Final Report of the Commission for the Study of Alternatives to the Panama Canal

Volume V

Commodity and Traffic Projections Phase I

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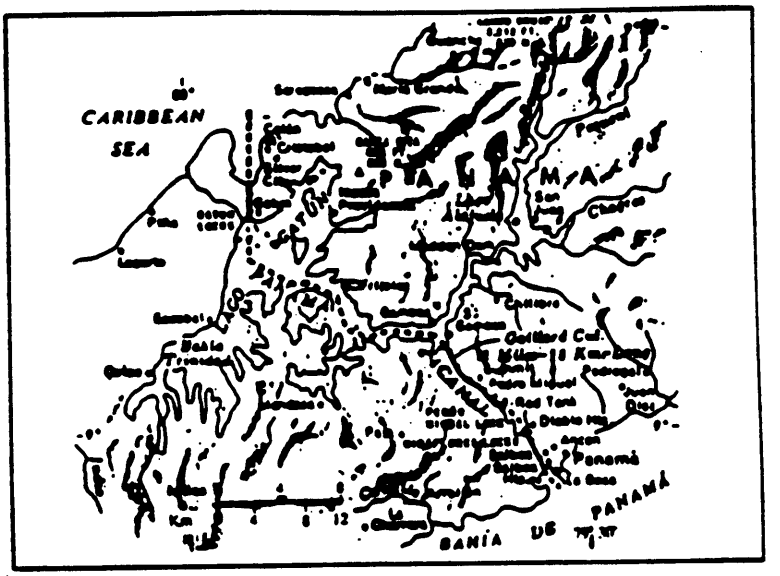

Commodity and Traffic Projections Study

To The

Commission for the Study of Alternatives to the Panama Canal

Prepared by

The WEFA Group
Richardson Lawrie Associates
BST Associates

THE WEFA GROUP

COMISION DE ESTUDIO DE LAS
ALTERNATIVAS AL CANAL DE PANAMA
CENTRO DE INFORMACION

Final Report

Commodity and Traffic Projections Study, Phase I

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Commission
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al Canal de Panamá
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1992

BACKGROUND

The Commission for the Study of Alternatives to the Panama Canal (CAS) engaged The WEFA Group, with subcontract support from Richardson Lawrie Associates (RLA) and BST Associates, to perform Phase I of the Commodity and Traffic Projections (CTP) Study for the Panama Canal Alternatives Study Program. This program is a result of the 1979 agreement under the Panama Canal Treaty that the United States and Panama would implement a feasibility study on a sea-level canal by the year 2000. Subsequently, Japan joined the United States and Panama to form CAS, which has operating offices in Panama City, Panama.

The CTP is one of a series of component studies performed by selected contractors. In Phase I of the CTP, CAS requested WEFA, and its subcontractors, RLA and BST, to develop preliminary projections of commodity flows and ship traffic for the existing canal and alternatives for the years 2020 and 2060, and additional vessel economics. CAS intended that these provide an initial projection of future demand for trans-Isthmian commerce as a function of time for the prescreening and selection of canal alternatives for full study.

The primary purpose of Phase I of the CTP is to provide projections of annual Panama Canal vessel transits by ship type and size range which are then used by the Operating Characteristic and Capacity Evaluation (OCCE) Component Contractor to determine the number of ships which will be able to pass the Canal annually. It is expected that the more detailed forecasts to be carried out in Phase II will take into account these capacity estimates as well as other Canal characteristics.

This report contains the results of that study.

Respectfully submitted,

Bradley W. Perry, Ph.D.

Comisión de Estudio
de las Alternativas
al Canal de Panamá
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1.0 EXECUTIVE SUMMARY

In August, 1991 the Commission for the Study of Alternatives to the Panama Canal (CAS) engaged The WEFA Group, with subcontract support from Richardson Lawrie Associates (RLA) and BST Associates, to develop preliminary projections for the years 2020 and 2060 of commodity flows and ship traffic for the existing Panama Canal and for four alternative Canals through Panama. Known as Phase I of the Commodity and Traffic Projections (CTP) Study, this is part of a group of studies, including preliminary engineering, capacity and operating characteristics studies, designed to provide sufficient information for the prescreening and selection of a very few Canal alternatives for full study. It is expected that the more detailed forecasts to be carried out in Phase II will take into account the capacity estimates as well as other Canal characteristics such as the toll structure.

The alternative Canals for the purposes of Phase I of the CTP were defined only in terms of maximum design ship size. These were defined by CAS as:

65,000 DWT (Status Quo)
100,000 DWT (Case 2)
150,000 DWT (Case 3)
250,000 DWT (Case 4)
300,000 DWT (Case 5)

The scope of Phase I CTP study excluded several issues, both from necessity and from the limited needs of the prescreening process. The study explicitly did not take into account the following issues:

- The constraints of the Panama Canal and of other pertinent parts of the world transportation system, such as the U.S. rail system;
- The effect of an enlarged or alternative Canal on the world economy, on global trade in aggregate, and on patterns of world trade;
- The effect of the Canal construction itself on the world economy and on world trade;
- The effects of projected improvements in infrastructure in Panama, such as the Centerport project;

- Alternative assumptions to those which define our baseline scenario.

The base year for the study is 1990 and the forecast periods are the years 2020 and 2060.

To accomplish this task, the WEFA team first reviewed the available data and the previous approaches to this task which had been carried out for the Panama Canal Commission (PCC). Because CAS was not able to make detailed PCC data available to us in sufficient time to be used in Phase I of the CTP, other sources of Canal transit and related data also had to be developed.

To carry out the study, the following additional work had to be carried out first:

- Develop a substitute synthetic Panama Canal vessel transit database for FY 1990;

- Combine the synthetic database with data on loadings of commodities into ship cargoes from another study and with published PCC commodity flow data to create a coherent Master Study Database;

- Develop forecasts for 2020 and 2060 of world trade, consistent with the Master Study Database in sufficient detail to develop projections of the world vessel fleet by ship type and size category for 2020 and 2060;

- Develop a forecast of the world vessel fleet for each of the alternative Canals:

- Develop the comparative economics of shipping each type of cargo by each type of ship in each ship size range through the Panama Canal and on bypass routes, including routes which include surface transport across the United States, the so-called "landbridge".

The fundamental approach used in this study was to initially apply global trade growth rates for 1990-2020 and 2020-2060 for a given commodity and pair of trading partners to that commodity and origin/destination pair in the FY 1990 Panama Canal data, to load these commodities onto the ships available from the projected world vessel fleet according to the rules incorporated into the Master Study Database, and then to examine all bypass routes for potential shifts away from the Canal and to search forecast bypass traffic for potential shifts to the Canal.

The microeconomic approach used throughout the transportation analysis of this study is a point of departure for Panama Canal studies. Prior studies shifted trade based on trends or on judgement. In this study, we determined the least cost mode of transportation and shifted cargoes to those least-cost modes and routes. If costs per ton differed by only a few cents per ton, this was taken as being not significant, and the routing was not changed.

Therefore, the final commodity flow projections were a result of the vessel transit projections, rather than the other way round. This approach was the result of the incorporation of transport economics in the analysis, a factor which previous projections had not taken into account. The surprising nature of some of the results stem from this approach as well as of the use of top-down, bottom-up approaches to the projections of both world trade and the world vessel fleet.

The top-down, bottom-up approach in the context of the trade and fleet applications is equivalent to a supply/demand equilibration. In the case of trade, the WEFA World Model provided the top-down or demand part of the approach. This Model solves 30 country and regional macroeconomic models simultaneously with an allocation of import demand bilaterally to all of the exporting countries. The resulting trade matrix is broken into three commodities groupings: energy, non-energy primary, and manufactured goods. This matrix of trade among thirty countries and three commodities is then divided into the detail required for the study by using stochastic share equations.

This top-down approach to commodity forecasting is combined with WEFA's special world models for various industries: agriculture, energy, and steel. These cover the greater part of the commodity flows. These bottom-up forecasts use WEFA's World Model forecasts as economic drivers but focus on the supply relationships involved with renewable and non-renewable resources and the location of each part of the chain from extraction to finished goods manufacture.

The top-down, bottom-up approach to the world fleet forecasts is similar. The forecasts of world trade provide demand for shipping. Combining this with scrappage forecasts results in demand for ships to carry the forecast trade. This is the top-down part of the forecast. Then, combining this with changes in technology and vessel economics, provides the required supply of new ships each year. This is the bottom-up part of the vessel forecast.

Because of the very long term nature of this study, several departures from and additions to our normal methods had to be incorporated. In the case of the economic and trade forecasts, we shifted from the stochastically based, that is, based on historical relationships,

WEFA World Model[1] to a judgmental approach to the forecasts beyond the year 2010 of the key top-down variables: population, productivity, and the relation of trade to output. In the bottom-up part of the approach, allowance had to be made for the exhaustion of significant amounts of the world's total resource base. This was particularly true of oil, but important for the other resources which we tracked, namely, coal, natural gas, and iron ore. We estimate that approximately half of the total remaining world coal reserves, two-thirds of the remaining world oil resources and 85% of estimated natural gas resources are consumed in the 1990-2060 period.

On the vessel side, extensive research was carried out as to the technical innovations planned and possible during the course of the study. In light of this research, it was decided to adopt the following principles in developing, for particular ship types, a scenario of techno-economic changes likely to be achieved during the forecast period:

- remembering that some ships on order in 1991 will still be operational in the year 2020, we assume that the levels of technology incorporated in the newest ships of 1991 will be the average level of technology in the year 2020;

- Between 2020 and 2060, it is assumed that the 2020 level of technology will persist, excepting only cases where it is now apparent that change will be made. This includes, however, continuing trends in vessel propulsion and manning efficiencies. A particular conclusion in this regard will be the requirement for skilled crew leading to the eventual disappearance of cheap labor from the global fleet.

Because a new Panama Canal will make a qualitative change in the size of the ships being constructed, the WEFA team at an early stage needed to develop assumptions as to the construction dates of an alternative Canal. For this purpose, CAS provided us with the following assumptions:

- Start date for construction of the alternative Canal - 2000;
- Completion date for construction of the alternative Canal - 2010.

After consultation with CAS, the specific assumption was made that the Jones Act, the U.S.

[1] The WEFA World Model is a traditional structural econometric model consisting of a system of deterministic and stochastic equations which are currently used to generate projections until the year 2010.

regulation that requires intra-United States maritime trade to move in U.S. ships, would remain in force.

Because there is only one scenario in Phase I, we have made what we consider "conservative" assumptions. This should not be taken to imply that they are either pessimistic or optimistic. We believe the assumption that global warming does not become a serious policy issue to be conservative; that is, we believe that alternative assumptions would be speculative. However, this assumption leads to higher consumption of oil and coal worldwide and thus to higher levels of world trade than would be the case in a scenario where emissions of carbon dioxide and other "greenhouse gases" were limited to 1990 values, for example.

The following are other important assumptions on which we have based the study.

- Geopolitical Factors:

  We assume continued world stability, that is, no major wars or political instability in the major countries of the world.

- Environmental Policy

  WEFA assumes that the current environmental policy of each nation, such as the United States or Korea, or group of nations, such as the European Community or the Commonwealth of Independent States, is maintained and are made neither more stringent nor eased. This implies, for example, that a carbon tax to reduce greenhouse emissions is not enacted.

- Population, Labor Force and Employment

  The population figures through 2025 are from the United Nations. WEFA has extended the U.N. fertility and mortality assumptions to 2060 in a manner consistent with our projections of GDP per capita in each region.

  A long term forecast such as we have undertaken focuses on the supply side, namely the growth in labor productivity due to technological progress. Short term fluctuations in unemployment and labor force participation are ignored; rather, the equilibrium levels of these variables are assumed. That is to say, our scenario has no business cycle behavior. It is not our belief that business

cycles will never occur. Rather, we do not know when they will occur this far into the future. Taking only two points into the future requires that the scenario not involve any cyclical behavior.

- Technological Innovation and Transfer

We assume that the long-term trends toward greater efficiency in production and toward a greater services share of consumption will continue. An important assumption in this area is the diffusion of technology now on the drawing boards to even the most undeveloped countries, allowing for a convergence of per capita GDP without an accelerated strain on the earth's resources.

- Productivity by Region

Per capita GDP is assumed to continue on the historical trajectories and those of our short-term model based forecasts. In the most industrialized countries it is assumed to rise at slightly lower rates than historically.

A basic assumption underlying the work is that the ranking of countries/regions in terms of per capita GDP remains fixed over the period, but that there is some convergence toward the standard of living of the most developed countries.

As a result of these considerations, we expect total output in the developing world to rise considerably more rapidly than that in the developed world, but to still remain behind on a per capita basis. The relative levels within the groupings have more to do with the size of the countries/regions than anything else.

- Transportation Costs

In terms of the various components of ship operating costs, between 1990 and 2020, increases in real terms are assumed for wage rates, repairs and maintenance, insurance and fuel costs. There is also likely to be a cost push effect in shipping market rates as a result of technological change. Nevertheless in the calculation of freight costs there are offsetting factors, in

particular with regard to vessel efficiency and manning levels. Between 2020 and 2060 only fuel costs and labor rates rise in real terms.

We assume that over the long term real world labor costs rise at a rate of one percent per year. Oil prices are assumed to rise more rapidly as world reserves are depleted to an expected 30 percent of their 1990 level, and to reach $55 per barrel in 1990 dollars by 2060. Note that labor compensation is related to labor cost by labor productivity. That is, real labor compensation will rise faster than real labor cost by just the increase in labor productivity. Thus, if labor productivity were rising at one percent per year, the growth in labor compensation would be one percent higher than the rise in labor cost.

Panama Canal tolls are grown with average transportation costs, as there are no basis for speculating on another growth trajectory. These were also part of the terms of reference.

In addition to transportation costs, inventory carrying costs are computed as well, based on average value per ton, differences in origin to destination trips, and interest rates.

- Structural Change

Possibly the most important factor in the relation of merchandise trade to World GDP is the structural change which world economies are undergoing, namely, the shift away from goods and toward services. The gradual depletion of non-renewable resources means that new deposits are of lower quality, harder to reach, and more expensive to extract and refine. This results in gradually rising real costs for these resources.

These structural change considerations lead to a continuation of the long-term trend in the shift from goods toward services which produces a downward curvature in the ratio of total world trade to world GDP.

- Terms of Trade

By terms of trade we mean the trade barriers or lack of them between countries. These can be unilateral, such as the barriers to agricultural products; bilateral, such as the U.S.-Canada free trade agreement; and

multilateral, such at the EC common market and the General Agreement on Trade and Tariffs (GATT). In a recent review of the economics of trade policy[2], Professor Baldwin of the University of Wisconson and the National Bureau of Economic Research states as follows: "The new [economic] trade theorists ... believe that, as a rule of thumb, free trade is the best policy for countries to follow". We assume, therefore, that the emerging world trading blocs continue the post World War trend toward freer trade, specifically toward a continued lowering of tariff and non-tariff barriers.

Because the country for which there is the greatest degree of understanding in terms of the dynamics of growth is the United States, the analysis begins there. At present, per capita U.S. GDP is growing at slightly less than 2%. This is composed of two parts: productivity is growing at about 1% and labor force relative to population is growing at less than 1%. Eventually, we expect labor force and population to grow in tandem, with the result that the growth of per capita GDP drops to the 1% we continue to assume for productivity growth. The average per capita U.S. GDP growth over the 70 year period is slightly less than 1.5% per year.

This is not to suggest that the total tons of goods produced, or any such physical measure, grows at this rate. The trend in industrialized societies has been toward a saturation in physical goods and a relative shift to services. We expect this to continue, such that eventually most of the increase in output is in ever more efficiently provided services. These services will continue to require electric power and other energy forms, and other physical goods associated with them. Thus, trade in physical goods among the developed countries can be expected to grow, but at a decreasing rate. Finally, services are assumed to take greater and greater advantage of efficiencies to be gained from electronic advances, as is the case in the U.S. at present, and which we are seeing in Europe, Japan and elsewhere: automatic teller machines, home shopping, etc.

In general, we assume continued movement toward free markets in goods and most services. This underlies both the assumption of per capita GDP convergence and continued improvement in productivity. It also has the implication of freer trade, since trade barriers are merely another form of government interference in the free functioning of markets.

The growth of energy consumption is expected to slow in the industrialized countries and

[2] Robert E. Baldwin, "Are Economists' Traditional Trade Policy Views Still Valid?", Journal of Economic Literature XXX (June 1992), pp.804-829.

level off after 2020. Passive solar heating of homes, greater energy efficiency and cogeneration in buildings, the aforementioned shifts away from heavy industry, and growth in non-fossil fuel sources of power are all expected to contribute. The ratio of energy consumption to GDP is expected to continue to fall at a 1.9% annual average rate worldwide over the period.

In this forecast, global warming is assumed not to be an issue affecting fuel choice. Nor do we assume that nuclear power growth slows, outside of the U.S. and those European countries where opposition is strong. The major sources of energy are expected to be coal and natural gas.

Many countries such as the states of the former Soviet Union lag significantly behind developed nations in agricultural productivity. We assume that, as a result of technology transfer and the shift to a market economy, food imports into these countries will decline sharply. At the same time we believe that productivity growth in agriculture will slow in the next 70 years compared to the last 70. For both of these reasons we expect the growth in exports from current producers to slow significantly.

In general, we expect countries to become more self-sufficient in goods as the technological and labor cost advantages of the newly industrialized countries wanes. However, one of the principal engines of growth in newly industrialized countries is the newer plant and equipment and the lower wages paid. Thus, it is principally as per capita GDP converges that this advantage declines.

Steel production is an example of this trend. As a result of both lower unit demand for steel, due to the substitution of other materials, and increased self sufficiency, trade in steel products is expected to grow at less than 1% per year.

In the case of energy, oil trade must clearly fall off during this period because resources will be declining markedly worldwide, falling to 30% of their 1990 value. Coal and natural gas will come into their own during the first part of the next century. Even so, by 2060 coal reserves are expected to be depleted by 50% and natural gas resources by 85% from their present published estimated values[3]. Natural gas resource estimates are more uncertain that coal or oil, and, as a result, we have assumed that methane resources will be higher than published estimates. So long as extensive reserves of coal and natural gas remain to

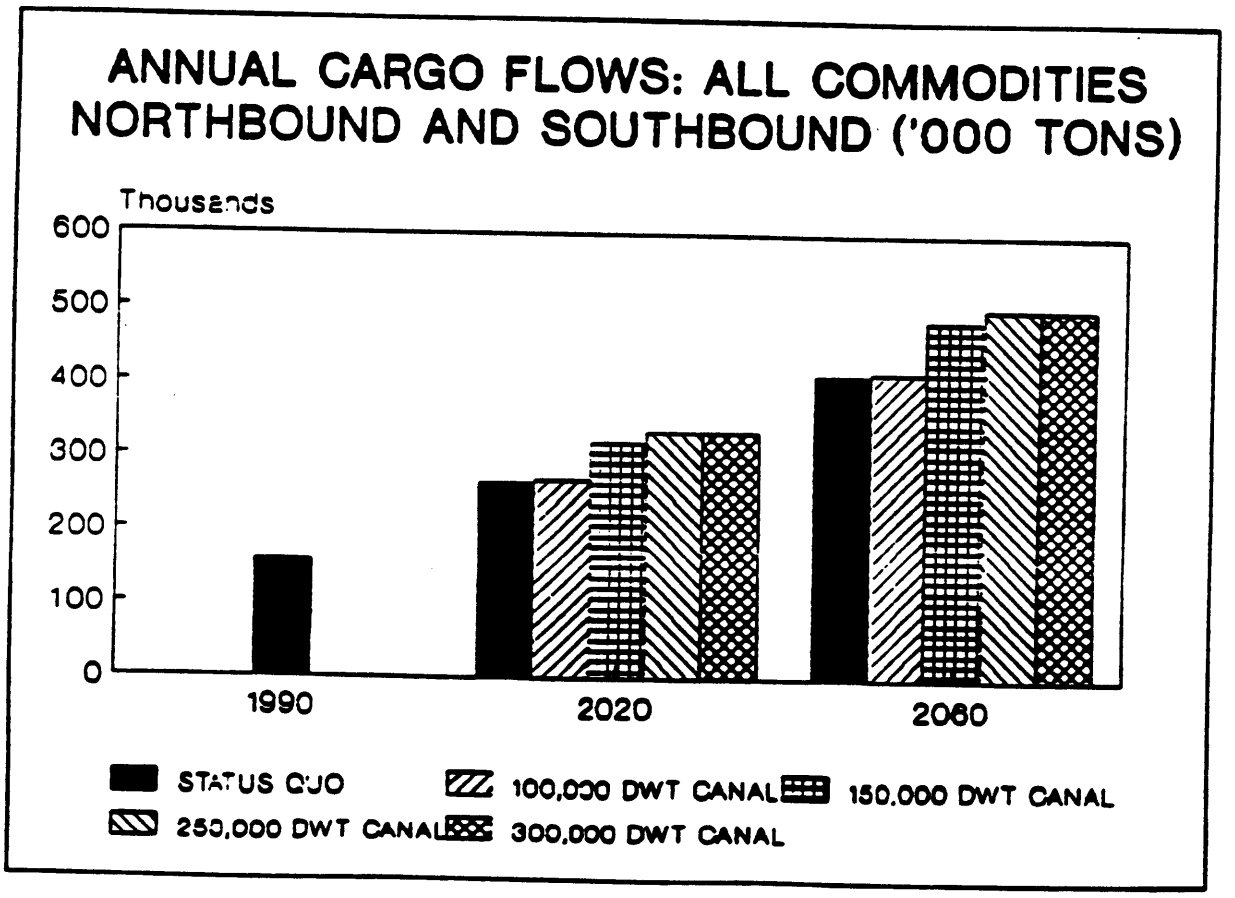
[3] BP Statistical Review of World Energy (June 1991), and C.D. Masters, D.H. Root, and E.D. Attanasi, "World Oil and Gas Resources - Future Production Realities", Annual Review of Energy, Vol. 15, 1990, pp. 23-51.

be exploited, it can be expected that it will be cheaper to transform these into sources of clean energy than to develop more costly technologies.

