of total world bulk carrier tonnage had been constructed since 1966, and only 15 percent of it had been constructed before 1961 (table 12). Within the group, the average age of combined carriers was lowest at 4.0 years per d.w.t., followed by other bulk carriers at 5.8 years per d.w.t. and ore carriers at a relatively aged 7.8 years per d.w.t.2/

Trends in Vessel Supply

General

Since the early 1960's, growth in the total supply of tankers and bulk carriers and in their average size has been remarkable. At the beginning of 1963 there were some 3,400 vessels above 10,000 d.w.t. By early 1972 that fleet had grown 70 percent to nearly 5,800 vessels, but its tonnage expanded more than threefold to 2.5 million d.w.t. Total world fleet capacity thus expanded nearly 14 percent annually over the 9-year period. Increases were particularly great for combined carrier and dry bulk ships, whose tonnage expanded over tenfold and fivefold, respectively, while tanker supply grew by less than 160 percent (table 13). On the basis of shipyard backlogs in January 1972, the world fleet of tankers and bulk carriers is expected to increase by 105 million d.w.t. in the following 3 years, or by more than 40 percent (table 14).

Even more striking than its aggregate growth has been the trend in vessel size. In merely 9 years

1/ Fearnley & Egers Chartering Company Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 7.
2/ Fearnley & Egers Chartering Company Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 9.

Table 11. Age Distribution of World Tanker Fleet, by Vessel Size, as of January 1, 1971

Year built	Vessels over 10,000 d.w.t.a/		Vessels over 60,000 d.w.t.	
	D.w.t. (1,000)	Pct. of total	D.w.t. (1,000)	Pct. of total
1955........	21,815	14.4	n.a.	n.a.
1956........	3,642	2.4	n.a.	n.a.
1957........	5,395	3.6	n.a.	n.a.
1958........	6,620	4.4	n.a.	n.a.
1959........	7,630	5.0	n.a.	n.a.
1960........	5,722	3.8	n.a.	n.a.
Subtotal...	50,824	33.5	2,257	2.8
1961........	5,037	3.3	761	0.9
1962........	5,204	3.4	1,101	1.4
1963........	5,986	3.9	2,288	2.8
1964........	8,811	5.8	5,637	7.0
1965........	9,608	6.3	7,522	9.3
1966........	10,575	7.0	8,963	11.1
1967........	8,034	5.3	7,370	9.1
1968........	11,071	7.3	10,417	12.9
1969........	16,370	10.8	15,851	19.6
1970........	20,192	13.3	18,694	23.1
Total......	151,712	100.0	80,861	100.0

n.a. = not available.
a/ Includes government-owned and miscellaneous vessels.

Source: John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), pp. 14-15; and Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 7.

Table 12. Age Distribution of World Bulk Carriers, by Class, as of January 1, 1971

Year built	Ore carriers		Combined car.		Other bulk car.		Total	
	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)
Through 1950.....	9	155	7	97	119	2,369	135	2,621
1951-55...	12	366	15	304	66	1,291	93	1,961
1956-60...	111	2,531	30	1,197	196	3,426	337	7,154
1961-65...	76	2,335	34	1,907	482	12,879	592	17,121
1966......	26	1,206	14	950	155	4,963	195	7,119
1967......	13	580	40	3,075	210	7,874	272	11,529
1968......	4	221	30	2,640	254	7,954	288	10,855
1969......	14	874	21	1,784	190	5,476	225	8,134
1970......	7	679	30	3,384	178	5,529	215	9,592
Total....	272	8,947	221	15,338	1,859	51,801	2,352	76,086

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 8.

Table 13. Growth of World Wet and Dry Bulk Carriers Exceeding 10,000 Deadweight Tons, by Three Major Vessel Types, 1960-72

Year[a/]	Vessel types			Total
	Tankers	Combined carriers	Dry bulk carriers	
	Number of vessels			
1960....	n.a.	55	310	365
1961....	n.a.	63	408	471
1962....	n.a.	67	544	611
1963....	2,650	69	687	3,406
1964....	2,656	77	843	3,576
1965....	2,704	83	917	3,704
1966....	2,782	95	1,073	3,950
1967....	2,864	109	1,271	4,244
1968....	2,918	153	1,498	4,569
1969....	2,982	175	1,761	4,918
1970....	3,016	195	1,964	5,179
1971....	3,102	221	2,131	5,454
1972....	3,219	251	2,327	5,797
	Deadweight tonnage (in millions)			
1960....	n.a.	1.3	5.3	n.a.
1961....	n.a.	1.5	7.2	n.a.
1962....	n.a.	1.7	9.9	n.a.
1963....	65.1	1.9	13.2	80.2
1964....	69.2	2.4	17.1	88.7
1965....	76.0	2.8	19.3	98.1
1966....	84.9	3.4	24.2	112.5
1967....	94.4	4.3	30.5	129.2
1968....	103.0	7.7	38.7	149.4
1969....	114.1	10.2	47.4	171.7
1970....	129.6	12.2	54.2	196.0
1971....	149.2	15.3	60.7	225.2
1972....	168.2	20.2	68.7	257.1

n.a. = not available.
a/ As of January 1.
Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), pp. 9, and World Bulk Carriers, January 1971 (Oslo, March 1971), p. 4.

Table 14. Projected Growth in World Fleet of Wet and Dry Bulk Carriers Exceeding 10,000 Deadweight Tons, 1972-75

Type of vessel	Total d.w.t. (millions)			
	1972[a/]	1973	1974	1975
Tankers.........	168.2	187.5	210.0	232.0
Combined carriers..........	20.2	28.0	35.5	40.5
Dry bulk carriers..........	68.7	76.5	84.5	90.0
Total..........	257.1	292.0	330.0	362.5

a/ Actual as of January 1, 1972.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 11.

(between 1963 and 1972) the size of the average tanker over 10,000 d.w.t. in the world fleet increased from less than 25,000 d.w.t. to over 52,000 d.w.t.; the average combined carrier, from under 28,000 d.w.t. to more than 80,000 d.w.t.; and the average dry bulk carrier, from a bit over 19,000 d.w.t. to nearly 30,000 d.w.t (see table 15). Average vessel sizes are certain to increase further in the next few years: typical tonnages of vessels on order are 167,000 d.w.t. for tankers, 152,000 d.w.t. for combined carriers, and 42,000 d.w.t. for dry bulkers (table 16).

Tankers

In January 1957, the world tanker fleet included only a single vessel larger than 60,000 d.w.t. By January 1960 this fleet had added 15 more, including the first tanker exceeding 100,000 d.w.t. The first 200,000-d.w.t. vessel was launched in 1966, and several years later tankers in the 300,000-d.w.t. class began to make their appearance (table 17). The largest ship in the world -- a 477,000-d.w.t. tanker now under construction in Japan -- is expected to be in service in early 1973.1/ These trends in development of the largest tankers have been paralleled by changes in size distribution of the entire world tanker fleet, as indicated in tables 17 and 18. Thus, in January 1963, the 42 vessels over 60,000 d.w.t. represented only 1.5 percent of the world's 2,650 tankships over 10,000 d.w.t. and 5 percent of the world's total tonnage. However, only 8 years later these larger tankers constituted 22 percent of the world fleet in number and 54 percent of its capacity.

The preceding developments reflect both the expansion of the world tanker fleet to meet growing demand and the replacement of obsolete older and smaller vessels. Thus, the number of tankers under 60,000 d.w.t. declined from 2,608 in January 1963 to 2,406 in January 1971. However, their total tonnage increased somewhat from 1963 to 1967 and has since stabilized in the 68 to

1/ Journal of Commerce, April 20, 1972.

Table 15. Trends in Average Size of World Wet and Dry Bulk Carriers Exceeding 10,000 Deadweight Tons, by Major Vessel Type, 1960-72

(In thousands of d.w.t.)

Year[a]	Vessel type						
	Tankers	Combined carriers			Dry bulk carriers		
		Total	Ore/oil	Bulk/oil[b]	Total	Ore	Other bulk
1960........	n.a.	23.9	23.9	c/	17.1	20.8	14.3
1961........	n.a.	24.5	24.4	28.0	17.6	20.7	15.4
1962........	n.a.	25.4	25.4	28.0	18.1	20.6	16.7
1963........	24.6	27.5	26.8	28.0	19.2	21.4	18.1
1964........	26.1	31.2	30.4	48.0	20.3	22.4	19.5
1965........	28.1	33.7	33.3	48.0	21.0	23.2	20.3
1966........	30.5	35.8	34.5	48.2	22.5	25.0	21.8
1967........	33.0	39.4	35.2	64.2	24.0	27.7	23.0
1968........	35.3	50.3	43.1	69.3	25.8	28.3	25.3
1969........	38.3	58.3	50.9	72.8	26.9	28.5	26.6
1970........	43.0	62.6	55.9	74.7	27.6	30.3	27.2
1971........	48.1	69.2	61.6	82.7	28.5	32.9	27.9
1972........	52.3	80.5	--	--	29.5	--	--

n.a. = not available.
a/ As of January 1.
b/ Includes ore/bulk/oil.
c/ None.
Source: Table 13.

Table 16. Average Size Characteristics of World Wet and Dry Bulk Carriers Exceeding 10,000 Deadweight Tons On Order as of January 1, 1971

Vessel type	Number of vessels	D.w.t. (000's)	Average d.w.t.
Tankers.............	476	79,349	166.7
Combined carriers...	173	26,359	152.3
Total dry bulk carriers...........	528	22,015	41.7
Ore carriers.......	23	1,549	67.3
Other bulk carriers.............	505	20,466	40.5

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, 1972), p. 11; and World Bulk Carriers, January 1971 (Oslo, March 1971), p. 17.

Table 17. Number of World Tankers by Vessel Size Group, 1957-71

Year[a/]	Vessel size group (in thousands of d.w.t.)								
	10-60	60-80	80-100	100-150	150-200	200-250	Over 250	Total over 60	Total over 10
1957....	n.a.		1					1	
1958....	n.a.		4					4	
1959....	n.a.	1	7					8	
1960....	n.a.	8	7	1				16	
1961....	n.a.	13	7	2				22	
1962....	n.a.	20	8	3				31	
1963....	2,608	23	15	4				42	2,650
1964....	2,588	38	26	4				68	2,656
1965....	2,574	77	48	5				130	2,704
1966....	2,567	136	65	14				215	2,782
1967....	2,544	198	86	34	1	1		320	2,864
1968....	2,510	229	110	59	8	2		408	2,918
1969....	2,479	244	142	83	16	16	2	503	2,982
1970....	2,426	243	157	96	31	54	9	590	3,016
1971....	2,406	2 5	163	112	35	113	18	696	3,102

n.a. = not available.
a/ As of January 1.
Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), and Review 1971 (Oslo, January 1972), p. 9.

Table 18. Tonnage Distribution of World Tankers by Vessel Size Group

(In millions of deadweight tons)

Year[a]	Vessel size group (in thousands of d.w.t.)								
	10-60[b]	60-80	80-100	100-150	150-200	200-250	Over 250	Total over 60[c]	Total over 10
1957....	n.a.		0.1					0.1	n.a.
1958....	n.a.		0.3					0.3	n.a.
1959....	n.a.	0.1	0.6					0.7	n.a.
1960....	n.a.	0.5	0.6	0.1				1.2	n.a.
1961....	n.a.	0.9	0.6	0.2				1.7	n.a.
1962....	n.a.	1.4	0.7	0.3				2.4	n.a.
1963....	61.8	1.6	1.3	0.5				3.3	65.1
1964....	63.9	2.6	2.3	0.5				5.3	69.2
1965....	65.1	5.2	4.3	0.6				10.1	76.0
1966....	68.4	9.2	5.7	1.6				16.5	84.9
1967....	69.9	13.6	7.6	4.0	0.2	0.2		25.5	94.4
1968....	68.8	15.9	9.8	6.7	1.3	0.4		34.2	103.0
1969....	68.1	17.0	12.7	9.5	2.8	3.3	0.7	46.0	114.1
1970....	68.0	16.9	14.1	11.0	5.5	11.4	2.7	61.6	129.6
1971....	68.3	17.8	14.6	13.0	6.2	24.3	5.0	80.9	149.2

n.a. = not available.

a/ As of January 1.

b/ Derived from difference between total over 10,000 d.w.t. and total over 60,000 d.w.t. 1971 figure reported as 67.8 in several other sources -- see table 9.

c/ Figures by size group over 60,000 d.w.t. sometimes do not add to total shown because of rounding.

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 4; and Review 1971 (Oslo, January 1972), p. 9.

69 million ton range. This indicates that some new tankers of under 60,000 d.w.t. have been added to the fleet in recent years.

Bulk Carriers

Recent trends in the development of the world bulk carrier fleet have been both similar to and different from tankers. On the one hand, total supply and average ship size have grown rapidly. On the other hand, aggregate capacity has increased at a substantially faster rate, while average size has grown more slowly (for dry bulk carriers).

From January 1960 to January 1971 the world bulk carrier fleet increased from 6.6 million d.w.t. to more than 76 million d.w.t., an average annual rate of nearly 25 percent. Growth was relatively faster for (low-density) bulk carriers, whose share of total tonnage increased from less than two-fifths in 1960 to over two-thirds in 1971. Among the other types of bulk carriers, growth was extraordinarily rapid for combined bulk/oil (including O/B/O) vessels, and was relatively slow, though strong nonetheless, for combined ore/oil and specialized ore carriers (table 19).

Size characteristics of the world bulk carrier fleet have changed notably. In the 1940's an insignificant proportion of this fleet exceeded 10,000 d.w.t. In the early 1950's the largest bulk ships were in the 20,000- to 25,000-d.w.t. range. By 1960, 10 percent of the 365 vessels in the fleet exceeded 30,000 d.w.t. At that time the three largest bulk carriers were in the 50,000- to 60,000-d.w.t. class, and represented only an insignificant proportion of world capacity. The first bulk carrier exceeding 100,000 d.w.t. went into service in 1966. By January 1971 there were 49 such vessels (mostly combined carriers), probably representing less than 10 percent of total world tonnage (tables 19 and 20).

Despite the evident trend toward increasing average size, dry bulk carriers on the average tend to

Table 19. Development of Main Bulk Carrier Types Over 10,000 Deadweight Tons, 1960-71

Year[a]	Ore carriers		Combined carriers				Other bulk carriers		Total	
			Ore/oil		Bulk/oil					
	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)
1960...	131	2,727	55	1,317	--	--	179	2,563	365	6,607
1961...	168	3,480	62	1,514	1	28	240	3,689	471	8,711
1962...	201	4,131	66	1,675	1	28	343	5,731	611	11,565
1963...	218	4,674	68	1,824	1	28	469	8,488	756	15,014
1964...	233	5,227	74	2,250	3	144	610	11,893	920	19,514
1965...	229	5,315	80	2,662	3	144	688	13,960	1,000	22,081
1966...	238	5,950	89	3,072	6	289	835	18,241	1,168	27,552
1967...	260	7,192	92	3,239	17	1,092	1,011	23,263	1,380	34,786
1968...	269	7,606	111	4,784	42	2,912	1,229	31,055	1,651	46,357
1969...	269	7,660	116	5,899	59	4,295	1,492	39,734	1,936	57,588
1970...	273	8,265	126	7,047	69	5,151	1,691	45,968	2,159	66,431
1971...	272	8,947	139	8,557	82	6,781	1,859	51,801	2,352	76,086
1971[b].	--	9,410	--	9,111	--	8,462	--	54,960	--	81,943

a/ As of January 1.
b/ As of July 1.
Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 4; and World Bulk Carriers, July 1971 (Oslo, August 1971), p. 3.

Table 20. Number of World Bulk Carriers by Vessel Size Group, 1960-71

Year[a]	Vessel size group (in thousands of d.w.t.)									Total
	10-18	18-25	25-30	30-40	40-50	50-60	60-80	80-100	100+	
1960....	252	68	9	20	13	3	--	--	--	365
1961....	300	111	14	27	14	5	--	--	--	471
1962....	350	186	22	32	16	5	--	--	--	611
1963....	397	242	41	44	22	9	1	--	--	756
1964....	414	325	61	70	29	17	4	--	--	920
1965....	416	360	74	87	27	28	7	1	--	1,000
1966....	436	394	101	139	36	47	13	2	--	1,168
1967....	487	425	122	188	52	66	36	3	1	1,380
1968....	521	460	155	220	91	105	78	18	3	1,651
1969....	571	514	206	236	120	139	103	37	10	1,936
1970....	605	553	259	249	156	147	126	43	21	2,159
1971....	599	598	309	283	163	161	137	53	49	2,352

a/ As of January 1.

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 6.

be considerably smaller than tankers. This fact reflects the many short routes and the limited markets served, for which very large vessels are often unsuited, as well as the numerous physical constraints presented to those vessels in the various ports involved. Thus, over half of the world's bulk carriers remained under 25,000 d.w.t. in early 1971, although this proportion had declined from 87 percent 10 years earlier (table 20).

New Vessel Construction

Rapid growth in the world fleet of tankers and bulk carriers has been paralleled by shipyard activity. From the early 1960's through 1970, annual orders for new vessels tended to increase sharply, with occasional dips. Thus, in 1963 new orders for nearly 23 million d.w.t. of wet and dry bulk ships were placed with shipbuilders, rising irregularly to nearly 72 million tons in 1970 (tables 21 and 22). Whereas in 1963 new tanker orders amounted to only 29 percent of total world supply at the beginning of the year, and new orders for bulk carriers amounted to only 26 percent, in 1970 the corresponding values -- on a much larger base -- were 64 and 46 percent, respectively.

This extraordinary rate of new construction orders is not likely to continue indefinitely. Thus, a pronounced decline in new construction contracts during 1971 to less than 52 million tons may be the forerunner of an extended period of much lower demand for new tonnage while the still rapidly growing world vessel fleet waits for demand to catch up.

During much of the 1960's, new orders for tonnage increased faster than deliveries, which are indicated in table 23. This fact reflects the difficulty of expanding productive capacity in the short run. Thus, at the end of 1962 the world's shipyards had an order backlog for only 19 million d.w.t. of tankers and bulk carriers. By the end of 1971 that backlog had increased to over 143 million d.w.t. (tables 21 and 24). At the 1971 (historically high) delivery rate of 32 million d.w.t. of tankers and bulk carriers, the average

Table 21. World Orders and Shipyard Backlogs for New Tankers Over 10,000 Deadweight Tons, 1962-71

Year	New orders a/ (1,000 d.w.t.)	Construction orders outstanding b/	
		Number of ships	D.w.t. (1,000)
1962.........	n.a.	263	12,940
1963.........	10,800	327	18,799
1964.........	7,700	299	18,817
1965.........	10,900	263	19,726
1966.........	16,200	251	24,606
1967.........	24,200	307	41,453
1968.........	23,800	349	52,749
1969.........	23,500	400	58,354
1970.........	41,200	476	79,349
1971.........	38,100	542	95,708

n.a. = not available.
a/ During the year.
b/ As of year end.

Scurce: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), pp. 10-11.

Table 22. World Orders for New Bulk Carriers Over 10,000 Deadweight Tons, 1963-71

(In thousands of d.w.t.)

Year	Combined carriers	Dry bulk carriers	Total
1963...........	400	3,500	3,900
1964...........	500	5,300	5,800
1965...........	2,400	9,900	12,300
1966...........	1,500	7,600	9,100
1967...........	2,400	4,000	6,400
1968...........	5,200	8,400	13,600
1969...........	8,500	10,000	18,500
1970...........	16,200	14,400	30,600
1971[a].........	3,600	10,600	14,200

a/ Preliminary.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 10.

Table 23. New Tankers and Bulk Carriers Over 10,000 Deadweight Tons Delivered by World Shipyards, 1963-71

Year	Tankers		Combined car.		Dry bulk car.		Total	
	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)
1963......	129	5,821	7	411	127	3,278	263	9,510
1964......	168	8,499	9	523	70	1,890	247	10,912
1965......	201	9,539	12	631	159	4,920	372	15,090
1966......	144	10,347	15	978	179	5,881	338	17,206
1967......	103	7,967	41	3,073	236	8,166	380	19,206
1968......	114	11,097	32	2,720	249	7,897	395	21,714
1969......	125	16,385	23	2,028	200	5,999	348	24,412
1970......	142	20,122	30	3,384	185	6,208	357	29,714
1971[a/]....	140	19,400	40	5,100	195	7,600	375	32,100

a/ Preliminary.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 9.

Table 24. World Bulk Carrier Construction Orders Outstanding by Class, 1961-71

Year[a]	Ore carriers		Combined car.		Other bulk car.		Total	
	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)	Number	D.w.t. (000)
1961......	38	838	5	218	190	3,924	233	4,980
1962......	35	958	11	662	227	5,398	273	7,018
1963......	23	701	19	1,185	152	3,808	194	5,694
1964......	11	460	22	1,221	148	4,176	181	5,857
1965......	16	825	21	1,199	246	7,386	283	9,410
1966......	26	1,371	48	3,445	351	12,144	425	16,960
1967......	21	863	57	4,237	421	14,719	499	19,819
1968......	12	563	54	4,453	360	11,451	426	16,467
1969......	10	704	64	6,907	358	11,709	432	19,320
1970......	9	716	111	14,575	361	13,136	481	28,427
1971......	23	1,549	173	26,359	505	20,466	701	48,374
1971:								
July.....	--	1,590	--	27,295	--	23,918	--	52,803
Dec......	--	--	149	22,799	595[b]	24,760[b]	744	47,559

a/ As of January 1, except as otherwise noted.
b/ Includes ore carriers.

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 12; World Bulk Carriers, July 1971 (Oslo, August 1971), p. 5; and Review 1971 (Oslo, January 1972), p. 11.

shipyard had nearly 4.5 years of work. However, increased shipyard capacity in the next few years, especially from new facilities designed to produce very large vessels, will reduce this value substantially. If, as several informed trade sources have recently indicated, "the shipbuilding boom of recent years has been arrested,"1/ if "the market for new vessels will remain bleak until 1974-75,"2/ and if "there can be no shadow of doubt that state aid will again be given to many...,"3/ then the intermediate-term outlook for orders at the world's shipyards stands in sharp contrast to its recent pattern of activity.

Among the world's shipbuilders of tankers and bulk carriers, those of Japan and of Scandinavia and other Western European nations are dominant. At the end of 1970, Japan alone accounted for over half of all the outstanding worldwide orders for bulk carriers over 10,000 d.w.t. and for approximately a third of such orders for tankers. Among the others, Sweden was a distant second, accounting for more or less than 10 percent of all outstanding orders for new tankers and bulk carriers. Other leading shipbuilding nations include Spain, West Germany, the United Kingdom, France, Denmark and Norway (tables 25 and 26).

Much of the tonnage on order is destined for inclusion in fleets operating under the flag of the same country in which the vessels are constructed. However, although some countries give preference to vessels built at home, many do not. Thus, to a substantial degree, shipyards among the different countries are in direct competition for orders from clients located throughout the world. These competitive circumstances help to explain the position of dominance achieved by Japanese shipbuilders, whose output in recent years for Japanese operators has been exceeded by overseas sales. It also helps to explain why, with the prospect of weak markets for new ships in the next few years, European shipyards

1/ Lloyd's Register, as quoted in the Journal of Commerce, January 27, 1972.
2/ Eggar Forrester (London Shipbrokers), as quoted in the Journal of Commerce, March 10, 1972.
3/ Ibid.

Table 25. Tankers Over 10,000 Deadweight Tons on Order by Country of Construction, Selected Years
(In millions of d.w.t.)

Country	Dec. 31, 1960	Dec. 31, 1969	Dec. 31, 1970
Japan.......	2.8	21.1	24.2
Sweden......	2.6	7.3	7.9
France......	1.2	6.1	6.6
Denmark.....	0.8	3.7	6.2
Spain.......	0.5	3.9	5.6
Norway......	0.8	2.6	4.8
West Germany.......	1.8	2.7	4.2
Netherlands.	0.8	1.9	3.9
United Kingdom....	2.6	3.5	3.0
Italy.......	0.5	2.3	3.0
United States.....	0.5	1.5	1.9
U.S.S.R.....	--	0.6	1.4
Others......	0.4	2.2	2.6
Total......	15.4	59.3	75.4

Note: Numbers do not add to totals because of rounding.

Source: Sun Oil Company, Analysis of World Tank Ship Fleet, December 31, 1970 (Philadelphia, August 1971), p. 16.

Table 26. Bulk Carriers over 10,000 Deadweight Tons on Order, by Country of Construction, as of January 1, 1970 and 1971

Country	January 1, 1971		January 1, 1970	
	Mil. of d.w.t.	Pct. of total	Mil. of d.w.t.	Pct. of total
Japan.............	25.4	52.6	12.1	42.5
Sweden............	4.7	9.6	3.0	10.6
United Kingdom....	3.8	7.8	3.2	11.5
West Germany......	3.3	6.8	2.3	8.0
Yugoslavia........	2.2	4.6	1.8	6.2
Spain.............	2.0	4.2	0.9	3.2
Norway............	1.3	2.7	0.9	3.2
Italy.............	1.2	2.6	1.2	4.1
Poland............	1.1	2.2	0.9	3.3
Others............	3.3	6.9	2.1	7.4
Total...........	48.4	100.0	28.4	100.0

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 13.

have reportedly been meeting with their Japanese counterparts to "exercise some self-restraint in accepting orders for very big vessels."1/

Flag Distribution

The world's tanker and bulk shipping fleet travels under flags of many nations, particularly those of Western Europe, Scandinavia, Japan and Liberia. The latter nation's flag alone recently accounted for one-fourth of the world's tanker and bulk carrier capacity. The three other flags of greatest global importance are the United Kingdom, Norway and Japan. Together this "Big Four" represented approximately 60 percent of total world tanker tonnage over 10,000 d.w.t., approximately 72 percent of that tonnage in excess of 60,000 d.w.t., and 68 percent of its bulk carrier capacity (table 27). On the basis of outstanding orders for new ships, fleet shares of the four dominant flags are expected to remain about the same over the next several years.2/

To a large degree, the flag distribution of vessels which are used to carry bulk commodities between any two countries is determined by market or economic rather than political criteria. Thus, as the costs of constructing vessels in U.S. shipyards and operating them with American crews have become unfavorable relative to foreign competitors, the U.S.-flag share of U.S. seaborne trade in bulk commodities has declined precipitously. Whereas in 1950, 42 percent of U.S. bulk imports and 27 percent of U.S. bulk exports traveled in U.S.-flag vessels, by 1970 less than 4 percent of that trade traveled in carriers bearing the national flag (table 28). A substantial proportion of even that reduced market owed its existence to legislative requirements for carriage of some bulk commodities in U.S. bottoms (principally wheat exports under P.L. 480, and certain military preference cargoes).

1/ Journal of Commerce, May 9, 1972.
2/ See Fearnley & Egers Chartering Company Ltd., Large Tankers, January 1971, p. 10; and World Bulk Carriers, January 1971, p. 17.

Table 27. Distribution of World Tanker and Bulk Carrier Fleet by Flag as of January 1, 1971

(In millions of d.w.t.)

Flag	Oil tankers		Bulk carriers (10,000 d.w.t. and over)
	10,000 d.w.t. and over	60,000 d.w.t. and over	
Liberia...	37.4	20.7	19.4
United Kingdom..	21.7	13.2	6.8
Norway....	17.0	11.9	11.7
Japan.....	15.2	12.7	14.0
United States...	9.3	a/	0.8
Greece....	7.7	2.7	3.7
France....	5.7	3.7	1.1
Panama....	5.5	1.9	0.9
Italy.....	4.3	1.7	3.6
U.S.S.R...	4.2	a/	a/
Netherlands....	3.5	1.9	0.8
West Germany.....	2.8	1.8	2.7
Sweden....	2.6	1.7	2.4
Denmark...	2.3	1.6	0.8
Spain.....	2.2	1.5	0.6
Other.....	10.3	3.8	6.8
Total....	151.7b/	80.9	76.1

a/ Included in other.
b/ Includes government-owned and miscellaneous vessels.
Source: Tankers over 10,000 d.w.t. -- John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 12. Tankers over 60,000 d.w.t. -- Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 6. Bulk carriers -- Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 17.

Table 28. U.S.-Flag Carrier Share of U.S. Waterborne Foreign Trade Transported in Wet and Dry Bulk Carriers, Selected Years

(In millions of short tons)

U.S. trade and vessel type	1950	1960	1969	1970
Waterborne imports carried by				
Irregular dry cargo vessels:a/				
Total	27.3	74.6	111.2	114.2
U.S. flag:				
Amount	5.4	8.0	2.1	4.6
Percent of total	19.7	10.7	1.9	4.0
Tankers:b/				
Total	50.1	103.9	156.9	161.4
U.S. flag:				
Amount	27.4	5.8	4.2	5.6
Percent of total	54.8	5.6	2.7	3.4
Total wet and dry bulk carriers:				
Total	77.4	178.5	268.1	275.6
U.S. flag:				
Amount	32.8	13.8	6.3	10.2
Percent of total	42.4	7.7	2.3	3.7
Waterborne exports carried by				
Irregular dry cargo vessels:a/				
Total	33.4	70.4	156.3	187.5
U.S. flag:				
Amount	7.6	6.9	5.3	5.3
Percent of total	22.8	10.9	3.4	2.8
Tankers:b/				
Total	9.1	16.3	17.0	20.0
U.S. flag:				
Amount	4.0	3.2	1.7	2.1
Percent of total	43.4	19.3	10.2	10.2

continued--

Table 28. U.S.-Flag Carrier Share of U.S. Waterborne Foreign Trade Transported in Wet and Dry Bulk Carriers, Selected Years continued--

(In millions of short tons)

U.S. trade and vessel type	1950	1960	1969	1970
Total wet and dry bulk carriers:				
Total..................	42.5	86.7	173.3	207.5
U.S. flag:				
Amount.................	11.6	10.1	7.0	7.4
Percent of total.......	27.3	11.6	4.0	3.6

a/ These vessels transported dry bulk commodities and some general cargo.
b/ Includes dry bulk cargo transported by tankers (especially grain).

Source: U.S. Department of Commerce, Bureau of the Census, Waterborne Exports and General Imports, Series FT 985.

Data on U.S. bulk commodity trade by specific foreign flag are not published. However, discussions with shipping firms indicate that recently some 60 percent of U.S. oil imports were transported by vessels flying flags of convenience (primarily Liberia, and to a lesser degree Panama). A substantial proportion of such ships are U.S. owned and operated.1/ Movements of U.S. dry bulk exports and imports are more widely distributed among foreign-flag vessels. However, a significant proportion of coal exports to Japan are transported by Japanese-flag ships, and of iron ore imports, by flag-of-convenience vessels.

Speed and Propulsion

Most tankers and bulk carriers are designed to operate at speeds of 14 to 17 knots. At the end of 1970, the average oceangoing tanker of more than 2,000 gross tons could move at 15.8 knots. The average design speed of large tankers exceeding 60,000 d.w.t. was about the same.

Bulk carriers are typically designed to operate at slightly lower speeds than tankers, averaging 14.8 knots in 1970 (table 29). Within the group, ore carriers averaged 14.3-knot design speeds; other dry bulk carriers, 14.8 knots; and combined carriers, 15.4 knots. Speed differences among major flags were relatively small.2/

Typical vessel speeds have tended to increase gradually over the years with improvements in vessel design and propulsion technology, reductions in unit fuel consumption, and increasing vessel size. However, optimal speeds vary considerably with such specific circumstances as the level of freight rates and bunker

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1/ American and Greek owners are believed to control, in about equal proportions, 85 to 90 percent of the Liberian and Panamanian tonnage. See S.G. Sturmey, British Shipping and World Competition (London: University of London, 1962), pp. 213-14.
2/ Fearnley & Egers Chartering Company Ltd., World Bulk Carriers, January 1971, p. 10.

Table 29. Speed Distribution of World Tanker and Bulk Carrier Fleet at End of 1970

(In percent)

Knots	Tankers over 2,000 g.r.t.	Large tankers over 60,000 d.w.t.	Bulk carriers over 10,000 d.w.t.
Less than 13...	2	--	3
13-14..........	2	--	5
14-15..........	10	2	24
15-16..........	28	35	46
16-17..........	45	57	21
17 and over....	13	6	1
Total.........	100	100	100
Average knots..	15.8	15.7	14.8

Source: Sun Oil Company, Analysis of World Tank Ship Fleet, December 31, 1970 (Philadelphia, August 1971), Tables 3A and B; Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 7; and Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 10.

fuel prices, turnaround time in ports, and trip distance. In many instances total unit transport costs actually increase when speed exceeds a certain point. This reflects the fact that fuel consumption rises at a disproportionately high rate. Accordingly, generalization is hazardous. Nevertheless, the fastest vessels are most likely to be found in regular service between ports which minimize terminal times.1/

The two dominant types of propulsion used in tankers and bulk carriers are steam turbine and diesel (motor) engines. At the beginning of 1971, turbine power was somewhat more common than diesel in tankers, while motor propulsion was relatively dominant in bulk carriers (table 30). To some degree, propulsion by steam is apparently considered advantageous in very large vessels, but, as in the case of operating speeds, the choice of the most favorable propulsion system depends on numerous factors which vary on a case-by-case basis.2/

Thus, for example, the U.S. tanker fleet is almost entirely steam driven, although vessels are relatively small in size. On the other hand, Norwegian-flag tankers, which are typically much larger, are predominantly motor driven.3/ Furthermore, of 69 orders placed during the latter half of 1970 for new tankers over 200,000 d.w.t., nine were to be diesel powered.4/ These circumstances suggest that any differences in overall cost and efficiency between steam turbine and diesel propulsion must generally be small.

1/ Trevor D. Heaver, The Economics of Vessel Size (Ottawa: National Harbours Board, 1968, mimeo), p. 24.
2/ A good summary of these factors is given on p. 23 of Heaver's The Economic of Vessel Size.
3/ See John I. Jacobs & Company Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 23.
4/ Ibid., p. 6.

Table 30. Distribution of World Tankers and Bulk Carriers by Method of Propulsion, as of January 1, 1971

Method of propulsion	Tankers		Bulk carriers over 10,000 d.w.t.
	10,000-60,000 d.w.t.	Over 60,000 d.w.t.	
	Millions of d.w.t.		
Turbine...	42.2	50.7	9.7
Motor.....	28.6	30.2	66.4
Total....	70.8	80.9	76.1
	Percent		
Turbine...	60	63	13
Motor.....	40	37	87
Total....	100	100	100

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 11, and Large Tankers, January 1971 (Oslo, June 1971), p. 6; and John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 12.

Vessel Dimensions and Capacity

In the context of this study, relationships between a vessel's size or capacity and its dimensional characteristics are of considerable interest. Waterways on various routes, terminals, or connecting channels often impose constraints on one or more dimensions of a ship used for a particular movement. The Panama Canal is a notable example. It can accommodate vessels only up to 106 feet in beam (width), and they may not draw more than 36 feet of water under seasonally low water conditions. Vessels built for service requiring regular use of the canal are therefore often specially designed. They are longer than usual to compensate for the other dimensional constraints.

A vessel's beam or length may also be limited by physical conditions of port channels or berths or, in the case of dry bulk commodities, by the nature of dockside handling equipment. Relatively shallow harbor depths are, however, typically the most serious constraints for tankers and bulk carriers. They usually impose draft limitations before any constraints on other dimensions become effective. Unfortunately, these constraining influences among the world's many harbors and channels, as well as their significance for vessel design, vary considerably. Therefore, a determination of the most efficient ship size and design characteristics, even for a given draft constraint, produces varied results in individual cases.

These circumstances are strikingly revealed in tables 31 and 32, which summarize the major dimensional characteristics of the world tanker and bulk carrier fleets by size class. As is evident from even a cursory review of these tables, there is a considerable range of values for length, draft or beam for any given size level of ship. For example, existing tankers or bulk carriers of 60,000 to 80,000 d.w.t. draw anywhere from 36 feet to 50 feet of water. Similarly, the capacity of tankers requiring 50- to 55-foot drafts ranges from less than 100,000 d.w.t. to more than 200,000 d.w.t.

Table 31. Distribution of World Large Tankers by Dimensional Characteristics as of January 1, 1971

Dimension (in feet)	No. of vessels by size group (000 d.w.t.)						
	60-80	80-100	100-150	150-200	200-250	250 & over	Total
Draft							
Under 40....	8	--	--	--	--	--	8
40-45.......	223	61	--	--	--	--	284
45-50.......	24	94	46	--	--	--	164
50-55.......	--	8	55	4	3	--	70
55-60.......	--	--	11	20	1	--	32
60-65.......	--	--	--	11	88	1	100
65 and over.	--	--	--	--	21	17	38
Length							
Under 800...	160	1	--	--	--	--	161
800-850.....	90	96	19	--	--	--	205
850-900.....	5	65	52	--	--	--	122
900-950.....	--	1	35	1	--	--	37
950-1,000...	--	--	5	16	--	--	21
1,000-1,050.	--	--	1	10	21	--	32
1,050-1,100.	--	--	--	8	87	--	95
Over 1,100..	--	--	--	--	5	18	23
Beam							
Under 110...	99	1	--	--	--	--	100
110-120.....	98	13	--	--	--	--	111
120-130.....	58	146	51	--	--	--	255
130-140.....	--	3	45	4	--	--	52
140-150.....	--	--	16	6	8	--	30
150-160.....	--	--	--	17	79	--	96
Over 160....	--	--	--	8	26	18	52
Total number of ships....	255	163	112	35	113	18	696

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 8.

Table 32. Distribution of Bulk Carriers by Draft and Length Characteristics as of January 1, 1971

Dimensions (in feet)	Number of vessels by size group (in 1,000 d.w.t.)								
	10-18	18-25	25-30	30-40	40-50	50-60	60-80	80-100	Over 100
Draft									
Under 30	424	56	2	--	--	--	--	--	--
30 and 31	186	275	16	1	--	--	--	--	--
32 and 33	9	225	108	12	2	--	--	--	--
34 and 35	--	42	177	118	8	1	--	--	--
36 and 37	--	--	6	136	41	11	2	--	--
38 and 39	--	--	--	16	83	71	5	--	--
40-44	--	--	--	--	29	78	89	9	1
45-49	--	--	--	--	--	--	43	42	13
50 and over	--	--	--	--	--	--	--	2	35
Length									
Under 500	589	259	11	--	--	--	--	--	--
550-600	10	274	188	9	--	--	--	--	--
600-650	--	65	105	162	39	--	--	--	--
650-700	--	--	5	105	69	11	--	--	--
700-750	--	--	--	7	47	115	10	--	--
750-800	--	--	--	--	8	33	49	2	--
800-850	--	--	--	--	--	2	73	44	14
850-900	--	--	--	--	--	--	5	7	18
Over 900	--	--	--	--	--	--	--	--	17
Total no. of ships	599	598	309	283	163	161	137	53	49

Source: Fearnley & Egers Chartering Co. Ltd., World Bulk Carriers, January 1971 (Oslo, March 1971), p. 11.

Furthermore, some analysts note a tendency for vessel deadweight to increase at a given draft. For example, in 1968 Meredith and Wordsworth observed that:

> ...whereas a few years ago a 65,000 ton ship might draw 42 feet fully laden, there are now tankers and a few bulk carriers of 85,000 tons deadweight or more on the same draught. The authors expect eventually to see 100,000 ton ships drawing no more than 44 feet, but with breadths of as much as 140 feet.1/

The preceding circumstances clearly show that there is no fixed relationship between vessel size (in deadweight) and draft. A ship's capacity is governed primarily by the particular combination of length, beam and draft incorporated in its design. Since the number of dimensional combinations is virtually without limit, vessel design optimization is moderately complex. This topic is considered further in chapter III, where differences in transport costs associated with alternative design concepts for vessels of varying sizes are analyzed.

Bulk Commodity Movements by Type and Size of Vessel

General

The preceding sections have shown that both demands for and supplies of ocean vessels to transport major bulk commodities have been growing rapidly, especially for vessels of larger size. Those trends can be illuminated more clearly for individual commodities by considering the types and sizes of vessels actually used in the movement of each over time. Table 33 gives tonnages of crude oil in world trade transported in tankers and combined carriers exceeding 60,000 d.w.t.

1/ W.G. Meredith and C. Wordsworth, "Size of Ore Carriers for the New Port Talbot Harbour," Journal of the Iron and Steel Institute, vol. 204, November 1968, p. 1077.

Table 33. Estimated World Seaborne Shipments of Dry Bulk Commodities in Bulk Carriers Exceeding 18,000 Deadweight Tons, 1960-70, and of Crude Oil in Vessels Exceeding 60,000 Deadweight Tons, 1962-70

(In millions of metric tons)

Commodities	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Crude oil..............	n.a.	n.a.	23.1	34.0	67.7	116.2	195.0	258.1	348.9	445.8	566.3
In tankers............	n.a.	n.a.	23.1	34.0	67.7	116.2	192.4	242.9	312.1	402.4	517.8
In combined carriers[a/].	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2.6	15.2	36.8	43.4	48.5
Major dry bulk											
Iron ore...............	31	38	47	54	80	98	107	127	151	181	212
Coal....................	3	6	12	18	25	30	34	39	48	60	70
Grain[b/]...............	1	3	7	14	16	17	25	29	40	36	43
Bauxite, alumina.......	3	5	6	8	10	12	13	15	16	19	20
Phosphates.............	--	--	--	1	1	2	4	7	12	12	14
Subtotal.............	38	52	72	95	132	159	183	217	267	30	359
Other dry bulk..........	--	1	1	3	6	12	24	41	59	66	80
Total dry bulk..........	38	53	73	98	138	171	207	258	326	374	439

n.a. = not available.
a/ Negligible prior to 1966.
b/ Includes only wheat, corn, barley, rye, and oats.

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), pp. 5 and 24, and Trades of World Bulk Carriers in 1970 (Oslo, November 1971), p. 7.

in each year from 1962 through 1970. It also shows annual volumes from 1960 through 1970 for each major dry bulk commodity in world trade carried in bulk carriers exceeding 18,000 d.w.t. Table 34 reveals total ton-miles of ocean transport corresponding to the movements given in table 33, while table 35 indicates the equivalent average trip distances.

Comparison of the data in those tables with like information for total world seaborne trade given in tables 1, 4 and 5 is instructive. Such a comparison shows that the proportion of total trade in each commodity shipped in larger vessels has grown very rapidly. Thus, in 1962 only 6 percent of crude oil seaborne trade -- in both tonnage and ton-miles -- was transported by ships over 60,000 d.w.t. By 1970 these vessels' share of total tonnage and ton-miles had increased to 58 and 70 percent, respectively (table 36).

The pattern for world seaborne trade of the five major dry bulk commodities is similar. Whereas only about one-sixth of that trade moved in bulk carriers exceeding 18,000 d.w.t. in 1960, 10 years later these vessels accounted for 74 percent of total tonnage and 81 percent of total ton-miles (table 37). Allowing for cargo carried by the smallest bulk carriers in the 10,000- to 18,000-d.w.t. range, bulk carriers taken as a whole were responsible for nearly 90 percent of total ton-miles of the five major dry bulk commodities in world seaborne trade in 1970.1/ The balance of that trade moved in tankers, small tramps and general cargo ships.

Thus, diversion of bulk traffic from other vessels explains why growth in demand for and supply of dry bulk carriers has greatly exceeded growth in total trade. As is evident from 1970 data, however, further possibilities of diversion for the five major dry bulk commodities are quite limited. Nevertheless, attraction of other commodities to bulk carriers has considerable further potential: from negligible levels in

1/ Fearnley & Egers Chartering Company Ltd., Trades of World Bulk Carriers in 1970, p. 7.

Table 34. Estimated World Seaborne Shipments of Dry Bulk Commodities in Bulk Carriers Exceeding 18,000 Deadweight Tons, 1960-70, and of Crude Oil in Vessels Exceeding 60,000 Deadweight Tons, 1962-70

(In billions of ton-miles)

Commodities	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Crude oil......	n.a.	n.a.	104 [a]	148 [a]	311	550	956	1,589	2,310	2,992	3,860
In tankers....	n.a.	n.a.	104 [a]	148 [a]	311	550	943	1,495	2,063	2,696	3,493
In combined carriers [b]...	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	13 [c]	94 [c]	247 [d]	296 [d]	367 [d]
Major dry bulk											
Iron ore......	98	123	149	184	278	356	424	514	653	822	976
Coal..........	13	29	59	87	121	146	167	203	269	347	421
Grain [e].......	5	17	38	74	90	95	151	188	233	218	257
Bauxite, alumina......	6	9	11	14	18	21	26	35	39	54	62
Phosphates....	--	--	--	2	4	6	12	29	56	50	55
Subtotal.....	122	178	257	361	511	624	780	969	1,250	1,491	1,771
Other dry bulk.	--	2	4	9	19	35	98	199	295	334	400
Total dry bulk.	122	180	261	370	530	659	878	1,168	1,545	1,825	2,171

n.a. = not available.
a/ Assumes average distance of movement the same as for all tankers over 10,000 d.w.t.
b/ Negligible prior to 1966.
c/ Assumes average distance of movement the same as for large tankers.
d/ Assumes average distance of movement the same as for all combined carriers exceeding 18,000 d.w.t.
e/ Includes only wheat, corn, barley, rye, and oats.

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 5; Review 1971 (Oslo, January 1972), p. 8; Trades of World Bulk Carriers in 1970 (Oslo, November 1971), pp. 7, 30; and Trades of World Bulk Carriers in 1969 (Oslo, November 1970), p. 31.

Table 35. Average Distances of Seaborne Movement of Dry Bulk Commodities in World Trade Transported in Bulk Carriers Exceeding 18,000 Deadweight Tons, 1960-70, and of Crude Oil in Vessels Exceeding 60,000 Deadweight Tons, 1962-70

(In nautical miles)

Commodities	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Crude oil...	n.a.	n.a.	4,508 a/	4,361 a/	4,594 a/	4,733 a/	4,901 a/	6,155 a/	6,621	6,712	6,816
In tankers.	n.a.	n.a.	n.a.	n.a.	4,594	4,733	4,901	6,155	6,610	6,700	6,746
In combined carriers..	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	6,722	6,826	7,561
Major dry bulk											
Iron ore...	3,161	3,237	3,170	3,407	3,475	3,633	3,963	4,047	4,325	4,541	4,604
Coal.......	4,333	4,833	4,917	4,833	4,840	4,867	4,912	5,205	5,604	5,783	6,014
Grain b/....	5,000	5,667	5,429	5,286	5,625	5,588	6,040	6,483	5,825	6,056	5,977
Bauxite, alumina...	2,000	1,800	1,833	1,750	1,800	1,750	2,000	2,333	2,438	2,842	3,100
Phosphates.	--	--	--	2,000	4,000	3,000	3,000	4,143	4,667	4,167	3,929
Subtotal..	3,211	3,423	3,569	3,800	3,871	3,925	4,262	4,465	4,682	4,841	4,933
Other dry bulk.......	--	2,000	4,000	3,000	3,167	2,917	4,083	4,854	5,000	5,061	5,000
Total dry bulk.......	3,211	3,396	3,575	3,776	3,841	3,854	4,242	4,527	4,739	4,880	4,945

n.a. = not available.

a/ Assumes average distance of movement by large combined carriers is the same as for large tankers.

b/ Includes only wheat, corn, barley, rye, and oats.

Source: Tables 33 and 34.

Table 36. Seaborne Movements of Crude Oil in World Trade by Vessels Exceeding 60,000 Deadweight Tons in Relation to Total Trade, 1962-70

Year	World seaborne trade		
	Total[a]	In vessels over 60,000 d.w.t.	
		Amount	Percent of total
	Metric tons		
1962.....	366	23	6
1963.....	424	34	8
1964.....	482	68	14
1965.....	552	116	21
1966.....	607	195	32
1967.....	672	258	38
1968.....	768	349	45
1969.....	871	446	51
1970.....	979	566	58
	Metric ton-miles		
1962.....	1,650	104	6
1963.....	1,850	148	8
1964.....	2,150	311	15
1965.....	2,480	550	22
1966.....	2,629	956	36
1967.....	3,400	1,589	47
1968.....	4,197	2,310	57
1969.....	4,853	2,992	62
1970.....	5,536	3,860	70

a/ Total tons in millions of metric tons; total ton-miles in billions of metric ton-miles.

Source: Tables 1, 4, 33 and 34.

Table 37. Seaborne Movements of Five Major Dry Bulk Commodities[a] in World Trade by Bulk Carriers Exceeding 18,000 Deadweight Tons in Relation to Total Trade, 1960-70

Year	World seaborne trade		
	Total[b]	In vessels over 18,000 d.w.t.	
		Amount	Percent of total
	Metric tons		
1960.....	228	38	17
1961.....	239	52	22
1962.....	246	72	29
1963.....	269	95	35
1964.....	308	132	43
1965.....	327	159	49
1966.....	340	183	54
1967.....	352	217	62
1968.....	384	267	70
1969.....	419	308	74
1970.....	488	359	74
	Metric ton-miles		
1960.....	746	122	16
1961.....	833	178	21
1962.....	854	257	30
1963.....	956	361	38
1964.....	1,146	511	45
1965.....	1,260	624	50
1966.....	1,360	780	57
1967.....	1,465	969	66
1968.....	1,614	1,250	77
1969.....	1,813	1,491	82
1970.....	2,182	1,771	81

a/ Coal, iron ore, grains, phosphate, and bauxite/alumina.
b/ Total tons in millions of metric tons; total ton-miles in billions of metric ton-miles.
Source: Tables 1, 4, 33, and 34.

1960, bulk carriers over 18,000 d.w.t. hauled around 80 million tons of other (bulk) commodities in 1970. This represented only a bit more than 10 percent of all other dry cargo, an uncertain but large part of which can conveniently be transported in bulk.

1970 Ship Size Distribution in Major U.S. Commodity Trades

No U.S. sources are known to publish or otherwise make available data indicating, by specific bulk commodity, the proportion of annual seaborne trade moved in vessels of various sizes. The basic information exists in raw form; that is, in operating records of the nation's ports and local customs offices. An extraordinarily time-consuming effort would be required to extract and organize the data for analytic purposes. Ideally they should be integrated with detailed commodity-flow data by origin and destination that are regularly published by the Census Bureau in its series SA-305 and SA-705.1/ That would permit illumination of those movements by trade route and even by port pair.

Until the prior statistical infrastructure is created, one must resort to trade sources, among which publications of Fearnley & Egers Chartering Company appear to provide the most comprehensive understanding. The only commodity for which available data effectively illuminate ship size distribution by U.S. trade route is crude oil. As indicated in table 38, 57 percent of U.S. 1970 seaborne crude imports arrived in vessels exceeding 60,000 d.w.t., predominantly in the 60,000- to 80,000-d.w.t. range and to a lesser degree in larger ships. Most of the shipments from the Persian Gulf, and to a limited degree from North Africa and Indonesian origins, arrived in ships of at least 60,000 d.w.t. In contrast, around five-eighths of crude imports from Venezuela -- still the most important overseas source in 1970 -- arrived in ships smaller than 60,000 d.w.t., reflecting the relatively short hauls involved.

1/ And as presented in Annex G.

Table 38. U.S. Imports of Crude Oil by Vessel Size Groups and Major Point of Origin, 1970

(In millions of metric tons)

Origin	Vessel size group (1,000 d.w.t.)							
	Tankers under 60	Combined carriers		Tankers				Total
		Under 60	Over 60	60-80	80-100	100-150	Over 200	
Persian Gulf...	--	0.5	3.2	3.0	1.3	--	0.2	8.2
North Africa...	0.3	0.7	0.2	0.8	0.3	0.1	0.2	2.6
Caribbean......	7.7	1.4	0.7	4.5	0.1	--	--	14.4
Near East......	0.3	--	--	--	--	--	--	0.3
Other[a/]........	2.7	0.3	0.5	2.4	0.8	0.2	--	6.9
Total.........	11.0	2.9	4.6	10.7	2.5	0.3	0.4	32.4

a/ Largely from Indonesia.

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), pp. 14, 16, and 26, and Trades of World Bulk Carriers in 1970 (Oslo, November 1971), p. 31.

It is interesting to note that, although they were quantitatively quite small, several shipments of U.S. crude imports arrived in vessels of over 100,000 d.w.t. and even over 200,000 d.w.t. in 1970. Ports of destination are not indicated. However, several major ports on the west coast can presently accommodate vessels of such large size, while similar movements to major east coast ports are also feasible when the ocean vessel's cargo is lightened outside shallow harbors (see chapter IV).

No statistical data are available on the ship size distribution for U.S. (or other) petroleum product imports. In recent years, volumes have substantially exceeded seaborne crude imports. However, trade sources indicate that virtually all petroleum products in world seaborne trade, including that of the United States, are moved in vessels smaller than 60,000 d.w.t., generally reflecting prevailing demands for comparatively small lot sizes.1/

Data on ship size characteristics of dry bulk commodities in U.S. seaborne trade are available, but not by trade route. Table 39 indicates the proportion of total 1970 U.S. seaborne trade in each major bulk commodity by vessel size group. As shown there, typical ship sizes are smaller for dry bulk commodities than for crude oil. They tend to be relatively largest for iron ore and coal movements, somewhat smaller for grain and bauxite, and smallest of all for phosphate. The largest vessels carrying 1970 U.S. iron ore imports were in the 60,000- to 80,000-d.w.t. class, but most were smaller. Nearly one-fourth of U.S. coal exports in that year were shipped in vessels of more than 60,000 d.w.t., but the largest ones are believed to have been in the 80,000- to 100,000-d.w.t. range.

Data for the other dry bulk commodities are less detailed as to vessel size groups. They do indicate that only insignificant quantities of U.S. grain exports

1/ Fearnley & Egers Chartering Company Ltd., Large Tankers, January 1971, p. 4.

Table 39. Estimated Vessel Size Distribution of World and U.S. Seaborne Trade in Major Bulk Commodities, 1970

(In percent)

Commodity	Vessel size group (1,000 d.w.t.)							
	Under 18a/	18-25	25-40	40-60	60-80	80-100	Over 100	Total
Dry bulk								
Iron ore:								
World......	14	7	19	32	17	5	6	100
U.S........	13	8	26	46	7	--	--	100
Coal:								
World......	29	11	21	27	----12------			100
U.S........	3	12	26	35	----24------			100
Grain:								
World......	41	21	27	10	---- 1------			100
U.S........	19	26	36	18	---- 1------			100
Bauxite:								
World......	41	20	-------39b/---------					100
U.S........	<41	<20	------>39-----------					100
Phosphate:								
World......	59	14	22	----------5c/----				100
U.S........	33	n.a.	n.a.	--------->5------				100

Commodity	All ves. under 60	Comb. car. over 60	Tankers					Total
			60-80	80-100	100-150	150-200	Over 200	
Wet bulk								
Crude oil:								
World......	42	5	16	12	9	4	12	100
U.S........	43	14	33	8	1	--	1	100

n.a. = not available.

a/ May include a small proportion of tankers or other nonbulk carriers exceeding 18,000 d.w.t.

b/ Most vessels over 25,000 d.w.t. from Caribbean to U.S.

c/ Most vessels over 40,000 d.w.t. from U.S. to Europe and Canada.

Source: Fearnley & Egers Chartering Co. Ltd., Trades of World Bulk Carriers in 1970 (Oslo, November 1971), pp. 12, 16, 19, 22, and 25; and Large Tankers, January 1971 (Oslo, June 1971), p. 17.

in 1970 were shipped in vessels exceeding 60,000 d.w and imply the same for phosphate rock. Virtually a bauxite imports are believed to arrive in vessels o less than 50,000 d.w.t.

Table 39 also permits direct comparison of 1 U.S. ship size distributions with the rest of the w for the same commodities. In the case of crude oil the largest tankers in world trade are usually much larger than those serving the United States. Where 1970 U.S. crude oil imports were predominantly ship in vessels smaller than 100,000 d.w.t., and mostly under 80,000 d.w.t., at least 25 percent of world se borne trade in crude oil was served by vessels above 100,000 d.w.t., and 12 percent was accommodated by v sels exceeding 200,000 d.w.t.

Among the major dry bulk commodities, 1970 U. iron ore imports were transported in typically smal vessels than the rest of the world. Whereas the la ships serving the United States were in the 60,000- 80,000-d.w.t. range, 11 percent of world seaborne t in iron ore was transported in larger vessels, abou half of them exceeding 100,000 d.w.t.

For the other four dry bulk commodities, howe typical sizes of ships engaged in U.S. seaborne trad were larger than their counterparts in world trade generally. This reflects the fact that, with the ev dent exception of iron ore and the more limited exce tion of coal, there is presently little demand anyw in the world for shipments of dry bulk commodities i lots of 60,000 tons or more.

Large-Size Vessel Trades1/

The dominant trade routes for crude oil gener ally are the Persian Gulf to Japan and to Europe, an

1/ This discussion is drawn primarily from Fearnley Egers Chartering Company Ltd., Large Tankers, Januar 1971 and Trades of the World Bulk Carriers in 1970.

a lesser degree North Africa to Europe. In 1970, journeys of tankers exceeding 200,000 d.w.t. originated almost entirely in the Persian Gulf, and all but a small proportion of tankers in the 100,000- to 200,000-d.w.t. range were employed on the above-indicated three major trade routes. Even vessels in the 60,000- to 100,000-d.w.t. class were heavily concentrated on the same three routes. Since its crude imports accounted for only 3.3 percent of total world seaborne trade in 1970, the role of the United States was relatively insignificant.

The most important dry bulk commodity in world trade -- iron ore -- is dominated by Japan. In 1970 it accounted for 40 percent of total world seaborne tonnage moved in bulk carriers exceeding 18,000 d.w.t., and 58 percent of the ton-miles. Its most important sources were Australia, South America (Chile, Peru, Brazil), India and West Africa. Other major routes in world trade include West Africa, Scandinavia, Canada, and Brazil to Europe, as well as Canada and Venezuela to the United States.

The largest vessels employed in iron ore trades in 1970 -- those exceeding 80,000 to 100,000 d.w.t. -- were primarily engaged on the longer routes, especially from South America and Australia to Japan and to a much lesser degree from Brazil and West Africa to Europe. A large proportion of intra-European and intra-Asian traffic was served by small vessels, many of them under 18,000 d.w.t. Thus the range of ship sizes bearing U.S. iron ore imports in 1970 was quite high in light of the dominant short distance hauls from its nearby Western Hemisphere origins.

In the other bulk trades, the largest vessels operating in 1970 were most importantly utilized on routes involving the United States. Coal movements in vessels exceeding 60,000 d.w.t. were dominated by exports from Hampton Roads to Japan and Western Europe. Most ships of more than 40,000 d.w.t. carrying grain traveled from the U.S. gulf coast to Japan and Western Europe. Relatively large grain ships were also used for some movements originating in Australia and eastern Canada for Western Europe.

The largest bauxite shipments are made in vessels exceeding 25,000 d.w.t. Data on ship size distributions above that level are not available, but would probably reveal a heavy concentration in the 25,000- to 40,000-d.w.t. range. In spite of the relatively short distances involved, most of these larger vessels operate on the major Caribbean-U.S. route. Similar information on shipments of alumina, which are quantitatively much smaller than those for bauxite, is unavailable. However, industry sources indicate that some alumina shipments from Australia to the Pacific Northwest -- the dominant U.S. trade route -- are made in vessels as large as 40,000 to 50,000 d.w.t.

Small ships enjoy a larger share of world seaborne trade in phosphate rock than the trade in any other major bulk commodity. The limited number of vessels in the 25,000- to 40,000-d.w.t. range actually used to carry phosphate in 1970 was principally engaged in the evacuation of U.S. exports for Europe and the Canadian Pacific coast.

Combined Carriers

The role of combined carriers in world seaborne trade has grown rapidly in the last few years. Those over 18,000 d.w.t. carried 97 million tons of bulk commodities in 1970, up from only 38 million in 1966. Oil (mostly crude), iron ore and coal have constituted 95 to 99 percent of all cargoes carried since 1966 (table 40). Since 1967, oil has been by far the most important of the individual commodities transported by combined carriers. However, in the brief 5-year period for which data are available, there have been significant year-to-year changes in the commodity mix. This reflects one of the major advantages of combined carriers: their ability to adapt quickly to changing market circumstances in the short run.

Another notable feature of recent movements by combined carriers is the growing importance of the larger vessels. Whereas in 1966 only one-fourth of their total traffic was carried in ships exceeding 60,000 d.w.t., by 1970 the latter group accounted for

Table 40. Shipments of Major Bulk Commodities in World Seaborne Trade by Combined Carriers, 1966-70

(In millions of metric tons)

Commodity and vessel size (1,000 d.w.t.)	1966	1967	1968	1969	1970
Oil					
18-60................	8.2	13.5	17.5	15.2	13.0
Over 60.............	2.6	15.2	36.8	43.4	48.5
Total...............	10.8	28.7	54.3	58.6	61.5
Iron ore					
18-60................	17.9	12.4	5.3	9.1	8.8
Over 60.............	6.5	5.1	3.5	9.6	17.6
Total...............	24.4	17.5	8.8	18.7	26.4
Coal					
18-60................	0.7	0.9	1.6	1.3	1.4
Over 60.............	0.2	0.7	1.5	3.2	5.8
Total...............	0.9	1.6	3.1	4.5	7.2
Other					
18-60................	1.7	0.6	0.7	0.6	1.2
Over 60.............	0.1	0.2	--	--	0.7
Total...............	1.8	0.8	0.7	0.6	1.9
All					
18-60................	28.5	27.4	25.1	26.2	24.4
Over 60.............	9.4	21.2	41.8	56.2	72.6
Total...............	37.9	48.6	66.9	82.4	97.0

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 24; and Trades of World Bulk Carriers in 1970 (Oslo, November 1971), p. 29.

three-fourths of the movements. This trend is in keeping with more general trends in size distribution of both tankers and bulk carriers.

Despite their growing importance, combined carriers account for a relatively limited proportion of world seaborne trade. In 1970 combined carriers transported some 5 percent of all the oil moved in world seaborne trade, 7 percent of the coal, and 11 percent of the iron ore. Their relative importance in terms of ton-miles was greater, reflecting longer average distances of movement, especially for dry bulk (table 41).

At least in 1970, the relative importance of combined carriers in U.S. seaborne trade was somewhat greater for crude oil and coal, and considerably less significant for iron ore, than in world seaborne trade (table 41).

The most important movements of combined carriers in recent years have included: (1) oil from the Persian Gulf, mostly to Europe, and to a lesser degree to South America and the United States; (2) iron ore from South America, West Africa, and Canada to Japan, and to a lesser degree to Europe; and (3) coal from Hampton Roads to Japan.

Many of these separate movements are of course undertaken as related segments of two-legged, triangular, or quadrangular routing patterns of a single vessel. These matters are presented further in chapter II.

Table 41. Combined Carrier Share of World and U.S. Seaborne Trade in Major Bulk Commodities, 1970
(In percent)

Commodity and trade	Combined carrier share	
	Tonnage	Ton-miles
Oil (crude and products)		
World..............	5	7
U.S................	6	n.a.
Crude oil		
World..............	5-6[a/]	7-8
U.S................	14-23[a/]	n.a.
Iron ore		
World..............	11	18
U.S................	5	n.a.
Coal		
World..............	7	14
U.S................	12-14	n.a.

n.a. = not available.
a/ Range reflects uncertainty as to proportion of total oil shipments represented by petroleum products.

Source: Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), pp. 24 and 26; and Trades of World Bulk Carriers in 1970 (Oslo, November 1971), pp. 29-31.

II. OCEAN SHIPPING OF BULK COMMODITIES: SELECTED ECONOMIC AND INSTITUTIONAL CHARACTERISTICS

Introduction

As indicated in Chapter I, world shipping of bulk commodities is a large and growing business which has been changing rapidly in response to numerous dynamics. Among them, a single economic factor has been dominant: improved efficiency and lower unit costs obtainable through the use of vessels of larger size. In addition, but of lesser significance, vessel productivity has sometimes been increased through multipurpose ship design and related exploitation of opportunities for return cargoes. The quantitative implications of these economic factors for shipping costs are presented in chapter III.

In this chapter, an attempt is made to summarize some of the major institutional, operating, and other factors which influence the choice of vessel size for particular movements, and hence, the cost of ocean transport. It begins with a review of the shipping industry's market structure and determination of prices. It then considers institutional factors which have interacted with and contributed to changes in that structure. After a review of vessel operating and routing patterns, the chapter concludes with an overview of prospects for significant use of supercarriers to transport major bulk commodities in U.S. foreign trade, and it identifies some leading constraints.

Shipping Industry Market and Price Structure

Ocean shipping of both wet and dry bulk commodities can be carried on in two basically different ways: private or proprietary carriage by large industrial companies which also own and operate their own ships; and contract or "for hire" carriage by independent chartering or shipping firms. In the former case, an internationally integrated company typically controls or has a major interest in the bulk commodity produced in a particular area, as well as in its processing elsewhere. It operates its own vessels between origin and destination points.

In the latter case, vessel owners and operators are distinct parties from both buyers and sellers of the commodities. The former contract with the latter to perform specified transport services between terminal points. Arrangements vary widely from accommodation of single shipments, to short-term vessel leasing for a few months or a few years, to long-term contracts for periods of 5 to 15 years or more. Generally, long-term charters are related to a continuing pattern of commodity movement between given points which are not likely to change much over time. In the case of single-voyage hire, the buyer (for f.o.b. transactions) or seller (for c.i.f. transactions) negotiates shipping arrangements with a shipping concern for that particular transaction only. Sometimes various buyers and sellers (notably in the cereal trade) having compatible location characteristics group small orders to permit full use of a larger vessel than would otherwise be possible, but this is a minor variation of the case.

Proprietary operation of oil tankers is common. In recent years about a third of the world tanker fleet has been directly owned and operated by international oil companies (table 42). Most of these ships are used for the transport of crude oil between overseas producing areas and market-oriented refinery locations. The balance is predominantly owned and operated by private chartering companies.

Table 42. Oil Company Ownership of World Tanker Fleet, Selected Years

Vessel size and date	Total world fleet		Oil company ownership			
			Vessels		D.w.t.	
	Number of vessels	Total d.w.t. (mil.)	No.	As pct. of world	Total (mil.)	As pct. of world
Tankers over 10,000 d.w.t.						
December 31, 1970...	3,102	149.2	1,220	39.3	53.7	36.0
Tankers over 60,000 d.w.t.						
January 1, 1971.....	696	80.9	205	29.5	25.3	31.3
Tankers over 6,000 d.w.t.						
January 1, 1959.....	2,703	52.4	906	33.5	17.1	32.6
January 1, 1958.....	--	--	--	35.0	--	34.1
January 1, 1957.....	--	--	--	36.0	--	35.1

Source: John I. Jacobs & Co. Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 5; Fearnley & Egers Chartering Co. Ltd., Large Tankers, January 1971 (Oslo, June 1971), p. 6; Zenon S. Zannetos, The Theory of Oil Tankship Rates (Cambridge, Massachusetts: MIT Press, 1966), pp. 66, 67, and 72.

Ownership of the world tanker fleet is widely dispersed among individual owners, although it is much more dispersed for those tankers which are independently owned. In January 1959, the only period for which pertinent data are readily available, the world fleet of tankers exceeding 6,000 d.w.t. was distributed among more than 600 separate owners, the largest of which (an oil company) controlled about 7 percent. Five major oil companies owned 23 to 24 percent of the total tonnage, while the five largest independents owned 13 percent.1/

The oil companies provide only a part of their own shipping requirements, depending for the rest upon an independent tanker market. This is the result of one major factor: imbalances in the relation between crude oil production and refinery capacity of most individual oil companies. Complete self-sufficiency of each company in ocean transport under these circumstances would be wasteful. In addition, a sharing arrangement whereby some companies depended upon their competitors for delivery as well as for determination of transport charges would be unworkable. For these reasons the independent tank shipping market developed. That market operates in a perfectly competitive manner, reflecting its unregulated character, the relative ease of entry and exit, the apparent lack of scale economies in management or finance, and the relatively limited degree of risk, at least under circumstances of long-term charter arrangements.2/

Ownership characteristics of the world bulk carrier fleet are more complex than those of tankers, and available data are fragmentary. The ownership pattern is somewhat obscured, at least in relation to vessels engaged in the carriage of iron ore, because some steel and mining companies have indirect or partial control over many of the independents.3/ However, as of early

1/ Zenon S. Zannetos, The Theory of Oil Tankship Rates (Cambridge, Massachusetts: MIT Press, 1966), p. 175.
2/ Ibid., pp. 174-85.
3/ United Nations, Economic Commission for Europe, The World Market for Iron Ore (ST/ECE/STEEL/24), 1968, pp. 122-23.

1969, only about 10 percent of the total world fleet was believed to be owned by cargo interests, the balance being controlled largely by independent charterers. Some 400 to 500 separate enterprises owned the 2,000 or so vessels, and only a few owned more than a dozen. Thus international competition is strong, and "only the efficient (or highly subsidized) operator survives."1/

Proprietary carriage of dry bulk commodities by industrial enterprises is heavily concentrated among those engaged in ore mining and metal fabrication, especially in the iron ore and steel industries. Thus the U.S. Steel Corporation and the Bethlehem Steel Company own and operate a substantial proportion of the vessels bearing their iron ore imports from Latin American and other sources, especially from mines in which they have a major investment stake.2/ Major U.S. producers of aluminum also own and operate their own fleets to transport uncertain proportions of their bauxite and alumina imports, typically from origins where they have a financial interest in resource development. These underlying circumstances appear strikingly similar to those influencing proprietary operation of tankers by the petroleum industry.

By the same token, steel and aluminum companies also rely importantly on the independent bulk carrier charter market for much of their shipping requirements. In part this may reflect some imbalances between outputs of raw material and of processed commodities by individual companies. In addition, improved vessel utilization and hence lower costs can often be obtained through chartering. This is true for two reasons. First, in some cases, underused capacity of an ore ship on certain runs could be overcome by serving the joint

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1/ G.R. Snaith and I.L. Buxton, "Bulk Carrier Development," Conference on Tanker and Bulk Carrier Terminals (London: The Institution of Civil Engineers, 13 November 1969), p. 6.

2/ United Nations, Economic Commission for Europe, The World Market for Iron Ore (ST/ECE/STEEL/24), 1968, pp. 122-23.

needs of several companies in combination. Second, effective use of combined carriers to capture backhaul traffic in oil or in other commodities requires knowledge of and contacts with other segments of the shipping market.1/

So far as is known, movement of the three other major bulk commodities in world trade -- coal, grain, and phosphate rock (the major U.S. bulk exports) -- is overwhelmingly handled by the independent bulk shipping industry. This reflects the relatively more competitive nature of trade in those commodities, the typically smaller lot sizes, and especially the dominantly separate nature of commodity buyers and sellers.

In general, proprietary vessels serving oil, steel, aluminum or other companies are engaged in a continuous, long-term shuttle service between essentially fixed origins and destinations. With stable demands for the end product and a vested interest in particular supply sources, the need for changes of routing are infrequent. Since the operation of these ships falls outside the marketplace, ocean shipping "costs" are in principle determined by long-run real economic costs (although in multinational companies, actual charges to U.S. subsidiaries may also reflect accounting convenience or tax considerations, which may differ).

The role of chartered vessels in a shipper's operation depends largely upon the length of the contract. Most commonly, vessels secured on intermediate or long-term charter are used in the same way as proprietary vessels: for regular, continuing runs between specified points. Altogether, some 85 to 90 percent of the world's seaborne petroleum trade is normally carried on under these basically fixed patterns.2/ In 1965, an estimated 95 percent of the world steel industry's iron ore shipping requirements were satisfied in

1/ Gerald Manners, The Changing World Market for Iron Ore, 1955-1980 (Baltimore: Johns Hopkins Press, 1971), pp. 195-96.
2/ Zenon S. Zannetos, The Theory of Oil Tankship Rates, pp. 3-4.

the same way.[1] Comparable data for bauxite and alumina are lacking, but would probably show similar results.

Ocean shipping charges actually incurred by those companies under contract with the independent charterers are of course negotiated in the marketplace. Since the independent shipping market is highly competitive, prices for long-term charters would normally be expected to correspond rather closely to long-run real economic costs. The classic economic study of tankship pricing found this to be both theoretically and empirically true.[2] If prices departed materially from that standard for any length of time, the companies would presumably increase or reduce their proprietary stake accordingly, thereby reinforcing the basically competitive processes involved.

The small balance of U.S. crude oil, iron ore, bauxite and alumina imports, and perhaps the majority of U.S. major bulk exports as well as of U.S. petroleum product imports, are transported on the basis of single-voyage or short-term charter arrangements. Prices are also established competitively in the market. However, the short-run inelasticity of vessel supply, together with modest fluctuations in demand, produce a highly volatile and chaotic price structure common to spot markets for highly competitive agricultural commodities. The unstable nature of the price structure is illuminated in tables 43 and 44 for spot tanker rates during 1949-58 and 1967-71, respectively, and in table 45 for coal and grain rates in the 1967-71 period. As indicated in these tables, year-to-year fluctuations of 50 to 100 percent and more have been common. Intermediate and longer term charter rates are not impervious to spot market rates at any given moment. However, the longer the time charter, the less sensitivity there is (figure 1).

1/ Gerald Manners, The Changing World Market for Iron Ore, 1955-1980, p. 194.
2/ Zenon S. Zannetos, The Theory of Oil Tankship Rates, pp. 3-4.

Table 43. Average World Spot Tanker Rates, by Quarter, 1949-58

(In dollars per thousand ton-miles)

Year	Quarter				Average annual
	First	Second	Third	Fourth	
1949.......	1.35	1.13	0.93	1.08	1.12
1950.......	0.96	0.97	1.40	2.75	1.52
1951.......	4.06	2.47	2.04	3.59	3.04
1952.......	4.18	2.02	1.63	1.55	2.35
1953.......	1.08	0.95	0.80	0.91	0.94
1954.......	0.98	0.70	0.75	1.12	0.89
1955.......	1.32	0.88	1.05	2.01	1.32
1956.......	1.60	2.18	2.23	3.76	2.44
1957.......	3.57	1.11	0.73	0.65	1.52
1958.......	0.64	0.61	0.76	0.72	0.68

Source: Zenon S. Zannetos, The Theory of Oil Tankship Rates (Cambridge, Massachusetts: MIT Press, 1966), pp. 91, 92, and 98.

Table 44. Index of Average Annual Freight Rates for Medium-Size Tankers, Single Voyage, 1967-71[a]

Year	Worldwide		Persian Gulf to		Caribbean to	
	Source A[b]	Source B[c]	Western Europe	Japan	Western Europe	Northeast U.S.
1967...........	118	143	117	112	130	129
1968...........	106	115	108	104	106	101
1969...........	89	96	85	84	80	90
1970...........	190	196	181	190	178	206
1971...........	102	107	91	99	92	99

a/ World Scale since October 1969, and Intascale converted to World Scale prior to October 1969. All figures on dollar basis allowing for devaluations of sterling and the dollar in recent years.
b/ Mullin.
c/ Norwegian Shipping News.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 12.

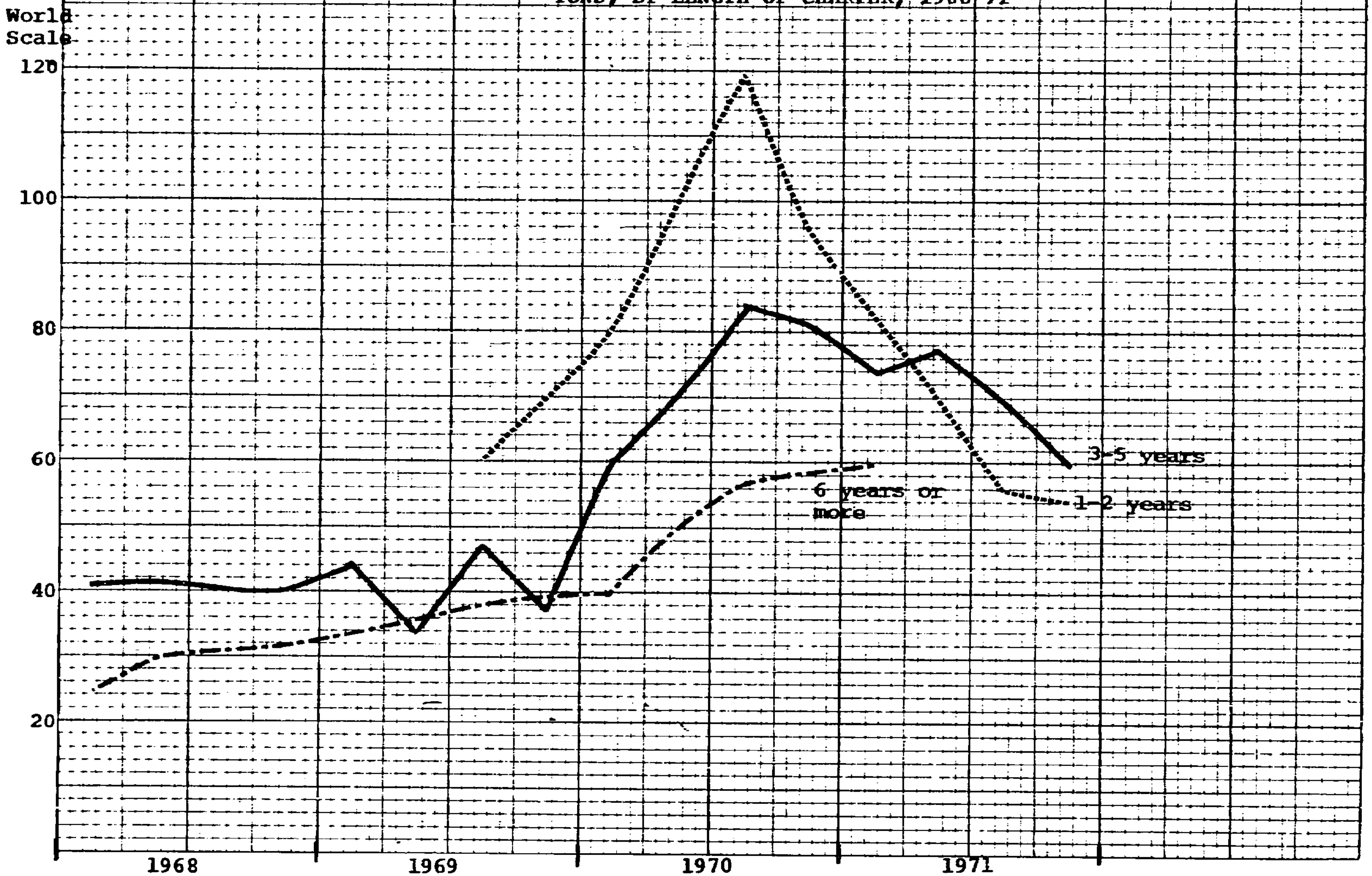
Table 45. Average Annual Freight Rates for Medium-Size Bulk Carriers, Single Voyage, 1967-71

Year	Worldwide aver. indices, major bulk[a]	Coal		Grain	
		U.S.-Japan	Aust.-Japan	U.S. gulf-W.Eur.	U.S. gulf-Japan
		dollars per trip			
1967..	94.1	7.80	4.50	5.10	11.65
1968..	92.4	6.85	3.70	4.20	8.30
1969..	85.2	6.55	3.60	4.10	8.05
1970..	119.4	11.70	7.05	8.00	13.15
1971..	81.2	5.13	3.86	3.82	6.05

a/ Index numbers, by Norwegian Shipping News.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 15, and Review 1970 (Oslo, January 1971), p. 19.

FIGURE 1. FREIGHT RATE INDICES FOR TIME CHARTERS OF TANKERS ABOVE 200,000 DEADWEIGHT TONS, BY LENGTH OF CHARTER, 1968-71



Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 13.

Price fluctuations in tanker and bulk carrier charter markets in response to short-term market conditions carry over to shipyard contracts for new tonnage. When backlogs are growing and available tonnage is relatively tight, as was particularly true in the late 1960's, prices (and hence first costs to vessel operators) are likely to rise rapidly (table 46). When market conditions slacken, as they did during 1971, prices are likely to move in the opposite direction. However, there appears to be some stickiness in this reverse movement where backlogs are particularly long, as has recently been the case for supertankers.

A more sensitive barometer of change in vessel ownership costs is the market for used ships. As strikingly revealed by table 47, their prices move rapidly and steeply in both directions. In time they must exercise an important influence on first costs of newly constructed ships since they are to an important degree in direct competition. The bleak short-term outlook for new tanker and bulk carrier tonnage, and the apparent fear by European shipyards of growing price competition with the Japanese (see chapter I), suggest that the recent downward trend in acquisition costs of new or used vessels may not yet have run its course.

Taken together, the preceding circumstances suggest that neither rates for shipping bulk commodities -- especially in the spot market -- nor prices of new vessels at any given time are reliable indications of real cost, in either the short or long run. Both are evidently very sensitive to market conditions, which are constantly changing. For that reason, an attempt is made in chapter III to estimate the structure of ocean shipping costs on the basis of real costs rather than prices.

The Changing Market Structure

Historically, most ocean shipping arrangements for oil and dry bulk commodities were made on an *ad hoc* or short-term basis. That situation still governs the movement of all *types* of bulk commodities, but not of

Table 46. Typical Prices for Newly Contracted Vessels, 1962-71[a/]
(In millions of dollars[b/])

Vessel type and size (d.w.t.)	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
Bulk carrier										
18,000............	2.9	3.1	3.5	3.6	3.6	3.8	4.3	4.6	6.3	5.4
30,000............	3.8	3.7	3.8	4.3	4.4	4.9	5.4	5.7	8.7	8.1
Tanker										
87,000............	8.4	7.9	8.2	8.5	8.8	9.0	9.4	10.0	17.0	17.3
210,000...........	--	--	--	--	13.2	14.7	16.6	19.0	31.0	33.5
OBO										
96,000............	--	--	--	--	9.7	10.0	11.0	12.0	23.0	23.7

a/ At year end.
b/ Current dollars, at valid rate of exchange.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), p. 16, and Review 1970 (Oslo, January 1971), p. 10.

Table 47. Average Prices for Used Tankers and Bulk Carriers, 1966-71[a]

(In millions of dollars)

Vessel size (d.w.t.) and type	Year built	1966	1967	1968	1969	1970	1971
18,000							
Bulk carrier.	1963	--	--	2.1	2.2	2.8	2.2
Tanker.......	1952-53	0.9	0.9	0.8	0.8	1.5	0.8
25,000							
Bulk carrier.	1966	--	--	3.5	3.6	4.8	3.1
Tanker.......	1958-59	1.5	2.0	1.8	1.9	4.0	2.2
35,000							
Bulk carrier.	1965	--	--	4.0	4.2	6.0	3.7
Tanker.......	1958-59	2.1	2.4	2.4	2.6	6.0	3.5
50,000							
Bulk carrier.	1967	--	--	5.0	5.2	9.0	5.7
Tanker.......	1963-64	3.6	4.4	4.2	4.5	10.0	7.0
60,000							
Bulk carrier.	1972[b]	--	--	--	--	11.0	8.3
Tanker.......	1964-65	--	5.3	5.5	5.8	12.0	8.5
70,000							
Bulk carrier.	1966	--	--	--	7.5	11.0	6.5
80,000							
Tanker.......	1966-67	--	--	7.7	8.0	19.0	12.0
100,000							
Tanker......	1967-68	--	--	--	12.0	26.0	16.0
200,000							
Tanker......	1969-70	--	--	--	--	40-45	30.0

a/ Market value estimates at year end for charter-free vessels in good condition and with fairly prompt delivery on a cash basis.
b/ Resale.

Source: Fearnley & Egers Chartering Co. Ltd., Review 1971 (Oslo, January 1972), pp. 16 and 17.

all shipments. As has been indicated above, growth of markets and of larger, more specialized, and less flexible vessels stimulated development of long-term contracts and fixed continuing route patterns in recent years. These trends are also deeply rooted in the desires of investors, operators and users of ocean transport services to reduce risks and costs and to facilitate stability in both commodity and transport markets.

Growing vertical integration of many huge industrial enterprises on an international scale has contributed to those desires. Manufacturers heavily dependent on imported raw materials have increasingly invested directly in their exploitation, both to permit or to accelerate their development and to insure themselves of long-term supplies. This situation creates commitments to particular supply sources, usually an important if not essential condition to the making of long-term transport arrangements. The pattern has had special significance for Japan, whose recent large investments to develop new oil, iron ore, coal and grain resources in other countries for its own use are notable.

Furthermore, supercarriers require large capital outlays. Where future market conditions are uncertain or completely open, risks are correspondingly great. Thus relatively few lenders would support the purchase of such vessels in the absence of long-term agreements by prospective users, and they would insist on a higher return to compensate for risks -- partly negating their very advantage.

Whatever consequences price fluctuations may have in the case of smaller ships, they are magnified for the larger ones. Thus long-term transport arrangements are a virtual precondition to their construction. Most important, they offer the incentive of lower long-run costs to users who ship in appropriate large volume and over long distances. This is true for two reasons: first, because of the scale economies inherent in the use of large ships under these conditions; and second, because of greatly reduced market risks for ship operators and lenders.

Finally, the volatile nature of spot shipping rates is unsettling, not only to those engaged in the shipping business, but perhaps especially to users. Small users may not easily have effective recourse. But large firms -- particularly in oligopolistic industries like steel and petroleum -- are increasingly geared to long-term planning and decision-making of all kinds that require knowledge of prices and costs, including those for shipping. The more they can reasonably be defined in advance, the more advantageous such enterprises are likely to find them -- for institutional as well as for economic reasons.

Vessel Operating and Routing Patterns

Ocean vessel operators generally attempt to optimize the size and design characteristics of carriers employed in the movement of a commodity or commodities among relevant port links. The optimal vessel is the one which produces the lowest total costs for the given ports, volumes, distances and other conditions which apply to a particular trip or series of trips between terminal points. This often means that tankers or bulk carriers approach the maximum size physically feasible at the various ports served, but that is not necessarily so. Vessels may occasionally draw more water when fully laden than is available at a port and thus arrive or leave light-loaded; more commonly the vessel is smaller than could physically be accommodated. Apart from such constraints as water depth, berth space and narrowness of channels, choice of vessel size and design characteristics must also reflect such other major factors as loading or unloading rates, storage capacity, quantities of the commodity desired in a single shipment, and distance of voyage. There are a great many different ports and individual facilities within them for which these questions apply. Thus, in 1969, 125 U.S. and 549 foreign ports shipped or received one or more of the major bulk commodities covered by this study (see Annex G).

The extraordinarily dynamic character of bulk shipping markets makes optimization challenging and difficult. Relevant conditions applicable to the movement of a single commodity between countries or regions frequently change. Commodity volumes requiring shipment often increase substantially and sometimes decrease; new ports are developed or existing ones improved.

Furthermore, operation of a vessel for the movement of one commodity between two ports can often be supplemented by the vessel's further use for the transport of other commodities between the same points or other points. Where market conditions permit, it is almost invariably more efficient for a vessel hauling cargo in one direction to return with another. As explained in chapter I, this led to the development of multiple stowage factor bulk carriers and of combined carriers. These vessels have substantially increased possibilities of a voyage routing pattern among three or more countries which would often be more efficient than a simple round trip between two points.

In U.S. bulk commodity trades, the most commonly cited example of this type of operation is an oil/bulk/ore (O/B/O) carrier (now 80,000 to 100,000 d.w.t., but soon to be 150,000 d.w.t.). It brings crude oil from the Persian Gulf to the east coast of the United States, loads partially with coal in Hampton Roads, and continues to Brazil or West Africa, where it completes its cargo with iron ore for a trip to Japan. Other examples of multiple routing patterns include coal from Hampton Roads to Canada or Brazil, with a short ballast leg to obtain a return cargo of iron ore for Baltimore or Philadelphia; iron ore from Chile or Peru to Japan, ballast leg to Indonesia, and oil movement to the United States; phosphate rock from Tampa to Vancouver, Canada, with a short ballast leg to another west coast port for wheat, timber or wood chips to Japan, and a return movement of Japanese cars to southern California. The latter voyage pattern is particularly interesting, because it suggests possibilities of efficient coordination of bulk and nonbulk commodity movements on compatible routes. A few other examples could also be cited. However, opportunities for these types of movements are necessarily limited.

On those links warranting the introduction of new large vessels, smaller ships are usually displaced. Most commonly, the latter are transferred to other (usually shorter) routes where distance and/or volume conditions make their use relatively more economic. If they are old, they may be scrapped. However, it is sometimes less costly to continue operation of a small vessel on the same link or to delay its replacement by a large ship. This could happen if there were no suitable alternative uses for the vessel and if it were able to cover marginal costs. Its relatively high unit operating costs might, at least for a while, be lower than the combined unit operating and investment costs of the new larger ships. These basic economic considerations help to explain why relatively old and small ships are sometimes found operating on transoceanic routes in direct competition for cargo which is also moved by much larger vessels, especially in the tramp market during periods of high spot rates.

Potential Supercarrier Markets in U.S. Trade

Because of the many factors and separate port facilities involved, valid global judgments as to ultimate developments in vessel size for the movement of each bulk commodity in U.S. foreign trade are impossible to make. Generally, average vessel size can be expected to increase progressively over time as markets grow and incremental improvements are made in relevant ports. But determination of optimum ship size depends on numerous trade-offs which will vary on a case-by-case basis. Thus there is likely to be a wide range of vessel sizes for any one commodity at any given time, each of which is more or less optimal for its particular mission.

Nevertheless, a few observations may be worth making as to the long-range potential of supercarriers in major U.S. bulk commodity trades. That potential is evidently greatest for crude oil, for numerous related reasons: huge projected total volumes of movement; large annual volumes of demand at individual refineries; substantial geographic concentration of crude origin and destination areas; typically long ocean shipping distances; and physical conditions in major overseas loading ports which are already conducive to their efficient use and which are becoming more so (see table 48).

On the other hand, petroleum products appear to be a marginal possibility at best. Although future volumes are expected to be large, distances of haul from the dominant Caribbean origin area are short, while the number of buyers at separate locations is great and their individual demands often variable as well as small for any single order.

Among the dry bulk imports, neither bauxite nor alumina appear to be strong candidates. Projected annual volumes of the latter are exceedingly small, and the annual input requirements for the largest aluminum plants are less than 0.5 million tons. Bauxite volumes are substantially greater in the aggregate as well as at some individual plant sites, but potential ocean shipping cost savings are otherwise exceedingly limited by the very short ocean shipping distances from major Caribbean origins as well as by draft constraints in relevant foreign ports (see table 49).

Iron ore is possibly a strong candidate because of large aggregate volumes as well as high demands of individual plants. Furthermore, many of the major overseas ports of origin now -- or prospectively -- can accommodate vessels of several hundred thousand tons deadweight (see table 50). On the other hand, distances of haul from most origin areas are rather short. The tentative economic and technical feasibility of several hypothesized deepwater ports in the United States to accommodate iron ore imports is evaluated in the benefit-cost analysis in Annex F.

Of the three major U.S. dry bulk export commodities, phosphate rock is probably the weakest candidate for potential use of supercarriers. Projected volumes are moderately substantial, and distances to dominant overseas markets in Europe and Japan are long. However,

Table 48. Major Foreign Ports for U.S. Imports of Crude Oil

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 2					
Venezuela:					
Puerto La Cruz.	60	150,000			
La Salina......	41				
Lake Maracaibo.	44	70,000			
Puerto Mirando.	39				
Mexico:					
Tampico........	30				
Netherlands Antilles:					
Aruba..........	39				
Colombia:					
Santa Marta....	32				
Buenaventura...	39	40,000			
Zone 3					
Chile:					
Arica..........	30				
Zone 7					
Libya:					
Marsa El Brega.	100	500,000	140		New single point mooring
Ras es Sider...		200,000			

continued--

Table 48. Major Foreign Ports for U.S. Imports of Crude Oil continued--

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Egypt (UAR):					
Port Said......	62	175,000			
<u>Zone 9</u>					
Nigeria:					
Forcados.......	70	250,000		500,000	Offshore fac. in Gulf of Guinea
<u>Zone 10</u>					
Kuwait:					
Mina Al Ahmadi.	100	500,000			
Mina Abdulla...	56				
Neutral Zone:					
Mena Saud......	52+				
Ras Al Khafji..	60	150,000			
Saudi Arabia:					
Ras Tanura.....	90	400,000			
Iran:					
Kharg Island...	70	250,000	105	500,000	Expansion of island terminal
Iraq:					
Khor Al Amya...	73	250,000			
Bahrain and Abu Dhabi:					
Bahrain........	44				
Jebel Dhana....	60				
Das Island.....	70	250,000			

continued--

Table 48. Major Foreign Ports for U.S. Imports of Crude Oil continued--

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 12					
Indonesia:					
Palembang-Pladju........	38	40,000			
Dumai..........	51				

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

Table 49. Major Foreign Ports for U.S. Imports of Bauxite and Alumina

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
	Bauxite				
Zone 2					
Trinidad:					
Port of Spain.	32				
Jamaica:					
Port Kaiser...	35-43				
Ocho Rios.....	38				
Surinam:					
Paramaribo....	31-35				
	Alumina				
Zone 13					
Australia:					
Gladstone.....	42				

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

Table 50. Major Foreign Ports for U.S. Imports of Iron Ore

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
<u>Zone 1</u>					
Canada:					
Seven Islands..	60	150,000			
Port Cartier...	55	100,000			
Pointe Noire...	46 1/2	80,000		300,000	Offshore berth
Texada Island..	45	80,000			
Toquart Bay....	45	80,000			
<u>Zone 2</u>					
Venezuela:					
Palua..........	35[a]	30,000			
	70[b]	200,000			
Puerto Ordaz...	32[a]	30,000			
	68[b]	200,000			
<u>Zone 3</u>					
Chile:					
Guayacan.......	40	40,000	58		
Huasco.........	65	200,000		250,000	
Peru:					
San Nicolas....	57	150,000			

continued--

Table 50. Major Foreign Ports for U.S. Imports of Iron Ore continued--

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 4					
Brazil:					
Tubaraco.......	55	100,000	90	250,000	
Sepetiba Bay...			82	350,000	Under construc.
Zone 9					
Liberia:					
Buchanan.......	80	300,000			
Monrovia.......	50	90,000			
Zone 13					
Australia:					
Port Latta.....	50	90,000			
Dampier........	51	90,000		250,000	
Port Hedlund...	51	90,000		300,000	

a/ Low water level.
b/ High water level.

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

the number of buyers is very great; their individual yearly demands, modest; and their specific locations, very widely scattered. Furthermore, physical constraints in major foreign port areas are great (table 51).

Underlying circumstances and emerging trends for U.S. coal exports present interesting possibilities for the employment of supercarriers. Projected volumes are substantial, and average distances of movement to major markets are typically long. Furthermore, all buyers of U.S. metallurgical coal are steel companies, many of which are very large and whose annual coal requirements are great. Furthermore, existing draft constraints in many major port areas are being rapidly overcome (table 52). The feasibility of a possible deepwater port site for use by supercarriers in the U.S. coal export trade is evaluated in the benefit-cost analysis (Annex F).

Cereals are a particularly problematic commodity group. Although annual volumes are substantial, the wide geographic dispersal and typically small scale of numerous grain processors using U.S. cereals as inputs are not yet compatible with the employment of supercarriers. The basically segmented pattern of purchase is also incompatible with such use. Furthermore, the variety of physical constraints in overseas ports of reception are great. No overseas port recently significant in U.S. cereal trade can presently accommodate a grain supercarrier, nor are there any known plans of improvement which would permit this (table 53). Furthermore, apart from limited water depths, most of the major grain receiving ports abroad have exceedingly limited storage capacity as well as low-capacity handling facilities. Thus, for example, the largest grain importer in the world, Japan, has over 2 million tons of seaboard grain silos for storage. However, they are so widely scattered spatially that only one single facility exceeds 100,000 tons in capacity, while most have very much less (table 54). Circumstances are believed to be similar in most Western European countries. Although the obstacles are formidable, they could be overcome in time. We have accordingly tested the potential feasibility of several deepwater port concepts for U.S. grain exports in the benefit-cost analysis (Annex F).

Table 51. Major Foreign Ports for U.S. Exports of Phosphate

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
<u>Zone 5</u>					
Belgium:					
Antwerp.......	45				
Netherlands:					
Rotterdam.....	36 1/2				
<u>Zone 15</u>					
Japan:					
Yokohama......	48-30				
Osaka.........	33-30				
Nagoya........	28-26				
Canada:					
Vancouver, B.C..........	36-40				

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

Table 52. Major Foreign Ports for U.S. Exports of Coal

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 5					
W. Germany:					
Bremen.........	31				
Hamburg........	40	50,000		300,000	Outer port
Bremerhaven....	48	80,000	50		
Netherlands:					
Rotterdam......	64 1/2	200,000	75	250,000	Maasvlakte
Amsterdam......	49	90,000	62		Outer port at Ijmuiden
France:					
Fos............	52 1/2	120,000	77		
Dunkirk........	46	80,000	80	300,000	
Le Havre.......	46	80,000		250,000-300,000	
Sweden:					
Gothenburg.....	26				
Oxelosund......	41-45				
Belgium:					
Antwerp........	45	80,000			
Spain:					
Cadiz..........	31				
Gijon..........	44	75,000		120,000-150,000	
Bilbao.........	31-35				

continued--

Table 52. Major Foreign Ports for U.S. Exports of Coal continued--

Zone, country and port	Existing situation: Depth (M.L.W. in feet)	Existing situation: Max. vessel size (d.w.t.)	Future developments: Depth (M.L.W. in feet)	Future developments: Vessel size (d.w.t.)	Future developments: Note
Zone 6					
Italy:					
Genoa..........	26-36				
Naples.........	34				
Leghorn........	30-27				
Bagnoli........	46	80,000			
Taranto........	52 1/2	120,000	80		
Savona.........	30				
Trieste........	30-26				
Zone 7					
Turkey:					
Istanbul.......	28				
Zone 15					
Japan:					
Kimitsu........	60	150,000-200,000			
Wakayama.......	48	80,000			Expansion underway
Mizushima......	58	150,000			Expansion underway
Kashima........	65	200,000	78		
Chiba..........	57	130,000	65		
Tsurusaki......	59	150,000			

continued--

Table 52. Major Foreign Ports for U.S. Exports of Coal continued--

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Tobata.........	57 5/12		71		
Muroran........	45 11/12		52		
Usaka..........	41				Expansion underway
Oita...........	89	300,000			Under construction in Beppu Bay
Kawasaki.......	44 1/4	70,000	75 1/2		

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

Table 53. Major Foreign Ports for U.S. Exports of Cereal (Grain)

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 5					
Germany:					
Bremen........	34-24				
Hamburg.......	45-29				
Sweden:					
Gothenburg....	29				
Netherlands:					
Rotterdam.....	29-26				
Amsterdam.....	51-31				
Belgium:					
Antwerp.......	30				
Gand-Ghent....	26-30				
United Kingdom:					
London........	45-38				
Felixstowe....	22				
Zone 6					
Italy:					
Genoa.........	34				
Naples........	30				
Leghorn.......	28				
Trieste.......	30				

continued--

Table 53. Major Foreign Ports for U.S. Exports of Cereal (Grain) continued--

Zone, country and port	Existing situation		Future developments		
	Depth (M.L.W. in feet)	Max. vessel size (d.w.t.)	Depth (M.L.W. in feet)	Vessel size (d.w.t.)	Note
Zone 7					
Turkey:					
Istanbul.......	34				
Israel:					
Haifa..........	37				
Zone 8					
Poland:					
Gdynia.........	36-40				
Zone 11					
India:					
Bombay.........	35				
Calcutta.......	26				
Zone 12					
So. Korea:					
Pusan..........	36-40				
Taiwan:					
Kaohsiung......	36				
Zone 15					
Japan:	See table 13				

Source: MARAD; Benn Brothers (Marine Publications) Ltd., Ports of the World, 1971-72, 25th ed., London, 1971; and others.

Table 54. Major Seaboard Grain Silos in Japan as of July 1971

District and silo	Storage capacity (tons)	Maximum vessel size (d.w.t.)	Draft (meters)
Kanto District			
Kashima Silo.......	99,779	50,000	
Chiba Kyodo Silo...	37,120	50,000	12
Niohn Silo.........	40,090	55,000	12
Chiba Grain Center.	21,000	50,000	12
Toyo Seiyu.........	35,000	55,000	12
Nitto Flour........	34,161	20,000	
Toyo Futo..........	75,000	60,000	12
Nisshin Flour......	69,520	50,000	11
Kokusai Futo.......	50,000	200,000	17.5
Nisshin Seiyu......	110,200	55,000	12.5
Food Agency Silo...	19,500	20,000	
Chubu District			
Shimizu Futo.......	25,820	15-20,000	
Hohnen Seiyu.......	66,480	25,000	11
Rnor Yusi..........	50,750	34,000	10
Chita Futo.........	31,433	50,000	12
Nagoya Futo Silo...	12,300	50,000	12
Toyo Grain Terminal	58,750	50,000	11.5
Nisshin Flour......	54,800	55,000	12
Nakanihon Grain....	27,560	55,000	
Shiko Silo.........	32,706	30,000	10
Kinki District			
Kobe Futo..........	38,260	40,000	
Tomen Silo.........	66,720	55,000	11.5
Kobe Silo..........	50,600	50,000	12.5
Konan Futo.........	32,400	60,000	12.5
Hanshin Silo.......	39,800	50,000	
Showa Sangyo.......	71,000	45,000	11.5
Chugoku District			
Nisinihon Grain....	52,422	60,000	12
Seto Futo..........	42,500	55,000	
Nihon Koyu.........	57,490	1,500	
Kyushu District			
Moji Shibusawa.....	6,400	25,000	9.3
Hakatako Silo......	41,016	25,000	9.5

continued--

Table 54. Major Seaboard Grain Silos in Japan as of July 1971

District and silo	Storage capacity (tons)	Maximum vessel size (d.w.t.)	Draft (meters)
Genkai Silo........	30,000	25,000	9.5
Meiko Silo.........	7,000	30,000	
Kamigumi...........	9,128	20,000	
Kagoshima Kumiai...	4,000	21,000	

Source: Japanese Ministry of Agriculture.

III. OCEAN TRANSPORT COSTS FOR BULK COMMODITIES

Introduction

The principal purpose of this chapter is to describe the real cost characteristics of ocean vessels engaged in the transport of bulk commodities, with emphasis on the economies of scale. To serve other related study needs, it treats the specific costs of vessels varying widely in size and draft.

A secondary purpose is to consider the technical possibilities and cost implications of achieving greater vessel size without correspondingly increasing the draft requirements. Physical constraints in most U.S. and foreign ports generally restrict permissible vessel draft well before they limit a vessel's other dimensions. It may therefore be advantageous to increase vessel capacity at a given draft by modifying other dimensional characteristics.

Means for satisfying the above objectives presented a challenge. Although detailed and comprehensive data on ocean shipping costs are held by shipbuilders, designers and operators, they are almost invariably proprietary. Numerous published articles and reports contain some information on the subject, but most tend to be either too general or too limited in focus for purposes of this study. Among these, appraisals by

Heaver[1] and Keith,[2] both published in 1968, were found generally to be more comprehensive and detailed than most others.

However, even these documents were considered inadequate to serve intended purposes. Neither covers the entire broad range of vessel size and distance that is needed; estimated first costs are based on prices of some Japanese and other shipyards; and neither provides dimensional or other design characteristics associated with the various ships costed. Furthermore, both are somewhat dated for so dynamically changing a subject.

We therefore elected to make independent cost estimates. We were assisted in this effort by Hydronautics, Inc., a firm having skills in naval architecture and a computerized design and cost estimating program directly related to our needs. In this broad study, the cost estimates are necessarily made parametrically at a general order-of-magnitude level only. In addition, they are made predominantly for vessels operating under foreign flags, which dominate the relevant shipping markets.

Our cost estimates are made separately for each of numerous ocean vessels ranging in size from 30,000 to 500,000 d.w.t., in loaded draft from 35 to 95 feet, and in other design characteristics. Furthermore, the estimates are made separately by trip distances (one way) ranging from 1,000 to 15,000 nautical miles. The broad ranges of vessel size, draft, and distance are believed to substantially cover existing and possible future conditions governing major movements of wet and dry bulk commodities in U.S. foreign trade.

1/ Trevor D. Heaver, The Economics of Vessel Size (Ottawa: National Harbors Board, 1968, mimeo).
2/ Virgil F. Keith, Analysis and Statistics of Large Tankers (Ann Arbor: University of Michigan, Department of Naval Architecture and Marine Engineering, October 1968).

Most of the estimates are presented in terms of the total average cost of moving 1 long ton of oil in a vessel of specified size and design characteristics over a given distance. They exclude loading, unloading, or other terminal costs except for typical ocean vessel time in port. To permit some understanding of the underlying cost structure, detailed breakdowns of cost components are presented illustratively for vessels of significantly different size.

All initial estimates of ocean shipping costs are presented as of early 1970 and are in 1970 dollars. Rather than a more recent date, 1970 has been used primarily because detailed data in appropriate technical format were already available for that year. In addition, uncertainties about dollar exchange rates after mid-1971 introduced unmanageable complications. Thus, if proper allowance were made both for inflation and for changing exchange rates, the estimates for foreign-flag vessels presented herein would have to be increased by perhaps 25 to 35 percent to obtain 1972 dollar equivalents.

In the following sections the methodology and assumptions used for estimating 1970 foreign-flag tanker costs are first summarized, and are then followed by a presentation of the results. In sequence, the chapter then presents (1) 1970 estimated costs of tankers operating under U.S. flag; (2) cost relationships of tankers, dry bulk and combined carriers; (3) the implications of alternative assumptions about many key variables for initially derived 1970 estimates; and (4) the future level of ocean shipping costs.

Methodology and Assumptions

Our approach to the cost of tankships involved four major steps:

1. The careful selection of a limited number of vessel designs among a great many candidates to serve costing objectives

2. The making of many parametric assumptions on major vessel design and operating characteristics common to ships costed

3. The establishment of the specific unit values of various cost components applicable to all vessels

4. The incorporation of all relevant design and cost parameters and assumptions in a computer program which calculates total unit costs per ton of cargo carried, separately by ship and distance.

These steps are described sequentially in the following paragraphs.

Selection of Vessels

For each 5-foot increment in draft between 35 and 60 feet, four vessels of significantly different size but of equal draft were finally selected for costing purposes from a larger matrix of ship designs and costs developed initially. Two vessels of "conventional" design were chosen, one at the lower end of the range of deadweight tonnage in the world tanker fleet, and the other at an intermediate or higher level in that range. Two vessels of modified design (restricted-draft tankers) were chosen, one of the maximum d.w.t. considered technically feasible at a given draft, and the other at a somewhat smaller, intermediate level.

For very large vessels exceeding 250,000 d.w.t. (usually requiring a draft of more than 60 feet), the selection procedure was somewhat different. For each of four size levels in the 250,000- to 500,000-d.w.t. range, two vessels were chosen for costing purposes. One was selected to represent a vessel of conventional or standard design at a given d.w.t.; the other was a vessel of modified design to indicate the minimum feasible draft for a ship of equal capacity. The technical procedures used in the selection process are described more fully in the appendix.

Basic Vessel Design and Operating Assumptions

All ship designs and corresponding cost estimates assume a standard tanker without such environmentally oriented features as double bottom or fully clean ballast systems. They also generally assume steam turbine and single-screw propulsion systems. Finally, all designs and cost estimates reflect, to a first approximation, recently promulgated Intergovernmental Maritime Consultative Organization (IMCO) standards which modestly restrict the size of cargo tanks.

Vessel operating assumptions include a 345-day service year; a 39.5-hour average port time; a uniform 16-knot service speed; a 50-percent load factor, with full cargo in one direction and ballast returns; sufficient bunker fuel for only one leg of a round trip; and crews at the low end of the range in recent manning scales: 26 men on all vessels through 200,000 d.w.t., with progressive increases to a 50-man crew for a 500,000-d.w.t. vessel.

The above design assumptions reflect recently prevailing conditions for the existing world tanker fleet, as well as for vessels on order. Most of those vessels, especially the larger ones, are likely to be in service for many years. The newly imposed tank size restrictions began to influence designs of tankships ordered in late 1971. However, they are expected to have no effects on the cost of vessels under 200,000 d.w.t., and only very minor effects on larger ones. Prospects for more restrictive environmental standards in vessel design are uncertain. However, the sensitivity of our cost estimates to several of them is considered later in this chapter.

Most of the indicated operating assumptions are in keeping with typical recent circumstances in world shipping. Any reasonable alternative assumptions would have very minor consequences on total costs, as is shown for most items in the sensitivity analysis.

The assumption as to bunker fuel is necessarily arbitrary. Vessels often load sufficient fuel for a round trip voyage when bunker costs in various locations make that strategy useful. However, this practice varies widely by specific route, time, and company. The trade-off is usually close, since any savings in bunker costs must be related to the corresponding loss of cargo capacity.

There has been a long-term trend, which is expected to continue, toward smaller crews on vessels of all sizes. For costing purposes, crews are assumed to be modestly smaller than on most ships now operating, but they do reflect planned complements for many vessels now on order.

Although strictly technical and operating requirements for manning very large crude carriers (VLCC's) are not materially greater than for smaller vessels, Hydronautics suggests that institutional and political factors are likely to constrain the rate of crew reductions on the largest vessels. Furthermore, the economic incentives for crew reduction are relatively greater for smaller than for larger vessels, as indicated in the sensitivity analysis.

The assumption that the largest vessels (approximately those exceeding 250,000 d.w.t.) would be propelled by single-screw systems at 16-knot service speeds is not altogether realistic and has been made here only for convenience. In practice, such very large ships are likely to operate at somewhat less than 16-knot service speeds if designed for single-screw propulsion, or to operate with twin-screw propulsion. Either approach would effectively increase total unit costs modestly. More detailed analysis of numerous factors, including speed variation, than is possible in this study would be necessary to determine optimal design and operating conditions, and related cost characteristics, for such vessels. However, the cost implications of twin-screw propulsion for a 300,000-d.w.t. and a 500,000-d.w.t. vessel are indicated in the sensitivity analysis.

Values of Unit Cost Components

Table 55 specifies each of the cost components used in the computer program and the value, factor, or equation used for each item. Since the original program is related to U.S. costs, in some instances we simply applied a multiplier to convert them to foreign-flag equivalents.

Investment costs for foreign-flag tankers were estimated in several stages. For each ship, independent estimates were made by Hydronautics of the approximate quantities of steel required for eight different construction items, as well as shaft horsepower and electric power requirements. Resulting values were then used as inputs to a subroutine of the computer program, which includes unit cost coefficients for each item and calculates total first costs (table 56). Coefficients were all based on actual unit prices of steel plate and machinery, and on a weighted average of shipyard labor costs, in the United States as of early 1970.

A multiplier was applied to total U.S. construction cost estimates for each ship to reflect lower foreign costs. In the absence of any data on real production costs in foreign shipyards, that value had to be based on a comparison of prices for equivalent ships. Unpublished Corps of Engineers' data for 1969-70 on prices of numerous foreign and U.S. tankers and bulk carriers of various sizes indicated a fairly consistent relationship of 46 foreign/100 U.S., which was therefore used initially as the multiplier. All Hydronautics' total unit cost estimates as shown in the appendix are based on that assumed relationship between U.S. and foreign first costs.

After the entire cost estimating program had been run, resulting estimates of foreign first costs were carefully appraised and found to be low relative to prevailing price levels of ships built abroad in 1967-68. Implied U.S. cost equivalents were also significantly lower than 1969-70 ship prices in the United States.

Table 55. Assumed Values of Individual Cost Components Used in Estimated Total Unit Shipping Costs for Foreign-Flag Tankers

(In 1970 dollars)

Cost component	U.S. costs used in computer program	RRNA adjustment multiplier or total value for foreign costs
Total investment.......	X	0.46X (initial) 0.55X (revised)
Annual capital charge..	--	0.11746X
Annual operating costs:		
Manpower..............	--	6,500/man
Subsistence...........	986/man	0.7 of U.S.
Stores and supplies...	$1.84[4{,}500+\left(\frac{SHP}{3} + 10{,}000\right) + 0.21(d.w.t. + 9{,}500)]$	0.93 of U.S.
Maintenance and repair.................	90,400 + 0.69 (CN-1,500) + 0.49 (CN)	0.56 of U.S.
H&M insurance.........	$\left(\frac{0.01 + 0.00006\ d.w.t.}{1{,}000}\right)X$	0.46X (initial) 0.55X (revised)
P&I insurance.........	750M + 0.61 CN	Same as U.S.
Annual overhead and general...............	--	25,000
Fuel (Bunker C)........	--	(2.50/bbl.)Y

Definitions

SHP Normal shaft horsepower
CN Cubic number = (length x beam x draft) ÷ 100
M Number of crew
d.w.t. Total deadweight tons
X Independent estimate for each vessel
Y Independent estimate of propulsion requirements for each vessel at 16 knot speed and corresponding fuel consumption rate

Source: Hydronautics, Inc., and RRNA.

Table 56. Initial Investment Cost Estimating Coefficients for Tank Vessel Computer Program, by Light Ship Weight Output Items

(In millions of 1970 dollars)

Item	Cost
1.0 <u>Steel</u>	
1.1 Cargo section........	(0.0004524 W + 0.78)
1.2 Ends.................	(0.0005678 W + 0.3963)
1.3 Superstructure....... 1.4 Houses...............	(0.000835 W + 0.031358)
2.0 <u>Outfit</u>	
2.1 Passenger and crew...	(0.00338 W + 0.704)
2.2 Cargo	
2.2.1 Heating coils	
2.2.2 Cargo pumps	
2.2.3 Cargo oil sys. and misc......	(0.002264 W + 0.2032)
2.3 Electric plant.......	(0.00045 P_{kw} + 0.450)
2.4 Fixed	
2.4.1 Steering gear and rudder....	(0.00106 W + 0.10163)
2.4.2 Dk. Mach'y, incl. anchors, chain, windlass, warping gear, winches.......	(0.00145 W + 0.0178)
2.4.3 Misc. items....	(0.00503 W + 0.161)
3.0 Machinery, steam turbine propulsion..............	[0.103(SHP x 10^{-3}) + 2.160]

<u>Definitions</u>

W Weight in long tons
P_{kw} Power in kilowatts
SHP Shaft horsepower

Source: Charles E. Dart, <u>Cost Estimating - Ship Design and Construction</u> (prepared for University of Michigan summer conference on Economics in Ship Design, June 8-12, 1970), pp. 25-26.

A probable explanation for this discrepancy was soon found. All initial computer estimates of first cost had reflected an assumed quantity discount for multiple orders (five ships) in the United States. Although such volume production has been highly relevant for major foreign tankship builders in recent years, U.S. shipyards have rarely had such good fortune. Their prices therefore had to absorb the higher costs of small orders and low volumes. However, if the same production conditions governed U.S. and foreign yards alike, differences in real costs (and in cost-based prices) would be smaller than they have been. Foreign production costs would accordingly represent a higher proportion of U.S. costs. After some testing for consistency and comparability with the earlier foreign and U.S. shipyard prices, we changed the initial multiplier of 0.46 to 0.55 and adjusted all original estimates of foreign investment costs accordingly (that is, by approximately 19.5 percent). That increment corresponded almost exactly to the value of the assumed quantity discount. All total unit costs were also adjusted to reflect the change.

Annual capital charges of 11.746 percent were applied to all estimates of first cost. They consist of two elements: an assumed 10-percent return to capital, and an assumed 20-year useful vessel life, which requires a depreciation allowance of 1.746 percent annually based on a sinking fund approach. These assumptions are based principally on discussions with top officials of several international oil companies and large chartering firms, whose practices they reflect. On the other hand, many other enterprises are known to have different concepts of expected capital recovery, of vessel life, and of approaches to depreciation. However, the assumptions made here are considered reasonable. Nevertheless, the implications for unit shipping costs of alternative assumptions are considered in the sensitivity analysis.

No provision for income taxes has been made in our annual capital charges, principally because they constitute transfer payments rather than economic costs. Since the cost estimates have been developed primarily as inputs to benefit-cost analysis, taxes cannot properly be included. Furthermore, taxes actually paid by most foreign-flag operators are likely to be small. That is particularly true for vessels sailing under flags of convenience, which dominate carriage of U.S. crude oil imports. The incidence of such income taxes as some operators must pay is often effectively reduced through liberal tax allowances for accelerated depreciation, reinvestment, and the like.

Of the six operating cost items, five were based initially on estimated U.S. values and then adjusted as appropriate to fit foreign-flag conditions. The single exception to this approach was manpower. Reflecting the dominant role of flags of convenience in the U.S. oil trade, average foreign 1970 crew costs were based on the experience of several companies operating under those flags. In practice, the level of crew costs varies widely by flag. Although often higher for some Western European operators, average 1970 compensation was believed to have been in the same range for some other flag vessels, including those of Japan, Greece, and Norway.

Unit cost estimates for subsistence, stores and supplies, maintenance and repair, and insurance were initially based on early 1970 circumstances for U.S.-flag ships as indicated by a major shipbuilding firm. They were then verified through personal interviews with officials of ship chartering and marine insurance firms.

Except for insurance, adjustments in estimated U.S. operating cost values for foreign-flag conditions were made primarily on the basis of unpublished Corps of Engineers' data, which indicated estimated annual costs for each item in 1969-70 for numerous U.S.- and foreign-flag vessels of varying size. As with manpower, actual values vary somewhat by specific case. However, since the quantitative significance of the combined three items in total shipping costs is quite small, any reasonable alternative assumptions would have only minor consequences.

The general level of insurance rates is essentially the same in the United States and abroad. However, types and extent of coverage purchased, relevant vessel operating conditions, actuarial experience, and insurers' perceptions of risk vary considerably in individual cases. Insurance costs assumed here reflect extended discussions with leading brokers and are considered indicative of 1970 conditions.

The two main components of insurance charges are hull and machinery (H&M) and protection and indemnity (P&I). H&M insurance covers loss and damage to the insured vessel itself, while P&I protects against loss of life or injury of crew or other persons, cargo loss or damage, and damages to other vessels or property, including those arising from water pollution. Recently, H&M insurance has been the far more important risk for insurers.

The structure of H&M insurance rates in relation to vessels of varying sizes has changed substantially in the last few years. Historically, insurance costs per d.w.t. tended to decline with vessel size. Because actuarial experience with the very large carriers is limited, several major losses of VLCC's resulted in a changing rate structure. By 1970, rates for H&M insurance per d.w.t. tended to increase with vessel size. The stability of this recent rate structure is subject to considerable uncertainty, and major changes could have significant impacts on costs. Issues and implications involved are treated further in the sensitivity analysis.

The assumed value for general overhead costs is necessarily arbitrary. Most ocean shipping enterprises operate a number of vessels often of different types and in significantly different markets. No empirical data are available on such costs, and there would still be a difficult problem of allocation. The underlying assumption in our modest value is that only limited office support is required for vessels operating regularly on particular links, and that it would not vary materially by vessel size.

Unit fuel costs are notoriously difficult to estimate generally. They vary considerably in different parts of the world at any given time and are highly volatile over time. The assumed value of $2.50 per barrel for Bunker C appeared to be a reasonably typical value within a broad range of actual worldwide prices during 1970. Because it constitutes a significant proportion of total shipping cost, implications for alternative unit fuel costs are considered in the sensitivity analysis.

Results

The Influence of Vessel Size on Ocean Shipping Costs

Comprehensive estimates of total unit ocean shipping costs which reflect the above methods and assumptions are presented here in both statistical and graphic form. Table 57 indicates the total cost in dollars per long ton of cargo carried in each of 31 vessels for 1-way trip distances ranging from 1,000 to 15,000 nautical miles. For the same ships and trip distances table 58 indicates those costs in terms of mills per ton-mile. The latter are also represented in the form of curves in appendix figures 4 through 14, based on the modestly lower, unadjusted cost estimates. Supplementary figures and tables drawing selectively upon these comprehensively presented data are also introduced in the discussion to facilitate understanding.

To illuminate the general influence of scale economies in ocean shipping, we have prepared a single curve (figure 2) which shows for trips (one way) of 5,000 miles the total cost of transporting a long ton of oil in tankers ranging from 30,000 to 500,000 d.w.t. As strikingly indicated by the curve, unit costs decline continuously as vessel size increases. However, the degree of cost reduction diminishes progressively over the full range.

Table 57. Estimated Unit Costs Per Cargo-Ton, by Foreign-Flag Vessel Size and Distance

(In 1970 dollars)

Vessel draft and d.w.t.	One-way trip distances (nautical miles)					
	1,000	2,000	5,000	7,500	10,000	15,000
35-foot draft						
30,000.......	1.079	1.808	4.040	5.948	7.890	12.000
40,000.......	.909	1.518	3.385	4.988	6.610	10.005
50,000.......	.806	1.356	3.020	4.433	5.910	8.925
51,500.......	.798	1.340	2.985	4.380	5.800	8.790
40-foot draft						
45,000.......	.848	1.416	3.165	4.658	6.190	9.375
60,000.......	.717	1.206	2.680	3.953	5.250	7.890
75,000.......	.654	1.096	2.435	3.593	4.750	7.200
78,500.......	.638	1.076	2.395	3.518	4.650	7.035
45-foot draft						
65,000.......	.685	1.156	2.595	3.810	5.060	7.635
80,000.......	.618	1.044	2.320	3.413	4.520	6.810
95,000.......	.576	.980	2.180	3.203	4.230	6.360
110,000......	.547	.914	2.055	3.015	4.000	6.015
50-foot draft						
90,000......	.571	.970	2.160	3.180	4.200	6.315
120,000......	.515	.870	1.935	2.835	3.760	5.640
140,000......	.500	.840	1.875	2.745	3.620	5.460
157,000......	.489	.828	1.835	2.700	3.570	5.385
55-foot draft						
120,000......	.500	.842	1.870	2.738	3.620	5.445
140,000......	.479	.818	1.830	2.678	3.540	5.325
180,000......	.470	.796	1.780	2.618	3.460	5.205
210,000......	.462	.784	1.750	2.573	3.410	5.130
60-foot draft						
150,000......	.462	.770	1.715	2.498	3.310	4.950
200,000......	.445	.760	1.690	2.475	3.290	4.935
263,000......	.448	.764	1.695	2.475	3.290	4.935
58½-foot draft						
250,000......	.454	.760	1.685	2.468	3.270	4.905
65-foot draft						
250,000......	.454	.760	1.680	2.460	3.270	4.905

continued--

Table 57. Estimated Unit Costs Per Cargo-Ton, by Foreign-Flag Vessel Size and Distance
continued--

(In 1970 dollars)

Vessel draft and d.w.t.	One-way trip distances (nautical miles)					
	1,000	2,000	5,000	7,500	10,000	15,000
62-foot draft 300,000......	.446	.746	1.655	2.423	3.200	4.770
71-foot draft 300,000......	.417	.692	1.530	2.235	2.950	4.425
68½-foot draft 400,000......	.430	.716	1.575	2.310	3.050	4.560
83-foot draft 400,000......	.388	.654	1.440	2.108	2.790	4.170
75-foot draft 500,000......	.432	.718	1.580	2.318	3.050	4.560
95-foot draft 500,000......	.386	.644	1.420	2.078	2.740	4.080

Source: Hydronautics, Inc., estimates, with RRNA adjustments.

Table 58. Estimated Unit Shipping Costs Per Ton-Mile, by Foreign-Flag Vessel Size and Distance

(In 1970 mills)

Vessel draft and d.w.t.	One-way trip distances (nautical miles)					
	1,000	2,000	5,000	7,500	10,000	15,000
35-foot draft						
30,000.......	1.079	.904	.808	.793	.789	.800
40,000.......	.909	.759	.677	.665	.661	.667
50,000.......	.806	.678	.604	.591	.591	.595
51,500.......	.798	.670	.597	.584	.580	.586
40-foot draft						
45,000.......	.848	.708	.633	.621	.619	.625
60,000.......	.717	.603	.536	.527	.525	.526
75,000.......	.654	.548	.487	.479	.475	.480
78,500.......	.638	.538	.479	.469	.465	.469
45-foot draft						
65,000.......	.685	.578	.519	.508	.506	.509
80,000.......	.618	.522	.464	.455	.452	.454
95,000.......	.576	.490	.436	.427	.423	.424
110,000......	.547	.457	.411	.402	.400	.401
50-foot draft						
90,000......	.571	.485	.432	.424	.420	.421
120,000......	.515	.435	.387	.378	.376	.376
140,000......	.500	.420	.375	.366	.362	.364
157,000......	.489	.414	.367	.360	.357	.359
55-foot draft						
120,000......	.500	.421	.374	.365	.362	.363
140,000......	.479	.409	.366	.357	.354	.355
180,000......	.470	.398	.356	.349	.346	.347
210,000......	.462	.392	.350	.343	.341	.342
60-foot draft						
150,000......	.462	.385	.343	.333	.331	.330
200,000......	.445	.380	.338	.330	.329	.329
263,000......	.448	.382	.339	.330	.329	.329
58½-foot draft						
250,000......	.454	.380	.337	.329	.327	.327
65-foot draft						
250,000.......	.454	.380	.336	.328	.327	.327

continued--

Table 58. Estimated Unit Shipping Costs Per Ton-Mile, by Foreign-Flag Vessel Size and Distance continued--

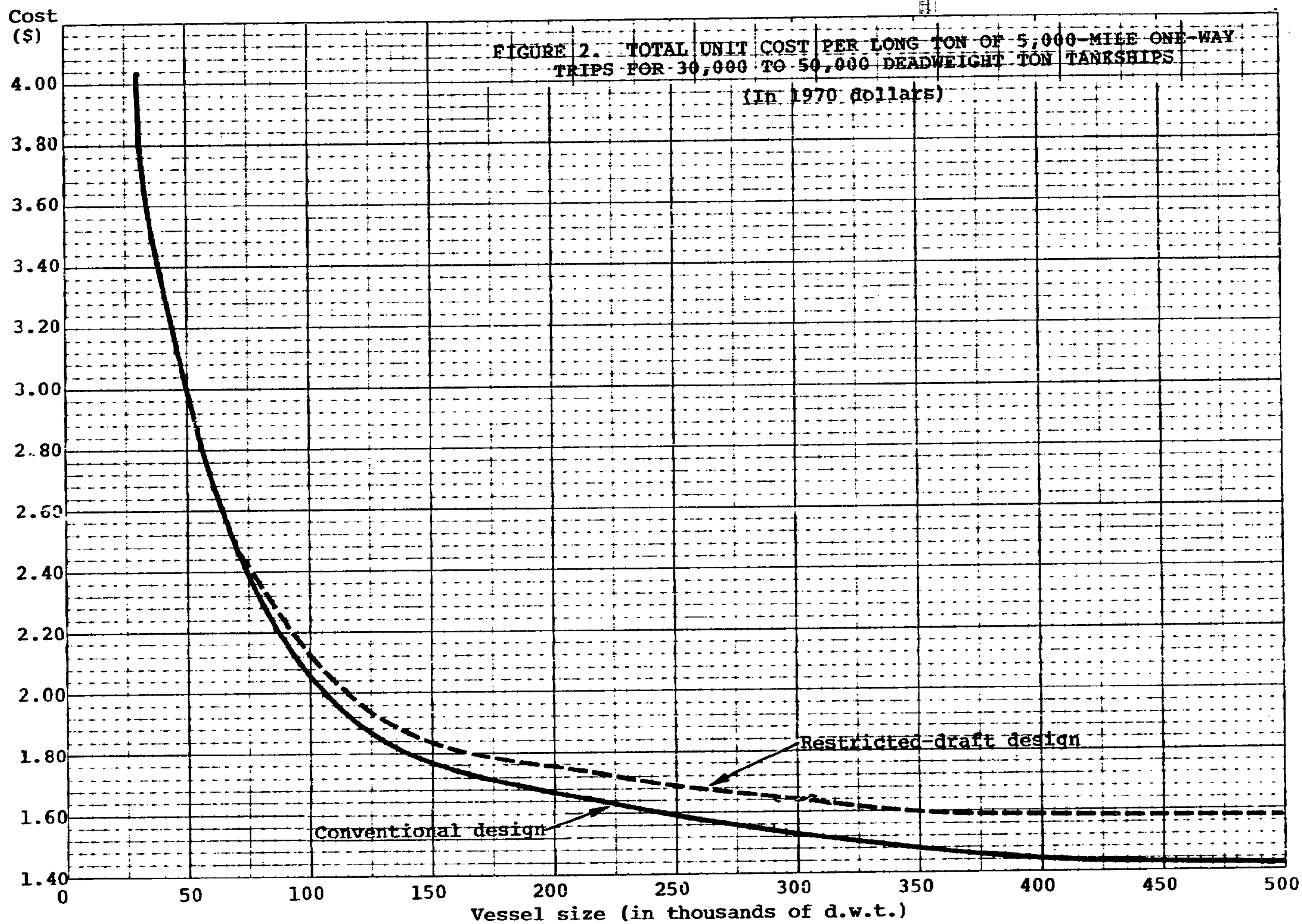
(In 1970 mills)

Vessel draft and d.w.t.	One-way trip distances (nautical miles)					
	1,000	2,000	5,000	7,500	10,000	15,000
62-foot draft						
300,000......	.446	.373	.331	.323	.320	.318
71-foot draft						
300,000......	.417	.346	.306	.298	.295	.295
68½-foot draft						
400,000......	.430	.358	.315	.308	.305	.304
83-foot draft						
400,000......	.388	.327	.288	.281	.279	.278
75-foot draft						
500,000......	.432	.359	.316	.309	.305	.304
95-foot draft						
500,000......	.386	.322	.284	.277	.274	.272

Source: Table 57.

FIGURE 2. TOTAL UNIT COST PER LONG TON OF 5,000-MILE ONE-WAY TRIPS FOR 30,000 TO 50,000 DEADWEIGHT TON TANKSHIPS

(In 1970 dollars)



Whereas shipment in a 30,000-d.w.t. vessel would cost a little over $4 per ton, the unit cost would be around $3 in a 50,000-d.w.t. vessel and approximately $2.10 in a 100,000-d.w.t. vessel. An additional doubling of vessel size to 200,000 d.w.t. would further reduce unit costs by less than 20 percent to the $1.70 range. A jump to still larger ships would produce further, but more modest, savings. A 500,000-d.w.t. vessel would be expected to lower unit costs by only some $0.12 to $0.30 a ton over the 200,000-d.w.t. vessel, depending upon its design characteristics. As is subsequently explained further, however, the <u>absolute</u> cost advantage of ship size also depends upon <u>voyage length</u> and therefore increases with distance.

A review of the internal structure of costs for tankers of different sizes may further illuminate the question of scale economies. To facilitate presentation, only three vessels are treated in depth, all of which are of conventional design and proportions but of sharply contrasting size. These are vessels of 40,000, 120,000, and 300,000 d.w.t. ("small," "medium" and "large" vessels). More detailed design characteristics of the three ships are specified in table 59, which also indicates total annual costs by various components for each vessel. Except for fuel, those components would be the same regardless of trip distances. Fuel costs are represented for 5,000-mile journeys. They would be somewhat higher for longer trips and lower for shorter ones, but not greatly different except for relatively very short journeys.

For analytic purposes it is more convenient to represent those annual costs by percentage distributions and by vessel capacity. As indicated in table 60, each cost component's proportion of total annual costs varies somewhat by vessel size. Annual capital charges represent somewhat less than half the total costs of all three vessels; operating costs, more or less than one-fourth; fuel, most of the balance. Some operating costs, notably crew, subsistence, and maintenance as well as overhead, decline sharply as a proportion of total annual cost in the larger vessels. The reverse is true, however, for H&M insurance, which accounts for nearly 11 percent of the 300,000-d.w.t. vessel's, but

Table 59. Estimated Annual Ocean Shipping Costs for Three Sizes of Foreign-Flag Tankers, by Cost Category

(In thousands of 1970 dollars)

Cost component	Vessel d.w.t.		
	40,000[a/]	120,000[b/]	300,000[c/]
Investment...........	739.4	1,286.1	2,409.4
Operating:			
Crew.................	169.0	169.0	221.0
Stores and supplies.	50.6	87.4	169.1
Subsistence.........	17.9	17.9	23.5
Maintenance, repair.	70.2	104.3	178.3
H&M insurance.......	78.3	188.2	574.2
P&I insurance.......	37.6	68.3	141.0
Subtotal...........	423.6	635.1	1,307.1
Overhead.............	25.0	25.0	25.0
Total annual cost excluding fuel......	1,188.0	1,946.2	3,741.5
Annual fuel costs, 5,000 mile, 1-way trips...............	351.4	729.8	1,583.1
Total annual cost....	1,539.4	2,676.0	5,324.6

a/ 35' draft; length, B.P. 650'; breadth, mld. 97'2"; depth, mld. 47'; SHP, 14,100; speed, 16 knots; crew, 26.
b/ 50' draft; length, B.P. 900'; breadth, mld. 136'; depth, mld. 65'4"; SHP, 28,100; speed, 16 knots; crew 26.
c/ 71' draft; length, B.P. 1,095'; breadth, mld. 190'; depth, mld. 91'; SHP, 58,000; speed, 16 knots; crew, 34.

Source: Hydronautics, Inc., estimates, with RRNA adjustments.

Table 60. Estimated Distribution of Annual Ocean Shipping Costs for Three Sizes of Foreign-Flag Tankers, by Cost Category

(In percent)

Cost component	Vessel d.w.t.		
	40,000 (35' draft)	120,000 (50' draft)	300,000 (71' draft)
Investment.........	48.0	48.1	45.3
Operating:			
Crew..............	11.0	6.3	4.2
Stores and supplies........	3.3	3.3	3.2
Subsistence	1.2	0.7	0.4
Maintenance, repair..........	4.6	3.9	3.3
H&M insurance....	5.1	7.0	10.8
P&I insurance....	2.4	2.6	2.6
Subtotal........	27.5	23.7	24.5
Overhead...........	1.6	0.9	0.5
Total annual cost excluding fuel...	77.2	72.7	70.3
Annual fuel costs - 5,000-mile, one-way trips........	22.8	27.3	29.7
Total annual cost.............	100.0	100.0	100.0

Source: Table 59.

only 5 percent of the 40,000-d.w.t. vessel's, total annual costs. In addition, while nearly 30 percent of a supertanker's total annual costs are attributable to fuel, the latter accounts for less than 23 percent of total costs for the 40,000-d.w.t. vessel.

The influence of scale economies in ocean shipping by type of cost is revealed in table 61 for the same three representative vessels. Nearly half the difference in total annual cost per d.w.t. between a 120,000-d.w.t. vessel and a 40,000-d.w.t. vessel is due to economies in construction costs. Another third of the difference is attributable to the larger vessel's lower unit crew and fuel costs, and the balance to minor economies in other elements.

Differences in total costs per d.w.t. between 120,000-d.w.t. and 300,000-d.w.t. vessels are very much smaller. However, the same three cost components account for all but a small part of the difference: capital costs, for nearly 60 percent; and fuel and crew costs combined, for nearly another third.

The preceding paragraphs pertain to voyages of 5,000 miles. Unit costs of ocean shipping are of course highly sensitive to voyage distance: the longer the trip, the greater the cost. However, incremental costs of transport per ton-mile tend to decrease with distance, up to a point which differs somewhat by vessel size.

The first point is documented by table 62, which shows unit shipping costs for the three representative small, medium and large vessels over a wide range of distances. The table also indicates cost differences among those vessels by trip length. Clearly, scale effects have their biggest payoffs on long journeys. It is precisely for this reason that large tankers and bulk carriers are engaged primarily in voyages exceeding 5,000 miles.

Table 61. Estimated Annual Ocean Shipping Costs Per Deadweight Ton for Three Sizes of Foreign-Flag Tankers

(In 1970 dollars)

Cost component	Vessel d.w.t.		
	40,000 (35' draft)	120,000 (50' draft)	300,000 (71' draft)
Investment........	18.49	10.72	8.03
Operating:			
Crew.............	4.23	1.41	0.74
Stores and supplies........	1.27	0.73	0.56
Subsistence......	0.45	0.15	0.08
Maintenance, repair............	1.76	0.87	0.59
H&M insurance....	1.96	1.57	1.91
P&I insurance....	0.94	0.57	0.47
Subtotal........	10.59	5.29	4.36
Overhead..........	0.63	0.21	0.08
Total annual cost excluding fuel...	29.70	16.22	12.47
Annual fuel costs, 5,000 mile, one-way trips........	8.79	6.08	5.28
Total annual cost.	38.49	22.30	17.75

Source: Table 60.

Table 62. Total Unit Cost, and Absolute Differences in Total Unit Cost, Per Cargo Long Ton by Distance, for Three Selected Foreign-Flag Vessels

(In 1970 dollars)

Vessel	One-way distance (nautical miles)				
	1,000	2,000	5,000	10,000	15,000
	Total unit cost				
40,000 d.w.t. (35' draft)....	0.91	1.52	3.39	6.61	10.01
120,000 d.w.t. (50' draft)....	0.52	0.87	1.94	3.76	5.64
300,000 d.w.t. (71' draft)....	0.42	0.69	1.53	2.95	4.43
	Absolute differences in total unit cost				
120,000 d.w.t. over 40,000 d.w.t..........	0.39	0.65	1.45	2.85	4.37
300,000 d.w.t. over 40,000 d.w.t..........	0.49	0.83	1.86	3.66	5.58
300,000 d.w.t. over 120,000 d.w.t..........	0.10	0.18	0.41	0.81	1.21

Source: Table 60.

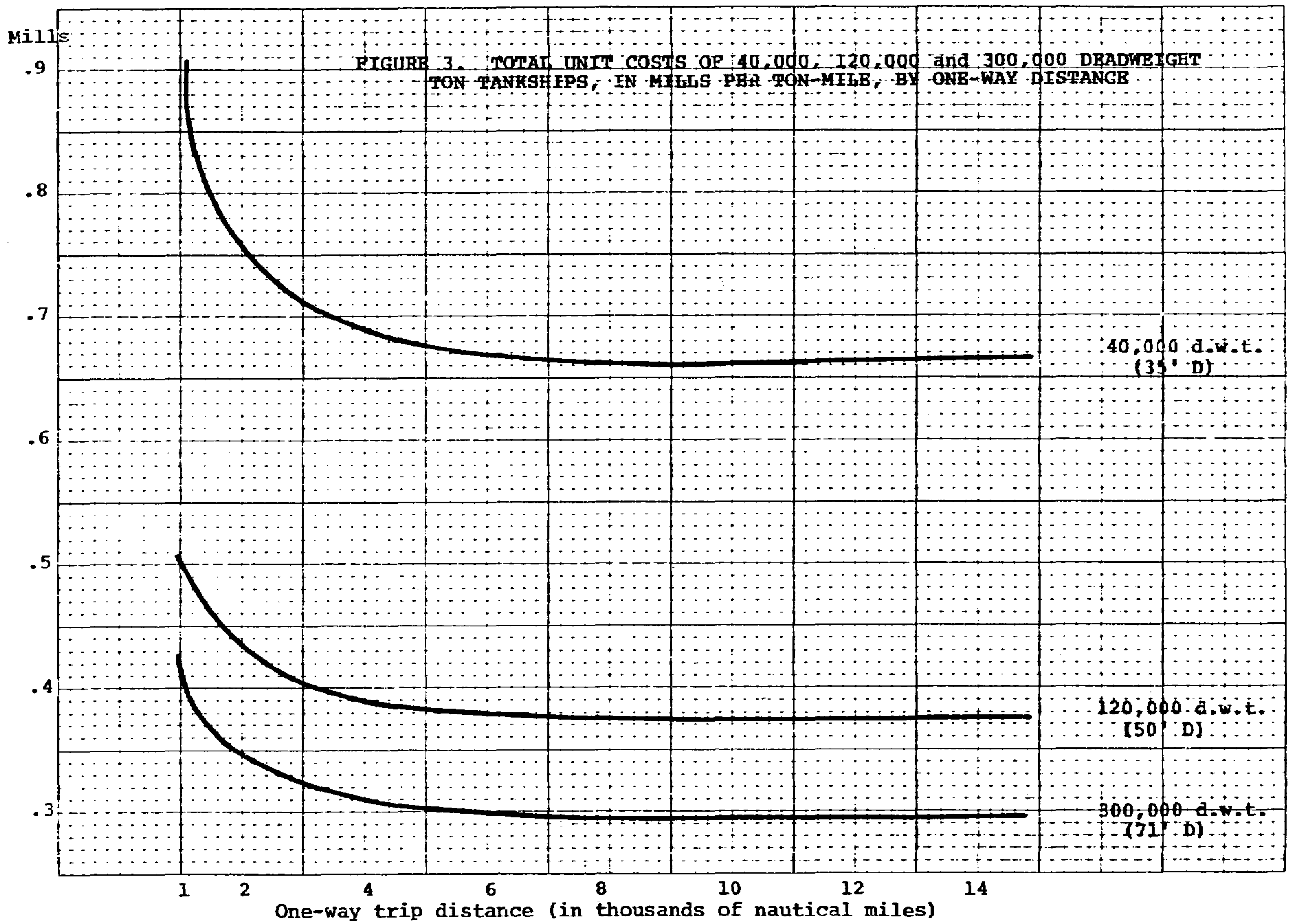
While the effect of voyage distance on incremental costs is suggested in table 62, it is more sensitively illustrated by figure 3. This figure clearly shows the substantial decrease in unit costs of ocean shipping per ton-mile up to 5,000 miles, and to a much more limited degree for greater distances, in our three representative vessels. The pronounced downward slope of the three curves over the shorter distance range is explained by the rapid increase in the proportion of total round-trip time spent at sea rather than in port, total daily costs for which are the same except for fuel. Whereas under our basic costing assumptions, nearly 39 percent of complete round-trip voyage time for vessels of all sizes would be spent in ports on 1,000-mile movements, it would fall to about 11 percent on 5,000-mile journeys and to only 4 percent on 15,000-mile trips. Conversely, a ship continuously engaged in the latter run would have 57 percent more miles at sea than if it operated on the 1,000-mile link. Its annual costs, which are mostly fixed, would therefore be spread over a substantially larger ton-mile base.

On relatively long voyages, incremental costs per ton-mile begin to level off and actually rise at some point. This reflects the need to use relatively more of the vessel's deadweight for fuel, making less deadweight available for cargo. When the effect of reduced cargo tonnage offsets the opposite influence of increased sea miles, average costs per ton-mile rise. As indicated in figure 3, that point is reached soonest by small ships, but in the case of all three representative vessels, is reached between 10,000 and 15,000 miles. This factor contributes to the cost advantage of large vessels over smaller ones on long hauls, although it is a very modest contribution.

Cost Implications of Increased Vessel Size with Restricted Drafts

Generally speaking, very substantial scale economies in ocean transport can be realized only by increasing all vessel dimensions, including draft. However, within certain practical limits, moderately significant reductions in unit shipping costs can be achieved

FIGURE 3. TOTAL UNIT COSTS OF 40,000, 120,000 and 300,000 DEADWEIGHT TON TANKSHIPS, IN MILLS PER TON-MILE, BY ONE-WAY DISTANCE



at a given draft by increasing the vessel's other dimensions (beam and length); that is, by altering its proportions. Since draft is usually the least costly dimension to increase, this approach to realization of scale economy normally incurs a penalty in relation to a vessel of equal capacity designed without regard to draft restriction. The quantitative value of the penalty, however, is very sensitive to specific design considerations.

Estimated unit costs for all the restricted-draft vessels1/ are included with the others in tables 57 and 58. However, to facilitate appraisal, table 63 arranges the data for relevant vessels by comparable size groups. Unfortunately, no vessels of precisely the same d.w.t. and different draft requirements were designed and costed below 120,000 d.w.t. Thus, to permit reasonable comparison, some interpolation was necessary for smaller ships. The data suggest that, at least for vessels up to 200,000 to 250,000 d.w.t., relatively modest draft restriction of about 8 to 12 percent for a given vessel size results in very small cost penalties. For the particular vessels costed up to 250,000 d.w.t., they range from virtually zero to 4 percent in total unit costs per cargo-ton.

It should be emphasized, however, that the precise penalties are subject to gross estimating error which probably exceeds the minor differences shown. Nevertheless, their general implication is clear. Furthermore, a firm associated with naval architects at the Webb Institute has been making more detailed studies of a similar nature. They reportedly indicate that incremental costs of increasing vessel capacity at a given draft constraint are very small. Unfortunately, these studies are proprietary.

A comparison of each pair of vessels designed for 300,000, 400,000 and 500,000 d.w.t., respectively,

1/ Sometimes casually referred to as "broad beam" ships. Since both length and beam are usually modified, the more general concept of "restricted draft" vessel is preferred.

Table 63. Estimated Total Unit Costs Per Long Ton of Cargo for Restricted-Draft vs. Standard Design Foreign-Flag Tankers of Selected Sizes

(In 1970 dollars)

Draft and d.w.t.		Cost per long ton by 1-way journey		
		2,000 miles	5,000 miles	10,000 miles
35'	30,000....	1.808	4.040	7.890
35'	40,000....	1.518	3.385	6.610
35'	50,000....	1.356	3.020	5.910
35'	45,000a/..	1.437	3.203	6.260
40'	45,000....	1.416	3.165	6.190
40'	60,000....	1.206	2.680	5.250
40'	75,000....	1.096	2.435	4.750
40'	65,000a/..	1.169	2.598	5.083
45'	65,000....	1.156	2.595	5.060
45'	80,000....	1.044	2.320	4.520
45'	95,000....	0.980	2.180	4.230
45'	90,000a/..	1.000	2.230	4.330
50'	90,000....	0.970	2.160	4.200
50'	120,000....	0.870	1.935	3.760
55'	120,000....	0.842	1.870	3.620
50'	140,000....	0.840	1.875	3.620
55'	140,000....	0.818	1.830	3.540
55'	180,000....	0.796	1.780	3.460
55'	210,000....	0.784	1.750	3.410
55'	200,000a/..	0.788	1.760	3.427
60'	200,000....	0.760	1.690	3.290
58½'	250,000....	0.760	1.685	3.270
65'	250,000....	0.760	1.680	3.270
62'	300,000....	0.746	1.655	3.200
71'	300,000....	0.692	1.530	2.950
68½'	400,000....	0.716	1.575	3.050
83'	400,000....	0.654	1.440	2.790
75'	500,000....	0.718	1.580	3.050
95'	500,000....	0.644	1.420	2.740

a/ Interpolated.
Source: Table 60.

suggests that cost penalties of draft restriction may be somewhat greater for very large vessels. In the three cases represented, they range from about 8 to 11 percent. However, the degree of draft restriction, from 13 to 21 percent, is also substantially greater than in the case of the smaller vessels. Furthermore, because of the very limited data available for such large vessels, the estimates are subject to greater error than for other vessels.

Further light on this subject may be cast by recent studies of a restricted-draft design for a 425,000-d.w.t. tanker by a Dutch group.1/ Preliminary reports of study findings, which were presented at a Rotterdam conference in mid-September 1971, suggested negligible differences in total unit costs between the specially designed tanker drawing only 72 feet and a tanker of the same capacity of "normal" design drawing 88 feet.2/ However, as of this writing, the relevant studies were still awaiting publication. In any event, much further investigation, well beyond the scope of this study and probably beyond that of the Dutch studies, is likely to be required to resolve numerous uncertainties.

Penalties may be incurred in the design of restricted-draft vessels relative to others of equal size whose draft is unconstrained. However, restricted-draft vessels may nevertheless provide significant cost gains over smaller ships of equal draft. It is, of course, precisely under the common conditions of constraint in available water depth that modified vessel design offers potential payoffs. Table 63 can now be appraised from a new vantage point. Instead of comparing the costs of vessels of equal capacities at different drafts, one can compare the costs of ships of different sizes at a given draft. As indicated in the table, restricted-draft designs (those of larger

1/ Verolme United Shipyards, Netherlands Ship Model Basin of Wageningen, Municipality of Rotterdam, and the Dutch Ministry of Transport.
2/ As reported in the Journal of Commerce, October 4, 1971.

capacities at a given draft) have lower total unit costs. This fact is in keeping with the general pattern of scale economies in ocean shipping discussed above. For example, total unit costs of a 50,000-d.w.t. vessel drawing 35 feet of water are approximately 25 percent lower than those of a 30,000-d.w.t. vessel of equal draft. The difference in total unit costs between a 75,000-d.w.t. and a 45,000-d.w.t. ship, each drawing 40 feet, is nearly as great. At 55 feet draft, the advantage in total unit costs of a 210,000-d.w.t. over a 140,000-d.w.t. vessel is less than 4 percent. Equivalent appraisal of larger vessels is difficult because none of the design drafts are directly comparable. However, a close examination of the table clearly suggests that differences would be relatively minor or inconsequential.

Estimated 1970 Unit Costs of U.S.-Flag Tankers

For study purposes, cost characteristics of ocean vessels operated under foreign flags are of primary interest. They have recently dominated carriage of bulk commodities in U.S. foreign trade, a situation which is expected to continue (see chapter I). The Merchant Marine Act of 1970 has provided a new subsidy program to builders and operators of U.S.-flag tankers, bulk carriers, and other types of ships which serve U.S. foreign commerce. In principle, the amount of subsidy for a particular vessel is designed to cover most of the difference between U.S.- and foreign-flag costs. Although effective interest by industry groups in the new program evolved slowly, by mid-1972, construction subsidies had been approved for 16 oil tankers and two O/B/O's, ranging in size from 35,000 d.w.t. to 265,000 d.w.t., as well as for 25 vessels of other kinds.

The degree to which this new subsidy program will increase the U.S.-flag carrier share of the large and growing market in seaborne trade of oil and dry bulk commodities is highly uncertain. The outcome is dependent mostly upon the number, type, and size characteristics of vessels actually put into service, their effective ability to compete in various cargo markets, and the rate of growth in those various markets. Nonetheless, one relevant ocean-shipping market is certain to be controlled by U.S.-flag ships: the Alaskan oil trade with the continental United States, when and if the proposed pipeline to Valdez is finally approved and constructed. Vessels operating exclusively in this domestic market would, of course, not qualify for subsidy under the Act. We have accordingly estimated total unit costs of oil movements in U.S.-flag tankers the same way as for foreign-flag vessels. All concepts and assumptions are identical. Differences arise only as to values of individual cost components.

Most of the corresponding foreign-flag values were arrived at by the application of various adjustment factors to U.S. costs, which have been explained earlier. For convenience, however, they are repeated in table 64. There are three exceptions: manpower, overhead and fuel. Values shown for them reflect discussion with several U.S.-flag shipping concerns, among which conditions vary somewhat. However, they are believed to be reasonably representative of prevailing circumstances in 1970.

The prior U.S. values were then substituted for corresponding foreign-flag cost components to derive estimates of total annual costs for the representative small, medium, and large tankers operating on a regular 5,000-mile journey with return in ballast. Results are shown in table 65, which is directly comparable to foreign-flag data contained in table 59.

Since U.S.-flag vessels are projected in this study only to carry oil from Valdez to major west coast ports, the distances of haul involved are relatively short. For each of the three representative tankers and for estimated distances on the three pertinent links, total annual costs in both U.S. and foreign vessels were estimated, as shown in table 66. Since vessel design and operating conditions are identical, relationships of total unit costs per cargo-ton would be the same.

As indicated in table 66, estimated unit costs are substantially higher for U.S.-flag than for

Table 64. Assumed Values of Individual Cost Components in Estimating Total Unit Shipping Costs for U.S.-Flag Tankers

(In 1970 dollars)

Cost component	Values
Total investment..........	X
Annual capital charge.....	0.11746X
Annual operating costs	
Manpower................	19,500/man
Subsistence.............	986/man
Stores & supplies.......	$1.84\left[4{,}500 + \frac{SHP}{3} + 10{,}000 + 0.21\ (d.w.t. + 9{,}500)\right]$
Maintenance & repair....	90,400 + 0.69(CN - 1,500) + 0.49(CN)
H&M insurance...........	$\left(0.1 + \frac{0.00006}{1{,}000}\right)X$
P&I insurance...........	750M + 0.61CN
Annual overhead & general.................	50,000
Fuel (Bunker C)...........	(2.50/bbl.)Y

Definitions:

SHP Normal shaft horsepower
CN Cubic number = (length x beam x draft) ÷ 100
M Number of crew
d.w.t. Total deadweight tons
X Independent estimate for each vessel
Y Independent estimate of propulsion requirements for each vessel at 16 knot speed and corresponding fuel consumption rate

Source: Hydronautics, Inc., and RRNA.

Table 65. Estimated Annual Ocean Shipping Costs for Three Sizes of U.S.-Flag Tankers, by Cost Category

(In thousands of 1970 dollars)

Cost component	Vessel d.w.t.		
	40,000[a/]	120,000[a/]	300,000[a/]
Investment.............	1,344.4	2,338.4	4,380.7
Operating:			
Crew...................	507.0	507.0	663.0
Stores and supplies....	54.4	94.0	181.8
Subsistence............	25.6	25.6	33.6
Maintenance, repair....	125.4	186.3	318.4
H&M insurance..........	142.4	342.0	1,044.0
P&I insurance..........	37.6	68.3	141.0
Subtotal.............	892.4	1,223.2	2,381.8
Overhead...............	50.0	50.0	50.0
Total annual cost, excluding fuel...........	2,286.8	3,611.6	6,812.5
Annual fuel cost, 5,000 mile, 1-way trips.................	351.4	729.8	1,583.1
Total annual cost.......	2,638.2	4,341.4	8,395.6

a/ For design characteristics, see table 59.

Source: RRNA estimates.

Table 66. Total Annual Costs,[a] and Ratio of U.S.-Flag to Foreign-Flag Ocean Shipping Costs For Three Sizes of Tankers, by Selected Distances

Item	Vessel d.w.t.		
	40,000[b]	120,000[b]	300,000[b]
5,000-mile trip[c]			
Total annual cost ($1,000):			
U.S. flag	2,638.2	4,341.4	8,395.6
Foreign flag	1,539.4	2,676.0	5,324.6
Ratio, U.S. to foreign (percent)	171.4	162.2	157.7
2,300-mile trip[c]			
Total annual cost ($1,000):			
U.S. flag	2,612.2	4,259.7	8,150.6
Foreign flag	1,513.4	2,594.3	5,079.6
Ratio, U.S. to foreign (percent)	172.6	164.2	160.5
2,000-mile trip[c]			
Total annual cost ($1,000):			
U.S. Flag	2,602.1	4,239.5	8,108.9
Foreign flag	1,503.3	2,574.1	5,037.9
Ratio, U.S. to foreign (percent)	173.1	164.7	161.0
1,200-mile trip[c]			
Total annual cost ($1,000):			
U.S. flag	2,558.6	4,152.9	7,930.1
Foreign flag	1,459.8	2,487.5	4,859.1
Ratio, U.S. to foreign (percent)	175.3	167.0	163.2

a/ In 1970 dollars.
b/ For design characteristics, see table 59.
c/ One-way, with return in ballast.

Source: RRNA and Hydronautics, Inc., estimates.

foreign-flag vessels. However, cost differences vary by ship size and trip distance. The increment in U.S. costs is greater for small ships on short hauls than for large ships on long hauls. This pattern largely reflects the significance of fuel consumption, the relative importance of which in total costs increases with ship size and distance at the constant 16-knot speed assumed for all vessels. Since fuel cost is assumed to be the same for tankers of any flag, it has the effect of reducing differences in total unit costs among the other cost components.

Unit Costs of Dry Bulk and Combined Carriers

The preceding discussion and analysis pertains to cost characteristics of vessels specifically designed for the carriage of crude oil or petroleum products. However, this study is also concerned with ocean transport of dry bulk commodities. It is therefore necessary to consider the way in which costs of the specialized vessels which carry dry bulk commodities may differ. Furthermore, with the recent emergence and growing importance of combined carriers, the nature of their costs also warrants treatment.

It would have been ideally desirable to develop cost estimates for these other vessel types in the same detail as was done for tankers. That approach was not used here because the substantial additional effort required would have had only marginal value. The cost differences involved are known to be modest. This reflects the fact that basic design and operating features of vessels engaged in either wet or dry bulk trades are generally similar, differing mostly in internal arrangements and design of cargo holds.

As far as ocean transport of ore, grain, coal and other dry bulk cargoes are concerned, several major chartering companies have advised us that real cost differences involved between tankers and dry bulk carriers of comparable size, speed and operating circumstances are negligible. This is partly confirmed by several published reports, which indicate that first costs of bulk carriers are some 3 to 4 percent higher (table 67).

Properly comparable published data on other specific cost elements of dry bulk vessels in relation to tankers are more difficult to find. However, crew size, average wages, subsistence, and general overhead reportedly would be comparable. On the other hand, maintenance and repair costs would perhaps slightly exceed those incurred in the operation of tankers of equal capacity because of the slightly greater lightship weight.

Combined carriers are relatively more costly than dry bulk carriers of equal size to build and to operate, reflecting their inherently more elaborate design. As shown in table 67, their investment costs are reportedly from 8 to 16 percent higher than those of tankers of equal d.w.t., depending largely upon the commodity mix for which they are designed. Ore/oil carriers are at the low end and ore/bulk/oil carriers are at the high end of that percentage range.

Detailed data on other cost elements of combined carriers permitting direct comparison with tankers or with dry bulk carriers are unavailable. Overall, they would certainly be higher than for tankers of equal capacity, for the same reasons as they are for dry bulk ships. One recent study examined costs of several 60,000-d.w.t. ships having similar dimensional characteristics but designed for different combinations of cargo. It suggests that the increment in capital costs for combined carriers would be significantly greater than the increment in all other costs (table 68).

Although total vessel costs of combined carriers per ton of capacity exceed those for tankers and dry bulk carriers, their costs per ton of cargo carried are likely to be somewhat lower. This is because they are built and operated entirely on the expectation of reducing voyage time in ballast. Thus, combined carriers should normally improve upon the 50-percent average load factor assumed in our estimates of tanker and dry

Table 67. Investment Cost Relationships of Tankers, Dry Bulk Vessels, and Combined Carriers of Equal Deadweight

Type of vessel	Index number	Source
Conventional tanker.............	100	--
Dry bulk carrier................	103-4	A
	104	B
Single stowage factor.........	X	C,D
Multiple stowage factor.......	1.03X	C,D
Combined carrier		
Ore/oil (O/O).................	109	E
	108	A
	1.05X	D
Ore/coal/oil (SOCO)...........	110-111	E
Bulk[a]/oil (B/O)...............	108X	C,D
Ore/bulk/oil (O/B/O)..........	116	E
	115	A

a/ Low density.

Sources:

A. "The Combination Bulk Carrier," Surveyor (quarterly publication of the American Bureau of Shipping), August 1970, p. 22.

B. Trevor D. Heaver, "The Cost of Large Vessels," National Ports Council Research and Technical Bulletin No. 70 (London, August 1970), p. 348 (Table 1-100,000 d.w.t. vessels).

C. Booz-Allen Applied Research, Inc., Trading Opportunities for U.S. Flag Dry Bulk Carriers (Federal Clearinghouse, PB 185761, August 1969), p. 13.

D. Booz-Allen Applied Research, Inc., Bulk Carrier Program Technical Requirements (Federal Clearinghouse, PB 185763, August 1969), p. 32.

E. John I. Jacobs & Company Ltd., World Tanker Fleet Review, 31 December 1970 (London, 1971), p. 7.

Table 68. Relationships of Capital and Total Costs Per Cargo-Ton for Selected Vessel Types of 60,000 Deadweight Tons

(Index: single stowage factor dry bulker = 100)

Vessel	First cost	Total unit cost
Single stowage factor dry bulker...........	100	100
Combination ore/bulk (multiple stowage factor dry bulker)...	103	102
Ore/oil carrier........	105	103
Bulk/oil carrier (low density)........	108	105
Ore/bulk/oil...........	Not reported	

Source: Booz-Allen Applied Research, Bulk Carrier Program Technical Requirements (Federal Clearinghouse PB 185763, August 1969), p. 32; and table 67.

bulk carrier costs. If total annual costs for a given combined carrier were 10 percent higher than those of a tanker of equal size, its average total costs per ton of cargo actually carried would be approximately the same with a load factor of 55 percent. In practice, many combined carriers would be able to exceed that rate, thereby reducing transport costs per ton. For example, if the same vessel transported cargo two-thirds of its time at sea, average unit costs per ton of cargo would be 17.5 percent lower than they would be for a tanker of equal size having only a 50-percent load factor (see table 69).

Sensitivity Analysis

All unit cost estimates and comparisons presented earlier necessarily reflect a single set of assumptions about numerous variables. Since other assumptions might often be warranted, it would be instructive to determine their implications for our costs as initially derived. Because of the great number of factors generally affecting ocean shipping costs, as well as the highly varied cost conditions which at any given time apply to shipping of bulk commodities throughout the world, only a few alternatives can be considered here. However, an effort has been made to include the more obvious and possibly important ones.

Since a major purpose of this chapter is to examine the question of scale economies in ocean shipping, the sensitivity analysis is applied basically to each of the three representative small, medium and large vessels, with some additional treatment of a 500,000-d.w.t. ship. To keep the presentation within manageable limits, the sensitivity of total unit costs to each alternative assumption is tested only for 5,000-mile (one-way) movements with return in ballast. Generally, the indicated rate of change in total unit costs for a given vessel would not vary significantly on journeys of different lengths, except for very short ones. However, with the same exception, absolute monetary values would change greatly, more or less in proportion to distance in most cases.

Table 69. Comparative Unit Costs[a] Per Long Ton of Cargo, in a Foreign-Flag Tanker and Combined Carrier of Equal Size[b]

Item	120,000 d.w.t., 50' draft vessel	
	Tanker	Combined carrier
Total annual cost ($1,000)............	2,676[c]	2,944[d]
50% load factor		
Total annual cargo (1,000 long tons)..	1,383[c]	--
Average cost per long ton ($)...........	1.935	--
55% load factor		
Total annual cargo (1,000 long tons)..	--	1,521
Average cost per long ton ($)...........	--	1.935
66 2/3% load factor		
Total annual cargo (1,000 long tons)..	--	1,844
Average cost per long ton:		
In dollars......	--	1.597
As percent of average cost per long ton at 55% load factor....	--	82.5

a/ In 1970 dollars.
b/ Data based on 5,000-mile (cargo or ballast) legs, 39.5 hours average time in each port, 50 percent load factor.
c/ From table 68.
d/ 10 percent higher than tanker, by rough interpolation from tables 67 and 68.

Source: RRNA estimates.

In table 70, 14 hypothesized changes in the value of cost components or in vessel operating conditions are briefly identified, and the indicated percentage effects on total unit costs are shown separately for each selected vessel. Table 71 expresses those effects in monetary terms.

The nature of most changes is, it is hoped, self-explanatory. A few comments may help to clarify one of them. Under annual capital charges, the fourth hypothesis is intended to reflect either a higher (or lower) than 10-percent net private return on total investment, some income tax payment, or any combination of the two. Because debt usually constitutes a substantial proportion, and equity a small proportion, of investment costs, and because liberal depreciation methods and investment credits are often available, the effect of a 50-percent income tax rate on annual average capital charges would be rather modest.

Generally, total unit costs of the representative vessels are quantitatively most sensitive to changes in investment costs or in capital charges, in both percentage and in absolute terms. This important result reflects the fact that capital costs and related charges constitute the largest single element of total unit costs for all ships.

Of equal or greater significance are the differential effects among the small, medium, and large vessels. For any given hypothesis, the percentage rate of change in total unit cost is sometimes approximately the same for all three ships, while in other cases it varies somewhat by vessel size. However, with only one exception, the smaller the vessel is, the greater is the <u>monetary</u> effect (usually upward) on costs per ton. This is attributable to scale economies, which apply not only to total unit costs but also to most of their individual components. The one exception to the preceding pattern is H&M insurance, reflecting a peculiar structural quality noted earlier. The cost implications of a possible change in that structure for large ships is noted below.

Table 70. Sensitivity of Total Unit Costs of Three Sizes of Foreign-Flag Tankers to Hypothesized Changes in Cost Components[a]

(In percent)

Assumed nature of change	Vessel d.w.t.		
	40,000	120,000	300,000
Total investment:			
25% higher	12.0	12.0	11.3
Annual capital charges:			
15-year useful life	5.7	5.7	5.4
25-year useful life	-3.0	-3.0	-2.8
7% return on investment	-12.2	-12.3	-11.6
15% return on investment, including taxes	20.3	20.5	19.3
Crew:			
50% increase/man	5.5	3.2	2.1
Maintenance and repair:			
50% increase	2.3	2.0	1.7
P&I insurance:			
50% lower	-1.2	-1.3	-1.3
H&M insurance:			
50% higher	2.6	3.5	5.4
Overhead and miscellaneous:			
100% increase	1.6	0.9	0.5
Fuel:			
25% higher or lower	±5.7	±6.8	±7.4
Average time in port:			
Each additional day in port	2.7	2.5	2.4
Average of 5 days/port	17.5	16.5	16.1
Annual days in service:			
Reduce from 345 to 335	2.9	2.9	2.9

a/ For 5,000-mile journeys only.

Source: RRNA estimates.

Table 71. Sensitivity of Total Unit Costs of Three Foreign-Flag Tankers to Hypothesized Changes in Cost Components

(In 1970 dollars)

Assumed nature of change	Vessel d.w.t.		
	40,000	120,000	300,000
Total investment:			
25% higher or lower........	±0.41	±0.23	±0.17
Annual capital charges:			
15-year useful life........	0.19	0.11	0.08
25-year useful life........	-0.10	-0.06	-0.04
7% return on investment....	-0.41	-0.24	-0.18
15% return on investment, including taxes...........	0.69	0.40	0.30
Crew:			
50% increase/man...........	0.19	0.06	0.03
Maintenance and repair:			
50% increase...............	0.08	0.04	0.03
P&I insurance:			
50% lower..................	-0.04	-0.03	-0.02
H&M insurance:			
50% higher.................	0.09	0.07	0.08
Overhead and miscellaneous:			
100% increase..............	0.05	0.02	0.01
Fuel:			
25% higher or lower........	±0.19	±0.13	±0.11
Port time:[a]			
Each additional day........	0.09	0.05	0.04
Average 5 days/port........	0.59	0.32	0.25
Days in service:[a]			
Reduce by 10...............	0.10	0.06	0.05
Total unit cost/long ton....	3.39	1.94	1.53

a/ Relatively insensitive to distance.

Source: Table 70.

The effect of port time on costs of ocean shipping is worthy of mention. As indicated in table 71, an increase to 5 days per terminal from the 39 1/2 hours originally assumed has a very significant effect on total unit costs, especially for small ships. In practice, this factor is likely to be less significant for oil than for dry bulk commodities at unloading terminals, many of whose handling facilities permit only slow rates of discharge.

Beyond their sensitivity to assumed changes in the value of given cost and time components, total unit costs of ocean shipping may be importantly affected by any number of other factors. For example, typical complements of tankers may exhibit a different pattern. As indicated in table 72, an assumption of much smaller crews for supertankers than was made initially would have very small effects on these tankers' total unit costs. The impact would be even smaller if side effects on other cost components were accounted for. The effect of a change in crew size on a 40,000-d.w.t. vessel is relatively much greater. It is partly for that reason that our basic unit cost estimates assumed greater emphasis on future crew reductions for small- and medium-sized vessels than for the largest ones.

One of the most controversial concerns about ocean transport of bulk commodities is their general safety and their implications for environmental damage. This concern is especially pronounced for oil movements in very large tankers. From the economic point of view, any human or physical damages or losses, including environmental ones, are costs. They may be private or social costs, but if they are attributable to a ship, they should be identified, measured and charged against its overall cost of operation.

In principle, these costs are reflected in insurance charges: H&M insurance covers damage to the insured vessel, and P&I insurance covers damage to other vessels or property, including oil pollution. However, to a large degree, the private sector (insurance) has until recently borne only an uncertain, but probably small, portion of the social costs above and beyond the more readily identifiable private ones.

Table 72. Estimated Order-of-Magnitude Effects of Selected Hypotheses on Total Unit Costs of Four Sizes of Foreign-Flag Tankers

(In 1970 dollars)

Item	Vessel d.w.t.			
	40,000	120,000	300,000	500,000
Ecology/safety features				
Wing tank size limit of 15,000-25,000 m.3a/......	--	--	0.01-0.03	0.03-0.10
Double bottomb/....	0.17c/	0.09c/	0.07c/	0.06c/
Clean ballastd/....	>.05-.15	>.05-.15	.05-.15	<.05-.15
Crew and subsistence				
Uniform 26-man crew..............	--	--	-0.02	-0.03
Uniform 34-man crew..............	0.13	0.04	--	-0.02
H&M insurance				
Supercarrier rate reduced 33 pct....	--	--	-0.06	-0.07
Twin screwse/......	--	--	0.18	0.11
Initial total cost/ long ton...........	3.39	1.94	1.53	1.42

a/ Very crudely estimated and interpolated from data in the first source.
b/ Estimated from data in the second source, by interpolation for 500,000-d.w.t. vessel.
c/ Effect on total cost from additional capital cost only. Uncertain values for other cost increments must be added.
d/ Estimated from the first source on basis of 250,000-d.w.t. vessel; range reflects "in ballast" displacement of 30 to 50 percent.
e/ Estimated from the third source.

continued--

Table 72. Estimated Order-of-Magnitude Effects of Selected Hypotheses on Total Unit Costs of Four Sizes of Foreign-Flag Tankers continued--

Source: 1. E. Scott Dillon, Ship Design Aspects of Oil Pollution Abatement (MARAD, March 1971), p. 42 (figure 15) and p. 24.
2. Joseph D. Porricelli, Virgil F. Keith, and Richard L. Storch, Tankers and the Ecology (paper presented at the November 1971 Annual Meeting of the Society of Naval Architects and Engineers), p. 26 (table 5).
3. J. Ch. de Does and H.W. Rijksen (Verolme United Shipyards), Design and Construction of the R.D. II Design (unpublished paper presented in September 1971 at a Rotterdam symposium on the development of a 425,000-d.w.t. tanker with "Restricted Draught"), figure 1.
4. Hydronautics and RRNA cost data in this study.

Unfortunately, total social costs have thus far largely been unmeasurable. Information is also lacking to fairly allocate them by type and size of vessel in relation to the various sets of risks involved. That information gap applies almost equally to the allocation of private costs. Until these issues can be factually illuminated and treated, growing concern by insurers as to private risks, and by environmentalists as to oil pollution, may bring tighter standards in the design of certain vessels, especially tankers.

Numerous proposals have been put forward to deal with the overall problem. Among the more dramatic and relatively costly concepts are:

1. Fully clean ballast systems, to completely eliminate overboard discharge of oily water

2. Double bottoms or hulls, to minimize vessel damage and oil spills from groundings, as well as to provide much of the space for clean ballast operation

3. Further size limitations on tanks used to carry oil, to reduce the volume of oil spill in accidents.

For reasons indicated above, there is presently no way of knowing whether the prospective benefits of any of these proposals are commensurate with their costs or whether various alternatives would be relatively more attractive. Nor is it possible to estimate when or if any new standards on vessel design will be implemented. However, it is possible to indicate the quantitative implications of the specified concepts for ocean shipping costs if and when they are adopted, as has been done in table 72. Of the three concepts considered, tank-size limits would penalize costs only of very large vessels, although by relatively modest amounts. On the other hand, double bottoms or clean ballast systems would presumably apply to all tankers regardless of size. Again, penalties seem rather modest. However, their incidence in costs per ton of cargo is greater for small vessels than for larger ones.

If any of the above features were incorporated in the design of new VLCC's, risks associated with their operation would presumably be reduced. This might result in a reduction of the premium insurance charges they must now bear. Although a hypothesized reduction of one-third in initially estimated H&M insurance charges would have only a modest downward effect on VLCC total unit costs (table 72), it would also mitigate cost increases resulting from the newly imposed vessel design features.

Future Ocean Shipping Costs

All previously estimated unit shipping costs reflect 1970 dollar values for each of the various cost elements. With a few minor exceptions, they also reflect 1970 technological, engineering, design, construction, and operating standards or practice. The estimates allow for the influence of the new IMCO regulations limiting tank size on large tankships, for modest further reductions in average crew size over recently prevailing levels, and for some state-of-the-art improvements in design of restricted-draft vessels. Otherwise, however, they are essentially static.

For purposes of appraising long-range investments in facilities to accommodate deep-draft vessels, it is necessary to consider how total unit costs of ocean shipping for any given ship design are likely to behave in the future. Certainly they will rise generally in response to price inflation, but this study is not concerned with that question. For purposes of economic, including benefit-cost, analysis, the critical issue is possible long-run changes in constant 1970 dollars, or real terms.

Ideally that approach calls for a broad assessment of the prospects for dynamic changes in ocean shipping technology and practices, in the various determinants of each cost factor, and their implications for the future level of total unit costs in vessels of different sizes and design characteristics. However, the difficulties of making such an assessment are formidable.

Consider the following examples: By far the two most significant components of total unit shipping costs are first costs and fuel. For the smaller vessels, crew costs are moderately important. What will the real costs of these items be in the future? On the basis of recent trends and prospective market conditions, it seems reasonable to expect higher real costs: (1) per worker in the world's major shipyards, including those of Japan; (2) per individual crew member on vessels operating under major flags in world trade; and (3) per barrel of fuel. But these expectations alone may not be sufficient to indicate long-run increases in real shipping costs, for there may be significant offsets.

The dynamics of shipbuilding are highly illustrative. Real costs of vessel construction are a function of three major factors, apart from shipyard labor: (1) the costs of steel, (2) output, and (3) machinery and shipyard efficiency, including the number of orders for a particular design. The long-range outlook for steel, output, and machinery prices in the major shipbuilding countries is unclear. However, on the basis of historic trends, they could not be expected to increase more rapidly than, if as much as, the general price level.

Furthermore, there is undoubtedly room for still further automation and other improvements in the shipbuilding process which would increase labor productivity. Indeed, particularly in Japan, increased shipyard automation has been induced by a shortage of available labor and its rapidly rising prices. Quantities of steel needed to build a given size and type of ship have tended historically to decline substantially in response to improvements in metallurgy, vessel design, and production methods.

With prospective growth in the market and in the size of individual company fleets, multiple orders for standard designs may gain an increasing share of production volume and stimulate mass production methods of shipbuilding. In combination, these factors could more than offset the influence of rapidly rising shipyard labor costs.

Even if these factors did not offset increasing labor costs in today's most important shipbuilding countries, new yards in low labor cost countries could bridge the gap. Just as Japan, in the last 2 decades, has replaced Britain as the world's dominant (and presumably at one time its most efficient) shipbuilder, so too the newer yards of such countries as Singapore, Korea, Taiwan, and Greece could become cost competitive and attain leadership positions in the industry. Under these dynamically changing circumstances, it is most difficult to predict the direction that world shipbuilding costs will take in the long run, let alone their magnitude.

Similar dynamics will influence the net effects of increasing unit crew costs. Historic reductions in the complements of tankers and bulk carriers constitute trends rather than ultimate developments. Rising wages could provide still further incentives for crew reductions beyond the levels assumed in our cost estimates, with crews perhaps approaching zero. The technology for completely unmanned ships at sea is already available and might one day be politically as well as commercially feasible. Although crew reductions imply at least partially offsetting investments in automated equipment, they also permit some reduction in ship cost.

The implications of higher fuel prices are equally uncertain. The cost of fuel for a given voyage is a function of engine efficiency, hydrodynamic factors, and vessel operating speed, in addition to the unit cost of fuel.

Fuel consumption can be lessened through reductions in hydrodynamic drag. Although the rate of change is uncertain, continual refinements in vessel shape and improvements in laminar flow can be expected.

Improvements in propulsion efficiency could also reduce unit fuel consumption. Some indication of the rate of technological development in this area may be suggested by recent trends. As late as 1960, marine steam turbines consumed 0.54 pounds of fuel per shaft horsepower-hour. Largely through increases in steam pressures and operating temperatures, fuel consumption has recently been reduced to 0.39 pounds per shaft horsepower-hour. Similar, if less dramatic, development has characterized diesel engine technology.

Although still relatively costly for use in tankers and bulk carriers, gas turbine technology may eventually become attractive. The technology has historically been developed for and applied to aircraft. More recently it has been adapted for marine applications. Gas turbine efficiency is a direct function of maximum gas temperature, which has been continually increasing with advances in material technology and with such innovations as the cooled turbine blade.

Other technological developments on the horizon also offer possibilities for lessened fuel consumption. They include the use of a heat exchanger between exhaust gases and compressor air, and the use of exhaust heat to raise steam or refrigerant vapor, which in turn powers a vapor turbine.

Beyond changes in technology, future unit costs of transport in tankers and bulk carriers will be affected by vessel utilization. The latter is influenced by numerous factors, of which time in ballast is perhaps most important. The recent emergence of combined carriers and their prospective further development suggests that, at least on the supply side, opportunities for increasing payload time at sea will generally improve. But the extent to which world demand will permit realization of those opportunities is uncertain.

Many of the world's bulk commodity flows are unbalanced by link, offering no useful opportunities for backhauls or efficient multi-leg vessel routings. Changes in the complex world trade structure are likely over time, but their implications for improved vessel utilization are highly uncertain.

In light of all the preceding considerations, we have concluded that no sound judgment as to the long-run real unit costs of ocean shipping1/ can now be made. Perhaps this subject would be amenable to rigorously detailed analysis, despite the inherent difficulties. In the absence of more understanding, we have reluctantly assumed that future real unit costs of ocean shipping2/ by tankers and bulk carriers will be more or less the same as in 1970.

1/ For any given size and type of vessel. Increasing vessel size, and related terminal improvements, clearly have the effect of reducing real unit shipping costs.
2/ Ibid.

IV. WATER TRANSSHIPMENT

Introduction

The purpose of this chapter is to provide estimates of unit costs for transshipping bulk cargoes by water in the United States, where such estimates are relevant to the appraisal of investment alternatives under investigation. There are two basically different circumstances under which such transshipment could usefully be employed:

1. Ship-to-ship transfer (offloading, lightering) of imported crude oil from large tankers to smaller vessels outside existing harbors, in the absence of any new deepwater port facility

2. Carriage of crude oil or various dry bulk commodities by small vessel between a deepwater port and existing port facilities. Oil can also be transshipped by pipeline, which is treated in Annex C.

Ship-to-ship product transfer at sea is considered in this report only for crude oil. Although theoretically possible for dry bulk commodities, it is typically hazardous, awkward, and relatively inefficient. For these very reasons, it is not a common practice and is usually done under conditions of grossly inadequate shore facilities and/or extremely shallow water.1/

1/ Gerald F. Manners, The Changing World Market for Iron Ore, 1950-1980 (Baltimore: Johns Hopkins Press, 1971), p. 176.

Examples of its use include coal movements from Hampton Roads to Argentina, where the relevant port permits only 25-foot drafts;1/ grain shipments to some Indian ports; and iron ore exports from Malaya and the Philippines.2/ For reasons which are discussed in the benefit-cost analysis (Annex F), formal treatment of lightering in this report is limited to three major importing areas: New York, the Delaware Bay, and San Francisco Bay.

Vessel transshipments are essential components in most hypothesized deepwater ports for dry bulk commodities, as well as in some concepts of possible new crude oil terminals. As is explained subsequently, these movements could probably best be handled by specially designed tug-barges operating in a virtually continuous shuttle between ports rather than by conventional tankers or bulk carriers.

As a preliminary step toward development of our unit cost estimates, this chapter first considers recent oil lightering operations in the major port areas and develops the conceptual approach that is later applied to future offloading of crude oil. It then outlines a system of shuttle movements to and from the deepwater port, followed by rough estimates of the unit costs involved. Estimates of lightering costs are presented last because they are related to, and have been built upon, the estimates for tug-barge shuttle operation.

Lightering of Crude Oil

Draft constraints at oil refineries receiving crude oil by water can often be partially overcome without any capital investment. The only requirement is

1/ Robert R. Nathan Associates, et al., Pre-Investment and Pre-Feasibility Study of a Deep Water Port in Argentina, December 1971 (in Spanish).
2/ In these cases, the ocean vessel is loaded partly at the terminal and partly at sea from the lighter ship, which is used to fill rather than to lighten the ocean vessel.

that somewhat deeper water, preferably sheltered from the elements, be located nearby. Under these conditions, a much larger ocean vessel than could otherwise be used could carry oil to the deepwater area and transfer it to a smaller vessel or vessels awaiting its arrival.

This practice is now commonly employed for both crude oil and products on a large scale in the New York area and in Delaware Bay, on a relatively small scale in San Francisco Bay, and in numerous other U.S. port areas. Specific anchorage areas in protected waters are usually designated for the offloading operation. In New York, the designated anchorages are just inside the Verrazano-Narrows Bridge, on both the Staten Island and Brooklyn sides. In Delaware Bay, they are near Cape Henlopen or Big Stone Beach, and in San Francisco Bay, they are under the Bay Bridge. However, to an uncertain degree, lightering is sometimes performed in other places as well.

In New York and in Delaware Bay, oceangoing tankers offload their oil cargo primarily into barges which are relatively small. In New York, these barges range in capacity from under 50,000 to as large as 100,000 barrels (approximately 7,000 to 14,000 tons), while the capacity of Delaware barges ranges from 16,000 to 90,000 barrels (around 2,000 to 12,000 tons). In San Francisco Bay, lightering is sometimes performed by old T-2 tankers (about 16,000 tons).

Size characteristics of ocean vessels which offload vary considerably. Trade sources indicate that they sometimes approach 100,000 d.w.t. in New York and in the Delaware Bay area, and often range from 70,000 to 80,000 d.w.t. or more in the San Francisco Bay area. These vessels frequently offload only part of their cargo and then proceed to final terminal destinations, although on occasion they may offload their entire cargo.

In all three areas, lightering is performed by companies specializing in this type of service. Prices are determined by market conditions. One can reasonably presume that prices reflect real cost, since there is a fair degree of competition in the provision of the services involved. In the New York area, recently prevailing rates charged for offloading were $0.07 to $0.08 per barrel (around $0.52 to $0.60 per long ton). This reflects both the size characteristics of the barges used and the average distances of haul, which are typically some 10 to 20 miles (one way). In the Delaware Bay, where distances between lightering areas and refineries range from 60 to around 100 miles, and where average barge sizes are about the same as or smaller than in New York, rates recently were some $0.125 to $0.14 per barrel (around $0.94 to $1.05 per long ton).

Our information on lightering in the San Francisco Bay area is limited to the practice of a single company, which may not be generally representative. A tanker of some 75,000 d.w.t. arrives with 570,000 barrels of crude oil. It offloads 120,000 barrels in a T-2 tanker, which then proceeds to the refinery some 35 miles away. The ocean vessel awaits the T-2 tanker's return, and then offloads an additional 120,000 barrels before proceeding to the refinery to discharge its remaining cargo. This operation takes 2 to 3 days, for which the price ranges from $5,000 to $8,000 per day. Taking mean values ($6,500 per day for 2.5 days), offloading of 240,000 barrels costs slightly less than $0.07 cents per barrel (about $0.52 per long ton). This rate approximates the corresponding charge in New York, where typical barge size is smaller and where typical distance of movement is a bit shorter.

Ocean shipping of crude oil and associated lightering operations have not yet realized their full potential. Substantially larger and more efficient vessels could be used for offloading in all three areas. Size characteristics of the existing barges used for lightering in New York and the Delaware Bay reflect their more frequent use in the movement of petroleum products, which have entirely different requirements. Vessels especially suited for offloading crude oil in large volumes have not yet been developed, partly because the market has until recently been small and partly because uncertainties exist about the future provision of deepwater port facilities, which could render lightering unnecessary.

Furthermore, substantially larger ocean vessels than are now commonly used could be offloaded in the designated anchorage areas. Present vessel size characteristics probably reflect short-term lags in adjustment to changing market conditions, as well as the relative inefficiency of existing lightering operations.

In the long run, it seems reasonable to expect that design and size characteristics of transoceanic and lightering vessels would be optimized. That generally implies resort to the maximum size tankers allowed by physical conditions in the anchorage areas. Permissible drafts, which reflect both mean low water depth and tide (but with a safety margin for clearance), would be approximately 45 feet in New York, 52.5 feet in San Francisco Bay, and 57.5 feet in Delaware Bay. For these three areas, tankers of up to 110,000, 183,000 and 236,000 d.w.t., respectively, could be accommodated if vessel designs were optimized for draft conditions (see Annex F).

For similar reasons, vessels used to lighten the large tankers would be expected to approach the largest size compatible with draft and other dimensional constraints imposed by connecting channels and terminal facilities. Such vessels might be in the 40,000-d.w.t. range or even larger. Since these constraints influence size characteristics of transshipment vessels at hypothesized deepwater port locations, this question is discussed further in the following section.

The above concepts of vessel size have important implications for one of the major trade-offs in lightering operations: Should the ocean vessel partially offload and proceed at reduced draft to the terminal to discharge its remaining cargo, or should it offload the entire cargo and then return to its overseas origin? Effective resolution of this issue requires detailed analysis of each case. However, to avoid unnecessary complications in this study, we have made the general assumption of complete offloading. This assumption was made because the largest feasible ocean vessels, even when partly lightened, would usually be difficult, if not impossible, to manuever in some of the narrow channels involved, and in some cases would be prohibited from doing so by existing regulations.

Water Transshipment at Deepwater Ports

The physical and operating conditions governing vessel transshipment between our hypothesized deepwater ports and existing ports for various bulk commodity movements have no exact current parallel in the United States. Intercoastal and Great Lakes traffic generally involves direct haul between ports of origin and destination without an intervening transshipment terminal, and distances of movement are relatively long. The extensive barge system on the inland waterways has evolved along unique lines because of its special physical circumstances. It is therefore necessary to design an approach to vessel transshipment at our hypothesized deepwater port that is best suited to its specific nature.

Several recent studies1/ suggest that a tug-barge system may be preferable to self-propelled tankers or bulk carriers employed in ocean shipping. This judgment reflects the fact that pertinent conditions are extremely different. Links between the deepwater ports and relevant existing ports are very short. For ocean shipping of U.S. bulk commodities in foreign trade, one-way distances generally range from 1,500 to 15,000 miles, whereas corresponding distances for vessel transshipment would fall between 60 and 460 miles. Furthermore,

1/ Matson Research Corporation, Transoceanic Tug-Barge Systems: A Conceptual Study (Maritime Administration, Federal Clearinghouse No. PB 194535-6-7), July 1970; and Adrian S. Hooper, "The Application of Super Barges for Distributing Petroleum Products," Maritime Reporter and Engineering News, October 1, 1971.

typical open-sea speeds of 16 knots are generally inappropriate, if not impermissible, on many waterways where transshipment vessels would be operating.

Tug-barge technology is particularly well suited to relatively low-speed, short-haul operations. In such uses, it promises improved efficiency over self-propelled vessels. Its principal advantage lies in greatly reduced manning needs of around 9 to 12 men (all of whom serve on the tug, the barges being unmanned), as opposed to 26 men assumed in our cost estimates for self-propelled ocean vessels and up to 40 or more aboard those now in U.S. coastal service. This great difference in manning requirements is attributable much less to technology than to institutional barriers against crew reduction on traditional vessels.

Essentially because of their manning requirements, tug-barges with oceangoing capabilities have begun to appear in U.S. cabotage operations. The largest such vessels presently in service are around 30,000 to 31,000 d.w.t., but a 52,000-d.w.t. vessel drawing only 28.5 feet fully loaded is under construction.1/ These tug-barges are not to be confused with entirely different types of barges found in U.S. river transport, which are much smaller and shallower, cannot safely go to sea, and are usually tied together in groups of 3 to 30 for pushing at slow speeds by a single towboat.

The two studies referred to above show that unit costs per ton of cargo carried by tug-barges from 20,000 to 60,000 d.w.t. are modestly lower than when carried by self-propelled vessels of equal size on routes up to 1,000 miles or more. The comparative advantage of tug-barges increases inversely with distance. Although barges can be designed either to be pulled or pushed by the towboat, the latter type are demonstrably less costly. That would explain why most barges now in service along the Atlantic and gulf coasts are of this design.

1/ *Traffic World*, December 13, 1971, p. 27.

Apart from their relatively low manpower costs, tug-barge systems offer two features which may enhance their appeal under certain conditions. The towboat can be detached and used elsewhere while the barge awaits loading or discharge. This flexibility would often be advantageous on very short links where terminal time is a large proportion of time at sea. Furthermore, barges can apparently be designed with somewhat greater capacity in relation to draft than tankers or bulk carriers, possibly a useful advantage in ports having particularly constrained water depths. The effective application of these features to the many different transshipment movements covered by this study, however, cannot be explored here.

For optimization of a tug-barge system, even for one particular port pair, is a complex matter requiring detailed feasibility analysis. Such an analysis would have to consider numerous alternative size, design, and operating characteristics for the system in light of various water, terminal and traffic conditions. Among the more important trade-offs involved are the number of barges per tug (e.g., tug "stay" with barge, or "swap" one for another), the choice of placing unloading equipment at the port or on the barges (mostly in the case of dry bulk commodities), and the rates of discharge to be used.

The broad nature of this study requires simplified assumptions about these questions. The assumptions we have made largely reflect discussions with several firms engaged in water transport, steel manufacture and barge design. A 40,000-d.w.t. barge was considered a reasonable order-of-magnitude size level generally suitable for the numerous gulf and east coast ports to be served, with an average service speed of 10 knots. Since relatively few of all hypothesized transshipment movements appeared to be short enough to make "swap" systems highly attractive, we have uniformly adopted a "stay" approach for costing purposes.

Tank barges transshipping crude oil at the deep-water port and discharging at port-based refineries would be equipped to self-unload at an hourly rate of

5,000 long tons. This reflects general practice in the design of tankers and oil barges, and the modest additional costs involved in self-unloading. On the other hand, iron ore imports would generally be discharged from barges at steel plants, which already have high-speed unloading equipment. Barges to accommodate ore have therefore not been designed for self-unloading, which is substantially more costly for dry bulk than for oil.

Dry bulk exports (coal and grain) passing through a new deepwater port present an entirely different trade-off, since accommodation for product discharge must be made somewhere -- either on the barges or at the deepwater port. The former is often advantageous where trip links are very short and annual volumes per vessel are high, precisely the conditions presented. We have accordingly assumed grain and coal barge designs which include self-unloading gear permitting discharge at a rate of 5,000 long tons per hour. However, the specialized manning and electric power required to unload are presumed to be port-based, because of difficulties in providing them on either tug or barge.

The approach used to develop estimates of unit costs for tug-barge transshipment is somewhat different from that used for ocean shipping, which is discussed in chapter III. However, the same assumptions as to capital charges, vessel utilization and load factors have been made. Relatively little material on costs of tug-barge systems, and virtually nothing on the special costs incurred for self-unloading of dry bulk commodities, has been published. Our estimates have been based primarily on data contained in the two studies previously mentioned, supplemented by discussion with several operators. However, the allowance we have made for general and administrative costs is smaller than the prevailing practice because of the presumed long-term continuous shuttle operation between the same port pairs and on behalf of the same users.

Estimates were developed initially on an annual basis by cost component for a single tug and a 40,000-d.w.t. tank barge, and were then converted to hourly equivalents (table 73). These costs would be virtually the same for a dry bulk tug-barge of comparable size which is not self-unloading (iron ore). Annual estimates by cost component were then made for the additional costs of high-speed self-unloading equipment applicable to coal and grain (table 74).

The preceding data provided major inputs for estimates of total unit costs per long ton by trip distance. For round trips ranging from 100 to 900 miles, preliminary unit cost estimates were made separately for each commodity, allowing for combinations of port and sea time required on each link (tables 75 and 76). All resulting total unit costs per trip were then increased by 20 percent to allow for necessarily underutilized capacity of the tug-barge fleet over time. These figures are plotted in figure 4.