Therefore, coal trade is expected to become increasingly important during the first half of the next century as oil reserves fall. Natural gas trade, primarily by pipeline but also in liquified natural gas (LNG) tankers is also expected to be significant. However, these LNG tankers would not be using the Canal to any great extent as we expect most of this trade to be concentrated in the Far East while the Americas and Eurasia would depend primarily on pipelines.

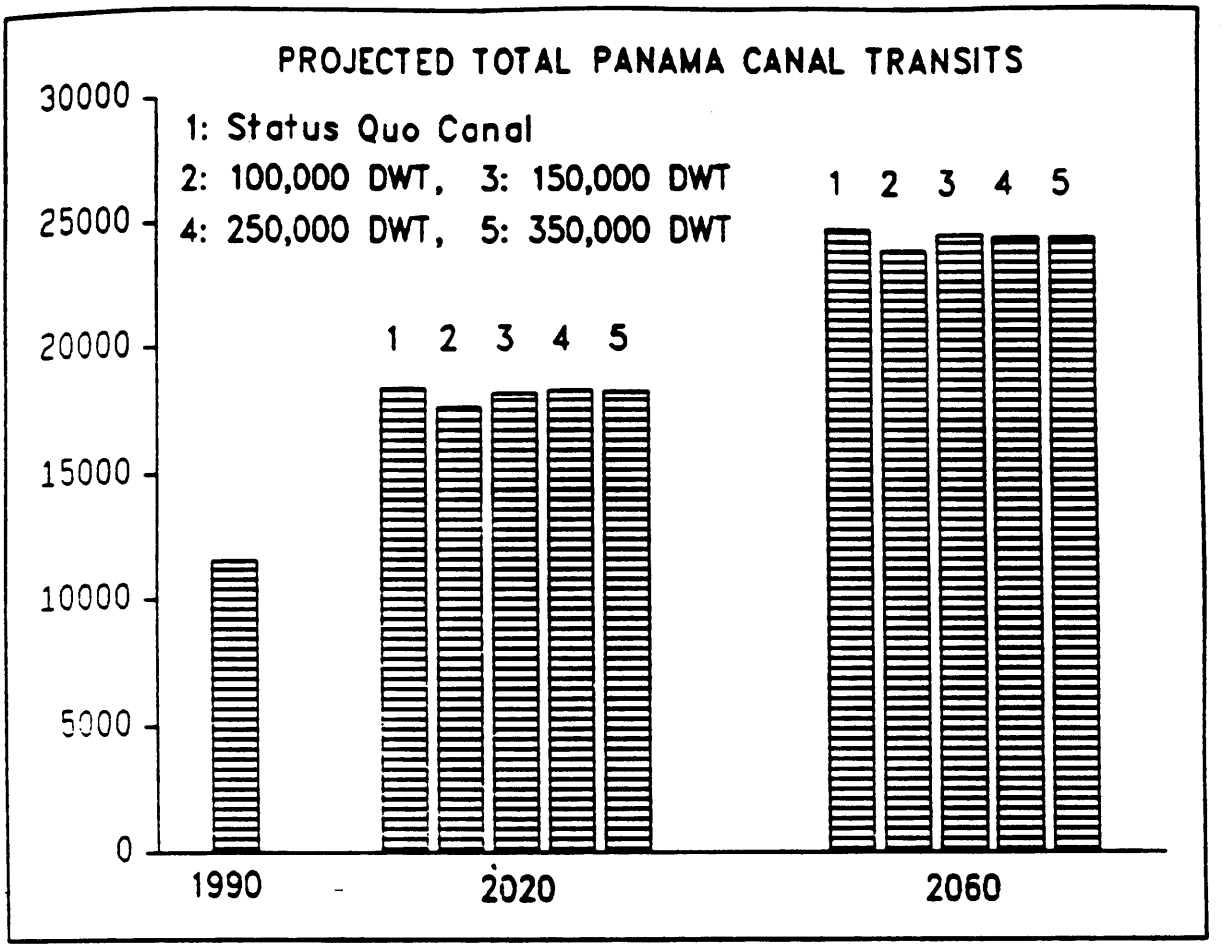
The results of the study are portrayed in Tables 1 and 2 and Figures 1 and 2.

Figure 1



Source: The WEFA Group

Figure 2



Source: The WEFA Group

Total cargo tonnage for the status quo Canal is projected to grow 1.8% per year on average for the next 30 years and 1.1% per year thereafter, averaging 1.4% annual growth over the entire period. For the largest two alternative Canals, these growth rates climb to 2.6%, 1.0%, and 1.7%, respectively. The shift to lower growth in the latter period is because of bypass capture in the first part of the projections.

Table 1

ANNUAL CARGO FLOWS BY COMMODITY TYPE

NORTHBOUND AND SOUTHBOUND

COMMODITY	(*000 TONS) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
STATUS QUO						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	48,572.5	63,633.1	2.9%	0.7%	1.6%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	55,864.5	88,275.5	1.3%	1.2%	1.2%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	265,121.1	411,687.0	1.8%	1.1%	1.4%
100,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	48,963.4	64,825.1	3.0%	0.7%	1.7%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	57,595.0	90,492.9	1.4%	1.1%	1.2%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	267,242.5	415,096.4	1.8%	1.1%	1.4%

Note: The source of the 1990 Commodity Flow Data is the Panama Canal Report (Tables 10 and 11), Panama Canal Commission, FY1990. Forecasts for 2020 and 2060 were developed by The WEFA Group.

Table 1 (Continued)
Annual Cargo Flows By Commodity Type

COMMODITY	('000 TONS) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
150,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	48,963.4	64,825.1	3.0%	0.7%	1.7%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	109,273.3	160,778.1	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	318,920.8	485,381.6	2.4%	1.1%	1.6%
250,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	48,963.4	64,825.1	3.0%	0.7%	1.7%
CRUDE OIL	9,220.0	18,108.1	14,821.1	2.3%	-0.5%	0.7%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	110,754.6	163,533.6	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	334,402.1	502,137.1	2.6%	1.0%	1.7%
300,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	48,963.4	64,825.1	3.0%	0.7%	1.7%
CRUDE OIL	9,220.0	18,108.1	14,821.1	2.3%	-0.5%	0.7%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	110,754.6	163,533.6	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	334,402.1	502,137.1	2.6%	1.0%	1.7%

Table 2
TOTAL PANAMA CANAL VESSEL TRANSITS

	Ballast		Laden					Percent Change
	North	South	North	South	North	South	Totals	Since 1990
1990:1	675	1,084	4,806	4,956	5,481	6,040	11,521	
2020:1	1,043	1,790	7,684	7,833	8,727	9,623	18,350	59%
2020:2	995	1,758	7,362	7,509	8,357	9,267	17,624	53%
2020:3	1,075	1,757	7,353	7,958	8,428	9,715	18,143	57%
2020:4	1,088	1,756	7,351	8,028	8,439	9,784	18,223	58%
2020:5	1,087	1,756	7,351	8,021	8,438	9,777	18,215	58%
2060:1	1,349	2,197	9,967	11,193	11,316	13,390	24,706	114%
2060:2	1,282	2,169	9,690	10,740	10,972	12,909	23,881	107%
2060:3	1,385	2,168	9,652	11,296	11,037	13,464	24,501	113%
2060:4	1,374	2,167	9,650	11,231	11,024	13,398	24,422	112%
2060:5	1,373	2,167	9,650	11,224	11,023	13,391	24,414	112%

Notes: 1: Status Quo - 65,000 DWT Design Ship
2: 100,000 DWT Design Ship
3: 150,000 DWT Design Ship
4: 250,000 DWT Design Ship
5: 300,000 DWT Design Ship

Source: Historical 1990 data: The PCC. Annual Report, FY 1990. Forecasts: The WEFA Group.

In our approach to determining bypass traffic shifting onto or away from the Canal, we have only moved traffic when the transportation economics showed significant departure from current relationships. This is because the aggregations across commodities of very different values and other approximations necessary in this work obviate precise cost comparisons. In any case, extensive discussions were held with shippers, port personnel, WEFA's commodity experts, and others each step of the way in order to provide CAS with the most informed judgements possible on these issues[4].

[4] A list of the organizations form whom information and guidance has been sought on issues relating to the questions of bypass traffic is given below:

Because each larger Canal involved larger ships in the World Fleet, the increase in the growth in the number of transits from one size Canal to the next is less than the increase in the commodity tonnage flows. In fact, between 2020 and 2060, the average growth rate for Case 2 (100,000 DWT design ship) is less than that for the Status Quo Canal. A surprising result of the entire study is that the average annual growth in vessel transits over the entire forecast period, 1990 - 2060, is between 1 and 1.1% for all cases.

As already noted, commodity flows were only shifted between Canal routes and bypass routes if there were significant differences in the transportation economics. Estimated Canal tolls are included, as agreed in the terms of reference and based on assumptions agreed with CAS, since it is inconceivable that ships in future will transit the Canal toll free. However, we recognize the uncertainty regarding future toll levels and therefore the impact of our assumptions is clearly presented in each of our comparisons of freight economics. Lower tolls for some ships/commodities could possibly attract significant bypass traffic. Conversely, higher tolls could discourage other traffic. One conclusion we have drawn from Phase I is that potential designs for optimal toll structures, drawing on the experience of the Suez Canal inter alia, should be an integral part of Phase II.

Other fine tuning issues which have arisen in Phase I include use of the actual PCC transit data, use of PIERS data to check implied PCC loadings, effects of the Canal on the world economy and trade effects of Canal and landbridge constraints, other periods and results by beam and draft.

Another set of issues for Phase II is the question of sensitivity analyses. In constructing the global scenario which we have used for Phase I, we have been conservative in our approach. Issues such as global warming, exotic hull designs and propulsion systems, as well as unmanned ships, are among the questions we have had to avoid. In designing Phase II. CAS should be cognizant of criticisms which might arise as to these and other issues. which could clearly result in quite different results and possibly different conclusions.

Port Authority of New York and New Jersey; Fearnley Research, Oslo; Port of Mobile; H.. Clarkson & Co. (Shipbrokers); Fairwind Enterprises Ltd.; International Iron & Steel Institute; Powergen, UK; International Wheat Council; Tradax, Geneva and London; U.S. Department of Agriculture; Shell International Marine; Bitumenes Orinoco S.A. (Bitor), Caracas; Sea-Land Services Inc.; Leif Hoegh & Co., Oslo; The East Asiatic Co. Ltd., Copenhagen; Hapag-Lloyd; Evergreen; Mitsui OSK; U.S. Department of Energy; U.S. Bureau of Mines; Ports Canada; M.A. Hanna & Co.; Hammersley Iron & Steel; UNC DAD Trust Fund.

2.0 INTRODUCTION

The Commodity and Traffic Projections (CTP) Study is one of a series of component studies in the Panama Canal Alternatives Study Program. For the Phase I of the CTP, CAS engaged WEFA, and its subcontractors, RLA, and BST to develop preliminary projections of potential cargo tonnage and number of transit vessels through the canal under constraints on passage inherent to each of the five alternatives. CAS intended that these provide an initial projection of future demand for trans-Isthmian commerce as a function of time for the prescreening and selection of canal alternatives for full study.

The Prescreening and Selection of Alternatives Phase of the overall project is described in the document presented in Appendix A. That document provides some of the analysis by which the present definition of Phase I of the CTP was developed. The pertinent information on the alternatives presently being studied is in Table 6 of Appendix A, "Study Case for Prescreening". In that table, the five maximum design ship sizes are provided in deadweight tons (DWT). These are:

65,000	DWT (Status Quo)
100,000	DWT (Case 2)
150,000	DWT (Case 3)
250,000	DWT (Case 4)
300,000	DWT (Case 5)

The scope of Phase I CTP study excluded several issues, both from necessity and from the limited needs of the prescreening process. The study explicitly did not take into account the following issues:

- The constraints of the Panama Canal and of other pertinent parts of the world transportation system, such as the U.S. rail system;
- The effect of an enlarged or alternative Canal on the world economy, on global trade in aggregate and on patterns of world trade;
- The effect of the Canal construction itself on the world economy and on world trade;
- The effects of projected improvements in infrastructure in Panama, such as the Centerport project;

- Alternative assumptions to those which define our baseline scenario.

The base year for the study is 1990. The forecast periods are the years 2020 and 2060.

We wish to emphasize that the commodity flow and vessel transit projections produced in the CTP study for the different alternatives are not forecasts, because they do not take into account the actual capacity of the Canal. Further, because of time constraints, other adjustments to the projections, such as the effect on global commodity trade of an alternative Canal, cannot be taken into account in Phase I but must wait for a refined forecast in Phase II. It is our professional opinion, however, that the projections that WEFA and its subcontractors have produced in Phase I are sufficiently precise for the purpose of prescreening alternatives.

CAS also developed an additional set of tasks for the CTP Phase I study, namely the provision of additional economic information to be used in the prescreening process. These data concern:

- vessel delay cost per hour
- transportation costs by route
- annual closure costs.

The work plan which WEFA developed in response to these terms for Phase I is as follows.

Task 1 **Review of Data and Approach** In this task, WEFA carried out a review of the available data and of possible approaches that one can use to carry out the study. Based on this review, we collected the necessary data and information beyond that in the existing WEFA, RLA and BST databases. Further. we established our approach for the present study.

Task 2 **Database Construction** Four basic databases were constructed for the project.

1) Because, as noted below, detailed ship transit data from The Panama Canal Commission (PCC) Ship Data Bank Master File was not available in time for Phase I, WEFA constructed a **Panama Canal Vessel Transit Database** from other sources.

2) The second database was the **World Commodity Flow Database** constructed primarily from WEFA historical and forecast commodity trade data. This was modified and augmented with data from other sources as needed for the project.

3) The third database was the **Panama Canal Commodity Flow Database**, constructed from historical PCC commodity flow data. This database was constructed from data published in the PCC annual reports.

4) Although not formally included in a single database, data has been used from other WEFA, RLA, BST proprietary databases as well as other published data in completing the project.

Task 3 **Forecast of Commodity Flows** The 2020 and 2060 forecasts of global bilateral cargo flows were consistent with WEFA's regular trade forecasts, which have 20-year and 30-year horizons depending on the projections, but used qualitatively different, primarily judgmental methods. These forecasts also drew heavily on the WEFA World Coal Trade System, the RLA Oil Trade System, BST's understanding of intermodal and U.S. coastal shipping, and WEFA's country and commodity experts. These latter include the WEFA World Agriculture and Fertilizer Trade Services and the WEFA Auto Service. Because of the time constraints of Phase I, only one set of commodity flow projections were developed, rather than one for each canal alternative.

To produce forecasts of Panama Canal commodity flows, the global bilateral trade forecasts were first aggregated to the appropriate region and commodity detail. The approach which we took to projecting Canal commodity flows was to initially apply global trade growth rates for 1990-2020 and 2020-2060 for a given commodity and pair of trading partners to that commodity and origin/destination pair in the FY 1990 Panama Canal data. These flows were then adjusted based on vessel economics as described in the next task.

Task 4 **Vessel Mix and Projections**

The world trade forecasts developed in Task 3.0 were initially used to

develop projections of the world vessel fleet for 2020 and 2060, for each maximum design vessel size that can transit the Canal fully laden. A top-down-bottom-up approach to vessel forecasting was used, combined with practical evaluations, to ensure that the changing impact of the Panama Canal is linked to other important global economic and trade developments.

The Panama Canal commodity forecasts were converted into numbers of laden and ballast transits by ship type and size. Physical and economic constraints were then be applied to this forecast to determine the numbers of vessels which transit the Panama Canal.

Task 5 **Additional Vessel Economics**

In order to compare the economic advantages and disadvantages of different canal alternatives, the economic effect of changes in the time for a ship to carry goods from one port to another must be considered. These changes include:

- delays, due to congestion
- reduction in length of voyage, as a result of being able to use the canal.
- cost of closing the canal due to construction.

These costs are developed from vessel and intermodal costs which are a fundamental part of the economic analysis of the project.

The WEFA Group provided international trade databases and long term forecasts of all relevant trades using their extensive computer models and modelling capabilities together with project management. WEFA is recognized as the foremost world coal supply/demand/ transportation consultant in the world. Further, WEFA's acknowledged expertise in world agriculture and steel, as well as its country and regional economic expertise, make it unique in its ability to provide the necessary economic and trade inputs for this project.

RLA provided projections of demand for ships by size and type and their projected Panama Canal transits, developments in the world fleet vessel mix and trends in the costs of ocean transportation. RLA's expertise in this area is unexcelled. Further, they are acknowledged as among the world's foremost consultants on oil trade.

BST Associates provided projections of U.S. coastal trade demand for each shipping mode and assessments of potential changes between Panama Canal transits and landbridge flows. BST has extensive experience in the U.S. transportation market including both seaborne and landbridge trade.

3.0 REVIEW OF DATA AND APPROACH

3.1 Review of the Data

3.1.1 World Economic Forecasts

To extend the WEFA World Economic Forecasts beyond 2010, we used two major sources. The United Nations Population Projections Division projects the population of each country through the year 2025. These data include births and deaths as well as total population. We found that these data imply net migration values that in many cases are not realistic. The United Nations accepts the projections of each country and, apparently, does not make an attempt to obtain world wide consistency. WEFA took the approach of accepting the population numbers and developing a consistent underlying approach to extend the population of each country to 2060.

In addition, we made use of The World Bank annual publication, World Development Report. This publication contains a great deal of useful information on the lesser developed countries, and it is these countries which can be expected to play a more important role in 2060 than they do now.

3.1.2 World Commodity Forecasts

To extend the WEFA Trade Analysis Service bilateral trade forecasts beyond the normal 10-year horizon, we undertook to examine reserve and resource information for depletable natural resources. The important commodities of this forecast type for world trade are petroleum, coal, iron ore, and other ores. WEFA keeps databases on energy commodities such as petroleum and coal. In the case of petroleum, we expect roughly 40% of the world petroleum reserves to be depleted by 2060. In the case of coal, the amount of reserve depletion is expected to be is smaller, but substantial.

Because of its potential importance for an alternative Canal, we examined iron ore carefully. From the U.S. Department of the Interior, Bureau of Mines, we obtained the following publications:

Mineral Industry Summaries, 1991

"Iron Ore", by Peter H. Kuck and Cheryl M. Cvetic, from the 1989 Mineral

Yearbook

Mineral Industry Surveys: Iron Ore Monthly, July 1991

In addition to using these sources for the iron ore projections, the first named publication was also used for the bauxite projections.

3.1.3 Global Trade Data

The WEFA historical trade database contains approximately 750,000 time series covering every major trade and commodity. These data were compiled beginning in the 1970's from U.S. Bureau of Census, TA380/780 data (formerly, SA305/705) and O.E.C.D. Series C bilateral trade data. These are annual data which begin in 1973 and are based on the Standard International Trade Classification (SITC) Revision 3. This classification is consistent with the Harmonized Commodity Codes in use worldwide.

Historical data are provided for approximately 800 bilateral trades in terms of approximately 150 individual or groups of commodities. The coverage includes historical data for world waterborne trades:

- in terms of tonnes and U.S. dollars;
- by country-pair and direction;
- for 60 countries and regions (see Appendix B, Table B.1);
- for approximately 150 commodity groups (see Appendix B, Table B.2);

In addition, both United States and other industrialized country maritime trades are delineated in terms of:

- liner and non-liner modes; and
- TEU and FEU for liner-like containerizable cargos.

To this database were added additional information as needed for the project. Data sources are:

- The trade and operating statistics of the Panama Canal Commission (PCC) as published in their annual reports;
- The International Trade Statistics compiled by the United Nations;
- Data from the preliminary studies, including the Historical Trade Analysis and the Future Transportation Systems studies;
- U.S. Army Corps of Engineers data on U.S. coastal shipping:
- ICC 1% waybill (U.S. rail movements)
- Statistics Canada Transportation (water borne and rail traffic)
- Data from specific ports, port regional authorities and marine exchanges
- Suez Canal Statistics
- U.S. Department of Energy data on oil and coal trade
- RLA's crude oil, petroleum products and bulk liquid chemicals trade data bases compiled from a range of government statistics, customs data, confidential commercial information, and trade associations
- RLA's global ship movements data.

3.1.4 Panama Canal Data

In principle, the most accurate data on commodity flow and vessel transits through the Panama Canal are those collected by the Panama Canal Commission (PCC). Because detailed ship transit data from the PCC Ship Data Bank Master File were not available in time for Phase I of the CTP, we were forced to seek out other sources. The following documents were provided to WEFA by CAS:

- Copies of the preliminary studies, "Historical Trade Analysis" and "Future Transportation Systems and Significance of the Panamanian Isthmus in World Trade";

- Annual reports of the PCC from FY 1976 to FY 1990;

- Copies of several studies carried out for the Panama Canal Commission (PCC). namely:

  - **Forecasts of Panama Canal Commodity Traffic, Vessel Transits, and Revenue, 1985-2010**, Manalytics, Inc, 1985;

  - **A Review of the Manalytics Forecasts of Panama Canal Commodity Traffic, Vessel Transits, and Revenue, 1985-2020**, Temple Barker & Sloane, Inc., December, 1985;

  - **A Sensitivity Analysis of Panama Canal Trade, 1984-2010**, Temple Barker & Sloane, Inc., April, 1986;

  - **Traffic Demand Forecast**, Temple Barker & Sloane, Inc., April, 1989;

  - **Forecast of Canal Traffic and Tolls Revenue, FY 1990 - FY2010**, Office of Executive Planning, Panama Canal Commission, March, 1990.

Neither these, nor any other sources, contain complete data on Panama Canal transits. The published PCC data provide almost no data on ships transiting the Canal. The commodity information provided in the PCC Annual Reports is much more detailed and provided the commodity origin and destination information used in the study.

The following two sources contain information on vessels which transit the Canal but contain no information on the contents of the vessels nor even whether they are loaded or in ballast. For this reason, they also do not give a clear picture of the origin/destination of the vessel in terms of its primary cargo.

Lloyd's Shipping Index, Lloyd's of London Press

Lloyd's Voyage Record, Lloyd's of London Press.

We used a hard copy rather than the computerized data base were used in constructing the synthetic Panama Canal Transit Data Base (see section 5.1) because we already had a

comprehensive source of information on ship transits by ship name and flag. To correlate these with Lloyd's data in order to determine vessel itineraries required visual inspection of records, whether in hard copy or in computerized data base. The lack of accuracy of the Lloyd's data as to Panama Canal transits required that this procedure be followed rather than commence with the Lloyd's data directly. In addition to these sources, several confidential industry sources were used.

3.1.5 World Vessel Fleet Data

RLA maintains a detailed database of operating costs for tankers, dry bulk carriers, container ships, general cargo ships, ro-ro ships, gas ships, chemical carriers and reefers (for the tanker and dry bulk sectors, this database contains quarterly data back to January 1977).

Data includes capital costs, fixed direct costs (manning, repairs and maintenance, insurance, stores and spares, overheads etc) and variable costs (bunker fuel costs and port charges) plus principal vessel characteristics such as speed, fuel consumption, draft, length, beam, immersion factor and horse power. These data are compiled directly from owners/operators actual cost data and, importantly, cover a wide range of vessel designs, flag registries and types of operation. Therefore we are in a position to provide estimates of representative costs plus minimum/maximum levels.

3.1.6 Landbridge Bypass Data

We examined only overland bypass traffic that involved commodity flows by rail/barge/truck overland links in the U.S. as other routes are negligible, with the exception of the pipeline which follows the Canal. These data were compiled from the following sources:

U.S. Department of Commerce 305/705 Export/Import Data;

U.S. Interstate Commerce Commission 1% Waybill Statistics;

U.S. Army Corps of Engineers Waterborne Commerce Data;

Statistics Canada Trade Data;

BST Proprietary Port Files.

3.2 Review of Previous Demand Analyses and Forecasts

In this section, we provide the results of an examination of the results and methodologies of previous Panama Canal demand analyses as an input to the establishment of forecasting methodologies for this study. Specifically, we examined the relationships between forecast elements for their applicability and compatibility:

- world economics
- trade demand
- vessel demand
- vessel supply
- vessel mix
- vessel costs/rates.

The reports which we examined are as follows:

March, 1990	Office of Executive Planning, Panama Canal Commission: Forecast of Canal Traffic and Tolls Revenue, FY 1990 - FY 2010 (PCC90)
April 14, 1989	Temple, Barker & Sloane, Inc *In Association with* Data Resources Inc. *and* Lloyd's Maritime Information Services, Ltd.: Traffic Demand Forecast (TBS89)
April 28, 1986	Temple, Barker & Sloane, Inc.: A Sensitivity Analysis of Panama Canal Trade, 1984-2010 (TBS86)
December 23, 1985	Temple, Barker & Sloane, Inc.: A Review of the Manalytics Forecasts of Panama Canal Commodity Traffic, Vessel Transits, and Review, 1985 - 2010 (TBS85)
1985	Manalytics, Inc.: Forecasts of Panama Canal Commodity Traffic, Vessel Transits, and Revenue, 1985 - 2010 (MAN85)

Since all of the studies except MAN85 use the approach developed by TBS for the PCC we will discuss them together, focussing primarily on the most recent (PCC90).
The approach developed by TBS begins with the DRI/TBS World Sea Trade System (WSTS). This system consists of a bottom up forecast of international trade flows for 40 commodity categories among an unspecified number of regions. Forecasts of bilateral trade among 22 OECD countries and 28 multi-country regions are developed from this, for a total of 300+ deepwater trade routes. The trade models are driven by DRI macroeconomic country and regional forecasts, but are not an integral part of these forecasts. This has the advantage of ease of forecasting on a commodity by commodity basis, but the disadvantage in that consistency with the foreign trade macroeconomic forecasts cannot be assured.

The TBS approach to forecasting Panama Canal commodity flows and vessel transits is described in detail in TBS89. The first step in producing the forecasts is to match WSTS commodity and route definitions with those in the PCC data. The PCC base-year commodity forecasts are then moved with the WSTS forecast growth rates to arrive at a first-cut Canal cargo forecast. This forecast is then adjusted judgementally to account for Canal cargo for a specific route and commodity not growing at the same rate as that route and commodity in world trade. Some of these changes are corrections to the WSTS projections and some are effects of increased bypass.

These cargo flows are then assigned to 11 vessel types, "based on analysis of PCC historical data and industry projections". The vessel allocations matrix and the size distribution of vessels appears to also be judgmental.

A major factor in the design of the TBS system is the provision of a user-friendly forecasting model to the PCC. Thus, the existence of judgementally-determined shift and allocation factors is a plus. That is, the client, namely the PCC, can apply their own judgements in a straight forward way without the "Black box" qualities of a complex model.

The other approach to projecting Canal cargo and traffic among the sources which we have received is in MAN85. The first difference in the approach of MAN85 from that of TBS89, etc. is in the level of detail. The 20 area descriptions of the PCC were expanded in MAN85 such that, for example, Asia was divided into Far East Asia, Southeast Asia, Centrally Planned Asia and South Asia. Thus, "when the Panama Commission would define two trade routes between Asia and the East Coast of the United States (one in each direction) the analysis was conducted utilizing 24 links". Further, the 25 PCC commodity categories were broken out into 28.

The second difference is that Panama Canal shares are not held fixed in the first step but linearly trended. The final step in the MAN85 cargo forecast is similar to TBS89, namely, a judgmental adjustment to each projection.

The procedure for assigning cargo to vessels was also both more detailed and made greater use of statistical techniques. Both linear regressions and logistics were used and adjusted judgementally to obtain the mix of ship types. Average size also used historical trends. By assigning the cargo to ship types, this then produces a forecast of vessel transits. One added difference between the two approaches appears to be that the vessel size categories are more detailed in TBS89, providing 5,000 PC Net Ton increments to 60,000 rather than only to 25,000, as in MAN85.

It is interesting to note that TBS89 is lower by about 5% in 2010 than MAN85 in total forecast cargo tons, and PCC90 is a further 4% lower. In terms of average daily transits TBS89 is 24% higher than MAN85, in its forecast for 2010, while PCC90 is 2% lower than TBS89. Clearly the major disagreement between TBS and the earlier Manalytics study appears to be in average vessel size. However, these aggregate comparisons mask significant underlying differences in components of the cargo forecast. Suffice it to say that even projecting to 2010 can lead to large variations in forecasting, so that extreme care must be taken. Finally, in neither of these approaches do vessel economics appear to be taken into account in any meaningful way, either in projecting the world vessel fleet or in developing route structures or transits.

4.0 ESTABLISHMENT OF THE 2020/2060 DEMAND FORECAST METHODOLOGY

4.1 Introduction

Developing a view of the world thirty to sixty years into the future is an extraordinarily difficult exercise. This is not a world whose characteristics we can develop based on simple increments of current trends - one must construct a completely new scenario to have a picture which is at all realistic.

For the near-term period, namely the next 20 years, the labor force has already been born, the major technical changes are already on the drawing board, and we do not expect any surprises in terms of how countries and their foreign trade develop. This is the reason that econometric models, models which are calibrated on current economic data, can be useful tools for developing a picture of economic development over this period.

For the longer term, structural econometric models are not adequate because they do not provide sufficient insight to construct a picture of the world thirty and seventy years in the future. The approach one is forced to take is to make careful estimates of key factors judgmentally and combine them to form the complete scenario. The key variables become:

- geopolitical factors
- population and labor force by region
- productivity by region
- structural change
- technological innovation
- transportation costs
- the terms of trade
- environmental policy

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Our assumptions for each of these factors and the consequences of these assumptions for

the projections are described in Sections 5 through 9.

A new Panama Canal will make a qualitative change in the size of the ships being constructed. Therefore at an early stage, the WEFA team needed to develop assumptions as to the date when the world shipping industry will take seriously the alternative Canal and the date when the maritime industry expects the Canal to be completed. For this purpose, CAS provided us with the following assumptions:

- Start date for construction of the alternative Canal - 2000;
- Completion date for construction of the alternative Canal - 2010.

Those constructing new vessels will take account of the increased canal size. There will thus be a different future vessel mix for each maximum design size vessel after that date, beginning at the point at which the shipping industry believes the new Canal will come to fruition. Before that time there will be only one world vessel mix; afterwards there will be five, according to the prescreening requirements.

In producing long-term forecasts, one must keep in mind the potential for the accumulation of small deviations in each iteration. In compiling long-term projections, WEFA produces high and low growth scenarios to provide an envelope covering what we believe to be the set of reasonable alternatives. The following table provides the long-term average divergence between these outlooks. To understand the table, recall that the rate of economic growth is just the product of the growth in the total number of hours worked by employed labor and the growth rate in labor productivity.

- Demographic projections - 0.2% per year;
- Labor force participation - 0.2% per year;
- Hours worked - 0.1% per year;
- Output per hour - 0.4% per year;
- GDP (sum of the above) - 0.9% per year;
- Exports (incl. above) - 1.3% per year;

- Imports (incl. above) - 1.5% per year;

If we take the average trade uncertainty expressed in the WEFA scenarios as 1.4% per year, this would imply +/- 0.7% per year. Then:

- in five years, this produces +/- 3.5% uncertainty;
- in ten years, this produces +7.2%/-6.8% uncertainty;
- in twenty years, this produces +15.0%/-13.1% uncertainty;
- in thirty years, this produces +23.3%/-19.0% uncertainty;
- in seventy years, this produces +63.0/-38.8% uncertainty.

Clearly, the level of uncertainty one gets from trend analysis for seventy years and even thirty years is unacceptable. It is just this level of uncertainty which one can expect from even the best type of forecasting model based solely on econometric analysis of recent trends. The inescapable conclusion is that one must use another method.

The method which we have used is as follows.

Steps for long-term forecasting

- We begin with a demographic forecast. Populations generally change slowly. For example, as already noted the labor force which will be available for the next fifteen to twenty years has already been born.
- We assume that labor force participation rates level out, at least in the industrial countries. This is happening already and is a result of the increasing value of leisure time with increasing per-capita income.
- As populations approach equilibrium, the relationship between the working age population and the total population becomes stable. If this is the case and if labor force participation rates level out, as we have already assumed, the rate of growth of employment is the same as that of population. Note that short-term econometric models forecast demand and produce forecasts of

unemployment. Long-term models take full employment as an assumption and forecast production and the share of that production which is consumed in the current period (consumer goods), the share which goes into goods which last more than three years (investment goods), the share which are used up in the production process (intermediate goods) and the share which is services.

- Likewise, we assume stability in hours worked. With this added assumption, the growth rate of hours worked and population will be the same. To the extent that all of these assumptions hold, we can have a high level of confidence in projections of the labor input to economic growth, namely, the growth rate in total hours worked, which is based on assumptions as to population growth.

- We examine the trends in labor productivity in the industrial economies. These are leveling off, as one might expect, as the great gains in efficiency have already been reached in the most industrialized areas. Further, significant output is being diverted to the production of benefit streams which are not included in the GDP concept, such as a cleaner environment.

- These trends are used to develop projections of GDP/capita for all countries over time. This GDP/capita projection is carefully examined for the sense it makes. Clearly, a great deal of judgement must be used at this point.

- We also examine trends in imports and exports as a ratio to GDP. The growth curve in these ratios is also expected to flatten out for two reasons:

  - the shift to services

  - the declining resource base.

- The sum total of this analysis provides a "top-down" forecast of world trade, that is, trade flows which are developed from a view of economic growth.

- At the same time, we develop a "bottom-up" view of bilateral trade in those specific commodities covered by the various WEFA commodity services - agriculture, energy, and industry. These cover all of bulk trade, both liquid and dry, and trade in motor vehicles, motor vehicle parts, and primary steel

products.

- Finally, we subject the long-term trade projections to the scrutiny of our experts in the WEFA energy, steel, auto, and agriculture departments for their adjustments. We also have compared them to other forecasts, including those of the PCC.

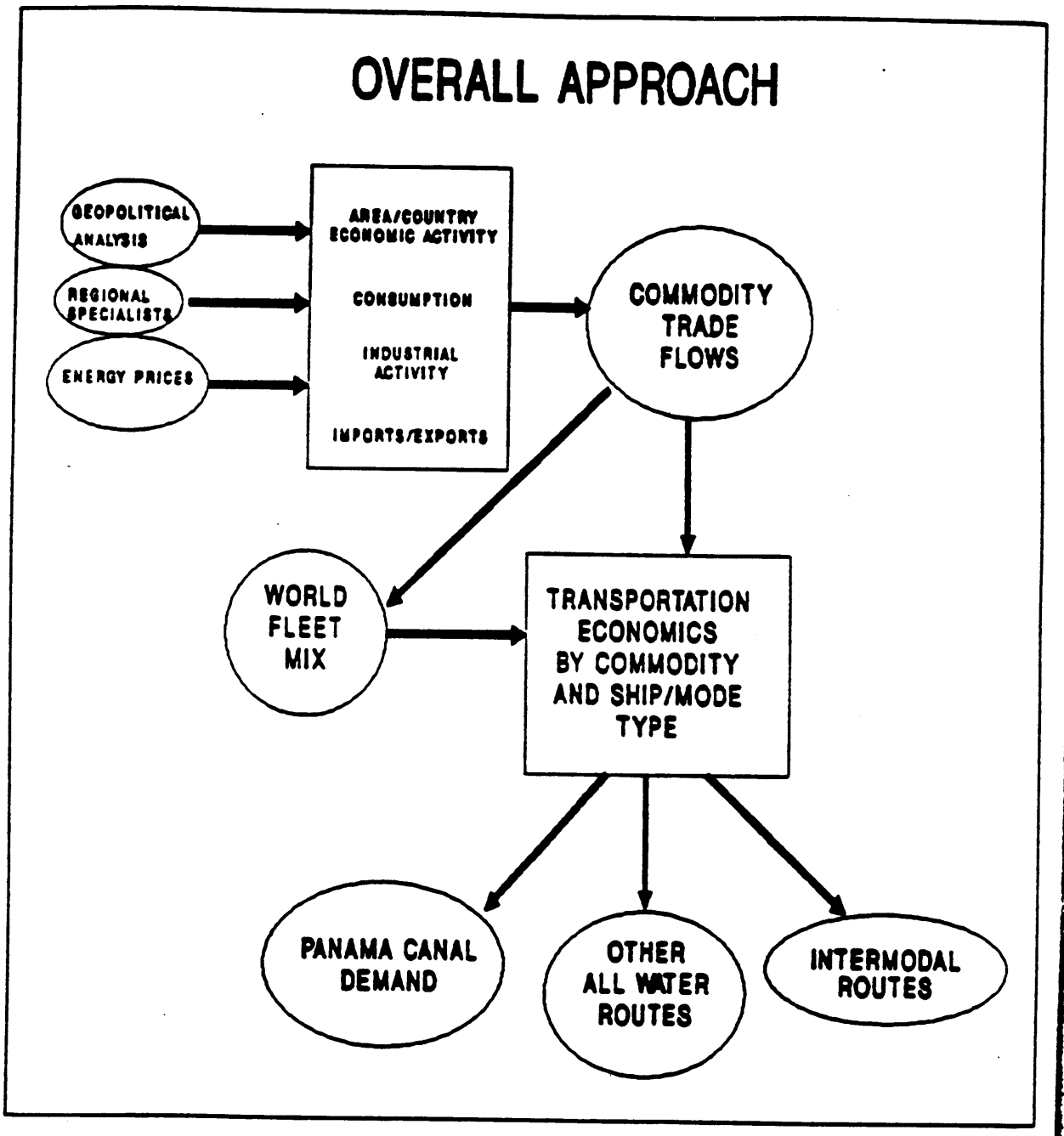
This is the procedure which we have used in developing the projections for 2020 and 2060. A schematic representation of this procedure is shown in Figure 4.1.

In these projections trade and traffic forecasts must build up from:

- forecasts of trade patterns
- ship demand by type and size
- ship supply by type and size
- total and marginal costs
- route choice forecasts.

First, it is useful to examine specific trade routes and commodities that currently utilize the Panama Canal. (See Tables 4.1, 4.2, and 4.3). Atlantic to Pacific (Southbound) commodity flows are dominated by grains, nitrates/phosphates/potash and petroleum products. These commodities represent 56.3% of the total volume of Southbound trade. Pacific to Atlantic (Northbound) commodity flows are dominated by petroleum products, lumber and related products and ores and minerals. These commodities represent 42.2% of the Northbound trade volume. Trade originating in or destined for North America (i.e., Canada and the U.S.) represents nearly two thirds of total Panama Canal traffic.