This underutilization of capacity arises from the inherent lumpiness of transport supply and the changing (usually growing) nature of demand. For example, on the basis of our operating assumptions, the full annual capacity of a single 40,000-d.w.t. tug-barge on a regular 300-mile (round trip) shuttle service would approximate 6.9 million tons. As soon as demand exceeded that level, another tug-barge of equal capacity would be required, although an extended time period would be necessary before growing traffic would utilize it fully. Furthermore, there are often seasonal fluctuations in demand for some commodities, and occasional work stoppages in U.S. or foreign ports or plants, which would have similar effects. Finally, the special design characteristics of the hypothesized tug-barge system would probably make it relatively unsuitable for short-term deployment in other (coastal) service.

Lightering Costs

The tug-barge system used for oil transshipment at a deepwater port would seem to be equally suitable for lightering of large ocean vessels. Unit cost characteristics should also be essentially the same. However, we have assumed that the rate of barge loading

Table 73. Estimated Costs of Oceangoing 40,000 Deadweight Ton Tug-Barge For Oil Transshipment

(In 1970 dollars)

Item	Cost
First costs	
Tug................................	1,500,000-2,500,000
Barge..............................	6,500,000-7,500,000
Total..............................	8,000,000-10,000,000 (average = 9,000,000)
Annual capital charges	
11.746% of first costs............	1,057,000
Fixed operating costs	
Crew: 8-12 men; assume 10 men at $20,000, including fringes.......	200,000
Stores, supplies, subsistence.....	26,000
Maintenance and repair (at 2% of first costs).................	180,000
Insurance (at 4% of first costs)..	360,000
Total..............................	766,000
General and administrative costs	
10% of fixed operating costs......	77,000
Total annual fixed costs (annual capital charges + total fixed operating costs + general and administrative costs).............	1,900,000
Fixed costs/hour (345 days/yr.)....	229
Variable costs/hour	
Fuel at sea, ± 10 m.p.h...........	31
Fuel in port, maneuvering, misc...	11
Total cost/hour	
At sea.............................	260
In port............................	240

Source: RRNA estimates.

Table 74. Estimated Incremental Costs of Self-Unloading Design Features in 40,000 Deadweight Ton Tug-Barge For Dry Bulk Transshipment

(In 1970 dollars)

Item	Cost
First costs	1,600,000
Annual capital charges	
11.746% of first costs	188,000
Fixed operating costs	
Crew	--
Stores, supplies, subsistence	--
Maintenance and repair (at 6% of first costs)	96,000
Insurance (at 5% of first costs)	80,000
Total	176,000
General and administrative costs	
10% of fixed operating costs	18,000
Total annual fixed costs	
Amount	382,000
As percent of basic tug-barge costs	20
Increment for port-based manning and electricity to discharge	0.02/long ton

Source: RRNA estimates.

Table 75. Estimated Unit Costs of Oil Transshipped in 40,000 Deadweight Ton Tug-Barge From Deepwater Terminal, by Distance of Haul

(In 1970 dollars)

Round-trip miles	In port		At sea		Total round-trip cost	Basic cost/LT	Adjusted cost/LT c/
	Hours a/	Cost	Hours b/	Cost			
100..........	18	4,320	10	2,600	6,920	.173	.208
200..........	18	4,320	20	5,200	9,520	.238	.286
300..........	18	4,320	30	7,800	12,120	.303	.364
400..........	18	4,320	40	10,400	14,720	.368	.442
500..........	18	4,320	50	13,000	17,320	.433	.520
600..........	18	4,320	60	15,600	19,920	.498	.598
700..........	18	4,320	70	18,200	22,520	.563	.676
800..........	18	4,320	80	20,800	25,120	.628	.754
900..........	18	4,320	90	23,400	27,720	.693	.832

a/ Loading at deepwater port (4 hours at 10,000 LT/hr. rate), discharging at refinery (8 hrs. at 5,000 LT/hr. rate), plus delay time at 2 terminals (6 hrs.).
b/ At assumed average speed of 10 knots.
c/ Includes 20% increment above basic cost to allow for underutilization of equipment over time.

Source: RRNA estimates.

Table 76. Estimated Unit Costs of Dry Bulk Transshipped in 40,000 Deadweight Ton Tug-Barge at Deepwater Terminal, by Distance of Haul

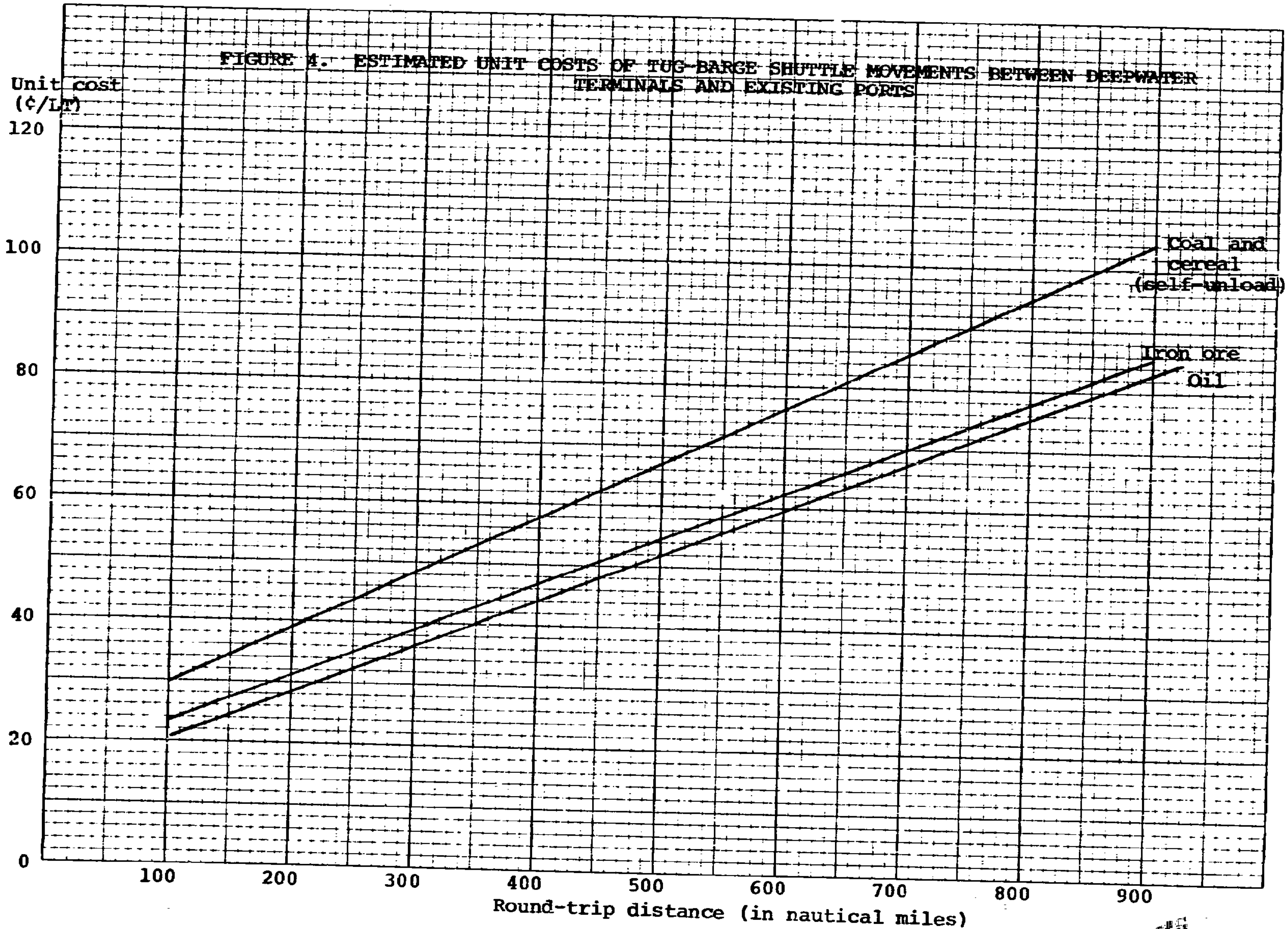
(In 1970 cents per long ton)

Round-trip miles	Oil total	Iron ore		Coal and grain		
		Increment a/	Total	Increment b/	Increment c/	Total d/
100...	20.8	2.4	23.2	2.0	4.6	29.8
200...	28.6	2.4	31.0	2.0	6.2	39.2
300...	36.4	2.4	38.8	2.0	7.8	48.6
400...	44.2	2.4	46.6	2.0	9.3	59.7
500...	52.0	2.4	54.4	2.0	10.9	67.3
600...	59.8	2.4	62.2	2.0	12.4	76.6
700...	67.6	2.4	70.0	2.0	14.0	86.0
800...	75.4	2.4	77.8	2.0	15.6	95.4
900...	83.2	2.4	85.6	2.0	17.0	104.6

a/ Four additional hours loading time over oil (5,000 long tons per hour rate).
b/ Port-based electricity and manpower for self-unloading.
c/ Self-unloading barge design, 5,000 ton/hr. rate (20% of iron ore total).
d/ Oil total, plus increments 1, 2 and 3.

Source: RRNA estimates.

FIGURE 4. ESTIMATED UNIT COSTS OF TUG-BARGE SHUTTLE MOVEMENTS BETWEEN DEEPWATER TERMINALS AND EXISTING PORTS



would be slower from ship to ship than from the deepwater port to ship. Furthermore, assumed waiting and delay time has been increased by 6 hours. This reflects an inherent disadvantage of all offloading systems dependent upon vessel arrival for product transfer: Ocean vessel arrivals can never be closely scheduled and are essentially random. For purposes of transshipment at deepwater ports, this problem does not exist, since exports are unloaded to storage and imports are loaded from normally sufficient quantities of cargo stored at the terminal. Shuttle movements would accordingly be independent of ocean vessel arrivals.

Estimates of total costs per long ton for lightering crude oil in the New York, San Francisco, and Delaware Bay areas, as indicated in table 77, reflect these factors. The estimated costs, however, are less than half of recently prevailing charges in the three areas. We therefore decided to cross-check their general reasonableness by consulting two of the major companies on the east coast now engaged in lightering operations. Under the market and operating conditions that we have assumed, their independent expectations of required revenue were basically consistent with our estimates, which were therefore allowed to stand.

As in the case of ocean shipping costs, the question of long-term trends in real costs of lightering and of vessel transshipment at a new deepwater port presents itself. However, most of the uncertainties indicated earlier are equally relevant. For example, the relatively conservative assumptions made as to operating speeds, loading and unloading rates, vessel size, and underutilization suggest considerable scope for increasing the efficiency of both lightering and shuttle movements. We have accordingly assumed that our estimates of unit cost would generally be indicative of future levels as well.

Table 77. Estimated Oil Lightering Costs Per Long Ton For 40,000 Deadweight Ton Tug-Barge Operation in Three U.S. Port Areas

(In 1970 dollars)

Area and item	Cost/hour ($)	Number of hours	Total cost ($)
New York and San Francisco Bay			
40 miles (round trip) at sea	260	4	1,040
Loading at 5,000 L. tons/hr	240	8	
Unloading at 5,000 L. tons/hr	240	8	6,720
Port delay, waiting	240	12	
Subtotal			7,760
20% increment for underutilized capacity			1,552
Total cost/operation			9,312
Cost/long ton			0.23
Delaware Bay			
200 miles (round trip) at sea[a/]	260	20	5,200
Loading at 5,000 L. tons/hr	240	8	
Unloading at 5,000 L. tons/hr	240	8	6,720
Port delay, waiting	240	12	
Subtotal			11,920
20% increment for underutilized capacity			2,384
Total cost/operation			14,304
Cost/long ton			0.36

a/ Average round-trip distance more properly 160 miles, which would result in a cost per long ton of $0.33. Error considered too small to justify revision of numerous later calculations based upon original figure.

Source: RRNA estimates.

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181

APPENDIX

HYDRONAUTICS, Incorporated

TECHNICAL REPORT 7216-1
FINAL

CHARACTERISTICS OF TANK VESSELS FOR RESTRICTED DRAFT SERVICE

By

Donald P. Roseman

January 1972

Prepared for
Robert R. Nathan Associates, Inc.

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

The studies reported herein were directed toward the investigation of the relationship of tank vessel principal characteristics, and corresponding required freight rates, to draft restrictions. A primary objective was the determination of the maximum feasible tank vessel capacities for given draft restrictions and the estimation of corresponding penalties, relative to tank vessels of the same deadweight designed for unrestricted draft operation.

The primary investigative tool used was a computer design program developed by HYDRONAUTICS, Incorporated for concept design and cost studies of dry and liquid bulk carriers. The program was used successfully for studies covering vessels up to about 250,000 DWT capacity. Larger vessels were defined conceptually by conventional design procedures, and the corresponding costs obtained from a subroutine of the concept design computer program.

The scope of the study was necessarily restricted by time and cost limitations. Output of the studies was oriented toward determining practical feasibility of building tank vessels beyond current normal capacity, for given operating drafts Beyond the exercise of good design judgement, no attempt was made to obtain optimized ship characteristics and corresponding costs. Efforts in this direction are more properly made in detailed subsequent studies for specific conditions of interest.

2.0 STUDY REQUIREMENTS

The requirements are defined in terms of two parametric series:

a) Draft variation series, for 35 ft. to 60 ft. drafts, in 5 ft. increments.

b) Deadweight series for large vessels for

250,000 DWT
300,000 DWT
400,000 DWT
500,000 DWT

In addition, vessel configurations for Panama Canal transit are to be identified.

For each discreet case defined above, the analysis is reported in terms of required freight rate (RFR), for the following conditions:

Voyage length, one way (two leg voyages), cargo on one leg only:

1000 miles
2000 miles
5000 miles
7500 miles
10,000 miles
15,000 miles

Number of vessels per production run = 5.

Other cost constants assumed for the study are given in the appendix.

To limit the scope of the study, an assumed service speed of 16 knots was held constant for both series. This value is near current practice for vessels up to about 225,000 DWT capacity.

3.0 METHODOLOGY

3.1 Background studies - As a prerequisite to defining a normal or standard baseline of ship characteristics, for each case of draft or deadweight, pertinent characteristics of existing and proposed tank vessels were tabulated and plotted. For the draft variation series, a clear lower bound of deadweight, as a function of draft, was identified and adopted as the starting point for parametric studies. For the larger 250,000 DWT to 500,000 DWT vessels, a summary of characteristics of existing and proposed vessels provided only limited trend information and a "standard" curve of deadweight vs. draft was adopted as the starting point for the investigation. These two baselines are shown as the lower curves on Figure 1.

3.2 Parametric studies - The computer design model used as the primary investigative tool defines ship characteristics in the iterative manner typical of the usual design process. The model provides characteristics, performance and cost data for a single discreet design for each case of input requirements. For each draft in the first series, input data was prepared in parametric form to cover a range of deadweights from the low normal value to some value judged to be near the feasible limit. For each value of deadweight, three ship lengths and corresponding form coefficients were selected, based on good design practice. Other constants selected for the parametric study are summarized in the appendix. Computer output was examined for each case and one case of length was selected for each value of deadweight, on the basis of design judgement and an examination of the cost information. No formal optimization procedure was used, other than selection of the characteristics and costs by examination of the computer output.

A second limited iteration of the parametric study was usually required to define with reasonable assurance the maximum feasible deadweight for a given draft, or the minimum feasible draft for a given deadweight in the case of the 250,000 DWT - 500,000 DWT series. These limiting cases were identified by testing the design characteristics against specific boundary conditions chosen for this study.

Characteristics of the large vessel series were generally beyond the capability of the computer design program and manual procedures were used to define characteristics for the standard draft vessel and the minimum draft vessel for each deadweight.

3.3 Boundary conditions

From the point of view of simple physics, there is no inherent limit to the size of vessel, in terms of deadweight capacity, that may be designed for a given draft. The converse is also implied for the case of minimum feasible draft for a given deadweight for the large vessel series. Accordingly, it was necessary to establish certain boundary conditions to provide conservative limits to hull geometry. The following conditions which were adopted reflect the author's judgement of reasonable limitations in proportions that may be acceptable for tank vessel design, with limited near term development work.

3.3.1 Length, B.P./ Breadth ≤ 5.75

This value is generally about 6.0 or greater for existing full seagoing tank vessels.

3.3.2 Breadth/Draft ≤ 3.25 at full load draft

For existing seagoing tank vessels this value is normally in the range of 2.25 to 2.75. The value of 3.0 has been reached for certain U. S. flag coastal tankers, designed for restricted draft U. S. ports, and for a Dutch proposal for a 425,000 DWT restricted draft tanker (Reference 1)

3.3.3 Length, B.P./Depth ≤ 15

This is a regulatory limit established by the classification societies and reflects limitations in the relationship of maximum bending moment to hull girder section modulus.

3.3.4 Draft/Depth, per Load Line Regulations (Reference 2)

For a given vessel geometry; e.g., length, depth, fullness, extent of effective superstructure; a discrete value of maximum permissible draft may be assigned by application of the Load Line Regulations. This requirement was coupled with the breadth/draft condition to define all vessels in the series as full scantling designs, i.e., designed to operate at the maximum permissible draft, and Length/Draft $\leq$ 15. It is clear, for example, that for a given draft, length could be increased indefinitely by simply adding depth such that L/D $\leq$ 15, while draft/depth would be well below regulatory limitations. This is analogous to the case of larger vessels operating at reduced draft. To provide a reasonable limit to the study, however, the condition of excess depth above freeboard requirements was not considered. This is a reasonable assumption consistent with current tank vessel design practice.

4.0 RESULTS AND DISCUSSION

4.1 <u>Draft and deadweight feasibility limits</u>.

4.1.1 Draft variation series - For the draft range of 35 ft. to 60 ft., the lower limits of existing normal deadweight values of about 30,000 DWT to 150,000 DWT, respectively, were identified. Parametric investigations of high deadweight values resulted in obtaining the maximum feasible values shown in the lower grid of Figure 1. Intermediate deadweight vessels were also identified to permit use of the data in subsequent tradeoff studies relating port dredging requirements to vessel size. The range of feasible values of deadweight for a given draft is approximately 170% to 175% over the lower bound values for the entire range.

4.1.2 250,000 DWT - 500,000 DWT Series

Reference information for the large vessel series is limited to data in the 250,000 DWT to 326,000 DWT range, for existing vessels, one existing new vessel at about 375,000 DWT and numerous published proposals for designs to 1,000,000 DWT. The data is necessarily scattered and a plot of these data relating deadweight to draft lies within a broad band. Accordingly, a reasonable "standard" draft-deadweight relationship was assumed, as shown on Figure 1. To obtain the minimum feasible draft case for each of the deadweight values, manual design procedures were used to define geometry at the approximate point that the three boundary conditions coincide, i.e.,

$$\text{Length/breadth} = 5.75$$
$$\text{Length/depth} = 15.00$$
$$\text{Breadth/draft} = 3.25$$

Results are shown as the minimum draft curve on the upper grid of Figure 1.

4.2 Dimensional limitations

Length and breadth values are given in Figure 2 for the end points at corresponding values of deadweight and draft, for the draft variation series. The values should be assumed as gross approximations only, particularly below the maximum deadweight value, since there exists an infinite possibility of combinations of length, breadth and hull fullness to obtain a required deadweight at a given draft. Unique values tend to be reached only at the upper values of deadweight where the boundary conditions are effective.

Similar information is given in Figure 3 for the large vessel series. Again, it should be noted that the values tend to be unique only at the minimum draft condition, for each value of deadweight, where the boundary conditions tend to be effective.

Characteristics of vessels designed for the constraints of Panama Canal transit are tabulated on Figure 10, for the unlimited seagoing case and for the 36'-0" canal transit condition. Dimensions of the 80,000 DWT, 45 ft. draft vessel are very close to comparable values of a U. S. flag 80,000 DWT ore-bulk-oil (OBO) carrier recently contracted to National Steel Co. of San Diego. The 85,000 DWT vessel indicated is probably near the maximum length for canal transit.

It is of interest to compare the deadweight capacities for these vessels in the transit condition with the corresponding value given in Figure 1 for a "maximum feasible" vessel designed for the same draft. The 58,800 DWT maximum value given in Figure 10 is significantly greater than the value of 50,700 read from Figure 1 at the same draft. The discrepancy is even greater when the values are corrected for water density. This condition is discussed in section 3.3.4 where reference is made to the case of large vessels operating at reduced draft, compared to a full scantling design such as the 50,700 DWT, 35 ft. draft vessel indicated in Figure 1.

4.3 Cost Studies

4.3.1 Draft variation series - Required freight rate (RFR) for a range of deadweights is given for each value of draft, as a function of voyage length, in Figures 4 through 9. The trend to decreased RFR with increase in deadweight is evident, as expected. For the smaller vessels particularly, an upturn in RFR is indicated for the long voyages. This illustrates clearly the effect of the high fuel capacity requirement on reduction in cargo deadweight.

Caution must be exercised in comparing the effect on RFR of reduced draft requirements, for any given deadweight. At the reduced draft, length and breadth will be greater, resulting in increased investment cost. However, increases in power requirements may be minimal, or even reduced, thus reducing the sensitivity to the draft restriction. Figure 11, for example, indicates no difference in RFR for a 250,000 DWT vessel designed for 58½ ft. or 65 ft. draft.

A similar comparison between Figures 6 and 10 indicates the penalty in RFR for restricting breadth for Panama Canal transit to be very small. For 80,000 DWT and 45 ft. draft, the penalty is about 1% in RFR for the 5,000 mile to 15,000 mile voyage lengths. This difference is well within the study error.

4.3.2 250,000 DWT-500,000 DWT series - Required freight rate vs. voyage length, for "standard" and minimum draft conditions, is given in Figures 11 through 14. Comparisons for this series indicate that a vessel designed for unrestricted draft operation may be less costly to operate than a significantly larger vessel designed for minimum draft service. The following comparison taken from Figures 12 and 13 illustrates this point clearly:

	Draft		RFR	
Deadweight	Standard	Minimum	5,000 miles	10,000 miles
300,000	71	-	0.278	0.269
400,000	-	68½	0.283	0.275

No firm conclusions should be drawn from this comparison since factors other than draft restriction may be involved in affecting the RFR. Some ship owners, for example, have indicated that optimum tank vessels for their services are of about 250,000 DWT capacity; well below the size of several classes of existing tank vessels.

4.4 Study Limitations

It must be emphasized that this study was necessarily limited in scope and was directed toward establishing feasibility rather than obtaining optimum ship characteristics for minimizing RFR. The following limitations should be noted:

a) Program limitations - The computer design program has proven to be a useful and reliable concept design tool, particularly for tank vessels of less than 250,000 DWT capacity. Certain approximations are recognized, however, and would be refined by conventional design procedures in a more definitive study. Powering calculations, for example are based on the assumption that all propulsion plants are single screw systems. The largest single screw system in operation today are about

35,000 SHP and a 40,000 SHP plant for installation in an LNG carrier is planned. It is likely that 50,000 SHP single screw plants will be installed in the future. In the current study, powers as high as 70,000 SHP were estimated for the largest vessels operating at 16 knots service speed, which is well into requirements for twin screw installation.

b) Optimization - Beyond the exercise of good design practice and engineering judgement, no attempt has been made to optimize vessel design. In a more definitive study, considerable additional use of the design program in a limited region of interest, followed by manual design refinement, would be necessary to obtain optimum ship characteristics with respect to defined economic criteria. For specific voyage or port limitations, such studies would be necessary to obtain a reliable estimate of the tradeoff between port or terminal development costs and the design of larger vessels to suit existing port restrictions.

5.0 NOTE

Cost estimating methods used in this study are given in a recent paper by Dart, Reference 3. Other modifying cost constants and various assumptions used in the study are summarized in the following notes:

5.1 Investment cost = program estimate x 0.46, to obtain approximate foreign flag cost.

5.2 Annual capital charges = investment cost x 0.11746, corresponding to a 20 year life, no scrap value, sinking fund depreciation and 10% return on investment.

5.3 Operating and support costs.

5.3.1 Manpower = $6,500 per man-year, reflecting foreign flag operation .

5.3.2 Stores and supplies = 0.93 x value given in Reference 3.

5.3.3 Subsistence = 0.7 x value given in Reference 3.

5.3.4 Maintenance and repair = 0.56 x value given in Reference 3.

5.4 Voyage costs.

5.4.1 Terminal costs deleted.

5.4.2 Brokerage and commission costs deleted.

5.4.3 Fuel cost = $2.50/bbl.

5.4.4 Other miscellaneous voyage costs given in Reference 3 are deleted.

5.5 Overhead = $25,000/year.

5.6 Taxes = 0

5.7 Manning - A manning level of 26 men was assumed for vessels up to about 200,000 DWT capacity. Above that size the manning level was increased in an approximately linear manner to about 50 men at 500,000 DWT.

REFERENCES

1.0 de Does and Rijksen, "The Development of a 425,000 DWT Tanker with Restricted Draft," Symposium on the Development of a 425,000 DWT Tanker with Restricted Draft, Netherlands Ship Model Basin, 9 September 1971, reprinted in Schiff und Hafen, October 1971.

2.0 Load Line Regulations, U. S. Coast Guard, CG-176, 1 February 1971.

3.0 Dart, Charles E., "Cost Estimating-Ship Design and Construction," Engineering Summer Conference on Economics in Ship Design, University of Michigan, Dept. of Naval Architecture and Marine Engineering, June 8-12, 1970.

202

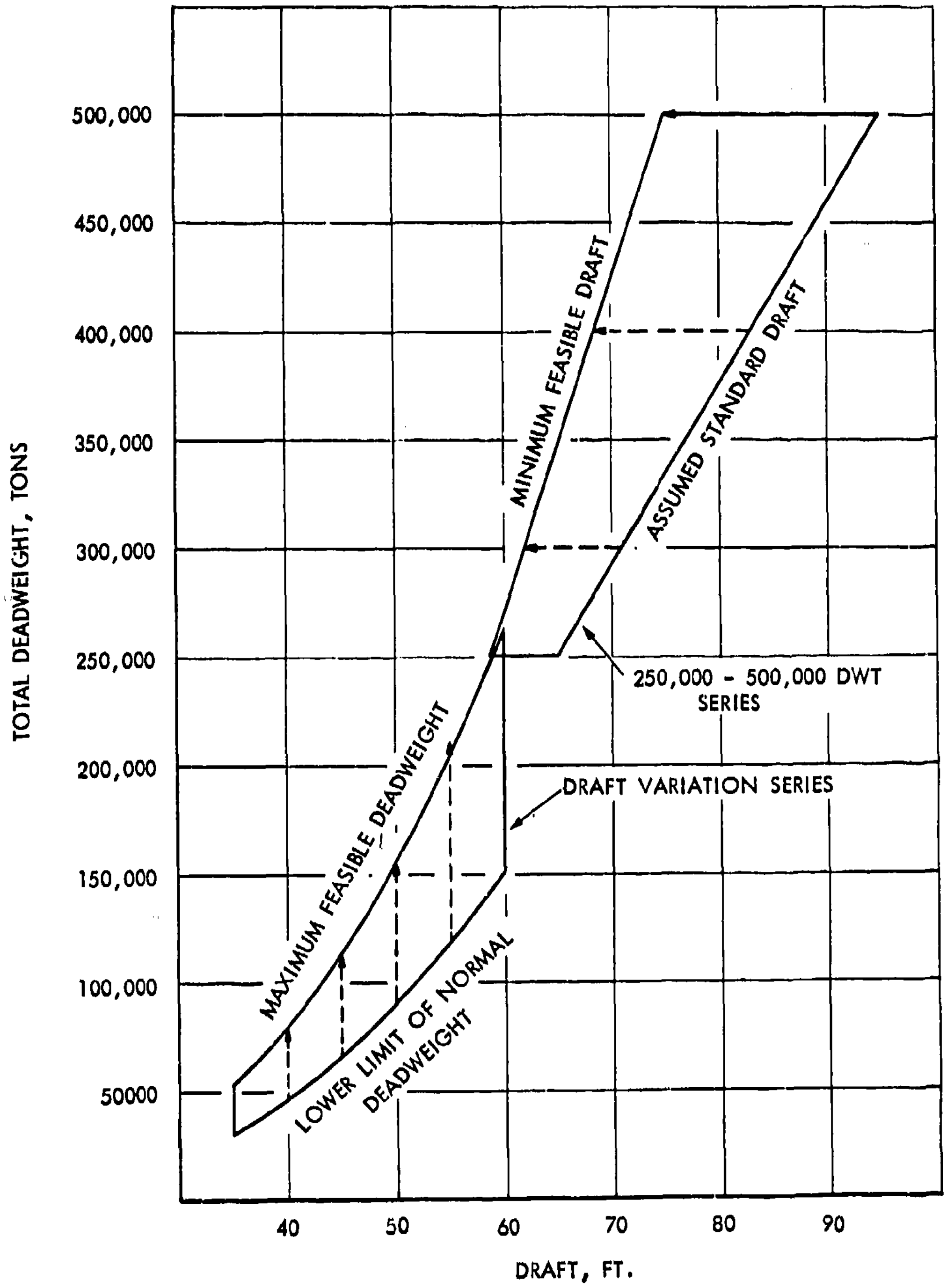

FIGURE 1 - TOTAL DEADWEIGHT vs. DRAFT

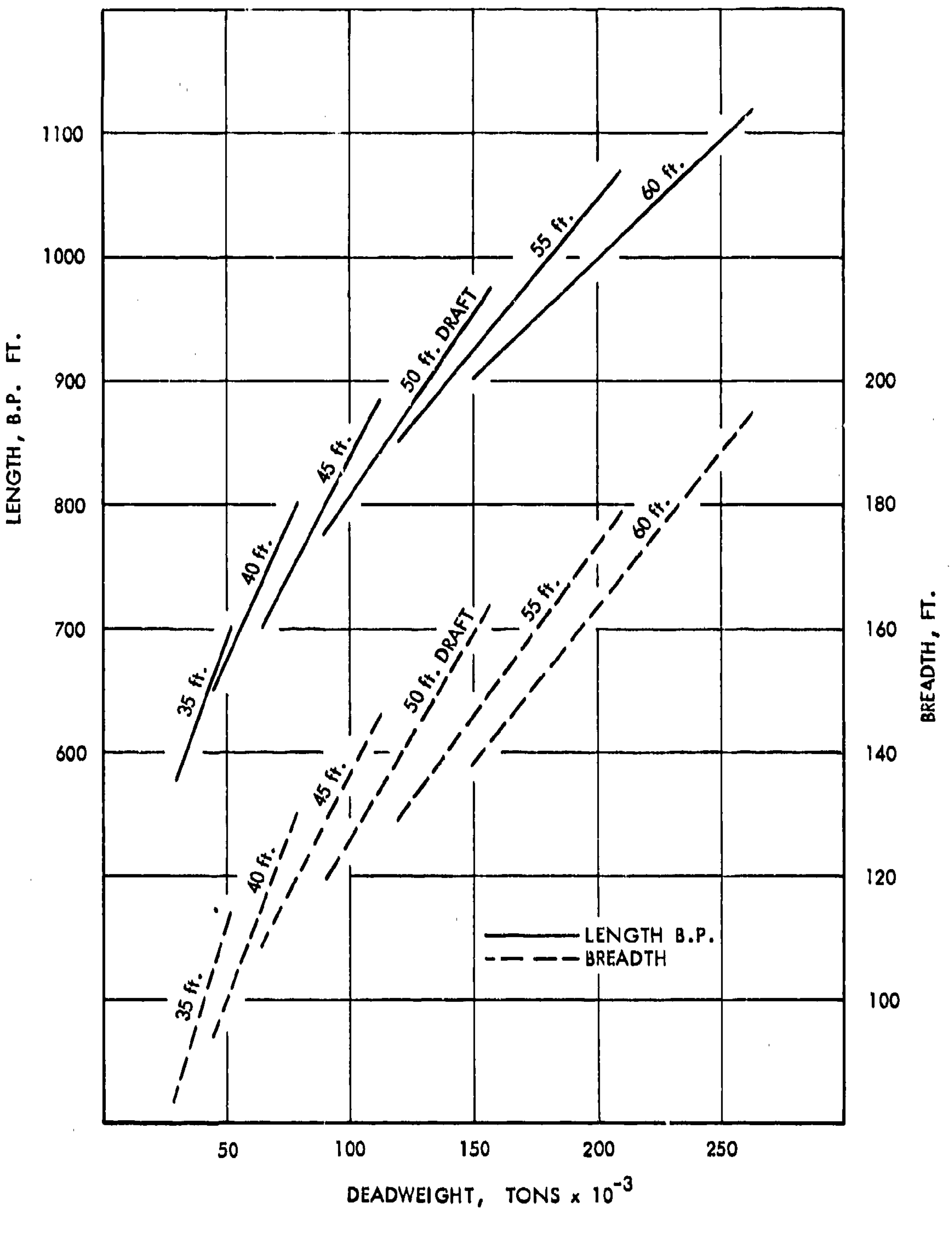

FIGURE 2 - DEADWEIGHT - DIMENSION RELATIONSHIP DRAFT VARIATION SERIES

204

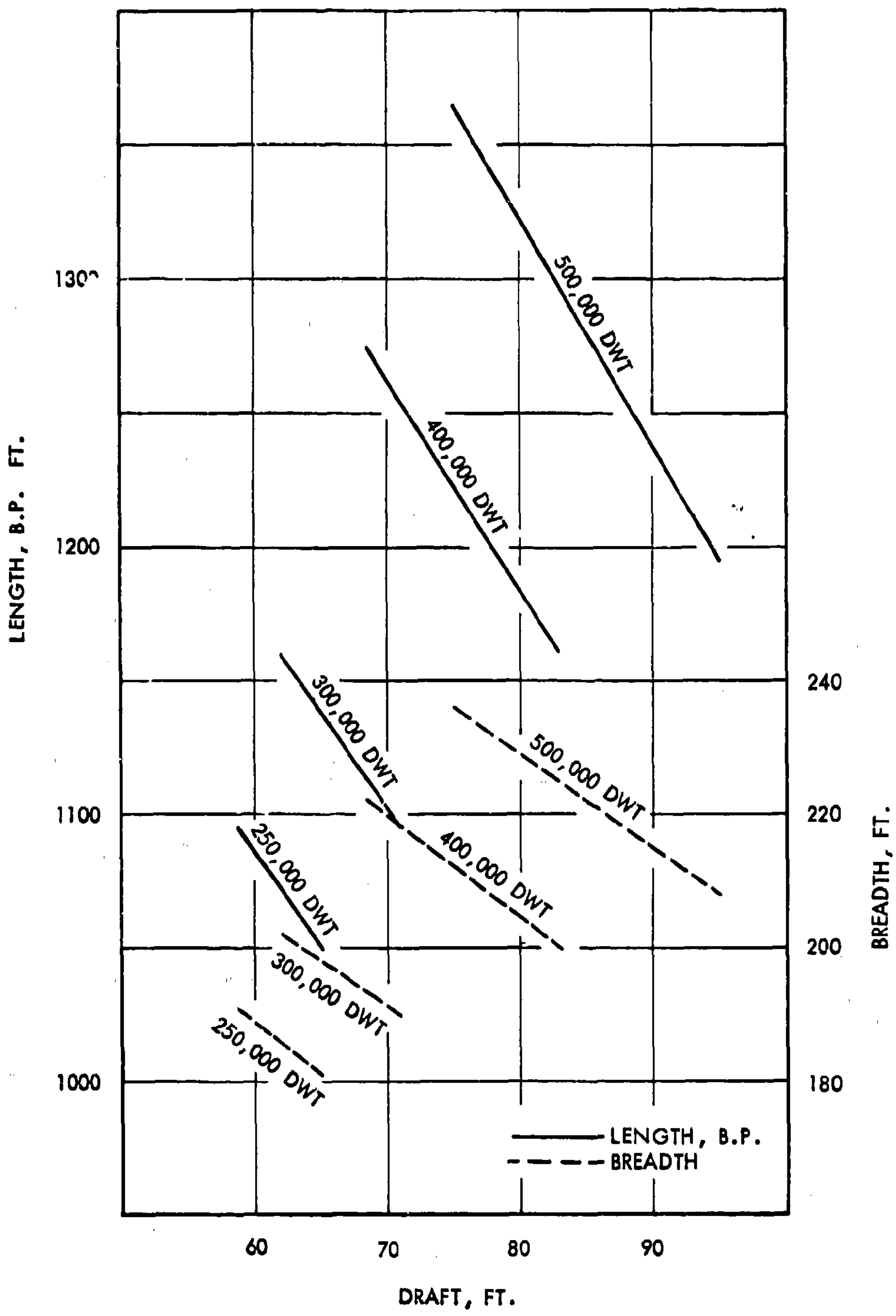

FIGURE 3 - DEADWEIGHT-DIMENSION RELATIONSHIP, 250,000 DWT - 500,000 DWT SERIES.

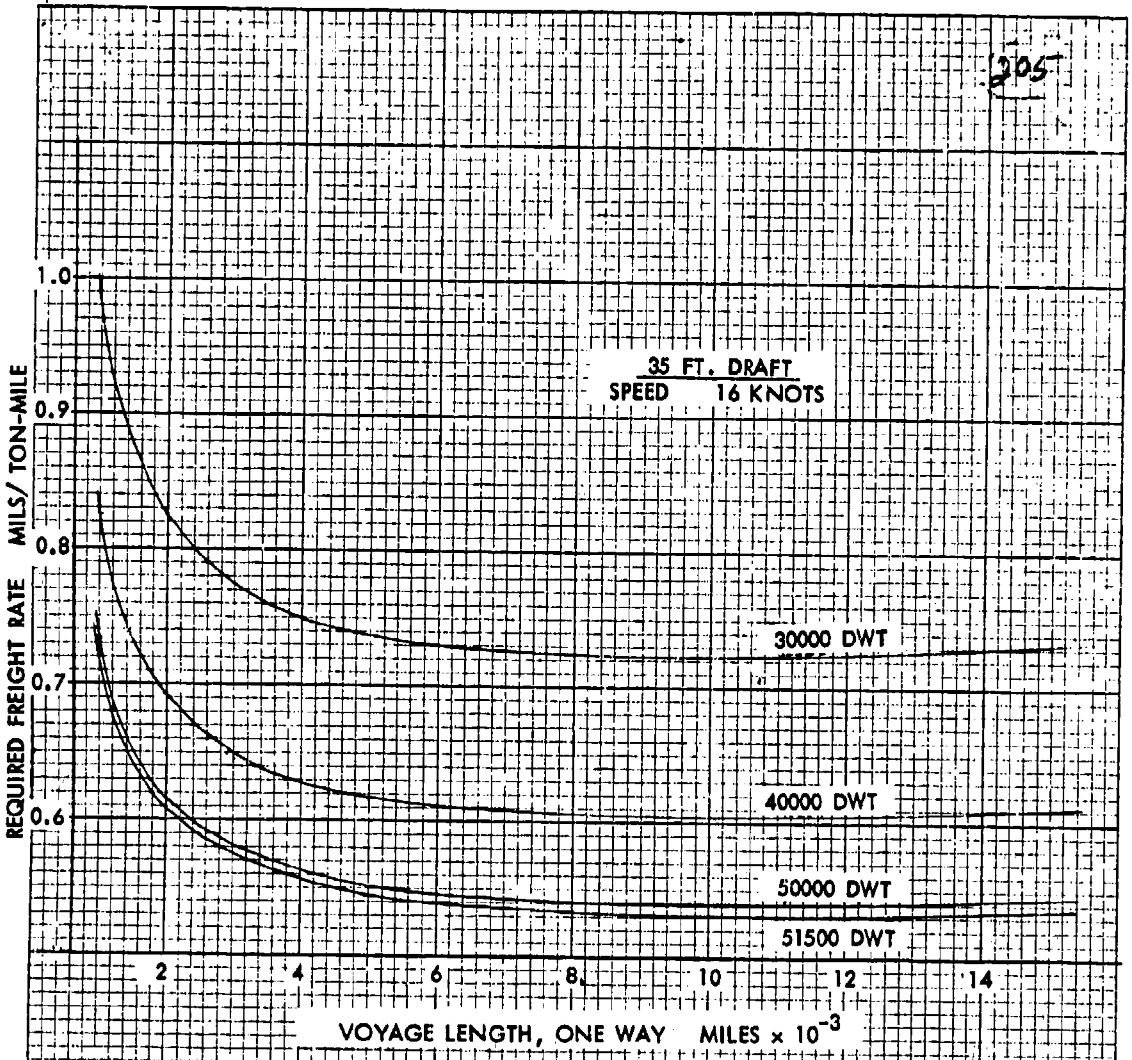

FIGURE 4 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

15

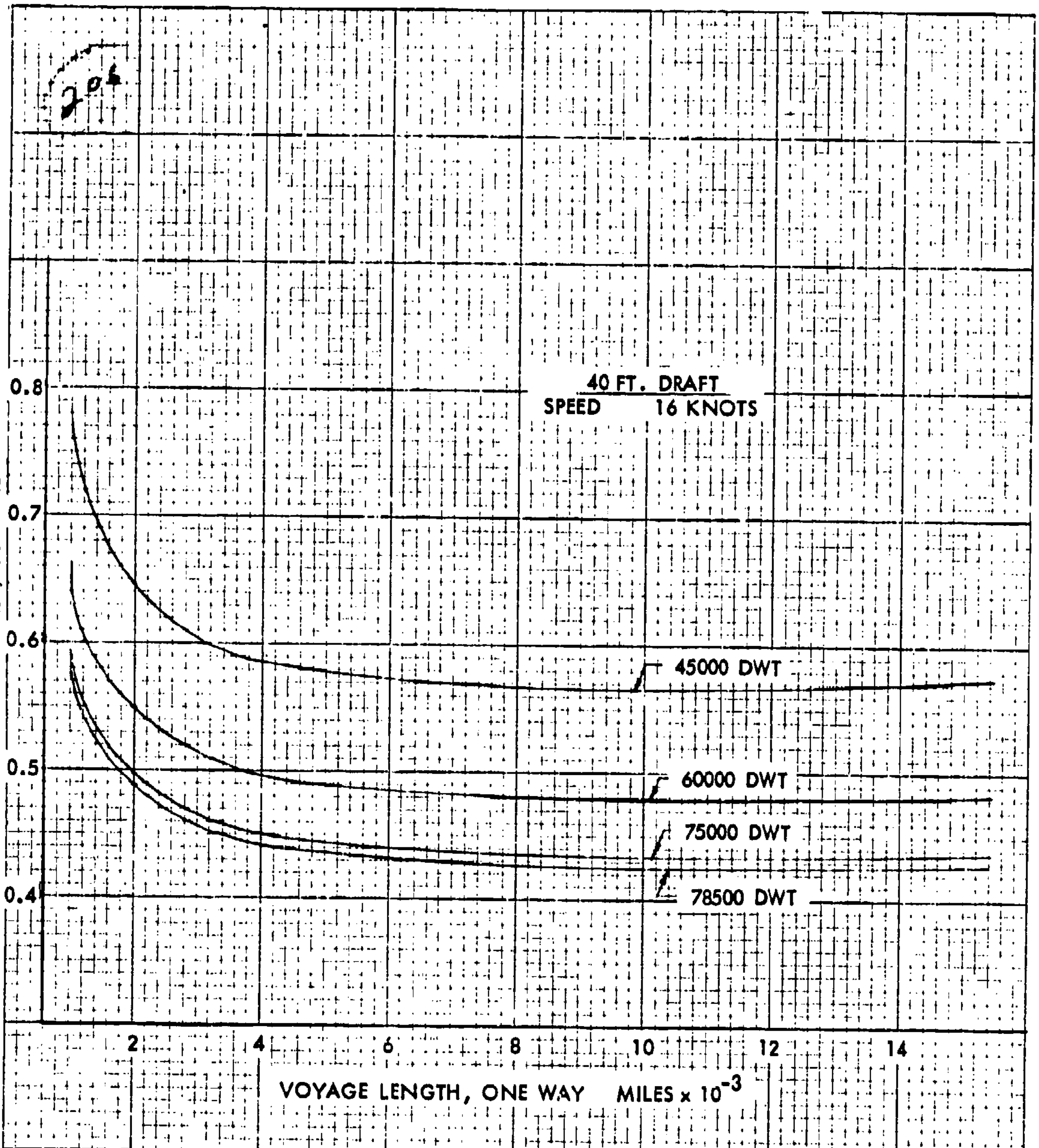

FIGURE 5 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

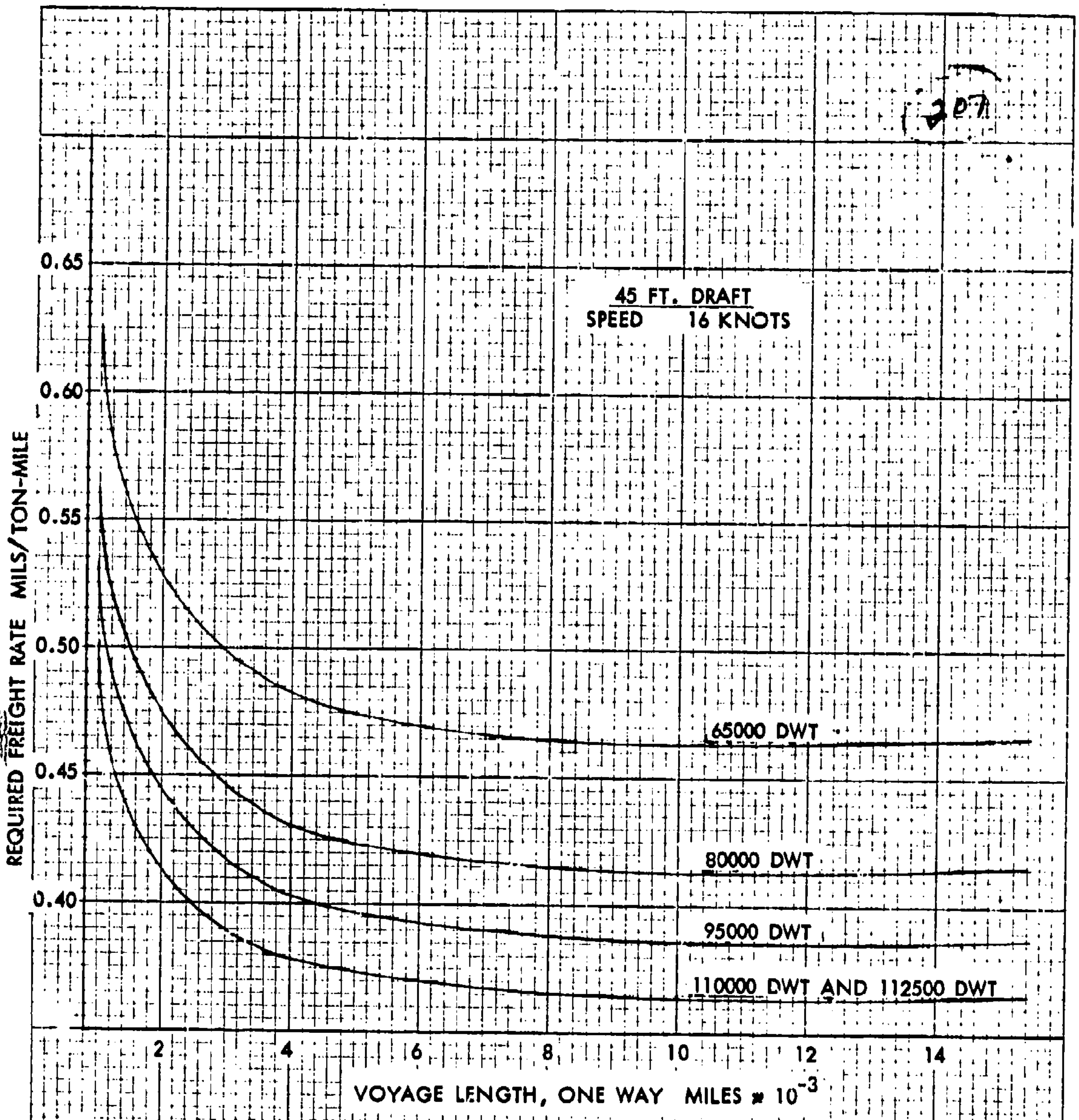

FIGURE 6 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

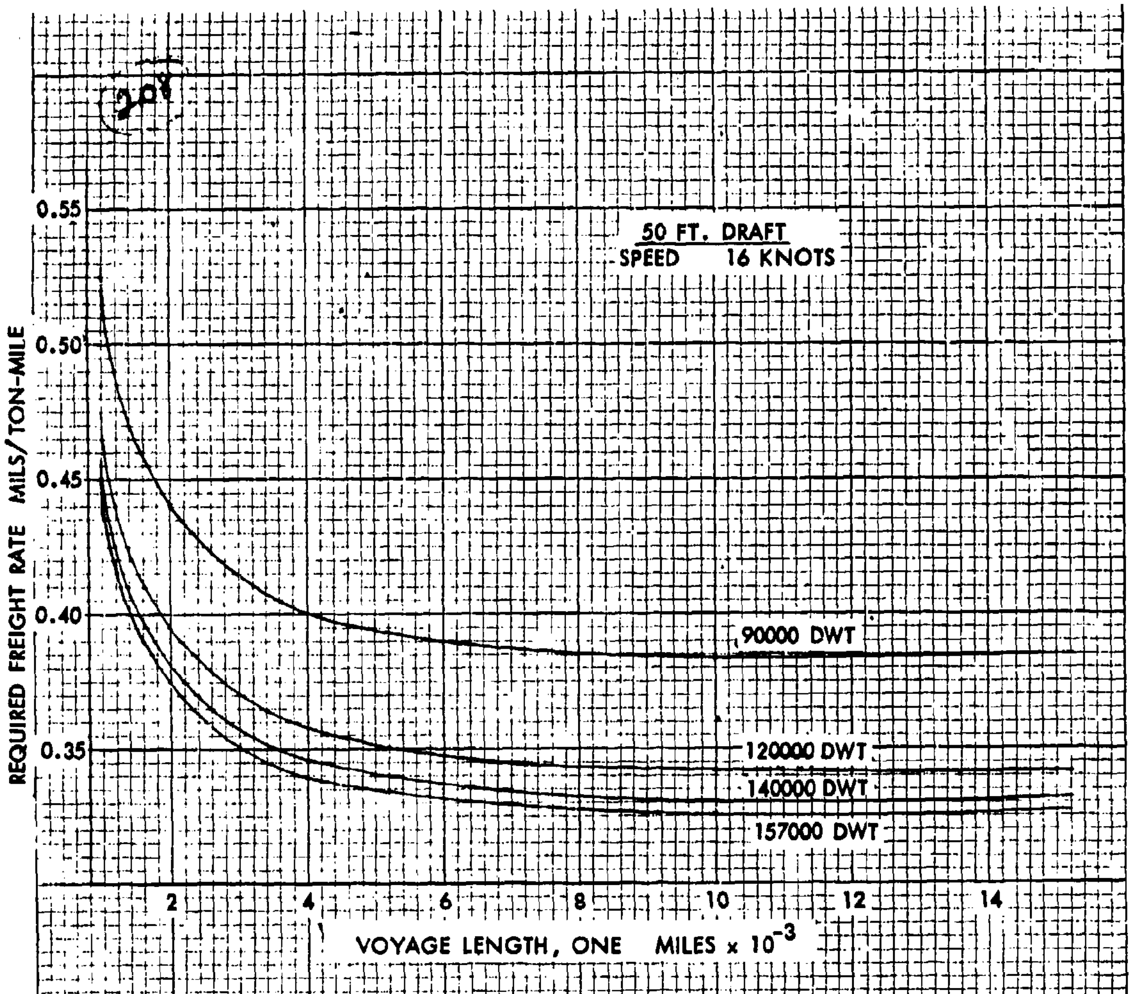

FIGURE 7 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

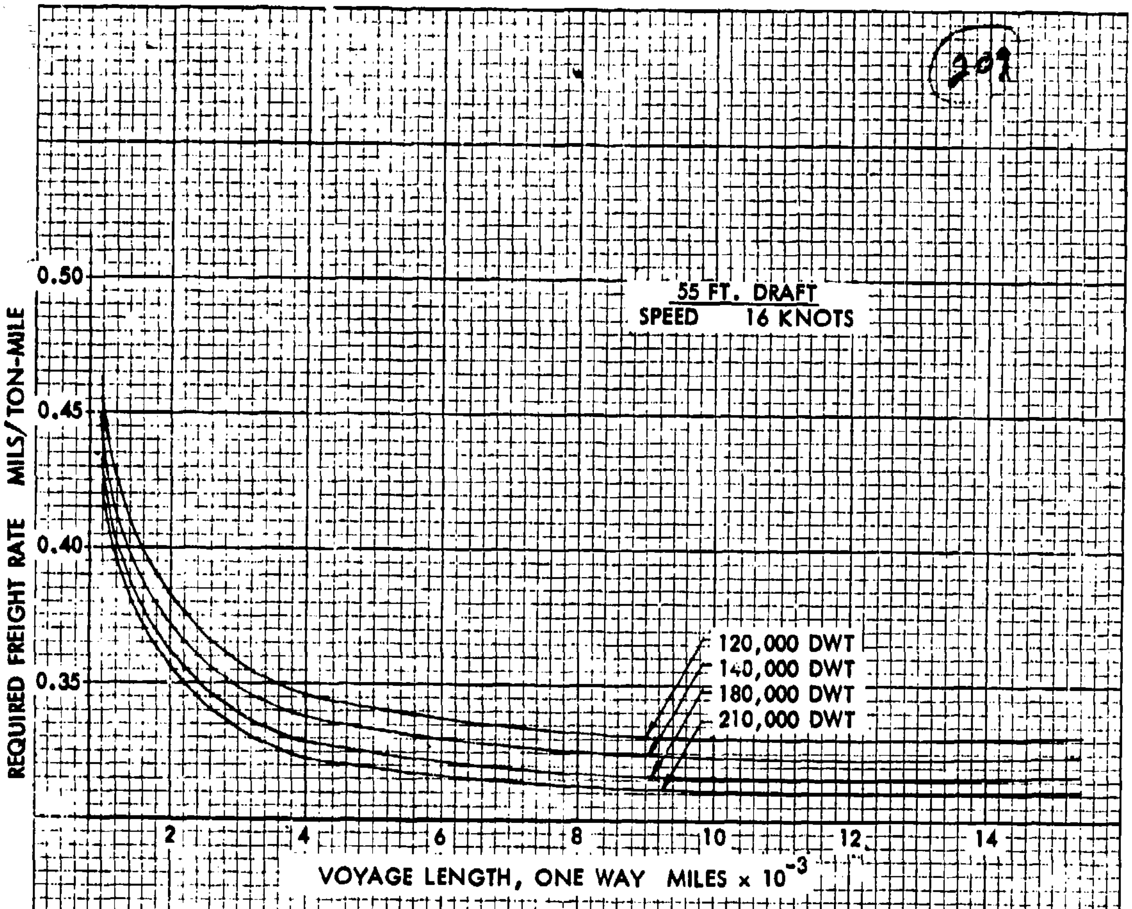

FIGURE 8 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

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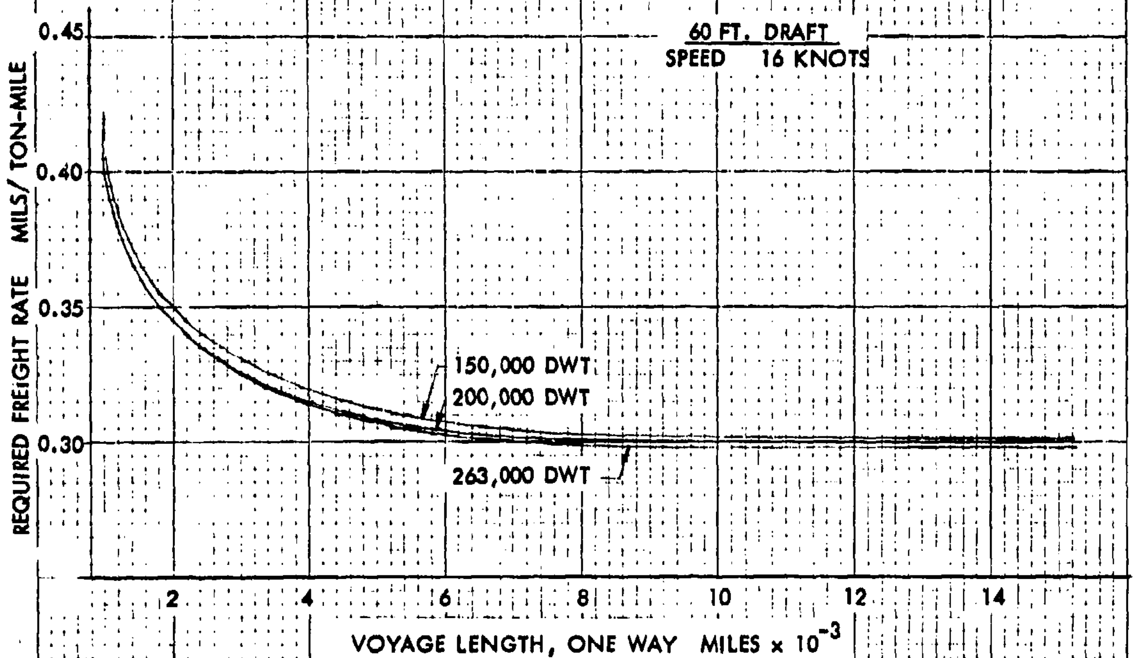
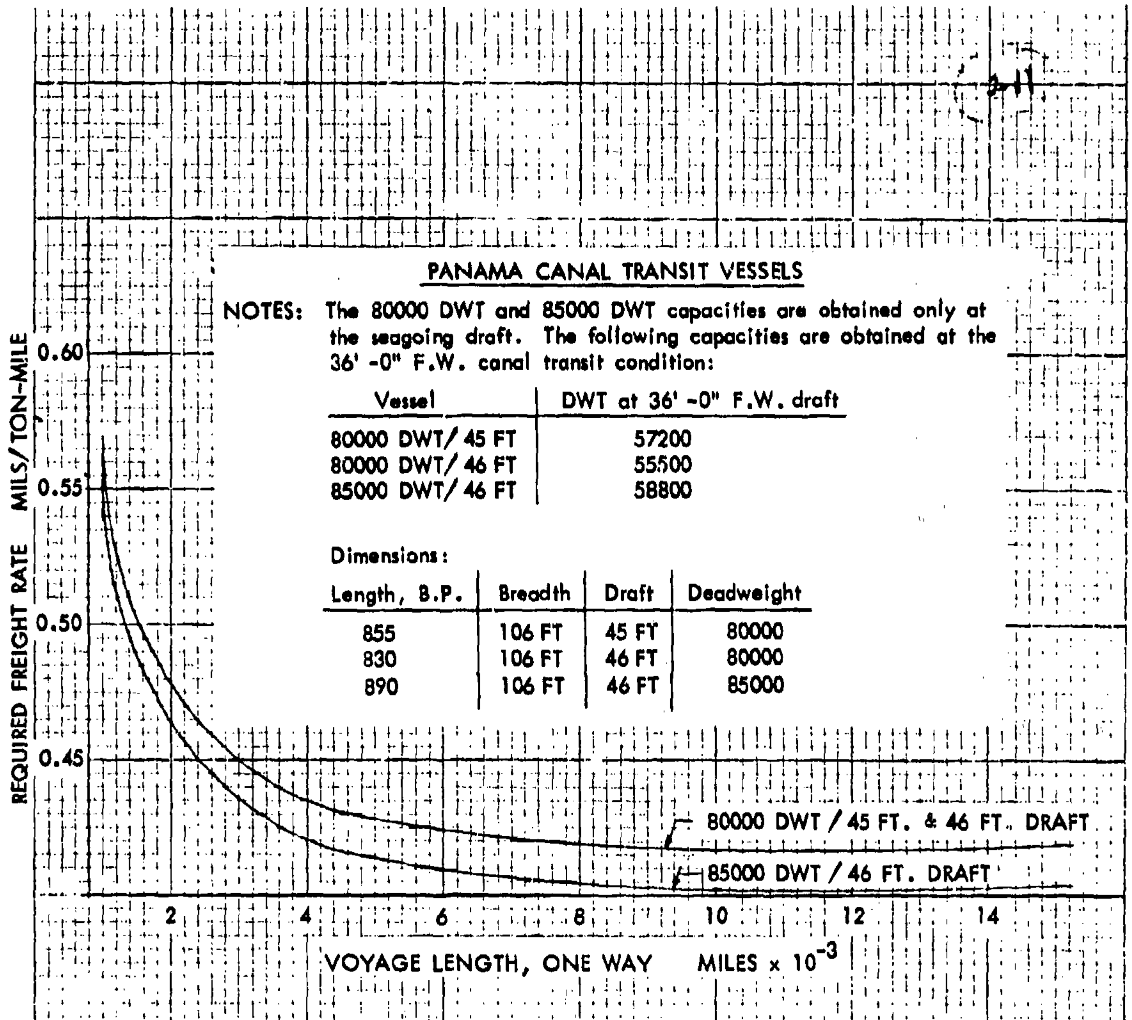


FIGURE 9 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH



PANAMA CANAL TRANSIT VESSELS

NOTES: The 80000 DWT and 85000 DWT capacities are obtained only at the seagoing draft. The following capacities are obtained at the 36' -0" F.W. canal transit condition:

Vessel	DWT at 36' -0" F.W. draft
80000 DWT/ 45 FT	57200
80000 DWT/ 46 FT	55500
85000 DWT/ 46 FT	58800

Dimensions:

Length, B.P.	Breadth	Draft	Deadweight
855	106 FT	45 FT	80000
830	106 FT	46 FT	80000
890	106 FT	46 FT	85000

FIGURE 10 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH
PANAMA CANAL TRANSIT VESSELS

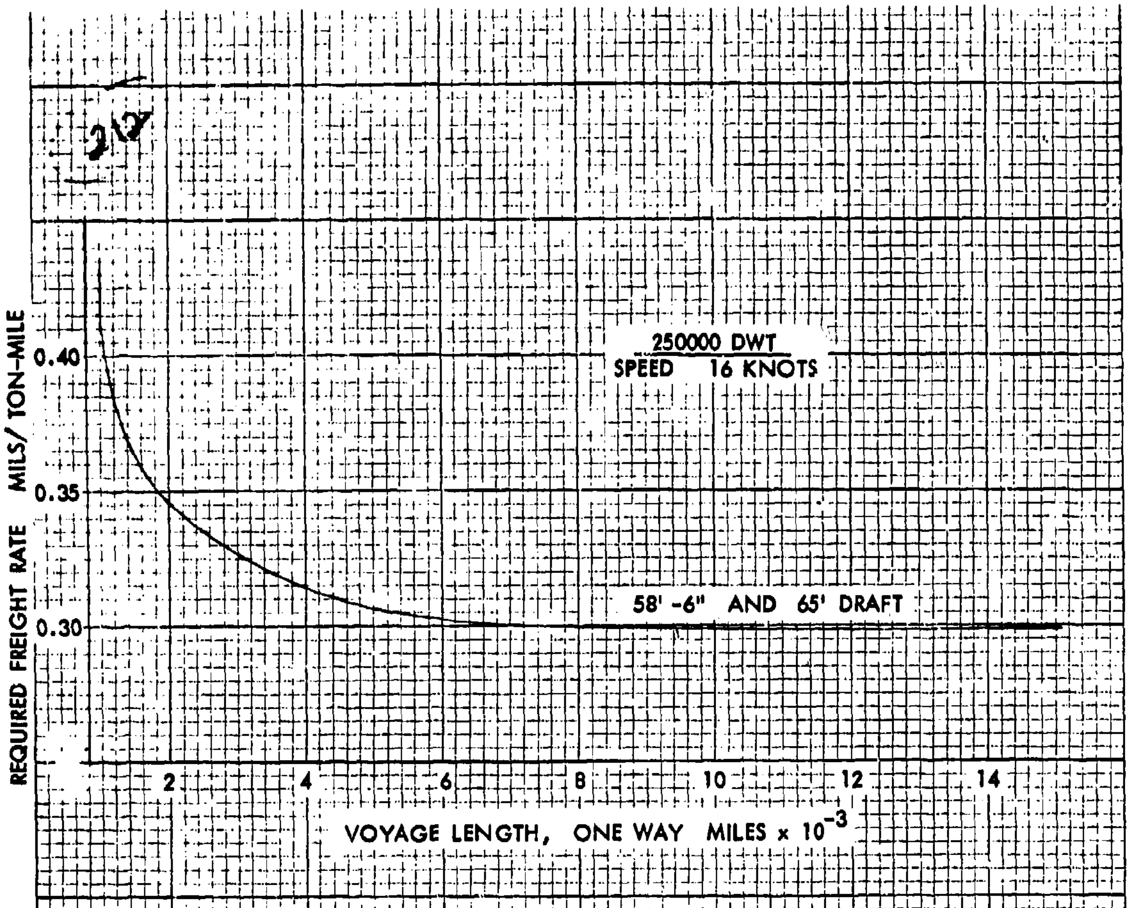


FIGURE 11 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

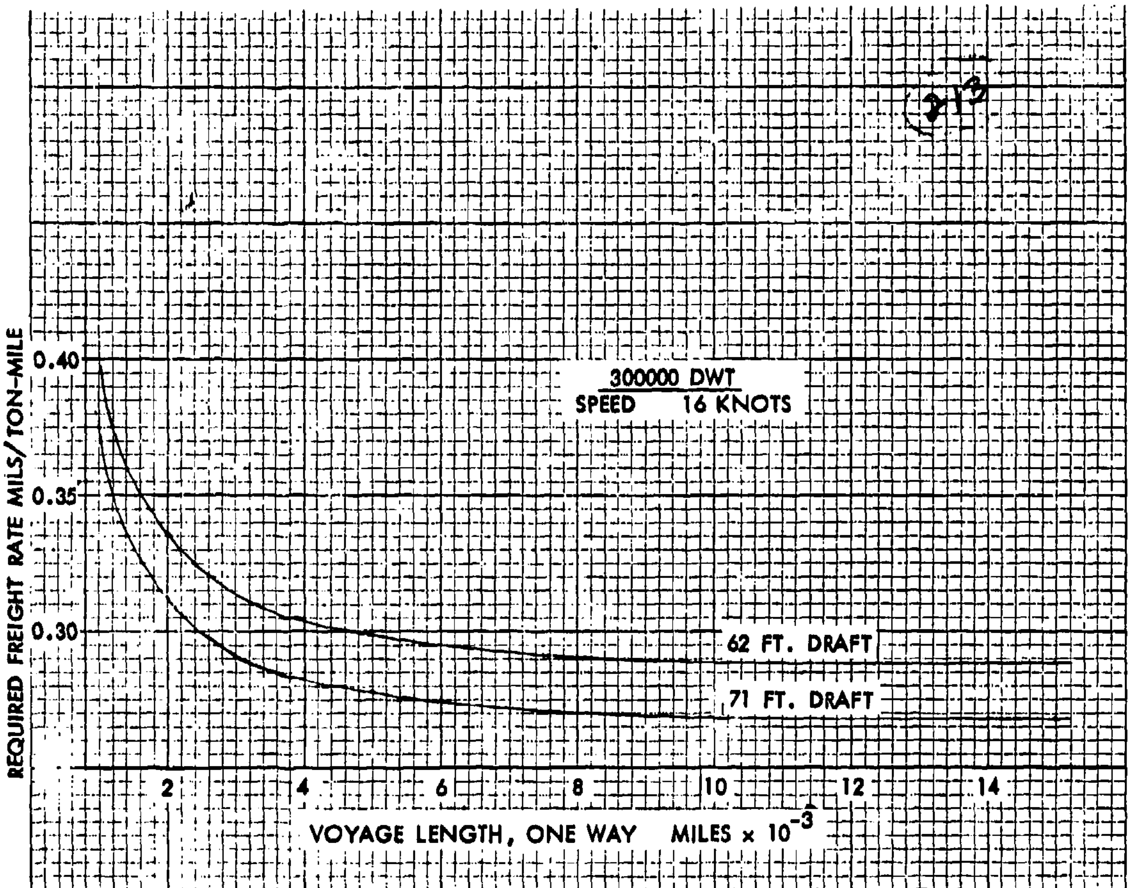


FIGURE 12 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

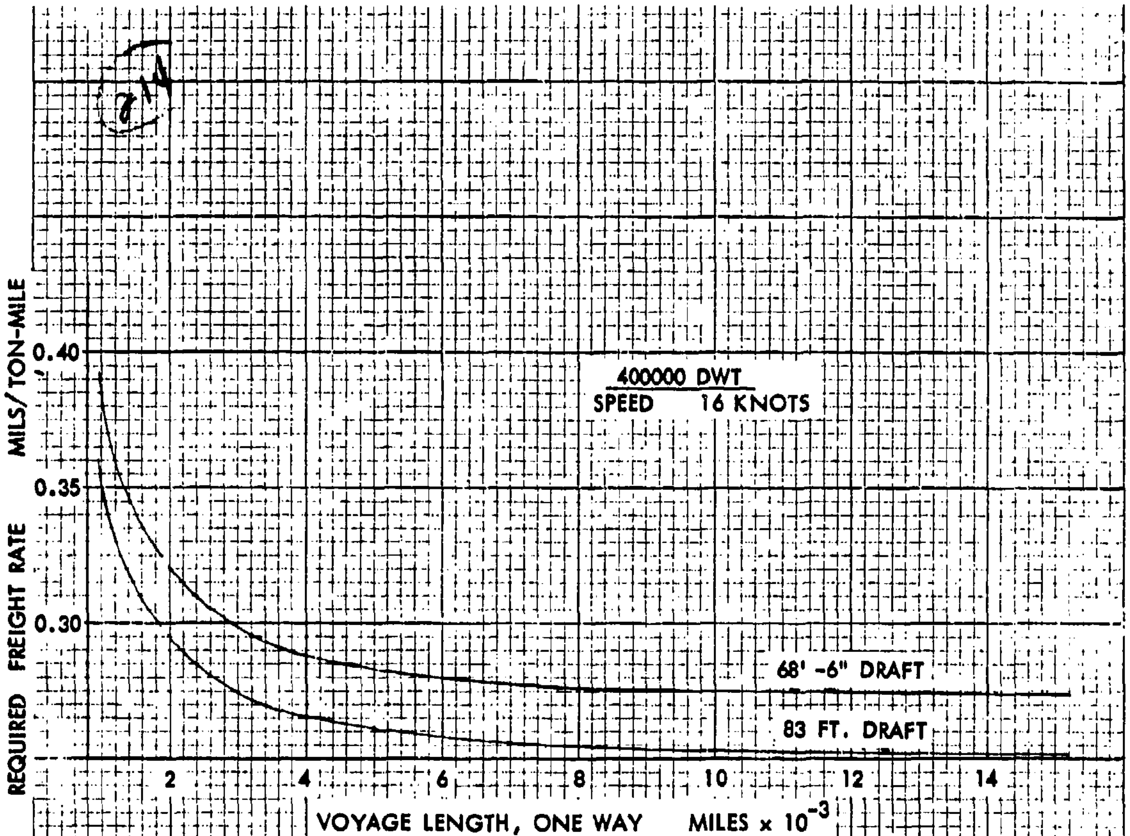


FIGURE 13 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

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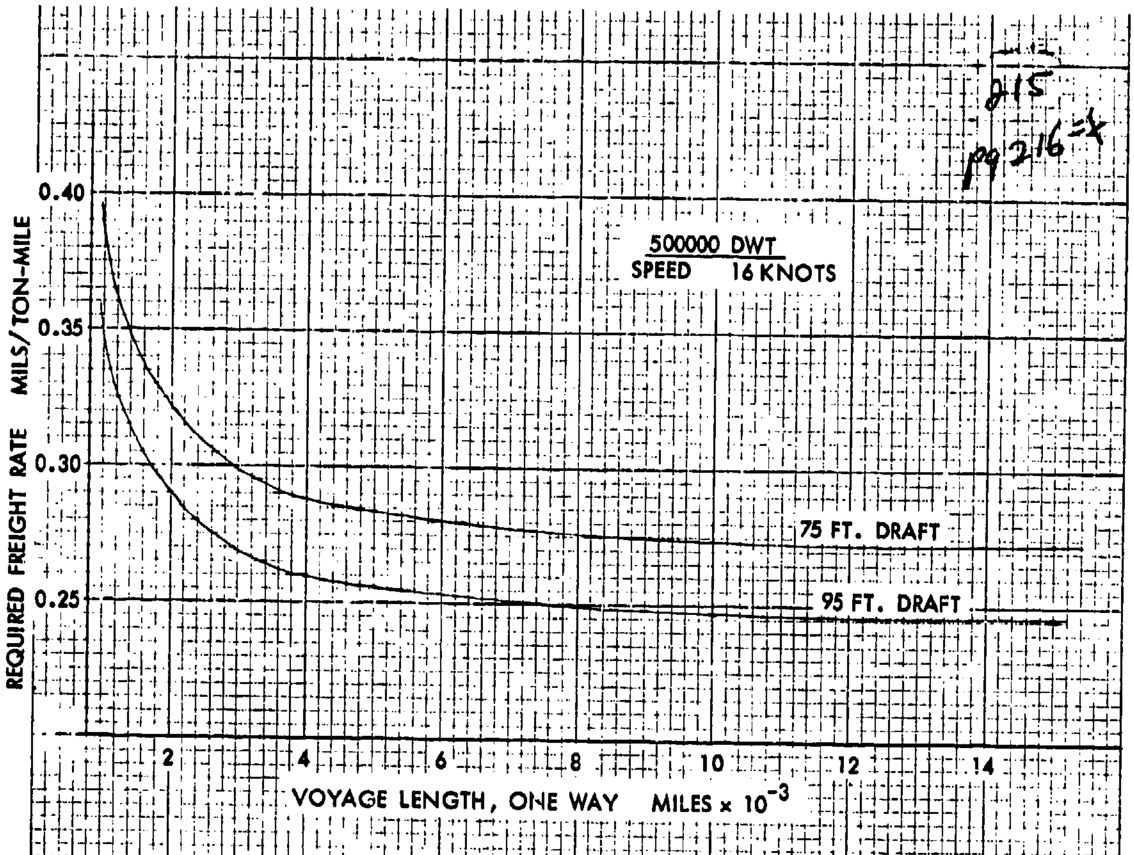

FIGURE 14 - REQUIRED FREIGHT RATE vs. VOYAGE LENGTH

ANNEX F. TRANSPORT BENEFIT-COST RELATIONSHIPS FOR SELECTED INVESTMENT ALTERNATIVES

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CONTENTS

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I. DEEPWATER PORT INVESTMENT ALTERNATIVES FOR CRUDE OIL

General

The purpose of this chapter is to provide a preliminary appraisal of the economic merits of numerous hypothesized deepwater port investments for crude oil on the basis of limited measures of benefits and costs. It attempts to determine the relative investment feasibility of these hypotheses, and thereby to identify those among them which may be worthy of further consideration and more detailed investigation. In essence, the measured feasibility of each deepwater port concept tested reflects the relation of its costs to the savings in ocean shipping costs generated.

The significance of the analysis presented herein should be qualified in three major ways. First, only a limited number of possible investments is considered. Other port improvements, beyond those treated here, could be made. Although considerable effort was made to include port developments of varied design and locational characteristics, time and budget constraints necessarily imposed limits on the number selected for detailed attention. Omission from the group in no way implies inferior standing. A proper judgment on omitted port concepts can be arrived at only through a process of appraisal comparable to the one applied here.

Second, measured values of both benefits and costs reflect numerous simplifying assumptions appropriate to a preliminary appraisal. They are thus subject to an uncertain, but possibly substantial, degree of error. The quantitative ratings for each alternative are accordingly to be taken only as very general order-of-magnitude indications of feasibility.

Third, at this preliminary stage of analysis, only the more readily measurable benefits and costs can be quantified. Since inclusion of unmeasured factors could often affect results, our presentation of findings attempts to identify some of the more important ones and to suggest their implications for relative feasibility among alternative investments.

Conceptual Approach

Measured benefits are defined as the difference in total ocean shipping costs for crude oil with a hypothesized investment alternative and without it (that is, under the "existing" or base situation). Those measured "savings" in ocean shipping costs, however, are net of any required vessel transshipments under either the hypothesized deepwater port alternative or its corresponding base situation. Measured costs are defined as the total investment, operating, and maintenance costs required to provide the hypothesized facility, including any pipelines used for transshipment.

This limited definition of measured benefits and costs requires special comment. Most notable is the absence of any accounting for costs which may have to be incurred at refinery terminals under the existing or base situation, or under deepwater port concepts calling for vessel transshipments to the refineries. Similarly, under the same conditions, large volumes of crude movement in relatively small vessels could have further cost consequences: in harbors or connecting waterways heavily used by other ships, traffic might become congested, increasing both average trip times for all vessels and possibilities of collision or oil spill. In this broad study, no attempt can be made at even rough quantification of these possibly important factors, which require detailed examination of specifics in many places.

Generally, inclusion of the preceding elements in the limited benefit-cost measures made here would result in higher absolute and relative indications of feasibility for those hypothesized investment alternatives which -- through provision of pipelines -- eliminate, or substantially reduce, the need for product delivery by water at refineries. Where relevant to proper comparison of the various alternatives considered, attention is specifically directed to these points.

Size and design characteristics of ocean vessels transporting crude petroleum are optimized for each U.S. port served under all future conditions, with or without a new deepwater port. This generally means that their carrying capacities are the largest economically feasible for any given draft constraint, often somewhat greater than for a "typical" vessel of equal draft in today's world fleet. However, the largest size ship presumed to be available is 500,000 d.w.t., for reasons explained below. All vessels are also presumed to operate under foreign flags (except for Alaska origins) and at a 50-percent load factor, normally with full cargo in one direction and return in ballast.

As a broad generalization, future physical circumstances in major relevant crude oil loading ports abroad, and production levels at major U.S. oil refineries, are expected to be fully compatible with the use of the very largest tankers, including those of restricted-draft design, for single shipments. These conditions are closely approached today, and will be increasingly realized over time. Long-range choice of size and design characteristics for tankers used on each route would thus be governed primarily by physical conditions in U.S. ports and the economies of scale (see Annex E, chapter II).

Vessels exceeding 500,000 d.w.t. have been excluded from treatment in this study for three reasons:

1. Detailed cost and other characteristics are subject to substantial uncertainty because available data are very limited

2. The pattern of scale economies for vessels of increasing size up to 500,000 d.w.t. implies that incremental savings, if any, would be quite modest for still larger ships (see Annex E, chapter III)

3. Growing worldwide environmental concern may result in absolute limitation of vessel size at about 500,000 d.w.t., or in design standards which could otherwise make ships of larger size uneconomic.

The foreign-flag and operating assumptions reflect dominant recent conditions, which are expected largely to continue (see Annex E, chapter I). Should recent U.S. subsidy programs or possible new protectionist legislation result in significant penetration of the crude oil import market by U.S.-flag carriers, somewhat higher average levels of ocean shipping costs, as well as differences in those costs among vessels of varying sizes, would be implied. On the other hand, growing use of combined carriers for crude movements will probably increase average vessel utilization rates. This would imply some decreases in average ocean shipping costs. However, directional imbalances in world trade patterns will probably impose major limits on the share of the U.S. crude import trade which combined carriers can realistically be expected to capture (see Annex E, chapter III).

Two alternative concepts of ocean transport in the base situation are often used to derive transport cost savings produced by a related deepwater port hypothesis:

1. Movement of an ocean vessel from its overseas origin to its final destination at the terminal of an oil refinery

2. Movement of a significantly larger ocean vessel to relatively deep water near the final destination, with offloading of cargo to smaller transshipment vessels which complete the journey.

This dual approach to the comparative base situation is employed for two principal reasons. First, it illuminates the potential significance of a large-scale, efficient offloading system for reducing ocean shipping costs (see Annex E, chapter IV for description). Secondly, it implies uncertainty as to whether lightering on the scale contemplated would be considered a generally acceptable approach in relevant U.S. port areas, and, if so, under what particular conditions. These matters seem to present major policy questions which to our knowledge have never been adequately formulated or appraised at a national, or perhaps even a local, level.

In this benefit-cost analysis, resort to lightering of crude oil from larger tankers to smaller vessels for transshipment to refineries is hypothesized only for New York, the Delaware Bay, and San Francisco Bay. These three areas have formally designated anchorages for the offloading of oil. They are well protected and offer significantly deeper water for incoming tankers than is available in channels leading to the refinery terminals. This circumstance offers the opportunity for substantial reduction of ocean shipping costs, which would generally be offset only in small part by the additional lightering costs involved. Comparable physical conditions do not exist in the gulf or in southern California.

In theory, lightering could be undertaken outside designated and well-protected areas. Further off shore, there are numerous places where water depth would often be great enough for vessels of 300,000 to 500,000 d.w.t. However, weather conditions would sometimes make offloading difficult and hazardous in such unprotected areas. From the commercial point of view, offloading in unprotected areas might present a problem of uncertain scheduling, since tankers would sometimes have to wait indefinitely before lightering. From the public standpoint, at least under marginal weather conditions, possibilities of oil spill are probably increased. For purposes of quantitative analysis we have assumed that lightering would be undertaken only in designated lightering areas, as described in chapter IV of Annex E. This is not to imply any preference or recommendation on our part. It is simply a question of trade-offs, which would probably vary in individual cases. Presumably, uncertainties as to vessel scheduling and possibly increased environmental risks would have to be weighed against potential incremental savings in transport costs.

Because the time distribution of benefits and of costs differs greatly, the stream of both benefits and costs is estimated annually over the useful economic life of each facility and is then discounted at several different rates to attain present (1980) values. Benefit-cost ratios are accordingly based on the relationships of those present values.

To allow sufficient lead time for additional study, investment decision, financing and construction, 1980 is assumed to be the first year any investment alternative could begin actual operation. Construction costs are time-phased in each case as necessary to permit full operation by January 1980.

The useful economic life of port and related investments, as distinguished from their physical life, is a matter of judgment which is somewhat arbitrary. This judgment is dependent on imperfect vision of long-range conditions. The economic life of any investment could be as long as one might confidently expect that its usefulness would not be impaired by changing technology, markets, etc., up to its physical age limit. In general, 20 to 30 years have been considered reasonable in many other studies for similar investments. We have assumed that all facilities would operate through the year 2009. This assumption implies a <u>maximum</u> life of 30 years (1980 through 2009) for all initial investments. However, for many facilities, additional investments are made in subsequent years (in some cases into the 1990's) to reflect growth in throughputs. For these investments, assumed lives are less than 30 years, but they usually represent a small proportion of total investment. Since discounted values of both benefits and costs so far into the future are relatively small, any alternative treatment of this difficult issue would have minor effects on investment feasibility.

In economic feasibility analysis, the appropriate criterion for selection of a discount rate is the opportunity cost of capital. In principle, this concept reflects the return on investment expected by prudent investors in light of the particular risks involved. Furthermore, when the appraisal is based on real costs, as in this study, expected returns should be net of anticipated inflation. This factor sharply differentiates the opportunity cost concept from conventional financial concepts, such as market rates of interest. Unfortunately, the "pure" opportunity cost of capital is unknown, and the special ingredients of economic risk associated with the investments at issue are impossible to value.

We have skirted this problem by applying three alternative discount rates -- 5 percent, 7 percent, and 10 percent -- to all benefit-cost calculations. Confronted with the same problem for public investments in developing countries, the World Bank has generally used rates in the 8 to 12 percent range, presumably somewhat higher than appropriate for the United States. On the other hand, 10 percent is the minimum standard currently considered desirable by the President's Office of Management and Budget for public investments in water resources projects. Hopefully, the range of rates used here will satisfy varying preferences. In any case, comparative positions of the various alternatives are not very sensitive to this question.

Methodology

1. Projected 1980 and 2000 crude oil imports in barrels per day (from Annex A) were converted to annual long ton equivalents and prepared in the form of an origin-destination zone matrix for purposes of transport analysis. All volumes were assigned to deepwater ports when provided.

2. Ocean shipping costs per long ton of cargo for 1980 and 2000 were estimated for the appropriate vessel and distance of haul from the ocean shipping cost analysis in chapter III of Annex E, separately for

each hypothesized deepwater port investment alternative and for each link in the aforementioned matrix. In each instance the vessel selected provided the lowest unit transport cost at the maximum permissible draft assumed for that port alternative. Where no vessels initially costed corresponded precisely to that draft, appropriate unit costs and vessel size characteristics were interpolated. In many cases, ships with restricted-draft design (i.e., larger than standard at a given draft) were selected.

Voyage distances on each link were estimated from the Naval Oceanographic Office's Distances Between Ports and, where appropriate, from the Coast and Geodetic Survey's Distances Between United States Ports. Because of extreme uncertainties about future operation of the Suez Canal, however, all projected crude oil imports from the Middle East were divided equally between the Persian Gulf and the Mediterranean for purposes of estimating shipping distances, as is explained more fully below.

3. For each hypothesized deepwater port alternative requiring, in whole or in part, vessel transshipment from the deepwater port to existing terminals, distances of movement on each relevant link were estimated from large-scale maps. Appropriate unit costs per ton of cargo on each link were estimated from data in chapter IV of Annex E.

4. Total annual transport costs for ocean shipping and for vessel transshipment (where incurred) associated with each deepwater port alternative were then calculated separately for the years 1980 and 2000. The data derived from the three previous steps were used as inputs.

5. The procedures described above were then essentially repeated for application to 1980 and 2000 movements of crude oil under the "existing," or base, situation (that is, the situation presumed to exist in the absence of any deepwater port investment). First,

unit costs of ocean shipping were estimated separately under conditions of no lightering and lightering. (Assumed vessel size characteristics for the various movements are shown in table 1.) Maximum permissible drafts at each existing port or lightering area were estimated on the basis of Corps of Engineers' data on mean low water depth and tide, with appropriate allowance for clearance. Additional costs for lightering were derived from chapter IV of Annex E. Resulting total unit costs were then applied to pertinent volumes transported on each link, separately for each base situation corresponding to one or more of the deepwater port alternatives. This procedure provided total annual shipping costs in 1980 and 2000 under all hypothesized base conditions.

6. For each hypothesized deepwater port alternative, estimates of total annual investment, operating and maintenance costs from 1975 through 2009 were made on the basis of unit cost factors developed in Annex C. These port cost data were then used as inputs to a computer program.

7. The computer program also included 1980 and 2000 projected volumes of traffic, and related ocean shipping costs, at each deepwater port. For each alternative, the computer output repeated the annual cost estimates (see first four columns of Computer Series 1 in the appendix), calculated annual throughput volumes on the assumption of linear growth from 1980 to 2000 and constant levels through 2009, and calculated corresponding annual ocean shipping costs over the same interval (see last two columns of Computer Series 1).

8. As part of the same computer run, the present (1980) value of the stream of deepwater port costs and of related ocean shipping costs through 2009 was calculated separately at discount rates of 5, 7, and 10 percent (see bottom three lines of Computer Series 1).

9. Steps 7 and 8 were then applied to 1980 and 2000 volumes and corresponding ocean shipping costs for

Table 1. Assumed Maximum Permissible Draft and Ocean Ship Size, 1980 and 2000 Crude Oil Imports, in the Base Situation, by Major Market Area

Market area	No lightering		Lightering	
	Draft (feet)	D.w.t. (thous.)	Draft (feet)	D.w.t. (thous.)
East coast:				
New York........	36	57	45	110
Delaware Bay....	36	57	57.5	236
Gulf coast.......	36	57	--	--
West coast:				
Los Angeles.....	46	119	--	--
Long Beach......	60	263	--	--
	53.5	190	--	--
San Francisco...	36	57	52.5	183

Source: RRNA estimates.

the "existing" situation, with and without lightering (Computer Series 2).

10. A second computer program was then written to calculate benefit-cost ratios for each investment alternative considered. For costs, the program used as an input all present value calculations of deepwater port costs derived from the initial run. For benefits, it used as an input the earlier present value calculations of shipping costs related to each deepwater port and its corresponding existing situation. It then calculated the difference between the latter two figures to determine net "savings" in ocean shipping costs, and it computed the ratio of those savings (benefits) to port costs in each case at all three discount rates (see Computer Series 3).

Mid-East Oil Movements to the United States

For study purposes, future routing of tankers from dominant Persian Gulf/Red Sea crude oil origins to the U.S. east and gulf coasts presents a special problem because of great uncertainties about the Suez Canal and about competitive pipeline transshipment to the Mediterranean. The problem has important implications for distances of haul, and hence for potential savings in ocean transport costs. Although it seems reasonable to expect the canal eventually to reopen, no one now knows the effective conditions which will govern its future operation. For example, what types of improvements will be made, and when? What schedule of charges will apply?

So long as the canal remains closed, there are two possible routing patterns: the long haul around the Cape of Good Hope, or a much shorter transatlantic voyage from eastern Mediterranean points after transshipment by pipeline or by a combination of tanker and pipeline. Although transshipment elements of the latter movement are part of total transport costs, they can reasonably be assumed to be indifferent to the size of ocean vessel used in subsequent movement to the United States, the critical issue for present purposes. Recent investment decisions by some major oil companies in relation to the huge European market indicate growing resort to the pipeline approach.

If the Suez Canal were to reopen with its physical constraints unchanged, it could be transited only by relatively small tankers that were fully laden, and by somewhat larger ones in ballast. In that event, the cost advantage of supertankers making the long circuitous journey would be reduced somewhat. If, on the other hand, the canal were eventually improved to permit transit by supertankers, distances to the United States would be substantially reduced for all ships. Therefore, either of these uncertain developments would have implications similar to those of the pipeline.

To take some meaningful account of these circumstances, we have assumed for purposes of ocean vessel routing and costing that half of projected total crude oil imports1/ from the Mideast would originate in the Mediterranean, and the balance would originate in the Persian Gulf, routed by the Cape of Good Hope.

Findings

Benefit-cost relationships for each of the various crude oil investment alternatives considered are summarized in tables 2 to 4. To simplify the presentation, all benefit-cost ratios shown in the tables are based on a 10-percent discount rate. As previously noted, this is the minimum standard currently considered desirable by the Office of Management and Budget. Ratios based on discount rates of 5 and 7 percent, which are shown in the appendix, Computer Series 3, are of course uniformly higher. However, they do not affect the relative standing of the various alternatives, nor (with one minor exception) do they imply feasibility for any alternatives which fail to qualify at the higher rate.

1/ To the U.S. east and gulf coasts. All Mideast crude oil imports to the west coast are assumed to originate in the Persian Gulf.

Table 2. Benefit-Cost Ratios, East Coast Crude Oil Deepwater Port Alternatives, with Alternative Throughputs and Base Situations, at 10-Percent Discount Rate

Description	Comparison number[a]/	Lightering		No lightering	
		Low vol.	High vol.	Low.vol.	High vol.
<u>New York local</u>					
300,000-d.w.t. ship....	1, 3, 5, 7	1.41	2.25	2.75	4.45
400,000-d.w.t. ship....	2, 4, 6, 8	1.28	2.05	2.50	4.05
<u>Delaware Bay local</u>					
300,000-d.w.t. ship					
Onshore site..........	9, 13, 17, 21	2.20	2.85	6.99	9.30
Island site...........	10, 14, 18, 22	2.04	2.74	6.46	8.96
400,000-d.w.t. ship:					
Onshore site..........	11, 15, 19, 23	2.08	2.70	6.59	8.80
Island site...........	12, 16, 20, 24	1.94	2.61	6.14	8.51
<u>East coast regional</u>					
300,000-d.w.t. ship:					
N.Y. site.............	25, 39, 53, 67	2.34	2.88	6.41	8.22
Long Beach, N.J. site.	26, 40, 54, 68	2.91	3.45	7.98	9.86
Delaware site:					
Onshore storage......	27, 41, 55, 69	2.56	3.32	7.01	9.47
Island storage.......	28, 42, 56, 70	2.46	3.22	6.74	9.20
Vessel transshipt....	29, 43, 57, 71	1.47	2.12	5.66	8.44
Combination of two sites:					
Comp. 1 and 9, etc...	30, 44, 58, 72	1.84	2.63	5.06	7.50
Comp. 1 and 10, etc..	31, 45, 59, 73	1.76	2.56	4.84	7.32

continued--

Table 2. Benefit-Cost Ratios, East Coast Crude Oil Deepwater Port Alternatives, with Alternative Throughputs and Base Situations, at 10-Percent Discount Rate continued--

Description	Comparison number[a/]	Lightering		No lightering	
		Low vol.	High vol.	Low vol.	High vol.
400,000-d.w.t. ship:					
N.Y. bay site.........	32, 46, 60, 74	2.16	2.69	5.92	7.68
Long Beach, N.J. site.	33, 47, 61, 75	2.59	3.24	7.37	9.25
Delaware site:					
Onshore storage......	34, 48, 62, 76	2.37	3.07	6.49	8.78
Island storage.......	35, 49, 63, 77	2.32	3.04	6.36	8.69
Vessel transshipt....	36, 50, 64, 78	1.33	1.97	5.14	7.85
Combination of two sites:					
Comp. 2 and 11, etc..	37, 51, 65, 79	1.71	2.45	4.68	6.99
Comp. 2 and 12, etc..	38, 52, 66, 80	1.64	2.40	4.51	6.85

a/ Comparison numbers refer to those used in the appendix, Part I: East Coast Oil, Computer Series 3: Benefit-Cost Comparisons.

Table 3. Comparison of Benefit-Cost Ratios, Gulf Coast Crude Oil Deepwater Port Alternatives,[a] at 10-Percent Discount Rate

Description	Comparison number[b]	Volume	
		Low	High
210,000-d.w.t. ship			
Miss. site, vessel transshipment......	1, 13	8.71	10.35
Texas site:			
Monobuoy..........	2, 14	6.60	7.21
Berth.............	3, 15	4.46	5.08
300,000-d.w.t. ship			
Miss. site, vessel transshipment.....	4, 16	10.64	13.06
Texas site:			
Monobuoy..........	5, 17	7.70	8.48
Berth.............	6, 18	5.80	6.89
400,000-d.w.t. ship			
Miss. site, vessel transshipment.....	7, 19	10.05	12.39
Texas site:			
Monobuoy..........	8, 20	7.70	8.49
Berth.............	9, 21	5.44	6.53
500,000-d.w.t. ship			
Miss. site, vessel transshipment.....	10, 22	11.21	13.60
Texas site:			
Monobuoy..........	11, 23	7.97	8.78
Berth.............	12, 24	4.24	5.21

a/ All alternatives are regional.
b/ Comparison numbers refer to those used in the appendix, Part II: Gulf Coast Oil, Computer Series 3: Benefit-Cost Comparisons.

Table 4. Comparison of Benefit-Cost Ratios, West Coast Crude Oil Deepwater Port Alternatives, at 10-Percent Discount Rate

Description	Comparison number[a]	Lightering	No Lightering
Los Angeles-Long Beach local			
300,000-d.w.t. ship.	1	--	4.01
400,000-d.w.t. ship.	2	--	3.40
San Francisco local			
157,000-d.w.t. ship:			
Long Wharf, Richmond..........	3, 9	0.57	3.85
Richmond-Avon......	4, 10	0.48	3.23
250,000-d.w.t. ship:			
Long Wharf, Richmond..........	5, 11	0.79	3.15
Richmond-Avon......	6, 12	0.47	1.86
400,000-d.w.t. ship:			
Moss Landing.......	7, 13	1.25	3.30
Puget Sound, pipeline transshipt...	8, 14	0.51	1.12
Regional: combination[b]			
Comp. 1 and 3 or 9..	15, 30	2.02	3.92
Comp. 1 and 4 or 10.	16, 31	1.82	3.53
Comp. 2 and 3 or 9..	17, 32	1.88	3.64
Comp. 2 and 4 or 10.	18, 33	1.71	3.31
Comp. 1 and 5 or 11.	19, 34	1.90	3.45
Comp. 1 and 6 or 12.	20, 35	1.31	2.37
Comp. 2 and 5 or 11.	21, 36	1.79	3.25
Comp. 2 and 6 or 12.	22, 37	1.25	2.27
Comp. 1 and 7 or 13.	23, 38	2.12	3.53
Comp. 1 and 8 or 14.	24, 39	0.93	1.46
Comp. 2 and 7 or 13.	25, 40	2.01	3.34
Comp. 2 and 8 or 14.	26, 41	0.91	1.43
Regional: integrated			
300,000-d.w.t. ship:			
Los Angeles-Long Beach, pipeline to San Francisco.....	27, 42	1.49	2.68

continued--

Table 4. Comparison of Benefit-Cost Ratios, West Coast Crude Oil Deepwater Port Alternatives, at 10-Percent Discount Rate --continued--

Description	Comparison number[a]	Lightering	No Lightering
400,000-d.w.t. ship:			
Los Angeles-Long Beach, pipeline to San Francisco.....	28, 43	1.41	2.53
Puget Sound, pipeline to Los Angeles and San Francisco.........	29, 44	0.73	1.01

a/ Comparison numbers refer to those used in the appendix, Part III: West Coast Oil, Computer Series 3: Benefit-Cost Comparisons.

b/ Combination of two local (Los Angeles/Long Beach and San Francisco) improvements.