Figure 4.1



Source: The WEFA Group

Table 4.1

Southbound (Atlantic to Pacific) Commodity Flows (1,000 long tons)

Commodity Group	1985	1986	1987	1988	1989	Percent 1989
Grains	20,843	20,427	29,936	32,761	28,127	31.9%
Miscellaneous	10,908	11,045	12,470	13,358	14,136	16.0%
Nitrates, Phosphates & Potash	9,530	7,572	9,888	10,289	11,702	13.3%
Petroleum Products	10,837	11,931	13,093	11,851	9,838	11.1%
Chemicals & Petroleum Products	3,855	3,722	4,862	5,522	6,000	6.8%
Coal and Coke	8,553	7,534	5,902	5,390	5,301	6.0%
Manufactures of Iron & Steel	2,725	2,538	3,346	2,736	4,325	4.9%
Ores & Metals	3,695	4,368	3,569	3,462	3,130	3.5%
Lumber & Products	582	763	928	1,671	2,465	2.8%
Other Agricultural Commodities	1,384	1,396	1,514	2,422	1,836	2.1%
Canned & Refrigerated Foods	459	589	697	846	768	0.9%
Machinery & Equipment	556	555	540	531	506	0.6%
Minerals, miscellaneous	225	235	261	144	142	0.2%
Total	74,152	72,675	87,006	90,983	88,276	

Source: Panama Canal Commission - Annual Reports

Table 4.2

Northbound (Pacific to Atlantic) Commodity Flows (1,000 long tons)

Commodity Group	1985	1986	1987	1988	1989	Percent 1989
Petroleum Products 15,936	18,918	12,840	12,740	12,840	20.8%	
Miscellaneous	9,889	1,593	10,381	1,367	10,381	16.8%
Lumber & Products	5,644	6,156	7,782	7,863	7,782	2.6%
Ores & Metals	6,037	5,423	5,412	6,872	,412	8.8%
Minerals, miscellaneous	4,194	4,589	4,85	4,977	4,851	7.9%
Manufactures of Iron & Steel	5,092	4,162	3,626	4,107	3,626	5.9%
Canned & Refrigerated foods	3,202	240	3,513	,021	3,53	5.7%
Other Agricultural Commodities	3,593	3,346	3,346	2,998	3,346	5.4%
Grains	2,668	2,521	2,432	3,109	2,432	3.9%
Machinery & Equipment	1,823	2,352	2,387	2,125	2,387	3.9%
Nitrates, Phosphates & Potash	2,331	2,376	2,114	1848	2,114	3.4%
Coal and Coke	2,929	2,672	2,020	3,186	2,020	3.3%
Chemicals & Petroleum Products	1,154	922	980	1,292	980	1.6%
Total	64,492	67,278	61,684	65,505	61,684	

Source: Panama Canal Commission, Annual Reports

Table 4.3

Major Voyage Trades Routes in Canal Traffic - 1987 to 1989
(Million long tons)

Trade Route	1987	Percent 1987	1988	Percent 1988	1989	Percent 1989
EC US - Asia	58.1	39.1%	63.4	40.%	59.7	39.4%
Others	30.4	20.4%	29.1	18.6%	25.1	16.6%
Europe - WC US/Canada	14.9	10.0%	15.0	9.6%	14.2	9.4%
EC US - WC South America	12.0	8.1%	12.3	7.9%	14.1	9.3%
Round the World	3.7	2.5%	5.5	3.5%	7.5	5.0%
US Intercoastal (Includes Alaska, Hawaii)	2.9	2.0%	2.3	1.5%	7.0	4.6%
Europe - WC South America	7.4	5.0%	7.3	4.7%	6.0	4.0%
EC US/Canada Oceania	4.8	3.2%	5.5	3.5%	3.7	2.4%
West Indies - Asia	1.8	1.2%	3.1	2.0%	3.5	2.3%
Central America Intercoastal	3.3	2.2%	2.8	1.8%	3.4	2.2%
West Indies - WC South America	2.7	1.8%	4.1	2.6%	2.8	1.8%
Europe - Asia	3.7	2.5%	2.9	1.9%	2.6	1.7%
EC US - WC Central America	3.0	2.0%	3.2	2.0%	1.9	1.3%
Total	148.7		156.5		151.5	

Source: Panama Canal Commission, Annual Reports

Growth in Panama Canal traffic will certainly focus on these commodities and trade routes. However, future traffic through an enlarged Panama Canal may increase from:

- diversion of existing cargoes from competing routes (e.g. U.S. midwest grain diverted from West Coast loading), as well as
- development of new cargoes (e.g. cargoes not currently transiting the Panama Canal).

To reiterate, the methodology to estimate future Panama Canal traffic depends on:

- Development of World Trade forecasts (WEFA Group/RLA Models)
- Development of Panama Canal market shares
  - non-Panama Canal route shares
  - Panama Canal route shares

These methodologies are described in greater detail below.

4.2 Commodity Flow Projections

4.2.1 World Commodity Flows to 2010: the Starting Point

World Economies

For forecasts to 2010, WEFA uses its World Model System that is diagrammed in Figure 4.2. The system consists of 30 macroeconomic models, a model for each of the 25 developed countries, namely the 24 members of the Organization for Economic Cooperation and Development (OECD) and South Africa, and for each of the following developing regions: Latin America, the Gulf Four, Africa (excluding South Africa), the Pacific Basin, Other Asia, and the current and former Centrally Planned Economies.

Each of these models is of the form shown in Figure 4.3 and consists of a total of 215 variables, of which 37 are determined by econometrically estimated stochastic equations and 38 are exogenous. The remaining 140 variables are determined by accounting identities or transformations. The major drivers for each model in the very short run are the 93 final expenditure variables covering consumption, investment, government, exports and imports.

In the longer run, supply side variables - labor, capital stocks, prices and the country's balance of payments - become the important variables. Each of these models can be used to produce twenty-year forecasts for each country or region.

The 30 models are tied together in the following way: each country's imports are divided into three categories - energy goods, primary non-energy goods, and manufactured goods. Then each of these values is divided into 29 parts: the imports from each of the other

countries/regions. When this process is carried out for all 30 countries/regions and the price markups due to trade added in, a summation can be performed for each of the exporting countries to identically determine exports by these three aggregate commodities.

These export calculations come at the end of the solution for a given period and produce a different value from the value exports are given at the beginning of the solution. Therefore, the solution for each period must be repeated until the starting and ending export values are the same within some predetermined level of precision. In this way, we use this system of models to produce 20-year forecasts. This study is based on the January. 1991 WEFA World Economic Forecast, carried out to 2010.

Figure 4.2

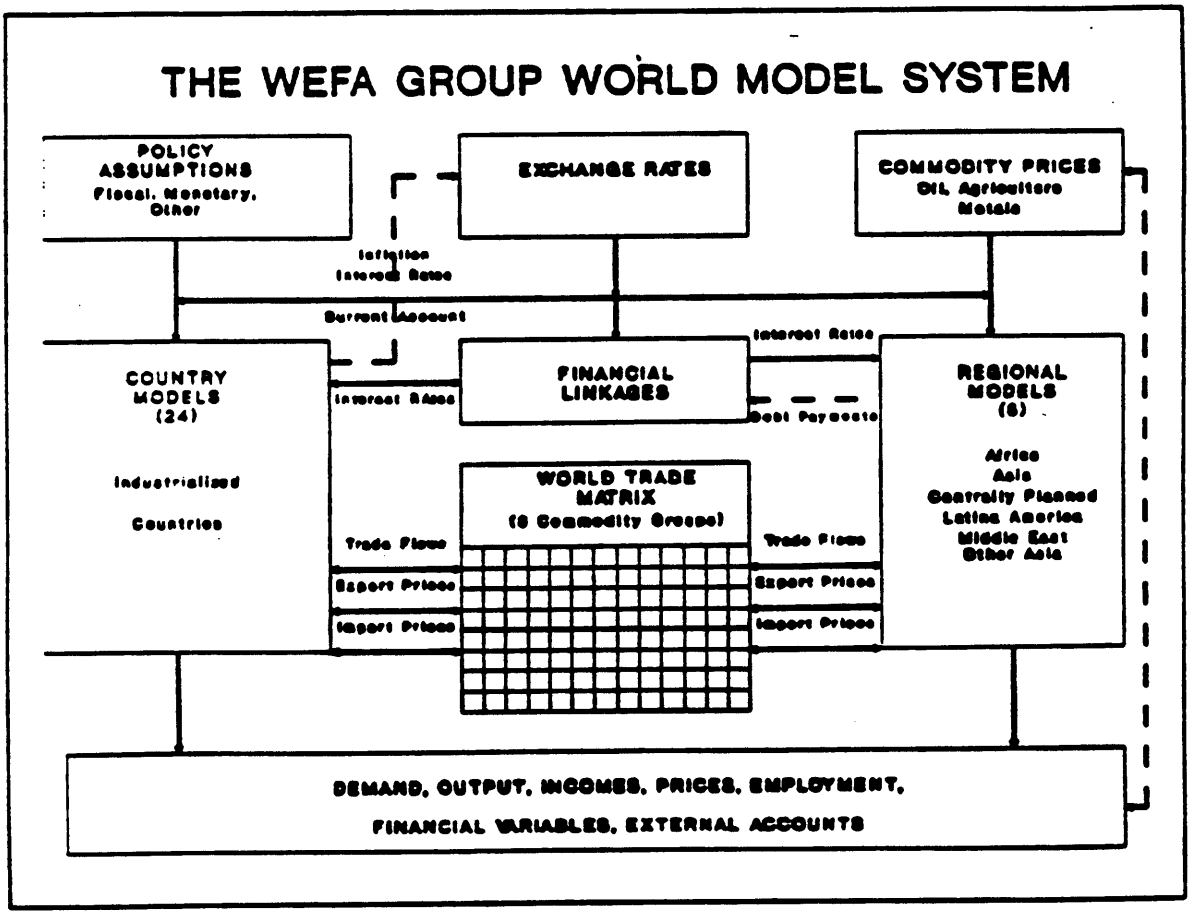
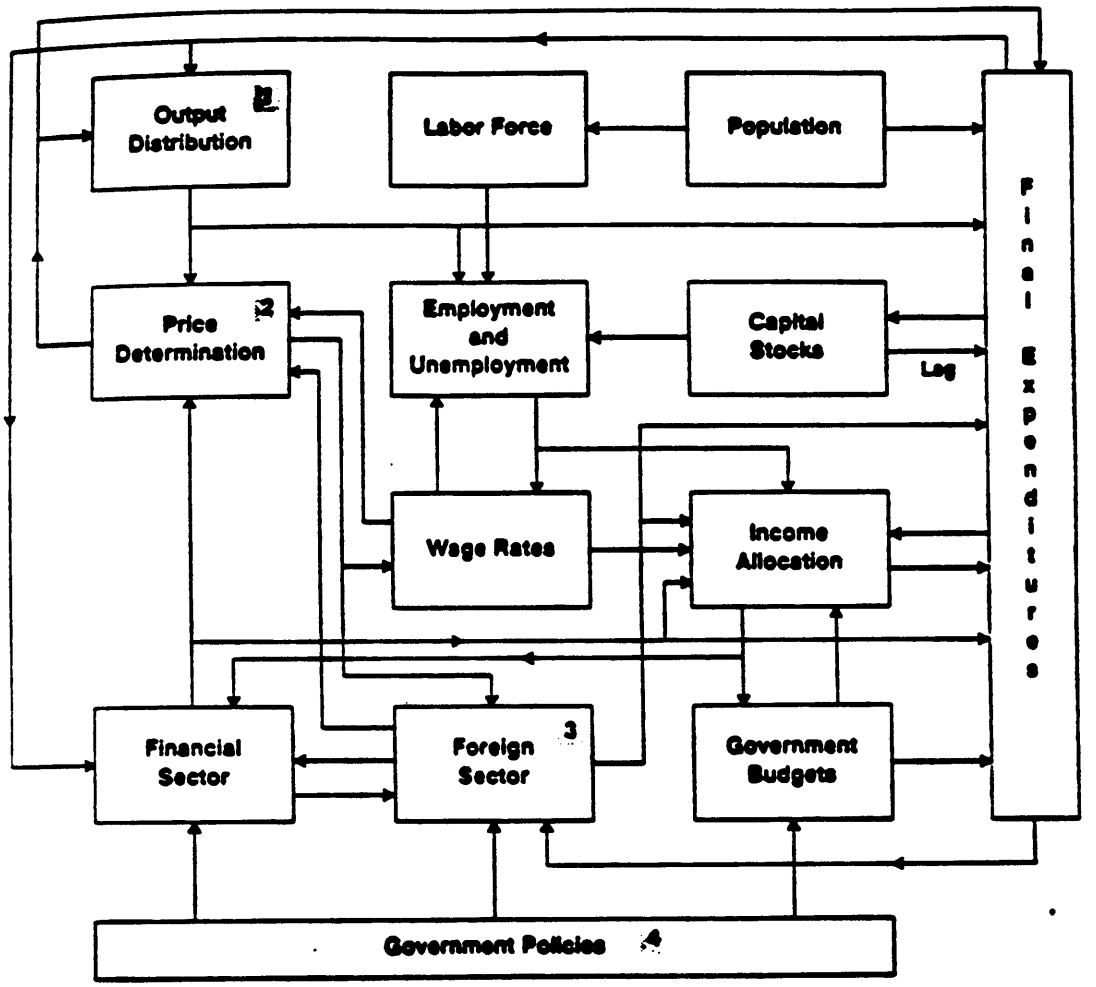


Figure 4.3

Simplified Schematic Relationships — Sample Macroeconometric Model



1. In development stages – current version has industrial production only
2. Includes commodity price assumptions – fuels and nonfuels
3. Links to trade and payments linkage bias of World Econometric Model
4. Includes exchange rates as well as government policies with regard to tax rates, money supply targets, discount interest rates, and government deficits/surpluses

Bilateral Trade

These very aggregate (3 sector) forecasts of bilateral trade among 30 countries/regions are divided into 60 countries/regions, 150 commodities for the 20-year short run by a top-down/bottom-up procedure as follows:

- The aggregate World Model System trade forecasts are combined with commodity-level detailed trend and share analyses, which are conducted for every commodity on every trade to produce an initial projection (top-down);
- These are then combined with micro-level reviews and revisions provided by WEFA's country, industry, and commodity experts.

Thus, as distinct other approaches to cargo forecasting, WEFA's approach is top-down bottom-up. The top-down portion from the world modelling system provides internal consistency. At the same time, we develop a bottom-up view based on the scrutiny of WEFA experts in our energy, industry, and agriculture departments.

This "top-down/bottom-up" approach to forecasting provides a deeper understanding of bilateral trades and translates the complex interdependencies of world economic activity into projections of specific county-to-country trades. Reasonable forecasts of specific trades are presented within the context of total world trade in which the sum of all exports add up to the sum of all imports.

4.2.2 Long-Term Commodity Flow Projections

World Economies

As suggested in the introduction to this section, to examine the period from 2010 to 2060. we constructed a new model: a simplified version of the WEFA World Model System and of the WEFA trade forecasting system. In this model, behavioral variables. which are based on stochastic equations values for the period 1990-2010, are projected judgementally.

We begin the forecasts with U.N. population forecasts, which are carried out though 2025. As noted above, under suitable assumptions, the growth in population is just the growth in employment.

The second step is to extend the short-term assumptions concerning labor productivity which

are implicit in our short-term forecasts. As already discussed, this process involves assumptions as to the rate of technological progress in the industrial world and the rate of diffusion of technological information from the industrial countries both to the emerging market economies and to the industrializing economies of the "third world".

We then extend the U.N. fertility and longevity assumptions consistent with the per capita GDP results. Finally, the total real GDP forecasts are just the product of the population and GDP per capita projections.

Bilateral Trade

For the 2020 and 2060 bilateral trade forecasts we also simplified the short-term trade part of the world model in much the same way as we did the economic section. The first step is to extend the ratio of imports to GDP for each country/region and commodity type. As noted in the introduction, for the very long term, there is less margin for error if these extensions are carried out judgementally rather than depending on an econometric equation estimated on at most 20 years of recent history. As with the short term model, these imports are distributed over all the other countries as their exports to form a [30 x 30] trade matrix. The total of these exports are also compared to GDP and adjusted judgementally if warranted. Each matrix is then adjusted so that imports and exports are consistent.

The resulting aggregate trade matrices were then subjected to the same process as with the short term forecast, distributing them to the detailed commodity/country bilateral trade numbers by making use of the trends in the shares the detailed sectors were of the aggregate sectors. They provide a first cut and are subject to the kinds of uncertainty which we described in the introduction. However, the major commodities are then, as before. analyzed from a bottom-up perspective, as discussed in the next section.

4.2.3 The Major Bulk Commodities

Specific commodity trades were examined making use of specialized WEFA/RLA models. Input into the **grain and fertilizer trade** projections were provided by the WEFA International Agricultural Service. This service provides projections of grain and fertilizer supply and demand for every country and region of the world.

The factors considered in the WEFA International Agriculture Service include:

- The production shifts that have occurred in recent years that have affected

world trade balances

- The commodity by commodity outlook for individual countries and regions of the world; and

- The future trade flows on a commodity and country basis

The commodities covered include: coarse grains, wheat, oilseeds, soybeans, and cotton. Seventeen individual countries (or country groups) are analyzed including all the major producing and consuming groups.

WEFA world fertilizer projections examine the industry at the regional aggregate level, providing world totals and breakdowns for eight producing, consuming, and trading regions. Forecast components include capacity, production, consumption, and total regional imports and exports of nitrogen, phosphate, and potash.

The forecasts of world coal trade drew heavily on WEFA's World Coal Trade Service. This is a coal supply/demand model optimized on a cost minimization basis under particular rules of market behavior, including the exercise of monopoly or monopsony power or the use of diversity constraints by consumers. Thermal coal demand is based country by country on industrial output, consumer expenditures and price; supply curves are corrected for exchange rates where appropriate; freight rates, port capacities, etc. are exogenous; cif and fob prices and quantities transported are produced.

Iron ore and metallurgical coal projections were based on the WEFA World Steel Service. This service provides supply and demand projections for steel for each major country and region. Likewise, the Auto and Chemicals services, and the other Industrial Services at WEFA were used for the appropriate projections.

The broad steps employed to develop the outlook for oil and liquefied natural/petroleum gas trades are shown in Figure 4.4 and are as follows:

- Against the established economic background, end-use energy demand projections were constructed for the main industrialized countries based on the WEFA world outlook by region, and the same overall energy demand/supply projections on which the coal trade forecasts are based. This resulted in forecasts of consumption by country/region for oil, natural gas and liquefied petroleum gas.

- With respect to oil supplies, for non OPEC producers, with the exception of North America, projections were based upon an examination of existing development plans together with known and potential reserves. For the U.S. and Canada, projections took into account potential government action to limit the extent of the envisaged fall off in production. OPEC production was, broadly speaking, treated as residual supply in the international system. The level of demand for OPEC oil during each time cycle was, along with a judgmental assessment of likely OPEC policy, the basis on which estimates of oil prices were made. This is an intrinsic part of establishing potential future world economic growth and trade (as illustrated in Figure 4.1) and the resulting general oil price levels then provide the basis on which the energy investment climate for the following cycle was based.

- While ensuring the level of detail was appropriate to the task in hand, projections of liquefied gas trades were determined by infrastructure developments in main consuming areas, known or planned projects and known or potential reserves, recognizing the bulk of deep sea LPG trades are sourced from major oil or gas producing areas.

Completion of this outlook provided a projection of world oil and liquified gas demand and supply for approximately nineteen regions with the US East, Gulf and West coasts delineated separately, although in reality significant gas trades will be confined to fewer areas.

Based on the above world oil price scenario and forecasts of world oil demand and supply, together with estimates of actual world oil trade by source/ destination, forecasts of world oil trade were developed which were also be used as the basis for estimating future world oil tanker demand by size range. Trade forecasts also took into account the potential utilization and development of the Suez and Panama Canals, Middle East pipelines and projected volumes of trans-shipment and lightering operations which impact on vessel demand and size utilization. As additional input to the estimation of future potential tanker demand by size, forecasts were broken down into crude oil and petroleum products trades, utilizing estimates of future refining developments to determine potential petroleum products trading patterns.

Figure 4.4 illustrates the construction of regional crude oil and petroleum products demand and supply balances which provided the basis for estimating future seaborne oil movements. Trade matrices were developed for a minimum of 15 sources/15 destinations with the US

importing regions sub-divided into US East, Gulf and West Coasts.

4.3 World Vessel Fleet

For each alternative Panama Canal case defined for these purposes by the design ship size that can transit the Canal fully laden viz:

65,000 DWT (Status Quo)
100,000 DWT (Case 2)
150,000 DWT (Case 3)
250,000 DWT (Case 4)
300,000 DWT (Case 5)

there is an alternative forecast for the world fleet. In this case, the world fleet was defined as the global supply of tonnage by ship type and size range. While vessels in excess of 65,000 DWT do not transit the Canal currently we have not assumed under Cases 2 to 5 that vessels will exceed the indicated design ship size, in accordance with the terms of reference. Consideration of the potential for ships larger than the indicated design ship sizes to transit the Canal might usefully be included as a future refinement as part of the Phase II studies.

These alternative world fleets derive from the premise that transits through the 'status quo' Canal are impacted by developments in the global fleet and that changes in the maximum design size of vessels that can transit the Panama Canal will impact upon the contracting decisions of the shipping industry. In other words, trade and traffic flows through the Panama Canal are both impacted by and impact upon decision making within the global transportation markets.