East Coast

The 20 basic crude oil investment alternatives considered for the east coast are arranged to facilitate proper comparison of the numerous variables governing major choices. Those alternatives which are designed to serve only the Greater New York refineries are presented first, followed by alternatives serving only refineries accessible to the Delaware Bay. The larger number of alternatives of regional scope follow.

For each physically distinct alternative and related ocean vessel size listed, four benefit-cost ratios are shown. Each reflects a different set of assumptions on two other variables: (1) high or low volumes of annual throughput, and (2) with or without full resort to lightering of imported crude oil in the comparative base situation.

All of the investments considered are at least marginally feasible on the basis of measured concepts, ranging from a high of nearly 10:1 to a low of 1.3:1. Absolute values are moderately sensitive to differences in assumed volumes, and are extremely sensitive to whether or not one presumes general resort to lightering of large tankers in the absence of a new deepwater port. However, the relative position of the various options is not importantly affected by those variables.

Thus, each facility has a higher benefit-cost ratio when designed to accommodate 300,000-d.w.t. rather than 400,000-d.w.t. ships. This reflects the fact that additional terminal costs are incurred in the latter case, while ocean shipping costs of restricted-draft, 400,000-d.w.t. vessels are approximately the same as those of a 300,000-d.w.t. ship at the assumed available draft of 70 feet. (At a deeper draft, the 400,000-d.w.t. ship would be less costly.)

Similarly, most of the regionally integrated facilities serving both the New York and Delaware Bay areas have higher benefit-cost ratios than any local investment designed to accommodate crude oil imports only in one area, or any combination of two such local investments. This suggests inherent efficiencies in a regional approach to deepwater port planning for the east coast.

Among the five regionally integrated port development concepts, the consistently least attractive under any combination of assumptions as to lightering, volumes, or vessel size is the site off the Delaware Capes utilizing vessel transshipment. At least under the circumstances governing the facilities under investigation here, pipeline transshipment is clearly a preferred approach from the viewpoint of transport benefits and costs.

Of the remaining four regional port designs, benefit-cost ratios for the site in Lower New York Bay are uniformly lower, by a moderate degree, than for other sites. Placement of oil storage at the offshore Delaware site appears to make it slightly less attractive than when it is located on shore. However, neither of these Delaware locations has as favorable a benefit-cost ratio as the facility located near Long Branch, New Jersey. Its measured feasibility ranges from 2.9:1 under the more conservative assumptions to 9.9:1 under the more favorable ones.

However, the degree of error to which the estimated benefit-cost ratios are subject probably exceeds the modest differences shown among the four indicated alternatives. Furthermore, environmental factors might also influence them differentially. More refined analysis of these alternatives is therefore certainly in order.

Gulf Coast

Only three basic design alternatives, all regional in scope, are considered for the gulf coast: a site at the mouth of the Mississippi River with complete reliance on vessel transshipment to various major refinery locations along the coast; an offshore monobuoy near Freeport, Texas; and a fixed terminal at

Freeport. Both Freeport alternatives provide for transshipment to refineries predominantly by pipeline. For each of these three basic design concepts, four different ship sizes and corresponding drafts, as well as two alternative sets of projected annual throughputs, are hypothesized. Presentation of the benefit-cost ratios in table 3 is arranged to facilitate appraisal of those variables.

As on the east coast, benefit-cost ratios for all options are favorable, ranging from 13.6:1 to 4.2:1. The higher range of values as compared with the east coast is due to: (1) the assumed avoidance of lightering in the gulf in the absence of a deepwater port; (2) somewhat larger volumes; and (3) modestly higher unit shipping cost savings because of greater average link distances.

Under all alternative concepts of vessel size and throughputs, the fixed terminal at Freeport is less attractive than the other facilities, especially where larger vessels are employed. This suggests substantial diseconomies from dredging.

Benefit-cost ratios for all other investment alternatives increase with increases in draft and corresponding ship size from 210,000 d.w.t. to 500,000 d.w.t. (except that, at the assumed draft of 70 feet, use of 400,000-d.w.t. vessels offers no advantage over, or is less favorable than, use of 300,000-d.w.t. vessels, for the same reasons indicated above in relation to the east coast). These circumstances reflect advantages of naturally deep water for accommodating vessels of very deep draft (up to 95 feet).

Surprisingly, and in marked contrast to analogous relationships on the east coast, measured feasibility for the Mississippi site, with full dependence on vessel transshipment, is significantly higher than for the Freeport monobuoy and pipeline transshipment concept over the full range of assumed vessel sizes and throughputs. This principally reflects the very substantial costs required to provide pipeline links to most of the widely scattered refinery locations along the gulf.

For reasons indicated earlier, however, benefit-cost ratios presented herein for any investment alternatives not dependent on large-scale vessel transshipment must be adjusted upward, to an uncertain but possibly substantial degree. This adjustment is to reflect their favorable impact on vessel traffic in possibly congested waterways and on reduced requirements for terminal improvements at the refineries. Thus, the Freeport monobuoy design concept, in addition to the Mississippi site, appears worthy of more detailed appraisal -- especially for accommodation of the very largest supercarriers.

West Coast

The numerous investment alternatives considered on the west coast fall into four broad groups. These are comprised of local approaches for two separate areas (the dominant southern California and northern California refinery concentrations) and regional approaches of two different types (those which constitute a combination of two separate improvements, each serving one of those local areas, and those which concentrate on a single deepwater site for the entire region, with pipeline transshipment as necessary). Benefit-cost ratios for each option within those four groups are shown sequentially in table 4. Except for local investments serving only southern California, two benefit-cost ratios are indicated, as they are on the east coast, to reflect alternative assumptions as to the use of lightering in the comparative base situation.

Most benefit-cost ratios are highly sensitive to whether lightering from large tankers in San Francisco Bay is assumed in the absence of a new deepwater port. Furthermore, measured indications of the relative, as well as the absolute, feasibility of alternatives affecting northern California are sensitive to this assumption.

Before considering that issue further, certain findings can be established which are not dependent on its resolution. First, the benefit-cost ratio of 4:1 clearly establishes that dredging of Los Angeles-Long

Beach for the accommodation of 300,000-d.w.t. tankers drawing 70 feet to serve the southern California market would be advantageous (more so than for the accommodation of 400,000-d.w.t. vessels at the same draft, for the same reasons as have been discussed earlier). That ratio would be still higher if an uncertain part of estimated costs had been subtracted to allow for the use of dredged materials in other harbor improvements.

It is also clear that regionally integrated investment alternatives are substantially less advantageous than most combinations of investments designed to separately serve the northern and southern California markets. This result reflects the relatively high cost of pipeline transshipment. Its disadvantage is particularly marked in the case of the hypothesized movement of all incoming tankers to the Puget Sound area, with pipeline transshipment to both northern and southern California refinery locations. Further consideration of all these options would appear justified only if unmeasured values, particularly those pertaining to the environment, should dictate a relatively much higher ranking.

We can now return to the issue previously mentioned. Since all remaining regional investments are combinations of two local solutions for northern and southern California, and since the latter has already been treated, attention may be concentrated on the six major options hypothesized for the San Francisco Bay area.

The first four of these six alternatives shown in table 4 are closely related. They are designed to consider two trade-offs regarding possible deepwater port improvements inside the San Francisco Bay area:

1. Incremental costs for providing deeper draft versus incremental savings in shipping costs through the use of larger vessels

2. Costs of deepening channels above Richmond, which would permit direct vessel access to all refineries, versus costs of pipeline transshipment to most refineries from a central tanker terminal at Richmond.

Examination of the benefit-cost ratios indicates that crude oil distribution by pipeline transshipment from Richmond is significantly more favorable under all conditions. However, resolution of the trade-off on ship size depends on the choice of base situations. Where no lightering is presumed, accommodation for relatively smaller tankers has a higher benefit-cost ratio than provision for larger ones. Where lightering is presumed, the reverse is true. However, in the latter instance, absolute feasibility is doubtful.

The two prior alternatives (for the Richmond site with pipeline transshipment) have considerably higher benefit-cost ratios than the sixth-listed option of supertanker movement to the Puget Sound area, with pipeline transshipment to northern California. The same observations made above on regionally integrated approaches apply equally to this alternative.

The last remaining option, a site at Moss Landing in Monterey Bay with pipeline transshipment to all refineries, is the only one whose benefit-cost ratio is favorable under both presumptions as to the base situation. It is modestly less favorable than for one of the Richmond choices where no lightering is allowed, but is very significantly more favorable where that restriction is removed.

Investment priorities among hypothesized northern California alternatives implied by the benefit-cost ratios do not, however, make any allowance for differential consequences among them as to traffic congestion in affected waterways. In general, those implications seem most favorable for the Moss Landing alternative, which is unique in the group in that it requires no vessel movement into San Francisco Bay. Further appraisal of the quantitative significance of this feature in relation to its absence in other deepwater port alternatives, as well as of the suitability of large-scale lightering in the base situation, would be highly instructive in resolving the uncertainties involved.

An Interregional Issue

One final issue with respect to deepwater port alternatives for the accommodation of crude oil imports can be illuminated from data developed earlier: the economic significance of not providing an east coast deepwater port to accommodate its projected crude oil import requirements. Among other approaches to the question, one might presume as a viable alternative the movement of oil in large vessels to a deepwater port in the gulf, with local refining and transshipment by product pipelines to the east coast. It was partly to test this approach that projected 1980 and 2000 import volumes for both east and gulf coasts were made in the alternative. Differences in the range of projection were the same in each case: 50 million long tons in 1980 and 150 million long tons in 2000. Those values are somewhat arbitrary, but would certainly be larger if full account were taken of the recent interregional flow of oil from the gulf to the east coast.

One way to express the economic penalties involved is to estimate the benefit-cost ratio for a gulf coast deepwater port serving the east coast market, including the interregional pipeline, and then compare it with benefit-cost ratios for some of the east coast regional facilities. Accordingly, we developed a benefit-cost ratio for a relatively favorable situation -- a deepwater port site near Freeport with a monobuoy for accommodating 500,000-d.w.t. ships -- and considered only the incremental costs of its provision to serve the east coast market. In this case, ocean shipping cost savings are measured by differences in costs for large tanker movement to the gulf coast and smaller vessel movement to the east coast, with and without lightering. As indicated in table 5, the absolute feasibility of this approach is at best marginal, and its relative feasibility is very low in relation to numerous east coast deepwater port alternatives.

Table 5. Illustrative Investment Feasibility of Gulf Coast Deepwater Port with Pipeline Transshipment to Serve the East Coast Market,[a] at 10-Percent Discount Rate

(In present [1980] values of mil. of 1970 dol.)

Item	East coast base situation assumes:	
	No lightering	Lightering
Benefits		
Ocean shipping costs:		
To east coast, existing situation..........	4,425.5	3,062.7
To gulf coast deepwater port (Freeport monobuoy, 500,000-d.w.t. ship)..................	2,517.2	2,517.2
Savings (benefits)......	1,907.3	545.2
Costs		
Incremental costs of gulf coast deepwater port....................	204.7	204.7
Costs of interregional pipeline to east coast..	1,381.4	1,381.4
Total costs...........	1,586.1	1,586.1
Benefit-cost ratio......	1.20	0.34

a/ 50 million long tons in 1980, increasing to 150 million in 2000 through 2009.

Source: Appendix and Annex C.

A closely related issue is the economic significance of possible constraints on expansion of east coast refineries, assuming that a regional deepwater port was located on that coast. In that event, again assuming (1) the alternative of ocean shipment to the gulf coast, (2) local refining, and (3) pipeline transshipment to the east coast, the penalties involved would include:

1. The cost of pipeline transshipment (the unit costs of which are given in table 6)

2. The increment in ocean shipping costs to the gulf over the east coast

3. The increment in gulf coast deepwater port costs over the east coast.

As shown in table 7, these penalties collectively amount to around $1.50 to $1.85 per long ton, or $0.20 to $0.25 per barrel.

Table 6. Estimated Unit Cost of Product Pipeline Transshipment, Gulf Coast-East Coast

(In 1970 dollars)

Item	1980	2000
	--- millions of $ ----	
First cost................	572.2	1,185.4
Annual costs:		
10-percent capital change	57.2	118.5
Operating................	10.8	36.2
Maintenance..............	1.8	4.7
Total annual cost......	69.8	159.4
	- mil. of long tons ---	
Annual throughput.........	50.0	150.0
	------ dollars --------	
Cost per long ton.........	1.40	1.06

Source: Appendix, Part IV: Texas-East Coast Products Pipeline.

Table 7. Estimated Penalty Per Barrel for Routing of East Coast Crude Import Requirements to Deepwater Port on Gulf Coast Rather Than on East Coast

(In 1970 dollars)

Item	Cost per long ton
Interregional pipeline[a/].........	1.06-1.40
Ocean shipping[b/].................	.35
Barge transshipment[c/]............	.06
Gulf coast deepwater port cost increment over east coast[d/].....	.03-.04
Total cost:	
Per long ton....................	1.50-1.85
Per barrel (at 7.5 barrels per long ton)......................	.20-.25

a/ From table 6.
b/ 300,000-d.w.t. ship to Freeport, Texas over 300,000-d.w.t. ship to Long Branch, New Jersey.
c/ Weighted average (10-percent of Freeport volume goes by barge, balance goes by pipeline to gulf coast refineries).
d/ Present (1980) value of this increment is \$41.1 million, about 3 percent of present (1980) value of \$1,381.4 million for the interregional pipeline.

Source: Table 6 and appendix.

II. DEEPWATER PORT INVESTMENT ALTERNATIVES FOR DRY BULK COMMODITIES

Conceptual Approach

In this chapter, the feasibility of a limited number of deepwater port improvements to serve dry bulk commodity movements are tested at a very preliminary level. As in the case of crude oil, other improvements might also be studied. However, from our analysis of traffic and market conditions, the improvements included here appear to be especially worthy of consideration. Except for a single hypothesized deepening by 10 feet of channels serving existing port facilities at Hampton Roads for coal exports, all deepwater port concepts examined here are entirely new facilities requiring water transshipment to or from existing ports.

On the east coast, a single transshipment terminal -- at Big Stone Beach in the mouth of the Delaware Bay -- is hypothesized. It would accommodate coal exports from Hampton Roads and Baltimore, with and without additional facilities to serve iron ore imports destined mostly for Baltimore and Trenton. On the gulf coast, two sites are considered. The more advantageous from the traffic standpoint is located at the mouth of the Mississippi River. It is designed to serve cereal exports or a combination of cereals and regional imports of iron ore. However, if the hypothesized site at Freeport, Texas, were developed for crude oil, incremental costs for further accommodation of cereals might be sufficiently low to offset the locational disadvantage. The Freeport site is therefore also considered.

The basic approach taken in measuring benefits and costs of investment alternatives for dry bulk commodities is essentially the same as that for crude oil. However, one major qualification made earlier no longer applies. Since all transshipments between hypothesized new terminals and existing ports are by vessel, any costs incurred in existing ports or connecting waterways (which are not encompassed by measured benefit or cost values) would be more or less the same under all circumstances. They would therefore not significantly affect comparisons.

Furthermore, the determination of "optimal" vessel sizes for ocean shipment of dry bulk commodities, in the absence of existing U.S. port draft constraints, is far more complex than for crude oil, as is indicated in Chapter II of Annex E. Future draft circumstances in the many hundreds of relevant overseas ports (especially for the reception of coal and grain) are uncertain. The long-term significance of numerous other physical constraints in those ports, including storage, berths, channel widths, handling equipment, etc., is unknown. Apart from physical limitations, judgments as to maximum desired shipment sizes among numerous overseas (or domestic) buyers are now necessarily speculative.

The only acceptable means of coping with these difficult questions in this study is to go around them. Instead of attempting to project the unknown, we have reformulated the question to fit the circumstances. Assuming no significant future physical constraints on vessel size abroad, and further assuming the general acceptability of very large individual shipments, how attractive might transshipment terminals serving dry bulk commodities be? In all cases we have hypothesized full reliance on a 250,000-d.w.t. vessel for any movement where such vessels would be less costly (after allowing for vessel transshipment costs) than smaller ships operating directly between existing ports of origin and destination. The choice of that size vessel is arbitrary, but a 250,000 tonner is certainly much larger than any dry bulk vessel now operating or planned. In addition, since so large a vessel may be especially unrealistic for cereals, we have hypothesized the use of a 120,000-d.w.t. ship for their evacuation from both deepwater port sites considered.

Finally, the circumstances which make sound projection of vessel size so difficult apply with equal force to vessel design characteristics. The practicability of restricted-draft vessel design is uncertain. We have accordingly made two alternative hypotheses as to vessel design characteristics in the existing or base situation: at any given draft, all vessels are assumed to be of typical design and average capacity, or they are assumed to be of restricted-draft design and maximum feasible capacity.

Methodology for Dry Bulk Transshipment Terminals

1. Initially projected 1980 and 2000 zone-to-zone trade flows (from Annex A) were reviewed separately for each investment concept and for each commodity (coal, iron ore, and cereal) to determine which particular links were clearly unsuitable candidates for supercarrier service. For coal, only projected exports to west coast South America, Eastern Europe, and the Mideast were excluded, principally because of the very small volumes and partly because of extreme doubts as to the adequacy of port facilities for supercarriers in those areas. For the same reasons, projected cereal exports to all overseas zones other than to Western Europe and Japan were excluded from further consideration. However, over two-thirds of total projected 1980 cereal exports, and over three-quarters of total projected 2000 cereal exports, remained as potential candidates for supercarrier transport. All projected 1980 and 2000 iron ore imports from various overseas origins were considered potentially assignable to such large vessels.

2. The basic 1980 and 2000 projections of cereal exports from the gulf coast and of iron ore imports to the gulf coast did not distinguish port areas within the coastal region. For purposes of transport analysis, this information is essential. The percentage distribution of cereal exports by initial gulf port of departure was assumed to be the same as in 1968-69, with or

without a new transshipment terminal. The same basic assumption was made for iron ore imports to the gulf coast, except that, to reflect expectations discussed in the commodity analysis (Annex A), the Houston share of total gulf coast imports in 1980 and 2000 was increased modestly. The overseas origin distribution of projected iron ore imports to each of the three major receiving areas is assumed to be the same as was projected for the entire gulf region.

3. Ocean shipping costs per long ton for 1980 and 2000 were estimated separately for each deepwater port investment concept, and for traffic on each U.S.-overseas route considered potentially suitable for assignment to very large bulk carriers. All cargoes were assumed to move in 250,000-d.w.t. ocean vessels. Cereal exports were also assumed, in the alternative, to be evacuated in ocean vessels of 120,000 d.w.t. from the transshipment terminal. Unit ocean shipping costs for those vessels (assumed to be the same as for tankers of equal size) were estimated for the distance of haul on each link from the ocean shipping cost analysis in chapter III of Annex E. Voyage distances in each case were estimated in the same way as for crude oil movements.

4. For each hypothesized transshipment terminal and for each commodity, costs of vessel transshipment to or from relevant existing terminals were estimated from unit cost data given in chapter IV of Annex E. Transshipment link distances between offshore terminals and existing ports were estimated from large-scale maps. Unit costs of vessel transshipment ranged from $0.33 to $1.03 per long ton among the many links involved.

5. The methods described in step 3 above for the determination of ocean shipping costs were then applied to the existing or base situation. Unit costs of ocean shipping on each link were estimated separately for two different concepts of vessel design: for a ship whose capacity in deadweight tons is "typical" for a given draft; and for a vessel of restricted-draft design (i.e., longer and wider than normal) whose capacity is the maximum feasible at the same draft level. Maximum

permissible drafts at each relevant existing port were estimated from Corps of Engineers' data on mean low water depth and tide, with appropriate allowance for clearance. To simplify calculating procedures, a typical permissible draft of 36 feet was assumed for the many gulf ports evacuating grain, which in fact governs most of them (see table 8).

6. Total unit shipping costs (including vessel transshipment) were compared with like costs of ocean shipping under the existing situation, separately for each hypothesized transshipment terminal and for each transport link. This comparison was made separately for the two different vessel concepts in the existing situation. Where unit shipping costs -- including vessel transshipment -- on a particular link exceeded unit costs under the existing situation, traffic on that link was eliminated from consideration for the new deepwater port. The balance of the traffic was then assigned to it, and potential savings per ton in shipping costs on each relevant link were multiplied by projected link volumes to obtain potential aggregate savings in 1980 and 2000.

7. Estimated total investment, maintenance, and operating costs for each year from 1975 through 2009 were developed from unit cost factors given in Annex C, and were applied to the design of each hypothesized transshipment terminal. The resulting port cost data were then used as inputs to a computer program.

8. That program also included 1980 and 2000 projected volumes of traffic at each deepwater port. For each transshipment terminal concept, the computer output repeated the annual cost estimates (see the first four columns of Computer Series 1 in Part V of the appendix), with annual throughput volumes being calculated on the assumptions of linear growth from 1980 to 2000 and of constant levels through 2009 (see the fifth column of Computer Series 1, Part V).

9. As part of the same computer run, the present (1980) value of the stream of deepwater port costs

Table 8. Assumed Ship Draft and Size Characteristics, 1980 and 2000, Dry Bulk Exports and Imports, in the Base Situation, By Commodity and Area

Commodity and area	Overseas origin or destination	Draft (feet)	D.w.t. (thousands)	
			Typical	Restricted draft
Coal				
Hampton Roads...........	Japan	36	57 [a]	57 [a]
	Other	42	68	91
Baltimore..............	Europe	38	52	68
Iron ore				
Baltimore..............	West coast S. Am.	36	57 [a]	57 [a]
	Other	38	52	68
Trenton................	West coast S. Am.	36	57 [a]	57 [a]
	Other	36	44	57
Mobile................. Baton Rouge............ Houston................	All	36	44	57
Cereals				
Gulf...................	Japan	36	57 [a]	57 [a]
	Other	36	44	57

a/ Special Panama Canal vessel.

Source: RRNA estimates.

through 2009 was calculated separately at discount rates of 5, 7, and 10 percent (see the bottom three lines of Computer Series 1, Part V).

10. A second computer run was then made to calculate present (1980) values of the stream of savings in ocean shipping costs (determined for 1980 and 2000 in step 6 above) over the life cycle of each deepwater port at the same three discount rates (see Computer Series 2, Part V).

11. Another computer program was then written to calculate benefit-cost ratios for each investment alternative considered, using data from steps 9 and 10 as inputs (see Computer Series 3, Part V).

Methodology for Incremental Improvement at Hampton Roads

The various analytic steps followed to determine investment feasibility of an incremental improvement at Hampton Roads for coal exports were exactly the same as for hypothesized transshipment terminals, with one major exception. Instead of assuming that all potential traffic would move in vessels of one common size, an effort was made to project 1980 and 2000 ship size distributions on each relevant link as realistically as possible. The projections are based partly on a crude extrapolation of recent trends (as best as they can be estimated from inadequate data) and partly on an evaluation of planned improvements in selected major overseas areas. They all assume vessels laden to their capacity and operating round trip on a single leg, and they make no allowance for partial loading of combined carriers which complete their cargo in another port. Projections should accordingly be considered highly approximate. A more detailed study ought probably to explore issues of shipment size and vessel routing patterns in greater depth, including direct contact with major coal importers in leading markets.

Projected 1980 and 2000 total coal exports from Hampton Roads were first distributed by five vessel size groups in terms of draft, assuming a maximum of 52 feet when the channel is improved (see table 9). For each of the four vessel size groups above 42 feet, an appropriate vessel was selected as representative, assuming, in the alternative, either typical or restricted-draft design concepts. In the absence of the 52-foot improvement (the existing or base situation), all traffic projected to utilize the greater draft was assumed to move in vessels of 42-foot draft, the maximum available under the existing situation, again assuming two alternative vessel design concepts (see table 10).

Findings

A summary of benefit-cost ratios for all dry bulk investment alternatives considered, based on a 10-percent discount rate, is given in table 11. Calculations have also been made on the basis of 5 and 7 percent discount rates, as shown in the appendix, Computer Series 3, Part V. However, as in the case of crude oil investments, findings are generally insensitive to choice of rate. To simplify presentation, table 11 is therefore limited to results which reflect the high value.

Investment alternatives in table 11 are arranged first by location and then by design concept. For each alternative listed, two benefit-cost ratios are shown. The first is based on the presumed uniform use of conventionally designed vessels in the absence of a deep-water port, and the other presumes full resort to restricted-draft design vessels under the same conditions. In actuality, some uncertain mix of the two would be expected. The latter approach tends to reduce savings in ocean shipping costs, and hence the benefit-cost ratios.

All of the alternatives listed, <u>except</u> for the incremental improvement at Hampton Roads for coal export, are decidedly unfavorable on the basis of measured

Table 9. Projected 1980 and 2000 Ship Size Distributions, by Draft Range, for Coal Exports from Hampton Roads with 52-foot Draft

Year and projected draft range	Overseas destination area					
	Japan	Northwest Europe	Southwest Europe	South America: East coast	South America: West coast	Other Mediterranean and Eastern Europe
1980						
Under 42.........	40	30	30	70	100	100
42-45............	--	10	10	20	--	--
45-50............	20	30	30	10	--	--
50-52............	20	10	10	--	--	--
52...............	20	20	20	--	--	--
Total long tons (in millions)...	11.5	16.0	12.2	4.4	0.5	1.5
2000						
Under 42.........	25	15	15	40	100	65
42-45............	--	10	10	15	--	35
45-50............	10	15	15	25	--	--
50-52............	15	20	20	20	--	--
52...............	50	40	40	--	--	--
Total long tons (in millions)...	6.4	18.1	12.6	6.1	0.8	2.6

Source: RRNA estimates.

Table 10. Assumed Vessel Characteristics for Projected Traffic at Hampton Roads if Left at 42-Foot Draft or if Deepened to 52-Foot Draft

Projected vessel draft (feet)	Representative vessel in projected range			
	Typical design		Restricted-draft design	
	Draft (ft.)	D.w.t. (1,000)	Draft (ft.)	D.w.t. (1,000)
	Left at 42-foot draft			
42........	42.0	68.0	42.0	91.0
	Deepened to 52-foot draft			
42-45.....	43.5	74.0	43.5	101.5
45-50.....	47.5	100.0	47.5	133.5
50-52.....	50.0	120.0	50.0	157.0
52........	52.0	128.0	52.0	179.2

Source: RRNA estimates, based on data in Annex E, chapter III.

Table 11. Benefit-Cost Ratios for Selected Deepwater Port Investments Serving Dry Bul.. Commodities at 10-Percent Discount Rate

Description and commodity handled	Comparison no.[a/]	Benefit-cost ratios assuming base vessels of	
		Typical design	Restricted-draft design
Transshipment terminal in Delaware Bay, all 250,000-d.w.t ships			
Coal:			
High storage.........	1,3	0.25	0.21
Low storage..........	2,4	0.35	0.30
Coal and iron ore:			
High coal storage....	5,7	0.28	0.21
Low coal storage.....	6,8	0.36	0.26
Transshipment terminal at Mississippi River mouth			
Cereals:			
250,000-d.w.t. ships.	11,12	0.58	0.45
120,000-d.w.t. ships.	13,14	0.61	0.32
Iron ore:			
250,000-d.w.t. ships.	15,16	0.27	0.17
Cereals and iron ore:			
Combination of comparisons 11 + 15, 12 + 16............	17,18	0.54	0.40
Combination of comparisons 13 + 15, 14 + 16............	19,20	0.55	0.31
Transshipment terminal near Freeport, Texas			
Cereals:			
250,000-d.w.t. ships.	21,22	0.47	0.11
120,000-d.w.t. ships.	23	0.25	b/
Incremental improvement at Hampton Roads[c/]			
Coal.................	9,10	2.17	1.61

continued--

Table 11. Benefit-Cost Ratios for Selected Deepwater Port Investments Serving Dry Bulk Commodities at 10-Percent Discount Rate continued--

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a/ Comparison numbers refer to those used in the appendix, Part V: Dry Bulk, Computer Series 3: Benefit-Cost Comparisons.
b/ No potential traffic.
c/ Deepening from 42- to 52-foot draft.

benefit-cost relationships under either concept of vessel design. They would be even less favorable, especially in relation to cereals, if realistic projections of ship size distributions could be made. As explained earlier, for purposes of benefit-cost analysis, all traffic to or from major overseas links was assigned to the largest ship size hypothesized at the deepwater port when shipping costs (after allowance for vessel transshipment) could theoretically be reduced. In fact, however, overseas market and physical constraints would often preclude the use of such large vessels for many movements.

The unattractive prospects for economically feasible investments in transshipment terminals to accommodate dry bulk commodities thus contrast strikingly with like investments for crude oil. This importantly different result reflects the combined impact of four major factors. In relation to the circumstances of transshipment terminals for crude oil, it appears that dry bulk transshipment terminals:

1. Generally have much smaller annual throughputs over the entire life cycle

2. Cannot provide as great an average saving in ocean shipping costs per ton of cargo, mostly because distances of haul are typically shorter or are subject to penalties of circuity (e.g., the Panama Canal)

3. Incur significantly greater investment, maintenance, and operating costs per ton of cargo handled, largely because of the inherently more costly nature of dry bulk storage and handling facilities and partly because of smaller throughputs

4. Are usually subject to higher unit costs for transshipment. This reflects the fact that transshipment by pipeline, available for oil and other wet bulk products, is often less costly than by water, the only suitable technology for dry bulk. However, even where oil and dry bulk are transshipped by vessel, unit costs

for the latter are usually higher because of inherently more costly handling requirements.

The preceding findings as to dry bulk transshipment terminals are totally inapplicable to the one investment option considered which involves deepening of an existing port. It therefore does not have to bear, as the others do, the substantial costs for construction and operation of new storage and handling facilities and for vessel transshipment. That alternative calls for deepening of channels serving Hampton Roads to permit the use of vessels drawing 52 feet instead of the present 42 feet. Measured benefits are 1.6 to 2.2 times measured costs, depending upon one's choice of vessel design characteristics. Results may be sensitive to the c[illegible]dely projected ship size distributions for this alternative, but those projections are very much more conservative than they are for all other hypothesized dry bulk facilities. This investment alternative therefore seems highly appropriate for more detailed study.

APPENDIX. BENEFIT-COST CALCULATIONS, INCLUDING ANNUAL COST ESTIMATES FOR DEEPWATER PORT ALTERNATIVES, ANNUAL THROUGHPUT PROJECTIONS, AND ANNUAL SAVINGS IN SHIPPING COSTS

(All costs are in millions of 1970 dollars; all volumes are in millions of long tons)

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CONTENTS

PART I. EAST COAST OIL

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Series 1

ALTERNATIVE NO. 10
L.N.Y.BAY,SERVING N.Y.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 D.T, 30-35 MTA,TR.PIPELINES,(
1-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	10.0				
1976	10.0				
1977	14.1				
1978	35.7				
1979	62.9				
1980	0.0	3.3	1.9	30.0	66.3
1981	0.0	3.3	1.9	30.3	66.4
1982	0.0	3.3	1.9	30.5	66.5
1983	0.0	3.3	1.9	30.8	66.6
1984	0.0	3.3	1.9	31.0	66.7
1985	0.0	3.3	1.9	31.3	66.7
1986	0.0	3.3	1.9	31.5	66.8
1987	0.0	3.3	1.9	31.8	66.9
1988	0.0	3.3	1.9	32.0	67.0
1989	0.0	3.3	1.9	32.3	67.1
1990	0.0	3.3	1.9	32.5	67.2
1991	0.0	3.3	1.9	32.8	67.3
1992	0.0	3.3	1.9	33.0	67.4
1993	0.0	3.3	1.9	33.3	67.5
1994	0.0	3.3	1.9	33.5	67.6
1995	0.0	3.3	1.9	33.6	67.6
1996	0.0	3.3	1.9	34.0	67.7
1997	0.0	3.3	1.9	34.3	67.8
1998	0.0	3.3	1.9	34.5	67.9
1999	0.0	3.3	1.9	34.8	68.0
2000	0.0	3.3	1.9	35.0	68.1
2001	0.0	3.3	1.9	35.0	68.1
2002	0.0	3.3	1.9	35.0	68.1
2003	0.0	3.3	1.9	35.0	68.1
2004	0.0	3.3	1.9	35.0	68.1
2005	0.0	3.3	1.9	35.0	68.1
2006	0.0	3.3	1.9	35.0	68.1
2007	0.0	3.3	1.9	35.0	68.1
2008	0.0	3.3	1.9	35.0	68.1
2009	0.0	3.3	1.9	35.0	68.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	146.6	53.3	30.7	TOTAL	230.6	1085.0
7.0%	152.6	43.8	25.2	TOTAL	221.6	891.3
10.0%	161.9	34.2	19.7	TOTAL	215.8	694.8

ALTERNATIVE NO. 2C
L.N.Y. BAY, SERVING:N.Y., FIXED BERTHS, ISLAND STORAGE, 70 FT. DRAFT, 300,000 DWT, 35-70 MTA, TR. PIPELINES, (
1-1-8).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	10.0				
1976	10.0				
1977	14.1				
1978	35.7				
1979	63.1				
1980	0.0	3.4	1.9	35.0	79.2
1981	0.0	3.4	1.9	36.8	83.2
1982	0.0	3.4	1.9	38.5	87.1
1983	0.5	3.4	1.9	40.3	91.1
1984	0.0	3.5	1.9	42.0	95.0
1985	0.0	3.5	1.9	43.8	99.0
1986	0.0	3.5	1.9	45.5	103.0
1987	0.0	3.5	1.9	47.3	106.9
1988	0.0	3.5	1.9	49.0	110.9
1989	0.0	3.5	1.9	50.8	114.8
1990	0.9	3.5	1.9	52.5	118.8
1991	0.0	3.7	2.0	54.3	122.8
1992	0.0	3.7	2.0	56.0	126.7
1993	0.0	3.7	2.0	57.8	130.7
1994	0.0	3.7	2.0	59.5	134.6
1995	0.0	3.7	2.0	61.3	138.6
1996	0.0	3.7	2.0	63.0	142.6
1997	0.0	3.7	2.0	64.8	146.5
1998	0.0	3.7	2.0	66.5	150.5
1999	0.0	3.7	2.0	68.3	154.4
2000	0.0	3.7	2.0	70.0	158.4
2001	0.0	3.7	2.0	70.0	158.4
2002	0.0	3.7	2.0	70.0	158.4
2003	0.0	3.7	2.0	70.0	158.4
2004	0.0	3.7	2.0	70.0	158.4
2005	0.0	3.7	2.0	70.0	158.4
2006	0.0	3.7	2.0	70.0	158.4
2007	0.0	3.7	2.0	70.0	158.4
2008	0.0	3.7	2.0	70.0	158.4
2009	0.0	3.7	2.0	70.0	158.4

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	147.8	57.6	31.4	TOTAL	236.9	1929.9
7.0%	153.7	47.2	25.8	TOTAL	226.6	1533.8
10.0%	162.8	36.6	20.0	TOTAL	219.5	1142.2

ALTERNATIVE NO. 30
L.N.Y.BAY,SERVING N.Y.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT, 30-35 MTA,TR.PIPELINES,(1-1-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	10.0				
1976	10.0				
1977	15.[illegible]				
1978	41.5				
1979	71.5				
1980	0.0	3.3	2.2	30.0	66.3
1981	0.0	3.3	2.2	30.3	66.4
1982	0.0	3.3	2.2	30.5	66.5
1983	0.0	3.3	2.2	30.8	66.6
1984	0.0	3.3	2.2	31.0	66.7
1985	0.0	3.3	2.2	31.3	66.7
1986	0.0	3.3	2.2	31.5	66.8
1987	0.0	3.3	2.2	31.8	66.9
1988	0.0	3.3	2.2	32.0	67.0
1989	0.0	3.3	2.2	32.3	67.1
1990	0.0	3.3	2.2	32.5	67.2
1991	0.0	3.3	2.2	32.8	67.3
1992	0.0	3.3	2.2	33.0	67.4
1993	0.0	3.3	2.2	33.3	67.5
1994	0.0	3.3	2.2	33.5	67.6
1995	0.0	3.3	2.2	33.8	67.6
1996	0.0	3.3	2.2	34.0	67.7
1997	0.0	3.3	2.2	34.3	67.8
1998	0.0	3.3	2.2	34.5	67.9
1999	0.0	3.3	2.2	34.8	68.0
2000	0.0	3.3	2.2	35.0	68.1
2001	0.0	3.3	2.2	35.0	68.1
2002	0.0	3.3	2.2	35.0	68.1
2003	0.0	3.3	2.2	35.0	68.1
2004	0.0	3.3	2.2	35.0	68.1
2005	0.0	3.3	2.2	35.0	68.1
2006	0.0	3.3	2.2	35.0	68.1
2007	0.0	3.3	2.2	35.0	68.1
2008	0.0	3.3	2.2	35.0	68.1
2009	0.0	3.3	2.2	35.0	68.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	164.2	53.3	35.5	TOTAL	252.9	1085.0
7.0%	170.6	43.8	29.2	TOTAL	243.7	891.3
10.0%	180.5	34.2	22.8	TOTAL	237.8	694.8

ALTERNATIVE NO. 4C
L.N.Y.BAY,SERVING N.Y.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,400,000 DWT, 35-70 MTA,TR.PIPELINES,(
1-1-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	10.0				
1976	10.0				
1977	15.9				
1978	41.5				
1979	71.7				
1980	0.0	3.4	2.2	35.0	79.2
1981	0.0	3.4	2.2	36.8	83.2
1982	0.0	3.4	2.2	38.5	87.1
1983	0.5	3.4	2.2	40.3	91.1
1984	0.0	3.5	2.2	42.0	95.0
1985	0.0	3.5	2.2	43.8	99.0
1986	0.0	3.5	2.2	45.5	103.0
1987	0.0	3.5	2.2	47.3	106.9
1988	0.0	3.5	2.2	49.0	110.9
1989	0.0	3.5	2.2	50.8	114.8
1990	0.9	3.5	2.2	52.5	115.8
1991	0.0	3.7	2.2	54.3	122.8
1992	0.0	3.7	2.2	56.0	126.7
1993	0.0	3.7	2.2	57.8	130.7
1994	0.0	3.7	2.2	59.5	134.6
1995	0.0	3.7	2.2	61.3	135.6
1996	0.0	3.7	2.2	63.0	142.6
1997	0.0	3.7	2.2	64.8	146.5
1998	0.0	3.7	2.2	66.5	150.5
1999	0.0	3.7	2.2	68.3	154.4
2000	0.0	3.7	2.2	70.0	158.4
2001	0.0	3.7	2.2	70.0	158.4
2002	0.0	3.7	2.2	70.0	158.4
2003	0.0	3.7	2.2	70.0	158.4
2004	0.0	3.7	2.2	70.0	158.4
2005	0.0	3.7	2.2	70.0	158.4
2006	0.0	3.7	2.2	70.0	158.4
2007	0.0	3.7	2.2	70.0	158.4
2008	0.0	3.7	2.2	70.0	156.4
2009	0.0	3.7	2.2	70.0	158.4

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	165.3	57.6	35.5	TOTAL	258.5	1929.9
7.0%	171.7	47.2	29.2	TOTAL	248.1	1533.8
10.0%	131.7	36.6	22.8	TOTAL	241.1	1142.2

ALTERNATIVE NO. 50
N.Y.BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,100-150 MTA,TR.PIPELINES,(1-2-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	11.0				
1976	11.0				
1977	15.2				
1978	67.2				
1979	126.3				
1980	0.0	5.7	2.5	100.0	230.0
1981	0.0	5.7	2.5	102.5	235.0
1982	0.0	5.7	2.5	105.0	240.1
1983	0.0	5.7	2.5	107.5	245.1
1984	0.0	5.7	2.5	110.0	250.2
1985	0.0	5.7	2.5	112.5	255.2
1986	0.0	5.7	2.5	115.0	260.3
1987	0.0	5.7	2.5	117.5	265.3
1988	8.1	5.7	2.5	120.0	270.4
1989	0.0	7.8	2.7	122.5	275.4
1990	0.0	7.8	2.7	125.0	280.4
1991	0.0	7.8	2.7	127.5	285.5
1992	0.0	7.8	2.7	130.0	290.5
1993	0.0	7.8	2.7	132.5	295.6
1994	0.0	7.8	2.7	135.0	300.6
1995	0.0	7.8	2.7	137.5	305.7
1996	0.0	7.8	2.7	140.0	310.7
1997	0.0	7.8	2.7	142.5	315.8
1998	0.0	7.8	2.7	145.0	320.8
1999	0.0	7.8	2.7	147.5	325.9
2000	0.0	7.8	2.7	150.0	330.9
2001	0.0	7.8	2.7	150.0	330.9
2002	0.0	7.8	2.7	150.0	330.9
2003	0.0	7.8	2.7	150.0	330.9
2004	0.0	7.8	2.7	150.0	330.9
2005	0.0	7.8	2.7	150.0	330.9
2006	0.0	7.8	2.7	150.0	330.9
2007	0.0	7.8	2.7	150.0	330.9
2008	0.0	7.8	2.7	150.0	330.9
2009	0.0	7.8	2.7	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	257.2	110.2	42.1	TOTAL	409.5	4542.5
7.0%	265.3	88.9	34.5	TOTAL	388.6	3668.3
10.0%	275.1	67.6	26.7	TOTAL	372.4	2793.9

ALTERNATIVE NO. 60
N.Y.BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,150-300 MTA,TR.PIPELINES,(1-2-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	13.0				
1976	13.0				
1977	16.0				
1978	95.2				
1979	130.1				
1980	0.0	9.3	3.1	150.0	359.0
1981	0.0	9.3	3.1	157.5	376.9
1982	0.0	9.3	3.1	165.0	394.9
1983	0.5	9.3	3.1	172.5	412.8
1984	0.0	9.4	3.1	180.0	430.8
1985	0.0	9.4	3.1	187.5	448.7
1986	0.0	9.4	3.1	195.0	466.7
1987	0.0	9.4	3.1	202.5	484.6
1988	17.1	9.4	3.1	210.0	502.6
1989	13.8	13.9	3.5	217.5	520.5
1990	0.0	13.9	3.7	225.0	538.4
1991	0.0	13.9	3.7	232.5	556.4
1992	0.0	13.9	3.7	240.0	574.3
1993	0.0	13.9	3.7	247.5	592.3
1994	0.0	13.9	3.7	255.0	610.2
1995	0.0	13.9	3.7	262.5	628.2
1996	0.0	13.9	3.7	270.0	646.1
1997	0.0	13.9	3.7	277.5	664.1
1998	0.0	13.9	3.7	285.0	682.0
1999	0.0	13.9	3.7	292.5	700.0
2000	0.0	13.9	3.7	300.0	717.9
2001	0.0	13.9	3.7	300.0	717.9
2002	0.0	13.9	3.7	300.0	717.9
2003	0.0	13.9	3.7	300.0	717.9
2004	0.0	13.9	3.7	300.0	717.9
2005	0.0	13.9	3.7	300.0	717.9
2006	0.0	13.9	3.7	300.0	717.9
2007	0.0	13.9	3.7	300.0	717.9
2008	0.0	13.9	3.7	300.0	717.9
2009	0.0	13.9	3.7	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	365.	190.4	55.1	TOTAL	611.4	8747.2
7.0%	374.5	152.8	44.8	TOTAL	572.1	6952.0
10.0%	388.8	115.3	34.5	TOTAL	538.5	5177.0

ALTERNATIVE NO. 70
N.Y.BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,400,000 DWT,100-150 MTA,TR.PIPELINES,(1-2-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	12.0				
1976	12.0				
1977	17.0				
1978	70.4				
1979	155.5				
1980	0.0	5.7	2.9	100.0	230.0
1981	0.0	5.7	2.9	102.5	235.0
1982	0.0	5.7	2.9	105.0	240.1
1983	0.0	5.7	2.9	107.5	245.1
1984	0.0	5.7	2.9	110.0	250.2
1985	0.0	5.7	2.9	112.5	255.2
1986	0.0	5.7	2.9	115.0	260.3
1987	0.0	5.7	2.9	117.5	265.3
1988	3.1	5.7	2.9	120.0	270.4
1989	0.0	7.8	3.1	122.5	275.4
1990	0.0	7.8	3.1	125.0	280.4
1991	0.0	7.8	3.1	127.5	285.5
1992	0.0	7.8	3.1	130.0	290.5
1993	0.0	7.8	3.1	132.5	295.6
1994	0.0	7.8	3.1	135.0	300.6
1995	0.0	7.8	3.1	137.5	305.7
1996	0.0	7.8	3.1	140.0	310.7
1997	0.0	7.8	3.1	142.5	315.8
1998	0.0	7.8	3.1	145.0	320.8
1999	0.0	7.8	3.1	147.5	325.9
2000	0.0	7.8	3.1	150.0	330.9
2001	0.0	7.8	3.1	150.0	330.9
2002	0.0	7.8	3.1	150.0	330.9
2003	0.0	7.8	3.1	150.0	330.9
2004	0.0	7.8	3.1	150.0	330.9
2005	0.0	7.8	3.1	150.0	330.9
2006	0.0	7.8	3.1	150.0	330.9
2007	0.0	7.8	3.1	150.0	330.9
2008	0.0	7.8	3.1	150.0	330.9
2009	0.0	7.8	3.1	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	281.6	110.2	48.5	TOTAL	440.3	4542.5
7.0%	290.6	88.9	39.8	TOTAL	419.2	3668.3
10.0%	304.8	67.6	30.9	TOTAL	403.3	2793.9

ALTERNATIVE NO. 80
N.Y.BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,400,000 DWT,150-300 MTA,TR.PIPELINES,(1-2-D).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	15.0				
1976	15.0				
1977	17.9				
1978	106.5				
1979	191.4				
1980	0.0	9.3	3.5	150.0	359.0
1981	0.0	9.3	3.5	157.5	376.9
1982	0.0	9.3	3.5	165.0	394.9
1983	0.5	9.3	3.5	172.5	412.8
1984	0.0	9.4	3.5	180.0	430.8
1985	0.0	9.4	3.5	187.5	448.7
1986	0.0	9.4	3.5	195.0	466.7
1987	0.0	9.4	3.5	202.5	484.6
1988	17.1	9.4	3.5	210.0	502.6
1989	0.0	13.9	4.0	217.5	520.5
1990	0.0	13.9	4.0	225.0	538.4
1991	0.0	13.9	4.0	232.5	556.4
1992	0.0	13.9	4.0	240.0	574.3
1993	18.2	13.9	4.0	247.5	592.3
1994	0.0	13.9	4.2	255.0	610.2
1995	0.0	13.9	4.2	262.5	628.2
1996	0.0	13.9	4.2	270.0	646.1
1997	0.0	13.9	4.2	277.5	664.1
1998	0.0	13.9	4.2	285.0	682.0
1999	0.0	13.9	4.2	292.5	700.0
2000	0.0	13.9	4.2	300.0	717.9
2001	0.0	13.9	4.2	300.0	717.9
2002	0.0	13.9	4.2	300.0	717.9
2003	0.0	13.9	4.2	300.0	717.9
2004	0.0	13.9	4.2	300.0	717.9
2005	0.0	13.9	4.2	300.0	717.9
2006	0.0	13.9	4.2	300.0	717.9
2007	0.0	13.9	4.2	300.0	717.9
2008	0.0	13.9	4.2	300.0	717.9
2009	0.0	13.9	4.2	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	398.1	190.4	62.0	TOTAL	650.5	8747.2
7.0%	407.3	152.8	50.4	TOTAL	610.5	6952.0
10.0%	423.0	115.3	38.8	TOTAL	577.0	5177.0

ALTERNATIVE NO. 90
LB,N.J.,SERVING EAST COAST,MONO-BUOYS,ONSHORE STORAGE,70 FT.DRAFT,300,000 DWT,100-150 MTA,TR.PIPEL
INES,(1-3-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	51.2				
1979	124.3				
1980	0.0	6.1	2.5	100.0	230.0
1981	0.0	6.1	2.5	102.5	235.0
1982	0.0	6.1	2.5	105.0	240.1
1983	0.0	6.1	2.5	107.5	245.1
1984	0.0	6.1	2.5	110.0	250.2
1985	0.0	6.1	2.5	112.5	255.2
1986	0.0	6.1	2.5	115.0	260.3
1987	0.0	6.1	2.5	117.5	265.3
1988	6.8	6.1	2.5	120.0	270.4
1989	0.0	7.9	2.7	122.5	275.4
1990	0.0	7.9	2.7	125.0	280.4
1991	0.0	7.9	2.7	127.5	285.5
1992	0.0	7.9	2.7	130.0	290.5
1993	0.0	7.9	2.7	132.5	295.6
1994	0.0	7.9	2.7	135.0	300.6
1995	0.0	7.9	2.7	137.5	305.7
1996	0.0	7.9	2.7	140.0	310.7
1997	0.0	7.9	2.7	142.5	315.8
1998	0.0	7.9	2.7	145.0	320.8
1999	0.0	7.9	2.7	147.5	325.9
2000	0.0	7.9	2.7	150.0	330.9
2001	0.0	7.9	2.7	150.0	330.9
2002	0.0	7.9	2.7	150.0	330.9
2003	0.0	7.9	2.7	150.0	330.9
2004	0.0	7.9	2.7	150.0	330.9
2005	0.0	7.9	2.7	150.0	330.9
2006	0.0	7.9	2.7	150.0	330.9
2007	0.0	7.9	2.7	150.0	330.9
2008	0.0	7.9	2.7	150.0	330.9
2009	0.0	7.9	2.7	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	191.6	114.1	42.1	TOTAL	347.7	4542.5
7.0%	195.6	92.3	34.5	TOTAL	322.4	3668.3
10.0%	201.9	70.5	26.7	TOTAL	299.1	2793.9

ALTERNATIVE No. 100
La,N.J.,SERVING EAST COAST,MONO-BUOYS,ONSHORE STORAGE,70 FT.DRAFT,300,000 DWT,150-300 MTA,TR.PIPELINES,(1-5-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	77.1				
1979	177.0				
1980	0.0	8.4	3.4	150.0	359.0
1981	0.0	8.4	3.4	157.5	376.9
1982	0.0	8.4	3.4	165.0	394.9
1983	0.0	8.4	3.4	172.5	412.8
1984	0.0	8.4	3.4	180.0	430.8
1985	0.0	8.4	3.4	187.5	448.7
1986	0.0	8.4	3.4	195.0	466.7
1987	0.0	8.4	3.4	202.5	484.6
1988	15.2	8.4	3.4	210.0	502.6
1989	19.3	13.3	3.7	217.5	520.5
1990	0.0	13.3	4.4	225.0	538.4
1991	0.0	13.3	4.4	232.5	556.4
1992	0.0	13.3	4.4	240.0	574.3
1993	0.0	13.3	4.4	247.5	592.3
1994	0.0	13.3	4.4	255.0	610.2
1995	0.0	13.3	4.4	262.5	628.2
1996	0.0	13.3	4.4	270.0	646.1
1997	0.0	13.3	4.4	277.5	664.1
1998	0.0	13.3	4.4	285.0	682.0
1999	0.0	13.3	4.4	292.5	700.0
2000	0.0	13.3	4.4	300.0	717.9
2001	0.0	13.3	4.4	300.0	717.9
2002	0.0	13.3	4.4	300.0	717.9
2003	0.0	13.3	4.4	300.0	717.9
2004	0.0	13.3	4.4	300.0	717.9
2005	0.0	13.3	4.4	300.0	717.9
2006	0.0	13.3	4.4	300.0	717.9
2007	0.0	13.3	4.4	300.0	717.9
2008	0.0	13.3	4.4	300.0	717.9
2009	0.0	13.3	4.4	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	293.6	178.0	63.1	TOTAL	534.7	8747.2
7.0%	297.0	142.4	51.1	TOTAL	490.5	6952.0
10.0%	303.3	106.8	39.0	TOTAL	449.1	5177.0

ALTERNATIVE NO. 110
LB,N.J.,SERVING EAST COAST,MONO-BUOYS,ONSHORE STORAGE,70 FT.DRAFT,400,000 DWT,100-150 MTA,TR.PIPEL
INES,(E-5-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	55.7				
1979	132.3				
1980	0.0	6.7	2.9	100.0	230.0
1981	0.0	6.7	2.9	102.5	235.0
1982	0.0	6.7	2.9	105.0	240.1
1983	0.0	6.7	2.9	107.5	245.1
1984	0.0	6.7	2.9	110.0	250.2
1985	0.0	6.7	2.9	112.5	255.2
1986	0.0	6.7	2.9	115.0	260.3
1987	0.0	6.7	2.9	117.5	265.3
1988	0.0	6.7	2.9	120.0	270.4
1989	0.0	8.6	3.1	122.5	275.4
1990	0.0	8.6	3.1	125.0	280.4
1991	0.0	8.6	3.1	127.5	285.5
1992	0.0	8.6	3.1	130.0	290.5
1993	0.0	8.6	3.1	132.5	295.6
1994	0.0	8.6	3.1	135.0	300.6
1995	0.0	8.6	3.1	137.5	305.7
1996	0.0	8.6	3.1	140.0	310.7
1997	0.0	8.6	3.1	142.5	315.8
1998	0.0	8.6	3.1	145.0	320.8
1999	0.0	8.6	3.1	147.5	325.9
2000	0.0	8.6	3.1	150.0	330.9
2001	0.0	8.6	3.1	150.0	330.9
2002	0.0	8.6	3.1	150.0	330.9
2003	0.0	8.6	3.1	150.0	330.9
2004	0.0	8.6	3.1	150.0	330.9
2005	0.0	8.6	3.1	150.0	330.9
2006	0.0	8.6	3.1	150.0	330.9
2007	0.0	8.6	3.1	150.0	330.9
2008	0.0	8.6	3.1	150.0	330.9
2009	0.0	8.6	3.1	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	204.9	124.6	48.5	TOTAL	378.1	4542.5
7.0%	209.3	100.9	39.8	TOTAL	350.0	3668.3
10.0%	216.1	77.1	30.9	TOTAL	324.1	2793.9

ALTERNATIVE NO. 120
LB,N.J.,SERVING EAST COAST,MONO-BUOYS,ONSHORE STORAGE,70 FT.DRAFT,400,000 DWT,150-300 MTA,TR.PIPEL
INES,(1-3-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	82.7				
1979	187.2				
1980	0.0	9.1	3.9	150.0	359.0
1981	0.0	9.1	3.9	157.5	376.9
1982	0.0	9.1	3.9	165.0	394.9
1983	0.0	9.1	3.9	172.5	412.8
1984	0.0	9.1	3.9	180.0	430.8
1985	0.0	9.1	3.9	187.5	448.7
1986	0.0	9.1	3.9	195.0	466.7
1987	0.0	9.1	3.9	202.5	484.6
1988	15.2	9.1	3.9	210.0	502.6
1989	0.0	13.8	4.3	217.5	520.5
1990	0.0	13.8	4.3	225.0	538.4
1991	0.0	13.8	4.3	232.5	556.4
1992	0.0	13.8	4.3	240.0	574.3
1993	23.0	13.8	4.3	247.5	592.3
1994	0.0	14.7	5.0	255.0	610.2
1995	0.0	14.7	5.0	262.5	628.2
1996	0.0	14.7	5.0	270.	646.1
1997	0.0	14.7	5.0	277.5	664.1
1998	0.0	14.7	5.0	285.0	682.0
1999	0.0	14.7	5.0	292.5	700.0
2000	0.0	14.7	5.0	300.0	717.9
2001	0.0	14.7	5.0	300.0	717.9
2002	0.0	14.7	5.0	300.0	717.9
2003	0.0	14.7	5.0	300.0	717.9
2004	0.0	14.7	5.0	300.0	717.9
2005	0.0	14.7	5.0	300.0	717.9
2006	0.0	14.7	5.0	300.0	717.9
2007	0.0	14.7	5.0	300.0	717.9
2008	0.0	14.7	5.0	300.0	717.9
2009	0.0	14.7	5.0	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	310.2	192.8	70.4	TOTAL	573.5	8747.2
7.0%	313.4	154.0	57.0	TOTAL	524.4	6952.0
10.0%	319.7	115.4	43.6	TOTAL	478.7	5177.0

ALTERNATIVE NO. 13C
B33,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT, 300,000 DWT,70-115 MTA,T
F,PIPELINES,(2-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	53.1				
1979	86.0				
1980	0.0	5.7	1.5	70.0	163.7
1981	0.0	5.7	1.5	72.3	168.7
1982	0.0	5.7	1.5	74.5	173.6
1983	0.0	5.7	1.5	76.8	178.6
1984	0.0	5.7	1.5	79.0	183.5
1985	21.6	5.7	1.5	81.3	188.5
1986	0.0	6.0	1.7	83.5	193.4
1987	0.0	6.0	1.7	85.8	198.4
1988	0.0	6.0	1.7	88.0	203.3
1989	5.5	6.0	1.7	90.3	208.3
1990	0.0	7.3	1.7	92.5	213.2
1991	0.0	7.3	1.7	94.8	218.2
1992	0.0	7.3	1.7	97.0	223.2
1993	0.0	7.3	1.7	99.3	228.1
1994	0.0	7.3	1.7	101.5	233.1
1995	0.0	7.3	1.7	103.8	238.0
1996	0.0	7.3	1.7	106.0	243.0
1997	0.0	7.3	1.7	108.3	247.9
1998	0.0	7.3	1.7	110.5	252.9
1999	0.0	7.3	1.7	112.8	257.8
2000	0.0	7.3	1.7	115.0	262.8
2001	0.0	7.3	1.7	115.0	262.8
2002	0.0	7.3	1.7	115.0	262.8
2003	0.0	7.3	1.7	115.0	262.8
2004	0.0	7.3	1.7	115.0	262.8
2005	0.0	7.3	1.7	115.0	262.8
2006	0.0	7.3	1.7	115.0	262.8
2007	0.0	7.3	1.7	115.0	262.8
2008	0.0	7.3	1.7	115.0	262.8
2009	0.0	7.3	1.7	115.0	262.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	169.3	105.7	26.4	TOTAL	301.4	3457.6
7.0%	171.2	85.6	21.6	TOTAL	278.4	2777.0
10.0%	174.6	65.5	16.7	TOTAL	256.7	2099.1

ALTERNATIVE NO. 140
DSA,3 DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT, 300,000 DWT,115-230 MTA,
TR.PIPELINES,(2-1-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	76.3				
1979	127.8				
1980	0.0	7.8	2.1	115.0	279.8
1981	0.0	7.8	2.1	120.8	293.8
1982	0.0	7.8	2.1	126.5	307.8
1983	0.0	7.8	2.1	132.3	321.8
1984	0.0	7.8	2.1	138.0	335.7
1985	25.9	7.8	2.1	143.8	349.7
1986	0.0	8.1	2.4	149.5	363.7
1987	0.0	8.1	2.4	155.3	377.7
1988	0.0	8.1	2.4	161.0	391.7
1989	11.0	8.1	2.4	166.8	405.7
1990	0.0	11.0	2.7	172.5	419.6
1991	0.0	11.0	2.7	178.3	433.6
1992	0.0	11.0	2.7	184.0	447.6
1993	0.0	11.0	2.7	189.8	461.6
1994	0.0	11.0	2.7	195.5	475.6
1995	0.0	11.0	2.7	201.3	489.6
1996	0.0	11.0	2.7	207.0	503.6
1997	0.0	11.0	2.7	212.8	517.5
1998	0.0	11.0	2.7	218.5	531.5
1999	0.0	11.0	2.7	224.3	545.5
2000	0.0	11.0	2.7	230.0	559.5
2001	0.0	11.0	2.7	230.0	559.5
2002	0.0	11.0	2.7	230.0	559.5
2003	0.0	11.0	2.7	230.0	559.5
2004	0.0	11.0	2.7	230.0	559.5
2005	0.0	11.0	2.7	230.0	559.5
2006	0.0	11.0	2.7	230.0	559.5
2007	0.0	11.0	2.7	230.0	559.5
2008	0.0	11.0	2.7	230.0	559.5
2009	0.0	11.0	2.7	230.0	559.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	245.7	152.4	39.6	TOTAL	437.7	6817.2
7.0%	248.6	122.7	32.1	TOTAL	403.3	5418.1
10.0%	253.8	93.0	24.5	TOTAL	371.2	4034.8

ALTERNATIVE NO. 150
OSS,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT, 400,000 DWT,70-115 MTA,T
-,PIPELINES,(2-1-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	59.0				
1979	92.9				
1980	0.0	5.7	1.8	70.0	163.7
1981	0.0	5.7	1.8	72.3	168.7
1982	0.0	5.7	1.8	74.5	173.6
1983	0.0	5.7	1.8	76.8	178.6
1984	0.0	5.7	1.8	79.0	183.5
1985	0.0	5.7	1.8	81.3	188.5
1986	0.0	5.7	1.8	83.5	193.4
1987	0.0	5.7	1.8	85.8	198.4
1988	0.0	5.7	1.8	88.0	203.3
1989	32.3	5.7	1.8	90.3	208.3
1990	0.0	7.3	2.2	92.5	213.2
1991	0.0	7.3	2.2	94.8	218.2
1992	0.0	7.3	2.2	97.0	223.2
1993	0.0	7.3	2.2	99.3	228.1
1994	0.0	7.3	2.2	101.5	233.1
1995	0.0	7.3	2.2	103.8	238.0
1996	0.0	7.3	2.2	106.0	243.0
1997	0.0	7.3	2.2	108.3	247.9
1998	0.0	7.3	2.2	110.5	252.9
1999	0.0	7.3	2.2	112.8	257.8
2000	0.0	7.3	2.2	115.0	262.8
2001	0.0	7.3	2.2	115.0	262.8
2002	0.0	7.3	2.2	115.0	262.8
2003	0.0	7.3	2.2	115.0	262.8
2004	0.0	7.3	2.2	115.0	262.8
2005	0.0	7.3	2.2	115.0	262.8
2006	0.0	7.3	2.2	115.0	262.8
2007	0.0	7.3	2.2	115.0	262.8
2008	0.0	7.3	2.2	115.0	262.8
2009	0.0	7.3	2.2	115.0	262.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	133.4	104.9	32.3	TOTAL	320.5	3457.6
7.0%	134.5	94.9	26.2	TOTAL	295.6	2777.0
10.0%	187.3	64.9	20.1	TOTAL	272.3	2099.1

ALTERNATIVE NO. 160
BSB,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT, 400,000 DWT,115-230 MTA,
TR.PIPELINES,(2-1-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	84.5				
1979	136.3				
1980	0.0	7.8	2.6	115.0	279.8
1981	0.0	7.8	2.6	120.8	293.8
1982	0.0	7.8	2.6	126.5	307.8
1983	0.0	7.8	2.6	132.3	321.8
1984	0.0	7.8	2.6	138.0	335.7
1985	0.0	7.8	2.6	143.8	349.7
1986	0.0	7.8	2.6	149.5	363.7
1987	0.0	7.8	2.6	155.3	377.7
1988	0.0	7.8	2.6	161.0	391.7
1989	42.3	7.8	2.6	166.8	405.7
1990	0.0	11.0	3.2	172.5	419.6
1991	0.0	11.0	3.2	178.3	433.6
1992	0.0	11.0	3.2	184.0	447.6
1993	0.0	11.0	3.2	189.8	461.6
1994	0.0	11.0	3.2	195.5	475.6
1995	0.0	11.0	3.2	201.3	489.6
1996	0.0	11.0	3.2	207.0	503.6
1997	0.0	11.0	3.2	212.8	517.5
1998	0.0	11.0	3.2	218.5	531.5
1999	0.0	11.0	3.2	224.3	545.5
2000	0.0	11.0	3.2	230.0	559.5
2001	0.0	11.0	3.2	230.0	559.5
2002	0.0	11.0	3.2	230.0	559.5
2003	0.0	11.0	3.2	230.0	559.5
2004	0.0	11.0	3.2	230.0	559.5
2005	0.0	11.0	3.2	230.0	559.5
2006	0.0	11.0	3.2	230.0	559.5
2007	0.0	11.0	3.2	230.0	559.5
2008	0.0	11.0	3.2	230.0	559.5
2009	0.0	11.0	3.2	230.0	559.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	264.0	151.6	46.8	TOTAL	462.4	6817.2
7.0%	266.1	122.0	38.0	TOTAL	426.1	5418.1
10.0%	270.6	92.4	29.1	TOTAL	392.2	4034.8

ALTERNATIVE NO. 170
BSE,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT, 300,000 DWT,70-115 MTA,T
R.PIPELINES,(2-2-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	7.0				
1978	56.2				
1979	79.9				
1980	0.0	6.2	1.7	70.0	163.7
1981	0.0	6.2	1.7	72.3	168.7
1982	0.0	6.2	1.7	74.5	173.6
1983	0.0	6.2	1.7	76.8	178.6
1984	0.0	6.2	1.7	79.0	183.5
1985	16.8	6.2	1.7	81.3	188.5
1986	0.0	6.2	1.9	83.5	193.4
1987	0.0	6.2	1.9	85.8	198.4
1988	0.0	6.2	1.9	88.0	203.3
1989	6.0	6.2	1.9	90.3	208.3
1990	0.0	7.8	2.0	92.5	213.2
1991	0.0	7.8	2.0	94.8	218.2
1992	0.0	7.8	2.0	97.0	223.2
1993	0.0	7.8	2.0	99.3	228.1
1994	0.0	7.8	2.0	101.5	233.1
1995	0.0	7.8	2.0	103.8	238.0
1996	0.0	7.8	2.0	106.0	243.0
1997	0.0	7.8	2.0	108.3	247.9
1998	0.0	7.8	2.0	110.5	252.9
1999	0.0	7.8	2.0	112.8	257.8
2000	0.0	7.8	2.0	115.0	262.8
2001	0.0	7.8	2.0	115.0	262.8
2002	0.0	7.8	2.0	115.0	262.8
2003	0.0	7.8	2.0	115.0	262.8
2004	0.0	7.8	2.0	115.0	262.8
2005	0.0	7.8	2.0	115.0	262.8
2006	0.0	7.8	2.0	115.0	262.8
2007	0.0	7.8	2.0	115.0	262.8
2008	0.0	7.8	2.0	115.0	262.8
2009	0.0	7.8	2.0	115.0	262.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	179.7	112.9	30.4	TOTAL	323.0	3457.6
7.0%	183.2	91.5	24.8	TOTAL	299.5	2777.0
10.0%	188.9	70.1	19.1	TOTAL	278.1	2099.1

ALTERNATIVE NO. 180
6S0,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,   300,000 DWT,115-230 MTA,
TR.PIPELINES,(2-2-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	2.5				
1977	7.8				
1978	80.7				
1979	118.6				
1980	0.0	7.9	2.1	115.0	279.8
1981	0.0	7.9	2.1	120.8	293.8
1982	0.0	7.9	2.1	126.5	307.8
1983	0.0	7.9	2.1	132.3	321.8
1984	0.0	7.9	2.1	138.0	335.7
1985	21.0	7.9	2.1	143.6	349.7
1986	0.0	3.0	2.4	149.5	363.7
1987	0.0	3.0	2.4	155.3	377.7
1988	0.0	8.0	2.4	161.0	391.7
1989	12.0	8.0	2.4	166.8	405.7
1990	0.0	11.1	2.7	172.5	419.6
1991	0.0	11.1	2.7	178.3	433.6
1992	0.0	11.1	2.7	184.0	447.6
1993	0.0	11.1	2.7	189.8	461.6
1994	0.0	11.1	2.7	195.5	475.6
1995	0.0	11.1	2.7	201.3	489.6
1996	0.0	11.1	2.7	207.0	503.6
1997	0.0	11.1	2.7	212.8	517.5
1998	0.0	11.1	2.7	218.5	531.5
1999	0.0	11.1	2.7	224.3	545.5
2000	0.0	11.1	2.7	230.0	559.5
2001	0.0	11.1	2.7	230.0	559.5
2002	0.0	11.1	2.7	230.0	559.5
2003	0.0	11.1	2.7	230.0	559.5
2004	0.0	11.1	2.7	230.0	559.5
2005	0.0	11.1	2.7	230.0	559.5
2006	0.0	11.1	2.7	230.0	559.5
2007	0.0	11.1	2.7	230.0	559.5
2008	0.0	11.1	2.7	230.0	559.5
2009	0.0	11.1	2.7	230.0	559.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	255.4	153.5	39.6	TOTAL	448.5	6817.2
7.0%	259.8	123.6	32.1	TOTAL	415.5	5418.1
10.0%	267.4	93.7	24.5	TOTAL	385.6	4034.8

ALTERNATIVE NO. 190
BSS,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT, 400,000 DWT,70-115 MTA,T
RIPELINES,(1-2-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	7.5				
1978	62.1				
1979	65.8				
1980	0.0	6.2	1.8	70.0	163.7
1981	0.0	6.2	1.8	72.3	168.7
1982	0.0	6.2	1.8	74.5	173.6
1983	0.0	6.2	1.8	76.8	178.6
1984	0.0	6.2	1.8	79.0	183.5
1985	0.0	6.2	1.8	81.3	188.5
1986	0.0	6.2	1.8	83.5	193.4
1987	0.0	6.2	1.8	85.8	198.4
1988	0.0	6.2	1.8	88.0	203.3
1989	27.4	6.2	1.8	90.3	208.3
1990	0.0	7.8	2.3	92.5	213.2
1991	0.0	7.8	2.3	94.8	218.2
1992	0.0	7.8	2.3	97.0	223.2
1993	0.0	7.8	2.3	99.3	228.1
1994	0.0	7.8	2.3	101.5	233.1
1995	0.0	7.8	2.3	103.8	238.0
1996	0.0	7.8	2.3	106.0	243.0
1997	0.0	7.8	2.3	108.3	247.9
1998	0.0	7.8	2.3	110.5	252.9
1999	0.0	7.8	2.3	112.8	257.8
2000	0.0	7.8	2.3	115.0	262.8
2001	0.0	7.8	2.3	115.0	262.8
2002	0.0	7.8	2.3	115.0	262.8
2003	0.0	7.8	2.3	115.0	262.8
2004	0.0	7.8	2.3	115.0	262.8
2005	0.0	7.8	2.3	115.0	262.8
2006	0.0	7.8	2.3	115.0	262.8
2007	0.0	7.8	2.3	115.0	262.8
2008	0.0	7.8	2.3	115.0	262.8
2009	0.0	7.8	2.3	115.0	262.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	193.6	112.9	33.1	TOTAL	339.6	3457.6
7.0%	196.5	91.5	26.8	TOTAL	314.8	2777.0
10.0%	201.9	70.1	20.5	TOTAL	292.4	2099.1

ALTERNATIVE NO. 200
BSB,DELAWARE BAY,SERVING DEL.,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT, 400,000 DWT,115-230 MTA,
TR.PIP_LINES,(2-2-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	6.5				
1978	88.9				
1979	126.3				
1980	0.0	7.9	2.4	115.0	279.8
1981	0.0	7.9	2.4	120.8	293.8
1982	0.0	7.9	2.4	126.5	307.8
1983	0.0	7.9	2.4	132.3	321.8
1984	0.0	7.9	2.4	138.0	335.7
1985	0.0	7.9	2.4	143.8	349.7
1986	0.0	7.9	2.4	149.5	363.7
1987	0.0	7.9	2.4	155.3	377.7
1988	0.0	7.9	2.4	161.0	391.7
1989	37.8	7.9	2.4	166.8	405.7
1990	0.0	11.1	3.0	172.5	419.6
1991	0.0	11.1	3.0	178.3	433.6
1992	0.0	11.1	3.0	184.0	447.6
1993	0.0	11.1	3.0	189.8	461.6
1994	0.0	11.1	3.0	195.5	475.6
1995	0.0	11.1	3.0	201.3	489.6
1996	0.0	11.1	3.0	207.0	503.6
1997	0.0	11.1	3.0	212.8	517.5
1998	0.0	11.1	3.0	218.5	531.5
1999	0.0	11.1	3.0	224.3	545.5
2000	0.0	11.1	3.0	230.0	559.5
2001	0.0	11.1	3.0	230.0	559.5
2002	0.0	11.1	3.0	230.0	559.5
2003	0.0	11.1	3.0	230.0	559.5
2004	0.0	11.1	3.0	230.0	559.5
2005	0.0	11.1	3.0	230.0	559.5
2006	0.0	11.1	3.0	230.0	559.5
2007	0.0	11.1	3.0	230.0	559.5
2008	0.0	11.1	3.0	230.0	559.5
2009	0.0	11.1	3.0	230.0	559.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	274.1	153.2	43.6	TOTAL	470.9	6817.2
7.0%	277.9	123.3	35.3	TOTAL	436.6	5418.1
10.0%	285.2	93.5	27.1	TOTAL	405.7	4034.8

ALTERNATIVE NO. 21C
35S,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT,300,000 DWT,100-150 MTA
,TR.PIPELINES,(2-3-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	83.7				
1979	133.1				
1980	0.0	6.4	2.0	100.0	230.0
1981	0.0	6.4	2.0	102.5	235.0
1982	0.0	6.4	2.0	105.0	240.1
1983	0.0	6.4	2.0	107.5	245.1
1984	0.0	6.4	2.0	110.0	250.2
1985	0.0	6.4	2.0	112.5	255.2
1986	3.3	6.4	2.0	115.0	260.3
1987	0.0	7.1	2.1	117.5	265.3
1988	0.0	7.1	2.1	120.0	270.4
1989	0.0	7.1	2.1	122.5	275.4
1990	0.0	7.1	2.1	125.0	280.4
1991	0.0	7.1	2.1	127.5	285.5
1992	0.0	7.1	2.1	130.0	290.5
1993	0.0	7.1	2.1	132.5	295.6
1994	0.0	7.1	2.1	135.0	300.6
1995	0.0	7.1	2.1	137.5	305.7
1996	0.0	7.1	2.1	140.0	310.7
1997	0.0	7.1	2.1	142.5	315.8
1998	0.0	7.1	2.1	145.0	320.8
1999	0.0	7.1	2.1	147.5	325.9
2000	0.0	7.1	2.1	150.0	330.9
2001	0.0	7.1	2.1	150.0	330.9
2002	0.0	7.1	2.1	150.0	330.9
2003	0.0	7.1	2.1	150.0	330.9
2004	0.0	7.1	2.1	150.0	330.9
2005	0.0	7.1	2.1	150.0	330.9
2006	0.0	7.1	2.1	150.0	330.9
2007	0.0	7.1	2.1	150.0	330.9
2008	0.0	7.1	2.1	150.0	330.9
2009	0.0	7.1	2.1	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	234.5	110.3	33.3	TOTAL	378.1	4542.5
7.0%	240.4	90.2	27.3	TOTAL	358.0	3668.3
10.0%	249.5	69.9	21.2	TOTAL	340.7	2793.9

ALTERNATIVE NO. 22C
BSB,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT,300,000 DWT,150-300 MTA
,TR.PIPELINES,(2-3-6).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	92.9				
1979	157.6				
1980	0.0	8.9	2.5	150.0	359.0
1981	0.0	8.9	2.5	157.5	376.9
1982	0.0	8.9	2.5	165.0	394.9
1983	11.1	8.9	2.5	172.5	412.8
1984	0.0	11.6	2.7	180.0	430.8
1985	0.0	11.6	2.7	187.5	448.7
1986	0.0	11.6	2.7	195.0	466.7
1987	0.0	11.6	2.7	202.5	484.6
1988	35.1	11.6	2.7	210.0	502.6
1989	26.6	12.2	2.9	217.5	520.5
1990	0.0	13.1	3.2	225.0	538.4
1991	0.0	13.1	3.2	232.5	556.4
1992	0.0	13.1	3.2	240.0	574.3
1993	0.0	13.1	3.2	247.5	592.3
1994	0.0	13.1	3.2	255.0	610.2
1995	0.0	13.1	3.2	262.5	628.2
1996	0.0	13.1	3.2	270.0	646.1
1997	0.0	13.1	3.2	277.5	664.1
1998	0.0	13.1	3.2	285.0	682.0
1999	0.0	13.1	3.2	292.5	700.0
2000	0.0	13.1	3.2	300.0	717.9
2001	0.0	13.1	3.2	300.0	717.9
2002	0.0	13.1	3.2	300.0	717.9
2003	0.0	13.1	3.2	300.0	717.9
2004	0.0	13.1	3.2	300.0	717.9
2005	0.0	13.1	3.2	300.0	717.9
2006	0.0	13.1	3.2	300.0	717.9
2007	0.0	13.1	3.2	300.0	717.9
2008	0.0	13.1	3.2	300.0	717.9
2009	0.0	13.1	3.2	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	318.4	185.6	47.0	TOTAL	555.0	8747.2
7.0%	319.0	153.2	38.1	TOTAL	510.3	6952.0
10.0%	321.8	116.5	29.2	TOTAL	467.5	5177.0

ALTERNATIVE NO. 220
DSC, DELAWARE BAY, SERVING EAST COAST, FIXED BERTHS, ONSHORE STORAGE, 70 FT. DRAFT, 400,000 DWT, 100-150 MTA
,1r.PIPELINES,(2-3-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	91.9				
1979	142.[illegible]				
1980	0.0	6.8	2.2	100.0	230.0
1981	0.0	6.8	2.2	102.5	235.0
1982	0.0	6.8	2.2	105.0	240.1
1983	0.0	6.8	2.2	107.5	245.1
1984	0.0	6.8	2.2	110.0	250.2
1985	0.0	6.8	2.2	112.5	255.2
1986	5.3	6.8	2.2	115.0	260.3
1987	0.0	7.6	2.3	117.5	265.3
1988	0.0	7.6	2.3	120.0	270.4
1989	0.0	7.6	2.3	122.5	275.4
1990	0.0	7.6	2.3	125.0	280.4
1991	0.0	7.6	2.3	127.5	285.5
1992	0.0	7.6	2.3	130.0	290.5
1993	0.0	7.6	2.3	132.5	295.6
1994	0.0	7.6	2.3	135.0	300.6
1995	0.0	7.6	2.3	137.5	305.7
1996	0.0	7.6	2.3	140.0	310.7
1997	0.0	7.6	2.3	142.5	315.8
1998	0.0	7.6	2.3	145.0	320.8
1999	0.0	7.6	2.3	147.5	325.9
2000	0.0	7.6	2.3	150.0	330.9
2001	0.0	7.6	2.3	150.0	330.9
2002	0.0	7.6	2.3	150.0	330.9
2003	0.0	7.6	2.3	150.0	330.9
2004	0.0	7.6	2.3	150.0	330.9
2005	0.0	7.6	2.3	150.0	330.9
2006	0.0	7.6	2.3	150.0	330.9
2007	0.0	7.6	2.3	150.0	330.9
2008	0.0	7.6	2.3	150.0	330.9
2009	0.0	7.6	2.3	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	253.7	117.8	36.5	TOTAL	408.1	4542.5
7.0%	260.2	96.3	30.0	TOTAL	386.5	3668.3
10.0%	270.1	74.5	23.3	TOTAL	368.0	2793.9

ALTERNATIVE NO. 24C
BSU,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ONSHORE STORAGE,70 FT.DRAFT,400,000 DWT,150-300 MTA
,TH.PIPELINES,(2-3-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	103.5				
1979	171.2				
1980	0.0	9.5	2.9	150.0	359.0
1981	0.0	9.5	2.9	157.5	376.9
1982	0.0	9.5	2.9	165.0	394.9
1983	11.1	9.5	2.9	172.5	412.8
1984	0.0	12.2	3.1	180.0	430.8
1985	0.0	12.2	3.1	187.5	448.7
1986	0.0	12.2	3.1	195.0	466.7
1987	0.0	12.2	3.1	202.5	484.6
1988	37.8	12.2	3.1	210.0	502.6
1989	2.2	12.6	3.2	217.5	520.5
1990	0.0	13.5	3.3	225.0	538.4
1991	0.0	13.5	3.3	232.5	556.4
1992	0.0	13.5	3.3	240.0	574.3
1993	27.3	13.5	3.3	247.5	592.3
1994	0.0	13.9	3.7	255.0	610.2
1995	0.0	13.9	3.7	262.5	628.2
1996	0.0	13.9	3.7	270.0	646.1
1997	0.0	13.9	3.7	277.5	664.1
1998	0.0	13.9	3.7	285.0	682.0
1999	0.0	13.9	3.7	292.5	700.0
2000	0.0	13.9	3.7	300.0	717.9
2001	0.0	13.9	3.7	300.0	717.9
2002	0.0	13.9	3.7	300.0	717.9
2003	0.0	13.9	3.7	300.0	717.9
2004	0.0	13.9	3.7	300.0	717.9
2005	0.0	13.9	3.7	300.0	717.9
2006	0.0	13.9	3.7	300.0	717.9
2007	0.0	13.9	3.7	300.0	717.9
2008	0.0	13.9	3.7	300.0	717.9
2009	0.0	13.9	3.7	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	344.9	200.0	53.3	TOTAL	598.2	8747.2
7.0%	345.1	161.6	43.2	TOTAL	550.1	6952.0
10.0%	346.4	123.0	33.1	TOTAL	504.4	5177.0

ALTERNATIVE NO. 25C
BSC,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,100-150 MTA,
TK.PIPELINE,(2-4-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	7.0				
1978	85.4				
1979	122.5				
1980	0.0	6.1	2.0	100.0	230.0
1981	0.0	6.1	2.0	102.5	235.0
1982	0.0	6.1	2.0	105.0	240.1
1983	0.0	6.1	2.0	107.5	245.1
1984	0.0	6.1	2.0	110.0	250.2
1985	0.0	6.1	2.0	112.5	255.2
1986	3.6	6.1	2.0	115.0	260.3
1987	0.0	7.0	2.1	117.5	265.3
1988	0.0	7.0	2.1	120.0	270.4
1989	0.0	7.0	2.1	122.5	275.4
1990	0.0	7.0	2.1	125.0	280.4
1991	0.0	7.0	2.1	127.5	285.5
1992	0.0	7.0	2.1	130.0	290.5
1993	0.0	7.0	2.1	132.5	295.6
1994	0.0	7.0	2.1	135.0	300.6
1995	0.0	7.0	2.1	137.5	305.7
1996	0.0	7.0	2.1	140.0	310.7
1997	0.0	7.0	2.1	142.5	315.8
1998	0.0	7.0	2.1	145.0	320.8
1999	0.0	7.0	2.1	147.5	325.9
2000	0.0	7.0	2.1	150.0	330.9
2001	0.0	7.0	2.1	150.0	330.9
2002	0.0	7.0	2.1	150.0	330.9
2003	0.0	7.0	2.1	150.0	330.9
2004	0.0	7.0	2.1	150.0	330.9
2005	0.0	7.0	2.1	150.0	330.9
2006	0.0	7.0	2.1	150.0	330.9
2007	0.0	7.0	2.1	150.0	330.9
2008	0.0	7.0	2.1	150.0	330.9
2009	0.0	7.0	2.1	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.04	246.7	107.5	35.3	TOTAL	387.5	4542.5
7.04	253.9	87.2	27.3	TOTAL	369.0	3668.3
10.04	265.0	67.8	21.2	TOTAL	354.0	2793.9

ALTERNATIVE NO. 260
BSB,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,150-300 MTA,
TR.PIPELINE,(2-4-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	[illegible]				
1977	[illegible]				
1978	94.9				
1979	144.2				
1980	0.0	8.8	2.5	150.0	359.0
1981	0.0	8.8	2.5	157.5	376.9
1982	0.0	8.8	2.5	165.0	394.9
1983	12.0	8.8	2.5	172.5	412.8
1984	0.0	11.7	2.8	180.0	430.8
1985	0.0	11.7	2.8	187.5	448.7
1986	0.0	11.7	2.8	195.0	466.7
1987	0.0	11.7	2.8	202.5	484.6
1988	41.8	11.7	2.8	210.0	502.6
1989	19.0	12.3	2.9	217.5	520.5
1990	0.0	13.0	3.2	225.0	538.4
1991	0.0	13.0	3.2	232.5	556.4
1992	0.0	13.0	3.2	240.0	574.3
1993	0.0	13.0	3.2	247.5	592.3
1994	0.0	13.0	3.2	255.0	610.2
1995	0.0	13.0	3.2	262.5	628.2
1996	0.0	13.0	3.2	270.0	646.1
1997	0.0	13.0	3.2	277.5	664.1
1998	0.0	13.0	3.2	285.0	682.0
1999	0.0	13.0	3.2	292.5	700.0
2000	0.0	13.0	3.2	300.0	717.9
2001	0.0	13.0	3.2	300.0	717.9
2002	0.0	13.0	3.2	300.0	717.9
2003	0.0	13.0	3.2	300.0	717.9
2004	0.0	13.0	3.2	300.0	717.9
2005	0.0	13.0	3.2	300.0	717.9
2006	0.0	13.0	3.2	300.0	717.9
2007	0.0	13.0	3.2	300.0	717.9
2008	0.0	13.0	3.2	300.0	717.9
2009	0.0	13.0	3.2	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	329.0	188.9	47.4	TOTAL	565.2	8747.2
7.0%	330.9	152.7	38.4	TOTAL	522.0	6952.0
10.0%	335.9	116.2	29.5	TOTAL	481.[illegible]	5177.0

ALTERNATIVE NO. 270
BSB, DELAWARE BAY, SERVING EAST COAST, FIXED BERTHS, ISLAND STORAGE, 70 FT. DRAFT, 400,000 DWT, 100-150 MTA, TR. PIPELINES, (2-4-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	7.5				
1978	97.6				
1979	130.7				
1980	0.0	6.1	2.2	100.0	230.0
1981	0.0	6.1	2.2	102.5	235.0
1982	0.0	6.1	2.2	105.0	240.1
1983	0.0	6.1	2.2	107.5	245.1
1984	0.0	6.1	2.2	110.0	250.2
1985	0.0	6.1	2.2	112.5	255.2
1986	3.6	6.1	2.2	115.0	260.3
1987	0.0	7.0	2.3	117.5	265.3
1988	0.0	7.0	2.3	120.0	270.4
1989	0.0	7.0	2.3	122.5	275.4
1990	0.0	7.0	2.3	125.0	280.4
1991	0.0	7.0	2.3	127.5	285.5
1992	0.0	7.0	2.3	130.0	290.5
1993	0.0	7.0	2.3	132.5	295.6
1994	0.0	7.0	2.3	135.0	300.6
1995	0.0	7.0	2.3	137.5	305.7
1996	0.0	7.0	2.3	140.0	310.7
1997	0.0	7.0	2.3	142.5	315.8
1998	0.0	7.0	2.3	145.0	320.8
1999	0.0	7.0	2.3	147.5	325.9
2000	0.0	7.0	2.3	150.0	330.9
2001	0.0	7.0	2.3	150.0	330.9
2002	0.0	7.0	2.3	150.0	330.9
2003	0.0	7.0	2.3	150.0	330.9
2004	0.0	7.0	2.3	150.0	330.9
2005	0.0	7.0	2.3	150.0	330.9
2006	0.0	7.0	2.3	150.0	330.9
2007	0.0	7.0	2.3	150.0	330.9
2008	0.0	7.0	2.3	150.0	330.9
2009	0.0	7.0	2.3	150.0	330.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	264.9	107.5	36.5	TOTAL	409.0	4542.5
7.0%	272.7	87.8	30.0	TOTAL	390.4	3668.3
10.0%	284.6	67.8	23.3	TOTAL	375.7	2793.9

ALTERNATIVE NO. 28C
BSB,DELAWARE BAY,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,400,000 DWT,150-300 MTA,
TR.PIPELINES,(2-4-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	3.5				
1976	3.5				
1977	9.0				
1978	103.2				
1979	154.8				
1980	0.0	8.8	2.8	150.0	359.0
1981	0.0	8.8	2.8	157.5	376.9
1982	0.0	8.8	2.8	165.0	394.9
1983	12.0	8.3	2.8	172.5	412.8
1984	0.0	11.7	3.1	180.0	430.8
1985	0.0	11.7	3.1	187.5	448.7
1986	0.0	11.7	3.1	195.0	466.7
1987	0.0	11.7	3.1	202.5	484.6
1988	41.8	11.7	3.1	210.0	502.6
1989	2.2	12.3	3.3	217.5	520.5
1990	0.0	13.0	3.3	225.0	538.4
1991	0.0	13.0	3.3	232.5	556.4
1992	0.0	13.0	3.3	240.0	574.3
1993	21.9	13.0	3.3	247.5	592.3
1994	0.0	13.0	3.6	255.0	610.2
1995	0.0	13.0	3.6	262.5	628.2
1996	0.0	13.0	3.6	270.0	646.1
1997	0.0	13.0	3.6	277.5	664.1
1998	0.0	13.0	3.6	285.0	682.0
1999	0.0	13.0	3.6	292.5	700.0
2000	0.0	13.0	3.6	300.0	717.9
2001	0.0	13.0	3.6	300.0	717.9
2002	0.0	13.0	3.6	300.0	717.9
2003	0.0	13.0	3.6	300.0	717.9
2004	0.0	13.0	3.6	300.0	717.9
2005	0.0	13.0	3.6	300.0	717.9
2006	0.0	13.0	3.6	300.0	717.9
2007	0.0	13.0	3.6	300.0	717.9
2008	0.0	13.0	3.6	300.0	717.9
2009	0.0	13.0	3.6	300.0	717.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	353.8	138.9	52.4	TOTAL	595.0	8747.2
7.0%	355.6	152.7	42.5	TOTAL	550.8	6952.0
10.0%	360.9	116.2	32.6	TOTAL	509.7	5177.0

ALTERNATIVE NO. 290
R3,ULL.,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,100-150 MTA,TR.BARGE S,(2-5-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	35.0				
1976	35.0				
1977	52.7				
1978	38.4				
1979	43.7				
1980	0.0	5.6	2.5	100.0	257.7
1981	0.0	5.6	2.5	102.5	263.4
1982	0.0	5.6	2.5	105.0	269.1
1983	0.0	5.6	2.5	107.5	274.8
1984	0.0	5.6	2.5	110.0	280.5
1985	0.0	5.6	2.5	112.5	286.2
1986	0.0	5.6	2.5	115.0	291.9
1987	0.0	5.6	2.5	117.5	297.6
1988	0.0	5.6	2.5	120.0	303.3
1989	0.0	5.6	2.5	122.5	309.0
1990	0.0	5.6	2.5	125.0	314.6
1991	0.0	5.6	2.5	127.5	320.3
1992	0.0	5.6	2.5	130.0	326.0
1993	0.0	5.6	2.5	132.5	331.7
1994	0.0	5.6	2.5	135.0	337.4
1995	0.0	5.6	2.5	137.5	343.1
1996	0.0	5.6	2.5	140.0	348.8
1997	0.0	5.6	2.5	142.5	354.5
1998	0.0	5.6	2.5	145.0	360.2
1999	0.0	5.6	2.5	147.5	365.9
2000	0.0	5.6	2.5	150.0	371.6
2001	0.0	5.6	2.5	150.0	371.6
2002	0.0	5.6	2.5	150.0	371.6
2003	0.0	5.6	2.5	150.0	371.6
2004	0.0	5.6	2.5	150.0	371.6
2005	0.0	5.6	2.5	150.0	371.6
2006	0.0	5.6	2.5	150.0	371.6
2007	0.0	5.6	2.5	150.0	371.6
2008	0.0	5.6	2.5	150.0	371.6
2009	0.0	5.6	2.5	150.0	371.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	241.7	90.4	40.4	TOTAL	372.4	5096.6
7.0%	255.6	74.4	33.2	TOTAL	363.1	4115.2
10.0%	277.8	58.1	25.9	TOTAL	361.8	3133.8

ALTERNATIVE NO. 300
PB,CLL.,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,300,000 DWT,150-300 MTA,TR.BARGE
S,(2-5-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	45.0				
1976	45.0				
1977	66.9				
1978	47.2				
1979	60.5				
1980	0.0	5.7	3.1	150.0	399.6
1981	0.0	5.7	3.1	157.5	419.6
1982	0.0	5.7	3.1	165.0	439.6
1983	0.0	5.7	3.1	172.5	459.5
1984	2.0	5.7	3.1	180.0	479.5
1985	0.0	5.8	3.1	187.5	499.5
1986	0.0	5.8	3.1	195.0	519.5
1987	0.0	5.8	3.1	202.5	539.5
1988	0.0	5.8	3.1	210.0	559.4
1989	19.4	5.8	3.1	217.5	579.4
1990	2.0	5.9	3.4	225.0	599.4
1991	0.0	6.0	3.4	232.5	619.4
1992	0.0	6.0	3.4	240.0	639.4
1993	0.0	6.0	3.4	247.5	659.3
1994	0.0	6.0	3.4	255.0	679.3
1995	0.0	6.0	3.4	262.5	699.3
1996	2.0	6.0	3.4	270.0	719.3
1997	0.0	6.1	3.4	277.5	739.3
1998	0.0	6.1	3.4	285.0	759.2
1999	0.0	6.1	3.4	292.5	779.2
2000	0.0	6.1	3.4	300.0	799.2
2001	0.0	6.1	3.4	300.0	799.2
2002	0.0	6.1	3.4	300.0	799.2
2003	0.0	6.1	3.4	300.0	799.2
2004	0.0	6.1	3.4	300.0	799.2
2005	0.0	6.1	3.4	300.0	799.2
2006	0.0	6.1	3.4	300.0	799.2
2007	0.0	6.1	3.4	300.0	799.2
2008	0.0	6.1	3.4	300.0	799.2
2009	0.0	6.1	3.4	300.0	799.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	321.3	95.1	52.4	TOTAL	468.9	9737.3
7.0%	336.5	76.0	42.9	TOTAL	457.3	7736.9
10.0%	361.7	60.6	33.2	TOTAL	455.5	5762.9

ALTERNATIVE NO. 316
NEW ORL.,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT,400,000 DWT,100-150 MTA,TR.BARGE
S,(2-5-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	37.5				
1976	37.5				
1977	56.2				
1978	47.5				
1979	57.8				
1980	0.0	5.6	2.8	100.0	257.7
1981	0.0	5.6	2.8	102.5	263.4
1982	0.0	5.6	2.8	105.0	269.1
1983	0.0	5.6	2.8	107.5	274.8
1984	0.0	5.6	2.8	110.0	280.5
1985	0.0	5.6	2.8	112.5	286.2
1986	0.0	5.6	2.8	115.0	291.9
1987	0.0	5.6	2.8	117.5	297.6
1988	0.0	5.6	2.8	120.0	303.3
1989	0.0	5.6	2.8	122.5	309.0
1990	0.0	5.6	2.8	125.0	314.6
1991	0.0	5.6	2.8	127.5	320.3
1992	0.0	5.6	2.8	130.0	326.0
1993	0.0	5.6	2.8	132.5	331.7
1994	0.0	5.6	2.8	135.0	337.4
1995	0.0	5.6	2.8	137.5	343.1
1996	0.0	5.6	2.8	140.0	348.8
1997	0.0	5.6	2.8	142.5	354.5
1998	0.0	5.6	2.8	145.0	360.2
1999	0.0	5.6	2.8	147.5	365.9
2000	0.0	5.6	2.8	150.0	371.6
2001	0.0	5.6	2.8	150.0	371.6
2002	0.0	5.6	2.8	150.0	371.6
2003	0.0	5.6	2.8	150.0	371.6
2004	0.0	5.6	2.8	150.0	371.6
2005	0.0	5.6	2.8	150.0	371.6
2006	0.0	5.6	2.8	150.0	371.6
2007	0.0	5.6	2.8	150.0	371.6
2008	0.0	5.6	2.8	150.0	371.6
2009	0.0	5.6	2.8	150.0	371.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	271.6	90.4	45.2	TOTAL	407.1	5096.6
7.0%	286.8	74.4	37.2	TOTAL	398.4	4115.2
10.0%	311.2	56.1	29.0	TOTAL	398.3	3133.8

ALTERNATIVE NO. 320
RB,DLL.,SERVING EAST COAST,FIXED BERTHS,ISLAND STORAGE 70 FT.DRAFT,400,000 DWT,150-300 MTA,TR.BARGE S,(2-5-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	45.0				
1976	45.0				
1977	69.4				
1978	58.4				
1979	71.7				
1980	0.0	5.7	3.6	150.0	399.6
1981	0.0	5.7	3.6	157.5	419.6
1982	0.0	5.7	3.6	165.0	439.6
1983	0.0	5.7	3.6	172.5	459.5
1984	2.0	5.7	3.6	180.0	479.5
1985	0.0	5.8	3.6	187.5	499.5
1986	0.0	5.8	3.6	195.0	519.5
1987	0.0	5.8	3.6	202.5	539.5
1988	0.0	5.8	3.6	210.0	559.4
1989	0.0	5.8	3.6	217.5	579.4
1990	2.0	5.8	3.6	225.0	599.4
1991	0.0	5.9	3.6	232.5	619.4
1992	25.7	5.9	3.6	240.0	639.4
1993	0.0	6.0	4.0	247.5	659.3
1994	0.0	6.0	4.0	255.0	679.3
1995	0.0	6.0	4.0	262.5	699.3
1996	2.0	6.0	4.0	270.0	719.3
1997	0.0	6.1	4.0	277.5	739.3
1998	0.0	6.1	4.0	285.0	759.2
1999	0.0	6.1	4.0	292.5	779.2
2000	0.0	6.1	4.0	300.0	799.2
2001	0.0	6.1	4.0	300.0	799.2
2002	0.0	6.1	4.0	300.0	799.2
2003	0.0	6.1	4.0	300.0	799.2
2004	0.0	6.1	4.0	300.0	799.2
2005	0.0	6.1	4.0	300.0	799.2
2006	0.0	6.1	4.0	300.0	799.2
2007	0.0	6.1	4.0	300.0	799.2
2008	0.0	6.1	4.0	300.0	799.2
2009	0.0	6.1	4.0	300.0	799.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	350.2	95.0	60.6	TOTAL	505.8	9737.3
7.0%	365.3	77.8	49.5	TOTAL	492.7	7738.9
10.0%	391.0	60.5	38.4	TOTAL	489.8	5762.9

Series 2

ALTERNATIVE NO. 1
EXISTING SITUATION, SERVING N.Y., 30-35 MTA, NO LIGHTERING, (1-1X).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	30.0	123.0
1981	0.0	0.0	0.0	30.3	123.2
1982	0.0	0.0	0.0	30.5	123.3
1983	0.0	0.0	0.0	30.8	123.5
1984	0.0	0.0	0.0	31.0	123.6
1985	0.0	0.0	0.0	31.3	123.8
1986	0.0	0.0	0.0	31.5	124.0
1987	0.0	0.0	0.0	31.8	124.1
1988	0.0	0.0	0.0	32.0	124.3
1989	0.0	0.0	0.0	32.3	124.4
1990	0.0	0.0	0.0	32.5	124.6
1991	0.0	0.0	0.0	32.8	124.8
1992	0.0	0.0	0.0	33.0	124.9
1993	0.0	0.0	0.0	33.3	125.1
1994	0.0	0.0	0.0	33.5	125.2
1995	0.0	0.0	0.0	33.8	125.4
1996	0.0	0.0	0.0	34.0	125.6
1997	0.0	0.0	0.0	34.3	125.7
1998	0.0	0.0	0.0	34.5	125.9
1999	0.0	0.0	0.0	34.8	126.0
2000	0.0	0.0	0.0	35.0	126.2
2001	0.0	0.0	0.0	35.0	126.2
2002	0.0	0.0	0.0	35.0	126.2
2003	0.0	0.0	0.0	35.0	126.2
2004	0.0	0.0	0.0	35.0	126.2
2005	0.0	0.0	0.0	35.0	126.2
2006	0.0	0.0	0.0	35.0	126.2
2007	0.0	0.0	0.0	35.0	126.2
2008	0.0	0.0	0.0	35.0	126.2
2009	0.0	0.0	0.0	35.0	126.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	2011.7
7.0%	0.0	0.0	0.0	TOTAL	0.0	1652.6
10.0%	0.0	0.0	0.0	TOTAL	0.0	1288.4

ALTERNATIVE NO. 11
EXISTING SITUATION, SERVING N.Y., 35-70 MTA, NC LIGHTERING, (1-1Y).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	35.0	146.9
1981	0.0	0.0	0.0	36.8	154.2
1982	0.0	0.0	0.0	38.5	161.6
1983	0.0	0.0	0.0	40.3	168.9
1984	0.0	0.0	0.0	42.0	176.3
1985	0.0	0.0	0.0	43.8	183.6
1986	0.0	0.0	0.0	45.5	191.0
1987	0.0	0.0	0.0	47.3	198.3
1988	0.0	0.0	0.0	49.0	205.7
1989	0.0	0.0	0.0	50.8	213.0
1990	0.0	0.0	0.0	52.5	220.3
1991	0.0	0.0	0.0	54.3	227.7
1992	0.0	0.0	0.0	56.0	235.0
1993	0.0	0.0	0.0	57.8	242.4
1994	0.0	0.0	0.0	59.5	249.7
1995	0.0	0.0	0.0	61.3	257.1
1996	0.0	0.0	0.0	63.0	264.4
1997	0.0	0.0	0.0	64.8	271.8
1998	0.0	0.0	0.0	66.5	279.1
1999	0.0	0.0	0.0	68.3	286.5
2000	0.0	0.0	0.0	70.0	293.8
2001	0.0	0.0	0.0	70.0	293.8
2002	0.0	0.0	0.0	70.0	293.8
2003	0.0	0.0	0.0	70.0	293.8
2004	0.0	0.0	0.0	70.0	293.8
2005	0.0	0.0	0.0	70.0	293.8
2006	0.0	0.0	0.0	70.0	293.8
2007	0.0	0.0	0.0	70.0	293.8
2008	0.0	0.0	0.0	70.0	293.8
2009	0.0	0.0	0.0	70.0	293.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	3579.6
7.0%	0.0	0.0	0.0	TOTAL	0.0	2845.0
10.0%	0.0	0.0	0.0	TOTAL	0.0	2118.6

ALTERNATIVE NO. 21
EXISTING SITUATION, SERVING DEL., 70-115 MTA, NO LIGHTERING, (2-1X).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	70.0	303.7
1981	0.0	0.0	0.0	72.3	312.9
1982	0.0	0.0	0.0	74.5	322.1
1983	0.0	0.0	0.0	76.8	331.3
1984	0.0	0.0	0.0	79.0	340.5
1985	0.0	0.0	0.0	81.3	349.7
1986	0.0	0.0	0.0	83.5	358.9
1987	0.0	0.0	0.0	85.8	368.1
1988	0.0	0.0	0.0	88.0	377.3
1989	0.0	0.0	0.0	90.3	386.5
1990	0.0	0.0	0.0	92.5	395.6
1991	0.0	0.0	0.0	94.8	404.8
1992	0.0	0.0	0.0	97.0	414.0
1993	0.0	0.0	0.0	99.3	423.2
1994	0.0	0.0	0.0	101.5	432.4
1995	0.0	0.0	0.0	103.8	441.6
1996	0.0	0.0	0.0	106.0	450.8
1997	0.0	0.0	0.0	108.3	460.0
1998	0.0	0.0	0.0	110.5	469.2
1999	0.0	0.0	0.0	112.8	478.4
2000	0.0	0.0	0.0	115.0	487.6
2001	0.0	0.0	0.0	115.0	487.6
2002	0.0	0.0	0.0	115.0	487.6
2003	0.0	0.0	0.0	115.0	487.6
2004	0.0	0.0	0.0	115.0	487.6
2005	0.0	0.0	0.0	115.0	487.6
2006	0.0	0.0	0.0	115.0	487.6
2007	0.0	0.0	0.0	115.0	487.6
2008	0.0	0.0	0.0	115.0	487.6
2009	0.0	0.0	0.0	115.0	487.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	6414.9
7.0%	0.0	0.0	0.0	TOTAL	0.0	5152.2
10.0%	0.0	0.0	0.0	TOTAL	0.0	3894.4

ALTERNATIVE NO. 31
EXISTING SITUATION, SERVING DEL., 115-230 MTA, NO LIGHTERING, (2-1Y).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	115.0	519.2
1981	0.0	0.0	0.0	120.8	545.2
1982	0.0	0.0	0.0	126.5	571.1
1983	0.0	0.0	0.0	132.3	597.1
1984	0.0	0.0	0.0	138.0	623.0
1985	0.0	0.0	0.0	143.8	649.0
1986	0.0	0.0	0.0	149.5	675.0
1987	0.0	0.0	0.0	155.3	700.9
1988	0.0	0.0	0.0	161.0	726.9
1989	0.0	0.0	0.0	166.8	752.8
1990	0.0	0.0	0.0	172.5	778.8
1991	0.0	0.0	0.0	178.3	804.8
1992	0.0	0.0	0.0	184.0	830.7
1993	0.0	0.0	0.0	189.8	856.7
1994	0.0	0.0	0.0	195.5	882.6
1995	0.0	0.0	0.0	201.3	908.6
1996	0.0	0.0	0.0	207.0	934.6
1997	0.0	0.0	0.0	212.8	960.5
1998	0.0	0.0	0.0	218.5	986.5
1999	0.0	0.0	0.0	224.3	1012.4
2000	0.0	0.0	0.0	230.0	1038.4
2001	0.0	0.0	0.0	230.0	1038.4
2002	0.0	0.0	0.0	230.0	1038.4
2003	0.0	0.0	0.0	230.0	1038.4
2004	0.0	0.0	0.0	230.0	1038.4
2005	0.0	0.0	0.0	230.0	1038.4
2006	0.0	0.0	0.0	230.0	1038.4
2007	0.0	0.0	0.0	230.0	1038.4
2008	0.0	0.0	0.0	230.0	1038.4
2009	0.0	0.0	0.0	230.0	1038.4

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	12651.7
7.0%	0.0	0.0	0.0	TOTAL	0.0	10055.1
10.0%	0.0	0.0	0.0	TOTAL	0.0	7487.8

ALTERNATIVE NO. 41
EXISTING SITUATION, SERVING EAST COAST, 100-150 MTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	100.0	426.6
1981	0.0	0.0	0.0	102.5	436.0
1982	0.0	0.0	0.0	105.0	445.3
1983	0.0	0.0	0.0	107.5	454.7
1984	0.0	0.0	0.0	110.0	464.0
1985	0.0	0.0	0.0	112.5	473.4
1986	0.0	0.0	0.0	115.0	482.7
1987	0.0	0.0	0.0	117.5	492.1
1988	0.0	0.0	0.0	120.0	501.4
1989	0.0	0.0	0.0	122.5	510.8
1990	0.0	0.0	0.0	125.0	520.1
1991	0.0	0.0	0.0	127.5	529.5
1992	0.0	0.0	0.0	130.0	538.9
1993	0.0	0.0	0.0	132.5	548.2
1994	0.0	0.0	0.0	135.0	557.6
1995	0.0	0.0	0.0	137.5	566.9
1996	0.0	0.0	0.0	140.0	576.3
1997	0.0	0.0	0.0	142.5	585.6
1998	0.0	0.0	0.0	145.0	595.0
1999	0.0	0.0	0.0	147.5	604.3
2000	0.0	0.0	0.0	150.0	613.7
2001	0.0	0.0	0.0	150.0	613.7
2002	0.0	0.0	0.0	150.0	613.7
2003	0.0	0.0	0.0	150.0	613.7
2004	0.0	0.0	0.0	150.0	613.7
2005	0.0	0.0	0.0	150.0	613.7
2006	0.0	0.0	0.0	150.0	613.7
2007	0.0	0.0	0.0	150.0	613.7
2008	0.0	0.0	0.0	150.0	613.7
2009	0.0	0.0	0.0	150.0	613.7

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	8425.0
7.0%	0.0	0.0	0.0	TOTAL	0.0	6803.5
10.0%	0.0	0.0	0.0	TOTAL	0.0	5181.8

ALTERNATIVE NO. 51
EXISTING SITUATION, SERVING EAST COAST, 150-300 MTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	150.0	666.1
1981	0.0	0.0	0.0	157.5	699.4
1982	0.0	0.0	0.0	165.0	732.7
1983	0.0	0.0	0.0	172.5	766.0
1984	0.0	0.0	0.0	180.0	799.3
1985	0.0	0.0	0.0	187.5	832.6
1986	0.0	0.0	0.0	195.0	865.9
1987	0.0	0.0	0.0	202.5	899.2
1988	0.0	0.0	0.0	210.0	932.5
1989	0.0	0.0	0.0	217.5	965.8
1990	0.0	0.0	0.0	225.0	999.1
1991	0.0	0.0	0.0	232.5	1032.5
1992	0.0	0.0	0.0	240.0	1065.8
1993	0.0	0.0	0.0	247.5	1099.1
1994	0.0	0.0	0.0	255.0	1132.4
1995	0.0	0.0	0.0	262.5	1165.7
1996	0.0	0.0	0.0	270.0	1199.0
1997	0.0	0.0	0.0	277.5	1232.3
1998	0.0	0.0	0.0	285.0	1265.6
1999	0.0	0.0	0.0	292.5	1298.9
2000	0.0	0.0	0.0	300.0	1332.2
2001	0.0	0.0	0.0	300.0	1332.2
2002	0.0	0.0	0.0	300.0	1332.2
2003	0.0	0.0	0.0	300.0	1332.2
2004	0.0	0.0	0.0	300.0	1332.2
2005	0.0	0.0	0.0	300.0	1332.2
2006	0.0	0.0	0.0	300.0	1332.2
2007	0.0	0.0	0.0	300.0	1332.2
2008	0.0	0.0	0.0	300.0	1332.2
2009	0.0	0.0	0.0	300.0	1332.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	16231.3
7.0%	0.0	0.0	0.0	TOTAL	0.0	12900.1
10.0%	0.0	0.0	0.0	TOTAL	0.0	9606.3

ALTERNATIVE NO. 61
EXISTING SITUATION, SERVING N.Y., 30-35 MTA, LIGHTERING, (1-1X).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	30.0	95.1
1981	0.0	0.0	0.0	30.2	95.3
1982	0.0	0.0	0.0	30.5	95.4
1983	0.0	0.0	0.0	30.8	95.6
1984	0.0	0.0	0.0	31.0	95.8
1985	0.0	0.0	0.0	31.3	95.9
1986	0.0	0.0	0.0	31.5	96.1
1987	0.0	0.0	0.0	31.8	96.3
1988	0.0	0.0	0.0	32.0	96.5
1989	0.0	0.0	0.0	32.3	96.6
1990	0.0	0.0	0.0	32.5	96.8
1991	0.0	0.0	0.0	32.8	97.0
1992	0.0	0.0	0.0	33.0	97.1
1993	0.0	0.0	0.0	33.3	97.3
1994	0.0	0.0	0.0	33.5	97.5
1995	0.0	0.0	0.0	33.8	97.6
1996	0.0	0.0	0.0	34.0	97.8
1997	0.0	0.0	0.0	34.3	98.0
1998	0.0	0.0	0.0	34.5	98.2
1999	0.0	0.0	0.0	34.8	98.3
2000	0.0	0.0	0.0	35.0	98.5
2001	0.0	0.0	0.0	35.0	98.5
2002	0.0	0.0	0.0	35.0	98.5
2003	0.0	0.0	0.0	35.0	98.5
2004	0.0	0.0	0.0	35.0	98.5
2005	0.0	0.0	0.0	35.0	98.5
2006	0.0	0.0	0.0	35.0	98.5
2007	0.0	0.0	0.0	35.0	98.5
2008	0.0	0.0	0.0	35.0	98.5
2009	0.0	0.0	0.0	35.0	98.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	1563.0
7.0%	0.0	0.0	0.0	TOTAL	0.0	1283.4
10.0%	0.0	0.0	0.0	TOTAL	0.0	999.9

ALTERNATIVE No. 71
EXISTING SITUATION, SERVING N.Y., 35-70 MTA, LIGHTERING, (1-1Y).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	35.0	113.4
1981	0.0	0.0	0.0	36.8	119.1
1982	0.0	0.0	0.0	38.5	124.7
1983	0.0	0.0	0.0	40.3	130.4
1984	0.0	0.0	0.0	42.0	136.1
1985	0.0	0.0	0.0	43.8	141.7
1986	0.0	0.0	0.0	45.5	147.4
1987	0.0	0.0	0.0	47.3	153.1
1988	0.0	0.0	0.0	49.0	158.8
1989	0.0	0.0	0.0	50.8	164.4
1990	0.0	0.0	0.0	52.5	170.1
1991	0.0	0.0	0.0	54.3	175.8
1992	0.0	0.0	0.0	56.0	181.4
1993	0.0	0.0	0.0	57.8	187.1
1994	0.0	0.0	0.0	59.5	192.8
1995	0.0	0.0	0.0	61.3	198.4
1996	0.0	0.0	0.0	63.0	204.1
1997	0.0	0.0	0.0	64.8	209.8
1998	0.0	0.0	0.0	66.5	215.5
1999	0.0	0.0	0.0	68.3	221.1
2000	0.0	0.0	0.0	70.0	226.8
2001	0.0	0.0	0.0	70.0	226.8
2002	0.0	0.0	0.0	70.0	226.8
2003	0.0	0.0	0.0	70.0	226.8
2004	0.0	0.0	0.0	70.0	226.8
2005	0.0	0.0	0.0	70.0	226.8
2006	0.0	0.0	0.0	70.0	226.8
2007	0.0	0.0	0.0	70.0	226.8
2008	0.0	0.0	0.0	70.0	226.8
2009	0.0	0.0	0.0	70.0	226.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	2763.3
7.0%	0.0	0.0	0.0	TOTAL	0.0	2196.2
10.0%	0.0	0.0	0.0	TOTAL	0.0	1635.4

ALTERNATIVE NO. 81
EXISTING SITUATION, SERVING DEL., 70-115 MTA, LIGHTERING, (2-1X).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	70.0	207.5
1981	0.0	0.0	0.0	72.3	213.8
1982	0.0	0.0	0.0	74.5	220.2
1983	0.0	0.0	0.0	76.8	226.5
1984	0.0	0.0	0.0	79.0	232.8
1985	0.0	0.0	0.0	81.3	239.2
1986	0.0	0.0	0.0	83.5	245.5
1987	0.0	0.0	0.0	85.8	251.8
1988	0.0	0.0	0.0	88.0	258.2
1989	0.0	0.0	0.0	90.3	264.5
1990	0.0	0.0	0.0	92.5	270.8
1991	0.0	0.0	0.0	94.8	277.2
1992	0.0	0.0	0.0	97.0	283.5
1993	0.0	0.0	0.0	99.3	289.9
1994	0.0	0.0	0.0	101.5	296.2
1995	0.0	0.0	0.0	103.8	302.5
1996	0.0	0.0	0.0	106.0	308.9
1997	0.0	0.0	0.0	108.3	315.2
1998	0.0	0.0	0.0	110.5	321.5
1999	0.0	0.0	0.0	112.8	327.9
2000	0.0	0.0	0.0	115.0	334.2
2001	0.0	0.0	0.0	115.0	334.2
2002	0.0	0.0	0.0	115.0	334.2
2003	0.0	0.0	0.0	115.0	334.2
2004	0.0	0.0	0.0	115.0	334.2
2005	0.0	0.0	0.0	115.0	334.2
2006	0.0	0.0	0.0	115.0	334.2
2007	0.0	0.0	0.0	115.0	334.2
2008	0.0	0.0	0.0	115.0	334.2
2009	0.0	0.0	0.0	115.0	334.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	4391.6
7.0%	0.0	0.0	0.0	TOTAL	0.0	3526.6
10.0%	0.0	0.0	0.0	TOTAL	0.0	2665.1

ALTERNATIVE NO. 91
EXISTING SITUATION, SERVING DEL., 115-230 MTA, LIGHTERING, (2-1Y).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	115.0	353.1
1981	0.0	0.0	0.0	120.8	370.8
1982	0.0	0.0	0.0	126.5	388.4
1983	0.0	0.0	0.0	132.3	406.1
1984	0.0	0.0	0.0	138.0	423.7
1985	0.0	0.0	0.0	143.8	441.4
1986	0.0	0.0	0.0	149.5	459.0
1987	0.0	0.0	0.0	155.3	476.7
1988	0.0	0.0	0.0	161.0	494.3
1989	0.0	0.0	0.0	166.8	512.0
1990	0.0	0.0	0.0	172.5	529.6
1991	0.0	0.0	0.0	178.3	547.3
1992	0.0	0.0	0.0	184.0	565.0
1993	0.0	0.0	0.0	189.8	582.6
1994	0.0	0.0	0.0	195.5	600.3
1995	0.0	0.0	0.0	201.3	617.9
1996	0.0	0.0	0.0	207.0	635.6
1997	0.0	0.0	0.0	212.8	653.2
1998	0.0	0.0	0.0	218.5	670.9
1999	0.0	0.0	0.0	224.3	688.5
2000	0.0	0.0	0.0	230.0	706.2
2001	0.0	0.0	0.0	230.0	706.2
2002	0.0	0.0	0.0	230.0	706.2
2003	0.0	0.0	0.0	230.0	706.2
2004	0.0	0.0	0.0	230.0	706.2
2005	0.0	0.0	0.0	230.0	706.2
2006	0.0	0.0	0.0	230.0	706.2
2007	0.0	0.0	0.0	230.0	706.2
2008	0.0	0.0	0.0	230.0	706.2
2009	0.0	0.0	0.0	230.0	706.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	8604.2
7.0%	0.0	0.0	0.0	TOTAL	0.0	6838.3
10.0%	0.0	0.0	0.0	TOTAL	0.0	5092.3

ALTERNATIVE NO. 101
EXISTING SITUATION, SERVING EAST COAST, 100-150 MTA, LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	100.0	302.6
1981	0.0	0.0	0.0	102.5	309.1
1982	0.0	0.0	0.0	105.0	315.6
1983	0.0	0.0	0.0	107.5	322.1
1984	0.0	0.0	0.0	110.0	328.6
1985	0.0	0.0	0.0	112.5	335.1
1986	0.0	0.0	0.0	115.0	341.6
1987	0.0	0.0	0.0	117.5	348.1
1988	0.0	0.0	0.0	120.0	354.6
1989	0.0	0.0	0.0	122.5	361.1
1990	0.0	0.0	0.0	125.0	367.6
1991	0.0	0.0	0.0	127.5	374.2
1992	0.0	0.0	0.0	130.0	380.7
1993	0.0	0.0	0.0	132.5	387.2
1994	0.0	0.0	0.0	135.0	393.7
1995	0.0	0.0	0.0	137.5	400.2
1996	0.0	0.0	0.0	140.0	406.7
1997	0.0	0.0	0.0	142.5	413.2
1998	0.0	0.0	0.0	145.0	419.7
1999	0.0	0.0	0.0	147.5	426.2
2000	0.0	0.0	0.0	150.0	432.7
2001	0.0	0.0	0.0	150.0	432.7
2002	0.0	0.0	0.0	150.0	432.7
2003	0.0	0.0	0.0	150.0	432.7
2004	0.0	0.0	0.0	150.0	432.7
2005	0.0	0.0	0.0	150.0	432.7
2006	0.0	0.0	0.0	150.0	432.7
2007	0.0	0.0	0.0	150.0	432.7
2008	0.0	0.0	0.0	150.0	432.7
2009	0.0	0.0	0.0	150.0	432.7

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	5954.6
7.0%	0.0	0.0	0.0	TOTAL	0.0	4810.0
10.0%	0.0	0.0	0.0	TOTAL	0.0	3665.0

ALTERNATIVE NO. 111
EXISTING SITUATION, SERVING EAST COAST, 150-300 MTA, LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	150.0	466.5
1981	0.0	0.0	0.0	157.5	489.8
1982	0.0	0.0	0.0	165.0	513.1
1983	0.0	0.0	0.0	172.5	536.5
1984	0.0	0.0	0.0	130.0	559.8
1985	0.0	0.0	0.0	187.5	583.1
1986	0.0	0.0	0.0	195.0	606.4
1987	0.0	0.0	0.0	202.5	629.8
1988	0.0	0.0	0.0	210.0	653.1
1989	0.0	0.0	0.0	217.5	676.4
1990	0.0	0.0	0.0	225.0	699.7
1991	0.0	0.0	0.0	232.5	723.1
1992	0.0	0.0	0.0	240.0	746.4
1993	0.0	0.0	0.0	247.5	769.7
1994	0.0	0.0	0.0	255.0	793.0
1995	0.0	0.0	0.0	262.5	816.4
1996	0.0	0.0	0.0	270.0	839.7
1997	0.0	0.0	0.0	277.5	863.0
1998	0.0	0.0	0.0	285.0	886.3
1999	0.0	0.0	0.0	292.5	909.7
2000	0.0	0.0	0.0	300.0	933.0
2001	0.0	0.0	0.0	300.0	933.0
2002	0.0	0.0	0.0	300.0	933.0
2003	0.0	0.0	0.0	300.0	933.0
2004	0.0	0.0	0.0	300.0	933.0
2005	0.0	0.0	0.0	300.0	933.0
2006	0.0	0.0	0.0	300.0	933.0
2007	0.0	0.0	0.0	300.0	933.0
2008	0.0	0.0	0.0	300.0	933.0
2009	0.0	0.0	0.0	300.0	933.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	11367.5
7.0%	0.0	0.0	0.0	TOTAL	0.0	9034.5
10.0%	0.0	0.0	0.0	TOTAL	0.0	6727.7

Series 3

(Note: Alternative 2 signifies dummy)

COMPARISON NO. 1

ALTERNATIVE NO.	1		2		VS 10		2				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	0.0	230.6	1085.0	0.0	0.0	230.6	926.7	4.0191
7.0%	0.0	[illegible]	0.0	0.0	221.6	891.3	0.0	0.0	221.6	761.4	3.4354
10.0%	0.0	[illegible]	0.0	0.0	215.8	694.8	0.0	0.0	215.8	593.6	2.7506

COMPARISON NO. 2

ALTERNATIVE NO.	1		2		VS 30		2				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	0.0	252.9	1085.0	0.0	0.0	252.9	926.7	3.6640
7.0%	0.0	1652.6	0.0	0.0	243.7	891.3	0.0	0.0	243.7	761.4	3.1248
10.0%	0.0	[illegible]	0.0	0.0	237.8	694.8	0.0	0.0	237.8	593.6	2.4963

COMPARISON NO. 3

ALTERNATIVE NO.	11		2		VS 20		2				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	[illegible]	0.0	0.0	236.9	1929.9	0.0	0.0	236.9	1649.7	6.9650
7.0%	0.0	2345.0	0.0	0.0	226.6	1533.8	0.0	0.0	226.6	1311.1	5.7867
10.0%	0.0	[illegible]	0.0	0.0	219.5	1142.2	0.0	0.0	219.5	976.4	4.4489

COMPARISON NO. 4

ALTERNATIVE NO. 11 2 VS 40 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3579.5	0.0	0.0	253.5	1925.9	0.0	0.0	258.5	1649.7	6.3827
7.0%	0.0	2545.0	0.0	0.0	243.1	1533.8	0.0	0.0	248.1	1311.1	5.2851
10.0%	0.0	2118.6	0.0	0.0	241.1	1142.2	0.0	0.0	241.1	976.4	4.0493

COMPARISON NO. 5

ALTERNATIVE NO. 61 2 VS 10 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	0.0	230.6	1085.0	0.0	0.0	230.6	478.0	2.0732
7.0%	0.0	1233.4	0.0	0.0	221.6	891.3	0.0	0.0	221.6	392.1	1.7694
10.0%	0.0	935.9	0.0	0.0	215.8	694.8	0.0	0.0	215.8	305.1	1.4138

COMPARISON NO. 6

ALTERNATIVE NO. 61 2 VS 30 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	0.0	252.9	1085.0	0.0	0.0	252.9	478.0	1.8900
7.0%	0.0	1282.4	0.0	0.0	243.7	891.3	0.0	0.0	243.7	392.1	1.6094
10.0%	0.0	999.9	0.0	0.0	237.8	694.6	0.0	0.0	237.8	305.1	1.2831

COMPARISON NO. 7

ALTERNATIVE NO. 71 2 VS 20 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.3	0.0	0.0	236.9	1929.9	0.0	0.0	236.9	833.4	3.5185
7.0%	0.0	2196.2	0.0	0.0	226.6	1533.8	0.0	0.0	226.6	662.3	2.9233
10.0%	0.0	1635.4	0.0	0.0	219.5	1142.2	0.0	0.0	219.5	493.2	2.2475

COMPARISON NO. 8

ALTERNATIVE NO. 71 2 VS 40 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.3	0.0	0.0	258.5	1929.9	0.0	0.0	258.5	833.4	3.2244
7.0%	0.0	2196.2	0.0	0.0	248.1	1533.8	0.0	0.0	248.1	662.3	2.6699
10.0%	0.0	1635.4	0.0	0.0	241.1	1142.2	0.0	0.0	241.1	493.2	2.0456

COMPARISON NO. 9

ALTERNATIVE NO 21 2 VS 130 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	6414.9	0.0	0.0	301.4	3457.6	0.0	0.0	301.4	2957.4	9.8128
7.0%	0.0	5152.2	0.0	0.0	278.4	2777.0	0.0	0.0	278.4	2375.2	8.5321
10.0%	0.0	3894.4	0.0	0.0	256.7	2099.1	0.0	0.0	256.7	1795.4	6.9930

COMPARISON NO. 10

ALTERNATIVE NO. 21 2 VS 170 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	6414.9	0.0	0.0	323.0	3457.6	0.0	0.0	323.0	2957.4	9.1546
7.0%	0.0	5152.2	0.0	0.0	299.5	2777.0	0.0	0.0	299.5	2375.2	7.9312
10.0%	0.0	3894.4	0.0	0.0	278.1	2099.1	0.0	0.0	278.1	1795.4	6.4554

COMPARISON NO. 11

ALTERNATIVE NO. 21 2 VS 150 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	6414.9	0.0	0.0	320.5	3457.6	0.0	0.0	320.5	2957.4	9.2262
7.0%	0.0	5152.2	0.0	0.0	295.6	2777.0	0.0	0.0	295.6	2375.2	8.0344
10.0%	0.0	3894.4	0.0	0.0	272.3	2099.1	0.0	0.0	272.3	1795.4	6.5940

COMPARISON NO. 12

ALTERNATIVE NO. 21 2 VS 190 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	6414.9	0.0	0.0	339.6	3457.6	0.0	0.0	339.6	2957.4	8.7078
7.0%	0.0	5152.2	0.0	0.0	314.8	2777.0	0.0	0.0	314.8	2375.2	7.5448
10.0%	0.0	3894.4	0.0	0.0	292.4	2099.1	0.0	0.0	292.4	1795.4	6.1396

COMPARISON NO. 13

ALTERNATIVE NO. 31 2 VS 140 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	12651.7	0.0	0.0	437.7	6817.2	0.0	0.0	437.7	5834.5	13.3302
7.0%	0.0	10055.1	0.0	0.0	403.3	5416.1	0.0	0.0	403.3	4637.0	11.4962
10.0%	0.0	7487.8	0.0	0.0	371.2	4034.8	0.0	0.0	371.2	3453.0	9.3019

COMPARISON NO. 14

ALTERNATIVE NO. 31 2 VS 180 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	12651.7	0.C	0.0	448.5	6817.2	0.0	0.0	448.5	5834.5	13.0091
7.0%	0.0	10055.1	0.0	0.0	415.5	5418.1	0.0	0.0	415.5	4637.0	11.1603
10.0%	0.0	7487.8	0.C	0.0	385.6	4034.8	0.0	0.0	385.6	3453.0	8.9552

COMPARISON NO. 15

ALTERNATIVE NO. 31 2 VS 160 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	12651.7	0.0	0.0	462.4	6817.2	0.0	0.0	462.4	5834.5	12.6178
7.0%	0.0	10055.1	0.0	0.0	426.1	5418.1	0.0	0.0	426.1	4637.0	10.8834
10.0%	0.0	7487.8	0.0	0.0	392.2	4034.8	0.0	0.0	392.2	3453.0	8.8044

COMPARISON NO. 16

ALTERNATIVE NO. 31 2 VS 200 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	12651.7	0.0	0.0	470.9	6817.2	0.0	0.0	470.9	5834.5	12.3911
7.0%	0.0	10055.1	0.0	0.0	436.6	5418.1	0.0	0.0	436.6	4637.0	10.6210
10.0%	0.0	7487.8	0.0	0.0	405.7	4034.8	0.0	0.0	405.7	3453.0	8.5115

COMPARISON NO. 17

ALTERNATIVE NO. 81 2 VS 130 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4391.6	0.0	0.0	301.4	3457.6	0.0	0.0	301.4	934.0	3.0992
7.0%	0.0	3526.6	0.0	0.0	278.4	2777.0	0.0	0.0	278.4	749.6	2.6927
10.0%	0.0	2665.1	0.0	0.0	256.7	2099.1	0.0	0.0	256.7	566.0	2.2047

COMPARISON NO. 18

ALTERNATIVE NO. 81 2 VS 170 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4391.6	0.0	0.0	323.0	3457.6	0.0	0.0	323.0	934.0	2.8913
7.0%	0.0	3526.6	0.0	0.0	299.5	2777.0	0.0	0.0	299.5	749.6	2.5031
10.0%	0.0	2665.1	0.0	0.0	278.1	2099.1	0.0	0.0	278.1	566.0	2.0352

COMPARISON NO. 19

ALTERNATIVE NO. 81 2 VS 150 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4391.6	0.0	0.0	320.5	3457.6	0.0	0.0	320.5	934.0	2.9139
7.0%	0.0	3526.6	0.0	0.0	295.6	2777.0	0.0	0.0	295.6	749.6	2.5357
10.0%	0.0	2665.1	0.0	0.0	272.3	2099.1	0.0	0.0	272.3	566.0	2.0789

COMPARISON NO. 20

ALTERNATIVE NO. 81 2 VS 190 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4391.6	0.0	0.0	339.6	3457.6	0.0	0.0	339.6	934.0	2.7502
7.0%	0.0	3526.6	0.0	0.0	314.8	2777.0	0.0	0.0	314.8	749.6	2.3811
10.0%	0.0	2665.1	0.0	0.0	292.4	2099.1	0.0	0.0	292.4	566.0	1.9356

COMPARISON NO. 21

ALTERNATIVE NO. 91 2 VS 140 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	[illegible]	0.0	0.0	437.7	6517.2	0.0	0.0	437.7	1787.0	4.0828
7.0%	0.0	[illegible]	0.0	0.0	403.3	5418.1	0.0	0.0	403.3	1420.2	3.5210
10.0%	0.0	5092.[illegible]	0.0	0.0	371.2	4034.3	0.0	0.0	371.2	1057.5	2.8488

COMPARISON NO. 22

ALTERNATIVE NO. 91 2 VS 180 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8604.2	0.0	0.0	448.5	6817.2	0.0	0.0	448.5	1787.0	3.9844
7.0%	0.0	6838.3	0.0	0.0	415.5	5418.1	0.0	0.0	415.5	1420.2	3.4181
10.0%	0.0	5092.3	0.0	0.0	385.6	4034.8	0.0	0.0	385.6	1057.5	2.7426

COMPARISON NO. 23

ALTERNATIVE NO. 91 2 VS 160 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8604.2	0.0	0.0	462.4	6817.2	0.0	0.0	462.4	1787.0	3.8646
7.0%	0.0	6838.3	0.0	0.0	426.1	5418.1	0.0	0.0	426.1	1420.2	3.3333
10.0%	0.0	5092.3	0.0	0.0	392.2	4034.8	0.0	0.0	392.2	1057.5	2.6964

COMPARISON NO. 24

ALTERNATIVE NO. 91 2 VS 200 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8604.2	0.0	0.0	470.9	6817.2	0.0	0.0	470.9	1787.0	3.7951
7.0%	0.0	6838.3	0.0	0.0	436.6	5418.1	0.0	0.0	436.6	1420.2	3.2529
10.0%	0.0	5092.3	0.0	0.0	405.7	4034.8	0.0	0.0	405.7	1057.5	2.6067

COMPARISON NO. 25

ALTERNATIVE NO. 41 2 VS 50 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	409.5	4542.5	0.0	0.0	409.5	3882.5	9.4809
7.0%	0.0	6803.5	0.0	0.0	388.6	3668.3	0.0	0.0	388.6	3135.2	8.0671
10.0%	0.0	5181.8	0.0	0.0	372.4	2793.9	0.0	0.0	372.4	2387.9	6.4126

COMPARISON NO. 26

ALTERNATIVE NO. 41 2 VS 50 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	347.7	4542.5	0.0	0.0	347.7	3882.5	11.1650
7.0%	0.0	6803.5	0.0	0.0	322.4	3668.3	0.0	0.0	322.4	3135.2	9.7253
10.0%	0.0	5181.8	0.0	0.0	299.1	2793.9	0.0	0.0	299.1	2387.9	7.9837

COMPARISON NO. 27

ALTERNATIVE NO. 41 2 VS 210 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	378.1	4542.5	0.0	0.0	378.1	3882.5	10.2674
7.0%	0.0	6803.5	0.0	0.0	358.0	3668.3	0.0	0.0	358.0	3135.2	8.7580
10.0%	0.0	5181.8	0.0	0.0	340.7	2793.9	0.0	0.0	340.7	2387.9	7.0096

COMPARISON NO. 23

ALTERNATIVE NO. 41 2 VS 250 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8429.0	0.0	0.0	387.5	4542.5	0.0	0.0	387.5	3882.5	10.0191
7.0%	0.0	6503.5	0.0	0.0	369.0	3668.3	0.0	0.0	369.0	3135.2	8.4975
10.0%	0.0	5251.7	0.0	0.0	354.0	2793.9	0.0	0.0	354.0	2387.9	6.7448

COMPARISON NO. 29

ALTERNATIVE NO. 41 2 VS 290 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	372.4	5096.6	0.0	0.0	372.4	3328.4	8.9370
7.0%	0.0	6603.5	0.0	0.0	363.1	4115.2	0.0	0.0	363.1	2683.3	7.4027
10.0%	0.0	5181.8	0.0	0.0	361.8	3133.6	0.0	0.0	361.8	2048.0	5.6609

COMPARISON NO. 30

ALTERNATIVE NO. 1 21 VS 10 130

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	6414.9	220.6	1085.0	301.4	3457.6	532.0	3884.1	7.3015
7.0%	0.0	1652.0	0.0	5152.2	221.6	891.3	278.4	2777.0	500.0	3136.5	6.2730
10.0%	0.0	1288.4	0.0	3894.4	215.8	694.6	256.7	2099.1	472.6	2389.0	5.0554

COMPARISON NO. 51

ALTERNATIVE NO. 1 21 VS 10 170

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	6414.9	230.[illegible]	1085.0	323.0	3457.6	553.6	3884.1	7.0157
7.0%	0.0	1652.6	0.0	5152.2	221.6	891.3	299.5	2777.0	521.1	3136.6	6.0191
10.0%	0.0	1298.4	0.0	3394.4	215.8	694.8	278.1	2099.1	495.9	2389.0	4.8366

COMPARISON NO. 52

ALTERNATIVE NO. 41 2 VS 70 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	440.3	4542.5	0.0	0.0	440.3	3882.5	8.8170
7.0%	0.0	[illegible]	0.0	0.0	419.2	3666.3	0.0	0.0	419.2	3135.2	7.4782
10.0%	0.0	[illegible]	0.0	0.0	403.3	2793.9	0.0	0.0	403.3	2387.9	5.9217

COMPARISON NO. [illegible]

ALTERNATIVE NO. 41 2 VS 110 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	6415.0	0.0	0.0	378.1	4542.5	0.0	0.0	378.1	3882.5	10.2682
7.0%	0.0	[illegible]	0.0	0.0	350.0	3666.3	0.0	0.0	350.0	3135.2	8.9578
10.0%	0.0	5131.3	0.0	0.0	324.1	2793.9	0.0	0.0	324.1	2387.9	7.3675

COMPARISON NO. 34

ALTERNATIVE NO. 41 2 VS 230 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	408.1	4542.5	0.0	0.0	408.1	3882.5	9.5147
7.0%	0.0	6803.5	0.0	0.0	386.5	3668.3	0.0	0.0	386.5	3135.2	8.1125
10.0%	0.0	5181.8	0.0	0.0	368.0	2793.9	0.0	0.0	368.0	2387.9	6.4893

COMPARISON NO. 35

ALTERNATIVE NO. 41 2 VS 270 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	409.0	4542.5	0.0	0.0	409.0	3882.5	9.4934
7.0%	0.0	6803.5	0.0	0.0	390.4	3668.3	0.0	0.0	390.4	3135.2	8.0310
10.0%	0.0	5181.8	0.0	0.0	375.7	2793.9	0.0	0.0	375.7	2387.9	6.3556

COMPARISON NO. 36

ALTERNATIVE NO. 41 2 VS 310 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	8425.0	0.0	0.0	407.1	5096.6	0.0	0.0	407.1	3328.4	8.1751
7.0%	0.0	6803.5	0.0	0.0	398.4	4115.2	0.0	0.0	398.4	2688.3	6.7484
10.0%	0.0	5181.8	0.0	0.0	398.3	3133.8	0.0	0.0	398.3	2048.0	5.1425

COMPARISON NO. 37

ALTERNATIVE NO. 1 21 VS 30 150

	1 PC	1 SC	21 PC	21 SC	30 PC	30 SC	150 PC	150 SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	6414.9	252.9	1085.0	320.5	3457.6	573.5	3884.1	6.7730
7.0%	0.0	1652.6	0.0	5152.2	243.7	891.3	295.6	2777.0	539.3	3136.6	5.8162
10.0%	0.0	1288.4	0.0	3894.4	237.8	694.8	272.3	2099.1	510.1	2389.0	4.6836

COMPARISON NO. 38

ALTERNATIVE NO. 1 21 VS 30 190

	1 PC	1 SC	21 PC	21 SC	30 PC	30 SC	190 PC	190 SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2011.7	0.0	6414.9	252.9	1085.0	339.6	3457.6	592.5	3884.1	6.5549
7.0%	0.0	1652.6	0.0	5152.2	243.7	891.3	314.8	2777.0	558.5	3136.6	5.6164
10.0%	0.0	1288.4	0.0	3894.4	237.8	694.8	292.4	2099.1	530.2	2389.0	4.5056

COMPARISON NO. 39

ALTERNATIVE NO. 51 2 VS 60 [illegible]

	51 PC	51 SC	2 PC	2 SC	60 PC	60 SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	611.4	8747.2	0.0	0.0	611.4	7484.2	12.2410
7.0%	0.0	12900.1	0.0	0.0	572.1	6952.0	0.0	0.0	572.1	5948.1	10.3969
10.0%	0.0	9606.3	0.0	0.0	538.5	5177.0	0.0	0.0	538.5	4429.3	8.2247

COMPARISON NO. 40

ALTERNATIVE NO. 51 2 VS 100 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	534.7	8747.2	0.0	0.0	534.7	7484.2	13.9961
7.0%	0.0	12900.1	0.0	0.0	490.5	6952.0	0.0	0.0	490.5	5948.1	12.1277
10.0%	0.0	9606.3	0.0	0.0	449.1	5177.0	0.0	0.0	449.1	4429.3	9.8628

COMPARISON NO. 41

ALTERNATIVE NO. 51 2 VS 220 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	555.0	8747.2	0.0	0.0	555.0	7484.2	13.4850
7.0%	0.0	12900.1	0.0	0.0	510.3	6952.0	0.0	0.0	510.3	5948.1	11.6567
10.0%	0.0	9606.3	0.0	0.0	467.5	5177.0	0.0	0.0	467.5	4429.3	9.4745

COMPARISON NO. 42

ALTERNATIVE NO. 51 2 VS 260 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	565.2	8747.2	0.0	0.0	565.2	7484.2	13.2406
7.0%	0.0	12900.1	0.0	0.0	522.0	6952.0	0.0	0.0	522.0	5948.1	11.3939
10.0%	0.0	9606.3	0.0	0.0	481.5	5177.0	0.0	0.0	481.5	4429.3	9.1982

COMPARISON NO. 43

ALTERNATIVE NO. 51 2 VS 300 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1623[illegible]	0.0	0.0	463.9	9737.3	0.0	0.0	466.9	6494.0	13.8493
7.0%	0.0	12930.1	0.0	0.0	457.3	7738.9	0.0	0.0	457.3	5161.2	11.2856
10.0%	0.0	9600.3	0.0	0.0	455.5	5762.9	0.0	0.0	455.5	3843.4	8.4373

COMPARISON NO. 44

ALTERNATIVE NO. 11 31 VS 20 140

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3579.6	0.0	12651.7	236.9	1929.9	437.7	6817.2	674.5	7484.2	11.0952
7.0%	0.0	2845.0	0.0	10055.1	226.6	1533.8	405.3	5418.1	629.9	5948.1	9.4426
10.0%	0.0	2118.6	0.0	7487.3	219.5	1142.2	371.2	4034.8	590.7	4429.3	7.4988

COMPARISON NO. 45

ALTERNATIVE NO. 11 31 VS 20 130

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3579.6	0.0	12651.7	236.9	1929.9	448.5	6817.2	685.3	7484.2	10.9203
7.0%	0.0	2845.0	0.0	10055.1	226.6	1533.8	415.5	5416.1	642.1	5948.1	9.2640
10.0%	0.0	2118.6	0.0	7487.8	219.5	1142.2	385.6	4034.8	605.0	4429.3	7.3207

COMPARISON NO. 46

ALTERNATIVE NO. 51 2 VS 80 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	650.5	8747.2	0.0	0.0	650.5	7484.2	11.5047
7.0%	0.0	12900.1	0.0	0.0	610.5	6952.0	0.0	0.0	610.5	5948.1	9.7429
10.0%	0.0	9606.3	0.0	0.0	577.0	5177.0	0.0	0.0	577.0	4429.3	7.6762

COMPARISON NO. 47

ALTERNATIVE NO. 51 2 VS 120 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	573.5	8747.2	0.0	0.0	573.5	7484.2	13.0497
7.0%	0.0	12900.1	0.0	0.0	524.4	6952.0	0.0	0.0	524.4	5948.1	11.3422
10.0%	0.0	9606.3	0.0	0.0	478.7	5177.0	0.0	0.0	478.7	4429.3	9.2519

COMPARISON NO. 48

ALTERNATIVE NO. 51 2 VS 240 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	598.2	8747.2	0.0	0.0	598.2	7484.2	12.5111
7.0%	0.0	12900.1	0.0	0.0	550.1	6952.0	0.0	0.0	550.1	5948.1	10.8134
10.0%	0.0	9606.3	0.0	0.0	504.4	5177.0	0.0	0.0	504.4	4429.3	8.7807

COMPARISON NO. 49

ALTERNATIVE NO. 51 2 VS 280 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	595.0	8747.2	0.0	0.0	595.0	7484.2	12.5778
7.0%	0.0	12500.1	0.0	0.0	550.8	6952.0	0.0	0.0	550.8	5948.1	10.7999
10.0%	0.0	9606.3	0.0	0.0	509.7	5177.0	0.0	0.0	509.7	4429.3	8.6902

COMPARISON NO. 50

ALTERNATIVE NO. 51 2 VS 320 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	16231.3	0.0	0.0	505.8	9737.3	0.0	0.0	505.8	6494.0	12.8385
7.0%	0.0	12500.1	0.0	0.0	492.7	7738.9	0.0	0.0	492.7	5161.2	10.4758
10.0%	0.0	9606.3	0.0	0.0	489.8	5762.9	0.0	0.0	489.8	3843.4	7.8463

COMPARISON NO. 51

ALTERNATIVE NO. 11 31 VS 40 160

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3579.5	0.0	12651.7	258.5	1929.9	462.4	6817.2	720.9	7484.2	10.3822
7.0%	0.0	2845.0	0.0	10055.1	248.1	1533.8	426.1	5418.1	674.1	5948.1	8.8232
10.0%	0.0	2118.6	0.0	7487.3	241.1	1142.2	392.2	4034.8	633.3	4429.3	6.9939

COMPARISON NO. 52

ALTERNATIVE NO.	11		31		VS 40		200				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3579.6	0.0	12651.7	258.5	1929.9	470.9	6817.2	729.3	7484.2	10.2618
7.0%	0.0	2845.0	0.0	10055.1	248.1	1533.8	436.6	5418.1	684.7	5948.1	8.6876
10.0%	0.0	2116.6	0.0	7487.8	241.1	1142.2	405.7	4034.8	646.8	4429.3	6.8480

COMPARISON NO. 53

ALTERNATIVE NO.	101		2		VS 50		2				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	409.5	4542.5	0.0	0.0	409.5	1412.1	3.4482
7.0%	0.0	4810.0	0.0	0.0	388.6	3668.3	0.0	0.0	388.6	1141.7	2.9378
10.0%	0.0	3665.0	0.0	0.0	372.4	2793.9	0.0	0.0	372.4	871.2	2.3394

COMPARISON NO. 54

ALTERNATIVE NO.	101		2		VS 90		2				
	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	347.7	4542.5	0.0	0.0	347.7	1412.1	4.0607
7.0%	0.0	4810.0	0.0	0.0	322.4	3668.3	0.0	0.0	322.4	1141.7	3.5416
10.0%	0.0	3665.0	0.0	0.0	299.1	2793.9	0.0	0.0	299.1	871.2	2.9126

COMPARISON NO. 55

ALTERNATIVE NO. 101 2 VS 210 2

	101 PC	101 SC	2 PC	2 SC	210 PC	210 SC	2 PC	2 SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	378.1	4542.5	0.0	0.0	378.1	1412.1	3.7343
7.0%	0.0	4810.0	0.0	0.0	358.0	3668.3	0.0	0.0	358.0	1141.7	3.1893
10.0%	0.0	3665.0	0.0	0.0	340.7	2793.9	0.0	0.0	340.7	871.2	2.5572

COMPARISON NO. 56

ALTERNATIVE NO. 101 2 VS 250 2

	101 PC	101 SC	2 PC	2 SC	250 PC	250 SC	2 PC	2 SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	387.5	4542.5	0.0	0.0	387.5	1412.1	3.6439
7.0%	0.0	4810.0	0.0	0.0	369.0	3668.3	0.0	0.0	369.0	1141.7	3.0945
10.0%	0.0	3665.0	0.0	0.0	354.0	2793.9	0.0	0.0	354.0	871.2	2.4606

COMPARISON NO. 57

ALTERNATIVE NO. 101 2 VS 290 2

	101 PC	101 SC	2 PC	2 SC	290 PC	290 SC	2 PC	2 SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	372.4	5096.6	0.0	0.0	372.4	858.0	2.3038
7.0%	0.0	4810.0	0.0	0.0	363.1	4115.2	0.0	0.0	363.1	694.8	1.9132
10.0%	0.0	3665.0	0.0	0.0	361.8	3133.8	0.0	0.0	361.8	531.2	1.4684

COMPARISON NO. 58

ALTERNATIVE NO.	61		81		VS	10		130				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	4391.6		230.6	1085.0	301.4	3457.6	532.0	1412.1	2.6545
7.0%	0.0	1283.4	0.0	3526.6		221.6	691.3	278.4	2777.0	500.0	1141.8	2.2835
10.0%	0.0	999.9	0.0	2665.1		215.8	694.8	256.7	2099.1	472.6	871.2	1.8435

COMPARISON NO. 59

ALTERNATIVE NO.	61		81		VS	10		170				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	4391.6		230.6	1085.0	323.0	3457.6	553.6	1412.1	2.5506
7.0%	0.0	1283.4	0.0	3526.6		221.6	691.3	299.5	2777.0	521.1	1141.8	2.1911
10.0%	0.0	999.9	0.0	2665.1		215.8	694.8	278.1	2099.1	493.9	871.2	1.7637

COMPARISON NO. 60

ALTERNATIVE NO.	161		2		VS	70		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0		440.3	4542.5	0.0	0.0	440.3	1412.1	3.2067
7.0%	0.0	4810.0	0.0	0.0		419.2	3668.3	0.0	0.0	419.2	1141.7	2.7233
10.0%	0.0	3565.0	0.0	0.0		403.3	2793.9	0.0	0.0	403.3	871.2	2.1603

COMPARISON NO. 61

ALTERNATIVE NO. 101 2 VS 110 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	378.1	4542.5	0.0	0.0	378.1	1412.1	3.7345
7.0%	0.0	4810.0	0.0	0.0	350.0	3668.3	0.0	0.0	350.0	1141.7	3.2621
10.0%	0.0	3665.0	0.0	0.0	324.1	2793.9	0.0	0.0	324.1	871.2	2.6878

COMPARISON NO. 62

ALTERNATIVE NO. 101 2 VS 230 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	408.1	4542.5	0.0	0.0	408.1	1412.1	3.4605
7.0%	0.0	4810.0	0.0	0.0	386.5	3668.3	0.0	0.0	386.5	1141.7	2.9543
10.0%	0.0	3665.0	0.0	0.0	368.0	2793.9	0.0	0.0	368.0	871.2	2.3674

COMPARISON NO. 63

ALTERNATIVE NO. 101 2 VS 270 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	409.0	4542.5	0.0	0.0	409.0	1412.1	3.4527
7.0%	0.0	4810.0	0.0	0.0	390.4	3668.3	0.0	0.0	390.4	1141.7	2.9246
10.0%	0.0	3665.0	0.0	0.0	375.7	2793.9	0.0	0.0	375.7	871.2	2.3186

COMPARISON NO. 64

ALTERNATIVE NO. 10. 2 VS 310 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5954.6	0.0	0.0	407.1	5040.6	0.0	0.0	407.1	858.0	2.1074
7.0%	0.0	4610.0	0.0	0.0	398.4	4115.2	0.0	0.0	398.4	694.8	1.7441
10.0%	0.0	3635.0	0.0	0.0	398.3	3133.8	0.0	0.0	398.3	531.2	1.3339

COMPARISON NO. 65

ALTERNATIVE NO. 61 81 VS 30 150

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	4391.6	252.9	1085.0	320.5	3457.6	573.5	1412.1	2.4623
7.0%	0.0	1233.4	0.0	3526.6	243.7	891.3	295.6	2777.0	539.3	1141.8	2.1172
10.0%	0.0	[illegible]	0.0	2665.1	237.6	694.8	272.3	2099.1	510.1	871.2	1.7079

COMPARISON NO. 66

ALTERNATIVE NO. 61 81 VS 30 190

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1563.0	0.0	4391.6	252.9	1085.0	339.6	3457.6	592.5	1412.1	2.3830
7.0%	0.0	1233.4	0.0	3526.6	243.7	891.3	314.8	2777.0	558.5	1141.8	2.0444
10.0%	0.0	994.9	0.0	2665.1	237.6	694.8	292.4	2099.1	530.2	871.2	1.6430

COMPARISON NO. 67

ALTERNATIVE NO. 111 2 VS 60 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	611.4	8747.2	0.0	0.0	611.4	2620.4	4.2858
7.0%	0.0	9034.5	0.0	0.0	572.1	6952.0	0.0	0.0	572.1	2082.5	3.6401
10.0%	0.0	6727.7	0.0	0.0	538.5	5177.0	0.0	0.0	538.5	1550.7	2.8795

COMPARISON NO. 68

ALTERNATIVE NO. 111 2 VS 100 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	534.7	8747.2	0.0	0.0	534.7	2620.4	4.9003
7.0%	0.0	9034.5	0.0	0.0	490.5	6952.0	0.0	0.0	490.5	2082.5	4.2461
10.0%	0.0	6727.7	0.0	0.0	449.1	5177.0	0.0	0.0	449.1	1550.7	3.4530

COMPARISON NO. 69

ALTERNATIVE NO. 111 2 VS 220 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	555.0	8747.2	0.0	0.0	555.0	2620.4	4.7214
7.0%	0.0	9034.5	0.0	0.0	510.3	6952.0	0.0	0.0	510.3	2082.5	4.0812
10.0%	0.0	6727.7	0.0	0.0	467.5	5177.0	0.0	0.0	467.5	1550.7	3.3171

COMPARISON NO. 70

ALTERNATIVE NO. 111 2 VS 260 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	565.2	6747.2	0.0	0.0	565.2	2620.4	4.6358
7.0%	0.0	9034.5	0.0	0.0	522.0	6952.0	0.0	0.0	522.0	2082.5	3.9892
10.0%	0.0	6727.7	0.0	0.0	481.5	5177.0	0.0	0.0	481.5	1550.7	3.2203

COMPARISON NO. 71

ALTERNATIVE NO. 111 2 VS 300 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	468.9	9737.3	0.0	0.0	468.9	1630.2	3.4766
7.0%	0.0	9034.5	0.0	0.0	457.3	7738.9	0.0	0.0	457.3	1295.6	2.8331
10.0%	0.0	6727.7	0.0	0.0	455.5	5762.9	0.0	0.0	455.5	964.8	2.1180

COMPARISON NO. 72

ALTERNATIVE NO. 71 91 VS 20 140

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.3	0.0	8604.2	236.9	1929.9	437.7	6817.2	674.5	2620.4	3.8847
7.0%	0.0	2196.2	0.0	6838.3	226.6	1533.8	403.3	5418.1	629.9	2082.5	3.3060
10.0%	0.0	1635.4	0.0	5092.3	219.5	1142.2	371.2	4034.8	590.7	1550.7	2.6254

COMPARISON NO. 73

ALTERNATIVE NO. 71 91 VS 20 180

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.1	0.0	8604.2	236.9	1929.9	448.5	6817.2	685.3	2620.4	3.8234
7.0%	0.0	2156.7	0.0	6838.3	226.6	1533.8	415.5	5418.1	642.1	2082.5	3.2435
10.0%	0.0	1655.4	0.0	5092.3	219.5	1142.2	385.6	4034.8	605.0	1550.7	2.5630

COMPARISON NO. 74

ALTERNATIVE NO. 111 2 VS 80 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	650.5	8747.2	0.0	0.0	650.5	2620.4	4.0280
7.0%	0.0	9034.5	0.0	0.0	610.5	6952.0	0.0	0.0	610.5	2082.5	3.4111
10.0%	0.0	6727.7	0.0	0.0	577.0	5177.0	0.0	0.0	577.0	1550.7	2.6875

COMPARISON NO. 75

ALTERNATIVE NO. 111 2 VS 120 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	573.5	8747.2	0.0	0.0	573.5	2620.4	4.5690
7.0%	0.0	9034.5	0.0	0.0	524.4	6952.0	0.0	0.0	524.4	2082.5	3.9711
10.0%	0.0	6727.7	0.0	0.0	478.7	5177.0	0.0	0.0	478.7	1550.7	3.2392

COMPARISON NO. 76

ALTERNATIVE NO. 111 2 VS 240 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	598.2	8747.2	0.0	0.0	598.2	2620.4	4.3804
7.0%	0.0	9034.5	0.0	0.0	550.1	6952.0	0.0	0.0	550.1	2082.5	3.7860
10.0%	0.0	6727.7	0.0	0.0	504.4	5177.0	0.0	0.0	504.4	1550.7	3.0742

COMPARISON NO. 77

ALTERNATIVE NO. 111 2 VS 280 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	595.0	8747.2	0.0	0.0	595.0	2620.4	4.4037
7.0%	0.0	9034.5	0.0	0.0	550.8	6952.0	0.0	0.0	550.8	2082.5	3.7812
10.0%	0.0	6727.7	0.0	0.0	509.7	5177.0	0.0	0.0	509.7	1550.7	3.0425

COMPARISON NO. 78

ALTERNATIVE NO. 111 2 VS 320 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	11367.5	0.0	0.0	505.8	9737.3	0.0	0.0	505.8	1630.2	3.2229
7.0%	0.0	9034.5	0.0	0.0	492.7	7738.9	0.0	0.0	492.7	1295.6	2.6298
10.0%	0.0	6727.7	0.0	0.0	489.8	5762.9	0.0	0.0	489.8	964.8	1.9697

COMPARISON NO. 79

ALTERNATIVE NO.	71		91		VS	40		100				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.3	0.0	8604.2		258.5	1929.9	462.4	6817.2	720.9	2620.4	3.6350
7.0%	0.0	2196.[illegible]	0.0	6838.3		248.1	1533.6	426.1	5418.1	674.1	2082.5	3.0892
10.0%	0.0	1635.4	0.0	5092.3		241.1	1142.2	392.2	4034.8	633.3	1550.7	2.4486

COMPARISON NO. 80

ALTERNATIVE NO.	71		91		VS	40		200				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2763.3	0.0	8604.2		258.5	1929.9	470.9	6817.2	729.3	2620.4	3.5929
7.0%	0.0	2196.[illegible]	0.0	6338.3		248.1	1533.8	436.6	5418.1	684.7	2082.5	3.0417
10.0%	0.0	1635.4	0.0	5092.3		241.1	1142.2	405.7	4034.8	646.8	1550.7	2.3975

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PART II. GULF COAST OIL

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Series 1

ALTERNATIVE NO. 350
GIB,NEW ORLEANS,SERVING GULF COAST,FIXED BERTHS,ISLAND STORAGE,55 FT.DRAFT, 200,000 DWT,100-450 MTA.
TA.BARGES,(4-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	59.1				
1978	34.3				
1979	53.2				
1980	0.0	5.6	2.2	100.0	381.5
1981	0.0	5.6	2.2	117.5	448.3
1982	4.8	5.6	2.2	135.0	515.0
1983	50.2	5.9	2.3	152.5	581.8
1984	0.0	6.0	2.7	170.0	648.6
1985	0.0	6.0	2.7	187.5	715.3
1986	0.0	6.0	2.7	205.0	782.1
1987	4.8	6.0	2.7	222.5	848.9
1988	0.0	6.2	2.7	240.0	915.6
1989	54.6	6.2	2.7	257.5	982.4
1990	0.0	6.3	3.1	275.0	1049.1
1991	0.0	6.3	3.1	292.5	1115.9
1992	4.8	6.3	3.1	310.0	1182.7
1993	0.0	7.5	3.2	327.5	1249.4
1994	0.0	7.5	3.2	345.0	1316.2
1995	35.1	7.5	3.2	362.5	1383.0
1996	0.0	10.1	3.6	380.0	1449.7
1997	0.0	10.1	3.6	397.5	1516.5
1998	0.0	10.1	3.6	415.0	1583.3
1999	0.0	10.1	3.6	432.5	1650.0
2000	0.0	10.1	3.6	450.0	1716.8
2001	0.0	10.1	3.6	450.0	1716.8
2002	0.0	10.1	3.6	450.0	1716.8
2003	0.0	10.1	3.6	450.0	1716.8
2004	0.0	10.1	3.6	450.0	1716.8
2005	0.0	10.1	3.6	450.0	1716.8
2006	0.0	10.1	3.6	450.0	1716.8
2007	0.0	10.1	3.6	450.0	1716.8
2008	0.0	10.1	3.6	450.0	1716.8
2009	0.0	10.1	3.6	450.0	1716.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	329.3	118.1	47.6	TOTAL	494.9	17142.7
7.0%	333.7	92.8	38.1	TOTAL	465.6	13195.9
10.0%	345.2	69.9	28.7	TOTAL	443.9	9366.8

ALTERNATIVE NO. 340
GIS,NEW ORLEANS,SERVING GULF COAST,FIXED BERTHS,ISLAND STORAGE,55 FT.DRAFT, 200,000 DWT,150-600 MTA,
TR.BARGES,(4-I-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	64.9				
1978	47.1				
1979	75.4				
1980	0.0	6.0	2.7	150.0	572.3
1981	0.0	6.0	2.7	172.5	658.1
1982	0.0	6.0	2.7	195.0	744.0
1983	0.0	6.0	2.7	217.5	829.8
1984	4.8	6.0	2.7	240.0	915.6
1985	34.6	6.2	2.7	262.5	1001.5
1986	0.0	6.3	3.1	235.0	1087.3
1987	4.8	7.5	3.1	307.5	1173.1
1988	0.0	7.5	3.2	330.0	1259.0
1989	35.1	10.1	3.2	352.5	1344.8
1990	0.0	10.1	3.6	375.0	1430.6
1991	4.8	10.3	3.6	397.5	1516.5
1992	0.0	10.3	3.7	420.0	1602.3
1993	36.2	10.4	3.7	442.5	1688.2
1994	0.0	10.4	4.2	465.0	1774.0
1995	4.8	10.7	4.2	487.5	1859.8
1996	0.0	10.7	4.2	510.0	1945.7
1997	0.0	10.7	4.2	532.5	2031.5
1998	19.6	10.7	4.2	555.0	2117.3
1999	0.0	10.7	4.5	577.5	2203.2
2000	0.0	10.7	4.5	600.0	2289.0
2001	0.0	10.7	4.5	600.0	2289.0
2002	0.0	10.7	4.5	600.0	2289.0
2003	0.0	10.7	4.5	600.0	2289.0
2004	0.0	10.7	4.5	600.0	2289.0
2005	0.0	10.7	4.5	600.0	2289.0
2006	0.0	10.7	4.5	600.0	2289.0
2007	0.0	10.7	4.5	600.0	2289.0
2008	0.0	10.7	4.5	600.0	2289.0
2009	0.0	10.7	4.5	600.0	2289.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	537.2	138.6	56.6	TOTAL	582.4	23360.1
7.0%	388.9	110.2	45.2	TOTAL	544.4	18051.6
10.0%	398.1	82.0	33.9	TOTAL	514.0	12890.8

ALTERNATIVE NO. 350
GIB,NEW ORLEANS,SERVING GULF COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.DRAFT, 300,000 DWT,100-450 MTA,
TR.BARGES,(4-2-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	38.4				
1978	45.9				
1979	65.4				
1980	0.0	5.6	2.6	100.0	344.0
1981	0.0	5.6	2.6	117.5	404.2
1982	4.8	5.6	2.6	135.0	464.4
1983	0.0	5.8	2.6	152.5	524.6
1984	0.0	5.6	2.6	170.0	584.8
1985	0.0	5.8	2.6	187.5	645.0
1986	20.3	5.8	2.6	205.0	705.2
1987	4.8	5.9	2.9	222.5	765.4
1988	0.0	6.1	2.9	240.0	825.6
1989	0.0	6.1	2.9	257.5	885.8
1990	17.7	6.1	2.9	275.0	946.0
1991	0.0	6.2	3.2	292.5	1006.2
1992	4.8	6.2	3.2	310.0	1066.4
1993	0.0	7.4	3.2	327.5	1126.6
1994	25.5	7.4	3.2	345.0	1186.8
1995	0.0	7.5	3.5	362.5	1247.0
1996	0.0	7.5	3.5	380.0	1307.2
1997	21.0	7.5	3.5	397.5	1367.4
1998	0.0	7.5	3.8	415.0	1427.6
1999	0.0	7.5	3.8	432.5	1487.8
2000	0.0	7.5	3.8	450.0	1548.0
2001	0.0	7.5	3.8	450.0	1548.0
2002	0.0	7.5	3.8	450.0	1548.0
2003	0.0	7.5	3.8	450.0	1548.0
2004	0.0	7.5	3.8	450.0	1548.0
2005	0.0	7.5	3.8	450.0	1548.0
2006	0.0	7.5	3.8	450.0	1548.0
2007	0.0	7.5	3.8	450.0	1548.0
2008	0.0	7.5	3.8	450.0	1548.0
2009	0.0	7.5	3.8	450.0	1548.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	336.7	104.7	49.9	TOTAL	491.4	15457.3
7.0%	341.9	84.7	40.2	TOTAL	466.7	11898.5
10.0%	355.0	64.6	30.4	TOTAL	450.1	8445.9

ALTERNATIVE NO. 560
[illegible], NEW ORLEANS, SERVING GULF COAST, FIXED BERTHS, ISLAND STORAGE, 70 FT. DRAFT, 300,000DWT, 150-600 MTA, T
[illegible], (4-2-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	62.6				
1978	45.9				
1979	70.2				
1980	0.0	5.8	2.6	150.0	516.0
1981	0.0	5.6	2.6	172.5	593.4
1982	20.3	5.7	2.6	195.0	670.8
1983	0.0	5.9	2.9	217.5	748.2
1984	4.3	5.9	2.9	240.0	825.6
1985	17.7	6.1	2.9	262.5	903.0
1986	0.0	6.2	3.1	285.0	980.4
1987	4.[illegible]	6.2	3.1	307.5	1057.8
1988	25.5	7.4	3.2	330.0	1135.2
1989	0.0	7.5	3.5	352.5	1212.6
1990	0.0	7.5	3.5	375.0	1290.0
1991	25.3	7.5	3.5	397.5	1367.4
1992	0.0	7.7	3.8	420.0	1444.3
1993	0.0	7.7	3.8	442.5	1522.2
1994	25.5	7.7	3.8	465.0	1599.6
1995	4.8	10.2	4.2	487.5	1677.0
1996	20.0	10.5	4.2	510.0	1754.4
1997	0.0	10.5	4.5	532.5	1831.8
1998	0.0	10.5	4.5	555.0	1909.2
1999	0.0	10.5	4.5	577.5	1986.6
2000	0.0	10.5	4.5	600.0	2064.0
2001	0.0	10.5	4.5	600.0	2064.0
2002	0.0	10.5	4.5	600.0	2064.0
2003	0.0	10.5	4.5	600.0	2064.0
2004	0.0	10.5	4.5	600.0	2064.0
2005	0.0	10.5	4.5	600.0	2064.0
2006	0.0	10.5	4.5	600.0	2064.0
2007	0.0	10.5	4.5	600.0	2064.0
2008	0.0	10.5	4.5	600.0	2064.0
2009	0.0	10.5	4.5	600.0	2064.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	334.6	126.3	57.1	TOTAL	568.0	21063.5
7.0%	300.4	100.3	45.6	TOTAL	532.3	16276.9
10.0%	295.6	74.6	34.2	TOTAL	504.4	11623.4

ALTERNATIVE NO. 370
GIG, NEW ORLEANS, SERVING GULF COAST, FIXED BERTHS, ISLAND STORAGE, 70 FT. DRAFT, 400,000 DWT, 100-450 MTA,
TF. BARGES, (4-2-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	56.7				
1976	56.7				
1977	54.5				
1978	57.1				
1979	75.5				
1980	0.0	5.6	2.9	100.0	344.0
1981	0.0	5.6	2.9	117.5	404.2
1982	4.8	5.6	2.9	135.0	464.4
1983	0.0	5.8	2.9	152.5	524.6
1984	0.0	5.8	2.9	170.0	584.8
1985	0.0	5.8	2.9	187.5	645.0
1986	0.0	5.8	2.9	205.0	705.2
1987	4.8	5.8	2.9	222.5	765.4
1988	26.5	6.1	3.0	240.0	825.6
1989	0.0	6.1	3.3	257.5	885.8
1990	0.0	6.1	3.3	275.0	946.0
1991	0.0	6.1	3.3	292.5	1006.2
1992	4.8	6.1	3.3	310.0	1066.4
1993	23.5	7.3	3.4	327.5	1126.6
1994	0.0	7.4	3.7	345.0	1186.8
1995	0.0	7.4	3.7	362.5	1247.0
1996	0.0	7.4	3.7	380.0	1307.2
1997	5.0	7.4	3.7	397.5	1367.4
1998	0.0	7.5	4.1	415.0	1427.6
1999	0.0	7.5	4.1	432.5	1487.8
2000	0.0	7.5	4.1	450.0	1548.0
2001	0.0	7.5	4.1	450.0	1548.0
2002	0.0	7.5	4.1	450.0	1548.0
2003	0.0	7.5	4.1	450.0	1548.0
2004	0.0	7.5	4.1	450.0	1548.0
2005	0.0	7.5	4.1	450.0	1548.0
2006	0.0	7.5	4.1	450.0	1548.0
2007	0.0	7.5	4.1	450.0	1548.0
2008	0.0	7.5	4.1	450.0	1548.0
2009	0.0	7.5	4.1	450.0	1548.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	[illegible]	104.3	[illegible]	TOTAL	516.7	15457.3
7.0%	364.2	84.4	43.7	TOTAL	492.2	11898.5
10.0%	276.7	64.4	33.2	TOTAL	476.3	8445.9

ALTERNATIVE NO. 380
GIE,NEW ORLEANS,SERVING GULF COAST,FIXED BERTHS,ISLAND STORAGE,70 FT.CRAFT, 400,000 DWT,150-600 MTA,
TN.BARGES,(4-C-D).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	64.9				
1978	57.1				
1979	51.4				
1980	0.0	5.8	2.9	150.0	516.0
1981	0.0	5.8	2.9	172.5	593.4
1982	0.0	5.8	2.9	195.0	670.8
1983	0.0	5.6	2.9	217.5	748.2
1984	31.4	5.6	2.9	240.0	825.6
1985	0.0	6.1	3.3	262.5	903.0
1986	0.0	6.1	3.3	285.0	980.4
1987	28.3	6.1	3.3	307.5	1057.8
1988	0.0	7.4	3.7	330.0	1135.2
1989	0.0	7.4	3.7	352.5	1212.6
1990	31.0	7.4	3.7	375.0	1290.0
1991	4.6	7.5	4.1	397.5	1367.4
1992	0.0	7.7	4.2	420.0	1444.8
1993	0.0	7.7	4.2	442.5	1522.2
1994	25.8	7.7	4.2	465.0	1599.6
1995	4.8	7.7	4.5	487.5	1677.0
1996	10.0	8.0	4.5	510.0	1754.4
1997	32.6	8.0	4.5	532.5	1831.8
1998	0.0	10.5	5.0	555.0	1909.2
1999	0.0	10.5	5.0	577.5	1986.6
2000	0.0	10.5	5.0	600.0	2064.0
2001	0.0	10.5	5.0	600.0	2064.0
2002	0.0	10.5	5.0	600.0	2064.0
2003	0.0	10.5	5.0	600.0	2064.0
2004	0.0	10.5	5.0	600.0	2064.0
2005	0.0	10.5	5.0	600.0	2064.0
2006	0.0	10.5	5.0	600.0	2064.0
2007	0.0	10.5	5.0	600.0	2064.0
2008	0.0	10.5	5.0	600.0	2064.0
2009	0.0	10.5	5.0	600.0	2064.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	412.3	122.5	62.3	TOTAL	597.2	21063.5
7.0%	413.2	97.4	49.7	TOTAL	560.3	16276.9
10.0%	421.8	72.7	37.2	TOTAL	531.7	11623.4

ALTERNATIVE NO. 39C
GIB,NEW ORLEANS,SERVING GULF COAST,FIXED BERTHS,ISLAND STORAGE,95 FT.DRAFT, 500,000 DWT,100-450 MTA,
TR.BARGES,(4-3-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	36.7				
1976	36.7				
1977	59.5				
1978	51.3				
1979	66.4				
1980	0.0	5.6	3.0	100.0	319.0
1981	0.0	5.6	3.0	117.5	374.8
1982	4.3	5.6	3.0	135.0	430.6
1983	0.0	5.8	3.0	152.5	486.5
1984	25.6	5.8	3.0	170.0	542.3
1985	0.0	5.8	3.4	187.5	598.1
1986	0.0	5.8	3.4	205.0	653.9
1987	4.3	5.8	3.4	222.5	709.8
1988	0.0	6.1	3.4	240.0	765.6
1989	29.8	6.1	3.4	257.5	821.4
1990	0.0	6.1	3.8	275.0	877.2
1991	0.0	6.1	3.8	292.5	933.1
1992	4.6	6.1	3.8	310.0	988.9
1993	23.5	7.3	3.9	327.5	1044.7
1994	0.0	7.4	4.2	345.0	1100.5
1995	0.0	7.4	4.2	362.5	1156.4
1996	0.0	7.4	4.2	380.0	1212.2
1997	0.0	7.4	4.2	397.5	1268.0
1998	36.3	7.4	4.2	415.0	1323.8
1999	0.0	7.5	4.7	432.5	1379.7
2000	0.0	7.5	4.7	450.0	1435.5
2001	0.0	7.5	4.7	450.0	1435.5
2002	0.0	7.5	4.7	450.0	1435.5
2003	0.0	7.5	4.7	450.0	1435.5
2004	0.0	7.5	4.7	450.0	1435.5
2005	0.0	7.5	4.7	450.0	1435.5
2006	0.0	7.5	4.7	450.0	1435.5
2007	0.0	7.5	4.7	450.0	1435.5
2008	0.0	7.5	4.7	450.0	1435.5
2009	0.0	7.5	4.7	450.0	1435.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	367.1	104.3	60.4	TOTAL	531.8	14333.9
7.0%	370.1	84.3	48.4	TOTAL	502.8	11033.8
10.0%	380.9	64.4	36.6	TOTAL	481.8	7832.1

ALT [illegible] 400
[illegible] VING GULF COAST, FIXED BERTHS, ISLAND STORAGE, 95 FT. DRAFT, 500,000 DWT, 150-600 MTA,
T[illegible] (4-[illegible]).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	30.7				
1976	36.7				
1977	64.4				
1978	63.0				
1979	87.4				
1980	0.0	5.8	3.1	150.0	478.5
1981	0.0	5.3	3.1	172.5	550.3
1982	0.0	5.8	3.1	195.0	622.0
1983	0.0	5.8	3.1	217.5	693.8
1984	54.5	5.8	3.3	240.0	765.6
1985	0.0	6.1	3.6	262.5	837.4
1986	0.0	6.1	3.6	285.0	909.1
1987	4.8	6.1	3.6	307.5	980.9
1988	23.5	7.3	3.6	330.0	1052.7
1989	0.0	7.4	3.9	352.5	1124.5
1990	0.0	7.4	3.9	375.0	1196.2
1991	4.3	7.4	3.9	397.5	1268.0
1992	36.[illegible]	7.6	3.9	420.0	1339.8
1993	0.0	7.6	4.5	442.5	1411.6
1994	0.0	7.6	4.5	465.0	1483.3
1995	51.4	7.6	4.5	487.5	1555.1
1996	0.0	7.[illegible]	4.9	510.0	1626.9
1997	0.0	7.5	4.9	532.5	1698.7
1998	35.[illegible]	7.[illegible]	4.9	555.0	1770.4
1999	0.0	10.4	5.4	577.5	1842.2
2000	0.0	10.4	5.4	600.0	1914.0
2001	0.0	10.4	5.4	600.0	1914.0
2002	0.0	10.4	5.4	600.0	1914.0
2003	0.0	10.4	5.4	600.0	1914.0
2004	0.0	10.4	5.4	600.0	1914.0
2005	0.0	10.4	5.4	600.0	1914.0
2006	0.0	10.4	5.4	600.0	1914.0
2007	0.0	10.4	5.4	600.0	1914.0
2008	0.0	10.4	5.4	600.0	1914.0
2009	0.0	10.4	5.4	600.0	1914.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	42[illegible]	120.6	66.[illegible]	TOTAL	614.6	19532.7
7.0%	427.[illegible]	[illegible].0	52.[illegible]	TOTAL	576.2	15094.0
10.0%	435.[illegible]	71.5	39.4	TOTAL	546.4	10778.7

ALTERNATIVE NO. 41C
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,55 FT.DRAFT,200,000 DWT,100-450 MTA,TR.PIPE LINE,BARGES,(5-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	76.4				
1978	81.6				
1979	166.5				
1980	338.0	8.7	3.1	100.0	368.0
1981	397.2	8.7	3.1	117.5	455.9
1982	456.3	8.7	3.1	135.0	523.8
1983	515.5	9.9	3.2	152.5	591.7
1984	574.6	12.7	3.9	170.0	659.6
1985	633.8	12.7	3.9	187.5	727.5
1986	692.9	13.1	4.0	205.0	795.4
1987	752.1	15.7	4.7	222.5	863.3
1988	811.2	16.1	4.7	240.0	931.2
1989	870.4	16.1	4.7	257.5	999.1
1990	929.5	19.6	5.5	275.0	1067.0
1991	988.7	20.8	5.6	292.5	1134.9
1992	1047.8	21.4	5.7	310.0	1202.8
1993	1107.0	22.1	6.3	327.5	1270.7
1994	1166.1	26.4	6.7	345.0	1338.6
1995	1225.3	26.6	6.7	362.5	1406.5
1996	1284.4	27.1	7.3	380.0	1474.4
1997	1343.6	27.9	7.3	397.5	1542.3
1998	1402.7	27.0	7.4	415.0	1610.2
1999	1461.9	30.2	8.0	432.5	1678.1
2000	1521.0	30.2	8.0	450.0	1746.0
2001	1521.0	30.2	8.0	450.0	1746.0
2002	1521.0	30.2	8.0	450.0	1746.0
2003	1521.0	30.2	8.0	450.0	1746.0
2004	1521.0	30.2	8.0	450.0	1746.0
2005	1521.0	30.2	8.0	450.0	1746.0
2006	1521.0	30.2	8.0	450.0	1746.0
2007	1521.0	30.2	8.0	450.0	1746.0
2008	1521.0	30.2	8.0	450.0	1746.0
2009	1521.0	30.2	8.0	450.0	1746.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	15187.4	310.9	87.4	TOTAL	955.8	17434.4
7.0%	11690.6	239.9	68.3	TOTAL	849.3	13420.4
10.0%	8298.1	170.9	49.6	TOTAL	747.3	9526.2

ALTERNATIVE NO. 420
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,55 FT.DRAFT,200,000 DWT,150-600 MTA,TR.PIPE
LINE,BARGES,(5-1-8).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	73.7				
1978	108.0				
1979	221.3				
1980	507.0	11.3	3.9	150.0	582.0
1981	583.1	11.3	3.9	172.5	669.3
1982	659.1	11.3	3.9	195.0	756.6
1983	735.2	11.4	4.0	217.5	843.9
1984	811.2	17.7	5.3	240.0	931.2
1985	887.3	17.7	5.3	262.5	1018.5
1986	963.3	17.9	5.4	285.0	1105.8
1987	1039.4	20.7	5.6	307.5	1193.1
1988	1115.4	22.5	6.8	330.0	1280.4
1989	1191.5	23.4	6.9	352.5	1367.7
1990	1267.5	23.8	7.0	375.0	1455.0
1991	1343.6	24.2	7.0	397.5	1542.3
1992	1419.6	25.8	8.2	420.0	1629.6
1993	1495.7	27.4	8.3	442.5	1716.9
1994	1571.7	29.1	8.5	465.0	1804.2
1995	1647.8	30.5	8.6	487.5	1891.5
1996	1723.8	32.1	9.7	510.0	1978.8
1997	1799.9	32.9	9.9	532.5	2066.1
1998	1875.9	33.5	9.9	555.0	2153.4
1999	1952.0	34.9	10.1	577.5	2240.7
2000	2028.0	34.9	10.1	600.0	2328.0
2001	2028.0	34.9	10.1	600.0	2328.0
2002	2028.0	34.9	10.1	600.0	2328.0
2003	2028.0	34.9	10.1	600.0	2328.0
2004	2028.0	34.9	10.1	600.0	2328.0
2005	2028.0	34.9	10.1	600.0	2328.0
2006	2028.0	34.9	10.1	600.0	2328.0
2007	2028.0	34.9	10.1	600.0	2326.0
2008	2028.0	34.9	10.1	600.0	2328.0
2009	2028.0	34.9	10.1	600.0	2328.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	20695.6	379.4	113.7	TOTAL	1206.6	23757.7
7.0%	15992.6	295.2	89.0	TOTAL	1072.6	18358.8
10.0%	11420.2	212.6	64.7	TOTAL	941.6	13110.1

ALTERNATIVE NO. 430
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,70 FT.DRAFT,300,000 DWT,100-450 MTA,TR.PIPE LINE,BARGES,(5-2-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	60.1				
1978	88.3				
1979	179.8				
1980	0.0	9.2	3.1	100.0	298.5
1981	0.0	9.2	3.1	117.5	350.7
1982	62.5	9.2	3.1	135.0	403.0
1983	7.7	11.1	3.8	152.5	455.2
1984	0.0	13.4	4.0	170.0	507.5
1985	1.4	13.4	4.0	187.5	559.7
1986	70.0	13.8	4.0	205.0	611.9
1987	1.2	16.7	4.8	222.5	664.2
1988	0.0	17.1	4.9	240.0	716.4
1989	9.3	17.1	4.9	257.5	768.7
1990	61.4	19.5	5.1	275.0	820.9
1991	2.0	21.5	5.8	292.5	873.1
1992	0.3	22.0	5.9	310.0	925.4
1993	38.4	22.3	5.9	327.5	977.6
1994	30.9	26.6	6.3	345.0	1029.9
1995	0.0	27.6	7.0	362.5	1082.1
1996	2.0	27.6	7.0	380.0	1134.3
1997	34.5	23.4	7.1	397.5	1186.6
1998	2.6	30.2	7.9	415.0	1238.8
1999	0.0	30.9	7.9	432.5	1291.1
2000	0.0	30.9	7.9	450.0	1343.3
2001	0.0	30.9	7.9	450.0	1343.3
2002	0.0	30.9	7.9	450.0	1343.3
2003	0.0	30.9	7.9	450.0	1343.3
2004	0.0	30.9	7.9	450.0	1343.3
2005	0.0	30.9	7.9	450.0	1343.3
2006	0.0	30.9	7.9	450.0	1343.3
2007	0.0	30.9	7.9	450.0	1343.3
2008	0.0	30.9	7.9	450.0	1343.3
2009	0.0	30.9	7.9	450.0	1343.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	571.9	321.7	87.8	TOTAL	981.4	13413.2
7.0%	554.5	248.8	68.8	TOTAL	872.1	10325.0
10.0%	538.8	177.9	50.1	TOTAL	766.8	7329.0

ALTERNATIVE NO. 440
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,70 FT.DRAFT,300,000 DWT,150-600 MTA,TR.PIPE LINE,BARGES,(5-2-b).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	73.7				
1978	109.0				
1979	224.2				
1980	0.0	12.0	4.0	150.0	447.8
1981	0.0	12.0	4.0	172.5	515.0
1982	25.4	12.0	4.0	195.0	582.1
1983	34.0	12.9	4.6	217.5	649.3
1984	0.0	17.6	4.9	240.0	716.4
1985	29.2	17.6	4.9	262.5	783.6
1986	99.7	18.5	5.6	285.0	850.8
1987	3.2	21.4	5.9	307.5	917.9
1988	55.2	22.2	5.9	330.0	985.1
1989	1.6	23.8	6.7	352.5	1052.2
1990	1.2	24.3	6.7	375.0	1119.4
1991	33.2	24.7	6.8	397.5	1186.6
1992	35.2	26.1	7.5	420.0	1253.7
1993	6.3	27.8	7.7	442.5	1320.9
1994	57.2	29.4	7.8	465.0	1388.0
1995	0.0	32.2	8.7	487.5	1455.2
1996	35.0	32.9	8.7	510.0	1522.4
1997	1.6	34.5	9.5	532.5	1589.5
1998	5.6	35.1	9.5	555.0	1656.7
1999	0.0	36.5	9.6	577.5	1723.3
2000	0.0	36.5	9.6	600.0	1791.0
2001	0.0	36.5	9.6	600.0	1791.0
2002	0.0	36.5	9.6	600.0	1791.0
2003	0.0	36.5	9.6	600.0	1791.0
2004	0.0	36.5	9.6	600.0	1791.0
2005	0.0	36.5	9.6	600.0	1791.0
2006	0.0	36.5	9.6	600.0	1791.0
2007	0.0	36.5	9.6	600.0	1791.0
2008	0.0	36.5	9.6	600.0	1791.0
2009	0.0	36.5	9.6	600.0	1791.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	722.3	392.8	109.7	TOTAL	1224.7	18277.9
7.0%	693.0	305.4	86.1	TOTAL	1089.5	14124.3
10.0%	674.8	220.1	63.0	TOTAL	957.9	10086.3

ALTERNATIVE NO. 450
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,70 FT.DRAFT,400,000 DWT,100-450 MTA,TR.PIPE
LINES,BARGES,(5-2-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	60.1				
1978	95.5				
1979	185.1				
1980	0.0	9.2	3.4	100.0	298.5
1981	0.0	9.2	3.4	117.5	350.7
1982	33.3	9.2	3.4	135.0	403.0
1983	39.7	10.3	3.5	152.5	455.2
1984	0.0	13.4	4.4	170.0	507.5
1985	2.4	13.4	4.4	187.5	559.7
1986	44.0	[illegible]	4.5	205.0	611.9
1987	1.2	15.9	4.6	222.5	664.2
1988	26.1	16.4	4.7	240.0	716.4
1989	9.3	17.1	5.4	257.5	768.7
1990	34.0	[illegible]	5.6	275.0	820.9
1991	1.6	20.8	5.7	292.5	873.1
1992	0.3	21.3	5.8	310.0	925.4
1993	70.2	21.6	5.8	327.5	977.6
1994	0.7	26.6	7.0	345.0	1029.9
1995	[illegible]	[illegible]	7.0	362.5	1082.1
1996	[illegible]	[illegible]	7.0	380.0	1134.3
1997	36.3	27.6	7.1	397.5	1186.6
1998	2.6	29.5	7.9	415.0	1238.8
1999	0.0	30.2	8.0	432.5	1291.1
2000	0.0	30.2	8.0	450.0	1343.3
2001	0.0	30.2	8.0	450.0	1343.3
2002	0.0	30.2	8.0	450.0	1343.3
2003	0.0	30.2	8.0	450.0	1343.3
2004	0.0	30.2	8.0	450.0	1343.3
2005	0.0	30.2	8.0	450.0	1343.3
2006	0.0	30.2	8.0	450.0	1343.3
2007	0.0	30.2	8.0	450.0	1343.3
2008	0.0	30.2	8.0	450.0	1343.3
2009	0.0	30.2	8.0	450.0	1343.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	570.5	315.0	90.3	TOTAL	975.7	13413.2
7.0%	554.6	243.8	70.9	TOTAL	869.3	10325.0
10.0%	540.9	174.4	51.9	TOTAL	767.3	7329.0

ALTERNATIVE NO. 460
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,70 FT.DRAFT,400,000 DWT,150-600 MTA,TR.PIPE LINE,BARGES,(5-2-D).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	73.7				
1978	115.6				
1979	230.9				
1980	0.0	12.0	4.4	150.0	447.8
1981	0.0	12.0	4.4	172.5	515.0
1982	0.4	12.0	4.4	195.0	582.1
1983	34.0	12.1	4.4	217.5	649.3
1984	28.1	16.8	4.7	240.0	716.4
1985	0.8	17.6	5.5	262.5	783.6
1986	99.7	17.8	5.5	285.0	850.8
1987	36.0	20.6	5.8	307.5	917.9
1988	25.0	22.2	6.6	330.0	985.1
1989	1.6	23.1	6.7	352.5	1052.2
1990	33.7	23.5	6.7	375.0	1119.4
1991	2.5	24.7	7.5	397.5	1186.6
1992	35.2	25.3	7.6	420.0	1253.7
1993	6.3	27.0	7.8	442.5	1320.9
1994	61.1	28.6	7.9	465.0	1388.0
1995	0.0	30.3	8.9	487.5	1455.2
1996	5.3	31.5	8.9	510.0	1522.4
1997	35.7	32.3	9.0	532.5	1589.5
1998	5.6	34.3	9.8	555.0	1656.7
1999	0.0	35.7	10.0	577.5	1723.8
2000	0.0	35.7	10.0	600.0	1791.0
2001	0.0	35.7	10.0	600.0	1791.0
2002	0.0	35.7	10.0	600.0	1791.0
2003	0.0	35.7	10.0	600.0	1791.0
2004	0.0	35.7	10.0	600.0	1791.0
2005	0.0	35.7	10.0	600.0	1791.0
2006	0.0	35.7	10.0	600.0	1791.0
2007	0.0	35.7	10.0	600.0	1791.0
2008	0.0	35.7	10.0	600.0	1791.0
2009	0.0	35.7	10.0	600.0	1791.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	722.9	382.7	113.3	TOTAL	1219.0	18277.9
7.0%	699.1	297.7	89.0	TOTAL	1085.9	14124.3
10.0%	676.8	214.7	65.2	TOTAL	956.8	10086.3

ALTERNATIVE NO. 470
FREEPORT,TX.,SERVING GULF COAST,MONO-BUOYS,SHORE STORAGE,95 FT.DRAFT,500,000 DWT,100-450 MTA,TR.PIPE
LINE,BARGES,(5-3-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	60.1				
1978	94.5				
1979	207.6				
1980	0.0	10.3	3.7	100.0	272.5
1981	0.0	10.3	3.7	117.5	320.2
1982	33.3	10.3	3.7	135.0	367.9
1983	7.7	11.4	3.8	152.5	415.6
1984	39.6	13.8	4.0	170.0	463.3
1985	1.4	15.0	4.9	187.5	510.9
1986	44.0	15.4	4.5	205.0	558.6
1987	1.2	17.5	5.1	222.5	606.3
1988	0.0	17.9	5.1	240.0	654.0
1989	45.9	17.9	5.1	257.5	701.7
1990	34.0	21.5	6.2	275.0	749.4
1991	2.6	22.7	6.3	292.5	797.1
1992	0.3	23.2	6.4	310.0	844.8
1993	75.7	23.5	6.4	327.5	892.5
1994	0.7	29.0	7.6	345.0	940.2
1995	0.0	29.1	7.6	362.5	987.8
1996	2.6	29.1	7.6	380.0	1035.5
1997	3.8	29.9	7.7	397.5	1083.2
1998	44.3	31.0	7.8	415.0	1130.9
1999	0.0	32.9	8.8	432.5	1178.6
2000	0.0	32.9	8.8	450.0	1226.3
2001	0.0	32.9	8.8	450.0	1226.3
2002	0.0	32.9	8.8	450.0	1226.3
2003	0.0	32.9	8.8	450.0	1226.3
2004	0.0	32.9	8.8	450.0	1226.3
2005	0.0	32.9	8.8	450.0	1226.3
2006	0.0	32.9	8.8	450.0	1226.3
2007	0.0	32.9	8.8	450.0	1226.3
2008	0.0	32.9	8.8	450.0	1226.3
2009	0.0	32.9	8.8	450.0	1226.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	605.8	343.3	97.4	TOTAL	1050.5	12244.9
7.0%	591.0	265.8	76.4	TOTAL	933.3	9425.7
10.0%	574.3	190.4	55.8	TOTAL	820.6	6690.6

ALTERNATIVE NO. 43C
FREEPORT,TX.,SERVING GULF COAST,MONO BUOYS,SHORE STORAGE,95 FT.DRAFT,500,000 DWT,150-600 MTA,TR.PIPE
LIN.,BARGES,(5-3-8).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	73.7				
1978	110.9				
1979	260.8				
1980	0.0	13.6	4.9	150.0	408.8
1981	0.0	13.6	4.9	172.5	470.1
1982	0.4	13.6	4.9	195.0	531.4
1983	34.0	13.7	4.9	217.5	592.7
1984	35.3	19.3	5.2	240.0	654.0
1985	0.6	19.5	6.0	262.5	715.3
1986	99.7	19.7	6.0	285.0	776.7
1987	3.2	22.5	6.3	307.5	838.0
1988	63.6	23.3	6.4	330.0	899.3
1989	1.6	25.4	7.3	352.5	960.6
1990	1.2	25.3	7.4	375.0	1021.9
1991	2.5	26.2	7.4	397.5	1083.2
1992	76.9	26.9	7.7	420.0	1144.5
1993	6.3	29.7	8.5	442.5	1205.8
1994	27.0	31.3	8.7	465.0	1267.1
1995	40.4	32.7	9.0	487.5	1328.4
1996	5.3	34.6	9.7	510.0	1389.8
1997	1.6	35.4	9.8	532.5	1451.1
1998	46.6	35.9	9.9	555.0	1512.4
1999	0.0	39.2	10.8	577.5	1573.7
2000	0.0	39.2	10.8	600.0	1635.0
2001	0.0	39.2	10.8	600.0	1635.0
2002	0.0	39.2	10.8	600.0	1635.0
2003	0.0	39.2	10.8	600.0	1635.0
2004	0.0	39.2	10.8	600.0	1635.0
2005	0.0	39.2	10.8	600.0	1635.0
2006	0.0	39.2	10.8	600.0	1635.0
2007	0.0	39.2	10.8	600.0	1635.0
2008	0.0	39.2	10.8	600.0	1635.0
2009	0.0	39.2	10.8	600.0	1635.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	772.1	418.6	121.7	TOTAL	1312.7	16685.9
7.0%	744.8	326.1	95.6	TOTAL	1166.7	12894.1
10.0%	719.4	235.6	70.3	TOTAL	1025.3	9207.8