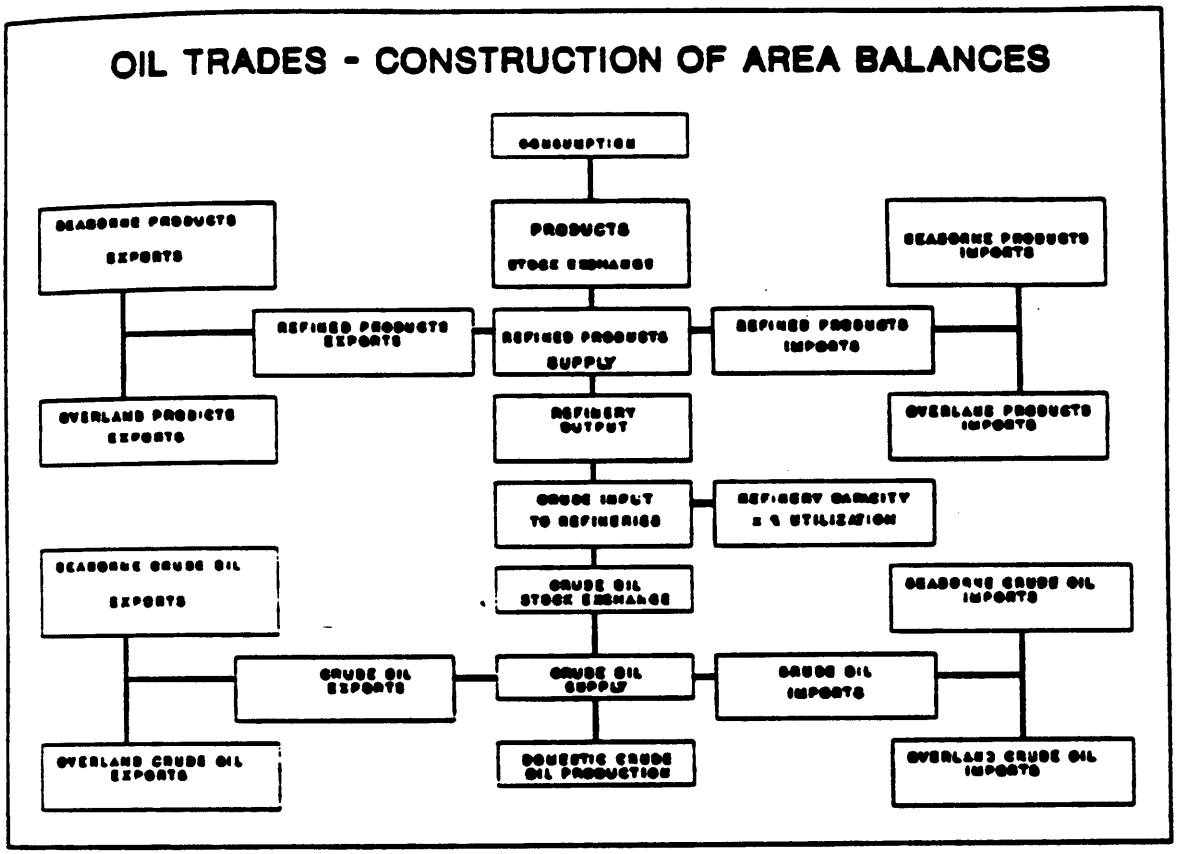
In addition to these considerations, there are modal changes over time that reflect shifts in the carriage of cargo between one ship type and size range and alternative ship types and size ranges.

The method that we adopted to forecast global vessel supply and mix is a top-down-bottom up approach similar to the method used to generate bilateral trade forecasts.

Utilizing this approach ensures that the changing impact of the Panama Canal is linked to other important global economic and trade developments. The impact of changes under each design case was tested on each ship type delineated in this study. Nevertheless, there were a range of economic and practical limits that were applied to this testing. For example,

we considered it highly unlikely that changes in the maximum design size of vessel that can transit the Canal will have an impact on container size mixes in the world fleet beyond the 150,000 DWT case. For dry bulk carriers, however, we considered it necessary to test the impact of all maximum design ship cases on likely developments of the world fleet and subsequent transits. Throughout this forecasting and testing process, we undertook to combine rigorous analytical approaches with practical evaluations.

Figure 4.4



Source: RLA

A further important element of this approach was to establish the limits to technological change by ship type over the period. We therefore undertook a literature search, combined

this with limited discussion with individuals and academics engaged on this work and derived conclusions that were utilized in the forecasting approach described above and reported in Section 8. A description of the literature search is included in Section 8.2.2, while a list of references to papers and individuals consulted is included at the end of Section 8.

It was essential to develop imaginative scenarios that over the long run encompassed a range of technological factors. Provisionally, a base case scenario might establish, from historical data, the shape of the curve representing the rate of change in size for all ship types. Intuitively, the shape of such a curve is likely to be exponential, implying some "levelling off" in ship size developments that is explained by a combination of technical and economic considerations. The advantages of such an approach lie in an internally consistent statistical methodology the results of which can be reviewed, on a first principles basis, from a technological perspective.

RLA has developed a reliable methodology for relating 'calculated' demand to 'observed' demand using its databases of demand by vessel size using a 'top-down' approach by size range. Vessel demand is quantified by deducting the vessel surplus from supply. Surpluses are developed on the basis of identified idle capacity and formulae which calculate the surplus equivalent of slow steaming and part cargoes. Utilizing this approach wherever possible ensures that all trade flows are effectively captured in demand assessments and therefore allows for a consistent quantification of supply and demand balances. Further, deriving demand on this basis is highly cost effective as it precludes the need for calculation and forecast from very detailed trade patterns. Figure 4.5 illustrates graphically our approach.

The approach to forecasting future demand and supply of ships employs a reactive technique whereby relative surpluses in one time period are deemed to influence, through the medium of rate formation, the ensuing investment cycle. and therefore pattern of relative supply/demand. Figure 4.6 illustrates this interactive approach.

Within this structure, fleet supply and the future fleet mix were forecast on the basis of the current structure of the fleet, forecasts of incremental demand, forecasts of replacement requirements of older obsolete tonnage, and conditions in the shipping market together with technological changes and port developments. The conditions in the shipping market - i.e. the current and anticipated future balances between vessel demand and supply and the extent to which market freight rates either encourage owners to scrap tonnage or justify the construction of new tonnage - are important determinants of the pace of evolution of the size and composition of the future world fleet. Technological developments including. for

example, improvements in fuel efficiency, propulsion and automation all serve to encourage the replacement of older ships with more competitive vessels. These are discussed in more detail in Section 8.2. Finally, as trade flows increase and new trades emerge and mature, ports and associated infrastructures are developed and upgraded to accommodate increasingly larger ships in order to maximize economies of scale in transportation. This has generally resulted in the upward drift of average ship sizes in the global fleet and, in the general cargo sector, the switching of trade between one ship type and another. In some cases major infrastructure developments - such as that contemplated in this study - can have substantial impact on the global fleet structure. For example, the dredging and widening of the Suez Canal to accommodate 150,000 DWT ships was a significant factor in the development of 'Suezmax' tankers in the global fleet in the range of 120,000-150,000 DWT.

The forecasts encompass the changing structure of shipping fleets in terms of draft, beam immersion factor and age as older ships are phased out and new designs are introduced, which additionally impact upon speed and consumption curves. Figure 4.7 illustrates RLA's model structure for supply forecasting i.e., a combination of scrapping, new orders for construction and assessments of the proportions of multi-purpose vessels in alternative employment all of which are related to demand in previous time periods. RLA developed a methodology for forecasting scrapping based on the establishment of a series of relationships by size range which describe the probability of a vessel of any given age remaining in operation. This work has been undertaken under both buoyant and depressed market conditions and therefore the combined results are well suited to the development of long term assessments. In this way it was possible to develop statistical relationships between the age at which ships have been scrapped against the remaining fleet as a percentage of the original delivered fleet for any one year. Developments of future scrapping also took into account the potential impact of stricter anti-pollution and safety measures.

Forecasts of new deliveries were based on the current order book plus estimates of future new orders modelled on analyses of historical ordering activity in relation to fleet size and market conditions and related in an iterative process to annual projections of supply and demand.

In developing forecasts of future new buildings we also took into account:

- the costs of maintaining existing vessels in service as against new buildings;
- worldwide shipbuilding capacity, demand and profitability;
- the availability of financing to support ship construction;

As the next step, we reviewed changes taking place or likely to take place that may affect drafts, beams length and speed/fuel consumption characteristics. Emphasis was placed on changes in physical dimensions and propulsion characteristics of ship types critical to the design sizes of the Canal and the evaluation of shipping economics on Canal and by-pass trade routes. In order to do this, existing information was supplemented through consultation with the classification societies and contacts in the ship construction sector.

Using the results from the assessments of shipping demand and shipping supply in time cycles provided a means of capturing the interactive structure of shipping markets. This was extremely important because "balanced" market conditions in which rate levels equate to fully built up costs are transitory.

4.4 Vessel Transits

In addition to economic and trade developments, there are a number of other issues which determine the volume of Panama Canal transits under each of the cases under consideration[1]:

- Other water routes
- intermodal traffic (mainly U.S./Canadian traffic)

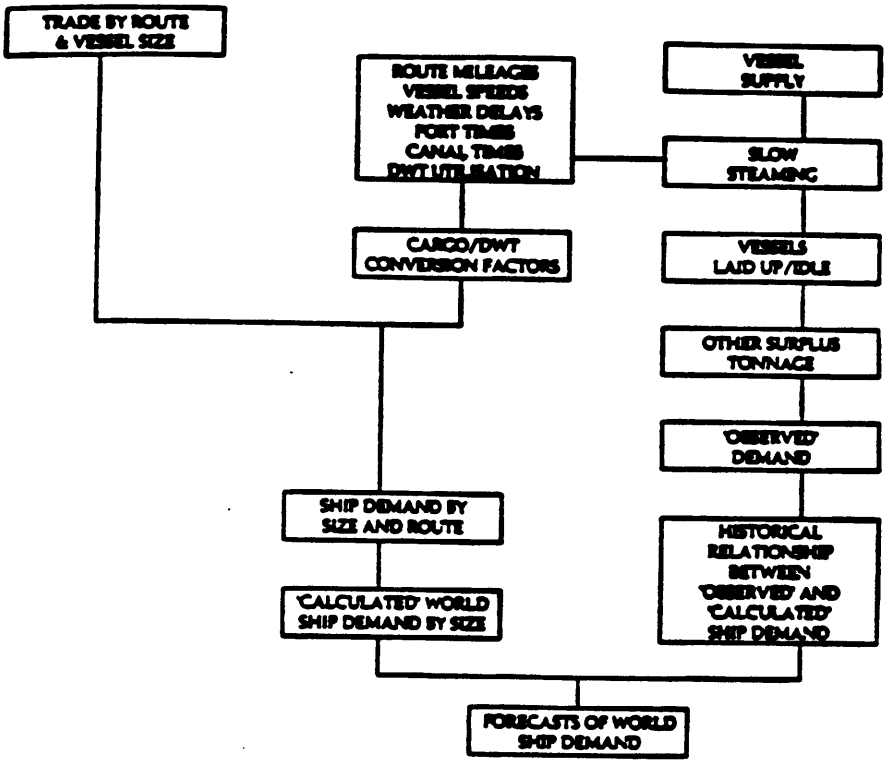
Below we include discussion of issues which relate to competing seaborne routes. Discussion of intermodal traffic is provided in Section 4.5 below.

The global forecasts produced above were a direct input to the determination of future bulk ship demand (crude oil and petroleum products tankers, dry bulk carriers, combined carriers, chemical carriers and LPG/Chemical gas carriers) which is an essential input to vessel operators future shipping costs through the Canal and on competing routes for these ship types. Global forecasts were also a supporting element to changing freight costs for general cargo shipping (conventional general cargo ships, refrigerated cargo ships, full container ships, roll on roll off ships, vehicle carriers and container/break bulk vessels). LNG transportation developments were an integral part of specific export projects and long term supply contracts.

There were two inter-related elements in our approach to forecasting numbers of cargo carrying vessel transits through the Canal by ship type and representative sizes:

[1] Consideration of the future volumes and direction of flow in the trans-Panama pipeline are excluded from this study.

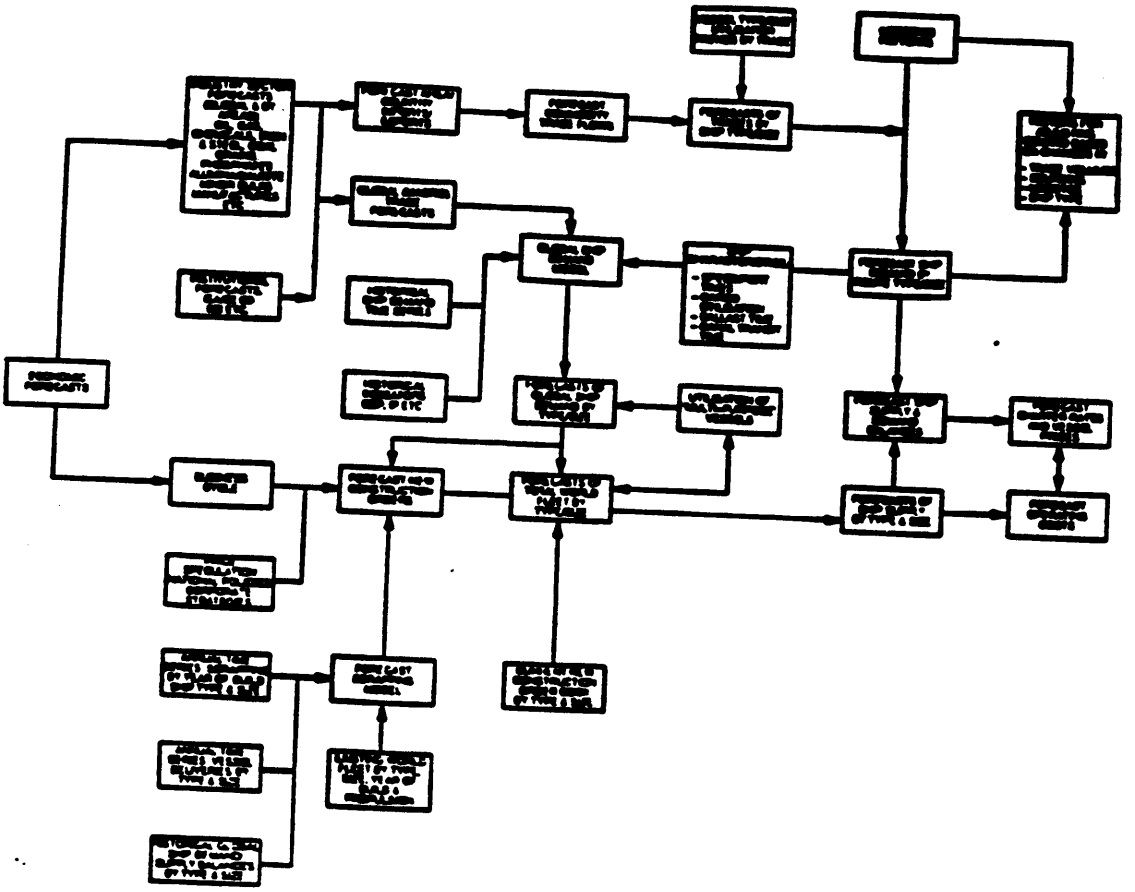
Figure 4.5



SHIP DEMAND MODEL

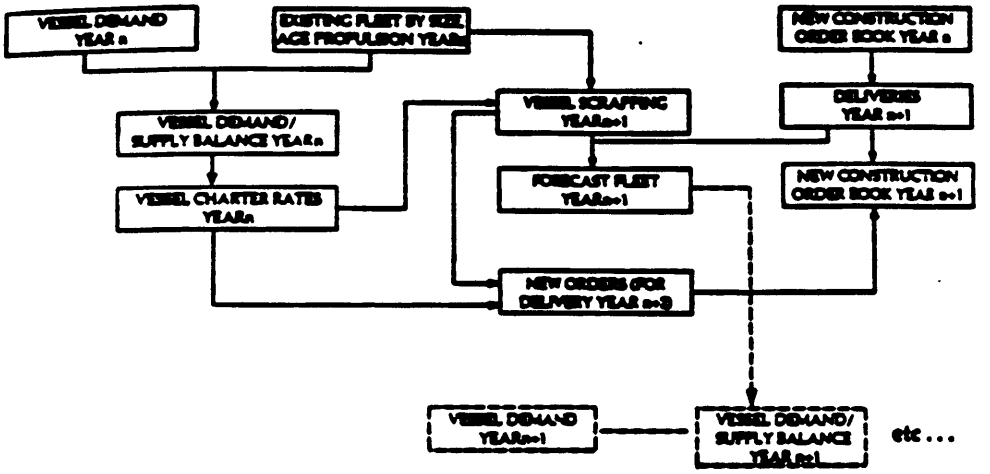
Source: RLA

Figure 4.6



Source: RLA

Figure 4.7



VESSEL SUPPLY MODEL

Source: RLA

1. Utilization of annual cargo flow: vessel unit (deadweight tonnes, TEU/FEU, cu. ft and so on) conversion factors by representative vessel sizes that take into account all relevant stowage and port time criteria. The development of vessel routing patterns included consideration of logistics systems. For example, the use of feedering services and transhipment have a bearing on the size of vessel employed and freight economics. The representative vessel sizes were taken from the "Future Transportation Systems" supporting study or were augmented within this study. Transits of the Canal by vessel size were evaluated by route in order to realistically determine future total transits taking into account developments in the global fleet, the existing pattern of representative sizes, laden and ballast transits and, where appropriate, potential port and cargo handling developments.

2. Considered simultaneously, if appropriate. were the relative transportation economics of transiting the Canal, compared to utilizing other seaborne routings and utilizing other systems such as the landbridge, the trans-Panama pipeline, or other relevant routes for the commodity and trade route under consideration.

In reviewing future seaborne costs there were two significant elements to consider:

> In the shipping sector, long run costs do not equal long run revenue when long run costs are defined as the freight rate equivalent of the fully built up costs for a vessel delivered in the year in question: this approach is therefore not utilized in our forecasts of future transportation costs. Owners' decisions whether to route ships via the Canal when there are potentially other options are based on market freight rate levels. This is because utilization of the Canal impacts on owners vessel requirements which are covered, at the margin, in the market. It is marginal economics, therefore, which determines operators' routing structure.

The differences in structure between the bulk shipping markets and general cargo carrying shipping are such that differing methodologies are employed to determine relative shipping costs and marginal economics over time. Both approaches, however, have as their central tenets the two elements described above.

For the bulk shipping markets, the state of the art approach is to develop forecasts of vessel supply and demand, linked to forecasts of owner's operating cost structures in order to

determine relative freight costs. This approach was used to provide robust statistical forecasts for the years 2000 and 2010 which were then utilized as a basis for long term forecasting to 2060.

For the liner-type markets, it is also in theory possible to construct a series of global balances which determine future $/TEU, $/tonne and so on. In practice however, this is not a valid exercise for anything other than the short term (around 5 years) forecasting as:

- from our experience, it is virtually impossible to accurately define all containerized and other general cargo trades on all routes worldwide on a consistent basis. With the exception of data published by the U.S. Department of Commerce which for U.S. seaborne trade, specifies the cargo on individual ships, we are not aware of any other data source which provides this exact match, although access to detailed PCC data would have gone some way to addressing this issue for Canal trades. Within the general cargo trades, it is possible to say what commodities are 'containerizable'. However, these cargoes may be carried by a variety of ship types within the general description of general cargo vessels. Whether a commodity on a specific route is actually carried in containers is dependent on the nature of the trade on that route and shipping services available. Therefore in the absence of hard data, estimates have to be developed by attempting to match trade flows with vessel movements data which on a global basis can never be totally precise. In addition, it is not possible to track every piece of global trade data - in particular, coastal or intra-regional commodity movements;

- global ship surpluses cannot be readily calculated on a "top down" basis (that is the effect of slow steaming and lay up of vessels) because liner operators, ever since the virtual demise of the traditional conference system, tend to ride out short term downward trends in trade cycles and upward trends in over supply because of market share considerations;

- while there is a readily identifiable time-charter market for smaller container carriers and some specialty ships, the charter market for larger vessels is small and not necessarily representative of relative ship surpluses.

The approach we adopted to forecast representative unit costs for general cargo ships of all types was based on a combination of rigorous analysis and empiricism and reflected the requirements, within this study, to determine the potential shifting of cargoes between the

landbridge and the Canal and between substitutable ship types.

Our approach to developing future comparative freight costs in both the bulk and general cargo sectors are outlined below. This approach was utilized in those instances where it was necessary to determine comparative transportation economics in order to finalize forecasts of Panama Canal transits.

4.4.1 Bulk Shipping Markets

This segment includes crude oil and petroleum products tankers, dry bulk carriers/combined carriers, LPG/chemical gas carriers, chemical carriers.

In order to determine future costs on a unit basis, we adopted, in the first instance, the traditional approach of calculating global vessel demand for the base year of 1990 using a matrix of commodity trade flows between major areas. This involved the conversion of annual flows to vessel demand, expressed in deadweight, by applying a series of factors which represent the deadweight tonnes required to transport 1 tonne of cargo on a given route.

These calculations were then aggregated by size range. However, experience, in particular for the tanker and dry bulk markets, has shown that demand derived in this way differs from 'observed' demand.

Within the limitations imposed by the practical and efficient use of resources, it is not possible to capture adequately every single trade. Even the use of ship movements data globally is resource intensive and still potentially misleading for those routes where trade may exist in both directions and where, for example, delineations between cargoes and ship types are not clear.

Although a significant proportion of the world fleet operates on the basis of round voyage trading, owners seek to optimize their operations by 'triangular trading' thereby reducing the length of time in which vessels are in ballast. This is particularly the case for combined carriers where owners have additional opportunities to optimize operations between the oil and dry bulk trades.

The forecasts of vessel demand and supply are the major input to the projection of shipping costs to shippers, in other words, freight rates. The other determinants of rates are owners' operating cost structures.