ALTERNATIVE NO. 490
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,55 FT.DRAFT,200,000 DWT,100-450 MTA,TR.PI
PELINE,BARGES,(5-4-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	17.2				
1976	17.2				
1977	77.3				
1978	117.7				
1979	170.5				
1980	0.0	9.0	2.9	100.0	388.0
1981	0.0	9.0	2.9	117.5	455.9
1982	41.4	9.0	2.9	135.0	523.8
1983	30.3	10.1	3.1	152.5	591.7
1984	0.0	12.0	3.6	170.0	659.6
1985	1.4	12.6	3.6	187.5	727.5
1986	44.0	12.9	3.6	205.0	795.4
1987	1.2	15.0	3.8	222.5	863.3
1988	8.1	15.5	3.8	240.0	931.2
1989	36.3	15.5	3.8	257.5	999.1
1990	34.0	18.0	4.4	275.0	1067.0
1991	2.0	19.2	4.6	292.5	1134.9
1992	0.3	19.7	4.6	310.0	1202.8
1993	38.4	20.0	4.6	327.5	1270.7
1994	8.8	24.3	5.1	345.0	1338.6
1995	27.5	24.5	5.1	362.5	1406.5
1996	2.6	27.1	5.5	380.0	1474.4
1997	3.8	27.9	5.6	397.5	1542.3
1998	2.6	29.0	5.7	415.0	1610.2
1999	0.0	29.6	5.7	432.5	1678.1
2000	0.0	29.6	5.7	450.0	1746.0
2001	0.0	29.6	5.7	450.0	1746.0
2002	0.0	29.6	5.7	450.0	1746.0
2003	0.0	29.6	5.7	450.0	1746.0
2004	0.0	29.6	5.7	450.0	1746.0
2005	0.0	29.6	5.7	450.0	1746.0
2006	0.0	29.6	5.7	450.0	1746.0
2007	0.0	29.6	5.7	450.0	1746.0
2008	0.0	29.6	5.7	450.0	1746.0
2009	0.0	29.6	5.7	450.0	1746.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	633.0	302.2	69.6	TOTAL	1004.8	17434.4
7.0%	625.8	233.4	55.2	TOTAL	914.4	13420.4
10.0%	624.1	166.6	41.0	TOTAL	831.8	9526.2

ALTERNATIVE NO. 500
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,55 FT.DRAFT,200,000 DWT,150-600 MTA,TR.PIPELINE,BARGES,(5-4-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	18.8				
1976	18.8				
1977	92.5				
1978	142.5				
1979	207.6				
1980	0.0	11.1	3.5	150.0	582.0
1981	0.0	11.1	3.5	172.5	669.3
1982	0.4	11.1	3.5	195.0	756.6
1983	34.0	11.3	3.6	217.5	843.9
1984	8.1	15.9	3.9	240.0	931.2
1985	27.3	15.9	3.9	262.5	1018.5
1986	99.7	16.2	4.3	285.0	1105.8
1987	5.2	19.0	4.6	307.5	1193.1
1988	33.1	19.9	4.7	330.0	1280.4
1989	29.1	20.7	4.8	352.5	1367.7
1990	1.2	23.7	5.2	375.0	1455.0
1991	2.5	24.1	5.2	397.5	1542.3
1992	44.6	24.8	5.3	420.0	1629.6
1993	34.9	26.4	5.5	442.5	1716.9
1994	27.0	28.2	6.0	465.0	1804.2
1995	0.0	29.6	6.2	487.5	1891.5
1996	5.3	30.3	6.2	510.0	1978.8
1997	1.6	31.1	6.3	532.5	2066.1
1998	20.5	31.6	6.3	555.0	2153.4
1999	0.0	33.2	6.7	577.5	2240.7
2000	0.0	33.2	6.7	600.0	2328.0
2001	0.0	33.2	6.7	600.0	2328.0
2002	0.0	33.2	6.7	600.0	2328.0
2003	0.0	33.2	6.7	600.0	2328.0
2004	0.0	33.2	6.7	600.0	2328.0
2005	0.0	33.2	6.7	600.0	2328.0
2006	0.0	33.2	6.7	600.0	2328.0
2007	0.0	33.2	6.7	600.0	2328.0
2008	0.0	33.2	6.7	600.0	2328.0
2009	0.0	33.2	6.7	600.0	2328.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	775.8	359.5	81.6	TOTAL	1217.0	23757.7
7.0%	762.2	279.6	64.7	TOTAL	1106.5	18358.8
10.0%	754.0	201.4	48.1	TOTAL	1003.5	13110.1

ALTERNATIVE NO. 51G
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,70 FT.DRAFT,300,000 DWT,100-450 MTA,TR.PI
PELINE,BARGES,(5-5-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	39.7				
1976	39.7				
1977	39.8				
1978	155.6				
1979	208.3				
1980	0.0	9.0	5.2	100.0	298.5
1981	0.0	9.0	5.2	117.5	350.7
1982	33.3	9.0	5.2	135.0	403.0
1983	7.7	10.1	5.3	152.5	455.2
1984	0.0	12.4	5.5	170.0	507.5
1985	13.1	12.4	5.5	187.5	559.7
1986	57.1	12.8	5.6	205.0	611.9
1987	1.2	15.0	5.9	222.5	664.2
1988	0.0	15.4	6.0	240.0	716.4
1989	9.3	15.4	6.0	257.5	768.7
1990	47.4	17.8	6.4	275.0	820.9
1991	2.6	19.1	6.5	292.5	873.1
1992	0.3	19.6	6.6	310.0	925.4
1993	50.1	19.9	6.6	327.5	977.6
1994	19.0	24.2	7.1	345.0	1029.9
1995	0.0	24.4	7.4	362.5	1082.1
1996	2.6	24.4	7.4	380.0	1134.3
1997	20.5	25.2	7.4	397.5	1186.6
1998	2.6	26.4	7.7	415.0	1238.8
1999	0.0	27.1	7.8	432.5	1291.1
2000	0.0	27.1	7.8	450.0	1343.3
2001	0.0	27.1	7.8	450.0	1343.3
2002	0.0	27.1	7.8	450.0	1343.3
2003	0.0	27.1	7.8	450.0	1343.3
2004	0.0	27.1	7.8	450.0	1343.3
2005	0.0	27.1	7.8	450.0	1343.3
2006	0.0	27.1	7.8	450.0	1343.3
2007	0.0	27.1	7.8	450.0	1343.3
2008	0.0	27.1	7.8	450.0	1343.3
2009	0.0	27.1	7.8	450.0	1343.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	779.5	289.1	103.4	TOTAL	1172.0	13413.2
7.0%	781.3	224.5	83.1	TOTAL	1088.9	10325.0
10.0%	794.4	161.5	62.9	TOTAL	1018.8	7329.0

ALTERNATIVE NO. 520
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,70 FT.DRAFT,[illegible]00,000 DWT,150-600 MTA,TR.PIPELINE,BARGES,(5-5-5).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	35.7				
1976	39.7				
1977	115.4				
1978	169.2				
1979	230.7				
1980	0.0	11.0	5.5	150.0	447.8
1981	11.7	11.0	5.5	172.5	515.0
1982	13.5	11.0	5.5	195.0	582.1
1983	34.0	11.2	5.7	217.5	649.3
1984	0.0	15.8	6.1	240.0	716.4
1985	14.2	15.6	6.1	262.5	783.6
1986	99.7	16.1	6.3	285.0	850.8
1987	14.9	18.9	6.5	307.5	917.9
1988	43.3	19.7	6.7	330.0	985.1
1989	1.6	20.7	7.0	352.5	1052.2
1990	1.2	21.1	7.1	375.0	1119.4
1991	15.2	21.5	7.1	397.5	1186.6
1992	35.2	22.2	7.4	420.0	1253.7
1993	18.0	23.9	7.5	442.5	1320.9
1994	45.3	25.5	7.8	465.0	1388.0
1995	0.0	29.4	8.1	487.5	1455.2
1996	21.0	30.1	8.1	510.0	1522.4
1997	1.6	31.0	8.5	532.5	1589.5
1998	5.6	31.5	8.5	555.0	1656.7
1999	0.0	33.0	8.7	577.5	1723.8
2000	0.0	33.0	8.7	600.0	1791.0
2001	0.0	33.0	8.7	600.0	1791.0
2002	0.0	33.0	8.7	600.0	1791.0
2003	0.0	33.0	8.7	600.0	1791.0
2004	0.0	33.0	8.7	600.0	1791.0
2005	0.0	33.0	8.7	600.0	1791.0
2006	0.0	33.0	8.7	600.0	1791.0
2007	0.0	33.0	8.7	600.0	1791.0
2008	0.0	33.0	8.7	600.0	1791.0
2009	0.0	33.0	8.7	600.0	1791.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	914.8	350.5	114.2	TOTAL	1379.6	18277.9
7.0%	909.3	272.4	91.6	TOTAL	1273.3	14124.3
10.0%	913.9	196.2	69.2	TOTAL	1179.2	10086.3

ALTERNATIVE NO. 530
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,70 FT.DRAFT,400,000 DWT,100-450 MTA,TR.PI
PELINE,BARGES,(5-5-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	46.5				
1976	46.5				
1977	106.6				
1978	170.7				
1979	223.1				
1980	0.0	9.0	5.9	100.0	298.5
1981	0.0	9.0	5.9	117.5	350.7
1982	53.3	9.0	5.9	135.0	403.0
1983	7.7	10.1	6.0	152.5	455.2
1984	0.0	12.4	6.2	170.0	507.5
1985	1.4	12.4	6.2	187.5	559.7
1986	44.0	12.8	6.2	205.0	611.9
1987	19.9	14.9	6.4	222.5	664.2
1988	17.1	15.3	6.5	240.0	716.4
1989	9.3	15.4	6.7	257.5	768.7
1990	34.0	17.6	7.0	275.0	820.9
1991	2.6	19.0	7.1	292.5	873.1
1992	0.3	19.5	7.2	310.0	925.4
1993	56.6	19.6	7.2	327.5	977.6
1994	0.7	24.2	7.6	345.0	1029.9
1995	0.0	24.4	7.9	362.5	1082.1
1996	2.6	24.4	[illegible]	380.0	1134.3
1997	25.3	25.2	7.9	397.5	1186.6
1998	2.6	26.3	8.3	415.0	1238.8
1999	0.0	27.0	8.4	432.5	1291.1
2000	0.0	27.0	8.4	450.0	1343.3
2001	0.0	27.0	8.4	450.0	1343.3
2002	0.0	27.0	8.4	450.0	1343.3
2003	0.0	27.0	8.4	450.0	1343.3
2004	0.0	27.0	8.4	450.0	1343.3
2005	0.0	27.0	8.4	450.0	1343.3
2006	0.0	27.0	8.4	450.0	1343.3
2007	0.0	27.0	8.4	450.0	1343.3
2008	0.0	27.0	8.4	450.0	1343.3
2009	0.0	27.0	8.4	450.0	1343.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	830.0	228.4	113.4	TOTAL	1231.9	13413.2
7.0%	835.6	224.0	91.4	TOTAL	1151.1	10325.0
10.0%	854.2	161.2	69.5	TOTAL	1084.9	7329.0

ALTERNATIVE NO. 540
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,70 FT.DRAFT,400,000 DWT,150-600 MTA,TR.PI
PELINE,BARGES,(5-5-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	46.5				
1976	46.5				
1977	120.2				
1978	193.9				
1979	245.5				
1980	0.0	11.0	6.1	150.0	447.8
1981	0.0	11.0	6.1	172.5	515.0
1982	0.4	11.0	6.1	195.0	582.1
1983	49.6	11.1	6.2	217.5	649.3
1984	17.1	15.8	6.6	240.0	716.4
1985	0.3	15.9	6.8	262.5	783.6
1986	99.7	16.0	6.8	285.0	850.8
1987	21.4	18.9	7.1	307.5	917.9
1988	25.0	19.7	7.4	330.0	985.1
1989	20.3	20.6	7.5	352.5	1052.2
1990	22.7	21.0	7.6	375.0	1119.4
1991	2.5	21.5	8.0	397.5	1186.6
1992	35.2	22.2	8.0	420.0	1253.7
1993	6.3	23.6	8.2	442.5	1320.9
1994	47.5	25.5	8.3	465.0	1388.0
1995	0.0	26.9	8.6	487.5	1455.2
1996	5.3	27.6	8.8	510.0	1522.4
1997	24.7	28.4	8.9	532.5	1589.5
1998	5.6	31.5	9.3	555.0	1656.7
1999	0.0	32.9	9.4	577.5	1723.8
2000	0.0	32.9	9.4	600.0	1791.0
2001	0.0	32.9	9.4	600.0	1791.0
2002	0.0	32.9	9.4	600.0	1791.0
2003	0.0	32.9	9.4	600.0	1791.0
2004	0.0	32.9	9.4	600.0	1791.0
2005	0.0	32.9	9.4	600.0	1791.0
2006	0.0	32.9	9.4	600.0	1791.0
2007	0.0	32.9	9.4	600.0	1791.0
2008	0.0	32.9	9.4	600.0	1791.0
2009	0.0	32.9	9.4	600.0	1791.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	970.9	346.4	124.3	TOTAL	1441.6	18277.9
7.0%	967.1	269.3	99.8	TOTAL	1336.3	14124.3
10.0%	975.0	194.2	75.5	TOTAL	1244.7	10086.3

ALTERNATIVE NO. 550
FREEPORT,TX.,SERVING GULF COAST,FIXED BERTHS,SHORE STORAGE,95 FT.DRAFT,500,000 DWT,100-450 MTA,TR.PI
PELINE,BARGES,(5-6-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	101.3				
1976	101.3				
1977	161.4				
1978	231.4				
1979	282.5				
1980	0.0	8.9	11.1	100.0	272.5
1981	0.0	8.9	11.1	117.5	320.2
1982	33.3	8.9	11.1	135.0	367.9
1983	26.7	10.0	11.2	152.5	415.6
1984	14.6	12.4	11.5	170.0	463.3
1985	1.4	12.4	11.7	187.5	510.9
1986	44.0	12.8	11.7	205.0	558.6
1987	1.2	14.9	11.9	222.5	606.3
1988	0.0	15.3	11.9	240.0	654.0
1989	25.6	15.3	11.9	257.5	701.7
1990	34.0	17.8	12.4	275.0	749.4
1991	2.6	19.0	12.5	292.5	797.1
1992	19.3	19.5	12.6	310.0	844.8
1993	59.5	19.8	12.7	327.5	892.5
1994	0.7	24.2	13.4	345.0	940.2
1995	0.0	24.4	13.4	362.5	987.9
1996	2.6	24.4	13.4	380.0	1035.5
1997	3.8	25.2	13.5	397.5	1083.2
1998	27.3	26.3	13.6	415.0	1130.9
1999	0.0	27.0	14.0	432.5	1178.6
2000	0.0	27.0	14.0	450.0	1226.3
2001	0.0	27.0	14.0	450.0	1226.3
2002	0.0	27.0	14.0	450.0	1226.3
2003	0.0	27.0	14.0	450.0	1226.3
2004	0.0	27.0	14.0	450.0	1226.3
2005	0.0	27.0	14.0	450.0	1226.3
2006	0.0	27.0	14.0	450.0	1226.3
2007	0.0	27.0	14.0	450.0	1226.3
2008	0.0	27.0	14.0	450.0	1226.3
2009	0.0	27.0	14.0	450.0	1226.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	1189.4	288.0	200.8	TOTAL	167[illegible].2	12244.9
7.0%	1211.2	223.6	163.1	TOTAL	15[illegible]7.9	9425.7
10.0%	1257.3	160.6	125.2	TOTAL	1543.2	6690.6

ALTERNATIVE NO. 560
[illegible], TX., SERVING GULF COAST, FIXED BERTHS, SHORE STORAGE, 95 FT. CRAFT, 500,000 DWT, 150-600 MTA, TR. PI
PELINE, BARGES, (5-6-3).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	104.6				
1976	104.6				
1977	176.3				
1978	257.0				
1979	31[illegible].6				
1980	0.0	11.0	11.7	150.0	408.8
1981	0.0	11.0	11.7	172.5	470.1
1982	0.4	11.0	11.7	195.0	531.4
1983	5[illegible].0	11.1	11.7	217.5	592.7
1984	[illegible]	15.5	12.1	240.0	654.0
1985	0.8	15.8	12.4	262.5	715.3
1986	99.7	16.0	12.4	285.0	776.7
1987	[illegible].2	13.9	12.7	307.5	838.0
1988	41.7	19.7	12.8	330.0	899.3
1989	1.[illegible]	20.6	13.1	352.5	960.6
1990	1.2	21.0	13.1	375.0	1021.9
1991	25.1	21.5	13.1	397.5	1083.2
1992	[illegible]9.4	22.2	13.3	420.0	1144.5
1993	6.3	23.8	13.8	442.5	1205.8
1994	27.0	25.5	14.0	465.0	1267.1
1995	19.[illegible]	26.9	14.1	487.5	1328.4
1996	5.3	27.6	14.4	510.0	1389.8
1997	1.6	28.4	14.5	532.5	1451.1
1998	29.8	29.0	14.6	555.0	1512.4
1999	0.0	32.9	15.0	577.5	1573.7
2000	0.0	32.9	15.0	600.0	1635.0
2001	0.0	32.9	15.0	600.0	1635.0
2002	0.0	32.9	15.0	600.0	1635.0
2003	0.0	32.9	15.0	600.0	1635.0
2004	0.0	32.9	15.0	600.0	1635.0
2005	0.0	32.9	15.0	600.0	1635.0
2006	0.0	32.9	15.0	600.0	1635.0
2007	0.0	32.9	15.0	600.0	1635.0
2008	0.0	32.9	15.0	600.0	1635.0
2009	0.0	32.9	15.0	600.0	1635.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	1[illegible]4[illegible].4	345.3	213.7	TOTAL	1902.3	16685.9
7.0%	1359.5	260.5	173.3	TOTAL	1801.4	12894.1
10.0%	1400.[illegible]	194.7	132.9	TOTAL	1726.9	9207.8

Series 2

ALTERNATIVE NO. 121
EXISTING SITUATION, SERVING GULF COAST, 100-450 MTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SHIPPING COST
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	100.0		539.0
1981	0.0	0.0	0.0	117.5		633.3
1982	0.0	0.0	0.0	135.0		727.6
1983	0.0	0.0	0.0	152.5		822.0
1984	0.0	0.0	0.0	170.0		916.3
1985	0.0	0.0	0.0	187.5		1010.6
1986	0.0	0.0	0.0	205.0		1104.9
1987	0.0	0.0	0.0	222.5		1199.3
1988	0.0	0.0	0.0	240.0		1293.6
1989	0.0	0.0	0.0	257.5		1387.9
1990	0.0	0.0	0.0	275.0		1482.2
1991	0.0	0.0	0.0	292.5		1576.6
1992	0.0	0.0	0.0	310.0		1670.9
1993	0.0	0.0	0.0	327.5		1765.2
1994	0.0	0.0	0.0	345.0		1859.5
1995	0.0	0.0	0.0	362.5		1953.9
1996	0.0	0.0	0.0	380.0		2048.2
1997	0.0	0.0	0.0	397.5		2142.5
1998	0.0	0.0	0.0	415.0		2236.8
1999	0.0	0.0	0.0	432.5		2331.2
2000	0.0	0.0	0.0	450.0		2425.5
2001	0.0	0.0	0.0	450.0		2425.5
2002	0.0	0.0	0.0	450.0		2425.5
2003	0.0	0.0	0.0	450.0		2425.5
2004	0.0	0.0	0.0	450.0		2425.5
2005	0.0	0.0	0.0	450.0		2425.5
2006	0.0	0.0	0.0	450.0		2425.5
2007	0.0	0.0	0.0	450.0		2425.5
2008	0.0	0.0	0.0	450.0		2425.5
2009	0.0	0.0	0.0	450.0		2425.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	24219.4
7.0%	0.0	0.0	0.0	TOTAL	0.0	18643.4
10.0%	0.0	0.0	0.0	TOTAL	0.0	13233.5

ALTERNATIVE NO. 131
EXISTING SITUATION, SERVING GULF COAST, 150-600 MTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	150.0	808.5
1981	0.0	0.0	0.0	172.5	929.8
1982	0.0	0.0	0.0	195.0	1051.0
1983	0.0	0.0	0.0	217.5	1172.3
1984	0.0	0.0	0.0	240.0	1293.6
1985	0.0	0.0	0.0	262.5	1414.9
1986	0.0	0.0	0.0	285.0	1536.1
1987	0.0	0.0	0.0	307.5	1657.4
1988	0.0	0.0	0.0	330.0	1778.7
1989	0.0	0.0	0.0	352.5	1900.0
1990	0.0	0.0	0.0	375.0	2021.2
1991	0.0	0.0	0.0	397.5	2142.5
1992	0.0	0.0	0.0	420.0	2263.8
1993	0.0	0.0	0.0	442.5	2385.1
1994	0.0	0.0	0.0	465.0	2506.3
1995	0.0	0.0	0.0	487.5	2627.6
1996	0.0	0.0	0.0	510.0	2748.9
1997	0.0	0.0	0.0	532.5	2870.2
1998	0.0	0.0	0.0	555.0	2991.4
1999	0.0	0.0	0.0	577.5	3112.7
2000	0.0	0.0	0.0	600.0	3234.0
2001	0.0	0.0	0.0	600.0	3234.0
2002	0.0	0.0	0.0	600.0	3234.0
2003	0.0	0.0	0.0	600.0	3234.0
2004	0.0	0.0	0.0	600.0	3234.0
2005	0.0	0.0	0.0	600.0	3234.0
2006	0.0	0.0	0.0	600.0	3234.0
2007	0.0	0.0	0.0	600.0	3234.0
2008	0.0	0.0	0.0	600.0	3234.0
2009	0.0	0.0	0.0	600.0	3234.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	33003.6
7.0%	0.0	0.0	0.0	TOTAL	0.0	25503.6
10.0%	0.0	0.0	0.0	TOTAL	0.0	18212.2

Series 3

COMPARISON NO.

ALTERNATIVE NO. 121 2 VS 330 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	494.9	17142.7	0.0	0.0	494.9	7076.7	14.2986
7.0%	0.0	18643.4	0.0	0.0	465.6	13195.9	0.0	0.0	465.6	5447.5	11.7003
10.0%	0.0	13233.5	0.0	0.0	443.9	9366.8	0.0	0.0	443.9	3866.7	8.7114

COMPARISON NO. 2

ALTERNATIVE NO. 121 2 VS 410 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	955.8	15187.4	0.0	0.0	955.8	9032.0	9.45
7.0%	0.0	18643.4	0.0	0.0	849.3	11690.6	0.0	0.0	849.3	6952.8	8.19
10.0%	0.0	13233.5	0.0	0.0	747.3	8298.1	0.0	0.0	747.3	4935.4	6.60

COMPARISON NO. 3

ALTERNATIVE NO. 121 2 VS 490 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	1004.8	17434.4	0.0	0.0	1004.8	6785.1	6.7525
7.0%	0.0	18643.4	0.0	0.0	914.4	13420.4	0.0	0.0	914.4	5222.9	5.7120
10.0%	0.0	13233.5	0.0	0.0	831.8	9526.2	0.0	0.0	831.8	3707.4	4.4573

COMPARISON NO. 4

ALTERNATIVE NO. 121 2 VS 350 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	491.4	15457.3	0.0	0.0	491.4	8762.1	17.8319
7.0%	0.0	18643.4	0.0	0.0	466.7	11898.5	0.0	0.0	466.7	6744.8	14.4514
10.0%	0.0	13233.5	0.0	0.0	450.1	8445.9	0.0	0.0	450.1	4787.6	10.6380

COMPARISON NO. 5

ALTERNATIVE NO. 121 2 VS 430 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	981.4	13413.2	0.0	0.0	981.4	10806.2	11.0106
7.0%	0.0	18643.4	0.0	0.0	872.1	10325.0	0.0	0.0	872.1	8318.3	9.5385
10.0%	0.0	13233.5	0.0	0.0	766.8	7329.0	0.0	0.0	766.8	5904.6	7.7004

COMPARISON NO. 6

ALTERNATIVE NO. 121 2 VS 510 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	1172.0	13413.2	0.0	0.0	1172.0	10806.2	9.2205
7.0%	0.0	18643.4	0.0	0.0	1088.9	10325.0	0.0	0.0	1088.9	8318.3	7.6389
10.0%	0.0	13233.5	0.0	0.0	1018.8	7329.0	0.0	0.0	1018.8	5904.6	5.7956

COMPARISON NO. 7

ALTERNATIVE NO. 121 2 VS 370 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	516.7	15457.3	0.0	0.0	516.7	8762.1	16.9568
7.0%	0.0	[illegible]	0.0	0.0	492.2	11898.5	0.0	0.0	492.2	6744.8	13.7027
10.0%	0.0	[illegible]	0.0	0.0	476.3	8445.9	0.0	0.0	476.3	4787.6	10.0523

COMPARISON NO. 8

ALTERNATIVE NO. 121 2 VS 450 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	975.7	13413.2	0.0	0.0	975.7	10806.2	11.0758
7.0%	0.0	18643.4	0.0	0.0	869.3	10325.0	0.0	0.0	869.3	8318.3	9.5691
10.0%	0.0	[illegible]	0.0	0.0	767.3	7329.0	0.0	0.0	767.3	5904.6	7.6956

COMPARISON NO. 9

ALTERNATIVE NO. 121 2 VS 530 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	[illegible]	0.0	0.0	1231.9	13413.2	0.0	0.0	1231.9	10806.2	8.7720
7.0%	0.0	18643.4	0.0	0.0	1151.1	10325.0	0.0	0.0	1151.1	8318.3	7.2267
10.0%	0.0	[illegible]	0.0	0.0	1084.9	7329.0	0.0	0.0	1084.9	5904.6	5.4427

COMPARISON NO. 10

ALTERNATIVE NO. 121 2 VS 390 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	24219.4	0.0	0.0	531.8	14333.9	0.0	0.0	531.8	9865.5	18.5893
7.0%	0.0	13643.4	0.0	0.0	502.8	11033.8	0.0	0.0	502.8	7609.6	15.1334
10.0%	0.0	13233.5	0.0	0.0	481.8	7832.1	0.0	0.0	481.8	5401.4	11.2107

COMPARISON NO. 11

ALTERNATIVE NO. 121 2 VS 470 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	14219.4	0.0	0.0	1050.5	12244.9	0.0	0.0	1050.5	11974.5	11.3988
7.0%	0.0	13643.4	0.0	0.0	933.3	9425.7	0.0	0.0	933.3	9217.6	9.8768
10.0%	0.0	13233.5	0.0	0.0	820.6	6690.6	0.0	0.0	820.6	6542.9	7.9737

COMPARISON NO. 12

ALTERNATIVE NO. 121 2 VS 550 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	14219.4	0.0	0.0	1678.2	12244.9	0.0	0.0	1678.2	11974.5	7.1352
7.0%	0.0	13643.4	0.0	0.0	1597.9	9425.7	0.0	0.0	1597.9	9217.6	5.7687
10.0%	0.0	13233.5	0.0	0.0	1543.2	6690.6	0.0	0.0	1543.2	6542.9	4.2397

COMPARISON NO. 13

ALTERNATIVE NO. 131 2 VS 340 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	582.4	23360.1	0.0	0.0	582.4	9643.5	16.5569
7.0%	0.0	25503.6	0.0	0.0	544.4	18051.6	0.0	0.0	544.4	7452.0	13.6891
10.0%	0.0	18212.2	0.0	0.0	514.0	12890.8	0.0	0.0	514.0	5321.4	10.3525

COMPARISON NO. 14

ALTERNATIVE NO. 131 2 VS 420 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1206.6	20695.6	0.0	0.0	1206.6	12308.0	10.20
7.0%	0.0	25503.6	0.0	0.0	1072.6	15992.6	0.0	0.0	1072.6	9511.0	8.87
10.0%	0.0	18212.2	0.0	0.0	941.6	11420.2	0.0	0.0	941.6	6792.0	7.21

COMPARISON NO. 15

ALTERNATIVE NO. 131 2 VS 500 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1217.0	23757.7	0.0	0.0	1217.0	9245.9	7.5975
7.0%	0.0	25503.6	0.0	0.0	1106.5	18358.8	0.0	0.0	1106.5	7144.8	6.4573
10.0%	0.0	18212.2	0.0	0.0	1003.5	13110.1	0.0	0.0	1003.5	5102.1	5.0843

COMPARISON NO. 16

ALTERNATIVE NO. 131 2 VS 360 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.[illegible]	0.0	0.0	563.0	21063.5	0.0	0.0	563.0	11940.1	21.0213
7.0%	0.0	25503.6	0.0	0.0	532.3	16270.9	0.0	0.0	532.3	9226.8	17.3339
10.0%	0.0	18212.2	0.0	0.0	504.4	11623.4	0.0	0.0	504.4	6588.9	13.0639

COMPARISON NO. 17

ALTERNATIVE NO. 131 2 VS 440 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1224.7	18277.9	0.0	0.0	1224.7	14725.7	12.0238
7.0%	0.0	25503.6	0.0	0.0	1089.5	14124.3	0.0	0.0	1089.5	11379.3	10.4442
10.0%	0.0	18212.2	0.0	0.0	957.9	10086.3	0.0	0.0	957.9	8125.9	8.4832

COMPARISON NO. 18

ALTERNATIVE NO. 131 2 VS 520 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.[illegible]	0.0	0.0	1379.6	18277.9	0.0	0.0	1379.6	14725.7	10.6741
7.0%	0.0	25503.6	0.0	0.0	1273.3	14124.3	0.0	0.0	1273.3	11379.3	8.9369
10.0%	0.0	18212.2	0.0	0.0	1179.2	10086.3	0.0	0.0	1179.2	8125.9	6.8908

COMPARISON NO. 19

ALTERNATIVE NO. 131 2 VS 380 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	597.2	21063.5	0.0	0.0	597.2	11940.1	19.9949
7.0%	0.0	25503.6	0.0	0.0	560.3	16276.5	0.0	0.0	560.3	9226.8	16.4674
10.0%	0.0	18212.2	0.0	0.0	531.7	11623.4	0.0	0.0	531.7	6588.9	12.3920

COMPARISON NO. 20

ALTERNATIVE NO. 131 2 VS 460 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1219.0	18277.9	0.0	0.0	1219.0	14725.7	12.0806
7.0%	0.0	25503.6	0.0	0.0	1085.9	14124.3	0.0	0.0	1085.9	11379.3	10.4794
10.0%	0.0	18212.2	0.0	0.0	956.8	10086.3	0.0	0.0	956.8	8125.9	8.4929

COMPARISON NO. 21

ALTERNATIVE NO. 131 2 VS 540 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1441.6	18277.9	0.0	0.0	1441.6	14725.7	10.2150
7.0%	0.0	25503.6	0.0	0.0	1336.3	14124.3	0.0	0.0	1336.3	11379.3	8.5158
10.0%	0.0	16212.2	0.0	0.0	1244.7	10086.3	0.0	0.0	1244.7	8125.9	6.5285

COMPARISON NO. 22

ALTERNATIVE NO. 131 2 VS 400 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	614.6	19532.7	0.0	0.0	614.6	13470.9	21.9173
7.0%	0.0	25503.6	0.0	0.0	576.2	15094.0	0.0	0.0	576.2	10409.7	18.0658
10.0%	0.0	16212.2	0.0	0.0	546.4	10778.7	0.0	0.0	546.4	7433.6	13.6038

COMPARISON NO. 23

ALTERNATIVE NO. 131 2 VS 480 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1312.7	16685.9	0.0	0.0	1312.7	16317.7	12.4311
7.0%	0.0	25503.6	0.0	0.0	1166.7	12894.1	0.0	0.0	1166.7	12609.5	10.8079
10.0%	0.0	16212.2	0.0	0.0	1025.3	9207.8	0.0	0.0	1025.3	9004.5	8.7820

COMPARISON NO. 24

ALTERNATIVE NO. 131 2 VS 560 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	33003.6	0.0	0.0	1902.3	16685.9	0.0	0.0	1902.3	16317.7	8.5777
7.0%	0.0	25503.6	0.0	0.0	1801.4	12894.1	0.0	0.0	1801.4	12609.5	6.9998
10.0%	0.0	16212.2	0.0	0.0	1726.9	9207.8	0.0	0.0	1726.9	9004.5	5.2141

PART III. WEST COAST OIL

Series 1

ALTERNATIVE NO. 57.
SAN PABLO BAY, C.A., SERVING L.A.-L.B., FIXED BERTHS, SHORE STORAGE, 70 FT. DRAFT, 300,000 DWT, 28-111 MTA, T
R, PIPELINES, (6-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	6.[illegible]				
1978	6.[illegible]				
1979	31.[illegible]				
1980	0.0	2.4	.5	28.0	36.4
1981	0.0	2.4	.5	32.1	48.9
1982	0.	2.4	.5	36.3	61.4
1983	0.0	2.4	.5	40.4	73.8
1984	0.0	2.4	.5	44.6	86.3
1985	0.0	2.4	.5	48.7	98.8
1986	0.0	2.4	.5	52.9	111.3
1987	0.0	2.4	.5	57.0	123.8
1988	0.0	2.4	.5	61.2	136.2
1989	0.	2.4	.5	65.3	148.7
1990	0.0	2.4	.5	69.5	161.2
1991	0.0	2.4	.5	73.6	173.7
1992	6.0	2.4	.5	77.[illegible]	186.2
1993	0.0	2.4	.5	81.[illegible]	198.6
1994	0.0	2.4	.5	86.1	211.1
1995	0.	2.4	.5	90.2	223.6
1996	0.0	2.4	.5	94.4	236.1
1997	0.0	2.4	.5	98.5	248.6
1998	0.0	2.4	.5	102.7	261.0
1999	0.0	2.4	.5	106.8	273.5
2000	0.0	2.4	.5	111.0	286.0
2001	0.0	2.4	.5	111.0	286.0
2002	0.0	2.4	.5	111.0	286.0
2003	0.0	2.4	.5	111.0	286.0
2004	0.0	2.4	.5	111.0	286.0
2005	0.0	2.4	.5	111.0	286.0
2006	0.	2.4	.5	111.0	286.0
2007	0.0	2.4	.5	111.0	286.0
2008	0.	2.4	.5	111.0	286.0
2009	0.0	2.4	.5	111.0	286.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	50.2	38.7	8.1	TOTAL	97.0	2640.9
7.0%	51.3	31.9	6.6	TOTAL	89.3	2033.1
10.0%	52.[illegible]	24.9	5.2	TOTAL	82.9	1388.9

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ALTERNATIVE NO. 580
SAN PABLO BAY,L.A.,SERVING L.A.-L.B.,FIXED BERTHS,SHORE STORAGE,60 FT.DRAFT,400,000 DWT,28-111 MTA,T
R,PIPELINE,(6-1-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	7.4				
1978	7.4				
1979	35.8				
1980	0.0	2.9	.6	26.0	36.4
1981	0.0	2.9	.6	32.1	48.9
1982	0.0	2.9	.6	36.3	61.4
1983	0.0	2.9	.6	40.4	73.8
1984	0.0	2.9	.6	44.6	86.3
1985	0.0	2.9	.6	48.7	98.8
1986	0.0	2.9	.6	52.9	111.3
1987	0.0	2.9	.6	57.0	123.8
1988	0.0	2.9	.6	61.2	136.2
1989	0.0	2.9	.6	65.3	148.7
1990	0.0	2.9	.6	69.5	161.2
1991	0.0	2.9	.6	73.6	173.7
1992	0.0	2.9	.6	77.8	186.2
1993	0.0	2.9	.6	81.9	198.6
1994	0.0	2.9	.6	86.1	211.1
1995	8.5	2.9	.6	90.2	223.6
1996	0.0	2.9	.7	94.4	236.1
1997	0.0	2.9	.7	98.5	248.6
1998	0.0	2.9	.7	102.7	261.0
1999	0.0	2.9	.7	106.8	273.5
2000	0.0	2.9	.7	111.0	286.0
2001	0.0	2.9	.7	111.0	286.0
2002	0.0	2.9	.7	111.0	286.0
2003	0.0	2.9	.7	111.0	286.0
2004	0.0	2.9	.7	111.0	286.0
2005	0.0	2.9	.7	111.0	286.0
2006	0.0	2.9	.7	111.0	286.0
2007	0.0	2.9	.7	111.0	286.0
2008	0.0	2.9	.7	111.0	286.0
2009	0.0	2.9	.7	111.0	286.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	58.3	46.8	10.2	TOTAL	115.3	2640.9
7.0%	58.9	33.5	8.3	TOTAL	105.6	2003.1
10.0%	65.2	[illegible]	6.4	TOTAL	96.6	1388.9

ALTERNATIVE NO. 593
SAN PABLO BAY,L.A.,SERVING CALIF.,FIVE BERTHS,SHORE STORAGE,70 FT.DRAFT,300,000 DWT,43-171 MTA,IR.P
IPELINE,(6-2-A1).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	6.3				
1978	65.5				
1979	106.4				
1980	0.0	4.9	1.0	43.0	55.3
1981	0.0	4.9	1.0	49.4	73.4
1982	0.0	4.9	1.0	55.8	91.5
1983	0.0	4.9	1.0	62.2	109.6
1984	0.0	4.9	1.0	68.6	127.7
1985	12.9	4.9	1.0	75.0	145.8
1986	0.0	6.2	1.3	81.4	164.0
1987	0.0	6.2	1.3	87.8	182.1
1988	0.0	6.2	1.3	94.2	200.2
1989	7.5	6.2	1.3	100.6	218.3
1990	0.0	8.1	1.5	107.0	236.4
1991	0.0	8.1	1.5	113.4	254.5
1992	0.0	8.1	1.5	119.8	272.6
1993	15.0	8.1	1.5	126.2	290.7
1994	0.0	12.1	1.8	132.6	308.8
1995	1.0	12.1	1.8	139.0	326.9
1996	10.4	12.1	1.8	145.4	345.1
1997	0.0	12.1	2.0	151.8	363.2
1998	0.0	12.1	2.0	158.2	381.3
1999	0.0	12.1	2.0	164.6	399.4
2000	0.0	12.1	2.0	171.0	417.5
2001	0.0	12.1	2.0	171.0	417.5
2002	0.0	12.1	2.0	171.0	417.5
2003	0.0	12.1	2.0	171.0	417.5
2004	0.0	12.1	2.0	171.0	417.5
2005	0.0	12.1	2.0	171.0	417.5
2006	0.0	12.1	2.0	171.0	417.5
2007	0.0	12.1	2.0	171.0	417.5
2008	0.0	12.1	2.0	171.0	417.5
2009	0.0	12.1	2.0	171.0	417.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	219.4	131.3	23.6	TOTAL	374.2	3872.3
7.0%	219.9	102.2	18.6	TOTAL	343.8	2939.7
10.0%	222.7	73.9	13.8	TOTAL	310.4	2041.1

ALTERNATIVE NO. 6?
SAN PABLO BAY,L.A.,SERVING CALIF.,FIXED BERTHS,SHORE STORAGE,70 FT.DRAFT,4?,000 DWT,43-171 MTA.TR.P
IPELINE,(6-2-6).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	7.4				
1978	67.9				
1979	113.4				
1980	0.0	5.6	1.2	43.0	55.3
1981	0.0	5.6	1.2	49.4	73.4
1982	0.	5.6	1.2	55.8	91.5
1983	0.0	5.6	1.2	62.2	109.6
1984	0.0	5.6	1.2	68.6	127.7
1985	3.5	5.6	1.2	75.0	145.8
1986	0.0	6.8	1.3	81.4	164.0
1987	11.4	6.8	1.3	87.8	182.1
1988	0.0	6.9	1.5	94.2	200.2
1989	7.5	6.9	1.5	100.6	218.3
1990	0.0	8.8	1.7	107.0	236.4
1991	0.0	8.8	1.7	113.4	254.5
1992	0.0	8.8	1.7	119.8	272.6
1993	15.0	8.8	1.7	126.2	290.7
1994	0.0	12.7	2.0	132.6	308.8
1995	0.	12.7	2.0	139.0	326.9
1996	0.0	12.7	2.0	145.4	345.1
1997	0.0	12.7	2.0	151.8	363.2
1998	0.0	12.7	2.0	158.2	381.3
1999	0.0	12.7	2.0	164.6	399.4
2000	0.0	12.7	2.0	171.0	417.5
2001	0.0	12.7	2.0	171.0	417.5
2002	0.0	12.7	2.0	171.0	417.5
2003	0.0	12.7	2.0	171.0	417.5
2004	0.0	12.7	2.0	171.0	417.5
2005	0.0	12.7	2.0	171.0	417.5
2006	0.0	12.7	2.0	171.0	417.5
2007	0.0	12.7	2.0	171.0	417.5
2008	0.0	12.7	2.0	171.0	417.5
2009	0.0	12.7	2.0	171.0	417.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	226.4	142.0	25.7	TOTAL	394.0	3872.3
7.0%	228.3	111.1	20.5	TOTAL	359.8	2939.7
10.0%	232.5	83.9	15.3	TOTAL	323.7	2041.1

ALTERNATIVE NO. 61.
L.A.,PICHMOND,SERVING S.FRAN.,FIXED BERTHS,SHORE STORAGE,50 FT.DRAFT,157,000 DWT,15-60 MTA,TR.PIPELI
NE,(7-1).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	3.0				
1978	15.0				
1979	43.5				
1980	0.0	2.8	.7	15.0	20.0
1981	0.0	2.9	.7	17.3	26.4
1982	0.2	2.9	.7	19.5	32.7
1983	0.0	2.9	.7	21.8	39.1
1984	0.0	2.9	.7	24.0	45.4
1985	0.3	2.9	.7	26.3	51.8
1986	0.0	3.0	.7	28.5	58.1
1987	0.0	3.0	.7	30.8	64.5
1988	0.0	3.0	.7	33.0	70.8
1989	0.0	3.[illegible]	.7	35.3	77.2
1990	0.7	3.[illegible]	.7	37.5	83.5
1991	0.0	3.2	.7	39.8	89.9
1992	0.0	3.2	.7	42.0	96.3
1993	1.4	3.2	.7	44.3	102.6
1994	0.0	3.5	.7	46.5	109.0
1995	0.0	3.5	.7	48.8	115.3
1996	0.0	3.5	.7	51.0	121.7
1997	0.0	3.5	.7	53.3	128.0
1998	0.	3.5	.7	55.5	134.4
1999	0.0	3.5	.7	57.8	140.7
2000	0.0	3.5	.7	60.0	147.1
2001	0.0	3.5	.7	60.0	147.1
2002	0.0	3.5	.7	60.0	147.1
2003	0.0	3.5	.7	60.0	147.1
2004	0.0	3.5	.7	60.0	147.1
2005	0.0	3.5	.7	60.0	147.1
2006	0.0	3.5	.7	60.0	147.1
2007	0.0	3.5	.7	60.0	147.1
2008	0.0	3.5	.7	60.0	147.1
2009	0.0	3.5	.7	60.0	147.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	59.3	51.1	11.3	TOTAL	131.7	1368.4
7.0%	70.9	41.6	9.3	TOTAL	121.6	1039.5
10.0%	73.2	32.0	7.3	TOTAL	112.4	722.4

ALTERNATIVE NO. 620
RICHMOND-AVON,SERVING S.FRAN.,FIXED BERTHS,SHORE STORAGE,50 FT.DRAFT,157,000 DWT,15-60 MIA,TR.PIPELINE,(7-2).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	19.0				
1978	19.0				
1979	42.8				
1980	0.0	2.9	0.8	15.0	20.0
1981	0.0	2.9	0.8	17.3	26.4
1982	0.0	2.9	0.6	19.5	32.7
1983	0.0	2.9	0.6	21.8	39.1
1984	0.0	2.9	0.8	24.0	45.4
1985	0.0	2.9	0.8	26.3	51.8
1986	0.0	2.9	0.8	28.5	58.1
1987	0.0	2.9	0.6	30.8	64.5
1988	0.0	2.9	0.8	33.0	70.8
1989	0.0	2.9	0.8	35.3	77.2
1990	0.0	2.9	0.8	37.5	83.5
1991	0.0	2.9	0.8	39.8	89.9
1992	0.0	2.9	0.8	42.0	96.3
1993	0.0	2.9	0.8	44.3	102.6
1994	0.0	2.9	0.9	46.5	109.0
1995	0.0	2.9	0.8	48.8	115.3
1996	0.0	2.9	0.8	51.0	121.7
1997	0.0	2.9	0.8	53.3	128.0
1998	0.0	2.9	0.8	55.5	134.4
1999	0.0	2.9	0.8	57.8	140.7
2000	0.0	2.9	0.8	60.0	147.1
2001	0.0	2.9	0.8	60.0	147.1
2002	0.0	2.9	0.8	60.0	147.1
2003	0.0	2.9	0.8	60.0	147.1
2004	0.0	2.9	0.8	60.0	147.1
2005	0.0	2.9	0.8	60.0	147.1
2006	0.0	2.9	0.6	60.0	147.1
2007	0.0	2.9	0.8	60.0	147.1
2008	0.0	2.9	0.8	60.0	147.1
2009	0.0	2.9	0.8	60.0	147.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	97.9	46.8	12.9	TOTAL	147.6	1368.4
7.0%	90.8	38.5	10.6	TOTAL	140.0	1039.5
10.0%	95.4	31.1	5.3	TOTAL	133.7	722.4

ALTERNATIVE NO. 630
L.A., RICHMOND, SERVING S.FRAN., FIXED BERTHS, SHORE STORAGE, 58.5 FT.DRAFT, 250,000 DWT, 15-6) MTA, TR.PIPE LINE, (7-3).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	4.3				
1976	4.3				
1977	6.9				
1978	21.6				
1979	48.7				
1980	0.0	2.8	1.1	15.0	18.5
1981	0.0	2.8	1.1	17.3	24.3
1982	0.2	2.8	1.1	19.5	30.1
1983	0.0	2.9	1.1	21.8	36.0
1984	13.1	2.9	1.1	24.0	41.8
1985	0.3	2.9	1.2	26.3	47.6
1986	0.0	3.0	1.2	28.5	53.4
1987	0.0	3.0	1.2	30.8	59.2
1988	0.0	3.0	1.2	33.0	65.1
1989	0.0	3.0	1.2	35.3	70.9
1990	0.7	3.	1.2	37.5	76.7
1991	0.0	3.2	1.2	39.8	82.5
1992	0.0	3.2	1.2	42.0	88.3
1993	1.4	3.2	1.2	44.3	94.2
1994	0.0	3.5	1.3	46.5	100.0
1995	0.0	3.5	1.3	48.8	105.8
1996	0.0	3.5	1.3	51.0	111.6
1997	0.0	3.5	1.3	53.3	117.4
1998	0.0	3.5	1.3	55.5	123.3
1999	0.0	3.5	1.3	57.8	129.1
2000	0.0	3.5	1.3	60.0	134.9
2001	0.0	3.5	1.3	60.0	134.9
2002	0.0	3.5	1.3	60.0	134.9
2003	0.0	3.5	1.3	60.0	134.9
2004	0.0	3.5	1.3	60.0	134.9
2005	0.	3.5	1.3	60.0	134.9
2006	0.0	3.5	1.3	60.0	134.9
2007	0.	3.5	1.3	60.0	134.9
2008	0.0	3.5	1.3	60.0	134.9
2009	0.0	3.5	1.3	60.0	134.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	106.[illegible]	5[illegible].8	19.5	TOTAL	176.3	1256.2
7.0%	108.3	41.3	15.9	TOTAL	165.4	954.4
10.0%	112.1	31.7	12.3	TOTAL	156.6	663.5

ALTERNATIVE NO. 64[illegible]
RICHMOND-AVON,SERVING S.FRAN.,FIXED BERTHS,SHORE STORAGE,58.5 FT.DRAFT,250,000 DWT,15-6 MTA,TR.PIPE
LINE,(7-4).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	24.1				
1976	24.1				
1977	26.7				
1978	26.7				
1979	65.7				
1980	0.0	2.9	1.9	15.0	18.5
1981	0.0	2.9	1.9	17.3	24.3
1982	0.0	2.9	1.9	19.5	30.1
1983	0.0	2.9	1.9	21.8	36.0
1984	0.0	2.9	1.9	24.0	41.8
1985	0.0	2.9	1.9	26.3	47.6
1986	0.0	2.9	1.9	28.5	53.4
1987	0.0	2.9	1.9	30.8	59.2
1988	0.0	2.9	1.9	33.0	65.1
1989	0.0	2.9	1.9	35.3	70.9
1990	0.0	2.9	1.9	37.5	76.7
1991	0.0	2.9	1.9	39.8	82.5
1992	0.0	2.9	1.9	42.0	88.3
1993	0.0	2.9	1.9	44.3	94.2
1994	0.0	2.9	1.9	46.5	100.0
1995	0.0	2.9	1.9	46.8	105.8
1996	0.0	2.9	1.9	51.0	111.6
1997	0.0	2.9	1.9	53.3	117.4
1998	0.0	2.9	1.9	55.5	123.3
1999	0.0	2.9	1.9	57.8	129.1
2000	0.0	2.9	1.9	60.0	134.9
2001	0.0	2.9	1.9	60.0	134.9
2002	0.0	2.9	1.9	60.0	134.9
2003	0.0	2.9	1.9	60.0	134.9
2004	0.0	2.9	1.9	60.0	134.9
2005	0.0	2.9	1.9	60.0	134.9
2006	0.0	2.9	1.9	60.0	134.9
2007	0.0	2.9	1.9	60.0	134.9
2008	0.0	2.9	1.9	60.0	134.9
2009	0.0	2.9	1.9	60.0	134.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	189.4	46.8	30.7	TOTAL	266.9	1256.2
7.5%	199.0	38.5	25.2	TOTAL	262.7	954.4
10.0%	214.2	30.1	19.7	TOTAL	264.0	663.5

ALTERNATIVE NO. 650
ML,MONTEREY BAY,SERVING S.FRAN.,MONO-BUOYS,SHORE STORAGE,83 FT.DRAFT,400,000 DWT,15-60 MIA,TR.PIPELI
NE,(7-5).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	23.4				
1979	85.2				
1980	0.0	2.5	1.9	15.0	15.5
1981	0.0	2.5	1.9	17.3	20.5
1982	0.	2.5	1.9	19.5	25.4
1983	0.0	2.5	1.9	21.8	30.4
1984	0.0	2.5	1.9	24.0	35.3
1985	1.3	2.5	1.9	26.3	40.3
1986	0.0	2.9	1.9	28.5	45.2
1987	0.0	2.9	1.9	30.8	50.2
1988	0.0	2.9	1.9	33.0	55.1
1989	2.6	2.9	1.9	35.3	60.1
1990	0.0	3.6	2.0	37.5	65.0
1991	0.0	3.6	2.0	39.8	70.0
1992	0.0	3.6	2.0	42.0	75.0
1993	5.1	3.6	2.0	44.3	79.9
1994	0.0	4.9	2.1	46.5	84.9
1995	0.0	4.9	2.1	48.8	89.8
1996	0.0	4.9	2.1	51.0	94.8
1997	0.0	4.9	2.1	53.3	99.7
1998	0.0	4.9	2.1	55.5	104.7
1999	0.0	4.9	2.1	57.8	109.6
2000	0.0	4.9	2.1	60.0	114.6
2001	0.0	4.9	2.1	60.0	114.6
2002	0.0	4.9	2.1	60.0	114.6
2003	0.0	4.9	2.1	60.0	114.6
2004	0.0	4.9	2.1	60.0	114.6
2005	0.0	4.9	2.1	60.0	114.6
2006	0.0	4.9	2.1	60.0	114.6
2007	0.0	4.9	2.1	60.0	114.6
2008	0.0	4.9	2.1	60.0	114.6
2009	0.0	4.9	2.1	60.0	114.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	123.7	57.8	32.0	TOTAL	210.5	1065.4
7.0%	122.4	45.6	26.2	TOTAL	194.2	809.2
10.0%	125.4	33.6	23.3	TOTAL	179.3	562.3

ALTERNATIVE NO. 660
ST.OF GA.,WASH.,SERVING S.FRAN.,FIXED BERTHS,SHORE STORAGE,83 FT.DRAFT,400,000 DWT,15-60 MTA,TR.PIPE
LINE,(8-1).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	91.4				
1978	114.7				
1979	161.3				
1980	0.0	5.7	1.9	15.0	10.2
1981	0.0	5.7	1.9	17.3	14.9
1982	0.0	5.7	1.9	19.5	19.5
1983	0.0	5.7	1.9	21.8	24.2
1984	0.0	5.7	1.9	24.0	28.8
1985	9.3	5.7	1.9	26.3	33.5
1986	0.0	8.7	2.1	28.5	38.1
1987	0.0	8.7	2.1	30.8	42.8
1988	0.0	8.7	2.1	33.0	47.4
1989	18.5	8.7	2.1	35.3	52.1
1990	0.0	13.5	2.6	37.5	56.7
1991	0.0	13.5	2.6	39.8	61.4
1992	0.0	13.5	2.6	42.0	66.1
1993	37.1	13.5	2.6	44.3	70.7
1994	0.0	23.1	3.5	46.5	75.4
1995	0.0	23.1	3.5	48.8	80.0
1996	0.0	23.1	3.5	51.0	84.7
1997	0.0	23.1	3.5	53.3	89.3
1998	0.0	23.1	3.5	55.5	94.0
1999	0.0	23.1	3.5	57.8	98.6
2000	0.0	23.1	3.5	60.0	103.3
2001	0.0	23.1	3.5	60.0	103.3
2002	0.0	23.1	3.5	60.0	103.3
2003	0.0	23.1	3.5	60.0	103.3
2004	0.0	23.1	3.5	60.0	103.3
2005	0.0	23.1	3.5	60.0	103.3
2006	0.0	23.1	3.5	60.0	103.3
2007	0.0	23.1	3.5	60.0	103.3
2008	0.0	23.1	3.5	60.0	103.3
2009	0.0	23.1	3.5	60.0	103.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	440.4	218.2	42.0	TOTAL	790.6	930.5
7.0%	447.8	165.5	33.3	TOTAL	646.6	702.3
10.0%	462.1	114.9	24.7	TOTAL	601.7	483.0

ALTERNATIVE NO. 67[illegible]
ST.OF JA.,WASH.,SERVING CALIF.,FIXED BERTHS,SHORE STORAGE,63 FT.DRAFT,400,000 DWT,43-171 MTA,TR.PIPE LINE,(3-2).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	149.5				
1978	172.9				
1979	248.0				
1980	0.0	11.7	2.9	43.0	30.6
1981	0.0	11.7	2.9	49.4	45.8
1982	0.0	11.7	2.9	55.8	60.9
1983	33.0	11.7	2.9	62.2	76.1
1984	0.0	21.5	3.7	68.6	91.3
1985	218.2	21.5	3.7	75.0	106.5
1986	225.9	21.7	4.1	81.4	121.6
1987	24.5	29.9	4.8	87.8	136.8
1988	0.0	30.4	5.1	94.2	152.0
1989	1.0	30.4	5.1	100.6	167.2
1990	0.0	30.6	5.1	107.0	182.3
1991	0.0	30.6	5.1	113.4	197.5
1992	8.2	30.6	5.1	119.8	212.7
1993	2.0	33.5	5.3	126.2	227.9
1994	16.6	34.0	5.4	132.6	243.0
1995	0.0	38.3	5.3	139.0	258.2
1996	33.0	38.3	5.8	145.4	273.4
1997	0.0	46.9	6.6	151.8	288.6
1998	0.0	46.9	6.6	158.2	303.7
1999	0.0	46.9	6.6	164.6	318.9
2000	0.0	46.9	6.6	171.0	334.1
2001	0.0	46.9	6.6	171.0	334.1
2002	0.0	46.9	6.6	171.0	334.1
2003	0.0	46.9	6.6	171.0	334.1
2004	0.0	46.9	6.6	171.0	334.1
2005	0.0	46.9	6.6	171.0	334.1
2006	0.0	46.9	6.6	171.0	334.1
2007	0.0	46.9	6.6	171.0	334.1
2008	0.0	46.9	6.6	171.0	334.1
2009	0.0	46.9	6.6	171.0	334.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	1139.3	482.2	78.3	TOTAL	1599.8	2990.7
7.0%	1017.4	371.8	61.8	TOTAL	1451.0	2254.3
10.0%	996.5	264.4	45.4	TOTAL	1306.4	1547.1

Series 2

ALTERNATIVE NO. 141
EXISTING SITUATION, SERVING L.A.-L.B., 28-111 KTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	28.0	45.3
1981	0.0	0.0	0.0	32.1	60.7
1982	0.0	0.0	0.0	36.3	76.1
1983	0.0	0.0	0.0	40.4	91.5
1984	0.0	0.0	0.0	44.6	106.9
1985	0.0	0.0	0.0	48.7	122.3
1986	0.0	0.0	0.0	52.9	137.7
1987	0.0	0.0	0.0	57.0	153.1
1988	0.0	0.0	0.0	61.2	168.5
1989	0.0	0.0	0.0	65.3	183.9
1990	0.0	0.0	0.0	69.5	199.3
1991	0.0	0.0	0.0	73.6	214.7
1992	0.0	0.0	0.0	77.8	230.1
1993	0.0	0.0	0.0	81.9	245.5
1994	0.0	0.0	0.0	86.1	260.9
1995	0.0	0.0	0.0	90.2	276.3
1996	0.0	0.0	0.0	94.4	291.7
1997	0.0	0.0	0.0	98.5	307.1
1998	0.0	0.0	0.0	102.7	322.5
1999	0.0	0.0	0.0	106.8	337.9
2000	0.0	0.0	0.0	111.0	353.3
2001	0.0	0.0	0.0	111.0	353.3
2002	0.0	0.0	0.0	111.0	353.3
2003	0.0	0.0	0.0	111.0	353.3
2004	0.0	0.0	0.0	111.0	353.3
2005	0.0	0.0	0.0	111.0	353.3
2006	0.0	0.0	0.0	111.0	353.3
2007	0.0	0.0	0.0	111.0	353.3
2008	0.0	0.0	0.0	111.0	353.3
2009	0.0	0.0	0.0	111.0	353.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	0.0	0.0	0.0	TOTAL	0.0	3265.[illegible]
7.[illegible]	0.0	0.0	0.0	TOTAL	0.0	2476.9
10.[illegible]	0.0	0.0	0.0	TOTAL	0.0	1717.6

ALTERNATIVE NO. 151
EXISTING SITUATION, SERVING SAN FRANSISCO, 15-[illegible] FTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	15.0	33.3
1981	0.0	0.0	0.0	17.3	43.3
1982	0.0	0.0	0.0	19.5	53.3
1983	0.0	0.0	0.0	21.8	63.3
1984	0.0	0.0	0.0	24.0	73.3
1985	0.0	0.0	0.0	26.3	83.2
1986	0.0	0.0	0.0	28.5	93.2
1987	0.0	0.0	0.0	30.8	103.2
1988	0.0	0.0	0.0	33.0	113.2
1989	0.0	0.0	0.0	35.3	123.2
1990	0.0	0.0	0.0	37.5	133.2
1991	0.0	0.0	0.0	39.8	143.2
1992	0.0	0.0	0.0	42.0	153.2
1993	0.0	0.0	0.0	44.3	163.2
1994	0.0	0.0	0.0	46.5	173.2
1995	0.0	0.0	0.0	48.8	183.1
1996	0.0	0.0	0.0	51.0	193.1
1997	0.0	0.0	0.0	53.3	203.1
1998	0.0	0.0	0.0	55.5	213.1
1999	0.0	0.0	0.0	57.8	223.1
2000	0.0	0.0	0.0	6[illegible].0	233.1
2001	0.0	0.0	0.0	[illegible]	233.1
2002	0.0	0.0	0.0	[illegible]	233.1
2003	0.0	0.0	0.0	[illegible]	233.1
2004	0.0	0.0	0.0	[illegible]	233.1
2005	0.0	0.0	0.0	[illegible]	233.1
2006	0.0	0.0	0.0	[illegible]	233.1
2007	0.0	0.0	0.0	[illegible]	233.1
2008	0.0	0.0	0.0	[illegible]	233.1
2009	0.0	0.0	0.0	[illegible]	233.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	0.0	0.0	0.0	TOTAL	0.0	2161.2
7.[illegible]	0.0	0.0	0.0	TOTAL	0.0	1658.7
10.[illegible]	0.0	0.0	0.0	TOTAL	0.0	1154.9

ALTERNATIVE NO. 161
EXISTING SITUATION, SERVING CALIFORNIA, 43-171 MTA, NO LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	43.0	78.6
1981	0.0	0.0	0.0	49.4	104.0
1982	0.0	0.0	0.0	55.8	129.4
1983	0.0	0.0	0.0	62.2	154.6
1984	0.0	0.0	0.0	68.6	180.2
1985	0.0	0.0	0.0	75.0	205.5
1986	0.0	0.0	0.0	81.4	230.9
1987	0.0	0.0	0.0	87.8	256.3
1988	0.0	0.0	0.0	94.2	281.7
1989	0.0	0.0	0.0	100.6	307.1
1990	0.0	0.0	0.0	107.0	332.5
1991	0.0	0.0	0.0	113.4	357.9
1992	0.0	0.0	0.0	119.8	383.3
1993	0.0	0.0	0.0	126.2	408.7
1994	0.0	0.0	0.0	132.6	434.1
1995	0.0	0.0	0.0	139.0	459.4
1996	0.0	0.0	0.0	145.4	484.8
1997	0.0	0.0	0.0	151.8	510.2
1998	0.0	0.0	0.0	158.2	535.6
1999	0.0	0.0	0.0	164.6	561.0
2000	0.0	0.0	0.0	171.0	586.4
2001	0.0	0.0	0.0	171.0	586.4
2002	0.0	0.0	0.0	171.0	586.4
2003	0.0	0.0	0.0	171.0	586.4
2004	0.0	0.0	0.0	171.0	586.4
2005	0.0	0.0	0.0	171.0	586.4
2006	0.0	0.0	0.0	171.0	586.4
2007	0.0	0.0	0.0	171.0	586.4
2008	0.0	0.0	0.0	171.0	586.4
2009	0.0	0.0	0.0	171.0	586.4

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	5446.1
7.0%	0.0	0.0	0.0	TOTAL	0.0	4135.6
10.0%	0.0	0.0	0.0	TOTAL	0.0	2872.7

ALTERNATIVE NO. 171
EXISTING SITUATION, SERVING SAN FRANSISCO, 15-60 MTA, LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	15.0	23.3
1981	0.0	0.0	0.0	17.3	30.0
1982	0.0	0.0	0.0	19.5	36.8
1983	0.0	0.0	0.0	21.8	43.5
1984	0.0	0.0	0.0	24.0	50.2
1985	0.0	0.0	0.0	26.3	56.9
1986	0.0	0.0	0.0	28.5	63.7
1987	0.0	0.0	0.0	3[illegible]	70.4
1988	0.0	0.0	0.0	33.0	77.1
1989	0.0	0.0	0.0	35.3	83.9
1990	0.0	0.0	0.0	37.5	90.6
1991	0.0	0.0	0.0	39.8	97.3
1992	0.0	0.0	0.0	42.0	104.1
1993	0.0	0.0	0.0	44.3	110.8
1994	0.0	0.0	0.0	46.5	117.5
1995	0.0	0.0	0.0	48.8	124.2
1996	0.0	0.0	0.0	51.0	131.0
1997	0.0	0.0	0.0	53.3	137.7
1998	0.0	0.0	0.0	55.5	144.4
1999	0.0	0.0	0.0	57.8	151.2
2000	0.0	0.0	0.0	60.0	157.9
2001	0.0	0.0	0.0	60.0	157.9
2002	0.0	0.0	0.0	60.0	157.9
2003	0.0	0.0	0.0	60.0	157.9
2004	0.0	0.0	0.0	60.0	157.9
2005	0.0	0.0	0.0	60.0	157.9
2006	0.0	0.0	0.0	60.0	157.9
2007	0.0	0.0	0.0	60.0	157.9
2008	0.0	0.0	0.0	60.0	157.9
2009	0.0	0.0	0.0	60.0	157.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	1483.4
7.0%	0.0	0.0	0.0	TOTAL	0.0	1128.9
10.0%	0.0	0.0	0.0	TOTAL	0.0	787.3

ALTERNATIVE NO. 181
EXISTING SITUATION, SERVING CALIFORNIA, 43-171 MTA, LIGHTERING.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	43.0	68.5
1981	0.0	0.0	0.0	49.4	90.6
1982	0.0	0.0	0.0	55.8	112.8
1983	0.0	0.0	0.0	62.2	134.9
1984	0.0	0.0	0.0	68.6	157.0
1985	0.0	0.0	0.0	75.0	179.2
1986	0.0	0.0	0.0	81.4	201.3
1987	0.0	0.0	0.0	87.8	223.4
1988	0.0	0.0	0.0	94.2	245.6
1989	0.0	0.0	0.0	100.6	267.7
1990	0.0	0.0	0.0	107.0	289.8
1991	0.0	0.0	0.0	113.4	312.0
1992	0.0	0.0	0.0	119.8	334.1
1993	0.0	0.0	0.0	126.2	356.3
1994	0.0	0.0	0.0	132.6	378.4
1995	0.0	0.0	0.0	139.0	400.5
1996	0.0	0.0	0.0	145.4	422.7
1997	0.0	0.0	0.0	151.8	444.8
1998	0.0	0.0	0.0	158.2	466.9
1999	0.0	0.0	0.0	164.6	489.1
2000	0.0	0.0	0.0	171.0	511.2
2001	0.0	0.0	0.0	171.0	511.2
2002	0.0	0.0	0.0	171.0	511.2
2003	0.0	0.0	0.0	171.0	511.2
2004	0.0	0.0	0.0	171.0	511.2
2005	0.0	0.0	0.0	171.0	511.2
2006	0.0	0.0	0.0	171.0	511.2
2007	0.0	0.0	0.0	171.0	511.2
2008	0.0	0.0	0.0	171.0	511.2
2009	0.0	0.0	0.0	171.0	511.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	4747.5
7.0%	0.0	0.0	0.0	TOTAL	0.0	3605.1
10.0%	0.0	0.0	0.0	TOTAL	0.0	2504.2

Series 3

COMPARISON NO. 1

ALTERNATIVE NO.	141		2		VS	57		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.	3265.0	0.0	0.0		97.0	2640.9	0.0	0.0	97.0	624.1	6.4334
7.0%	0.0	2476.9	0.0	0.0		89.3	2[illegible]3.1	0.0	0.0	89.3	473.8	5.3066
10.0%	0.0	1717.8	0.0	0.0		82.0	1388.9	0.0	0.0	82.0	328.9	4.0098

COMPARISON NO. 2

ALTERNATIVE NO. 141 2 VS 583 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	0.0	115.3	2641.9	0.0	0.	115.3	624.1	5.4138
7.0%	0.0	2476.9	0.0	0.0	105.6	2003.1	0.0	0.0	105.6	473.8	4.4846
10.0%	0.	1717.8	0.0	0.0	96.6	1388.9	0.0	0.0	96.6	328.9	3.4037

COMPARISON NO. 3

ALTERNATIVE NO. 151 2 VS 61 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0	131.7	1368.4	0.0	0.0	131.7	812.7	6.1727
7.0%	0.0	1658.7	0.0	0.0	121.6	1039.5	0.0	0.0	121.6	619.3	5.0909
10.0%	0.0	1154.9	0.0	0.0	112.4	722.4	0.0	0.0	112.4	432.5	3.8467

COMPARISON NO. 4

ALTERNATIVE NO. 151 2 VS 62 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0	147.6	1368.4	0.0	0.0	147.6	812.7	5.5062
7.0%	0.0	1658.7	0.0	0.0	140.0	1039.5	0.0	0.0	140.0	619.3	4.4248
10.0%	0.	1154.9	0.0	0.0	133.7	722.4	0.0	0.0	133.7	432.5	3.2343

COMPARISON NO. 5

ALTERNATIVE NO.	151		2		VS	631		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0		176.3	1256.2	0.0	0.0	176.3	925.0	5.2461
7.0%	0.0	1658.7	0.0	0.0		165.4	954.4	0.0	0.0	165.4	704.3	4.2574
10.0%	0.0	1154.9	0.0	0.0		156.0	663.5	0.0	0.0	156.0	491.4	3.1497

COMPARISON NO. 6

ALTERNATIVE NO.	151		2		VS	641		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0		266.9	1256.2	0.0	0.0	266.9	925.0	3.4662
7.0%	0.0	1658.7	0.0	0.0		262.7	954.4	0.0	0.0	262.7	704.3	2.6811
10.0%	0.0	1154.9	0.0	0.0		264.0	663.5	0.0	0.0	264.0	491.4	1.8615

COMPARISON NO. 7

ALTERNATIVE NO.	151		2		VS	653		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0		210.5	1365.4	0.0	0.0	210.5	1115.7	5.3009
7.0%	0.0	1658.7	0.0	0.0		194.2	609.2	0.0	0.0	194.2	849.5	4.3743
10.0%	0.0	1154.9	0.0	0.0		179.3	562.3	0.0	0.0	179.3	592.6	3.3045

COMPARISON NO. 8

ALTERNATIVE NO. 151 2 VS 663 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	2181.2	0.0	0.0	700.6	930.5	0.0	0.0	700.6	1250.6	1.7851
7.0%	0.0	1658.7	0.0	0.0	646.6	702.3	0.0	0.0	646.6	956.4	1.4791
10.0%	0.0	1154.9	0.0	0.0	601.7	433.0	0.0	0.0	601.7	671.9	1.1167

COMPARISON NO. 9

ALTERNATIVE NO. 171 2 VS 617 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0	131.7	1368.4	0.0	0.0	131.7	115.0	0.8731
7.0%	0.0	1128.9	0.0	0.0	121.6	1039.5	0.0	0.0	121.6	89.5	0.7356
10.0%	0.0	787.0	0.0	0.0	112.4	722.4	0.0	0.0	112.4	64.6	0.5747

COMPARISON NO. 10

ALTERNATIVE NO. 171 2 VS 620 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0	147.6	1368.4	0.0	0.0	147.6	115.0	0.7789
7.0%	0.0	1128.9	0.0	0.0	140.0	1039.5	0.0	0.0	140.0	89.5	0.6394
10.0%	0.0	787.0	0.0	0.0	133.7	722.4	0.0	0.0	133.7	64.6	0.4832

COMPARISON NO. 11

ALTERNATIVE NO. 171 2 VS 650 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0	176.3	1256.2	0.0	0.0	176.3	227.2	1.2886
7.0%	0.0	1128.9	0.0	0.0	165.4	954.4	0.0	0.0	165.4	174.6	1.0551
10.0%	0.0	787.0	0.0	0.0	156.0	663.5	0.0	0.0	156.0	123.5	0.7917

COMPARISON NO. 12

ALTERNATIVE NO. 171 2 VS 640 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0	266.9	1256.2	0.0	0.0	266.9	227.2	0.8514
7.0%	0.0	1128.9	0.0	0.0	262.7	954.4	0.0	0.0	262.7	174.6	0.6644
10.0%	0.0	787.0	0.0	0.0	264.0	663.5	0.0	0.0	264.0	123.5	0.4679

COMPARISON NO. 13

ALTERNATIVE NO. 171 2 VS 650 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0	210.5	1365.4	0.0	0.0	210.5	417.9	1.9857
7.0%	0.0	1128.9	0.0	0.0	194.2	809.2	0.0	0.0	194.2	319.7	1.6463
10.0%	0.0	787.0	0.0	0.0	179.3	562.3	0.0	0.0	179.3	224.7	1.2531

COMPARISON NO. 14

ALTERNATIVE NO.	171		2		VS	68		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	1483.4	0.0	0.0		703.6	935.5	0.0	0.0	703.6	552.9	0.7891
7.0%	0.0	1128.9	0.0	0.0		646.6	702.3	0.0	0.0	646.6	426.6	0.6598
10.0%	0.0	787.0	0.0	0.0		601.7	483.0	0.0	0.0	601.7	304.0	0.5052

COMPARISON NO. 15

ALTERNATIVE NO.	141		151		VS	57		61				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		97.0	2640.9	131.7	1368.4	228.7	1436.8	6.2833
7.0%	0.0	2476.9	0.0	1658.7		89.3	2003.1	121.6	1039.5	210.9	1093.0	5.1822
10.0%	0.0	1717.8	0.0	1154.9		82.[illegible]	1588.9	112.4	722.4	194.5	761.4	3.9155

COMPARISON NO. 16

ALTERNATIVE NO.	141		151		VS	57		62				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		97.0	2640.9	147.6	1368.4	244.6	1436.8	5.8739
7.0%	0.0	2476.9	0.0	1658.7		89.3	2003.1	140.0	1039.5	229.2	1093.0	4.7682
10.0%	0.0	1717.8	0.0	1154.9		82.0	1588.9	133.7	722.4	215.8	761.4	3.5291

COMPARISON NO. 17

ALTERNATIVE NO. 141 151 VS 58[illegible] 61[illegible]

	141 PC	141 SC	151 PC	151 SC	58[illegible] PC	58[illegible] SC	61[illegible] PC	61[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2	115.3	2640.9	131.7	1368.4	246.9	1436.8	5.8184
7.0%	0.0	2476.9	0.0	1658.7	105.5	2033.1	121.6	1039.5	227.3	1093.[illegible]	4.8091
10.0%	0.0	1717.8	0.0	1154.9	96.6	1383.9	112.4	722.4	209.1	761.4	3.6419

COMPARISON NO. 18

ALTERNATIVE NO. 141 151 VS 58[illegible] 62[illegible]

	141 PC	141 SC	151 PC	151 SC	58[illegible] PC	58[illegible] SC	62[illegible] PC	62[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2	115.3	2640.9	147.6	1368.4	262.9	1436.8	5.4657
7.0%	0.0	2476.9	0.0	1658.7	105.6	2033.1	140.0	1039.5	245.6	1093.[illegible]	4.4505
10.0%	0.0	1717.8	0.0	1154.9	96.6	1388.9	133.7	722.4	230.4	761.4	3.3053

COMPARISON NO. 19

ALTERNATIVE NO. 141 151 VS 57[illegible] 63[illegible]

	141 PC	141 SC	151 PC	151 SC	57[illegible] PC	57[illegible] SC	63[illegible] PC	63[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2	97.0	2640.9	176.3	1256.2	273.3	15[illegible]1	5.6674
7.0%	0.0	2476.9	0.0	1658.7	89.3	2033.1	165.4	954.4	254.7	11[illegible]1	4.6252
10.0%	0.0	1717.8	0.0	1154.9	82.[illegible]	1388.9	156.[illegible]	663.5	238.1	820.3	3.4461

COMPARISON NO. 20

ALTERNATIVE NO. 141 151 VS 571 641

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.	0.0	2181.2	97.0	2640.9	266.9	1256.2	363.9	1549.1	4.2572
7.0%	0.0	2476.9	0.0	1658.7	89.3	2003.1	262.7	954.4	352.0	1178.1	3.3470
10.0%	0.0	1717.8	0.0	1154.9	82.1	1388.9	264.0	663.5	346.0	820.3	2.3708

COMPARISON NO. 21

ALTERNATIVE NO. 141 151 VS 561 631

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.	3265.0	0.0	2181.2	115.3	2640.9	176.3	1256.2	291.6	1549.1	5.3124
7.0%	0.0	2476.9	0.0	1658.7	105.6	2003.1	165.4	954.4	271.1	1178.1	4.3460
10.0%	0.0	1717.8	0.0	1154.9	96.6	1388.9	156.0	663.5	252.7	820.3	3.2469

COMPARISON NO. 22

ALTERNATIVE NO. 141 151 VS 561 641

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2	115.3	2640.9	266.9	1256.2	382.1	1549.1	4.0537
7.0%	0.0	2476.9	0.0	1658.7	105.6	2003.1	262.7	954.4	368.3	1178.1	3.1984
10.0%	0.0	1717.8	0.0	1154.9	96.6	1388.9	264.0	663.5	360.6	820.3	2.2748

COMPARISON NO. 23

ALTERNATIVE NO.	141		151		VS	570		650				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		97.0	2640.9	210.5	1065.4	307.5	1739.8	5.6582
7.0%	0.0	2476.9	0.0	1658.7		89.3	2003.1	194.2	809.2	283.5	1323.3	4.6679
10.0%	0.0	1717.8	0.0	1154.9		82.0	1388.9	179.3	562.3	261.4	921.6	3.5259

COMPARISON NO. 24

ALTERNATIVE NO.	141		151		VS	570		660				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		97.0	2640.9	700.6	930.5	797.6	1874.7	2.3504
7.0%	0.0	2476.9	0.0	1658.7		89.3	2003.1	646.6	702.3	735.9	1439.2	1.9434
10.0%	0.0	1717.8	0.0	1154.9		82.0	1388.9	601.7	483.0	683.7	1000.8	1.4638

COMPARISON NO. 25

ALTERNATIVE NO.	141		151		VS	580		650				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		115.3	2640.9	210.5	1065.4	325.8	1739.8	5.3409
7.0%	0.0	2476.9	0.0	1658.7		105.6	2003.1	194.2	809.2	299.8	1323.3	4.4132
10.0%	0.0	1717.8	0.0	1154.9		96.6	1388.9	179.3	562.3	276.0	921.6	3.3392

COMPARISON NO. 26

ALTERNATIVE NO.	141		151		VS	580		660				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	2181.2		115.3	2640.9	700.6	930.5	815.9	1874.7	2.2978
7.0%	0.0	2476.9	0.0	1658.7		105.6	2053.1	646.6	702.3	752.3	1430.2	1.9011
10.0%	0.0	1717.8	0.0	1154.9		96.6	1368.9	601.7	483.0	698.3	1000.8	1.4332

COMPARISON NO. 27

ALTERNATIVE NO.	161		2		VS	597		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5446.1	0.0	0.0		374.2	3872.3	0.0	0.0	374.2	1573.9	4.2059
7.0%	0.0	4135.6	0.0	0.0		340.8	2939.7	0.0	0.0	340.8	1195.9	3.5093
10.0%	0.0	2872.7	0.0	0.0		310.4	2041.1	0.0	0.0	310.4	831.6	2.6792

COMPARISON NO. 28

ALTERNATIVE NO.	161		2		VS	600		2				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5446.1	0.0	0.0		394.0	3872.3	0.0	0.0	394.0	1573.9	3.9946
7.0%	0.0	4135.6	0.0	0.0		359.8	2939.7	0.0	0.0	359.8	1195.9	3.3238
10.0%	0.0	2872.7	0.0	0.0		328.7	2041.1	0.0	0.0	328.7	831.6	2.5300

COMPARISON NO. 29

ALTERNATIVE NO. 161 2 VS 67 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	5446.1	0.0	0.0	1599.8	2993.7	0.0	0.0	1599.8	2455.4	1.5349
7.0%	0.0	4135.6	0.0	0.0	1451.0	2254.3	0.0	0.0	1451.0	1881.3	1.2966
10.0%	0.0	2672.7	0.0	0.0	1386.4	1547.1	0.0	0.0	1336.4	1325.6	1.0147

COMPARISON NO. 30

ALTERNATIVE NO. 141 171 VS 57 61

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	97.0	2649.9	131.7	1368.4	228.7	739.0	3.2319
7.0%	0.0	2476.9	0.0	1128.9	69.3	2003.1	121.6	1039.5	210.0	563.2	2.6704
10.0%	0.0	1717.8	0.0	787.0	82.0	1388.9	112.4	722.4	194.5	393.5	2.0237

COMPARISON NO. 31

ALTERNATIVE NO. 141 171 VS 57 62

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	97.0	2649.9	147.6	1368.4	244.6	739.0	3.0213
7.0%	0.0	2476.9	0.0	1128.9	69.3	2003.1	140.0	1039.5	229.2	563.2	2.4571
10.0%	0.0	1717.8	0.0	787.0	82.0	1388.9	133.7	722.4	215.8	393.5	1.8240

COMPARISON NO. 32

ALTERNATIVE NO. 141 171 VS 56[illegible] 61[illegible]

	141 PC	141 SC	171 PC	171 SC	56[illegible] PC	56[illegible] SC	61[illegible] PC	61[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	115.3	2640.9	131.7	1368.4	246.9	739.0	2.9926
7.0%	0.0	2476.0	0.0	1128.9	105.[illegible]	2033.1	121.6	1039.5	227.3	563.2	2.4782
10.0%	0.0	1717.0	0.0	787.0	96.[illegible]	1388.9	112.4	722.4	209.1	393.5	1.8823

COMPARISON NO. 33

ALTERNATIVE NO. 141 171 VS 56[illegible] 62[illegible]

	141 PC	141 SC	171 PC	171 SC	56[illegible] PC	56[illegible] SC	62[illegible] PC	62[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	115.3	2640.9	147.6	1368.4	262.9	739.0	2.8113
7.0%	0.0	2476.0	0.0	1128.9	105.[illegible]	2033.1	14[illegible].0	1039.5	245.5	563.2	2.2934
10.0%	0.0	1717.0	0.0	787.0	96.6	1388.9	133.7	722.4	23[illegible].4	393.5	1.7083

COMPARISON NO. 34

ALTERNATIVE NO. 141 171 VS 57[illegible] 63[illegible]

	141 PC	141 SC	171 PC	171 SC	57[illegible] PC	57[illegible] SC	63[illegible] PC	63[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	97.1	2647.9	176.3	1256.2	273.[illegible]	851.3	3.1145
7.0%	0.0	2476.0	0.0	1128.9	89.3	2033.1	165.4	954.4	254.7	648.3	2.5453
10.0%	0.0	1717.0	0.0	787.0	82.[illegible]	1388.[illegible]	156.[illegible]	663.5	238.1	452.5	1.9007

COMPARISON NO. 35

ALTERNATIVE NO. 141 171 VS 57. [illegible]

	141 PC	141 SC	171 PC	171 SC	57. PC	57. SC	[illegible] PC	[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	97.0	2643.9	265.9	1256.2	363.9	651.3	2.3396
7.0%	0.0	2476.0	0.0	1128.9	87.3	2003.1	262.7	954.4	352.0	649.3	1.8419
10.0%	0.0	1717.8	0.0	787.0	62.0	1388.9	264.0	663.5	346.0	452.5	1.3076

COMPARISON NO. 36

ALTERNATIVE NO. 141 171 VS [illegible] [illegible]

	141 PC	141 SC	171 PC	171 SC	[illegible] PC	[illegible] SC	[illegible] PC	[illegible] SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	115.3	2643.9	176.3	1256.2	291.6	651.3	2.9194
7.0%	0.0	2476.9	0.0	1128.9	105.6	2003.1	165.4	954.4	271.1	649.3	2.3916
10.0%	0.0	1717.3	0.0	787.0	96.6	1388.9	156.0	663.5	252.7	452.5	1.7908

COMPARISON NO. 37

ALTERNATIVE NO. 141 171 VS [illegible] 64.

	141 PC	141 SC	171 PC	171 SC	[illegible] PC	[illegible] SC	64. PC	64. SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4	115.3	2643.9	265.9	1256.2	382.1	651.3	2.2277
7.0%	0.0	2476.9	0.0	1128.9	105.0	2003.1	262.7	954.4	368.3	648.3	1.7601
10.0%	0.0	1717.3	0.0	787.0	96.6	1388.9	264.0	663.5	360.6	452.5	1.2546

COMPARISON NO. 38

ALTERNATIVE NO.	141		171		VS	570		650				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4		97.0	2640.9	210.5	1065.4	307.5	1042.0	3.3889
7.0%	0.0	2476.9	0.0	1128.9		89.3	2033.1	194.2	809.2	283.5	793.5	2.7991
10.0%	0.0	1717.8	0.0	787.0		82.0	1388.9	179.3	562.3	261.4	553.7	2.1163

COMPARISON NO. 39

ALTERNATIVE NO.	141		171		VS	570		660				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4		97.0	2640.9	700.6	936.5	797.6	1176.3	1.4756
7.0%	0.0	2476.9	0.0	1128.9		89.3	2033.1	626.6	762.3	715.9	900.4	1.2235
10.0%	0.0	1717.8	0.0	787.0		82.0	1388.9	601.7	483.0	683.7	632.9	0.9257

COMPARISON NO. 40

ALTERNATIVE NO.	141		171		VS	580		650				
	PC	SC	PC	SC		PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.0	0.0	1483.4		115.3	2640.9	210.5	1065.4	325.8	1042.0	3.1988
7.0%	0.0	2476.9	0.0	1128.9		105.6	2033.1	194.2	809.2	299.8	793.5	2.6463
10.0%	0.0	1717.8	0.0	787.0		96.6	1388.9	179.3	562.3	276.0	553.7	2.0062

COMPARISON NO. 41

ALTERNATIVE NO. 141 171 VS 560 650

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	3265.[illegible]	0.0	1463.4	115.3	2640.9	700.6	930.5	815.9	1176.9	1.4425
7.0%	0.0	2476.9	0.0	1129.9	105.6	2053.1	646.6	702.3	752.3	900.4	1.1969
10.0%	0.0	1717.8	0.0	767.0	96.6	1338.9	601.7	483.0	698.3	632.9	0.9063

COMPARISON NO. 42

ALTERNATIVE NO. 181 2 VS 500 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4747.5	0.0	0.0	374.2	3672.3	0.0	0.0	374.2	875.3	2.3391
7.0%	0.0	3035.1	0.0	0.0	340.8	2939.7	0.0	0.0	340.8	665.4	1.9526
10.0%	0.[illegible]	2504.2	0.0	0.0	310.4	2341.1	0.0	0.0	310.4	463.1	1.4919

COMPARISON NO. 43

ALTERNATIVE NO. 181 2 VS 600 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	4747.5	0.0	0.0	394.0	3672.3	0.0	0.0	394.0	875.3	2.2216
7.0%	0.0	3035.1	0.0	0.0	359.8	2939.7	0.0	0.0	359.8	665.4	1.8494
10.0%	0.0	2504.2	0.0	0.0	328.7	2341.1	0.0	0.0	328.7	463.1	1.4088

COMPARISON NO. 44

ALTERNATIVE NO. 181 2 VS 67[illegible] 2

	181 PC	181 SC	2 PC	2 SC	67[illegible] PC	67[illegible] SC	2 PC	2 SC	COST	SAVINGS	B/C RATIO
5.63	0.	4747.[illegible]	0.0	0.0	1599.8	2[illegible].7	0.0	0.0	1599.8	1756.9	1.0982
7.38	0.	36[illegible]5.1	0.0	0.0	1451.[illegible]	2254.3	0.0	0.0	1451.[illegible]	1350.8	0.9313
1[illegible].08	0.[illegible]	2534.2	0.0	0.0	1336.4	1547.1	0.0	0.0	13[illegible]6.4	957.1	0.7326

411

PART IV. TEXAS-EAST COAST PRODUCTS PIPELINE

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ALTERNATIVE NO. 9C
TEXAS-EAST COAST PRODUCTS PIPELINE

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	180.8				
1978	180.[illegible]				
1979	210.6				
1980	0.0	10.4	1.8	50.0	0.0
1981	0.0	10.8	1.8	55.0	0.0
1982	29.8	10.8	1.3	60.0	0.0
1983	160.6	13.4	[illegible]	65.0	0.0
1984	183.6	16.4	2.6	70.0	0.0
1985	201.3	15.4	2.6	75.0	0.0
1986	0.0	29.	4.2	80.0	0.0
1987	0.0	29.0	4.2	85.0	0.0
1988	0.0	29.	4.2	90.0	0.0
1989	0.	29.0	4.2	95.0	0.0
1990	0.0	29.0	4.2	100.0	0.0
1991	0.0	29.	4.2	105.0	0.0
1992	0.0	29.	4.2	110.0	0.0
1993	0.0	29.0	4.2	115.0	0.0
1994	0.0	29.	4.2	120.0	0.0
1995	0.0	29.0	4.2	125.0	0.0
1996	0.0	36.2	4.7	130.0	0.0
1997	0.	36.2	4.7	135.0	0.0
1998	0.0	36.2	4.7	140.0	0.0
1999	0.0	36.2	4.7	145.0	0.0
2000	0.0	36.2	4.7	150.0	0.0
2001	0.0	36.2	4.7	15[illegible].0	0.0
2002	0.0	36.2	4.7	15[illegible].0	0.0
2003	0.0	36.2	4.7	15[illegible].0	0.0
2004	0.	36.2	4.7	15[illegible].0	0.0
2005	0.0	36.2	4.7	15[illegible].0	0.0
2006	0.0	36.2	4.7	15[illegible].0	0.0
2007	0.0	36.2	4.7	15[illegible].0	0.0
2008	0.	36.2	4.7	15[illegible].0	0.0
2009	0.0	36.2	4.7	15[illegible].0	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.00	1129.3	424.2	55.4	TOTAL	1612.8	0.0
7.00	1116.3	332.5	46.3	TOTAL	1495.7	0.0
10.00	1104.9	241.6	34.6	TOTAL	1381.4	0.0

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PART V. EAST AND GULF COAST DRY BULK

Series 1

(Note: Shipping Cost Column Signifies Dummy

ALTERNATIVE NO. 68

COAL,35F,DEL.,SERV. H. ROADS,BALT.,ISLAND STORAGE,[illegible] DWT,65 FT DRAFT, 45.4-43.7 MTA,TR.BARGES,
(2-6-41).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	31.3				
1976	31.3				
1977	61.5				
1978	33.[illegible]				
1979	48.[illegible]				
1980	0.0	11.4	4.5	45.4	0.0
1981	0.0	11.4	4.5	45.3	0.0
1982	0.0	11.4	4.5	45.2	0.0
1983	0.0	11.4	4.5	45.1	0.0
1984	0.0	11.4	4.5	45.1	0.0
1985	0.0	11.4	4.5	45.[illegible]	0.0
1986	0.0	11.4	4.5	44.9	0.0
1987	0.0	11.4	4.5	44.8	0.0
1988	0.0	11.4	4.5	44.7	0.0
1989	0.0	11.4	4.5	44.6	0.0
1990	0.0	11.4	4.5	44.5	0.0
1991	0.0	11.3	4.5	44.5	0.0
1992	0.0	11.3	4.5	44.4	0.0
1993	0.0	11.3	4.5	44.3	0.0
1994	0.0	11.3	4.5	44.2	0.0
1995	0.0	11.3	4.5	44.1	0.0
1996	0.0	11.3	4.5	44.[illegible]	0.0
1997	0.0	11.3	4.5	44.[illegible]	0.0
1998	0.0	11.3	4.5	43.9	0.0
1999	0.0	11.3	4.5	43.8	0.0
2000	0.0	11.3	4.5	43.7	0.0
2001	0.0	11.3	4.5	43.7	0.0
2002	0.0	11.3	4.5	43.7	0.0
2003	0.0	11.3	4.5	43.7	0.0
2004	0.0	11.3	4.5	43.7	0.0
2005	0.0	11.3	4.5	43.7	0.0
2006	0.0	11.3	4.5	43.7	0.0
2007	0.0	11.3	4.5	43.7	0.0
2008	0.0	11.3	4.5	43.7	0.0
2009	0.0	11.3	4.5	43.7	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	241.5	183.3	72.6	TOTAL	497.4	0.0
7.[illegible]	255.1	15[illegible].6	59.7	TOTAL	465.7	0.0
10.[illegible]	276.9	117.9	46.7	TOTAL	441.4	0.0

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ALTERNATIVE NO. 69[illegible]
COAL,PSP,DEL.,SERV. H. ROADS,BALT.,ISLAND STORAGE,.5 ,[illegible] DWT,65 FT DRAFT, 45.4-43.7 MTA,TR.BARGES,
(2-6-[illegible]).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	12.5				
1976	12.5				
1977	13.3				
1978	38.[illegible]				
1979	40.5				
1980	0.0	11.4	4.1	45.4	0.0
1981	0.0	11.4	4.1	45.3	0.0
1982	0.0	11.4	4.1	45.2	0.0
1983	0.0	11.4	4.1	45.1	0.0
1984	0.0	11.4	4.1	45.1	0.0
1985	0.0	11.4	4.1	45.0	0.0
1986	0.0	11.4	4.1	44.9	0.0
1987	0.0	11.4	4.1	44.8	0.0
1988	0.0	11.4	4.1	44.7	0.0
1989	0.0	11.4	4.1	44.6	0.0
1990	0.0	11.4	4.1	44.5	0.0
1991	0.0	11.3	4.1	44.5	0.0
1992	0.0	11.3	4.1	44.4	0.0
1993	0.0	11.3	4.1	44.3	0.0
1994	0.0	11.3	4.1	44.2	0.0
1995	0.0	11.3	4.1	44.1	0.0
1996	0.0	11.3	4.1	44.0	0.0
1997	0.	11.3	4.1	44.0	0.0
1998	0.0	11.3	4.1	43.9	0.0
1999	0.0	11.3	4.1	43.8	0.0
2000	0.0	11.3	4.1	43.7	0.0
2001	0.	11.3	4.1	43.7	0.0
2002	0.	11.3	4.1	43.7	0.0
2003	0.0	11.3	4.1	43.7	0.0
2004	0.0	11.3	4.1	43.7	0.0
2005	0.0	11.3	4.1	43.7	0.0
2006	0.0	11.3	4.1	43.7	0.0
2007	0.0	11.3	4.1	43.7	0.0
2008	0.0	11.3	4.1	43.7	0.0
2009	0.0	11.3	4.1	43.7	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	131.[illegible]	1[illegible]3.3	6[illegible].2	TOTAL	380.4	0.
7.[illegible]	137.1	1[illegible].8	54.4	TOTAL	342.3	0.
10.[illegible]	146.7	117.9	42.5	TOTAL	337.1	0.

ALTERNATIVE NO. 72.
COAL,BS3,DEL.,SERV. H. ROADS,BALT.,ISLAND STORAGE,250,000 DWT,58.5 FT DRAFT,11.5-6.4 MTA,TR.BARGES,(
2-5-FT).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	21.2				
1976	21.2				
1977	35.7				
1978	17.3				
1979	24.2				
1980	0.0	6.0	2.3	11.5	0.0
1981	0.0	6.0	2.3	11.2	0.0
1982	0.0	6.0	2.3	11.0	0.0
1983	0.0	6.0	2.3	10.7	0.0
1984	0.0	6.0	2.3	10.5	0.0
1985	0.0	6.0	2.3	10.2	0.0
1986	0.0	6.0	2.3	10.0	0.0
1987	0.0	6.0	2.3	9.7	0.0
1988	0.0	6.0	2.3	9.5	0.0
1989	0.0	6.0	2.3	9.2	0.0
1990	0.0	6.0	2.3	9.0	0.0
1991	0.0	5.6	2.3	8.7	0.0
1992	0.0	5.6	2.3	8.4	0.0
1993	0.0	5.6	2.3	8.2	0.0
1994	0.0	5.6	2.3	7.9	0.0
1995	0.0	5.6	2.3	7.7	0.0
1996	0.0	5.6	2.3	7.4	0.0
1997	0.0	5.6	2.3	7.2	0.0
1998	0.0	5.6	2.3	6.9	0.0
1999	0.0	5.6	2.3	6.7	0.0
2000	0.0	5.6	2.3	6.4	0.0
2001	0.0	5.6	2.3	6.4	0.0
2002	0.0	5.6	2.3	6.4	0.0
2003	0.0	5.6	2.3	6.4	0.0
2004	0.0	5.6	2.3	6.4	0.0
2005	0.0	5.6	2.3	6.4	0.0
2006	0.0	5.6	2.3	6.4	0.0
2007	0.0	5.6	2.3	6.4	0.0
2008	0.0	5.6	2.3	6.4	0.0
2009	0.0	5.6	2.3	6.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	139.3	93.9	37.1	TOTAL	270.3	0.0
7.0%	147.6	77.6	30.5	TOTAL	255.7	0.0
10.0%	161.0	60.9	23.9	TOTAL	245.8	0.0

ALTERNATIV_ NO. 71[illegible]
COAL,FSI,DEL.,SERV. H. ROADS,FALT.,ISLAND STORAGE,250,000 DWT,58.5 FT DRAFT,11.5-6.4 MTA,TR.BARGES,(
2-6-62).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	1[illegible]				
1976	19.[illegible]				
1977	8.1				
1978	17.9				
1979	19.5				
1980	0.0	6.0	2.1	11.5	0.0
1981	0.0	6.0	2.1	11.2	0.0
1982	0.0	6.0	2.1	11.0	0.0
1983	0.0	6.0	2.1	10.7	0.0
1984	0.0	6.0	2.1	10.5	0.0
1985	0.0	6.0	2.1	10.2	0.0
1986	0.0	6.0	2.1	10.0	0.0
1987	0.0	6.0	2.1	9.7	0.0
1988	0.0	6.0	2.1	9.5	0.0
1989	0.0	6.0	2.1	9.2	0.0
1990	0.0	6.0	2.1	9.0	0.0
1991	0.0	5.6	2.1	8.7	0.0
1992	0.0	5.6	2.1	8.4	0.0
1993	0.0	5.6	2.1	8.2	0.0
1994	0.0	5.6	2.1	7.9	0.0
1995	0.0	5.6	2.1	7.7	0.0
1996	0.0	5.6	2.1	7.4	0.0
1997	0.0	5.6	2.1	7.2	0.0
1998	0.0	5.6	2.1	6.9	0.0
1999	0.0	5.6	2.1	6.7	0.0
2000	0.0	5.6	2.1	6.4	0.0
2001	0.0	5.6	2.1	6.4	0.0
2002	0.0	5.6	2.1	6.4	0.0
2003	0.0	5.6	2.1	6.4	0.0
2004	0.0	5.6	2.1	6.4	0.0
2005	0.0	5.6	2.1	6.4	0.0
2006	0.0	5.6	2.1	6.4	0.0
2007	0.0	5.6	2.1	6.4	0.0
2008	0.0	5.6	2.1	6.4	0.0
2009	0.0	5.6	2.1	6.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	74.5	93.9	33.9	TOTAL	232.3	0.[illegible]
7.[illegible]	78.4	77.6	27.9	TOTAL	183.9	0.[illegible]
1[illegible]	64.6	53.9	21.8	TOTAL	167.3	0.0

ALTERNATIVE NO. 72
COAL,IRON ORE,PSF,DEL,SERV. NORTH EAST,ISLAND,250,000/65 FT,45.4-43.7 AND 12.5-17.1 MTA,TR.BARGES,
(2-7-ALL.

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SHIPPING COST
1975	32.5					
1976	32.5					
1977	72.3					
1978	79.2					
1979	39.9					
1980	0.0	16.2	8.1	45.4	12.5	0.0
1981	0.0	16.2	8.1	45.3	12.7	0.0
1982	0.0	16.2	8.1	45.2	13.0	0.0
1983	0.0	16.2	8.1	45.1	13.2	0.0
1984	0.0	16.2	8.1	45.1	13.4	0.0
1985	0.0	16.2	8.1	45.0	13.7	0.0
1986	0.0	16.2	8.1	44.9	13.9	0.0
1987	0.0	16.2	8.1	44.8	14.1	0.0
1988	0.0	16.2	8.1	44.7	14.3	0.0
1989	0.0	16.2	8.1	44.6	14.6	0.0
1990	0.0	16.2	8.1	44.5	14.8	0.0
1991	0.0	16.2	8.1	44.5	15.0	0.0
1992	0.0	16.2	8.1	44.4	15.3	0.0
1993	0.0	16.2	8.1	44.3	15.5	0.0
1994	0.0	16.2	8.1	44.2	15.7	0.0
1995	0.0	16.2	8.1	44.1	16.0	0.0
1996	0.0	16.2	8.1	44.0	16.2	0.0
1997	0.0	16.2	8.1	44.0	16.4	0.0
1998	0.0	16.2	8.1	43.9	16.6	0.0
1999	0.0	16.2	8.1	43.8	16.9	0.0
2000	0.0	16.2	8.1	43.7	17.1	0.0
2001	0.0	16.2	8.1	43.7	17.1	0.0
2002	0.0	16.2	8.1	43.7	17.1	0.0
2003	0.	16.2	8.1	43.7	17.1	0.0
2004	0.0	16.2	8.1	43.7	17.1	0.0
2005	0.0	16.2	8.1	43.7	17.1	0.0
2006	0.0	16.2	8.1	43.7	17.1	0.0
2007	0.0	16.2	8.1	43.7	17.1	0.0
2008	0.0	16.2	8.1	43.7	17.1	0.0
2009	0.	16.2	8.1	43.7	17.1	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	346.4	259.7	130.7	TOTAL	736.9	0.0
7.0%	363.6	213.5	107.5	TOTAL	684.7	0.0
10.0%	390.9	166.6	84.0	TOTAL	641.4	0.0

ALTERNATIVE NO. 73[illegible]
COAL,IRON ORE,PSF,DEL,SERV. NORTH [illegible]AST,ISLAND,[illegible]/65 FT,45.4-43.7 AND 12.5-17.1 MTA,TR.BARGES,
(2-7-72).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SHIPPING COST
1975	13.8					
1976	13.8					
1977	23.4					
1978	79.2					
1979	62.4					
1980	0.0	16.2	7.8	45.4	12.5	0.0
1981	0.0	16.2	7.8	45.3	12.7	0.0
1982	0.0	16.2	7.8	45.2	13.0	0.0
1983	0.0	16.2	7.8	45.1	13.2	0.0
1984	0.0	16.2	7.8	45.1	13.4	0.0
1985	0.0	16.2	7.8	45.0	13.7	0.0
1986	0.0	16.2	7.8	44.9	13.9	0.0
1987	0.0	16.2	7.8	44.8	14.1	0.0
1988	0.0	16.2	7.8	44.7	14.3	0.0
1989	0.0	16.2	7.8	44.6	14.6	0.0
1990	0.0	16.2	7.8	44.5	14.8	0.0
1991	0.0	16.2	7.8	44.5	15.0	0.0
1992	0.0	16.2	7.8	44.4	15.3	0.0
1993	0.0	16.2	7.8	44.3	15.5	0.0
1994	0.0	16.2	7.8	44.2	15.7	0.0
1995	0.0	16.2	7.8	44.1	16.0	0.0
1996	0.0	16.2	7.8	44.0	16.2	0.0
1997	0.0	16.2	7.8	44.0	16.4	0.0
1998	0.0	16.2	7.8	43.9	16.6	0.0
1999	0.0	16.2	7.8	43.9	16.9	0.0
2000	0.0	16.2	7.8	43.7	17.1	0.0
2001	0.0	16.2	7.8	43.7	17.1	0.0
2002	0.0	16.2	7.8	43.7	17.1	0.0
2003	0.0	16.2	7.8	43.7	17.1	0.0
2004	0.0	16.2	7.8	43.7	17.1	0.0
2005	0.0	16.2	7.8	43.7	17.1	0.0
2006	0.0	16.2	7.8	43.7	17.1	0.0
2007	0.0	16.2	7.8	43.7	17.1	0.0
2008	0.0	16.2	7.8	43.7	17.1	0.0
2009	0.0	16.2	7.8	43.7	17.1	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	235.3	259.7	125.9	TOTAL	621.[illegible]	0.
7.[illegible]	245.[illegible]	213.5	103.6	TOTAL	562.[illegible]	0.
1[illegible]	262.[illegible]	166.6	[illegible]	TOTAL	5[illegible]7.5	0.

ALTERNATIVE NO. 74[illegible]
COAL,IRON ORE,PSH,DEL,SERV. NORTH EAST,ISLAND,[illegible] [illegible]/5[illegible].5 FT,11.5-6.4 AND 12.5-17.1 MTA,TR.BARGES,
(2-7- 11).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SHIPPING COST
1975	22.5					
1976	22.5					
1977	46.[illegible]					
1978	58.7					
1979	65.[illegible]					
1980	0.0	9.6	6.2	11.5	12.5	0.0
1981	0.0	9.6	6.2	11.2	12.7	0.0
1982	0.0	9.6	6.2	11.0	13.0	0.0
1983	0.0	9.6	6.2	10.7	13.2	0.0
1984	0.0	9.6	6.2	10.5	13.4	0.0
1985	0.0	9.6	6.2	10.2	13.7	0.0
1986	0.0	9.6	6.2	10.0	13.9	0.0
1987	0.0	9.6	6.2	9.7	14.1	0.0
1988	0.0	9.6	6.2	9.5	14.3	0.0
1989	0.0	9.6	6.2	9.2	14.6	0.0
1990	0.0	9.6	6.2	9.0	14.8	0.0
1991	0.0	9.6	6.2	8.7	15.0	0.0
1992	0.0	9.6	6.2	8.4	15.3	0.0
1993	0.0	9.6	6.2	8.2	15.5	0.0
1994	0.0	9.6	6.2	7.9	15.7	0.0
1995	0.0	9.6	6.2	7.7	16.0	0.0
1996	0.0	9.6	6.2	7.4	16.2	0.0
1997	0.0	9.6	6.2	7.2	16.4	0.0
1998	0.0	9.6	6.2	6.9	16.6	0.0
1999	0.0	9.6	6.2	6.7	16.9	0.0
2000	0.0	9.6	6.2	6.4	17.1	0.0
2001	0.0	9.6	6.2	6.4	17.1	0.0
2002	0.0	9.6	6.2	6.4	17.1	0.0
2003	0.0	9.6	6.2	6.4	17.1	0.0
2004	0.0	9.6	6.2	6.4	17.1	0.0
2005	0.0	9.6	6.2	6.4	17.1	0.0
2006	0.0	9.6	6.2	6.4	17.1	0.0
2007	0.0	9.6	6.2	6.4	17.1	0.0
2008	0.0	9.6	6.2	6.4	17.1	0.0
2009	0.0	9.6	6.2	6.4	17.1	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

3.[illegible]	243.1	1[illegible]3.[illegible]	10[illegible].1	TOTAL	498.2	0.
7.[illegible]	255.	127.5	82.3	TOTAL	464.8	0.
10.[illegible]	273.9	[illegible].5	64.3	TOTAL	437.7	0.

ALTERNATIVE NO. 753
COAL,IRON ORE,CSF,DEL,SERV. NORTH EAST,ISLAND,250,.20/36.5 FT,11.5-6.4 AND 12.5-17.1 MTA,TR.BARGES,
(2-7-62).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SHIPPING COST
1975	11.3					
1976	11.3					
1977	18.[illegible]					
1978	58.7					
1979	60.[illegible]					
1980	0.0	9.6	6.0	11.5	12.5	0.0
1981	0.0	9.6	6.0	11.2	12.7	0.0
1982	0.0	9.6	6.0	11.0	13.0	0.0
1983	0.0	9.6	6.0	10.7	13.2	0.0
1984	0.0	9.6	6.0	10.5	13.4	0.0
1985	0.0	9.6	6.0	10.2	13.7	0.0
1986	0.0	9.6	6.0	10.0	13.9	0.0
1987	0.0	9.6	6.0	9.7	14.1	0.0
1988	0.0	9.6	6.0	9.5	14.3	0.0
1989	0.0	9.6	6.0	9.2	14.6	0.0
1990	0.0	9.6	6.0	9.0	14.8	0.0
1991	0.0	9.6	6.0	8.7	15.0	0.0
1992	0.0	9.6	6.0	8.4	15.3	0.0
1993	0.0	9.6	6.0	8.2	15.5	0.0
1994	0.0	9.6	6.0	7.9	15.7	0.0
1995	0.0	9.6	6.0	7.7	16.0	0.0
1996	0.0	9.6	6.0	7.4	16.2	0.0
1997	0.0	9.6	6.0	7.2	16.4	0.0
1998	0.0	9.6	6.0	6.9	16.6	0.0
1999	0.0	9.6	6.0	6.7	16.9	0.0
2000	0.0	9.6	6.0	6.4	17.1	0.0
2001	0.0	9.6	6.0	6.4	17.1	0.0
2002	0.0	9.6	6.0	6.4	17.1	0.0
2003	0.0	9.6	6.0	6.4	17.1	0.0
2004	0.0	9.6	6.0	6.4	17.1	0.0
2005	0.0	9.6	6.0	6.4	17.1	0.0
2006	0.0	9.6	6.0	6.4	17.1	0.0
2007	0.0	9.6	6.0	6.4	17.1	0.0
2008	0.0	9.6	6.0	6.4	17.1	0.0
2009	0.0	9.6	6.0	6.4	17.1	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	177.7	155.0	96.8	TOTAL	429.5	0.
7.0%	185.1	127.5	79.7	TOTAL	392.2	0.0
10.0%	196.7	99.5	62.2	TOTAL	358.5	0.0

ALTERNATIVE NO. 760
COAL,H.ROADS,SERV. H. ROADS,BALT.,ONSHORE,128,110/52 FT,46.1-46.6 MTA,DIRECT LOAD,(3-1-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	12.4				
1978	12.4				
1979	12.4				
1980	0.0	0.0	0.7	46.1	0.0
1981	0.0	0.0	0.7	46.1	0.0
1982	0.0	0.0	0.7	46.1	0.0
1983	0.0	0.0	0.7	46.2	0.0
1984	0.0	0.0	0.7	46.2	0.0
1985	0.0	0.0	0.7	46.2	0.0
1986	0.0	0.0	0.7	46.2	0.0
1987	0.0	0.0	0.7	46.3	0.0
1988	0.0	0.0	0.7	46.3	0.0
1989	0.0	0.0	0.7	46.3	0.0
1990	0.0	0.0	0.7	46.3	0.0
1991	0.0	0.0	0.7	46.4	0.0
1992	0.0	0.0	0.7	46.4	0.0
1993	0.0	0.0	0.7	46.4	0.0
1994	0.0	0.0	0.7	46.4	0.0
1995	0.0	0.0	0.7	46.5	0.0
1996	0.0	0.0	0.7	46.5	0.0
1997	0.0	0.0	0.7	46.5	0.0
1998	0.0	0.0	0.7	46.5	0.0
1999	0.0	0.0	0.7	46.6	0.0
2000	0.0	0.0	0.7	46.6	0.0
2001	0.0	0.0	0.7	46.6	0.0
2002	0.0	0.0	0.7	46.6	0.0
2003	0.0	0.0	0.7	46.6	0.0
2004	0.0	0.0	0.7	46.6	0.0
2005	0.0	0.0	0.7	46.6	0.0
2006	0.0	0.0	0.7	46.6	0.0
2007	0.0	0.0	0.7	46.6	0.0
2008	0.0	0.0	0.7	46.6	0.0
2009	0.0	0.0	0.7	46.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	41.0	0.0	11.3	TOTAL	52.3	0.0
7.0%	42.7	0.0	9.3	TOTAL	51.9	0.0
10.0%	45.1	0.0	7.3	TOTAL	52.4	0.0

ALTERNATIVE NO. 776
COAL,F.ROADS,SERV. F. ROADS,BALT.,ONSHORE,179,300/52 FT,46.1-46.6 MTA,DIRECT LOAD,(3-1-8).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.0				
1976	0.0				
1977	15.3				
1978	15.3				
1979	15.3				
1980	0.0	0.0	0.9	46.1	0.0
1981	0.0	0.0	0.9	46.1	0.0
1982	0.0	0.0	0.9	46.1	0.0
1983	0.0	0.0	0.9	46.2	0.0
1984	0.0	0.0	0.9	46.2	0.0
1985	0.0	0.0	0.9	46.2	0.0
1986	0.0	0.0	0.9	46.2	0.0
1987	0.0	0.0	0.9	46.3	0.0
1988	0.0	0.0	0.9	46.3	0.0
1989	0.0	0.0	0.9	46.3	0.0
1990	0.0	0.0	0.9	46.3	0.0
1991	0.0	0.0	0.9	46.4	0.0
1992	0.0	0.0	0.9	46.4	0.0
1993	0.0	0.0	0.9	46.4	0.0
1994	0.0	0.0	0.9	46.4	0.0
1995	0.0	0.0	0.9	46.5	0.0
1996	0.0	0.0	0.9	46.5	0.0
1997	0.0	0.0	0.9	46.5	0.0
1998	0.0	0.0	0.9	46.5	0.0
1999	0.0	0.0	0.9	46.6	0.0
2000	0.0	0.0	0.9	46.6	0.0
2001	0.0	0.0	0.9	46.6	0.0
2002	0.0	0.0	0.9	46.6	0.0
2003	0.0	0.0	0.9	46.6	0.0
2004	0.0	0.0	0.9	46.6	0.0
2005	0.0	0.0	0.9	46.6	0.0
2006	0.0	0.0	0.9	46.6	0.0
2007	0.0	0.0	0.9	46.6	0.0
2008	0.0	0.0	0.9	46.6	0.0
2009	0.0	0.0	0.9	46.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	50.6	0.0	14.5	TOTAL	65.2	0.0
7.0%	52.6	0.0	11.9	TOTAL	64.6	0.0
10.0%	55.7	0.0	9.3	TOTAL	65.0	0.0

ALTERNATIVE NO. 7B.
GRAIN,GIB,SERV. GULF,(ISLAND,25?,C?/765 FT,32.8-58.9 MTS,TR. BARGES,(4-4-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	22.				
1976	22.0				
1977	31.6				
1978	90.2				
1979	90.2				
1980	0.0	11.1	4.3	32.8	0.0
1981	0.0	11.1	4.3	34.1	0.0
1982	0.0	11.1	4.3	35.4	0.0
1983	0.0	11.1	4.3	36.7	0.0
1984	0.0	11.1	4.3	38.0	0.0
1985	0.0	11.1	4.3	39.3	0.0
1986	0.	11.1	4.3	40.6	0.0
1987	0.0	11.1	4.3	41.9	0.0
1988	0.	11.1	4.3	43.2	0.0
1989	0.	11.1	4.3	44.5	0.0
1990	0.0	11.1	4.3	45.8	0.0
1991	0.0	13.0	4.3	47.2	0.0
1992	0.0	13.0	4.3	48.5	0.0
1993	0.	13.	4.3	49.8	0.0
1994	0.	13.0	4.3	51.1	0.0
1995	0.0	13.	4.3	52.4	0.0
1996	0.	13.	4.3	53.7	0.0
1997	0.0	13.	4.3	55.0	0.0
1998	0.0	13.0	4.3	56.3	0.0
1999	0.	13.	4.3	57.6	0.0
2000	0.	13.0	4.3	58.9	0.0
2001	0.0	13.	4.3	58.9	0.0
2002	0.	13.	4.3	58.9	0.0
2003	0.0	13.	4.3	58.9	0.0
2004	0.0	13.0	4.3	58.9	0.0
2005	0.0	13.0	4.3	58.9	0.0
2006	0.0	13.	4.3	58.9	0.0
2007	0.	13.0	4.3	58.9	0.0
2008	0.0	13.0	4.3	58.9	0.0
2009	0.0	13.	4.3	58.9	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]%	225.6	133.3	63.4	TOTAL	548.2	0.
7.[illegible]%	298.2	137.4	57.1	TOTAL	512.6	0.
1[illegible]%	313.1	121.2	44.6	TOTAL	483.9	0.

ALTERNATIVE NO. 79[illegible]
GRAIN,[illegible]IB.SERV. GULF,ISLAND,25[illegible],[illegible]/56.5 FT,18.[illegible]-23.6 MTA,I[illegible].BARGES,(4-4-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	16.5				
1976	16.5				
1977	23.[illegible]				
1978	55.9				
1979	55.4				
1980	0.[illegible]	8.[illegible]	2.7	18.0	0.0
1981	0.[illegible]	8.[illegible]	2.7	1[illegible].3	0.0
1982	0.[illegible]	8.[illegible]	2.7	18.6	0.0
1983	0.[illegible]	8.[illegible]	2.7	18.9	0.0
1984	0.[illegible]	8.[illegible]	2.7	19.1	0.0
1985	0.[illegible]	8.[illegible]	2.7	19.4	0.0
1986	0.[illegible]	8.[illegible]	2.7	19.7	0.0
1987	0.[illegible]	8.[illegible]	2.7	20.0	0.0
1988	0.[illegible]	8.[illegible]	2.7	2[illegible].2	0.0
1989	0.[illegible]	8.[illegible]	2.7	20.5	0.0
1990	0.[illegible]	8.[illegible]	2.7	20.8	0.0
1991	0.[illegible]	8.4	2.7	21.1	0.0
1992	0.[illegible]	8.4	2.7	21.4	0.0
1993	0.[illegible]	8.4	2.7	21.6	0.0
1994	0.[illegible]	8.4	2.7	21.9	0.0
1995	0.[illegible]	8.4	2.7	22.2	0.0
1996	0.[illegible]	8.4	2.7	22.5	0.0
1997	0.[illegible]	8.4	2.7	22.8	0.0
1998	0.[illegible]	8.4	2.7	23.0	0.0
1999	0.[illegible]	8.4	2.7	23.3	0.0
2000	0.[illegible]	8.4	2.7	23.6	0.0
2001	0.[illegible]	8.4	2.7	23.6	0.0
2002	0.[illegible]	8.4	2.7	23.6	0.0
2003	0.[illegible]	8.4	2.7	23.6	0.0
2004	0.[illegible]	8.4	2.7	23.6	0.0
2005	0.[illegible]	8.4	2.7	23.6	0.0
2006	0.[illegible]	8.4	2.7	23.6	0.0
2007	0.[illegible]	8.4	2.7	23.6	0.0
2008	0.[illegible]	8.4	2.7	23.6	0.0
2009	0.[illegible]	8.4	2.7	23.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	128.1	132.1	43.6	TOTAL	363.7	0.
7.[illegible]	136.8	1[illegible]4.3	3[illegible].5	TOTAL	341.9	0.
10.[illegible]	213.5	[illegible]4.2	2[illegible]	TOTAL	322.7	0.

ALTERNATIVE NO. 80
GRAIN,OIL,SERV. GULF,ISLAND,12 ,00 /50 FT,18.0-23.6 MTA,TR. BARGES, (4-4-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	14.7				
1976	14.7				
1977	23.1				
1978	46.2				
1979	46.2				
1980	0.0	8.	2.3	18.0	0.0
1981	0.0	8.3	2.3	18.3	0.0
1982	0.0	8.	2.3	18.6	0.0
1983	0.0	8.	2.3	18.9	0.0
1984	0.0	8.3	2.3	19.1	0.0
1985	0.0	8.	2.3	19.4	0.0
1986	0.0	8.	2.3	19.7	0.0
1987	0.0	8.	2.3	20.0	0.0
1988	0.0	8.	2.3	20.2	0.0
1989	0.0	8.	2.3	20.5	0.0
1990	0.0	8.	2.3	20.8	0.0
1991	0.0	8.4	2.3	21.1	0.0
1992	0.0	8.4	2.3	21.4	0.0
1993	0.	8.4	2.3	21.6	0.0
1994	0.0	8.4	2.3	21.9	0.0
1995	0.0	8.4	2.3	22.2	0.0
1996	0.0	8.4	2.3	22.5	0.0
1997	0.0	8.4	2.3	22.8	0.0
1998	0.0	8.4	2.3	23.0	0.0
1999	0.0	8.4	2.3	23.3	0.0
2000	0.0	8.4	2.3	23.6	0.0
2001	0.0	8.4	2.3	23.6	0.0
2002	0.0	8.4	2.3	23.6	0.0
2003	0.0	8.4	2.3	23.6	0.0
2004	0.0	8.4	2.3	23.6	0.0
2005	0.0	8.4	2.3	23.6	0.0
2006	0.0	8.4	2.3	23.6	0.0
2007	0.0	8.4	2.3	23.6	0.0
2008	0.0	8.4	2.3	23.6	0.0
2009	0.	8.4	2.3	23.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.38	159.3	132.1	37.1	TOTAL	328.6	0.
7.38	166.3	108.3	30.5	TOTAL	335.7	0.0
10.00	178.7	94.2	23.9	TOTAL	286.8	0.

ALTERNATIVE NO. 816
IRON ORE,GIB,SERV. GULF,ISLAND,250,300/65 FT,7.6-10.4 MIA,TR. BARGES, (4-5-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	12.6				
1976	12.4				
1977	16.2				
1978	24.7				
1979	29.4				
1980	0.0	6.2	2.4	7.6	0.0
1981	0.0	6.2	2.4	7.7	0.0
1982	0.0	6.2	2.4	7.9	0.0
1983	0.0	6.2	2.4	8.0	0.0
1984	0.0	6.2	2.4	8.2	0.0
1985	0.0	6.2	2.4	8.3	0.0
1986	0.0	6.2	2.4	8.4	0.0
1987	0.0	6.2	2.4	8.6	0.0
1988	0.0	6.2	2.4	8.7	0.0
1989	0.0	6.2	2.4	8.9	0.0
1990	0.0	6.2	2.4	9.0	0.0
1991	0.0	6.4	2.4	9.1	0.0
1992	0.0	6.4	2.4	9.3	0.0
1993	0.0	6.4	2.4	9.4	0.0
1994	0.0	6.4	2.4	9.6	0.0
1995	0.0	6.4	2.4	9.7	0.0
1996	0.0	6.4	2.4	9.8	0.0
1997	0.0	6.4	2.4	10.0	0.0
1998	0.0	6.4	2.4	10.1	0.0
1999	0.0	6.4	2.4	10.3	0.0
2000	0.0	6.4	2.4	10.4	0.0
2001	0.0	6.4	2.4	10.4	0.0
2002	0.0	6.4	2.4	10.4	0.0
2003	0.0	6.4	2.4	10.4	0.0
2004	0.0	6.4	2.4	10.4	0.0
2005	0.0	6.4	2.4	10.4	0.0
2006	0.0	6.4	2.4	10.4	0.0
2007	0.0	6.4	2.4	10.4	0.0
2008	0.0	6.4	2.4	10.4	0.0
2009	0.0	6.4	2.4	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	107.1	101.6	38.7	TOTAL	247.4	0.0
7.0%	112.7	83.4	31.9	TOTAL	227.9	0.0
10.0%	121.4	64.9	24.9	TOTAL	211.3	0.0

ALTERNATIVE NO. 82C
IRON ORE,GIW,SERV. GULF,ISLAND,250,000/58.5 FT,7.6-10.4 MTA,TR. BARGES, (4-5-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	12.5				
1976	12.3				
1977	16.2				
1978	24.[illegible]				
1979	28.2				
1980	0.0	6.2	2.4	7.6	0.0
1981	0.0	6.2	2.4	7.7	0.0
1982	0.0	6.2	2.4	7.9	0.0
1983	0.0	6.2	2.4	8.0	0.0
1984	0.0	6.2	2.4	8.2	0.0
1985	0.0	6.2	2.4	8.3	0.0
1986	0.0	6.2	2.4	8.4	0.0
1987	0.0	6.2	2.4	8.6	0.0
1988	0.0	6.2	2.4	8.7	0.0
1989	0.0	6.2	2.4	8.9	0.0
1990	0.0	6.2	2.4	9.0	0.0
1991	0.0	6.4	2.4	9.1	0.0
1992	0.0	6.4	2.4	9.3	0.0
1993	0.0	6.4	2.4	9.4	0.0
1994	0.0	6.4	2.4	9.6	0.0
1995	0.0	6.4	2.4	9.7	0.0
1996	0.0	6.4	2.4	9.8	0.0
1997	0.0	6.4	2.4	10.0	0.0
1998	0.0	6.4	2.4	10.1	0.0
1999	0.0	6.4	2.4	10.3	0.0
2000	0.0	6.4	2.4	10.4	0.0
2001	0.0	6.4	2.4	10.4	0.0
2002	0.0	6.4	2.4	10.4	0.0
2003	0.0	6.4	2.4	10.4	0.0
2004	0.0	6.4	2.4	10.4	0.0
2005	0.0	6.4	2.4	10.4	0.0
2006	0.0	6.4	2.4	10.4	0.0
2007	0.0	6.4	2.4	10.4	0.0
2008	0.0	6.4	2.4	10.4	0.0
2009	0.0	6.4	2.4	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	136.7	101.6	35.7	TOTAL	247.0	0.0
7.0%	112.2	83.4	31.9	TOTAL	227.5	0.0
10.0%	121.0	64.9	24.9	TOTAL	210.8	0.0

ALTERNATIVE NO. 830
GRAIN,IRON ORE,GIG,SERV.GULF,ISLAND,25 ,30 65 FT,32.8-58.9 AND 7.6-10.4 MTA,TR.BARGES,(4-6-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SHIPPING COST
1975	25.7					
1976	25.7					
1977	37.7					
1978	114.4					
1979	113.5					
1980	0.0	14.7	6.4	32.8	7.6	0.0
1981	0.0	14.7	6.4	34.1	7.7	0.0
1982	0.0	14.7	6.4	35.4	7.9	0.0
1983	0.0	14.7	6.4	36.7	8.0	0.0
1984	0.0	14.7	6.4	38.0	8.2	0.0
1985	0.0	14.7	6.4	39.3	8.3	0.0
1986	0.0	14.7	6.4	40.6	8.4	0.0
1987	0.0	14.7	6.4	41.9	8.6	0.0
1988	0.0	14.7	6.4	43.2	8.7	0.0
1989	0.0	14.7	6.4	44.5	8.9	0.0
1990	0.0	14.7	6.4	45.8	9.0	0.0
1991	0.0	16.9	6.4	47.2	9.1	0.0
1992	0.0	16.9	6.4	48.5	9.3	0.0
1993	0.0	16.9	6.4	49.8	9.4	0.0
1994	0.0	16.9	6.4	51.1	9.6	0.0
1995	0.0	16.9	6.4	52.4	9.7	0.0
1996	0.0	16.9	6.4	53.7	9.8	0.0
1997	0.0	16.9	6.4	55.0	10.0	0.0
1998	0.0	16.9	6.4	56.3	10.1	0.0
1999	0.0	16.9	6.4	57.6	10.3	0.0
2000	0.0	16.9	6.4	58.9	10.4	0.0
2001	0.0	16.9	6.4	58.9	10.4	0.0
2002	0.0	16.9	6.4	58.9	10.4	0.0
2003	0.0	16.9	6.4	58.9	10.4	0.0
2004	0.0	16.9	6.4	58.9	10.4	0.0
2005	0.0	16.9	6.4	58.9	10.4	0.0
2006	0.0	16.9	6.4	58.9	10.4	0.0
2007	0.0	16.9	6.4	58.9	10.4	0.0
2008	0.0	16.9	6.4	58.9	10.4	0.0
2009	0.0	16.9	6.4	58.9	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.38	358.2	253.6	103.3	TOTAL	715.1	0.
7.38	373.7	206.7	85.0	TOTAL	665.4	0.
10.38	393.0	159.5	66.4	TOTAL	623.9	0.

ALTERNATIVE NO. 84[illegible]
GRAIN,IRON ORE,GIB,SERV.GULF,ISLAND,25 ,[illegible] 58.5 FT,25.,[illegible] 58.5 FT,18.[illegible]-23.6 AND 7.6-10.4 ,TA,TR.BA
RGES,(4-6-[illegible]).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SHIPPING COST
1975	23.2					
1976	23.7					
1977	29.1					
1978	79.9					
1979	84.[illegible]					
1980	0.0	10.6	4.9	18.0	7.6	0.0
1981	0.0	10.6	4.9	18.3	7.7	0.0
1982	0.0	10.6	4.9	18.6	7.9	0.0
1983	0.0	10.6	4.9	18.8	8.0	0.0
1984	0.	10.6	4.9	19.1	8.2	0.0
1985	0.0	10.6	4.9	19.4	8.3	0.0
1986	0.0	10.6	4.9	19.7	8.4	0.0
1987	0.	10.6	4.9	[illegible]	8.6	0.0
1988	0.0	10.6	4.9	20.2	8.7	0.0
1989	0.0	10.6	4.9	20.5	8.9	0.0
1990	0.0	10.6	4.9	2[illegible].8	9.0	0.0
1991	0.	11.3	4.9	21.1	9.1	0.0
1992	0.0	11.3	4.9	21.4	9.3	0.0
1993	0.0	11.3	4.9	21.6	9.4	0.0
1994	0.0	11.3	4.9	21.9	9.6	0.0
1995	0.0	11.3	4.9	22.2	9.7	0.0
1996	0.0	11.3	4.9	22.5	9.8	0.0
1997	0.	11.3	4.9	22.8	10.0	0.0
1998	0.0	11.3	4.9	23.0	10.1	0.0
1999	0.0	11.3	4.9	23.3	10.3	0.0
2000	0.0	11.3	4.9	23.6	10.4	0.0
2001	0.0	11.3	4.9	23.6	10.4	0.0
2002	0.0	11.3	4.9	23.6	10.4	0.0
2003	0.	11.3	4.9	23.6	10.4	0.0
2004	0.0	11.3	4.9	23.6	10.4	0.0
2005	0.0	11.3	4.9	23.6	10.4	0.0
2006	0.0	11.3	4.9	23.6	10.4	0.0
2007	0.0	11.3	4.9	23.6	10.4	0.0
2008	0.	11.3	4.9	23.6	10.4	0.0
2009	0.0	11.3	4.9	23.6	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	260.3	176.3	7[illegible].1	TOTAL	515.7	0.
7.[illegible]	271.6	144.4	65.1	TOTAL	481.3	0.[illegible]
10.[illegible]	269.9	112.2	5[illegible].8	TOTAL	452.9	0.[illegible]

ALTERNATIVE NO. 853
GRAIN,IRON ORE,GIB,SERV.GULF,ISLAND,12..,31.. 53 FT,25..,3.. 65 FT,18..-23.6 AND 7.6-10.4 MTA,TR.BARG
ES,(4-6-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SHIPPING COST
1975	18.3					
1976	13.3					
1977	25.1					
1978	73.5					
1979	74.0					
1980	0.0	10.7	4.5	18.0	7.6	0.0
1981	0.0	10.7	4.5	18.3	7.7	0.0
1982	0.0	10.7	4.5	18.6	7.9	0.0
1983	0.0	10.7	4.5	18.8	8.0	0.0
1984	0.0	10.7	4.5	19.1	8.2	0.0
1985	0.0	10.7	4.5	19.4	8.3	0.0
1986	0.0	10.7	4.5	19.7	8.4	0.0
1987	0.0	10.7	4.5	20.0	8.6	0.0
1988	0.0	10.7	4.5	20.2	8.7	0.0
1989	0.0	10.7	4.5	20.5	8.9	0.0
1990	0.0	10.7	4.5	20.8	9.0	0.0
1991	0.0	11.3	4.5	21.1	9.1	0.0
1992	0.0	11.3	4.5	21.4	9.3	0.0
1993	0.0	11.3	4.5	21.6	9.4	0.0
1994	0.0	11.3	4.5	21.9	9.6	0.0
1995	0.0	11.3	4.5	22.2	9.7	0.0
1996	0.0	11.3	4.5	22.5	9.8	0.0
1997	0.	11.3	4.5	22.8	10.0	0.0
1998	0.0	11.3	4.5	23.0	10.1	0.0
1999	0.0	11.3	4.5	23.3	10.3	0.0
2000	0.0	11.3	4.5	23.6	10.4	0.0
2001	0.0	11.3	4.5	23.6	10.4	0.0
2002	0.	11.3	4.5	23.6	10.4	0.0
2003	0.0	11.3	4.5	23.6	10.4	0.0
2004	0.0	11.3	4.5	23.6	10.4	0.0
2005	0.0	11.3	4.5	23.6	10.4	0.0
2006	0.0	11.3	4.5	23.6	10.4	0.0
2007	0.0	11.3	4.5	23.6	10.4	0.0
2008	0.0	11.3	4.5	23.6	10.4	0.0
2009	0.0	11.3	4.5	23.6	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	231.9	177.2	72.6	TOTAL	481.7	0.0
7.0%	242.2	145.2	59.7	TOTAL	447.1	0.0
10.0%	258.4	112.9	46.7	TOTAL	417.9	0.0

ALTERNATIVE NO. 86[illegible]
GRAIN,IRON ORE,DIB,SERV.GULF,ISLAND,12 [illegible] 50 FT,250,[illegible] 58.5 FT,18.0-23.6 AND 7.6-10.4 MTA,TR.BARGES,(4-6-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SHIPPING COST
1975	15.3					
1976	13.3					
1977	26.1					
1978	70.3					
1979	74.4					
1980	0.0	10.7	4.5	18.0	7.6	0.0
1981	0.0	10.7	4.5	18.3	7.7	0.0
1982	0.0	10.7	4.5	18.6	7.9	0.0
1983	0.0	10.7	4.5	18.8	8.0	0.0
1984	0.0	10.7	4.5	19.1	8.2	0.0
1985	0.0	10.7	4.5	19.4	8.3	0.0
1986	0.0	10.7	4.5	19.7	8.4	0.0
1987	0.0	10.7	4.5	20.0	8.6	0.0
1988	0.0	10.7	4.5	20.2	8.7	0.0
1989	0.0	10.7	4.5	20.5	8.9	0.0
1990	0.0	10.7	4.5	20.8	9.0	0.0
1991	0.0	11.3	4.5	21.1	9.1	0.0
1992	0.0	11.3	4.5	21.4	9.3	0.0
1993	0.0	11.3	4.5	21.6	9.4	0.0
1994	0.0	11.3	4.5	21.9	9.6	0.0
1995	0.0	11.3	4.5	22.2	9.7	0.0
1996	0.0	11.3	4.5	22.5	9.8	0.0
1997	0.0	11.3	4.5	22.8	10.0	0.0
1998	0.0	11.3	4.5	23.0	10.1	0.0
1999	0.0	11.3	4.5	23.3	10.3	0.0
2000	0.0	11.3	4.5	23.6	10.4	0.0
2001	0.0	11.3	4.5	23.6	10.4	0.0
2002	0.0	11.3	4.5	23.6	10.4	0.0
2003	0.0	11.3	4.5	23.6	10.4	0.0
2004	0.0	11.3	4.5	23.6	10.4	0.0
2005	0.0	11.3	4.5	23.6	10.4	0.0
2006	0.0	11.3	4.5	23.6	10.4	0.0
2007	0.0	11.3	4.5	23.6	10.4	0.0
2008	0.0	11.3	4.5	23.6	10.4	0.0
2009	0.0	11.3	4.5	23.6	10.4	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	231.4	177.2	72.6	TOTAL	481.2	0.0
7.0%	241.7	145.2	59.7	TOTAL	446.7	0.0
10.0%	257.0	112.9	46.7	TOTAL	417.5	0.0

ALTERNATIVE NO. 87[illegible]
GRAIN,FREEPORT,SERV.TEXAS,[illegible]5[illegible].5 FT,18.0-23.6 MTA,TR.BARGES,(5-7-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.[illegible]				
1976	0.				
1977	13.[illegible]				
1978	34.2				
1979	54.3				
1980	0.	5.4	2.3	18.0	0.0
1981	0.	5.4	2.3	18.3	0.0
1982	0.	5.4	2.3	18.6	0.0
1983	0.	5.4	2.3	18.8	0.0
1984	0.	5.4	2.3	19.1	0.0
1985	0.	5.4	2.3	19.4	0.0
1986	0.0	5.4	2.3	19.7	0.0
1987	0.	5.4	2.3	20.0	0.0
1988	0.[illegible]	5.4	2.3	20.2	0.0
1989	0.[illegible]	5.4	2.3	20.5	0.0
1990	0.[illegible]	5.4	2.3	20.8	0.0
1991	0.	5.8	2.3	21.1	0.0
1992	0.[illegible]	5.8	2.3	21.4	0.0
1993	0.[illegible]	5.8	2.3	21.6	0.0
1994	0.	5.8	2.3	21.9	0.0
1995	0.	5.[illegible]	2.3	22.2	0.0
1996	0.[illegible]	5.[illegible]	2.3	22.5	0.0
1997	0.[illegible]	5.8	2.3	22.8	0.0
1998	0.[illegible]	5.8	2.3	23.0	0.0
1999	0.[illegible]	5.8	2.3	23.3	0.0
2000	0.[illegible]	5.8	2.3	23.6	0.0
2001	0.[illegible]	5.[illegible]	2.3	23.6	0.0
2002	0.	5.[illegible]	2.3	23.6	0.0
2003	0.[illegible]	5.[illegible]	2.3	23.6	0.0
2004	0.	5.8	2.3	23.6	0.0
2005	0.	5.8	2.3	23.6	0.0
2006	0.	5.8	2.3	23.6	0.0
2007	0.	5.8	2.3	23.6	0.0
2008	0.[illegible]	5.8	2.3	23.6	0.0
2009	0.[illegible]	5.[illegible]	2.3	23.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	131.[illegible]	[illegible].1	37.1	TOTAL	259.1	0.[illegible]
7.[illegible]	136.1	73.8	3[illegible].5	TOTAL	240.4	0.[illegible]
1[illegible]	142.6	57.3	23.9	TOTAL	223.8	0.[illegible]

ALTERNATIVE NO. 88.
GRAIN,FREEPORT,SERV.TEXAS,INSHORE,12, [illegible] FT,16.0-23.0 MTA,TR.BARGES. (5-7-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SHIPPING COST
1975	0.				
1976	0.				
1977	13.				
1978	42.3				
1979	43.4				
1980	0.	5.7	1.8	16.0	0.0
1981	0.	5.7	1.8	16.3	0.0
1982	0.	5.7	1.8	16.6	0.0
1983	0.	5.7	1.8	16.8	0.0
1984	0.	5.7	1.8	19.1	0.0
1985	0.	5.7	1.8	19.4	0.0
1986	0.	5.7	1.8	19.7	0.0
1987	0.	5.7	1.8	20.0	0.0
1988	0.	5.7	1.8	20.2	0.0
1989	0.	5.7	1.8	20.5	0.0
1990	0.	5.7	1.8	20.8	0.0
1991	0.	6.1	1.8	21.1	0.0
1992	0.	6.1	1.8	21.4	0.0
1993	0.	6.1	1.8	21.6	0.0
1994	0.	6.1	1.8	21.9	0.0
1995	0.	6.1	1.9	22.2	0.0
1996	0.	6.1	1.9	22.5	0.0
1997	0.	6.1	1.8	22.8	0.0
1998	0.	6.1	1.8	23.0	0.0
1999	0.	6.1	1.8	23.3	0.0
2000	0.	6.1	1.8	23.6	0.0
2001	0.	6.1	1.8	23.6	0.0
2002	0.	6.1	1.8	23.6	0.0
2003	0.	6.1	1.8	23.6	0.0
2004	0.	6.1	1.9	23.6	0.0
2005	0.	6.1	1.8	23.6	0.0
2006	0.	6.1	1.8	23.6	0.0
2007	0.	6.1	1.8	23.6	0.0
2008	0.	6.1	1.8	23.6	0.0
2009	0.	6.1	1.8	23.6	0.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	137.3	95.	24.1	TOTAL	231.3	0.
7.0%	113.	77.8	23.3	TOTAL	212.5	0.
10.0%	115.2	63.4	19.7	TOTAL	195.3	0.

Series 2
(Note: 3 Cost Columns Signify Dummy)

ALTERNATIVE NO. 191
SAVINGS,COAL,BSH,DEL.,CONVENTIONAL DESIGN VESSEL,(2-6-A1,2-6-A2).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.				
1976	0.				
1977	0.				
1978	0.				
1979	0.				
1980	0.	0.	0.	45.4	11.3
1981	0.	0.	0.	45.3	11.2
1982	0.	0.	0.	45.2	11.1
1983	0.	0.	0.	45.1	11.0
1984	0.	0.	0.	45.1	10.9
1985	0.	0.	0.	45.0	10.8
1986	0.	0.	0.	44.9	10.7
1987	0.	0.	0.	44.8	10.6
1988	0.	0.	0.	44.7	10.5
1989	0.	0.	0.	44.6	10.4
1990	0.	0.	0.	44.5	10.3
1991	0.	0.	0.	44.5	10.1
1992	0.	0.	0.	44.4	10.0
1993	0.	0.	0.	44.3	9.9
1994	0.	0.	0.	44.2	9.8
1995	0.	0.	0.	44.1	9.7
1996	0.	0.	0.	44.0	9.6
1997	0.	0.	0.	44.0	9.5
1998	0.	0.	0.	43.9	9.4
1999	0.	0.	0.	43.8	9.3
2000	0.	0.	0.	43.7	9.2
2001	0.	0.	0.	43.7	9.2
2002	0.	0.	0.	43.7	9.2
2003	0.	0.	0.	43.7	9.2
2004	0.	0.	0.	43.7	9.2
2005	0.	0.	0.	43.7	9.2
2006	0.	0.	0.	43.7	9.2
2007	0.	0.	0.	43.7	9.2
2008	0.	0.	0.	43.7	9.2
2009	0.	0.	0.	43.7	9.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0	0.	0.0	0.0	TOTAL	0.0	165.1
7.0	0.	0.0	0.0	TOTAL	0.0	137.3
10.0	0.	0.0	0.0	TOTAL	0.0	108.7

ALTERNATIVE NO. 2-1
SAVINGS,COAL,ESC,DEL.,RESTRICTED DRAFT DESIGN,(2-6-51,2-6-62).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	11.5		5.9
1981	0.0	0.0	0.0	11.2		5.8
1982	0.0	0.0	0.0	11.0		5.6
1983	0.0	0.0	0.0	10.7		5.5
1984	0.0	0.0	0.0	10.5		5.4
1985	0.0	0.0	0.0	10.2		5.2
1986	0.0	0.0	0.0	10.0		5.1
1987	0.0	0.0	0.0	9.7		5.0
1988	0.0	0.0	0.0	9.5		4.9
1989	0.0	0.0	0.0	9.2		4.7
1990	0.0	0.0	0.0	9.0		4.6
1991	0.0	0.0	0.0	8.7		4.5
1992	0.0	0.0	0.0	8.4		4.3
1993	0.0	0.0	0.0	8.2		4.2
1994	0.0	0.0	0.0	7.9		4.1
1995	0.0	0.0	0.0	7.7		3.9
1996	0.0	0.0	0.0	7.4		3.3
1997	0.0	0.0	0.0	7.2		3.7
1998	0.0	0.0	0.0	6.9		3.6
1999	0.0	0.0	0.0	6.7		3.4
2000	0.0	0.0	0.0	6.4		3.3
2001	0.0	0.0	0.0	6.4		3.3
2002	0.0	0.0	0.0	6.4		3.3
2003	0.0	0.0	0.0	6.4		3.3
2004	0.0	0.0	0.0	6.4		3.3
2005	0.0	0.0	0.0	6.4		3.3
2006	0.0	0.0	0.0	6.4		3.3
2007	0.0	0.0	0.0	6.4		3.3
2008	0.0	0.0	0.0	6.4		3.3
2009	0.0	0.0	0.0	6.4		3.3

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]%	0.0	0.0	0.0	TOTAL	0.0	73.8
7.0%	0.0	0.0	0.0	TOTAL	0.0	62.5
10.0%	0.0	0.0	0.0	TOTAL	0.0	50.6

ALTERNATIVE NO. 211
SAVINGS,COAL AND IRON ORE,USE,PEL.,CONVENTIONAL DESIGN VESSEL,(2-7-A1,2-7-A2).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	45.4	12.5	17.5
1981	0.0	0.0	0.0	45.3	12.7	17.5
1982	0.0	0.0	0.0	45.2	13.0	17.5
1983	0.0	0.0	0.0	45.1	13.2	17.5
1984	0.0	0.0	0.0	45.1	13.4	17.6
1985	0.0	0.0	0.0	45.0	13.7	17.6
1986	0.0	0.0	0.0	44.9	13.9	17.6
1987	0.0	0.0	0.0	44.8	14.1	17.6
1988	0.0	0.0	0.0	44.7	14.3	17.6
1989	0.0	0.0	0.0	44.6	14.6	17.6
1990	0.0	0.0	0.0	44.5	14.8	17.6
1991	0.0	0.0	0.0	44.5	15.0	17.7
1992	0.0	0.0	0.0	44.4	15.3	17.7
1993	0.0	0.0	0.0	44.3	15.5	17.7
1994	0.0	0.0	0.0	44.2	15.7	17.7
1995	0.0	0.0	0.0	44.1	16.0	17.7
1996	0.0	0.0	0.0	44.0	16.2	17.7
1997	0.0	0.0	0.0	44.0	16.4	17.8
1998	0.0	0.0	0.0	43.9	16.6	17.8
1999	0.0	0.0	0.0	43.8	16.9	17.8
2000	0.0	0.0	0.0	43.7	17.1	17.8
2001	0.0	0.0	0.0	43.7	17.1	17.8
2002	0.0	0.0	0.0	43.7	17.1	17.8
2003	0.0	0.0	0.0	43.7	17.1	17.8
2004	0.0	0.0	0.0	43.7	17.1	17.8
2005	0.0	0.0	0.0	43.7	17.1	17.8
2006	0.0	0.0	0.0	43.7	17.1	17.8
2007	0.0	0.0	0.0	43.7	17.1	17.8
2008	0.0	0.0	0.0	43.7	17.1	17.8
2009	0.0	0.0	0.0	43.7	17.1	17.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	284.9
7.0%	0.0	0.0	0.0	TOTAL	0.0	234.2
10.0%	0.0	0.0	0.0	TOTAL	0.0	182.7

ALTERNATIVE NO. 221
SAVINGS,COAL AND IRON ORE,USD,PEL.,RESTRICTED DRAFT DESIGN,(2-7-81,2-7-82).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME COAL	VOLUME IRON ORE	SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	11.5	12.5	9.4
1981	0.0	0.0	0.0	11.2	12.7	9.3
1982	0.0	0.0	0.0	11.0	13.0	9.3
1983	0.0	0.0	0.0	10.7	13.2	9.2
1984	0.0	0.0	0.0	10.5	13.4	9.1
1985	0.0	0.0	0.0	10.2	13.7	9.1
1986	0.0	0.0	0.0	10.0	13.9	9.0
1987	0.0	0.0	0.0	9.7	14.1	8.9
1988	0.0	0.0	0.0	9.5	14.3	8.9
1989	0.0	0.0	0.0	9.2	14.6	8.8
1990	0.0	0.0	0.0	9.0	14.8	8.7
1991	0.0	0.0	0.0	8.7	15.0	8.7
1992	0.0	0.0	0.0	8.4	15.3	8.6
1993	0.0	0.0	0.0	8.2	15.5	8.6
1994	0.0	0.0	0.0	7.9	15.7	8.5
1995	0.0	0.0	0.0	7.7	16.0	8.4
1996	0.0	0.0	0.0	7.4	16.2	8.4
1997	0.0	0.0	0.0	7.2	16.4	8.3
1998	0.0	0.0	0.0	6.9	16.6	8.2
1999	0.0	0.0	0.0	6.7	16.9	8.2
2000	0.0	0.0	0.0	6.4	17.1	8.1
2001	0.0	0.0	0.0	6.4	17.1	8.1
2002	0.0	0.0	0.0	6.4	17.1	8.1
2003	0.0	0.0	0.0	6.4	17.1	8.1
2004	0.0	0.0	0.0	6.4	17.1	8.1
2005	0.0	0.0	0.0	6.4	17.1	8.1
2006	0.0	0.0	0.0	6.4	17.1	8.1
2007	0.0	0.	0.0	6.4	17.1	8.1
2008	0.0	0.0	0.0	6.4	17.1	8.1
2009	0.0	0.0	0.0	6.4	17.1	8.1

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	141.0
7.0%	0.0	0.0	0.0	TOTAL	0.0	116.0
10.0%	0.0	0.0	0.0	TOTAL	0.0	92.2

ALTERNATIVE NO. 231
SAVINGS,COAL,INCREMENTAL IMPROV.,H.ROADS,CONVENTIONAL DESIGN,(3-1A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	46.1	9.1
1981	0.0	0.0	0.0	46.1	9.3
1982	0.0	0.0	0.0	46.1	9.6
1983	0.0	0.0	0.0	46.2	9.8
1984	0.0	0.0	0.0	46.2	10.1
1985	0.0	0.0	0.0	46.2	10.3
1986	0.0	0.0	0.0	46.2	10.5
1987	0.0	0.0	0.0	46.3	10.8
1988	0.0	0.0	0.0	46.3	11.0
1989	0.0	0.0	0.0	46.3	11.3
1990	0.0	0.0	0.0	46.3	11.5
1991	0.0	0.0	0.0	46.4	11.7
1992	0.0	0.0	0.0	46.4	12.0
1993	0.0	0.0	0.0	46.4	12.2
1994	0.0	0.0	0.0	46.4	12.5
1995	0.0	0.0	0.0	46.5	12.7
1996	0.0	0.0	0.0	46.5	12.9
1997	0.0	0.0	0.0	46.5	13.2
1998	0.0	0.0	0.0	46.5	13.4
1999	0.0	0.0	0.0	46.6	13.7
2000	0.0	0.0	0.0	46.6	13.9
2001	0.0	0.0	0.0	46.6	13.9
2002	0.0	0.0	0.0	46.6	13.9
2003	0.0	0.0	0.0	46.6	13.9
2004	0.0	0.0	0.0	46.6	13.9
2005	0.0	0.0	0.0	46.6	13.9
2006	0.0	0.0	0.0	46.6	13.9
2007	0.0	0.0	0.0	46.6	13.9
2008	0.0	0.0	0.0	46.6	13.9
2009	0.0	0.0	0.0	46.6	13.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	196.4
7.0%	0.0	0.0	0.0	TOTAL	0.0	150.1
10.0%	0.0	0.0	0.0	TOTAL	0.0	113.8

ALTERNATIVE NO. 241
SAVINGS,COAL,INCREMENTAL IMPROV.,H.ROADS,CONVENTIONAL DESIGN,(3-19).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	46.1		9.0
1981	0.0	0.0	0.0	46.1		9.1
1982	0.0	0.0	0.0	46.1		9.3
1983	0.0	0.0	0.0	46.2		9.4
1984	0.0	0.0	0.0	46.2		9.6
1985	0.0	0.0	0.0	46.2		9.7
1986	0.0	0.0	0.0	46.2		9.8
1987	0.0	0.0	0.0	46.3		10.0
1988	0.0	0.0	0.0	46.3		10.1
1989	0.0	0.0	0.0	46.3		10.3
1990	0.0	0.0	0.0	46.3		10.4
1991	0.0	0.0	0.0	46.4		10.5
1992	0.0	0.0	0.0	46.4		10.7
1993	0.0	0.0	0.0	46.4		10.8
1994	0.0	0.0	0.0	46.4		11.0
1995	0.0	0.0	0.0	46.5		11.1
1996	0.0	0.0	0.0	46.5		11.2
1997	0.0	0.0	0.0	46.5		11.4
1998	0.0	0.0	0.0	46.5		11.5
1999	0.0	0.0	0.0	46.6		11.7
2000	0.0	0.0	0.0	46.6		11.8
2001	0.0	0.0	0.0	46.6		11.8
2002	0.0	0.0	0.0	46.6		11.8
2003	0.0	0.0	0.0	46.6		11.8
2004	0.0	0.0	0.0	46.6		11.8
2005	0.0	0.0	0.0	46.6		11.6
2006	0.0	0.0	0.0	46.6		11.8
2007	0.0	0.0	0.0	46.6		11.6
2008	0.0	0.0	0.0	46.6		11.8
2009	0.0	0.0	0.0	46.6		11.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0	0.0	0.0	0.0	TOTAL	0.0	168.[illegible]
7.5	0.0	0.0	0.0	TOTAL	0.0	136.5
10.0	0.0	0.0	0.0	TOTAL	0.0	134.7

ALTERNATIVE NO. 251
SAVINGS,GRAIN,GIR,MISS.,CONVENTIONAL DESIGN,(4-4-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	32.8	22.7
1981	0.0	0.0	0.0	34.1	23.2
1982	0.0	0.0	0.0	35.4	23.8
1983	0.0	0.0	0.0	36.7	24.3
1984	0.0	0.0	0.0	38.0	24.9
1985	0.0	0.0	0.0	39.3	25.4
1986	0.0	0.0	0.0	40.6	25.9
1987	0.0	0.0	0.0	41.9	26.5
1988	0.0	0.0	0.0	43.2	27.0
1989	0.0	0.0	0.0	44.5	27.6
1990	0.0	0.0	0.0	45.8	28.1
1991	0.0	0.0	0.0	47.2	28.6
1992	0.0	0.0	0.0	48.5	29.2
1993	0.0	0.0	0.0	49.8	29.7
1994	0.0	0.0	0.0	51.1	30.3
1995	0.0	0.0	0.0	52.4	30.8
1996	0.0	0.0	0.0	53.7	31.3
1997	0.0	0.0	0.0	[illegible]	31.9
1998	0.0	0.0	0.0	55.3	32.4
1999	0.0	0.0	0.0	57.6	33.0
2000	0.0	0.0	0.0	58.9	33.5
2001	0.0	0.0	0.0	58.9	33.5
2002	0.0	0.0	0.0	58.9	33.5
2003	0.0	0.0	0.0	58.9	33.5
2004	0.0	0.0	0.0	58.9	33.5
2005	0.0	0.0	0.0	58.9	33.5
2006	0.0	0.0	0.0	58.9	33.5
2007	0.0	0.0	0.0	58.9	33.5
2008	0.0	0.0	0.0	58.9	33.5
2009	0.0	0.0	0.0	58.9	33.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]%	0.0	0.0	0.0	TOTAL	0.0	455.[illegible]
7.5%	0.0	0.0	0.0	TOTAL	0.0	367.2
10.[illegible]%	0.0	0.0	0.0	TOTAL	0.0	279.2

ALTERNATIVE NO. 261
SAVINGS,GRAIN,DIP,MISS.,RESTRICTED DRAFT,(4-4-1).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	18.0	12.5
1981	0.0	0.0	0.0	18.3	12.7
1982	0.0	0.0	0.0	18.6	12.9
1983	0.0	0.0	0.0	18.8	13.1
1984	0.0	0.0	0.0	19.1	13.3
1985	0.0	0.0	0.0	19.4	13.5
1986	0.0	0.0	0.0	19.7	13.7
1987	0.0	0.0	0.0	20.0	13.9
1988	0.0	0.0	0.0	20.2	14.1
1989	0.0	0.0	0.0	20.5	14.3
1990	0.0	0.0	0.0	20.8	14.5
1991	0.0	0.0	0.0	21.1	14.8
1992	0.0	0.0	0.0	21.4	15.0
1993	0.0	0.0	0.0	21.6	15.2
1994	0.0	0.0	0.0	21.9	15.4
1995	0.0	0.0	0.0	22.2	15.6
1996	0.0	0.0	0.0	22.5	15.8
1997	0.0	0.0	0.0	22.8	16.0
1998	0.0	0.0	0.0	23.0	16.2
1999	0.0	0.0	0.0	23.3	16.4
2000	0.0	0.0	0.0	23.6	16.6
2001	0.0	0.0	0.0	23.6	16.6
2002	0.0	0.0	0.0	23.6	16.6
2003	0.0	0.0	0.0	23.6	16.6
2004	0.0	0.0	0.0	23.6	16.6
2005	0.0	0.0	0.0	23.6	16.6
2006	0.0	0.0	0.0	23.6	16.6
2007	0.0	0.0	0.0	23.6	16.6
2008	0.0	0.0	0.0	23.6	16.6
2009	0.0	0.0	0.0	23.6	16.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	0.0	0.0	0.0	TOTAL	0.0	235.5
7.[illegible]	0.0	0.0	0.0	TOTAL	0.0	190.9
10.[illegible]	0.0	0.0	0.0	TOTAL	0.0	146.2

ALTERNATIVE NO. 271
SAVINGS,,GRAIN,GIR,MISS..CONVENTIONAL DESIGN,(4-4-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	18.0	14.9
1981	0.0	0.0	0.0	18.3	15.1
1982	0.0	0.0	0.0	18.6	15.4
1983	0.0	0.0	0.0	18.8	15.6
1984	0.0	0.0	0.0	19.1	15.9
1985	0.0	0.0	0.0	19.4	16.1
1986	0.0	0.0	0.0	19.7	16.3
1987	0.0	0.0	0.0	20.0	16.6
1988	0.0	0.0	0.0	20.2	16.8
1989	0.0	0.0	0.0	20.5	17.1
1990	0.0	0.0	0.0	20.8	17.3
1991	0.0	0.0	0.0	21.1	17.5
1992	0.0	0.0	0.0	21.4	17.8
1993	0.0	0.0	0.0	21.6	18.0
1994	0.0	0.0	0.0	21.9	18.3
1995	0.0	0.0	0.0	22.2	18.5
1996	0.0	0.0	0.0	22.5	18.7
1997	0.0	0.0	0.0	22.8	19.0
1998	0.0	0.0	0.0	23.0	19.2
1999	0.0	0.0	0.0	23.3	19.5
2000	0.0	0.0	0.0	23.6	19.7
2001	0.0	0.0	0.0	23.6	19.7
2002	0.0	0.0	0.0	23.6	19.7
2003	0.0	0.0	0.0	23.6	19.7
2004	0.0	0.0	0.0	23.6	19.7
2005	0.0	0.0	0.0	23.6	19.7
2006	0.0	0.0	0.0	23.6	19.7
2007	0.0	0.0	0.0	23.6	19.7
2008	0.0	0.0	0.0	23.6	19.7
2009	0.0	0.0	0.0	23.6	19.7

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	0.0	0.0	0.0	TOTAL	0.0	280.[illegible]
7.[illegible]	0.0	0.0	0.0	TOTAL	0.0	227.1
1[illegible]	0.0	0.0	0.0	TOTAL	0.0	174.[illegible]

ALTERNATIVE NO. 281
SAVINGS,GRAIN,GIB,MISS.,RESTRICTED DRAFT,(4-4-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	18.0		7.9
1981	0.0	0.0	0.0	18.3		8.0
1982	0.0	0.0	0.0	18.5		8.2
1983	0.0	0.0	0.0	18.8		8.3
1984	0.0	0.0	0.0	19.1		8.4
1985	0.0	0.0	0.0	19.4		8.6
1986	0.0	0.0	0.0	19.7		8.7
1987	0.0	0.0	0.0	20.0		8.8
1988	0.0	0.0	0.0	20.2		9.0
1989	0.0	0.0	0.0	20.5		9.1
1990	0.0	0.0	0.0	20.8		9.2
1991	0.0	0.0	0.0	21.1		9.4
1992	0.0	0.0	0.0	21.4		9.5
1993	0.0	0.0	0.0	21.6		9.7
1994	0.0	0.0	0.0	21.9		9.8
1995	0.0	0.0	0.0	22.2		9.9
1996	0.0	0.0	0.0	22.5		10.1
1997	0.0	0.0	0.0	22.8		10.2
1998	0.0	0.0	0.0	23.0		10.3
1999	0.0	0.0	0.0	23.3		10.5
2000	0.0	0.0	0.0	23.6		10.6
2001	0.0	0.0	0.0	23.6		10.6
2002	0.0	0.0	0.0	23.6		10.6
2003	0.0	0.0	0.0	23.6		10.6
2004	0.0	0.0	0.0	23.6		10.6
2005	0.0	0.0	0.0	23.6		10.6
2006	0.0	0.0	0.0	23.6		10.6
2007	0.0	0.0	0.0	23.6		10.6
2008	0.0	0.0	0.0	23.6		10.6
2009	0.0	0.0	0.0	23.6		10.6

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.[illegible]	0.0	0.0	0.0	TOTAL	0.0	149.7
7.[illegible]	0.0	0.0	0.0	TOTAL	0.0	121.3
10.[illegible]	0.0	0.0	0.0	TOTAL	0.0	92.9

ALTERNATIVE NO. 291
SAVINGS,IRON ORE,GT2,MISS.,CONVENTIONAL DESIGN,(4-5-A)

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	7.6	4.7
1981	0.0	0.0	0.0	7.7	4.8
1982	0.0	0.0	0.0	7.9	4.9
1983	0.0	0.0	0.0	8.0	5.0
1984	0.0	0.0	0.0	8.2	5.1
1985	0.0	0.0	0.0	8.3	5.2
1986	0.0	0.0	0.0	8.4	5.3
1987	0.0	0.0	0.0	8.6	5.4
1988	0.0	0.0	0.0	8.7	5.5
1989	0.0	0.0	0.0	8.9	5.6
1990	0.0	0.0	0.0	9.0	5.7
1991	0.0	0.0	0.0	9.1	5.9
1992	0.0	0.0	0.0	9.3	6.0
1993	0.0	0.0	0.0	9.4	6.1
1994	0.0	0.0	0.0	9.6	6.2
1995	0.0	0.0	0.0	9.7	6.3
1996	0.0	0.0	0.0	9.8	6.4
1997	0.0	0.0	0.0	10.0	6.5
1998	0.0	0.0	0.0	10.1	6.6
1999	0.0	0.0	0.0	10.3	6.7
2000	0.0	0.0	0.0	10.4	6.8
2001	0.0	0.0	0.0	10.4	6.8
2002	0.0	0.0	0.0	10.4	6.8
2003	0.0	0.0	0.0	10.4	6.8
2004	0.0	0.0	0.0	10.4	6.8
2005	0.0	0.0	0.0	10.4	6.8
2006	0.0	0.0	0.0	10.4	6.8
2007	0.0	0.0	0.0	10.4	6.8
2008	0.0	0.0	0.0	10.4	6.8
2009	0.0	0.0	0.0	10.4	6.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	93.1
7.0%	0.0	0.0	0.0	TOTAL	0.0	75.2
10.0%	0.0	0.0	0.0	TOTAL	0.0	57.2

ALTERNATIVE NO. 301
SAVINGS, IRON ORE, GIR, MISS., RESTRICTED DRAFT, (4-5-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	7.6	2.9
1981	0.0	0.0	0.0	7.7	3.0
1982	0.0	0.0	0.0	7.9	3.0
1983	0.0	0.0	0.0	8.0	3.1
1984	0.0	0.0	0.0	8.2	3.2
1985	0.0	0.0	0.0	8.3	3.2
1986	0.0	0.0	0.0	8.4	3.3
1987	0.0	0.0	0.0	8.6	3.4
1988	0.0	0.0	0.0	8.7	3.4
1989	0.0	0.0	0.0	8.9	3.5
1990	0.0	0.0	0.0	9.0	3.5
1991	0.0	0.0	0.0	9.1	3.6
1992	0.0	0.0	0.0	9.3	3.7
1993	0.0	0.0	0.0	9.4	3.7
1994	0.0	0.0	0.0	9.6	3.8
1995	0.0	0.0	0.0	9.7	3.9
1996	0.0	0.0	0.0	9.8	3.9
1997	0.0	0.0	0.0	10.0	4.0
1998	0.0	0.0	0.0	10.1	4.1
1999	0.0	0.0	0.0	10.3	4.1
2000	0.0	0.0	0.0	10.4	4.2
2001	0.0	0.0	0.0	10.4	4.2
2002	0.0	0.0	0.0	10.4	4.2
2003	0.0	0.0	0.0	10.4	4.2
2004	0.0	0.0	0.0	10.4	4.2
2005	0.0	0.0	0.0	10.4	4.2
2006	0.0	0.0	0.0	10.4	4.2
2007	0.0	0.0	0.0	10.4	4.2
2008	0.0	0.0	0.0	10.4	4.2
2009	0.0	0.0	0.0	10.4	4.2

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	57.5
7.0%	0.0	0.0	0.0	TOTAL	0.0	46.4
10.0%	0.0	0.0	0.0	TOTAL	0.0	35.3

ALTERNATIVE NO. 311
SAVINGS, GRAIN AND IRON ORE, GIB, MISS., CONVENTIONAL DESIGN, (4-6-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	32.8	7.6	27.5
1981	0.0	0.0	0.0	34.1	7.7	28.1
1982	0.0	0.0	0.0	35.4	7.9	28.8
1983	0.0	0.0	0.0	36.7	8.0	29.4
1984	0.0	0.0	0.0	38.0	[illegible]	30.1
1985	0.0	0.0	0.0	39.3	[illegible]	30.7
1986	0.0	0.0	0.0	40.6	8.4	31.4
1987	0.0	0.0	0.0	41.9	8.6	32.0
1988	0.0	0.0	0.0	43.2	8.7	32.7
1989	0.0	0.0	0.0	44.5	8.9	33.3
1990	0.0	0.0	0.0	45.8	9.0	33.9
1991	0.0	0.0	0.0	47.2	9.1	34.6
1992	0.0	0.0	0.0	48.5	9.3	35.2
1993	0.0	0.0	0.0	49.8	9.4	35.9
1994	0.0	0.0	0.0	51.1	9.6	36.5
1995	0.0	0.0	0.0	52.4	9.7	37.2
1996	0.0	0.0	0.0	53.7	9.8	37.8
1997	0.0	0.0	0.0	55.0	10.0	38.5
1998	0.0	0.0	0.0	56.3	10.1	39.1
1999	0.0	0.0	0.0	57.6	10.3	39.8
2000	0.0	0.0	0.0	58.9	10.4	40.4
2001	0.0	0.0	0.0	58.9	10.4	40.4
2002	0.0	0.0	0.0	58.9	10.4	40.4
2003	0.0	0.0	0.0	58.9	10.4	40.4
2004	0.0	0.0	0.0	58.9	10.4	40.4
2005	0.0	0.0	0.0	58.9	10.4	40.4
2006	0.0	0.0	0.0	58.9	10.4	40.4
2007	0.0	0.0	0.0	58.9	10.4	40.4
2008	0.0	0.0	0.0	58.9	10.4	40.4
2009	0.0	0.0	0.0	58.9	10.4	40.4

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	550.[illegible]
7.0%	0.0	0.0	0.0	TOTAL	0.0	443.7
10.0%	0.0	0.0	0.0	TOTAL	0.0	337.4

ALTERNATIVE NO. 321
SAVINGS,GRAIN AND IRON ORE,GIB,MISS.,RESTRICTED DRAFT,(4-6-B).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	18.0	7.6	15.4
1981	0.0	0.0	0.0	18.3	7.7	15.7
1982	0.0	0.0	0.0	18.6	7.9	15.9
1983	0.0	0.0	0.0	18.8	8.0	16.2
1984	0.0	0.0	0.0	19.1	8.2	16.5
1985	0.0	0.0	0.0	19.4	8.3	16.7
1986	0.0	0.0	0.0	19.7	8.4	17.0
1987	0.0	0.0	0.0	20.0	8.6	17.3
1988	0.0	0.0	0.0	20.2	8.7	17.6
1989	0.0	0.0	0.0	20.5	8.9	17.8
1990	0.0	0.0	0.0	20.8	9.0	18.1
1991	0.0	0.0	0.0	21.1	9.1	18.4
1992	0.0	0.0	0.0	21.4	9.3	18.6
1993	0.0	0.0	0.0	21.6	9.4	18.9
1994	0.0	0.0	0.0	21.9	9.6	19.2
1995	0.0	0.0	0.0	22.2	9.7	19.4
1996	0.0	0.0	0.0	22.5	9.8	19.7
1997	0.0	0.0	0.0	22.8	10.0	20.0
1998	0.0	0.0	0.0	23.0	10.1	20.3
1999	0.0	0.0	0.0	23.3	10.3	20.5
2000	0.0	0.0	0.0	23.6	10.4	20.8
2001	0.0	0.0	0.0	23.6	10.4	20.8
2002	0.0	0.0	0.0	23.6	10.4	20.8
2003	0.0	0.0	0.0	23.6	10.4	20.8
2004	0.0	0.0	0.0	23.6	10.4	20.8
2005	0.0	0.0	0.0	23.6	10.4	20.8
2006	0.0	0.0	0.0	23.6	10.4	20.8
2007	0.0	0.0	0.0	23.6	10.4	20.8
2008	0.0	0.0	0.0	23.6	10.4	20.8
2009	0.0	0.0	0.0	23.6	10.4	20.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	293.
7.0%	0.0	0.0	0.0	TOTAL	0.0	237.4
10.0%	0.0	0.0	0.0	TOTAL	0.0	181.6

ALTERNATIVE NO. 331
SAVINGS, GRAIN AND IRON ORE, GIR, MISS., CONVENTIONAL DESIGN, (4-6-C).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SAVINGS
				GRAIN	IRON ORE	
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	18.0	7.6	19.6
1981	0.0	0.0	0.0	18.3	7.7	19.9
1982	0.0	0.0	0.0	18.6	7.9	20.3
1983	0.0	0.0	0.0	18.8	8.0	20.6
1984	0.0	0.0	0.0	19.1	8.2	21.0
1985	0.0	0.0	0.0	19.4	8.3	21.3
1986	0.0	0.0	0.0	19.7	8.4	21.7
1987	0.0	0.0	0.0	20.0	8.6	22.0
1988	0.0	0.0	0.0	20.2	8.7	22.4
1989	0.0	0.0	0.0	20.5	8.9	22.7
1990	0.0	0.0	0.0	20.8	9.0	23.0
1991	0.0	0.0	0.0	21.1	9.1	23.4
1992	0.0	0.0	0.0	21.4	9.3	23.7
1993	0.0	0.0	0.0	21.6	9.4	24.1
1994	0.0	0.0	0.0	21.9	9.6	24.4
1995	0.0	0.0	0.0	22.2	9.7	24.8
1996	0.0	0.0	0.0	22.5	9.8	25.1
1997	0.0	0.0	0.0	22.8	10.0	25.5
1998	0.0	0.0	0.0	23.0	10.1	25.8
1999	0.0	0.0	0.0	23.3	10.3	26.2
2000	0.0	0.0	0.0	23.6	10.4	26.5
2001	0.0	0.0	0.0	23.6	10.4	26.5
2002	0.0	0.0	0.0	23.6	10.4	26.5
2003	0.0	0.0	0.0	23.6	10.4	26.5
2004	0.0	0.0	0.0	23.6	10.4	26.5
2005	0.0	0.0	0.0	23.6	10.4	26.5
2006	0.0	0.0	0.0	23.6	10.4	26.5
2007	0.0	0.0	0.0	23.6	10.4	26.5
2008	0.0	0.0	0.0	23.6	10.4	26.5
2009	0.0	0.0	0.0	23.6	10.4	26.5

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	373.1
7.0%	0.0	0.0	0.0	TOTAL	0.0	302.3
10.0%	0.0	0.0	0.0	TOTAL	0.0	231.2

ALTERNATIVE NO. 341
SAVINGS,GRAIN AND IRON ORE,SIB,MISS.,RESTRICTED CRAFT,(4-6-0).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME GRAIN	VOLUME IRON ORE	SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.0					
1979	0.0					
1980	0.0	0.0	0.0	18.0	7.6	10.8
1981	0.0	0.0	0.0	18.3	7.7	11.0
1982	0.0	0.0	0.0	18.6	7.9	11.2
1983	0.0	0.0	0.0	18.8	8.0	11.4
1984	0.0	0.0	0.0	19.1	8.2	11.6
1985	0.0	0.0	0.0	19.4	8.3	11.8
1986	0.0	0.0	0.0	19.7	8.4	12.0
1987	0.0	0.0	0.0	20.0	8.6	12.2
1988	0.0	0.0	0.0	20.2	8.7	12.4
1989	0.0	0.0	0.0	20.5	8.9	12.6
1990	0.0	0.0	0.0	20.8	9.0	12.8
1991	0.0	0.0	0.0	21.1	9.1	13.0
1992	0.0	0.0	0.0	21.4	9.3	13.2
1993	0.0	0.0	0.0	21.6	9.4	13.4
1994	0.0	0.0	0.0	21.9	9.6	13.6
1995	0.0	0.0	0.0	22.2	9.7	13.8
1996	0.0	0.0	0.0	22.5	9.8	14.0
1997	0.0	0.0	0.0	22.8	10.0	14.2
1998	0.0	0.0	0.0	23.0	10.1	14.4
1999	0.0	0.0	0.0	23.3	10.3	14.6
2000	0.0	0.0	0.0	23.6	10.4	14.8
2001	0.0	0.0	0.0	23.6	10.4	14.8
2002	0.0	0.0	0.0	23.6	10.4	14.8
2003	0.0	0.0	0.0	23.6	10.4	14.8
2004	0.0	0.0	0.0	23.6	10.4	14.8
2005	0.0	0.0	0.0	23.6	10.4	14.8
2006	0.0	0.0	0.0	23.6	10.4	14.8
2007	0.0	0.0	0.0	23.6	10.4	14.8
2008	0.0	0.0	0.0	23.6	10.4	14.8
2009	0.0	0.0	0.0	23.6	10.4	14.8

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	237.2
7.0%	0.0	0.0	0.0	TOTAL	0.0	167.8
10.0%	0.0	0.0	0.0	TOTAL	0.0	128.2

ALTERNATIVE NO. 351
SAVINGS,GRAIN,FREEPORT,CONVENTIONAL DESIGN,(5-7-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME		SAVINGS
1975	0.0					
1976	0.0					
1977	0.0					
1978	0.					
1979	0.					
1980	0.0	0.0	0.0	18.0		9.0
1981	0.0	0.0	0.0	18.3		9.1
1982	0.0	0.0	0.0	18.6		9.3
1983	0.0	0.0	0.0	18.8		9.4
1984	0.0	0.0	0.0	19.1		9.6
1985	0.0	0.0	0.0	19.4		9.7
1986	0.0	0.0	0.0	19.7		9.9
1987	0.0	0.0	0.0	20.0		10.0
1988	0.0	0.0	0.0	20.2		10.2
1989	0.0	0.0	0.0	20.5		10.3
1990	0.0	0.0	0.0	20.8		10.5
1991	0.0	0.0	0.0	21.1		10.6
1992	0.0	0.0	0.0	21.4		10.8
1993	0.0	0.0	0.0	21.6		10.9
1994	0.0	0.0	0.0	21.9		11.1
1995	0.	0.0	0.0	22.2		11.2
1996	0.	0.0	0.0	22.5		11.4
1997	0.0	0.0	0.0	22.8		11.5
1998	0.0	0.0	0.0	23.0		11.7
1999	0.0	0.0	0.0	23.3		11.8
2000	0.0	0.0	0.0	23.6		12.0
2001	0.0	0.0	0.0	23.6		12.0
2002	0.0	0.	0.0	23.6		12.0
2003	0.0	0.	0.0	23.6		12.0
2004	0.0	0.	0.0	23.6		12.0
2005	0.0	0.0	0.0	23.6		12.0
2006	0.0	0.0	0.0	23.6		12.0
2007	0.0	0.	0.0	23.6		12.0
2008	0.0	0.0	0.0	23.6		12.0
2009	0.	0.0	0.0	23.6		12.0

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	170.[illegible]
7.0%	0.0	0.0	0.0	TOTAL	0.0	137.8
10.0%	0.0	0.0	0.0	TOTAL	0.0	1[illegible]5.5

ALTERNATIVE NO. 36L
SAVINGS,GRAIN,FREEPORT,RESTRICTED DESIGN,(5-7-A).

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	18.0	2.1
1981	0.0	0.0	0.0	18.3	2.1
1982	0.0	0.0	0.0	18.6	2.2
1983	0.0	0.0	0.0	18.8	2.2
1984	0.0	0.0	0.0	19.1	2.3
1985	0.0	0.0	0.0	19.4	2.3
1986	0.0	0.0	0.0	19.7	2.3
1987	0.0	0.0	0.0	20.0	2.4
1988	0.0	0.0	0.0	20.2	2.4
1989	0.0	0.0	0.0	20.5	2.5
1990	0.0	0.0	0.0	20.8	2.5
1991	0.0	0.0	0.0	21.1	2.5
1992	0.0	0.0	0.0	21.4	2.6
1993	0.0	0.0	0.0	21.6	2.6
1994	0.0	0.0	0.0	21.9	2.7
1995	0.0	0.0	0.0	22.2	2.7
1996	0.0	0.0	0.0	22.5	2.7
1997	0.0	0.0	0.0	22.8	2.8
1998	0.0	0.0	0.0	23.0	2.8
1999	0.0	0.0	0.0	23.3	2.9
2000	0.0	0.0	0.0	23.6	2.9
2001	0.0	0.0	0.0	23.6	2.9
2002	0.0	0.0	0.0	23.6	2.9
2003	0.0	0.0	0.0	23.6	2.9
2004	0.0	0.0	0.0	23.6	2.9
2005	0.0	0.0	0.0	23.6	2.9
2006	0.0	0.0	0.0	23.6	2.9
2007	0.0	0.0	0.0	23.6	2.9
2008	0.0	0.0	0.0	23.6	2.9
2009	0.0	0.0	0.0	23.6	2.9

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.??	0.0	0.0	0.0	TOTAL	0.0	40.?
7.??	0.0	0.0	0.0	TOTAL	0.0	32.?
10.??	0.0	0.0	0.0	TOTAL	0.	25.?

ALTERNATIVE NO. 371
SAVINGS,GRAIN,FREEPORT,CONVENTIONAL DESIGN,(5-7-9)

YEAR	FIRST COST	OPERATING COST	MAINTENANCE COST	VOLUME	SAVINGS
1975	0.0				
1976	0.0				
1977	0.0				
1978	0.0				
1979	0.0				
1980	0.0	0.0	0.0	18.0	4.2
1981	0.0	0.0	0.0	18.3	4.3
1982	0.0	0.0	0.0	18.6	4.3
1983	0.0	0.0	0.0	18.8	4.4
1984	0.0	0.0	0.0	19.1	4.5
1985	0.0	0.0	0.0	19.4	4.6
1986	0.0	0.0	0.0	19.7	4.6
1987	0.0	0.0	0.0	20.0	4.7
1988	0.0	0.0	0.0	20.2	4.8
1989	0.0	0.0	0.0	20.5	4.9
1990	0.0	0.0	0.0	20.8	4.9
1991	0.0	0.0	0.0	21.1	5.0
1992	0.0	0.0	0.0	21.4	5.1
1993	0.0	0.0	0.0	21.6	5.2
1994	0.0	0.0	0.0	21.9	5.2
1995	0.0	0.0	0.0	22.2	5.3
1996	0.0	0.0	0.0	22.5	5.4
1997	0.0	0.0	0.0	22.8	5.5
1998	0.0	0.0	0.0	23.0	5.5
1999	0.0	0.0	0.0	23.3	5.6
2000	0.0	0.0	0.0	23.6	5.7
2001	0.0	0.0	0.0	23.6	5.7
2002	0.0	0.0	0.0	23.6	5.7
2003	0.0	0.0	0.0	23.6	5.7
2004	0.0	0.0	0.0	23.6	5.7
2005	0.0	0.0	0.0	23.6	5.7
2006	0.0	0.0	0.0	23.6	5.7
2007	0.0	0.0	0.0	23.6	5.7
2008	0.0	0.0	0.0	23.	5.7
2009	0.0	0.0	0.0	23.6	5.7

CUMULATIVE PRESENT VALUE AT INDICATED INTEREST RATE

5.0%	0.0	0.0	0.0	TOTAL	0.0	80.1
7.0%	0.0	0.0	0.0	TOTAL	0.0	64.9
10.0%	0.0	0.0	0.0	TOTAL	0.0	49.6

Series 3

(Note: Alternative 2 Signifies Dummy; SC Means Net Savings in Shipping Costs

COMPARISON NO. 1

ALTERNATIVE NO. 19[illegible] 2 VS 63[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	165.1	0.0	0.0	497.4	0.0	0.0	0.0	497.4	165.1	0.3320
7.0%	0.0	137.3	0.0	0.0	465.7	0.0	0.0	0.0	465.7	137.3	0.2947
10.0%	0.0	108.7	0.0	0.0	441.4	0.0	0.0	0.0	441.4	108.7	0.2462

COMPARISON NO. 2

ALTERNATIVE NO. 19[illegible] 2 VS 6[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	165.1	0.0	0.0	380.4	0.0	0.0	0.0	380.4	165.1	0.4341
7.0%	0.0	137.3	0.0	0.0	342.3	0.0	0.0	0.0	342.3	137.3	0.4009
10.0%	0.0	108.7	0.0	0.0	307.1	0.0	0.0	0.0	307.1	108.7	0.3539

COMPARISON NO. 3

ALTERNATIVE NO. 201 2 VS 7[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	73.8	0.0	0.0	270.3	0.0	0.0	0.0	270.3	73.8	0.2732
7.0%	0.0	62.5	0.0	0.0	255.7	0.0	0.0	0.0	255.7	62.5	0.2444
10.0%	0.0	50.6	0.0	0.0	245.8	0.0	0.0	0.0	245.8	50.6	0.2061

COMPARISON NO. 4

ALTERNATIVE NO. 201 2 VS 71 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	73.8	0.0	0.0	202.3	0.0	0.0	0.0	202.3	73.8	0.3651
7.0%	0.0	62.5	0.0	0.0	183.9	0.0	0.0	0.0	183.9	62.5	0.3400
10.0%	0.0	50.6	0.0	0.0	167.3	0.0	0.0	0.0	167.3	50.6	0.3026

COMPARISON NO. 5

ALTERNATIVE NO. 211 2 VS 72 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	284.9	0.0	0.0	736.9	0.0	0.0	0.0	736.9	284.9	0.3867
7.0%	0.0	234.2	0.0	0.0	684.7	0.0	0.0	0.0	684.7	234.2	0.3420
10.0%	0.0	182.7	0.0	0.0	641.4	0.0	0.0	0.0	641.4	182.7	0.2848

COMPARISON NO.

ALTERNATIVE NO. 211 2 VS 73 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	284.9	0.0	0.0	621.0	0.0	0.0	0.0	621.0	284.9	0.4589
7.0%	0.0	234.2	0.0	0.0	562.0	0.0	0.0	0.0	562.0	234.2	0.4167
10.0%	0.0	182.7	0.0	0.0	507.5	0.0	0.0	0.0	507.5	182.7	0.3600

COMPARISON NO. 7

ALTERNATIVE NO. 221 2 VS 74[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	141.0	0.0	0.0	498.2	0.0	0.0	0.0	498.2	141.0	0.2831
7.0%	0.0	116.9	0.0	0.0	464.8	0.0	0.0	0.0	464.8	116.9	0.2515
10.0%	0.0	92.2	0.0	0.0	437.7	0.0	0.0	0.0	437.7	92.2	0.2107

COMPARISON NO. 8

ALTERNATIVE NO. 221 2 VS 75[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	141.0	0.0	0.0	429.5	0.0	0.0	0.0	429.5	141.0	0.3284
7.0%	0.0	116.9	0.0	0.0	392.2	0.0	0.0	0.0	392.2	116.9	0.2980
10.0%	0.0	92.2	0.0	0.0	358.5	0.0	0.0	0.0	358.5	92.2	0.2572

COMPARISON NO. 9

ALTERNATIVE NO. 231 2 VS 76[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	186.4	0.0	0.0	52.3	0.0	0.0	0.0	52.3	186.4	3.5605
7.0%	0.0	150.1	0.0	0.0	51.9	0.0	0.0	0.0	51.9	150.1	2.8885
10.0%	0.0	113.8	0.0	0.0	52.4	0.0	0.0	0.0	52.4	113.8	2.1717

COMPARISON NO. 1.

ALTERNATIVE NO. 241 2 VS 773 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	168.3	0.0	0.0	65.2	0.0	0.0	0.0	65.2	168.3	2.5825
7.0%	0.0	136.5	0.0	0.0	64.6	0.0	0.0	0.0	64.6	136.5	2.1144
10.0%	0.0	104.7	0.0	0.0	65.0	0.0	0.0	0.0	65.0	104.7	1.6094

COMPARISON NO. 11

ALTERNATIVE NO. 251 2 VS 780 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	455.3	0.0	0.0	548.2	0.0	0.0	0.0	548.2	455.3	0.8304
7.0%	0.0	367.2	0.0	0.0	512.6	0.0	0.0	0.0	512.6	367.2	0.7162
10.0%	0.0	279.2	0.0	0.0	483.9	0.0	0.0	0.0	483.9	279.2	0.5769

COMPARISON NO. 12

ALTERNATIVE NO. 261 2 VS 790 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	235.5	0.0	0.0	363.7	0.0	0.0	0.0	363.7	235.5	0.6474
7.0%	0.0	190.9	0.0	0.0	340.9	0.0	0.0	0.0	340.9	190.9	0.5600
10.0%	0.0	146.2	0.0	0.0	322.7	0.0	0.0	0.0	322.7	146.2	0.4531

COMPARISON NO. 13

ALTERNATIVE NO. 271 2 VS 80 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	280.0	0.0	0.0	328.6	0.0	0.0	0.0	328.6	280.0	0.8522
7.0%	0.0	227.1	0.0	0.0	305.7	0.0	0.0	0.0	305.7	227.1	0.7428
10.0%	0.0	174.0	0.0	0.0	286.8	0.0	0.0	0.0	286.6	174.0	0.6066

COMPARISON NO. 14

ALTERNATIVE NO. 291 2 VS 80 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	149.7	0.0	0.0	328.6	0.0	0.0	0.0	328.6	149.7	0.4557
7.0%	0.0	121.3	0.0	0.0	305.7	0.0	0.0	0.0	305.7	121.3	0.3969
10.0%	0.0	92.0	0.0	0.0	286.8	0.0	0.0	0.0	286.8	92.9	0.3238

COMPARISON NO. 15

ALTERNATIVE NO. 291 2 VS 81 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	93.1	0.0	0.0	247.4	0.0	0.0	0.0	247.4	93.1	0.3764
7.0%	0.0	75.2	0.0	0.0	227.9	0.0	0.0	0.0	227.9	75.2	0.3299
10.0%	0.0	57.2	0.0	0.0	211.3	0.0	0.0	0.0	211.3	57.2	0.2710

COMPARISON NO. 1[illegible]

ALTERNATIVE NO. 331 2 VS 83[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	57.5	0.0	0.0	247.0	0.0	0.0	0.0	247.0	57.5	0.2326
7.0%	0.0	46.4	0.0	0.0	227.5	0.0	0.0	0.0	227.5	46.4	0.2041
10.0%	0.0	35.3	0.0	0.0	210.8	0.0	0.0	0.0	210.8	35.3	0.1676

COMPARISON NO. 17

ALTERNATIVE NO. 311 2 VS 83[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	550.0	0.0	0.0	715.1	0.0	0.0	0.0	715.1	550.0	0.7691
7.0%	0.0	443.7	0.0	0.0	665.4	0.0	0.0	0.0	665.4	443.7	0.6668
10.0%	0.0	337.4	0.0	0.0	623.9	0.0	0.0	0.0	623.9	337.4	0.5409

COMPARISON NO. 1[illegible]

ALTERNATIVE NO. 321 2 VS 84[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	293.0	0.0	0.0	515.7	0.0	0.0	0.0	515.7	293.0	0.5682
7.0%	0.0	237.4	0.0	0.0	481.3	0.0	0.0	0.0	481.3	237.4	0.4932
10.0%	0.0	181.6	0.0	0.0	452.9	0.0	0.0	0.0	452.9	181.6	0.4009

COMPARISON NO. 19

ALTERNATIVE NO. 331 2 VS 833 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	373.1	0.0	0.0	481.7	0.0	0.0	0.0	481.7	373.1	0.7747
7.0%	0.0	302.3	0.0	0.0	447.1	0.0	0.0	0.0	447.1	302.3	0.6761
10.0%	0.0	231.2	0.0	0.0	417.9	0.0	0.0	0.0	417.9	231.2	0.5532

COMPARISON NO. 20

ALTERNATIVE NO. 341 2 VS [illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	207.2	0.0	0.0	481.2	0.0	0.0	0.0	481.2	207.2	0.4306
7.0%	0.0	167.8	0.0	0.0	446.7	0.0	0.0	0.0	446.7	167.8	0.3755
10.0%	0.0	128.2	0.0	0.0	417.5	0.0	0.0	0.0	417.5	128.2	0.3071

COMPARISON NO. 21

ALTERNATIVE NO. 351 2 VS 8[illegible] 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	170.0	0.0	0.0	259.1	0.0	0.0	0.0	259.1	170.0	0.6560
7.0%	0.0	137.8	0.0	0.0	240.4	0.0	0.0	0.0	240.4	137.8	0.5730
10.0%	0.0	105.5	0.0	0.0	223.9	0.0	0.0	0.0	223.8	105.5	0.4714

COMPARISON NO. 22

ALTERNATIVE NO. 361 2 VS 87 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	40.5	0.0	0.0	259.1	0.0	0.0	0.0	259.1	40.5	0.1562
7.0%	0.0	32.4	0.0	0.0	240.4	0.0	0.0	0.0	240.4	32.5	0.1362
10.0%	0.0	25.0	0.0	0.0	223.8	0.0	0.0	0.0	223.8	25.0	0.1118

COMPARISON NO. 23

ALTERNATIVE NO. 371 2 VS 8 2

	PC	SC	PC	SC	PC	SC	PC	SC	COST	SAVINGS	B/C RATIO
5.0%	0.0	80.1	0.0	0.0	231.3	0.0	0.0	0.0	231.3	80.1	0.3465
7.0%	0.0	64.9	0.0	0.0	212.5	0.0	0.0	0.0	212.5	64.9	0.3054
10.0%	0.0	49.6	0.0	0.0	195.3	0.0	0.0	0.0	195.3	49.6	0.2541

ANNEX G. OCEAN TRANSPORT OF MAJOR BULK COMMODITIES IN U.S. FOREIGN TRADE, 1968 AND 1969: PATTERNS OF GEOGRAPHIC LINKAGE AND FLOWS THROUGH U.S. AND FOREIGN PORTS

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CONTENTS

I. APPROACH AND METHODOLOGY

For purposes of transport analysis, it is useful to understand:

1. The flows of each commodity between U.S. and overseas areas by particular trade routes or links

2. The relative significance of various ports of origin or destination in those commodity flows.

Published data are not adequate to illuminate these matters. Through the Federal Clearinghouse, the Bureau of the Census makes available very detailed computer runs of its annual series SA-305 and SA-705 for all U.S. imports and exports. These documents list, by U.S. ports of destination or origin and by foreign port, the volume of each 4-digit commodity separately for liner, tanker and tramp vessels. However, the data contained in these publications on the few particular commodities of interest are exceedingly hard to extract and reclassify. We accordingly undertook a series of special tabulations from the same magnetic tapes used in the above published series for 1968 and 1969, the two most recent years available at the time of tabulation.

Initially two sets of tabulations were made for each commodity classification specified in table 1. One set listed each U.S. port of origin or destination, showing the quantities of the commodity shipped from or to every foreign port. The other set provided the same information, but started with each foreign port of origin or destination. One commodity, alumina, was excluded from these initial tabulations, for reasons explained subsequently. The tabulations served their intended purpose of quickly identifying all important U.S. and foreign ports for each commodity.

Additional tabulations were then made for 1968 and 1969 on the basis of a somewhat more aggregated set of commodity classifications (table 2). Precise statistical definitions of these classifications are given in table 3. Because the number of port-to-port links (one U.S. port and one foreign port in each case) in the movement of the commodities was unmanageably large, ports both in the United States and abroad were grouped by nine U.S. and 15 foreign zones. The general geographic scope of each U.S. zone is indicated in table 4, and of each foreign zone, in table 5. Detailed specification of individual ports included in each U.S. zone, and of countries and portions of countries included in each foreign zone, are given in tables 6 and 7 respectively.

For each specified commodity group, the annual quantity (in short tons) transported on each zone-to-zone link was tabulated in matrix form separately for 1968 and 1969. Detailed results are given in tables 8 through 23. In addition, separate tabulations were made of the intrazonal distributions of each commodity by port, separately for U.S. and foreign zones (tables 24 through 45). Highlights are summarized in the following chapters.