Capital costs are a function of shipbuilders costs and pressure on capacity created by demand from the shipping market. In periods of depressed shipping markets, capital prices may fall below shipbuilders costs and be subject to government subsidy. Conversely, in periods of buoyant shipping markets, prices may rise above shipbuilding costs. The approach to forecasting recognizes these issues and applies factors from the forecast supply and demand models to indicative new building price time series over the forecast period.

Because of pressures created by vessel surpluses, vessel operators have in recent years sought to reduce fixed direct costs such as manning (wages, allowances and subsistence), repairs and maintenance (stores, supplies, dry dockings and in-service maintenance), insurance and miscellaneous expenses. Depending upon vessel size we calculate that manning and repairs and maintenance constitute 80 -90% of the total direct costs although insurance, in particular in the tanker sector, is becoming more expensive.

For manning cost reductions, this has been accomplished through combinations of:

- setting up of 'offshore' registries
- reduction of crew numbers
- switching to other lower cost operations whether by registry changes or where possible changing the nationality of on board personnel.

As a result there have been significant structural changes reacting with changes in wage and salary levels, as well as currency effects.

The result has been that, in some instances. manning costs have declined in real US$ terms over the period to 1985 to 1988 but, for some ship types, have increased thereafter in response to a number of factors including environmental and regulatory issues and perceptions of current and future shipping market conditions. A judgmental methodology. influenced by shipping market developments, environmental constraints and quality audits, the existing structures of vessel ownership and control and manning profiles together with general economic developments. was adopted in order to determine manning cost developments over the short and medium term. A more extrapolatory approach was used thereafter.

The other major element of fixed direct costs, repairs and maintenance, was also generally cut back in response to market pressures over the second half of the 1980s. However, in a period of sustained improved freight rates, there is pressure to improve performance through the technological life of a vessel which can result in significant upward movements

in repair costs. Currently also ship repair prices are rising sharply as improving ship market conditions on some sectors encourage owners to prolong vessel lives and demand rises for repair facilities. Forecasting costs is therefore an iterative process, combining repair costs worldwide with shipping industry developments as previously described. While repairs and maintenance are carried out both while the vessel is in service and during regular drydocks, it is a common practice to represent the repair and maintenance costs on a three to five year cycle basis. This represents the way in which many shipping companies account for repairs and maintenance, and it also avoids the presentation of large year on year fluctuations which can 'skew' resulting fixed operating costs and fully built up costs. The remaining elements of fixed direct costs, predominantly insurance but also elements such as communications charges, can also vary considerably depending upon individual operators' policies. However, within the context of this study, we propose to adopt an extrapolation approach based upon the data for a wide range of ship sizes, types and flags already on the computerized database.

Voyage costs, predominantly bunkers plus port and ancillary charges, are a function of the way in which an operator trades vessels and the vessel type, size and propulsion efficiency.

Over the longer term propulsion efficiency in particular is likely to change and will be an important factor in the comparison with freight costs.

Over the time periods relevant in this study, bunker prices were derived from forecasts of crude oil prices and consideration of the impact of refining developments and crude oil consumption trends. The relationships between bunker prices and crude oil prices are derived from a model using time series regressions.

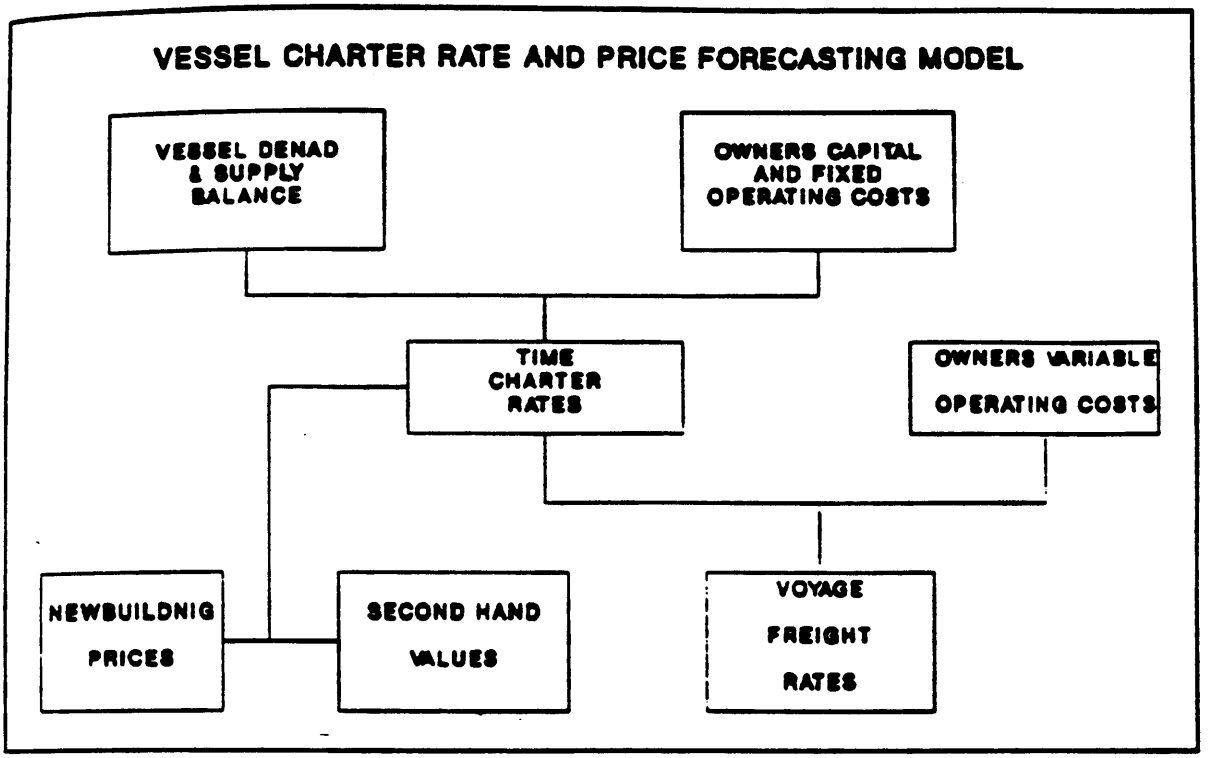
Data on individual port charges are maintained by RLA and also readily available from port agents. Generally such charges form a relatively small proportion of total costs, and we forecast them on an extrapolatory basis in line with inflation.

In comparing freight costs for the Canal and alternative routes, we also took into account differential inventory costs where they were significant based on the differing lengths of time for which cargoes are at sea or being transported by competing modes. Where necessary, the calculations also took account of transhipment or lightering fees in importing areas although in most cases these were common to both Canal and alternative options.

The models developed by RLA to forecast hire equivalents and freight rates are briefly outlined below and illustrated in Figure 4.8.

Freight rates are essentially a function of owners' operating costs plus supply/demand balances. The length of the charter, varying from spot rates through to long term and life of vessel charters, determines the cost criteria on which rate levels are based.

Figure 4.8



Source: RLA

In sustained periods of severely depressed market conditions, owners are able to save on their fixed direct costs such as manning, insurance, repairs and maintenance by laying tonnage up. Therefore, the floor to rates over a sustained period is defined by owners lay up breakeven costs. The owners lay up breakeven costs vary with the type of operation and therefore the "true" floor is represented by the lowest cost operator. Similarly, the theoretical floor to a spot rate is the variable direct costs such as bunkers and port charges on a given route. In practice however, no owner would operate vessels on the spot market

on this basis for a sustained period and the floor, in practice, is again the lay up breakeven cost. At the other end of the spectrum, an owner will not charter out a vessel long term unless full operating, capital and interest charges plus a profit element are recovered. The theoretical cost floor therefore shifts upwards when considering the long run.

There is interchangeability between size ranges of ships at the margin, effected by port cargo trading and vessels 'trading up' in response to local market circumstances. In addition, in some markets the barriers to entry between individual size ranges have been reduced as more flexible tonnage has been delivered. As a result, over the forecast time periods in this study, it was necessary to forecast hire equivalent rates for benchmark vessel sizes with respect to relative surpluses while recognizing that the overall surplus normally remains a function of varying scrapping and contracting profiles within size ranges.

In this study, we forecast a series of hire equivalent rates for each vessel type and size range, using models which are tested, for those vessel types where there are significant alternative routings (seaborne and overland/pipeline) to the Panama Canal, which were then utilized together with other voyage cost data in simulations developing trade flows and transits on a minimized cif basis.

4.4.2 General Cargo Carrying Ships

This category includes: Conventional general cargo ships, refrigerated cargo ships, full containerships, roll on roll off ships, vehicle carriers and container/break bulk vessels. For reasons of practicality, in this category we did not consider it appropriate to develop global supply/demand balances and freight rate structures as described above. Further such an approach is, in our experience in the general cargo carrying sector, highly susceptible to non-correcting internal errors because of the problems encountered in correctly 'stowing' and matching all trades on all routes globally to the correct ship types.

The approach that we took for the purposes of comparing both the development of freight costs between competing ship types, and the impact that this may have on substitutability between ship types over time and the development of costs vis-a-vis the landbridge is based on fixed direct (operating) costs, variable costs and capital costs.

The cost structure for each ship type was calculated for the 1990 base year from a sample of vessel sailings through the Canal, sailings of vessels utilized within intermodal systems and supporting data of fleet age profiles.

The calculation of these costs encompassed considerations of:

- the weighted ages of each relevant ship type by size and estimate of original delivered capital costs for these ships;

- a proper matching of weighted ages of each ship type with associated fixed direct (operating) costs and variable costs.

We verified the resulting data, converted into a hire equivalent format, through empirical market research with a sample of operators using the Canal.

Forecasts of these costs, by representative ship sizes, by size range, were undertaken as previously discussed. Global economic considerations not only impact upon unit costs for current ship types and sizes but will also directly impact upon the development of ship types and sizes.

4.4.3 Comparative Voyage Costs

In order to compare Panama Canal routings with alternative routings, voyage freight costs were also calculated for individual ship types and sizes as necessary. The formula used was:

$$S = [D*(T+B)+P]/T$$

where,

S = $/cargo unit

D = Voyage days, either round trip or based on other appropriate patterns such as triangulations or round the world

T = Daily charter hire

B = Daily Bunker Costs (on the basis of a weighing of at sea and in port costs.)

P = Port charges, on a round trip or based on other appropriate patterns such as triangulations or round the world

T = Cargo Unit

Bunker consumption was determined either at normal speed (design speed less an allowance for weather and hull fouling) or reduced speed, depending upon relevant market circumstances. Bunker consumption under reduced speeds is defined by an approximately cubic relationship.

Freight costs for the Canal and alternative routes based on marginal economics also took into account differential inventory costs based on the differing lengths of time for which cargoes are at sea, in transport using other modes and in addition, for oil cargoes, pipeline tariffs and cargo loss factors for competing routes. Other transhipment, lightening or feedering costs were considered as necessary.

4.5 U.S. Intermodal Trade

Intermodal opportunities include primarily shifts from all-water service to combination water/land service for specific products such as containerized high-valued commodities, grain, automobiles and like products.

As discussed above, this shift has occurred for five inter-related reasons:

- the limitations of the present Canal (i.e., size restrictions, increasing number of transits and the like) which do not allow passage of beyond Panamax vessels. These larger vessels could enable shippers/carriers to take advantage of increased economies of scale;
- increasing value of products and subsequent increase in inventory carrying costs which benefit faster methods of transport;
- improved inland transportation systems such as tri-level auto cars and double stack rail cars which minimize damage as well as improving overall transport time;
- improved port facilities which are integrated with inland transportation systems;
- increased volume of trade with Pacific Rim countries;

Future shifts depend upon the potential availability of intermodal systems and their relative

costs versus potential improvements to the Panama Canal system. We modelled intermodal traffic by evaluating the relative costs of intermodal traffic, the transit times and the potential congestion on major rail lanes.

The relevant comparison of costs includes all costs to the port of loading or from port of unloading and depends on:

- location of consumption/production by commodity;
- cost to transport product from location of consumption/production to coastal port including barging, truck and rail service;
- competitive port charges at various coasts (i.e., Gulf Coast ports generally have much lower wharfage and handling costs than East or West Coast ports);
- intermodal cost differentials;
- transit times;
- opportunity costs as a function of transit time and product value per ton;
- Alternative vessel costs for Panamax and larger vessels.

RLA/BST maintain in-house databases on international and U.S. transportation costs and port charges. Rail costs were modeled as a function of key fixed and variable elements, including:

- Fixed costs (recovery factors for trackage and equipment, insurance and like factors);
- Variable cost (labor, fuel and like factors);

BST has drawn heavily on recent studies done by the U.S. Federal Railroad Administration, Transport Canada and other sources in addition to in-house reports and models to determine future rates.

Rates do not generally reflect costs at any given point in time. However, in the long run, recovery of at least variable costs does set a bottom limit for rates. Calculated future costs were carefully reviewed for consistency and reasonableness.

5.0 DATABASE CONSTRUCTION

5.1 Construction of a Synthetic Panama Canal Transit Database

No data were available, from any studies previously carried out or from the PCC published data, which provided any basic transit information on deadweight tonnages of vessels either by ship type, by size range or even on some aggregate basis. Similarly, no data were available to the WEFA team which provided distinctions between laden and ballast transits by ship type in tonnage terms. No proper reconciliation of current and potential cargo flows (and particularly those cargo flows which currently do not use the Panama Canal) with demand for vessel transits for a range of Canal cases could be made unless basic data on laden deadweight tons have been compiled.

As a result, we had to carry out extensive data compilation and analyses to provide:

(i) a base for forecasting vessel transits by ship type, size range, laden and in ballast, by northbound and southbound in terms of both numbers of transits and in deadweight tons by the requirements of the capacity analysis studies, and by the requirements of other elements of this study;

(ii) analyses by ship type and size range, laden and ballast on a route basis. The size distribution of vessels and utilization of vessel types varied significantly by route, and this analysis was therefore a key element, together with trade flow forecasts on a route by route basis, in the determination of future size distributions and numbers of transits to be aggregated into the data described in (i) above. As unit costs of cargo shipped vary by vessel type, it was also a key element in the determination of relevant vessel economics used in a range of important calculations. These included but were not limited to:

- comparisons of cost forecasts for liner shipping companies providing all-water services through the Canal compared to those providing services via the U.S. landbridge;

- comparison of cost forecasts with seaborne by-pass trades both for the 'status quo' Canal case (from the perspective of potential further shifts of trade away from the Canal) as well as for alternative cases which were reviewed on a route by route basis;

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del Canal de Panamá

- forecasts of the costs of Canal closure and vessel transportation costs which were reviewed by major route.

In compiling the basic transit data, we had to ensure that our estimates of transits accorded with the highly aggregated information on total numbers of transits for northbound and southbound published by the PCC for FY1990. As may be seen from the specific points below, this was not a straightforward issue because of the lack of definition provided by the PCC for their ship types, but it was one of some importance to CAS.

Further, we have had to ensure that transit data and published PCC commodity trade data could be reconciled as a precursor to forecasting both Panama Canal trades and transits. In other words, the transit database could not be finalized unless and until there was a reasonable reconciliation of ship movements and commodity flows.

The lack of knowledge of the exact basis for the PCC data forced us at each stage of the analysis to spend considerable time adjusting our vessel and commodity definitions to reconcile them with what we deduced to be those of the PCC.

The steps in developing this data base were designed as follows:

- enter transit records from Lloyds and other sources showing the type, deadweight tonnage and route of each ship passing through the Panama Canal over a three month period;
- develop a distribution of ships by type, size and route from this database;
- annualize this distribution to Table 4 of the PCC annual report for FY1990.

In fact, in order to improve the annualization process and guard against potential problems arising from seasonal fluctuations, we compiled our three month sample after first reviewing data for a six month period.

At this stage of the work, we entered approximately three thousand complete records showing ship name, date of passage through the Panama Canal, direction of passage, ship type, deadweight tons, last port and next port. We further undertook to identify those vessels employed in 'round the world' trading and also dry bulk carriers carrying containers in liner trades which need to be reclassified as container/breakbulk ships in order to improve compatibility with trade data. We took special care in entering Port details, as ships often

make ports of call to leave off or load partial cargoes, and most of this cargo is from an earlier port or bound for a later port.

We assumed that the sample drawn was typical of the year as a whole. Therefore, we expanded the sample by ship type according to whether it was northbound or southbound according to Table 4 in the PCC FY1990 Annual Report. Because fewer ship types are shown in that table than we have used in this study, we also aggregated and then disaggregated the data.

The additional information from Table 4 of the PCC FY1990 Annual Report is the number of ballast and laden transits according to their more aggregate ship categories and by transit direction (northbound or southbound). There is no information in any of the data which we had available to us as to whether the individual ships were laden or in ballast. Because we knew that dividing the ships by laden and ballast simply according to the data in Table 4 would result in ship categories which are seldom in ballast being labelled as so, we developed rules for allocating ballast and laden transit.

Developing as correct as possible an allocation of ballast and laden by ship type by size range is not only necessary for the capacity evaluation work but also is essential because of the need to recognize the differential in dollar per Panama Canal Net Ton ($/PCNT) toll charge.

All Panama Canal toll charges are referenced to the PCNT of individual ships. However, PCNT information is not readily available for most ships from published sources, including Lloyds. It has been necessary therefore to carry out empirical research to determine data on PCNTs for sample ships and to relate these data to deadweight tons by ship type and size range to develop factors for use in the project.

The transit database also had to be consistent with the commodity flow data which was published in the PCC FY1990 Annual Report. We therefore undertook to develop commodity definitions, ship types and routes which would make a comparison of the two databases possible, recognizing also that in many instances routes are overlapping and ships could logically be allocated to more than one route.

There are no data in the PCC Annual Reports on the allocation of cargo to ship type. To accomplish this allocation, we initially utilized data from the report on an earlier project, namely Exhibit A-5 in the Temple, Barker and Sloane April 14, 1989 traffic demand report to the PCC. This Exhibit contains data for FY 1988.

Therefore, in parallel with constructing the PC Transit Database, we allocated the FY1990 PC commodity flow data from the FY1990 PCC Annual Report to data on tonnes by ship type by route, according to the ship type, commodity and route categories in Exhibit A-5 of the TBS report.

However, these 1988 data from the TBS report have limitations. The limitations arise from the fact that the TBS statistics are out of date; there are the problems, identified above, relating to the matching of ship types; and cargo allocation factors by vessel type are not specifically addressed for a large number of routes.

5.2 Construction of the Panama Canal Commodity Flow Database

As in the case of the vessel transit database, the lack of detailed data on Canal commodity flows severely hampered our work. However, contrary to the case of vessel transits, there are extensive data on commodity flows in the annual PCC reports. In addition, as part of the development of historical data on trade flows, Nippon Koei had put together for CAS nearly 20 years of data on commodity flows from the PCC reports. Nippon Koei kindly provided us this data, which is aggregated to the level of approximately 20 commodities, in machine readable form.

Because we were limited to the published PCC commodity flow data, the origin-destination pairs provided in that data of necessity became the maximum level of detail for our study. We did combine Hawaii with West Coast U.S., Balboa with West Coast Central America, and Cristobal and the West Indies with the East Coast of Central America. This set of regions is shown in Table B.8.

The level to which to aggregate the commodities was also a decision which had to be made. The level of aggregation in the PCC published data is limited, but was more detailed for some trades than we needed. However, the fact that the level of aggregation varied meant that we could only work at that level which was common to all routes. The level at which the FY 1990 data were entered is shown in Table B.5.

The level of detail in Table B.5 was useful for analysis purposes, but not for vessel transit forecasting purposes. To convert commodity flows to cargo flows by ship type, we were restricted to the level of detail of Exhibit A-5 in the Temple, Barker and Sloane April 14, 1989 traffic demand report. Therefore, once entered, the FY 1990 PCC published data were aggregated to the level of commodity detail shown in Table B.7.

In general, there are no clear time trends in the Canal commodity flow data nor is there any apparent relationship to trends in world trade. Therefore, we entered data for 1988, 1989 and 1990 only. Recall that we had the more aggregate data to examine for trends if need be.

In the PCC annual reports, there are no definitions of the commodity categories nor an indicated relationship to any standard categories. This was another reason that aggregation was both necessary and useful. An example of this is in the case of petroleum products. Some products go on tankers, some as general cargo, and some, like petroleum coke, are dry bulks. However, if only petroleum products are shown on a specific route, or even combined with crude oil, it is difficult to sort out what type of ship is involved. Grains and wood products produce the same kind of problem.

For Phase I of the CTP, these issues are probably not serious. However, they may very well be serious in the case of a refined study. Petroleum is a case in point. By 2020, Alaskan oil is expected to be exhausted with the result that crude oil transits through the canal are not expected to be of major importance. However, there will be local trades in crude and petroleum products. It makes a great deal of difference whether the cargoes are in tankers or general cargo ships.

The lack of congruence between the commodity data from the PCC report, the vessel transit data we collected from published and non-published sources as described in Section 5.1, and the data for loading of commodities on ships to form cargoes from Exhibit A-5 in the Temple, Barker and Sloane April 14, 1989 traffic demand report were a problem throughout the study. Dealing with this lack of congruence made up a great part of the work of the study. We believe that the aggregate commodity and route detail at which we finally worked countered any serious errors which might have resulted from this lack of congruence, and our experience and access to other data also assisted in correcting those problems which may have crept in.

6.0 WORLD COMMODITY FLOWS IN 2020 AND 2060

6.1 Economic Forecasts for 2020 and 2060

The economic analysis was carried out at several levels of detail. The major headings in Table B.4 (Appendix B) correspond to the country and regional detail for which most of the analysis was done. When applied to the Panama Canal, the regions in Table B.8 are the ones used. As discussed in the last section, we are limited to these regions by the origin/destination regions in the published PCC bilateral trade data.

For purposes of presentation in this section, we combine the East and West Coasts of the Western Hemispheric regions, and we combine Central and South America. On the other hand we have separated Asia into Far East Asia, which is the region of Asia of greatest importance to the Canal, and Other Asia. Far East Asia includes Japan, China, Korea, Taiwan, and Hong Kong. Trade with the countries in Other Asia, which includes the countries of the Indian subcontinent, of Southeast Asia, the Philippines, and Indonesia, does not in general use the Canal.

The following are the assumptions on which we have based our economic, commodity and transit forecasts. The results are first shown in charts and then discussed in the remainder of the section.

- Geopolitical Factors:

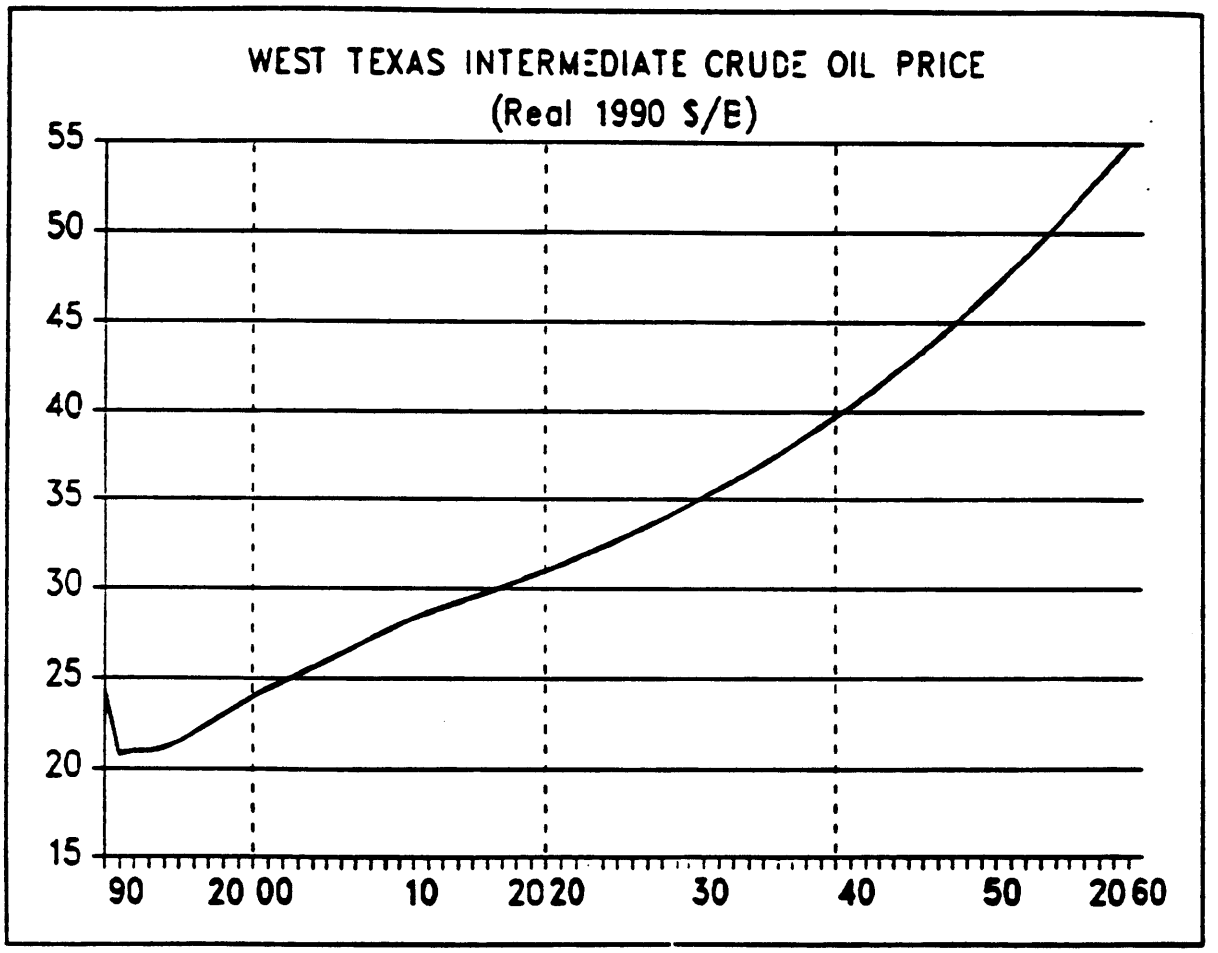
  We assume continued world stability, that is, no major wars or political instability in the major countries of the world. This latter assumption is problematic only for Russia. Here also we assume that the transition to a democratic political framework and a market economy, while arduous, is eventually successful.

- Environmental Policy

  WEFA assumes that the current environmental policy of each nation, such as the United States or Korea, or group of nations, such as the European Community or the Commonwealth of Independent States, is maintained and

make neither more stringent nor eased. This implies, for example, that a carbon tax to reduce greenhouse emissions is not enacted. We assume a continuation of the trend toward meeting new electricity demand with a combination of demand side management and of new capacity, where required, being fired primarily by natural gas and coal. Our assumption for oil prices is shown in Figure 6.1.

Figure 6.1



Source: The WEFA Group

- Population and Labor Force by Region

In Figures 6.2, 6.3, and 6.4, we show history and projections for world population. The population figures through 2025 are from the United Nations. WEFA has extended the U.N. fertility and mortality assumptions to 2060 in a manner consistent with our projections of GDP per capita in each region, which are discussed below. In extending these forecasts to the year 2060, we do not assume presence of cyclical behavior. This does not mean that business cycles will not occur. Rather, we do not know when they will occur this far into the future. Taking only two points into the future (2020 and 2060) requires that the scenario not involve any cyclicality.

The charts are logarithmic, and on such charts the slope of the curve is the growth rate. In Figure 6.2, we see that the population growth rate of the developing world, while slowing, remains above that of the developed world for the period which we are considering. As the per capita GDP of the developing regions is expected to remain far below that of developed regions, we have not reduced their population growth rates to those of the developed nations.

Within each of these two broad categories, the results follow a similar pattern. As shown in Figure 6.3, one exception is Oceania, which while having per capita GDP above that of Europe, has a slightly more rapidly rising population. The difference here is the amount of space in Australia and New Zealand relative to the population, which allows for both a higher natural increase in population and more immigration than in Europe. The United Nations forecasts of demographic trends in Europe are subject to somewhat greater margin of error than previous projections due to the potential impact of developments in CIS and in the former centrally planned economies of Eastern Europe.

In the developing world, whose population we break out in Figure 6.4, the exception is the Middle East, where oil revenues are expected to increase per capita GDP sharply, but not population growth. In the developing world, we see reduced population associated more with modernization, which is expected to proceed slowly in this conservative part of the world.

Among all regions considered in this study, Africa is the one whose population

is expected to grow at the fastest rate until the year 2060 (see Figure 6.4)[1]. Within the OECD area, Europe will experience the slowest rate of expansion (see figure 6.3), with six countries namely Austria, Belgium, Denmark, Germany, Italy, Sweden and Switzerland expected to register an absolute decline in population over the forecast period.

- Technological Innovation and Transfer

We assume that the long-term trend toward greater efficiency in production and consumption of services will continue. The major assumption in this area is the diffusion of technology now on the drawing boards to even the most undeveloped countries, allowing for a convergence of per capita GDP without an accelerated strain on the earth's resources. The former centrally planned economies of Europe and Other Asia, as well as India and the Asean countries, are expected to benefit the most from technology transfer, Africa the least because of the extreme difficulties with infrastructure, education and health.

- Productivity by Region

Figures 6.5 to 6.10 indicate WEFA's assumptions concerning GDP and per capita GDP. The most industrialized regions rise at slightly lower rates than historically. The exception is Far East Asia, where we expect China to slow the growth somewhat in the next century. "Europe", Figure 6.6 and 6.9, includes Eastern Europe and the Commonwealth of Independent States (CIS). This latter region pulls down the 1990 figure for per capita GDP but should contribute to a more rapid rise in the next century.

In the developing world, GDP per capita is expected to rise more rapidly in the Middle East and Other Asia than in Latin America or Africa. In the case of the Middle East this is associated with the rising real price of crude oil that is shown in Figure 6.1. Other Asia is expected to continue to benefit from the economic engines of Western and Japanese investment relative to Africa. These variations in productivity performance reflect differences in the investment propensity of the individual economies, as improvements in labor

[1] This is based on the U.N. forecasts. With War, famine and epidemics (including AIDS) cutting into population growth, the odds of this growth occurring are not high. However, Africa trade is a small part of canal trade, so a lower population forecast here would have little impact for the Canal traffic forecasts.

productivity generally tend to be associated with higher investment.

- Transportation Costs

In Figure 6.11, we present the components of transportation costs, namely, real wage rates and fuel costs. These indices are in real terms, that is, corrected for inflation. We assume that all other components of transportation costs do not change in real terms. That is, we assume transportation costs other than fuel and labor rise with the general level of inflation. Note that labor compensation is related to labor cost by labor productivity. That is, real labor compensation will rise faster than real labor cost by just the increase in labor productivity. Thus, if labor productivity were rising at one percent per year, the growth in labor compensation would be one percent higher than the rise in labor cost.

- Structural Change

Possibly the most important factor in the relation of merchandise trade to World GDP is the structural change which world economies are undergoing, namely, the shift away from goods, in relative terms, and toward services. The gradual depletion of non-renewable resources means that new deposits are of lower quality, harder to reach, and more expensive to extract and refine. This results in gradually rising real costs for these resources.

Historically, this process has not resulted in continually rising natural resource prices because of unevenness in the process of discovery, in world demand that results from changing world business conditions, and in the prevalence and power of cartels. In the future, we know that these factors will continue to be important, but, for purposes of our projections, we assume that they behave evenly over time.

These rising real price curves for natural resources lead to a gradual process of substitution of the consumption of services for the consumption of goods. This process is also affected by rising incomes, for example in the consumption of meals away from home rather than preparing them in the home.

These structural change considerations lead, as Figures 6.12, 6.13, 6.14 show, to a continuation of the long-term trend in the shift from goods toward

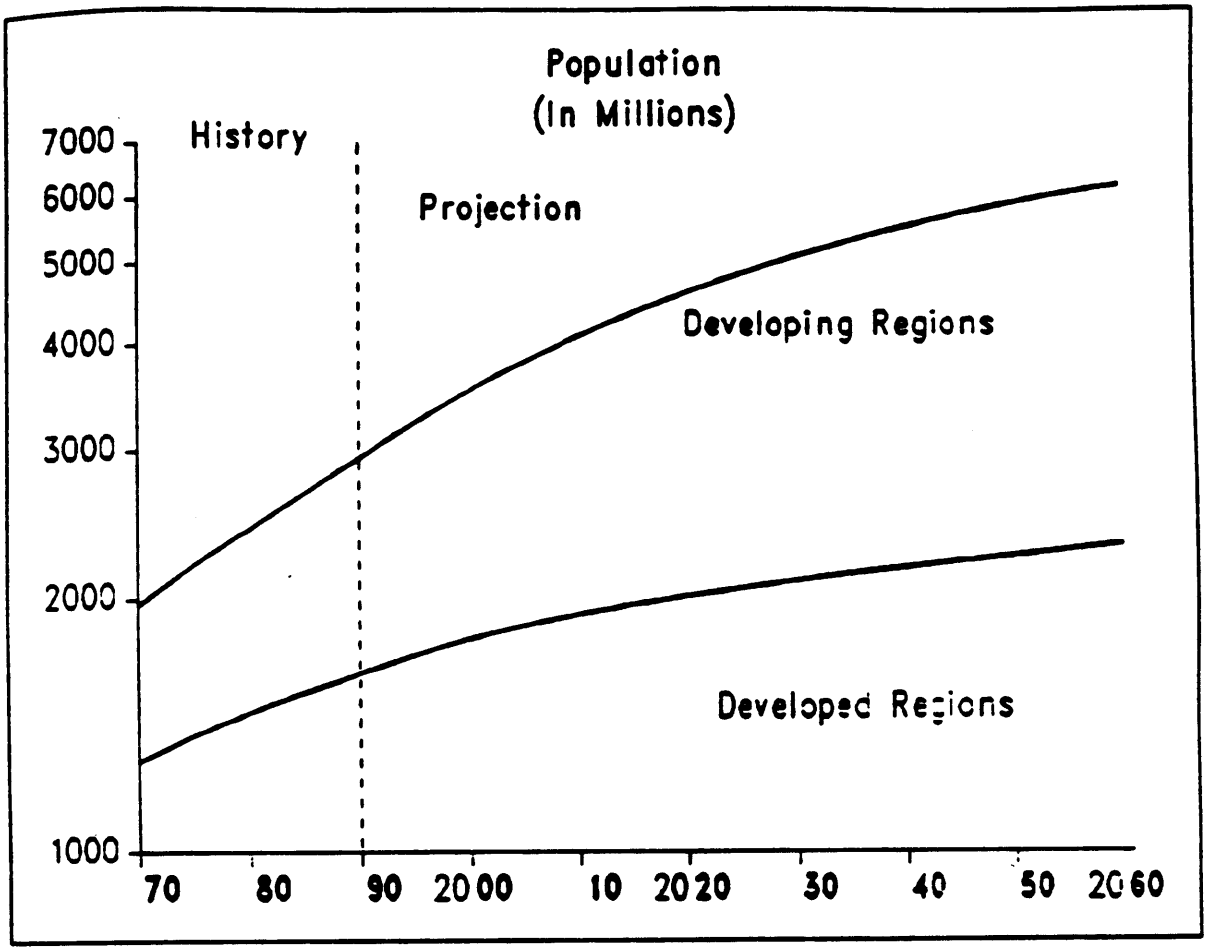
services which produces a downward curvature in the ratio of total world trade to world GDP.

- Terms of Trade:

  By terms of Trade we mean the trade barriers or lack of them between countries or regions. These can be unilateral, such as the barriers to agricultural products; bilateral, such as the U.S. - Canada free trade agreement; and multilateral, such as the EC common market and the General Agreement on Trade and Tariffs (GATT).

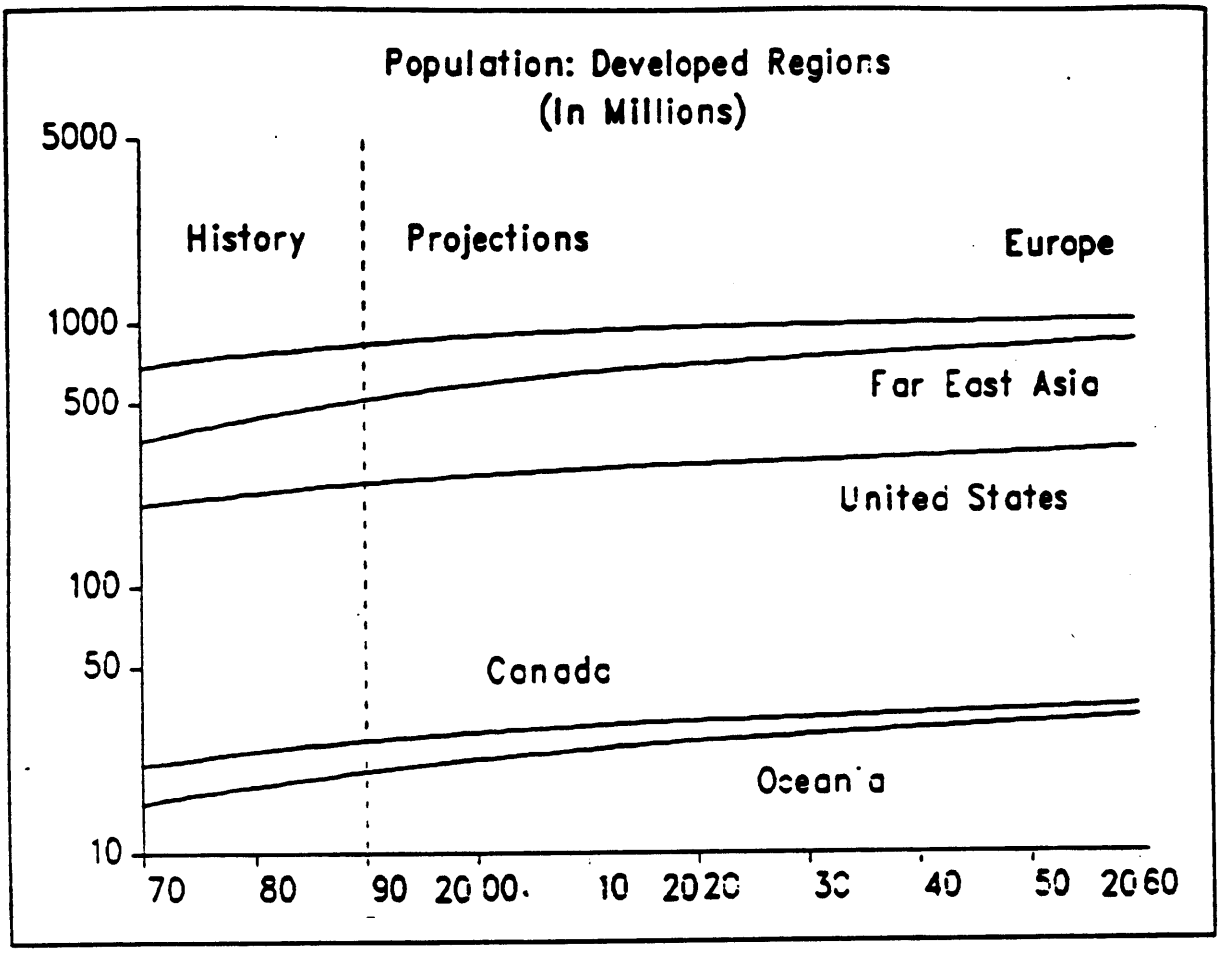
  We assume that the emerging world trading blocks continue the post World War trend toward freer trade, specifically toward a continued lowering of tariff and non-tariff barriers. This trend in trade policy towards reinforcement of market forces and reduction in government intervention is most apparent in the former communist countries of Eastern Europe. The Single Market project in the EC, aimed at reviving competition, is also expected to eliminate the remaining restrictive practices within the Community. The South East Asian Pacific region will also move to more open practices, particularly liberalization of trade and capital transactions.