II. THE SPECIAL PROBLEM OF ALUMINA

Appraisal of zone-to-zone and port movements for U.S. imports of alumina presents a special statistical problem. All Census Series SA-305 data, including those contained on the computer tapes used to evaluate other import commodity flows, do not distinguish alumina, a seven-digit commodity classification (5136 530). SA-305 aggregates it in the four-digit commodity classification 5136, which includes the following nine groups:

1. 5136 100: ammonia anhydrous, liquid anhydrous, and aqua
2. 5136 200: sodium hydroxide
3. 5136 300: potassium hydroxide
4. 5136 420: barium dioxide, hydroxide and oxide
5. 5136 460: magnesium oxide
6. 5136 520: aluminum oxide abrasives, crude
7. 5136 530: aluminum oxide, alumina, for use in producing aluminum
8. 5136 550: aluminum hydroxide, and oxide n.e.s.
9. 5136 600: aluminum oxide abrasives in grains, ground, pulverized, or refined.

In another Census tabulation of U.S. import data, FT-135, the seven-digit alumina classification, 5136 530, is separately treated. Although import data there pertain to all modes of transport, and are not reported separately for waterborne movements, virtually all U.S. imports of alumina -- at least from the major sources indicated -- are believed to arrive by ship. However, FT-135 shows alumina imports only by country of origin and does not indicate relevant U.S. and foreign ports. This source is therefore too general for present purposes. On the other hand, since SA-305 tabulations include several unwanted commodity groups together with alumina, their use might result in exaggerated volumes of alumina imports.

To aid in resolution of this issue, we extracted the appropriate data from each published source and tabulated them by country of origin for the years 1968 and 1969 (table 46). Only major countries from which alumina was shipped are included in the tabulation. Total import volumes indicated by the two sources differed by less than 7 percent in 1968 and by less than 3 percent in 1969. The differences were not accounted for by nonalumina components, which proved to be negligible. Contrary to logic or expectation, SA-305 totals were lower than the corresponding FT-135 totals, and differences by individual country were sometimes moderately substantial.

We have not been able to determine the reasons for these discrepancies. They might reflect minor errors either in Census tabulations or in our own. However, for purposes of this study they are relatively unimportant. We have therefore used the data reported in SA-305 to represent zone-to-zone movements of alumina and their distribution by U.S. and foreign ports in 1968 and 1969.

III. SUMMARY OF INTERZONAL FLOWS

U.S. imports of crude oil in 1968 and 1969 originated predominantly in the Caribbean area for destinations along the U.S. north Atlantic coast and in Puerto Rico. There were also small movements from the Caribbean to the U.S. gulf and California coasts. Substantial volumes of crude oil were shipped from Mediterranean and Red Sea areas to the U.S. north Atlantic coast, with smaller volumes from the Red Sea finding their way to the California coast and Hawaii. Important quantities of California crude imports also arrived from Southeast Asia.

Ocean transport patterns for U.S. imports of petroleum products (predominantly residual fuel oil) were somewhat similar to those indicated for crude in that the largest part of the movement originated in the Caribbean. However, they were supplemented by secondary quantities from Western Europe. And while some petroleum products were shipped into all but two or three of the nine U.S. zones, the dominant import area was the north Atlantic coast, followed at a considerable distance by the south Atlantic and gulf coasts.

U.S. iron ore imports in 1968 and 1969 by ocean vessel originated mostly in Canada for movement to or through ports on the Great Lakes and on the north Atlantic coast. The Caribbean was an important secondary source of ore imports for both north Atlantic and gulf zones. Small quantities of imported ore were also destined for north Atlantic and gulf areas from both the east and west coasts of South America, while West African and even some Western European ores found their way to north Atlantic coast ports.

Bauxite reveals the most geographically concentrated movement in U.S. bulk commodity trade among the commodities covered by this study. All but insignificant quantities of U.S. imports originated in the Caribbean and were destined for the gulf coast. The flow of alumina imports from Australia to the Pacific Northwest was recently dominant, with important secondary movements from the Caribbean to the Pacific Northwest and to a minor extent also to the gulf coast.

Tabulations of 1968 and 1969 U.S. coal export movements are somewhat misleading for purposes of this study, which projects exports of metallurgical coal only. Because the commodity classification includes varying qualities of steam and metallurgical grades, which cannot be distinguished statistically, significant quantities of the former are contained in the flows given in tables 18 and 19. Most of this distortion can be eliminated by excluding indicated movements from the Great Lakes to Canada. The balance, primarily coking coals, was all evacuated from the north Atlantic coast area (principally from Hampton Roads), with destinations largely in Japan and Western Europe. Modest quantities were destined for the east coast of South America.

U.S. cereal exports reveal the most complex geographic structure of transport flow among all bulk commodities covered by the study. They originated in five of the six continental U.S. zones, and were destined for all but three of the 15 foreign zones. This geographic complexity reflects the wide-ranging locational characteristics both of grain production and of its worldwide markets. Nevertheless, certain patterns emerge. In 1968 and 1969 the gulf coast dominated in the origination of U.S. cereal exports to most overseas markets, of which Western Europe and Japan were the most important. North Atlantic and Great Lakes ports were also significant conduits for the evacuation of grain to Western European markets, and all cereals for Canada understandably flowed across the Great Lakes.1/ Pacific

1/ Undetermined quantities of statistically classified U.S. cereal exports to Canada are in reality transshipments through Canadian ports. These movements reflect coast ports, particularly in the Northwest, participated significantly in grain movements destined for Japan and South Asia.

Phosphate rock exports were destined predominantly for Western Europe and Japan from the gulf coast. In addition, small volumes moved from the same origin area to Asia, Canada, and the Caribbean, and from the south Atlantic coast to Europe.

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limitations of seaway transit for large ocean vessels and superior physical conditions in several Canadian river ports close to the Atlantic Ocean.

IV. SUMMARY OF INTRAZONAL DISTRIBUTIONS BY PORTS

The number of U.S. and foreign ports engaged in the movement of major bulk commodities in U.S. foreign trade is extremely large. In 1969, 125 U.S. ports and 549 foreign ports shipped or received one or more of the commodities covered by this study. Corresponding figures for 1968 were slightly higher.

The number of relevant ports for any specific commodity varies considerably. At one extreme is alumina, for which only 13 U.S. and 11 foreign ports handled all U.S. imports in 1969. At the other extreme are the cereals, for which no less than 74 U.S. and 381 foreign ports were required to ship and receive U.S. exports in 1969. U.S. exports of coal and of phosphate rock are each distributed to a great many foreign ports as compared with the limited number of U.S. ports evacuating them. Among U.S. bulk imports, petroleum products revealed the most diversified port origin and distribution pattern in 1968 and 1969 (table 47).

As might be expected, the quantitative significance of the numerous ports involved in U.S. bulk commodity trade ranges widely. Full details on this matter are presented in tables 24 through 45. However, it may be useful to summarize their significance for study purposes. Of critical importance is the question of reasonably large annual volumes of movement, for this may often constitute a necessary condition for effective employment of very large vessels. We have accordingly aggregated the detailed port data contained in tables 24 through 45 to reveal the extent to which individual U.S. and foreign ports handled substantial volumes of each major commodity in 1968 and 1969.

As indicated in table 48, a limited number of either U.S. or foreign ports handled as much as 1 million short tons of any particular commodity in U.S. foreign trade during 1968 or 1969. The range was from 16 U.S. ports (for petroleum products in 1969 and for total grains in 1968) and 18 foreign ports (for crude oil in 1969) to none (for alumina in both 1968 and 1969). Very few ports were found to handle in excess of 10 million short tons per year. No foreign ports received any single bulk U.S. export commodity in such quantity, and only one U.S. port evacuated that much per year (for coal). Several U.S. and foreign ports handled over 10 million short tons of U.S. imports of crude oil, petroleum products, or iron ore in both 1968 and 1969.

The question of large annual commodity throughputs at individual ports can be further illuminated by considering quantities handled at the large-volume ports in relation to total trade. In table 49 the 1968 and 1969 tonnages of each major bulk export and import commodity are distributed by several classes of annual port volumes in the United States. Table 50 presents comparable data for the foreign ports. Tables 51 and 52 express in percentages the size distributions and relationships indicated in the earlier tables.

Among U.S. export commodities, coal reveals the greatest degree of concentration at large-volume ports, both in its evacuation from the United States and in its distribution among foreign ports. Thus in 1968 and 1969 all U.S. coal exports (excluding movements across the Great Lakes) left ports which evacuated over a million short tons, while 46 percent (in 1968) and 62 percent (in 1969) of those exports were delivered to foreign ports in large annual volumes. Well over three-fourths of U.S. total grain exports were loaded at ports handling over a million short tons both in 1968 and 1969. However, only around 40 percent was delivered to foreign ports receiving over a million short tons annually. Although all phosphate rock exports were evacuated through high-volume U.S. ports, they were distributed entirely in 1968 and predominantly in 1969 to foreign ports accepting only small annual volumes of U.S. exports.

U.S. bulk commodity imports are characterized by a fairly high degree of concentration at large-volume ports, both in the United States and abroad. The exception is alumina, whose annual volume is relatively insignificant. At least 79 percent of U.S. imports of crude oil, petroleum products, iron ore and bauxite originated at foreign ports and arrived at U.S. ports which handled a million short tons or more of U.S. imports in 1968 and 1969. And, bauxite excepted, substantial proportions of those bulk imports involved ports at each end which handled at least 5 million short tons in both years.

Table 1. Commodity Classifications for Initial RRNA Tabulations of 1968 and 1969 Port Movements

Port movements	Commodity classifications
<u>Exports</u>	
Total grains:	
Food grains............	041, 042, 045.1
Flour..................	046
Feed grains............	043, 044, 045.2, 045.9
Soybeans and mill products..............	081.2, 081.3, 221.4
Phosphate rock..........	271.3
Coal....................	321.4
<u>Imports</u>	
Iron ore................	281
Bauxite.................	283.3
Total petroleum and products:	
Crude..................	331
Gasoline...............	332.1
Jet fuel and kerosene..	332.2
Distillate fuel oils...	332.3
Residual fuel oils.....	332.4

Note: For precise statistical definitions of indicated codes, see table 3.

Table 2. Commodity Classifications for Final RRNA Tabulations of 1968 and 1969 Zone-to-Zone Movements and Port Distributions

Port movements	Commodity classifications
Exports	
Total grains:	
Food grains...........	041, 042, 045.1, 046
Feed grains...........	043, 044, 045.2, 045.9
Soybeans and mill products.............	081.2, 081.3, 221.4
Phosphate rock.........	271.3
Coal...................	321.4
Imports	
Iron ore...............	281
Bauxite................	283.3
Alumina................	5136 530
Crude oil..............	331
Petroleum products.....	332.1, 332.2, 332.3, 332.4

Note: For precise statistical definitions of indicated codes, see table 3.

Table 3. U.S. Bureau of the Census Definitions of Commodity Classifications

Code	Description
	Exports
041.........	Wheat, including spelt or meslin, unmilled
042.........	Rice, rough, brown, milled, glazed, or polished
045.1.......	Rye, unmilled
046.........	Wheat flour, meal and groats
043.........	Barley, unmilled
044.........	Corn or maize, unmilled
045.2.......	Oats, unmilled
045.9.......	Cereals, n.e.c., unmilled (sorghums)
081.2.......	Byproducts of cereal grains and leguminous vegetables
081.3.......	Oilseed cake, meal or residues
221.4.......	Soybeans, except roasted as coffee substitute
271.3.......	Natural phosphates
321.4.......	Coal, anthracite and bituminous
	Imports
281.........	Iron ores and concentrates, including roasted iron pyrites
283.3.......	Bauxite, including calcined
331.........	Petroleum, crude and partly refined for further refining
332.1.......	Gasoline and motor fuels
332.2.......	Jet fuel and kerosene
332.3.......	Distillate fuel oils
332.4.......	Residual fuel oils

Source: Department of Commerce, Bureau of the Census, Foreign Trade Commodity Classifications for Schedules A and B.

Table 4. General Geographical Classification of U.S. Port Zones

Port zone number	Geographical classification
1..................	Northeast (Maine through Virginia inclusive)
2..................	Southeast (Ncrth Carolina to but not including Key West, Florida)
3..................	Gulf (Key West through Texas, inclusive)
4..................	Southern Pacific coast (California)
5..................	Northern Pacific coast (Oregon and Washington)
6..................	Great Lakes
7..................	Alaska
8..................	Hawaii
9..................	Puerto Rico

Table 5. General Geographic Classification of Foreign Port Zones

Foreign port zone number	Geographical classification
1.................	Canada
2.................	Caribbean: Atlantic coast of Mexico, Central America, and Colombia; Caribbean Islands, Venezuela, the Guianas
3.................	Pacific coast of South America, Central America, and Mexico
4.................	Non-Caribbean Atlantic coast of South America (e.g., Brazil, Uruguay, Argentina, and Paraguay)
5.................	Northwest Europe: Atlantic and Baltic coasts of Spain, Portugal, France, U.K., Belgium, Holland, Denmark, Norway, Iceland, Sweden and Finland
6.................	Southwest Europe: Mediterranean coast of Spain, France and Italy
7.................	Other Mediterranean: Mediterranean coast of Greece, Yugoslavia, Turkey, Syria, Lebanon, Egypt, Israel, Malta, Cyprus, Libya, Algeria
8.................	Eastern Europe: Baltic and Black Sea coasts of U.S.S.R.
9.................	Non-Mediterranean Africa: Coast of Africa from Atlantic coast of Morocco through Somaliland, including Madagascar and adjacent islands
10................	Mideast: Djibouti, Ethiopia, Sudan, Egypt (Red Sea coast), Israel (Red Sea coast), Jordan, Saudi Arabia, Yemen, Aden, Trucial States, Kuwait, Iraq and Iran
11................	South Asia: Pakistan, India, Ceylon
12................	Southeast Asia: Burma, Thailand, Malaysia, Singapore, Indonesia, Philippines, South Korea, Taiwan, South Vietnam, Hong Kong

continued--

Table 5. General Geographic Classification of Foreign Port Zones continued--

Foreign port zone number	Geographical classification
13................	Australia, New Zealand and their Pacific Islands
14................	Communist East Asia: Mainland China, North Vietnam, North Korea and Pacific coast of the U.S.S.R.
15................	Japan and Ryukyu Islands

Table 6. U.S. Ports by Port Zone

U.S. port zone	Port
1 - Northeast (Maine through Virginia inclusive)........	Boston, Mass.
	Melville, R.I.
	New York, N.Y.
	Albany, N.Y.
	Philadelphia, Pa.
	Paulsboro, N.J.
	Camden, N.J.
	Baltimore, Md.
	Norfolk, Va.
	Newport News, Va.
	Richmond, Va.
	Alexandria, Va.
	Cape Charles, Va.
	Portland, Maine
	Bangor, Maine
	Bath, Maine
	Portsmouth, N.H.
	Belfast, Maine
	Seasport, Maine
	New Bedford, Mass.
	Plymouth, Mass.
	Fall River, Mass.
	Salem, Mass.
	Newport, R.I.
	Providence, R.I.
	Bridgeport, Conn.
	New Haven, Conn.
	New London, Conn.
	Wilmington, Del.
	Marcus Hook, Pa.
	Gloucester, Mass.
	Washington, D.C.
2 - Southeast (North Carolina to Key West, Florida).....	Beaufort/Morehead City, N.C.
	Charleston, S.C.
	Savannah, Ga.
	Jacksonville, Fla.

continued--

Table 6. U.S. Ports by Port Zone continued--

U.S. port zone	Port
	Miami, Fla.
	Georgetown, S.C.
	Brunswick, Ga.
	Port Canaveral, Fla.
	Port Pierce, Fla.
	Wilmington, N.C.
	West Palm Beach, Fla.
	Ft. Pierce, Fla.
	Port Everglades, Fla.
3 - Gulf (Key West, Fla. through Texas).....	Tampa, Fla.
	Boca Grande, Fla.
	Mobile, Ala.
	Gulfport, Miss.
	Pascagoula, Miss.
	Panama City, Fla.
	Pensacola, Fla.
	Port St. Joe, Fla.
	Morgan City, La.
	New Orleans, La.
	Baton Rouge, La.
	Port Sulphur, La.
	Destrehan, La.
	Avondale, La.
	St. Rose, La.
	Port Arthur, Tex.
	Orange, Tex.
	Beaumont, Tex.
	Lake Charles, La.
	Galveston, Tex.
	Freeport, Tex.
	Corpus Christi, Tex.
	Brownsville, Tex.
	Key West, Fla.
	Houston, Tex.
	St. Petersburg, Fla.
	Gramercy, La.
	Good Hope, La.
	Port Lavaca, Tex.

continued--

Table 6. U.S. Ports by Port Zone continued--

U.S. port zone	Port
4 - South Pacific coast (California).......	San Diego, Cal.
	Los Angeles, Cal.
	Long Beach, Cal.
	Monterey, Cal.
	San Francisco, Cal.
	Stockton, Cal.
	Oakland, Cal.
	Richmond, Cal.
	Alameda, Cal.
	Sacramento, Cal.
	Eureka, Cal.
	El Segundo, Cal.
	Crockett, Cal.
	Martiner, Cal.
	Redwood City, Cal.
	San Pablo Bay, Cal.
	Carguiner Strait, Cal.
	Selby, Cal.
	Suisun Bay, Cal.
5 - North Pacific coast (Oregon and Wash.).	Astoria, Ore.
	Portland, Ore.
	Longview, Wash.
	Vancouver, Wash.
	Kalama, Wash.
	Seattle, Wash.
	Tacoma, Wash.
	Everett, Wash.
	Port Angeles, Wash.
6 - Great Lakes.........	Duluth, Minn.
	Superior, Wisc.
	Milwaukee, Wisc.
	Racine, Wisc.
	Detroit, Mich.
	Saginaw/Bay City, Mich.
	Chicago, Ill.
	Cleveland, Ohio
	Toledo, Ohio
	Erie, Pa.

continued--

Table 6. U.S. Ports by Port Zone continued--

U.S. port zones	Port
	Sandusky, Ohio
	Ashtabula, Ohio
	Connecut, Ohio
	Lorain, Ohio
	Port Huron, Mich.
	Gary, Ind.
	Huron
	East Chicago, Ind.
	Ogdensburg, N.Y.
	Rochester, N.Y.
	Buffalo, N.Y.
	Massena, N.Y.
	Oswego, N.Y.
7 - Alaska.............	Wrangel, Alaska
	Ketchikan, Alaska
	Skagway, Alaska
	Sand Point, Alaska
	Anchorage, Alaska
	Juneau, Alaska
8 - Hawaii.............	Honolulu, Hawaii
	Kahului, Hawaii
9 - Puerto Rico.........	Ponce, P.R.
	San Juan, P.R.
	Fajardo, P.R.
	Guanica, P.R.
	Jobos, P.R.
	Guayanilla, P.R.
	Mayaguez, P.R.

Table 7. Foreign Port Zones by Countries and Subareas

Foreign port zone	Country or subarea
1............	All Canadian ports
	Miquelon and St. Pierre Islands
2............	Mexico (Gulf or east coast region)
	Guatemala (Caribbean region)
	British Honduras (Caribbean region)
	Honduras (Caribbean region)
	Nicaragua (Caribbean region)
	Costa Rica (Caribbean region)
	Panama (Caribbean region)
	Canal Zone (Caribbean region)
	Bermuda
	Bahamas
	Cuba
	Jamaica
	Haiti
	Dominican Republic
	Leeward and Windward Islands
	Barbados
	Trinidad and Tobago
	Netherlands Antilles
	French West Indies
	Colombia (Caribbean coast region)
	Venezuela
	Guyana
	Surinam
	French Guiana
3............	Mexico (Pacific coast region)
	Guatemala (Pacific coast region)
	El Salvador (Pacific coast region)
	Honduras (Pacific coast region)
	Costa Rica (Pacific coast region)
	Panama (Pacific coast region)
	Canal Zone (Pacific coast region)
	Ecuador
	Peru
	Chile
	Colombia (Pacific coast region)
	Bolivia

continued--

Table 7. Foreign Port Zones by Countries and Subareas continued--

Foreign port zone	Country or subarea
4............	Brazil
	Paraguay
	Uruguay
	Argentina
	Falkland Islands
5............	Iceland
	Sweden
	Norway
	Finland
	Denmark
	U.K.
	Ireland
	Netherlands
	Belgium
	France (Atlantic region)
	West Germany (Baltic and Atlantic coast regions)
	Azores
	Spain (Atlantic coast region)
	Portugal
6............	France (Mediterranean coast region)
	Corsica
	Monaco
	Spain (Mediterranean coast region)
	Gibraltar
	Italy (West and east coasts)
7............	Yugoslavia
	Greece
	Turkey
	Cyprus
	Syria
	Lebanon
	Israel (Mediterranean coast region)
	Spanish Africa (Mediterranean coast region)
	Morocco (Mediterranean coast region)
	Algeria
	Tunisia

continued--

Table 7. Foreign Port Zones by Countries and Subareas continued--

Foreign port zone	Country or subarea
	Libya
	U.A.R. (Mediterranean coast region)
	Malta
8............	Estonia
	Latvia
	Lithuania
	Poland and Danzig
	U.S.S.R. (Arctic, Baltic, and Black Sea coast regions)
	East Germany
	Rumania
	Bulgaria
9............	Morocco (Atlantic coast region)
	Canary Islands
	Spanish Africa (Atlantic coast region)
	Mauritania
	Cameroon
	Senegal
	Guinea
	Sierra Leone
	Ivory Coast
	Ghana
	Gambia
	Togo
	Nigeria
	Gabon
	Western Africa
	Tanzania
	Dahomey
	Congo (Brazzaville)
	British West Africa
	Western Portuguese Africa
	Angola
	Portuguese Guinea
	Sao Tome
	Liberia
	Congo (Kinshasa)
	Somali Republic

continued--

Table 7. Foreign Port Zones by Countries and Subareas continued--

Foreign port zone	Country or subarea
	Kenya
	Mauritius and Dgindencias
	Mozambique
	Malagasy Republic
	Reunion
	Comoro Islands
	Republic of South Africa
	Southwest Africa
10...........	Israel (Port of Elath)
	Jordan
	Iraq
	Iran
	Kuwait
	Saudi Arabia
	Arabia Peninsula States
	Aden
	Bahrain
	Ethiopia
	U.A.R. (Red Sea ports)
	French Somaliland (Djibouti)
11...........	India
	Pakistan
	Ceylon
12...........	Burma
	Thailand
	Malaysia
	Singapore
	Indonesia
	South Korea
	Taiwan
	South Vietnam
	Hong Kong
	Philippines
	Cambodia
	Macao
	Southern and Southeastern Asia
13...........	Australia
	New Zealand and Western Samoa

continued--

Table 7. Foreign Port Zones by Countries and Subareas continued--

Foreign port zone	Country or subarea
	Tasmania
	New Guinea
	Cook Islands
	Manakiki Islands
	Niue Islands
	British Western Pacific Islands
	Christmas Island
	Fanning Island
	French Pacific Islands
	Trust Territory of the Pacific Islands
14...........	China
	North Vietnam
	North Korea
	U.S.S.R. (Pacific coast)
15...........	Nansei and Nanpo Islands
	Japan

Table 8. U.S. Crude Oil Imports, Zone-to-Zone Waterborne Movements, 1968

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	21.8	0.1	2.1	1.5	0.1	--	--	--	9.9	35.5
3 - S. Am.-Pac.	--	--	--	1.1	--	--	--	--	--	1.2
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	0.2	--	--	--	--	--	--	--	--	0.2
6 - SW Eur.....	0.1	--	--	--	--	--	--	--	--	0.1
7 - Other Med..	7.6	--	--	--	--	--	--	--	--	7.6
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	0.5	--	--	--	--	--	--	--	--	0.5
10 - Mid-East...	9.5	--	--	1.4	--	--	--	1.5	--	12.5
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	0.2	--	--	2.9	0.2	--	--	0.5	--	3.8
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	40.0	0.1	2.2	6.9	0.4	--	--	2.0	9.9	61.4

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 9. U.S. Crude Oil Imports, Zone-to-Zone Waterborne Movements, 1969
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	19.3	0.1	2.2	1.4	0.1	--	--	--	10.4	33.6
3 - S. Am.-Pac.	0.7	--	--	1.3	--	--	--	--	--	2.0
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	0.2	--	--	--	--	--	--	--	0.1	0.4
6 - SW Eur.....	--	--	--	--	--	--	--	--	0.1	0.1
7 - Other Med..	7.9	--	--	--	--	--	--	--	--	8.0
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	2.9	--	--	--	--	--	--	--	0.1	3.0
10 - Mid-East...	9.0	--	--	1.6	--	--	--	1.5	--	12.2
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	4.0	0.2	--	--	0.4	--	4.7
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total.........	40.0	0.1	2.3	8.5	0.4	--	--	2.0	10.7	63.9

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 10. U.S. Petroleum Product Imports, Zone-to-Zone Waterborne Movements, 1968
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	0.1	--	--	--	0.2
2 - Caribbean..	53.3	7.7	3.2	1.5	0.2	--	0.3	1.1	0.6	67.9
3 - S. Am.-Pac.	--	--	--	--	--	--	--	--	--	--
4 - S. Am.-Atl.	0.7	0.1	--	--	--	--	--	--	--	0.8
5 - NW Eur.....	3.2	0.1	--	--	--	--	--	--	--	3.3
6 - SW Eur.....	4.0	--	--	--	--	--	--	--	--	4.0
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	0.1	--	--	--	--	--	--	--	--	0.1
9 - Other Afr..	0.3	--	--	--	--	--	--	--	--	0.3
10 - Mid-East...	0.1	--	--	0.1	--	--	--	0.5	--	0.7
11 - S. Asia....	0.1	--	--	--	--	--	--	--	--	0.1
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	61.8	7.9	3.2	1.6	0.2	0.1	0.4	1.7	0.6	77.4

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 11. U.S. Petroleum Product Imports, Zone-to-Zone Waterborne Movements, 1969
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	0.1	--	--	--	--	0.2	0.1	--	--	0.4
2 - Caribbean..	57.0	9.3	4.4	1.6	0.2	--	0.4	0.9	0.6	74.3
3 - S. Am.-Pac.	0.1	--	--	--	--	--	--	--	--	0.1
4 - S. Am.-Atl.	0.1	--	--	--	--	--	--	--	--	0.1
5 - NW Eur.....	4.6	0.1	--	--	--	--	--	--	--	4.7
6 - SW Eur.....	5.0	--	--	--	--	--	--	--	--	5.0
7 - Other Med..	0.2	--	--	--	--	--	--	--	--	0.2
8 - E. Eur.....	0.3	--	--	--	--	--	--	--	--	0.3
9 - Other Afr..	0.2	--	--	--	--	--	--	--	--	0.2
10 - Mid-East...	0.1	--	--	0.1	--	--	0.1	0.7	--	1.0
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	0.1	--	--	--	0.1	--	0.2
Total..........	67.6	9.4	4.4	1.8	0.2	0.2	0.5	1.8	0.6	86.5

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 12. U.S. Iron Ore Imports, Zone-to-Zone Waterborne Movements, 1968

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	6.5	--	1.4	--	--	20.0	--	--	--	27.9
2 - Caribbean..	8.7	--	2.9	--	--	--	--	--	--	11.6
3 - S. Am.-Pac.	1.9	--	0.7	--	--	--	--	--	--	2.6
4 - S. Am.-Atl.	0.9	--	0.5	--	--	--	--	--	--	1.4
5 - NW Eur.....	0.7	--	--	--	--	--	--	--	--	0.7
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	2.7	--	0.3	--	--	--	--	--	--	3.1
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	0.1	--	--	--	--	--	--	0.1
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total.........	21.3	--	6.0	--	--	20.0	--	--	--	47.4

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 13. U.S. Iron Ore Imports, Zone-to-Zone Waterborne Movements, 1969
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	4.4	--	0.5	--	--	13.3	--	--	--	18.5
2 - Caribbean..	12.1	--	3.2	--	--	--	--	--	--	15.4
3 - S. Am.-Pac.	2.0	--	1.0	--	0.1	--	--	--	--	3.1
4 - S. Am.-Atl.	0.9	--	0.5	--	--	--	--	--	--	1.4
5 - NW Eur.....	0.5	--	--	--	--	--	--	--	--	0.5
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	3.0	--	0.2	--	--	0.1	--	--	--	3.3
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	0.2	--	0.2	--	--	--	--	--	--	0.4
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total.........	23.1	--	5.8	--	0.1	13.4	--	--	--	42.5

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 14. U.S. Bauxite Imports, Zone-to-Zone Waterborne Movements, 1968
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	0.2	--	13.9	--	--	--	--	--	--	14.2
3 - S. Am.-Pac.	--	--	--	--	--	--	--	--	--	--
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	--	--	--	--	--	--	--	--	--	--
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	0.1	--	--	--	--	--	--	0.1
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	0.2	--	14.0	--	--	--	--	--	--	14.4

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 15. U.S. Bauxite Imports, Zone-to-Zone Waterborne Movements, 1969

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 ɔrth Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	0.2	--	15.9	--	--	--	--	--	--	16.2
3 - S. Am.-Pac.	--	--	--	--	--	--	--	--	--	--
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	--	--	--	--	--	--	--	--	--	--
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	0.2	0.1	15.9	--	--	--	--	--	--	16.3

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 16. U.S. Alumina Imports, Zone-to-Zone Waterborne Movements, 1968

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	--	--	0.2	--	0.4	--	--	--	--	0.6
3 - S. Am.-Pac.	--	--	--	--	--	--	--	--	--	--
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	--	--	--	--	--	--	--	--	--	--
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	0.7	--	--	--	--	0.7
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	--	--	0.2	--	1.1	--	--	--	--	1.3

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 17. U.S. Alumina Imports, Zone-to-Zone Waterborne Movements, 1969
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	--	--	--	--	--
2 - Caribbean..	--	--	0.1	--	0.4	--	--	--	--	0.5
3 - S. Am.-Pac.	--	--	--	--	--	--	--	--	--	--
4 - S. Am.-Atl.	--	--	--	--	--	--	--	--	--	--
5 - NW Eur.....	--	--	--	--	--	--	--	--	--	--
6 - SW Eur.....	--	--	--	--	--	--	--	--	--	--
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	1.3	--	--	--	--	1.3
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	--	--	0.1	--	--	--	--	0.1
Total.........	--	--	0.1	--	1.8	--	--	--	--	1.9

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305.

Table 18. U.S. Coal Exports, Zone-to-Zone Waterborne Movements, 1968

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	0.8	--	--	--	--	16.0	--	--	--	16.8
2 - Caribbean..	--	--	--	--	--	--	--	--	--	--
3 - S. Am.-Pac.	0.3	--	--	--	--	--	--	--	--	0.3
4 - S. Am.-Atl.	2.3	--	--	--	--	--	--	--	--	2.3
5 - NW Eur.....	10.4	--	--	--	--	--	--	--	--	10.4
6 - SW Eur.....	4.5	--	--	--	--	--	--	--	--	4.5
7 - Other Med..	0.4	--	--	--	--	--	--	--	--	0.4
8 - E. Eur.....	0.2	--	--	--	--	--	--	--	--	0.2
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	15.8	--	--	--	--	--	--	--	--	15.9
Total..........	34.7	--	--	--	--	16.0	--	--	--	50.7

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 19. U.S. Coal Exports, Zone-to-Zone Waterborne Movements, 1969

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	0.8	--	--	--	--	16.0	--	--	--	16.7
2 - Caribbean..	--	--	--	--	--	--	--	--	--	0.1
3 - S. Am.-Pac.	0.5	--	--	--	--	--	--	--	--	0.5
4 - S. Am.-Atl.	2.3	--	--	--	--	--	--	--	--	2.3
5 - NW Eur.....	11.1	--	--	--	--	--	--	--	--	11.1
6 - SW Eur.....	3.9	--	--	--	--	--	--	--	--	3.9
7 - Other Med..	0.2	--	--	--	--	--	--	--	--	0.2
8 - E. Eur.....	0.1	--	--	--	--	--	--	--	--	0.1
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	--	--	--	--	--	--	--	--
12 - SE Asia....	--	--	--	--	--	--	--	--	--	--
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	21.2	--	0.1	0.1	--	--	--	--	--	21.4
Total..........	40.1	--	0.1	0.1	--	16.0	--	--	--	56.3

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 20. U.S. Total Grain Exports, Zone-to-Zone Waterborne Movements, 1968

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	3.4	--	--	--	3.4
2 - Caribbean..	0.1	--	1.2	--	0.1	0.1	--	--	--	1.5
3 - S. Am.-Pac.	--	--	0.7	--	0.1	--	--	--	--	0.8
4 - S. Am.-Atl.	--	--	1.4	--	--	--	--	--	--	1.5
5 - NW Eur.....	2.7	0.3	10.2	--	--	3.1	--	--	--	16.3
6 - SW Eur.....	0.5	--	3.5	--	--	0.2	--	--	--	4.3
7 - Other Med..	0.4	--	1.8	--	--	0.2	--	--	--	2.3
8 - E. Eur.....	0.1	--	0.7	--	--	--	--	--	--	0.8
9 - Other Afr..	0.1	--	0.8	--	--	--	--	--	--	0.9
10 - Mid-East...	--	--	0.2	--	--	--	--	--	--	0.2
11 - S. Asia....	0.4	--	4.1	0.1	1.6	--	--	--	--	6.2
12 - SE Asia....	0.1	--	1.8	0.4	2.0	--	--	--	--	4.4
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	0.1	--	7.3	0.3	2.2	0.3	--	--	--	10.1
Total..........	4.5	0.3	33.8	0.8	6.0	7.3	--	--	--	52.8

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 21. U.S. Total Grain Exports, Zone-to-Zone Waterborne Movements, 1969

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	--	--	--	--	4.3	--	--	--	4.4
2 - Caribbean..	0.1	--	1.1	--	0.1	0.1	--	--	--	1.4
3 - S. Am.-Pac.	--	--	0.5	--	0.2	--	--	--	--	0.7
4 - S. Am.-Atl.	--	--	1.2	--	--	--	--	--	--	1.2
5 - NW Eur.....	1.8	0.2	8.4	--	--	2.7	--	--	--	13.1
6 - SW Eur.....	0.5	--	3.2	--	--	0.1	--	--	--	3.8
7 - Other Med..	0.5	--	2.4	--	--	0.1	--	--	--	3.0
8 - E. Eur.....	--	--	0.4	--	--	--	--	--	--	0.4
9 - Other Afr..	--	--	0.7	--	--	--	--	--	--	0.7
10 - Mid-East...	--	--	0.1	--	--	--	--	--	--	0.1
11 - S. Asia....	--	--	1.9	--	1.1	--	--	--	--	3.0
12 - SE Asia....	0.1	--	1.9	0.4	2.1	--	--	--	--	4.4
13 - Australia..	--	--	--	--	--	--	--	--	--	--
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	7.7	0.6	2.3	0.2	--	--	--	10.7
Total..........	3.0	0.2	29.4	1.0	5.8	7.6	--	--	--	47.0

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 22. U.S. Natural Phosphate Exports, Zone-to-Zone Waterborne Movements, 1958
(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	0.2	0.7	--	--	--	--	--	--	0.9
2 - Caribbean..	--	--	0.3	--	--	--	--	--	--	0.3
3 - S. Am.-Pac.	--	--	0.1	--	--	--	--	--	--	0.1
4 - S. Am.-Atl.	--	--	0.3	--	--	--	--	--	--	0.3
5 - NW Eur.....	0.1	0.2	2.7	--	--	--	--	--	--	3.0
6 - SW Eur.....	--	0.5	1.0	--	--	--	--	--	--	1.5
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	0.1	0.2	--	--	--	--	--	--	0.3
12 - SE Asia....	--	--	0.7	--	--	--	--	--	--	0.7
13 - Australia..	--	--	0.7	--	--	--	--	--	--	0.7
14 - Comm. Asia.	--	--	--	--	--	--	--	--	--	--
15 - Japan......	--	--	2.8	--	--	--	--	--	--	2.8
Total..........	0.1	1.0	9.5	--	--	--	--	--	--	10.6

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 23. U.S. Natural Phosphate Exports, Zone-to-Zone Waterborne Movements, 1969

(In millions of short tons)

Foreign port zone	U.S. port zone									Total
	1 North Atl.	2 South Atl.	3 Gulf	4 South Pac.	5 North Pac.	6 Great Lakes	7 Alaska	8 Hawaii	9 Puerto Rico	
1 - Canada.....	--	0.2	0.9	--	--	--	--	--	--	1.1
2 - Caribbean..	--	--	0.7	--	--	--	--	--	--	0.7
3 - S. Am.-Pac.	--	--	0.1	--	--	--	--	--	--	0.1
4 - S. Am.-Atl.	--	--	0.3	--	--	--	--	--	--	0.3
5 - NW Eur.....	--	0.5	2.4	--	--	--	--	--	--	2.9
6 - SW Eur.....	--	0.4	1.1	--	--	--	--	--	--	1.5
7 - Other Med..	--	--	--	--	--	--	--	--	--	--
8 - E. Eur.....	--	--	--	--	--	--	--	--	--	--
9 - Other Afr..	--	--	--	--	--	--	--	--	--	--
10 - Mid-East...	--	--	--	--	--	--	--	--	--	--
11 - S. Asia....	--	--	0.3	--	--	--	--	--	--	0.3
12 - SE Asia....	--	--	0.9	--	--	--	--	--	--	0.9
13 - Australia..	--	--	0.1	--	--	--	--	--	--	0.1
14 - Comm. Asia.	--	--	2.1	--	--	--	--	--	--	2.1
15 - Japan......	--	--	--	--	--	--	--	--	--	--
Total..........	--	1.1	8.9	--	--	--	--	--	--	10.0

Note: Annual zone-to-zone movements of less than 50,000 short tons are excluded from the above figures; all other data are rounded to nearest 100,000 short tons. Thus columns and rows may not add to totals shown.

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-705.

Table 24. U.S. Waterborne Imports of Crude Oil by U.S. Port Destination, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
New York, New York.......	10,502	8,747
Philadelphia, Pa.........	9,345	9,052
Paulsboro, N.J...........	8,117	7,446
Marcus Hook, Pa..........	5,797	7,405
Wilmington, Del..........	3,334	4,313
Newport News, Va.........	2,201	2,341
Baltimore, Md............	537	488
Total..................	39,833	39,791
3 - Gulf		
Brownsville, Tex.........	1,713	1,847
4 - South Pacific coast		
Los Angeles, Cal.........	2,096	2,431
San Pablo Bay, Cal.......	1,261	833
Richmond, Cal............	984	1,227
Long Beach, Cal..........	981	1,774
Martinez, Cal............	836	560
El Segundo, Cal..........	699	617
San Francisco, Cal.......	0	667
Total..................	6,856	8,109
8 - Hawaii		
Honolulu.................	1,963	1,984
9 - Puerto Rico		
Guayanilla...............	6,636	6,610
San Juan.................	2,013	2,715
Jobos....................	1,204	1,395
Total..................	9,853	10,720
Total, above-listed ports.	60,218	62,450
Total, all reported ports.	61,357	63,948

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 25. U.S. Waterborne Imports of Petroleum Products by U.S. Port Destination, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
New York, N.Y............	31,538	31,066
Boston, Mass.............	6,803	7,780
Baltimore, Md............	3,981	4,522
Paulsboro, N.J...........	3,825	3,617
New Haven, Conn..........	2,331	1,988
Norfolk, Va..............	2,087	3,347
Providence, R.I..........	1,616	1,973
Camden, N.J..............	1,394	2,170
Philadelphia, Pa.........	1,123	1,540
Portland, Me.............	1,093	1,117
Bridgeport, Conn.........	774	1,354
New Bedford, Mass........	693	429
Portsmouth, N.H..........	626	644
Searsport, Me............	593	701
New London, Conn.........	550	962
Marcus Hook, Pa..........	529	870
Salem, Mass..............	524	660
Albany, N.Y..............	476	879
Fall River, Mass.........	254	543
Total..................	60,809	66,161
2 - Southeast		
Jacksonville, Fla........	1,789	2,687
Charleston, S.C..........	947	1,087
Miami, Fla...............	942	794
Savannah, Ga.............	644	797
West Palm Beach, Fla.....	608	474
Wilmington, N.C..........	502	662
Port Canaveral, Fla......	367	654
Total..................	5,800	7,155
3 - Gulf		
Port Everglades, Fla.....	1,696	1,742
Houston, Tex.............	842	852
Tampa, Fla...............	687	1,221
New Orleans, La..........	439	812
Total..................	3,664	4,626
4 - South Pacific coast		
Los Angeles, Cal.........	707	882

continued--

Table 25. U.S. Waterborne Imports of Petroleum Products by U.S. Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

U.S. port zone	1968	1969
8 - Hawaii		
Honolulu................	1,652	1,754
9 - Puerto Rico		
San Juan................	594	633
Total, above-listed ports.	73,225	81,211
Total, all reported ports.	77,407	86,498

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 95 percent in 1968 and 94 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 26. U.S. Waterborne Imports of Iron Ore by U.S. Port Destination, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Philadelphia, Pa.	10,561	12,295
Baltimore, Md.	10,374	10,542
Total	20,936	22,837
3 - Gulf		
Mobile, Ala.	4,413	4,576
Houston, Tex.	889	753
Baton Rouge, La.	707	407
Total	6,010	5,736
6 - Great Lakes		
Cleveland, Ohio	4,058	3,215
Conneaut, Ohio	3,791	2,270
East Chicago, Ind.	3,730	1,922
Gary, Ind.	3,393	1,703
Detroit, Mich.	1,491	1,057
Ashtabula, Ohio	1,228	840
Buffalo, N.Y.	1,085	697
Chicago, Ill.	462	949
Total	19,238	12,653
Total, above-listed ports	46,183	41,226
Total, all reported ports	47,365	42,503

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 97 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 27. U.S. Waterborne Imports of Bauxite by U.S. Port Destination, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
3 - Gulf		
Baton Rouge, La..........	3,900	4,342
Mobile, Ala.............	2,748	2,314
Port Lavaca-Pnt. Cmfr., Tex....................	2,623	3,090
Corpus Christi, Tex......	2,391	3,416
Gramercy, La.............	2,282	2,206
New Orleans, La..........	28	554
Total..................	13,973	15,922
Total, above-listed ports.	13,973	15,922
Total, all reported ports.	14,356	16,281

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 97 percent in 1968 and 98 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 28. U.S. Waterborne Imports of Alumina by U.S. Port Destination, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
3 - Gulf		
New Orleans, La..........	156	73
5 - North Pacific coast		
Portland, Ore............	71	115
Longview, Wash...........	43	46
Vancouver, Wash..........	292	479
Bellingham, Wash.........	288	564
Tacoma, Wash.............	385	533
Everett, Wash............	--	24
Total..................	1,079	1,761
Total, above-listed ports.	1,235	1,834
Total, all reported ports.	1,316	1,884

Source: U.S. Bureau of the Census, SA-305.

Table 29. U.S. Waterborne Exports of Coal by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Norfolk, Va.............	24,410	27,669
Newport News, Va........	7,523	9,375
Baltimore, Md...........	2,442	2,659
Total..................	34,374	39,703
6 - Great Lakes		
Conneaut, Ohio..........	5,712	5,434
Toledo, Ohio............	4,360	3,347
Sandusky, Ohio..........	4,052	3,799
Ashtabula, Ohio.........	1,146	2,900
Total..................	15,270	15,480
Total, above-listed ports.	49,645	55,183
Total, all reported ports.	50,711	56,268

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 30. U.S. Waterborne Exports of Total Grains by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Norfolk, Va.	2,240	1,548
Baltimore, Md.	1,090	874
Philadelphia, Pa.	853	363
Albany, N.Y.	164	66
Total	4,349	2,852
2 - Southeast		
Charleston, S.C.	242	142
3 - Gulf		
New Orleans, La.	8,771	7,630
Houston, Tex.	6,777	3,902
Destrehan, La.	6,563	6,798
Baton Rouge, La.	3,663	3,202
Pascagoula, Miss.	1,942	1,200
Corpus Christi, Tex.	1,284	1,318
Beaumont, Tex.	1,224	717
Mobile, Ala.	1,157	950
Galveston, Tex.	740	625
Lake Charles, La.	574	595
St. Rose, La.	358	381
Port Arthur, Tex.	227	86
Brownsville, Tex.	183	307
Gramercy, La.	--	1,334
Total	33,462	29,042
4 - South Pacific coast		
Sacramento, Cal.	538	437
Long Beach, Cal.	59	368
Total	598	805
5 - North Pacific coast		
Portland, Ore.	2,596	2,310
Longview, Wash.	1,142	1,063
Seattle, Wash.	745	801
Kalama, Wash.	579	507
Vancouver, Wash.	505	694
Tacoma, Wash.	283	303
Total	5,850	5,678

continued--

Table 30. U.S. Waterborne Exports of Total Grains by U.S. Port Origin, 1968 and 1969 continued--

(In thousands of short tons)

U.S. port zone	1968	1969
6 - Great Lakes		
Toledo, Ohio.............	2,434	2,184
Chicago, Ill.............	2,316	2,762
Superior, Wis............	1,231	1,247
Duluth, Minn.............	1,013	943
Milwaukee, Wis...........	158	299
Saginaw-Bay City, Mich...	113	38
Total..................	7,264	7,473
Total, above-listed ports.	51,764	45,992
Total, all reported ports.	52,772	46,981

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 31. U.S. Waterborne Exports of Food Grain by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Norfolk, Va...............	549	501
Baltimore, Md............	240	127
Albany, N.Y..............	164	66
Philadelphia, Pa.........	157	51
Total....................	1,111	746
3 - Gulf		
Houston, Tex.............	4,984	3,168
New Orleans, La..........	1,426	983
Beaumont, Tex............	1,108	627
Destrehan, La............	722	323
Galveston, Tex...........	589	533
Lake Charles, La.........	574	595
Baton Rouge, La..........	483	391
Mobile, Ala..............	229	97
Corpus Christi, Tex......	170	152
Pascagoula, Miss.........	143	108
Port Arthur, Tex.........	106	75
Total....................	10,533	7,052
4 - South Pacific coast		
Sacramento, Cal..........	437	394
5 - North Pacific coast		
Portland, Ore............	2,473	2,235
Longview, Wash...........	1,142	1,063
Seattle, Wash............	745	801
Kalama, Wash.............	579	507
Vancouver, Wash..........	505	694
Tacoma, Wash.............	283	303
Total....................	5,727	5,603
6 - Great Lakes		
Superior, Wis............	832	702
Duluth, Minn.............	560	526
Toledo, Ohio.............	214	69
Saginaw-Bay City, Mich...	113	38
Total....................	1,719	1,335
Total, above-listed ports..	19,526	15,130
Total, all reported ports.	19,795	15,408

continued--

Table 31. U.S. Waterborne Exports of Food Grain by U.S. Port Origin, 1968 and 1969 continued--

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 99 percent in 1968 and 98 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 32. U.S. Waterborne Exports of Feed Grains by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Norfolk, Va...............	1,170	615
Philadelphia, Pa..........	635	207
Baltimore, Md.............	488	157
Total....................	2,294	979
3 - Gulf		
New Orleans, La...........	4,643	3,526
Destrehan, La.............	3,363	3,898
Houston, Tex..............	1,793	734
Baton Rouge, La...........	1,625	1,595
Corpus Christi, Tex.......	1,114	1,166
Pascagoula, Miss..........	974	405
St. Rose, La..............	290	194
Brownsville, Tex..........	183	307
Galveston, Tex............	151	92
Gramercy, La..............	--	1,068
Total....................	14,136	12,984
4 - South Pacific coast		
Sacramento, Cal...........	101	43
Long Beach, Cal...........	59	368
Total....................	161	411
5 - North Pacific coast		
Portland, Ore.............	123	75
6 - Great Lakes		
Chicago, Ill..............	1,448	1,672
Toledo, Ohio..............	1,243	905
Superior, Wis.............	342	423
Duluth, Minn..............	296	267
Milwaukee, Wis............	158	299
Total....................	3,486	3,567
Total, above-listed ports.	20,200	18,016
Total, all reported ports.	20,656	18,373

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 33. U.S. Waterborne Exports of Soybean and Mill Products by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
1 - Northeast		
Norfolk, Va.	521	432
Baltimore, Md.	362	590
Philadelphia, Pa.	61	105
Total	944	1,127
2 - Southeast		
Charleston, S.C.	242	142
3 - Gulf		
New Orleans, La.	2,702	3,121
Destrehan, La.	2,478	2,577
Baton Rouge, La.	1,555	1,216
Mobile, Ala.	928	853
Pascagoula, Miss.	825	687
Port Arthur, Tex.	121	11
Beaumont, Tex.	116	90
Gramercy, La.	--	266
St. Rose, La.	68	187
Total	8,793	9,006
6 - Great Lakes		
Toledo, Ohio	977	1,210
Chicago, Ill.	868	1,090
Duluth, Minn.	157	150
Superior, Wisc.	57	122
Total	2,059	2,571
Total, above-listed ports.	12,038	12,846
Total, all reported ports.	12,321	13,200

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 97 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 34. U.S. Waterborne Exports of Natural Phosphates by U.S. Port Origin, 1968 and 1969

(In thousands of short tons)

U.S. port zone	1968	1969
2 - Southeast		
Jacksonville, Fla........	907	811
3 - Gulf		
Tampa, Fla................	8,804	8,198
Boca Grande, Fla.........	712	712
Total....................	9,516	8,910
Total, above-listed ports.	10,423	9,720
Total, all reported ports.	10,612	9,993

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 97 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 35. U.S. Waterborne Imports of Crude Oil by Foreign Port Origin, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
2 - Caribbean		
Puerto La Cruz, Ven.......	13,612	12,446
La Salina, Ven............	5,723	4,943
Maracaibo, Ven............	4,150	4,471
Puerto Miranda, Ven.......	2,215	2,523
Tampico, Mex..............	1,589	1,847
Santa Marta, Col..........	1,223	559
Aruba, Neth. Ant..........	961	1,512
Amuay, Las Piedras, Ven...	892	620
Pt. a Pierre, Trinidad....	862	972
Covenas, Col..............	856	452
Punta Cardon, Ven.........	809	784
Curacao Isl., Neth. Ant...	616	869
Other Colombia Carib. Pts.	14	521
Total....................	33,520	32,520
3 - South America-Pacific		
Arica, Chile..............	1,130	1,119
Tumaco, Col...............	--	893
Total....................	1,130	2,011
7 - Other Mediterranean		
Other Libya Ports.........	6,464	7,730
9 - Other Africa		
Other Nigeria Ports.......	480	2,753
10 - Mid-East		
Kharg. Isl., Iran.........	2,959	1,026
Ras At Tannurah, Saud. Ar.	2,821	2,057
Al Ahmadi, Kuwait.........	2,248	2,440
Mena Saud, Neutral Zone...	1,618	1,781
Other Ar. Pen. Sts. Nes. Ports................	796	1,141
Other U.A.R. Egypt Red Sea Ports................	720	2,088
All other Iran Ports......	159	1,376
Total....................	11,321	11,909

continued--

Table 35. U.S. Waterborne Imports of Crude Oil by Foreign Port Origin, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
12 - Southeast Asia		
Dumai, Sumatra............	2,836	3,559
Other Sumatra Ports.......	868	1,008
Total....................	3,704	4,567
Total, above-listed ports..	56,620	61,491
Total, all reported ports..	61,357	63,984

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 92 percent in 1968 and 96 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 36. U.S. Waterborne Imports of Petroleum Products by Foreign Port Origin, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
2 - Caribbean		
Aruba, Neth. Ant.........	15,338	17,748
Amuay, Las Piedras, Ven.	9,545	10,616
Punta Cardon, Ven........	7,846	7,960
Port a Pierre, Trinidad..	7,798	9,629
Curacao Isl., Neth. Ant..	7,204	8,053
Puerto La Cruz, Ven......	5,429	4,428
Caripito, Ven............	2,553	2,892
El Palito, Ven...........	2,338	2,786
Port of Spain, Trinidad..	1,946	1,127
Other Trinidad Ports.....	1,536	1,600
Maracaibo, Ven...........	1,494	2,454
Cartagena, Col...........	1,124	1,472
Tampico, Mex.............	895	908
Puerto Ordaz, Ven........	733	257
San Lorenzo, Ven.........	392	716
Total..................	66,171	72,646
4 - South America-Atlantic		
La Plata, Arg............	718	40
5 - Northwest Europe		
Isle of Grain, Eng.......	858	449
Rotterdam, Neth..........	665	1,839
Total..................	1,523	2,287
6 - Southwest Europe		
Other Sicily Ports.......	1,683	916
Other Sardinia Ports.....	752	1,635
Other Sp. Med. Ports.....	693	138
Augusta, Sicily..........	326	1,080
Napoli, Naples, Italy....	405	648
Total..................	3,858	4,417
Total, above-listed ports.	72,270	79,389
Total, all reported ports.	77,407	86,498

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 93 percent in 1968 and 92 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 37. U.S. Waterborne Imports of Iron Ore by Foreign Port Origin, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Seven Islands, Que........	11,520	7,576
Port Cartier, Que.........	8,237	5,079
Clarke City, Que..........	2,729	1,469
Port Arthur, Ont..........	1,714	1,651
Fort William, Ont.........	901	673
Depot Harbor, Ont.........	829	553
Little Current, Ont.......	554	444
Picton, Ont...............	504	585
Total....................	26,988	18,031
2 - Caribbean		
Puerto Ordaz, Ven.........	8,737	11,484
Other Venezuela Ports.....	2,828	3,721
Total....................	11,564	15,205
3 - South America-Pacific		
All other Peru Ports......	952	1,022
Cruz Grande, Chile........	416	692
Huasco, Chile.............	285	506
Total....................	1,653	2,221
4 - South America-Atlantic		
Rio de Janeiro-Niteroi, Brz....................	841	647
9 - Other Africa		
Buchanan, Liberia.........	2,725	2,716
Total, above-listed ports.	43,771	38,820
Total, all reported ports.	47,365	42,503

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 92 percent in 1968 and 91 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 38. U.S. Waterborne Imports of Bauxite by Foreign Port Origin, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
2 - Caribbean		
Port Kaiser, Jam.........	4,911	5,410
Ocho Rios, Jam...........	2,073	3,046
Port of Spain, Trinidad..	1,848	1,517
Paramaribo, Surinam......	1,409	1,633
Cabo Rojo, Dom. Rep......	1,253	1,500
Other Jam. Ports.........	1,215	1,534
Miragoane, Haiti.........	493	799
Puerto of Hierro, Ven....	419	347
Gr. Abaco Isl., Bahamas..	134	--
McKenzie, Guyana.........	132	86
Everton, Guyana..........	118	168
Total..................	14,004	16,040
7 - Other Mediterranean		
Other Greece Ports.......	128	25
Total, above-listed ports.	14,132	16,064
Total, all reported ports.	14,356	16,281

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 98 percent in 1968 and 99 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 39. U.S. Waterborne Imports of Alumina by Foreign Port Origin, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
2 - Caribbean		
Longs Wharf, Jamaica.....	133	38
Port Kaiser, Jamaica.....	--	66
Paramaribo, Surinam......	47	14
Paranam, Surinam.........	329	341
McKenzie, Guyana.........	17	--
Total..................	526	459
13 - Australia		
Gladstone................	485	840
Fremantle................	32	--
Geelong..................	--	39
All other Aust. ports....	180	429
Total..................	697	1,308
15 - Japan		
Yokohama.................	11	11
Shimizo..................	--	32
Miihama..................	--	25
Total..................	11	68
Total, above-listed ports.	1,234	1,835
Total, all reported ports.	1,316	1,884

Source: U.S. Bureau of the Census, SA-305.

Table 40. U.S. Waterborne Exports of Coal by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Hamilton, Ont............	4,119	4,110
Port Credit, Ont.........	3,245	3,597
Sault St. Mar., Soo., Ont.....................	2,434	1,940
Toronto, Ont.............	1,733	2,276
Windsor, Ont.............	928	761
Sarnia, Ont..............	580	170
Little Current, Ont......	477	150
Sydney, CBI..............	447	469
Montreal, Que............	373	361
Courtright, Ont..........	337	938
Oshawa, Ont..............	200	168
Sorel, Que...............	199	247
Amherstburg, Ont.........	194	175
Thorold, Ont.............	194	140
Port Burwell, Ont........	179	57
Fort William, Ont........	158	107
Colborne-Cayuga, Ont.....	106	135
Total..................	15,901	15,801
3 - South America-Pacific		
Talcahuano, Chile........	277	359
Valparaiso, Chile........	16	107
Total..................	293	466
4 - South America-Atlantic		
Rio de Janiero-Niteroi, Brazil..................	919	913
Santos, Brazil...........	430	388
Vitoria, Brazil..........	404	508
San Nicolas, Arg.........	277	386
Total..................	2,029	2,196
5 - Northwest Europe		
Hamburg, W. Ger..........	2,630	2,636
Le Havre, Fr.............	927	551
Rotterdam, Neth..........	843	1,106
Anvers, Antwerp, Belg....	796	791
Bilbao, Sp...............	766	803
Ijmuiden, Yumeden, Neth..	707	1,126

continued--

Table 40. U.S. Waterborne Exports of Coal by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Bremen, W. Ger...........	707	615
Oxelosund, Swed..........	529	357
Aviles, Sp...............	475	395
Terneuzen, Neth..........	335	252
Brest, Fr................	303	333
Mo. I. Rana, Nor.........	275	237
Stockholm, Swed..........	221	264
Zeebrugge, Belg..........	194	204
Dublin, Ire..............	168	85
Emden, W. Ger............	127	60
Lubeck, W. Ger...........	101	91
Dunkerque, Fr............	--	550
Other Sp. Atl. Pts. N. of Por..................	85	438
Total..................	10,187	10,897
6 - Southwest Europe		
Savona, Italy............	2,072	2,203
Taranto, Italy...........	795	855
Genoa, Italy.............	516	123
Piombrino, Italy.........	283	--
La Spezia, Italy.........	205	206
Trieste, Trieste.........	161	124
Sagunto, Sp..............	160	156
Vado, Italy..............	141	34
Total..................	4,333	3,700
7 - Other Mediterranean		
Rijeka, Fiume, Yug.......	416	142
8 - East Europe		
Other East German ports..	102	54
15 - Japan		
Tobata...................	5,267	9,881
Muroran..................	2,713	2,154
Chiba....................	2,172	2,191
Wakayama.................	1,093	1,445
Kawasaki.................	980	444
Osaka....................	825	1,377

continued--

Table 40. U.S. Waterborne Exports of Coal by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Hirohata.................	443	216
Moji......................	406	1,007
Amagasaki................	372	510
Wakamatsu................	345	313
Yawata....................	239	121
Nagoya....................	189	173
Mizushima................	175	137
Tokyo.....................	174	390
Other Japan ports........	76	465
Kobe......................	52	162
Kamaishi.................	78	103
Total....................	15,596	21,088
Total, above-listed ports.	48,857	54,343
Total, all reported ports.	50,711	56,268

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 96 percent in 1968 and 97 percent in 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Comeau Bay, Que...........	892	1,153
Port Cartier, Que.........	552	684
Montreal, Que.............	485	633
Quebec, Que...............	468	607
Three Rivers, Que.........	370	440
Toronto, Ont..............	217	330
Hamilton, Ont.............	93	137
Cardinal, Ont.............	71	70
Prescott-Johnstown, Ont...	61	28
Total.....................	3,208	4,082
2 - Caribbean		
Puerto Cabello, Ven.......	375	364
La Guaira, Caracas, Ven...	152	170
Maracaibo, Ven............	136	130
Santo Domingo, Dom. Rep...	121	77
Santa Marta, Col..........	91	105
Port of Spain, Trinidad...	78	67
Kingston, Jam.............	76	102
Puerto Barrios, Guatemala.	54	40
Puerto Sucre, Cumana, Ven.	41	33
Puerto Cortes, Hond.......	38	25
Guanta, Ven...............	24	45
Barranquilla, Col.........	22	-
Cartagena, Col............	18	-
Georgetown, Guyana........	0	29
Total.....................	1,227	1,185
3 - South America-Pacific		
San Antonio, Chile........	133	11
Callao, Peru..............	118	59
Buenaventura, Col.........	89	92
Puntarenas, Costa Rica....	81	58
Acajutla, El Salv.........	71	82
Guayaquil, Inc. Duran, Ecu.....................	70	58
Valparaiso, Chile.........	70	183
All other Chile ports.....	48	-

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Balboa, C.Z................	37	45
Antofagasta, Chile.........	36	17
Corinto, Nicar.............	34	39
Salaverry, Peru............	19	6
Total......................	804	649
4 - South America-Atlantic		
Santos, Brazil.............	548	595
Montevideo, Uruguay........	342	0
Rio de Janiero-Niteroi, Brazil....................	321	282
Recife, Pernambuco, Braz..	65	42
Sao Salvador, Bahia, Braz.	55	23
Fortaleza, Ceara, Brazil..	44	45
Buenos Aires, Arg..........	41	178
Maceio, Braz...............	12	-
Rio Grande Do Sul, Braz...	11	0
Total......................	1,439	1,164
5 - Northwest Europe		
Rotterdam, Neth............	6,461	4,927
Hamburg, W. Ger............	2,244	1,762
Amsterdam, Neth............	1,213	912
Anvers, Antwerp, Belg.....	1,151	449
Bremen, W. Ger.............	728	686
Belfast, Ire...............	450	152
Avonmouth, Eng.............	375	138
Hull, Eng..................	299	87
Liverpool, Eng.............	288	112
Kobenhavn, Den.............	270	203
Manchester, Eng............	253	235
Bilboa, Sp.................	219	241
Glasgow, Scot..............	144	198
Bordeaux, Fr...............	137	118
Optional Denmark ports....	128	58
London, Eng................	127	42
Santander, Sp..............	105	112
Lisboa, Portugal...........	104	117
Nantes, Fr.................	96	105

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Oslo, Norway	94	34
Aarhus, Den	93	124
Seville, Sevilla, Sp	93	69
Fredrikstad, Nor	77	35
Birkenhead, Eng	74	-
Other France Atl. ports	74	94
Stavanger, Nor	68	0
Bremerhaven, W. Ger	66	46
Larvik, Nor	60	77
Optional England ports	58	77
La Coruna, Sp	57	72
Saint Nazaire, Fr	56	35
Gand, Ghent, Belg	47	631
Le Havre, Fr	22	39
Emden, W. Ger	13	-
Rochefort, Fr	11	-
Other Eng. S. and E. coast ports	3	466
All other Azores ports	-	14
Leith, Scot	-	55
Total	15,755	12,520
6 - Southwest Europe		
Ravenna, Italy	1,680	1,316
Genoa, Italy	542	422
Barcelona, Sp	443	482
Tarragona, Sp	372	311
Venice, Italy	340	409
Valencia, Sp	168	232
Marseille, Fr	159	182
Koper (Kopar), Trieste	122	135
Livorno, Leghorn, Italy	72	50
Savona, Italy	65	61
Civitavecchia, Italy	37	6
Trieste, Trieste	32	14
Other Italy W. coast ports	22	7
La Spezia, Italy	20	-

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Bari, Italy..............	17	12
Napoli, Naples, Italy....	4	60
Total..................	4,094	3,696
7 - Other Mediterranean		
Haifa, Isr...............	1,246	1,176
Piraieus (Piraeus), Gr...	235	386
Tunis, Tunisia...........	211	157
Algiers, Algeria.........	136	246
Optional Algeria ports...	95	24
Beirut, Beyrouth, Leb....	73	69
La Goulette, Tunisia.....	28	28
Other Cyprus ports.......	14	14
Rijeka, Fiume, Yug.......	13	-
Istanbul, Turkey.........	9	439
Alexandria, UAR Egypt....	-	58
Izmir, Turkey............	-	40
Sfax, Tunisia............	-	24
Oran, Algeria............	-	19
Total..................	2,058	2,679
8 - East Europe		
Gdynia, Pol..............	724	365
9 - Other Africa		
Casablanca, Morocco......	397	83
Apapa, Nigeria...........	107	143
Durban, Rep. of So. Afr..	63	61
Saffi, Safi, Morocco.....	58	-
Santa Cruz de Tenerife...	52	42
Monrovia, Liberia........	45	38
Las Palmas, Canary Isl...	29	52
Tema (Temo), Ghana.......	27	30
Freetown, Sierra Leone...	19	21
Cape Town, Rep. of So. Afr....................	19	19
Takoradi, Ghana..........	16	5
Matadi, Congo (Leoplov)..	14	3
Tangier, Morocco.........	12	-

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Optional Nigeria ports....	10	17
Luanda, Angola............	10	3
Lagos, Nigeria............	5	44
Conakry (Konakri), Guinea.	0	17
Agadir, Morocco...........	-	26
Total....................	881	602
10 - Mid-East		
Jidda, Saudi Ar...........	55	60
Aqaba, Jordan.............	35	17
Bandar-E-Shahpur, Iran....	21	-
Kuwait, Al Kuwait.........	18	3
Ad Damman, Saudi Ar.......	18	17
Aden, Southern Yemen......	14	12
Total....................	161	110
11 - South Asia		
Bombay, India.............	2,465	1,381
Calcutta, India...........	1,40[illegible]	662
Karachi, Pakistan.........	479	83
Optional Pakistan ports...	421	20
Chittagong, Pakistan......	402	134
Madras, India.............	383	321
Port Kandla, Kandla, India	237	145
Vishakhapatnam, India.....	97	68
Cochin, India.............	57	11
Other India W. coasts ports....................	49	36
Navalakhi, India..........	48	58
Bhavnagar, India..........	28	10
Tuticorin, India..........	16	-
Chalna, Pakistan..........	11	34
Total....................	6,095	2,961
12 - Southeast Asia		
Pusan, Rep. of Korea......	931	900
Kaohsuing, China (Taiwan).	515	650
Inchon, Rep. of Korea.....	474	586
Other South Vietnam ports.	349	26
Manila, Philippines.......	337	371

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Keelung, China (Taiwan)...	309	234
Rep. of Korea Opt. ports..	276	454
Saigon, South Vietnam.....	264	446
Djakarta (Batavia), Java..	182	184
All other Philippine ports..................	130	91
Hondagua, Philippines.....	94	33
Cebu, Philippines.........	72	15
Hong Kong.................	65	53
Belawan Deli, Sumatra.....	64	46
Other China (Taiwan) ports..................	38	24
Surabaja, Java............	25	46
Palembang, Sumatra........	23	27
Other Rep. of Korea ports.	20	38
Singapore.................	20	23
Other Sulawesi ports......	6	36
Muntok, Bangka............	6	13
Total....................	4,198	4,297
15 - Japan		
Kobe......................	1,960	1,424
Yokohama..................	1,924	1,500
Optional Japan ports[a/]....	1,902	1,893
Tokyo.....................	1,175	2,103
Kawasaki..................	912	1,521
Nagoya....................	758	473
Moji......................	665	369
Shimizu...................	224	209
Mizushima.................	201	529
Okinawa-Buckner Bay, Naha.	115	94
Yokkaichi.................	100	159
Chiba.....................	46	302
Other Japan ports.........	22	52
Otaru.....................	17	16
Total....................	10,021	10,643
Total, above-listed ports..	50,662	44,952
Total, all reported ports..	52,772	46,981

continued--

Table 41. U.S. Waterborne Exports of Total Grains by Foreign Port Destination, 1968 and 1969 continued--

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 96 percent in 1968 and 1969 of all reported ports.

a/ Mostly distributed among listed ports in unknown proportions.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Port Cartier, Que.........	377	313
Comeau Bay, Que...........	297	290
Three Rivers, Que.........	143	111
Quebec, Que...............	137	130
Montreal, Que.............	51	30
Total.....................	1,004	874
2 - Caribbean		
Puerto Cabello, Ven.......	325	322
La Guaira, Caracas, Ven...	152	170
Maracaibo, Ven............	136	130
Santo Domingo, Dom. Rep...	121	77
Santa Marta, Col..........	91	105
Port of Spain, Trinidad...	78	67
Puerto Sucre, Cumana, Ven.	41	33
Puerto Cortes, Hond.......	38	25
Kingston, Jam.............	29	44
Guanta, Ven...............	24	45
Barranquilla, Col.........	22	-
Cartagena, Col............	18	-
Puerto Barrios, Guatemala.	54	40
Georgetown, Guyana........	0	29
Total.....................	1,130	1,085
3 - South America-Pacific		
Callao, Peru..............	118	59
Buenaventura, Col.........	89	92
Puntarenas, Costa Rica....	81	58
Acajutla, El Salv.........	71	82
Guayaquil, inc. Duran, Ecu......................	70	58
San Antonio, Chile........	69	-
All other Chile ports.....	48	-
Antofagasta, Chile........	36	17
Curinto, Nicar............	34	39
Valparaiso, Chile.........	28	3
Salaverry, Peru...........	19	6
Balboa, C.Z...............	37	45
Total.....................	698	458

continued--

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
4 - South America-Atlantic		
Santos, Brazil............	548	595
Rio de Janeiro-Niteroi, Brazil..................	321	282
Montevideo, Uruguay.......	225	0
Recife, Pernambuco, Braz..	65	42
Sao Salvador, Bahia, Braz.	55	23
Fortaleza, Ceara, Brazil..	44	45
Buenos Aires, Arg.........	41	178
Maceio, Braz..............	12	-
Rio Grande Do Sul, Brazil.	11	0
Total....................	1,322	1,164
5 - Northwest Europe		
Rotterdam, Neth...........	764	362
Anvers, Antwerp, Belg.....	190	102
Amsterdam, Neth...........	188	89
Hamburg, W. Ger...........	79	38
Bremen, W. Ger............	63	29
Liverpool, Eng............	49	45
Le Havre, Fr..............	22	39
Lisboa, Portugal..........	21	41
Avonmouth, Eng............	18	-
Manchester, Eng...........	18	10
Stavanger, Nor............	17	-
London, Eng...............	15	8
Emden, W. Ger.............	13	-
Rochefort, Fr.............	11	-
Oslo, Nor.................	10	22
Gand, Ghent, Belg.........	10	34
All other Azores ports....	-	14
Total....................	1,488	832
6 - Southwest Europe		
Marseille, Fr.............	159	182
Civitavecchia, Italy......	37	6
Trieste, Trieste..........	32	14
Genoa, Italy..............	28	19
Venice, Italy.............	27	-

continued--

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Other Italy W. coast ports....................	22	7
La Spezia, Italy..........	20	-
Bari, Italy...............	17	12
Ravenna, Italy............	12	27
Napoli, Naples, Italy.....	4	60
Livorno, Leghorn, Italy...	0	23
Savona, Italy.............	0	13
Total....................	357	363
7 - Other Mediterranean		
Haifa, Isr................	429	328
Tunis, Tunisia............	211	157
Algiers, Algeria..........	136	246
Optional Algeria ports....	95	24
Beirut, Beyrouth, Leb.....	73	69
La Goulette, Tunisia......	28	28
Piraieus (Piraeus), Gr....	16	3
Other Cyprus ports........	14	14
Rijeka, Fiume, Yug........	13	-
Istanbul, Turkey..........	9	439
Izmir, Turkey.............	-	40
Sfax, Tunisia.............	-	24
Oran, Algeria.............	-	19
Total....................	1,022	1,390
8 - East Europe		
Gdynia, Pol...............	26	-
9 - Other Africa		
Casablanca, Morocco.......	397	83
Apapa, Nigeria............	107	143
Durban, Rep. of S. Afr....	63	61
Saffi, Safi, Morocco......	58	-
Monrovia, Liberia.........	45	38
Tema (Temo), Ghana........	27	30
Freetown, Sierra Leone....	19	21
Cape Town, Rep. of S. Afr.	19	19
Takoradi, Ghana...........	16	5

continued--

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Matadi, Congo (Leoplov)...	14	3
Tangier, Morocco.........	12	-
Optional Nigeria ports....	10	17
Luanda, Angola............	10	3
Lagos, Nigeria............	5	44
Agadir, Morocco...........	-	26
Conakry (Konakri), Guinea.	0	17
Total..................	801	508
10 - Mid-East		
Jidda, Saudi Ar...........	55	60
Aqaba, Jordan.............	35	17
Bandar-E-Shahpur, Iran....	21	-
Kuwait, Al Kuwait.........	18	3
Ad Damman, Saudi Ar.......	18	17
Aden, Southern Yemen......	14	12
Total..................	161	110
11 - South Asia		
Bombay, India.............	2,132	1,078
Calcutta, India...........	1,404	662
Karachi, Pakistan.........	479	83
Optional Pakistan ports...	421	20
Chittagong, Pakistan......	402	134
Madras, India.............	304	317
Port Kandla, Kandla, India	237	145
Vishakhapatnam, India.....	97	68
Cochin, India.............	57	11
Other India W. coast ports..................	49	36
Navalakhi, India..........	48	58
Bhavnagar, India..........	28	10
Tuticorin, India..........	16	-
Chalna, Pakistan..........	11	34
Total..................	5,683	2,654
12 - Southeast Asia		
Pusan, Rep. of Korea......	779	795
Inchon, Rep. of Korea.....	408	418

continued--

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Other South Vietnam ports.	349	26
Manila, Philippines.......	337	371
Keelung, China (Taiwan)...	309	234
Saigon, South Vietnam.....	226	374
Rep. of Korea optional ports..................	211	449
Djakarta (Batavia), Java..	182	184
Kaohsuing, China (Taiwan).	144	135
All other Philippine ports..................	130	91
Hondagua, Philippines.....	94	33
Cebu, Philippines.........	72	15
Hong Kong.................	65	53
Belawan Deli, Sumatra.....	64	46
Other China (Taiwan) ports..................	38	24
Surabaja, Java............	25	46
Palembang, Sumatra........	23	27
Other Rep. of Korea ports.	20	38
Singapore.................	20	23
Other Sulawesi ports......	6	36
Muntok, Bangka............	6	13
Total....................	3,506	3,432
15 - Japan		
Optional Japan ports......	1,207	1,229
Tokyo.....................	725	656
Yokohama..................	158	216
Okinawa-Buckner Bay, Naha.	115	94
Kobe......................	45	13
Nagoya....................	37	13
Other Japan ports.........	22	52
Otaru.....................	17	16
Kawasaki..................	-	21
Chiba.....................	-	18
Total....................	2,326	2,327
Total, above-listed ports..	19,523	15,196
Total, all reported ports..	19,795	15,408

continued--

Table 42. U.S. Waterborne Exports of Food Grain by Foreign Port Destination, 1968 and 1969 continued--

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 99 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 43. U.S. Waterborne Exports of Feed Grain by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Comeau Bay, Que...........	422	601
Montreal, Que.............	398	461
Quebec, Que...............	272	321
Port Cartier, Que.........	82	201
Cardinal, Ont.............	71	70
Prescott-Johnstown, Ont...	61	28
Three Rivers, Que.........	46	108
Total....................	1,352	1,791
2 - Caribbean		
Kingston, Jam.............	47	58
3 - South America-Pacific		
San Antonio, Chile........	64	11
Valparaiso, Chile.........	42	180
Total....................	106	191
4 - South America-Atlantic		
Montevideo, Uruguay.......	117	0
5 - Northwest Europe		
Rotterdam, Neth...........	2,778	1,686
Hamburg, W. Ger...........	1,478	851
Amsterdam, Neth...........	713	456
Anvers, Antwerp, Belg.....	695	241
Belfast, Ire..............	450	152
Avonmouth, Eng............	357	138
Hull, Eng.................	299	87
Bremen, W. Ger............	266	114
Liverpool, Eng............	239	67
Manchester, Eng...........	235	225
Glasgow, Scot.............	144	198
London, Eng...............	112	34
Oslo, Nor.................	84	12
Lisboa, Portugal..........	83	76
Birkenhead, Eng...........	74	-
Bremerhaven, W. Ger.......	66	46
Optional England ports....	58	77

continued--

Table 43. U.S. Waterborne Exports of Feed Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Bilbao, Sp.................	52	94
Stavanger, Nor.............	51	0
Gand, Ghent, Belg..........	37	442
Other Eng. S. and E. coast ports..............	0	403
Leith, Scot................	-	55
Santander, Sp..............	1	50
Total....................	8,270	5,503
6 - Southwest Europe		
Ravenna, Italy.............	1,381	866
Barcelona, Sp..............	391	468
Genoa, Italy...............	276	169
Venice, Italy..............	218	320
Savona, Italy..............	65	48
Valencia, Sp...............	0	76
Total....................	2,330	1,946
7 - Other Mediterranean		
Haifa, Isr.................	528	571
Piraieus (Piraeus), Gr....	219	383
Alexandria, UAR, Egypt....	-	58
Total....................	747	1,012
8 - East Europe		
Gdynia, Pol................	498	169
9 - Other Africa		
Santa Cruz De Tenerife....	52	42
Las Palmas, Canary Isl....	29	52
Total....................	80	94
11 - South Asia		
Bombay, India..............	333	303
Madras, India..............	79	4
Total....................	412	307
12 - Southeast Asia		
Pusan, Rep. of Korea......	152	105
Inchon, Rep. of Korea.....	66	168

continued--

Table 43. U.S. Waterborne Exports of Feed Grain by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Rep. of Korea optional ports....................	65	5
Saigon, South Vietnam.....	38	72
Total..................	321	350
15 - Japan		
Kobe.....................	1,342	873
Yokohama.................	978	767
Kawasaki.................	659	1,047
Optional Japan ports......	639	631
Nagoya...................	582	274
Moji.....................	523	307
Tokyo....................	397	1,269
Shimizu..................	102	128
Mizushima................	16	401
Chiba....................	46	185
Yokkaichi................	1	92
Total..................	5,285	5,973
Total, above-listed ports..	19,563	17,394
Total, all reported ports..	20,656	18,373

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 95 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 44. U.S. Waterborne Exports of Soybean and Mill Products by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Toronto, Ont.	217	330
Three Rivers, Que.	181	221
Comeau Bay, Que.	173	262
Port Cartier, Que.	93	170
Hamilton, Ont.	93	137
Quebec, Que.	59	156
Montreal, Que.	36	142
Total	852	1,417
2 - Caribbean		
Puerto Cabello, Ven.	50	42
5 - Northwest Europe		
Rotterdam, Neth.	2,919	2,879
Hamburg, W. Ger.	687	873
Bremen, W. Ger.	399	543
Amsterdam, Neth.	312	367
Kobenhavn, Den.	270	203
Anvers, Antwerp, Belg.	266	106
Bilboa, Sp.	167	147
Bordeaux, Fr.	137	118
Optional Denmark ports	128	58
Santander, Sp.	104	62
Nantes, Fr.	96	105
Aarhus, Den.	93	124
Seville, Sevilla, Sp.	93	69
Fredrikstad, Nor.	77	35
Other France Atl. ports	74	94
Larvik, Nor.	60	77
La Coruna, Sp.	57	72
St. Nazaire, Fr.	56	35
Gand, Ghent, Belg.	--	155
Other Eng. S. and E. coast ports	3	63
Total	5,997	6,185
6 - Southwest Europe		
Tarragona, Sp.	372	311
Ravenna, Italy	287	423

continued--

Table 44. U.S. Waterborne Exports of Soybean and Mill Products by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Genoa, Italy..............	238	234
Valencia, Sp..............	168	156
Kuper (Kopar), Trieste....	122	135
Venice, Italy.............	95	89
Livorno, Leghorn, Italy...	72	27
Barcelona, Sp.............	52	14
Total....................	1,407	1,387
7 - Other Mediterranean		
Haifa, Isr................	289	277
8 - East Europe		
Gdynia, Pol...............	200	196
12 - Southeast Asia		
Kaohsuing, China (Taiwan).	371	515
15 - Japan		
Yokohama..................	788	517
Kobe......................	573	538
Kawasaki..................	253	453
Mizushima.................	185	128
Moji......................	142	62
Nagoya....................	139	186
Shimizu...................	122	81
Yokkaichi.................	99	67
Optional Japan ports......	56	33
Tokyo.....................	53	178
Chiba.....................	--	99
Total....................	2,410	2,343
Total, above-listed ports..	11,576	12,362
Total, all reported ports..	12,321	13,200

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 94 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 45. U.S. Waterborne Exports of Natural Phosphates by Foreign Port Destination, 1968 and 1969

(In thousands of short tons)

Foreign port zone	1968	1969
1 - Canada		
Vancouver, B.C.	343	476
Contrecoeur, Que	189	159
All other NFLD ports	111	189
All other Canada Atl. ports	102	193
Sorel, Que	55	64
Victoria, B.C.	40	-
Grand Manan Isl, NB	33	-
Quebec, Que	28	-
Port Moody, B.C.	-	29
Montreal, Que	-	18
Total	900	1,127
2 - Caribbean		
Tampico, Mex	83	68
Puerto Mexico, Mex	83	422
Minatitlan, Mex	74	120
Vera Cruz, Mex	42	60
Cartagena, Col	24	19
Other Mex. Gulf-E. coast ports	-	21
Total	305	710
3 - South America-Pacific		
All other Chile ports	69	-
Acajutla, El Salv	14	13
Callao, Peru	13	9
Manzanillo, Mex	6	62
Talcahuano, Chile	-	15
Total	101	98
4 - South America-Atlantic		
Santos, Brazil	256	227
Rio Grande Do Sul, Brazil	36	18
Montevideo, Uruguay	23	11
Recife, Pernambuco, Braz.	3	14
Total	319	269

continued--

Table 45. U.S. Waterborne Exports of Natural Phosphates by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
5 - Northwest Europe		
Rotterdam, Neth...........	956	1,013
Anvers, Antwerp, Belg.....	896	795
Nordenham, W. Ger.........	242	249
Portishead, Eng...........	202	80
Brake, W. Ger.............	116	77
Rouen, Fr.................	98	80
La Coruna, Sp.............	68	45
Pasaje, Sp................	67	35
Other France Atl. ports...	65	185
La Pallice, Fr............	48	35
Avonmouth, Eng............	35	-
Heroya, Nor...............	23	33
Bilbao, Sp................	22	79
Oslo, Nor.................	20	37
Cadiz, Sp.................	16	-
Immingham, Eng............	16	6
Other Eng. W. coast ports.	11	-
Rendsburg, W. Ger.........	11	9
Barry, Wales..............	11	8
Santander, Sp.............	7	27
Manchester, Eng...........	6	19
Hamburg, W. Ger...........	7	13
All other Norway ports....	-	16
Rochefort, Fr.............	-	15
Total.....................	2,943	2,854
6 - Southwest Europe		
Other Sicily ports........	347	400
Porto Empedocle, Sicily...	174	114
Ancona, Italy.............	148	74
La Spezia, Italy..........	145	148
Venice, Italy.............	123	269
Savona, Italy.............	88	59
Crotone, Italy............	86	143
Catina, Sicily............	77	-
Other Italy W. coast ports	40	47
Barcelona, Sp.............	34	11
Brindisi, Italy...........	32	-

continued--

Table 45. U.S. Waterborne Exports of Natural Phosphates by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Barletta, Italy...........	31	45
Palermo, Sicily...........	24	-
Valencia, Sp..............	24	45
Gaeta, Italy..............	23	-
Cartagena, Sp.............	18	74
Napoli, Naples, Italy.....	13	-
Alicante, Sp..............	11	9
Genoa, Italy..............	11	0
Pirano (Piran), Trieste...	-	29
Augusta, Sicily...........	-	29
Total....................	1,447	1,496
7 - Other Mediterranean		
Rijeka, Fiume, Yug........	20	0
Kavala, Greece............	-	17
Total....................	20	17
9 - Other Africa		
Santa Cruz de Tenerife....	-	12
10 - Mid-East		
Khorramshahr, Iran........	11	3
11 - South Asia		
Vishakhapatnam, India.....	216	159
Bombay, India.............	71	66
Calcutta, India...........	12	-
Bhavnagar, India..........	-	82
Total....................	299	307
12 - Southeast Asia		
Other Rep. of Korea ports.	365	421
All other Philippine ports	127	173
Pusan, Rep. of Korea......	74	78
Inchon, Rep. of Korea.....	30	44
Rep. of Korea optional ports....................	30	37
Cebu, Philippines.........	26	10
Singapore.................	7	13

continued--

Table 45. U.S. Waterborne Exports of Natural Phosphates by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Keelung, China (Taiwan)...	0	13
Kaohsuing, China (Taiwan).	-	64
Total....................	657	854
13 - Australia		
Fremantle................	151	-
Geelung City.............	147	25
Auckland, N.Z............	93	16
Melbourne................	79	43
Port Kembla..............	71	25
Adelaide.................	57	-
All other Australia ports.	53	8
Newcastle................	32	7
Lyttleton, N.Z...........	22	-
Other Tasmania ports......	21	-
Port Lincoln.............	17	-
Total....................	743	124
15 - Japan		
Other Japan ports.........	724	608
Ube......................	264	212
Okinawa-Buckner Bay, Naha.	250	206
Niigata..................	235	156
Osaka....................	218	167
Miyako...................	132	31
Tokyo....................	110	89
Moji.....................	108	31
Sakaide..................	93	20
Wakamatsu................	90	38
Nagoya...................	79	38
Minamata.................	73	76
Miihama..................	66	61
Kawasaki.................	60	-
Chiba....................	50	107
Sakata...................	45	43
Tokuyama.................	40	-
Yokkaichi................	39	42
Kushiro..................	31	10

continued--

Table 45. U.S. Waterborne Exports of Natural Phosphates by Foreign Port Destination, 1968 and 1969 continued--

(In thousands of short tons)

Foreign port zone	1968	1969
Yokohama..................	29	99
Kobe......................	-	17
Total.....................	2,736	2,051
Total, above-listed ports..	10,482	9,921
Total, all reported ports..	10,612	9,993

Note: Individual items may not add to totals due to rounding. Figures are rounded to the nearest thousand. This accumulation accounts for approximately 99 percent in 1968 and 1969 of all reported ports.

Source: RRNA tabulations of unpublished Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 46. Comparison of Two Bureau of the Census Sources on U.S. Alumina Imports, 1968 and 1969

(In thousands of short tons)

Country of origin	Commodity code 5136 530 Series FT 135		Commodity code 5136 Series SA 305	
	1968	1969	1968	1969
Australia..............	697,929	1,309,810	697,293	1,308,325
Surinam................	474,402	402,653	375,753	355,084
Jamaica................	108,569	103,928	133,253	103,972
Guyana.................	24,176	--	17,446	--
Japan..................	10,957	67,983	10,957	68,084
Subtotal.............	1,316,033 a/	1,884,374 b/	1,234,702	1,835,465
Other code 5136 imports...............	340	370	--	--
Total..................	1,316,373	1,884,744	--	--

a/ Excludes 28,100 short tons of commodity code 5136 530 imports from the Leeward and Windward Islands, Republic of South Africa, Canada, and the Netherlands.
b/ Excludes 254 short tons of commodity code 5136 530 imports from Canada and West Germany.

Source: U.S. Department of Commerce, Bureau of the Census, statistical series as indicated.

Table 47. Number of U.S. and Foreign Ports Sending or Receiving Bulk Commodities in U.S. Foreign Trade, by Commodity, 1968 and 1969

Commodity groups	No. of U.S. ports		No. of foreign ports	
	1968	1969	1968	1969
Imports				
Crude oil....	44	39	84	81
Petroleum products....	73	75	110	115
Iron ore.....	26	23	51	52
Bauxite......	22	19	23	21
Alumina......	6	13	10	11
Exports...				
Coal.........	26	27	174	175
Total grains.	71	74	409	381
Food grains.	59	59	306	275
Feed grains.	52	55	270	252
Soybeans and meal...	46	46	181	179
Phosphate rock........	22	15	157	139
Total, all above-listed commodities..	130	125	626	594

Source: RRNA tabulations of unpublished U.S. Bureau of the Census data on computer tape, Series SA-305 and SA-705.

Table 48. Number of U.S. and Foreign Ports Sending or Receiving Large Quantities of Bulk Commodities in U.S. Foreign Trade, by Commodity and Volume Handled, 1968 and 1969

Commodity	No. of U.S. ports by mil. s.t. handled			No. of foreign ports by mil. s.t. handled		
	10+	5-10	1-5	10+	5-10	1-5
	1968					
Imports						
Crude oil....	1	4	8	1	2	10
Pet. prod....	1	1	11	1	5	7
Iron ore[a]...	2	0	8	1	2	4
Bauxite......	0	0	5	0	0	6
Alumina......	0	0	0	0	0	0
Exports						
Coal[b].......	1	1	1	0	1	5
Total grains.	0	3	13	0	1	10
Food grains.	0	0	5	0	0	2
Feed grains.	0	0	8	0	0	4
Soybeans and meal...	0	0	3	0	0	1
Phos. rock...	0	1	0	0	0	0
	1969					
Imports						
Crude oil....	0	5	9	1	1	16
Pet. prod....	1	1	14	2	3	10
Iron ore[a]...	2	0	6	1	2	5
Bauxite......	0	0	5	0	1	5
Alumina......	0	0	0	0	0	0
Exports						
Coal[b].......	1	1	1	0	1	9
Total grains.	0	2	11	0	0	10
Food grains.	0	0	3	0	0	1
Feed grains.	0	0	6	0	0	3
Soybeans and meal...	0	0	5	0	0	1
Phos. rock...	0	1	0	0	0	1

a/ Includes Canadian shipments from St. Lawrence and Great Lakes ports and deliveries to U.S. Great Lakes ports.
b/ Excludes U.S. shipments from Great Lakes ports and deliveries at Canadian ports.
Source: Tables 24 through 45.

Table 49. U.S. Major Bulk Commodity Imports or Exports Exceeding One Million Tons in 1968 and 1969 at U.S. Ports of Origin or Destination, by Commodity

(In millions of short tons)

Commodities	Annual volumes				
	Total	At ports handling (mil. s.t.)			
		Over 10	5-10	1-5	Total
	1968				
Imports					
Crude oil....	61.4	10.5	29.9	15.8	56.2
Pet. prod....	77.4	31.5	6.8	22.6	60.9
Iron ore.....	47.4	20.9	--	23.2	44.1
Bauxite......	14.4	--	--	13.9	13.9
Alumina......	1.3	--	--	--	--
Exports					
Coal[a].......	34.4	24.4	7.5	2.5	34.4
Total grains.	52.8	--	22.1	23.3	45.4
Food grains.	19.8	--	--	11.1	11.1
Feed grains.	20.7	--	--	16.4	16.4
Soybeans and meal...	12.3	--	--	6.7	6.7
Phos. rock...	10.6	--	8.8	--	8.8
	1969				
Imports					
Crude oil....	63.9	--	39.3	20.0	59.3
Pet. prod....	86.5	31.1	7.8	30.1	69.0
Iron ore.....	42.5	22.8	--	14.7	37.5
Bauxite......	16.3	--	--	15.4	15.4
Alumina......	1.9	--	--	--	--
Exports					
Coal[a].......	39.7	27.7	9.4	2.6	39.7
Total grains.	47.0	--	14.4	22.1	36.5
Food grains.	15.4	--	--	6.5	6.5
Feed grains.	18.4	--	--	12.9	12.9
Soybeans and meal...	13.2	--	--	9.2	9.2
Phos. rock...	10.0	--	8.2	--	8.2

a/ Excluding exports from ports on the Great Lakes.

Source: Tables 24 through 34.

Table 50. U.S. Major Bulk Commodity Exports and Imports Exceeding One Million Tons in 1968 and 1969 at Foreign Ports of Origin or Destination, by Commodity

(In millions of short tons)

Commodities	Annual volumes				
	Total	At ports handling (mil. s.t.)			
		Over 10	5-10	1-5	Total
	1968				
Imports					
Crude oil....	61.4	13.6	12.2	22.8	48.6
Pet. prod....	77.4	15.3	37.8	12.7	65.8
Iron ore.....	47.4	11.5	17.0	10.0	38.5
Bauxite......	14.4	--	--	12.7	12.7
Alumina......	1.3	--	--	--	--
Exports					
Coal[a]/.......	34.8	--	5.3	10.7	16.0
Total grains.	52.8	--	6.5	16.5	23.0
Food grains.	19.8	--	--	3.5	3.5
Feed grains.	20.7	--	--	7.0	7.0
Soybeans and meal...	12.3	--	--	2.9	2.9
Phos. rock...	10.6	--	--	--	--
	1969				
Imports					
Crude oil....	63.9	12.4	7.7	35.6	55.7
Pet. prod....	86.5	28.4	25.6	21.3	75.3
Iron ore.....	42.5	11.5	12.7	10.6	34.8
Bauxite......	16.3	--	5.4	9.2	14.6
Alumina......	1.9	--	--	--	--
Exports					
Coal[a]/.......	40.5	--	9.9	15.2	25.1
Total grains.	47.0	--	--	18.3	18.3
Food grains.	15.4	--	--	1.1	1.1
Feed grains.	18.4	--	--	4.0	4.0
Soybean and meal...	13.2	--	--	2.9	2.9
Phos. rock...	10.0	--	--	1.0	1.0

a/ Excluding exports to Canadian ports.

Source: Tables 35 through 52.

Table 51. Percentage Distribution of U.S. Major Bulk Commodity Imports or Exports Exceeding One Million Tons in 1968 and 1969 at U.S. Ports of Origin or Destination, by Commodity

Commodities	Annual volumes				
	Total	At ports handling (mil. s.t.)			
		Over 10	5-10	1-5	Total
	1968				
Imports					
Crude oil....	100.0	17.1	48.7	25.7	91.5
Pet. prod....	100.0	40.7	8.8	29.2	78.7
Iron ore.....	100.0	44.1	--	48.9	93.0
Bauxite......	100.0	--	--	96.5	96.5
Alumina......	100.0	--	--	--	--
Exports					
Coal.........	100.0	70.9	21.8	7.3	100.0
Total grains.	100.0	--	41.9	44.1	86.0
Food grains.	100.0	--	--	56.1	56.1
Feed grains.	100.0	--	--	79.2	79.2
Soybeans and meal...	100.0	--	--	54.5	54.5
Phos. rock...	100.0	--	83.0	--	83.0
	1969				
Imports					
Crude oil....	100.0	--	61.5	31.3	92.8
Pet. prod....	100.0	36.0	9.0	34.8	79.8
Iron ore.....	100.0	53.6	--	34.6	[illegible]8.2
Bauxite......	100.0	--	--	94.5	94.5
Alumina......	100.0	--	--	--	--
Exports					
Coal.........	100.0	69.8	23.7	6.5	100.0
Total grains.	100.0	--	30.6	47.0	77.6
Food grains.	100.0	--	--	42.2	42.2
Feed grains.	100.0	--	--	70.1	70.1
Soybean and meal...	100.0	--	--	69.7	69.7
Phos. rock...	100.0	--	82.0	--	82.0

Source: Table 49.

Table 52. Percentage Distribution of U.S. Major Bulk Commodity Exports and Imports Exceeding One Million Tons in 1968 and 1969 at Foreign Ports of Origin or Destination, by Commodity

Commodities	Annual volumes				
	Total	At ports handling (mil. s.t.)			
		Over 10	5-10	1-5	Total
	1968				
Imports					
Crude oil....	100.0	22.1	19.9	37.1	79.1
Pet. prod....	100.0	19.8	48.8	16.4	85.0
Iron ore.....	100.0	24.3	35.9	21.1	81.2
Bauxite......	100.0	--	--	88.2	88.2
Alumina......	100.0	--	--	--	--
Exports					
Coal........	100.0	--	15.2	30.7	46.0
Total grains.	100.0	--	12.3	31.3	43.6
Food grains.	100.0	--	--	17.7	17.7
Feed grains.	100.0	--	--	33.8	33.8
Soybeans and meal...	100.0	--	--	23.6	23.6
Phos. rock...	100.0	--	--	--	--
	1969				
Imports					
Crude oil....	100.0	19.4	12.1	55.7	87.2
Pet. prod....	100.0	32.8	29.6	24.6	87.0
Iron ore.....	100.0	27.1	29.9	24.9	81.9
Bauxite......	100.0	--	33.1	56.4	89.6
Alumina......	100.0	--	--	--	--
Exports					
Coal........	100.0	--	24.4	37.5	62.0
Total grains.	100.0	--	--	38.9	38.9
Food grains.	100.0	--	--	7.1	7.1
Feed grains.	100.0	--	--	21.7	21.7
Soybean and meal...	100.0	--	--	22.0	22.0
Phos. rock...	100.0	--	--	10.0	10.0

Source: Table 50.