Figure 6.2



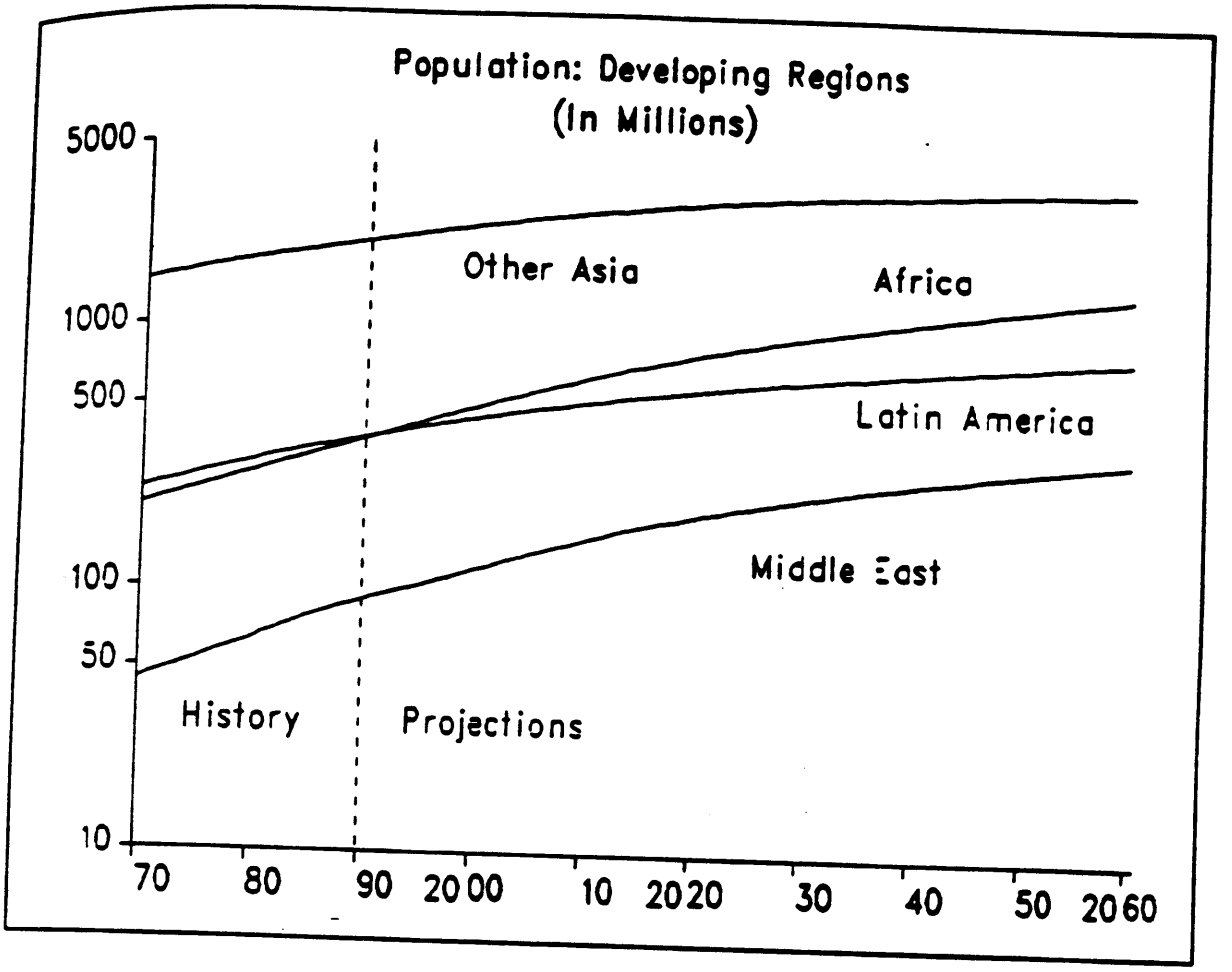
Source: The WEFA Group

Figure 6.3



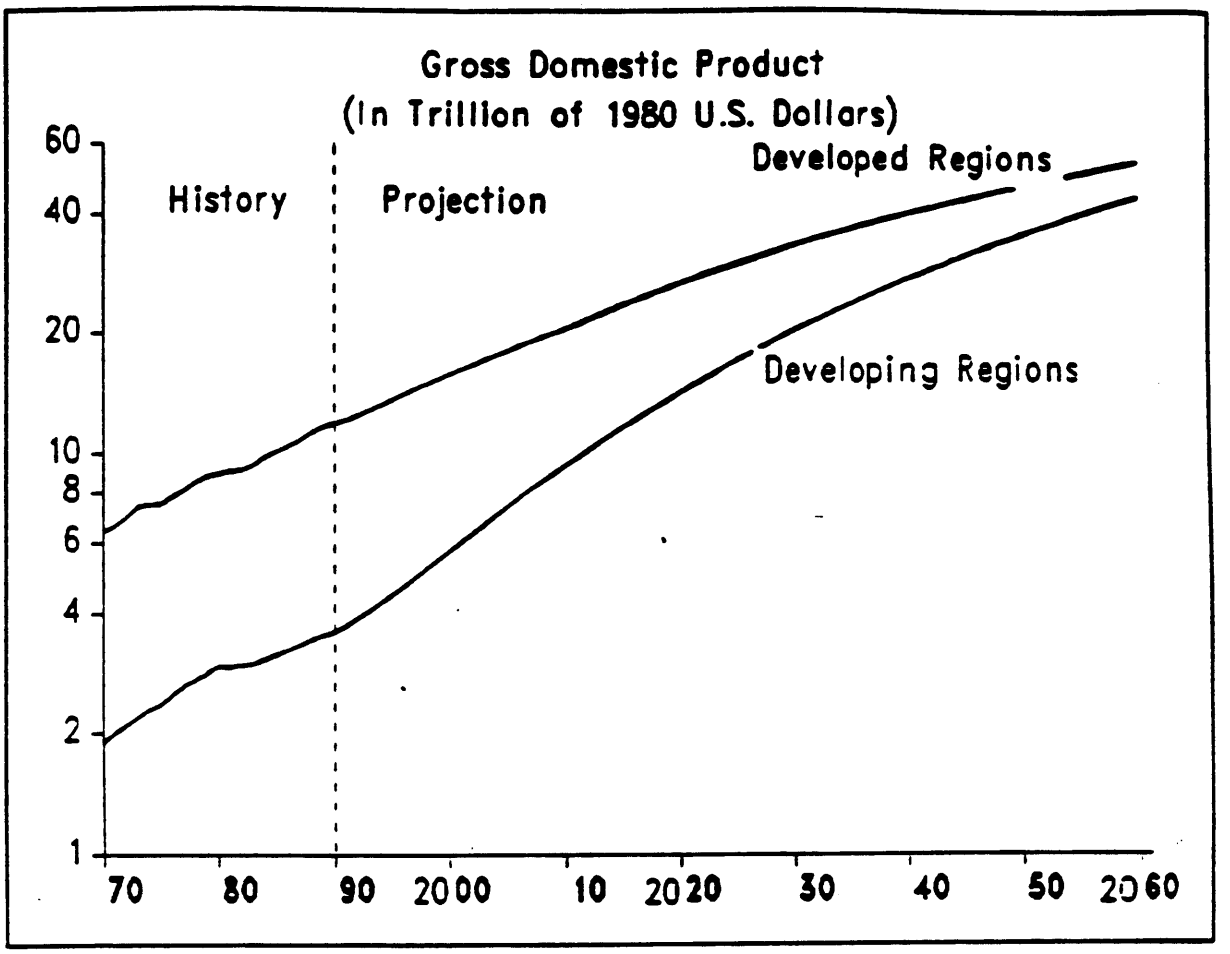
Source: The WEFA Group

Figure 6.4



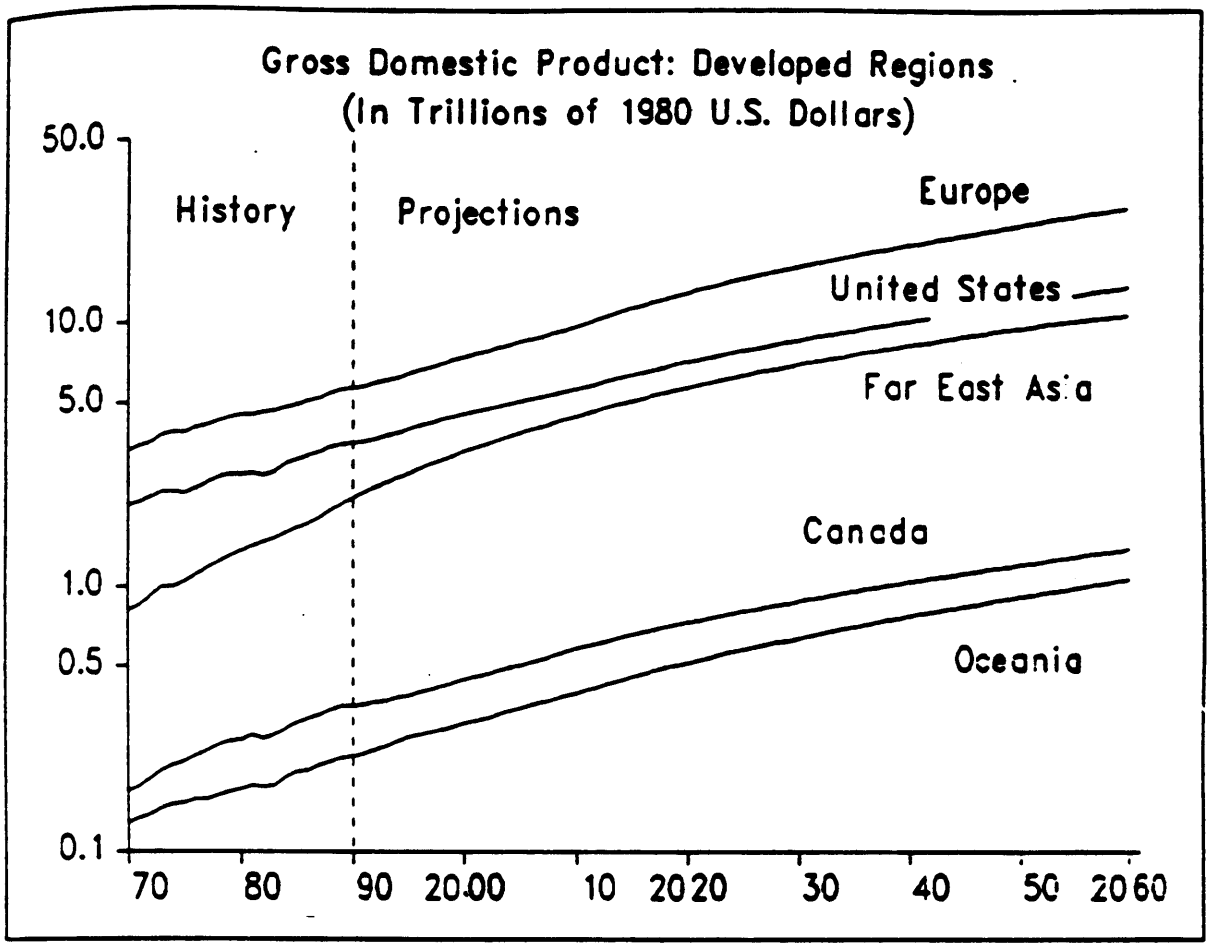
Source: The WEFA Group

Figure 6.5



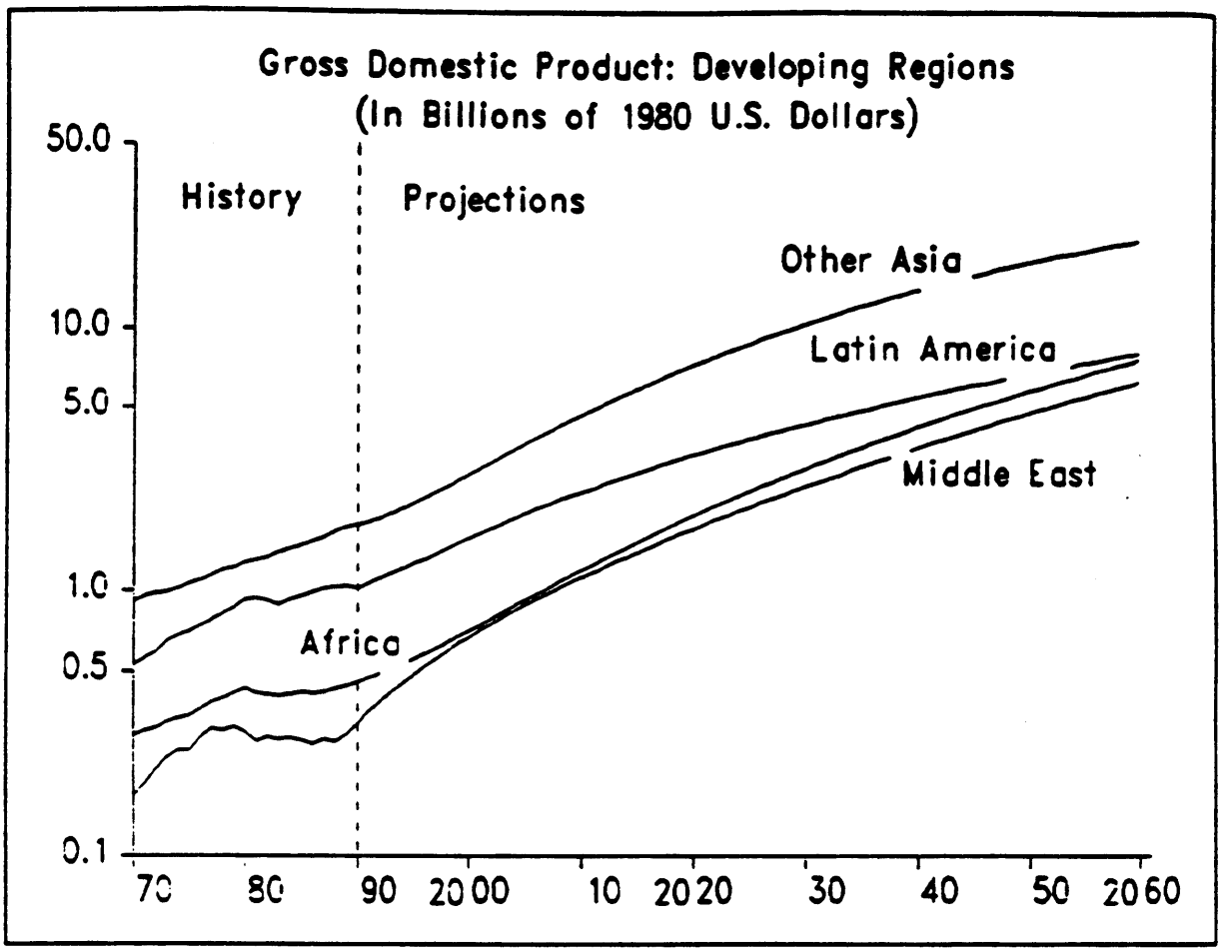
Source: The WEFA Group

Figure 6.6



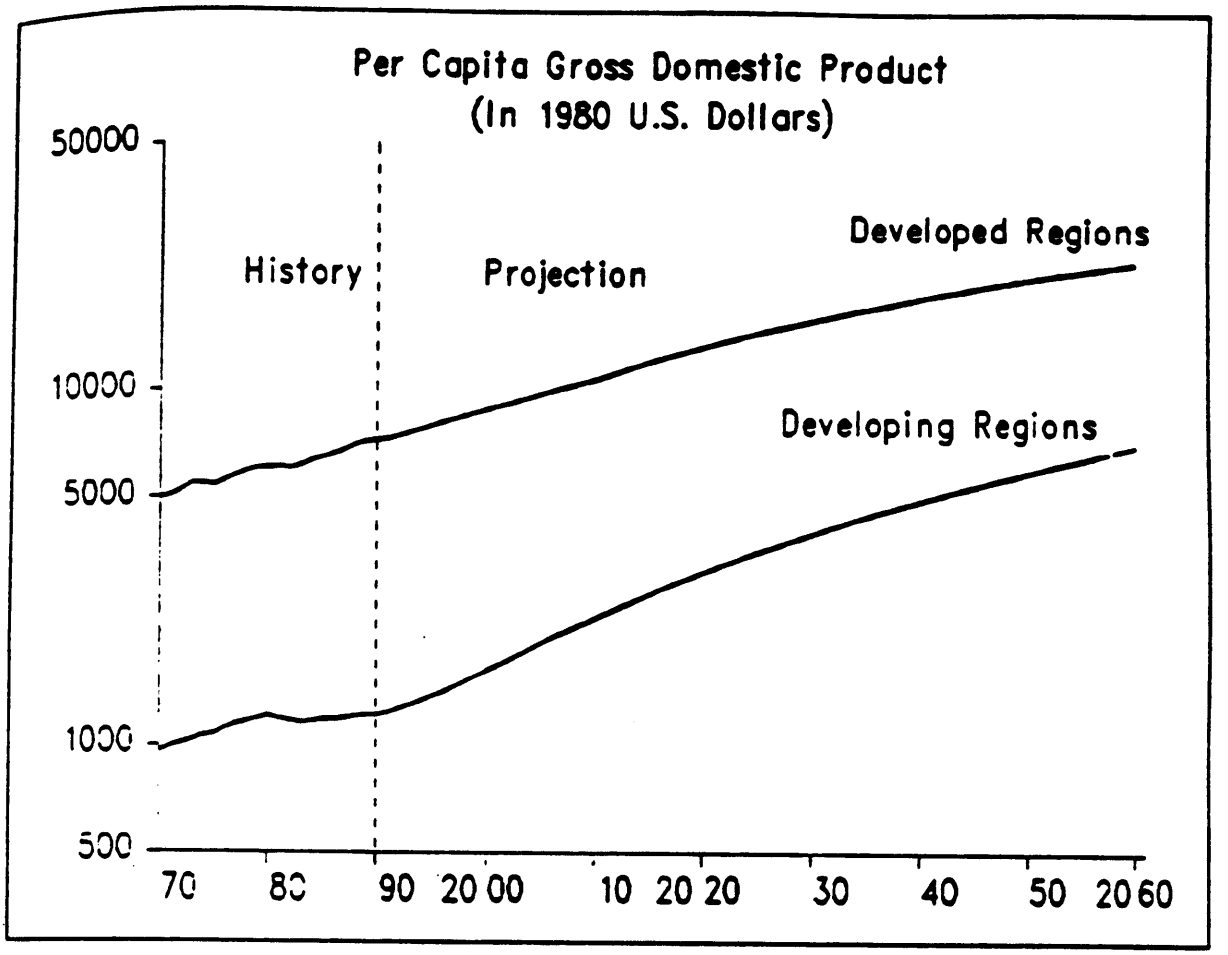
Source: The WEFA Group

Figure 6.7



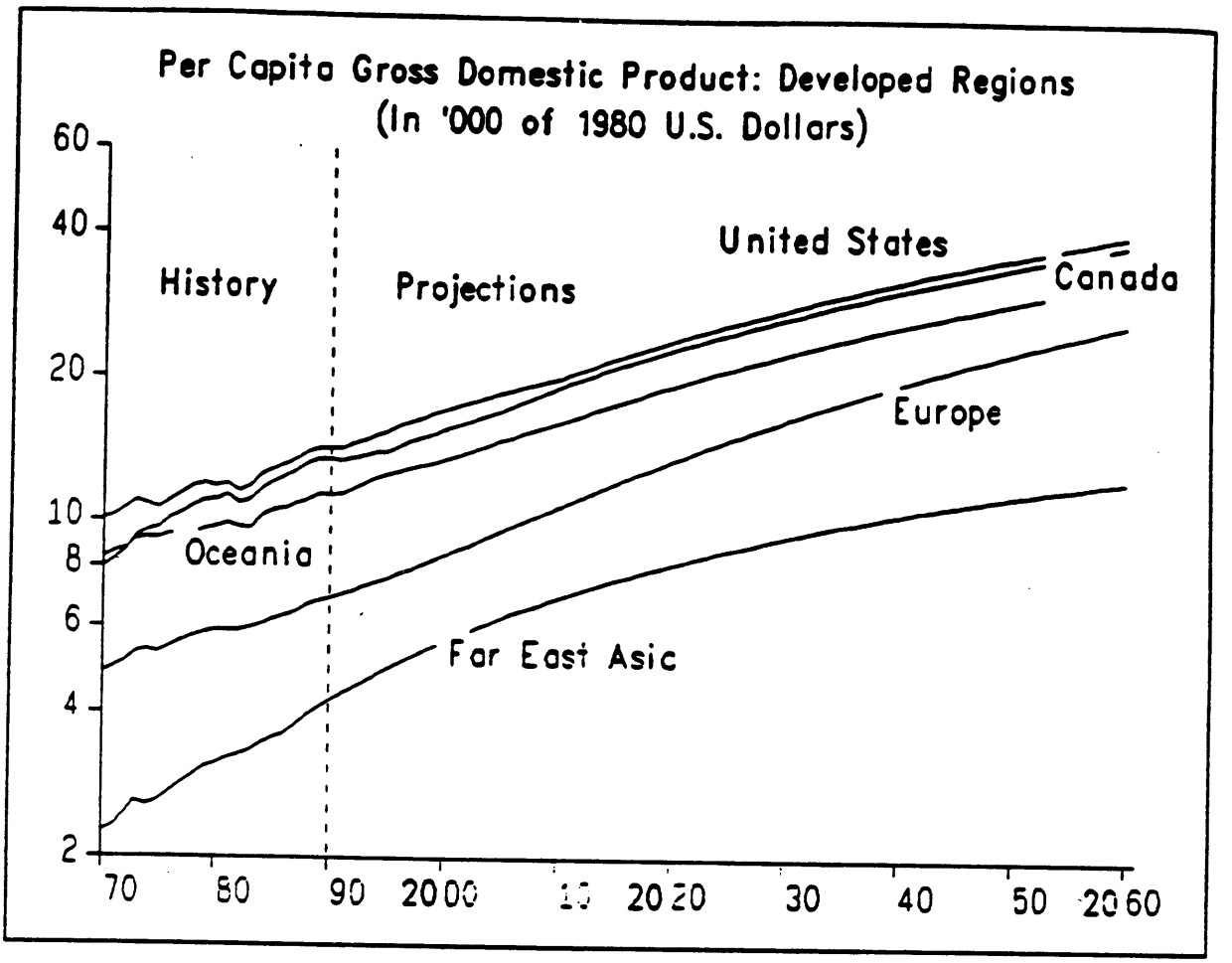
Source: The WEFA Group

Figure 6.8



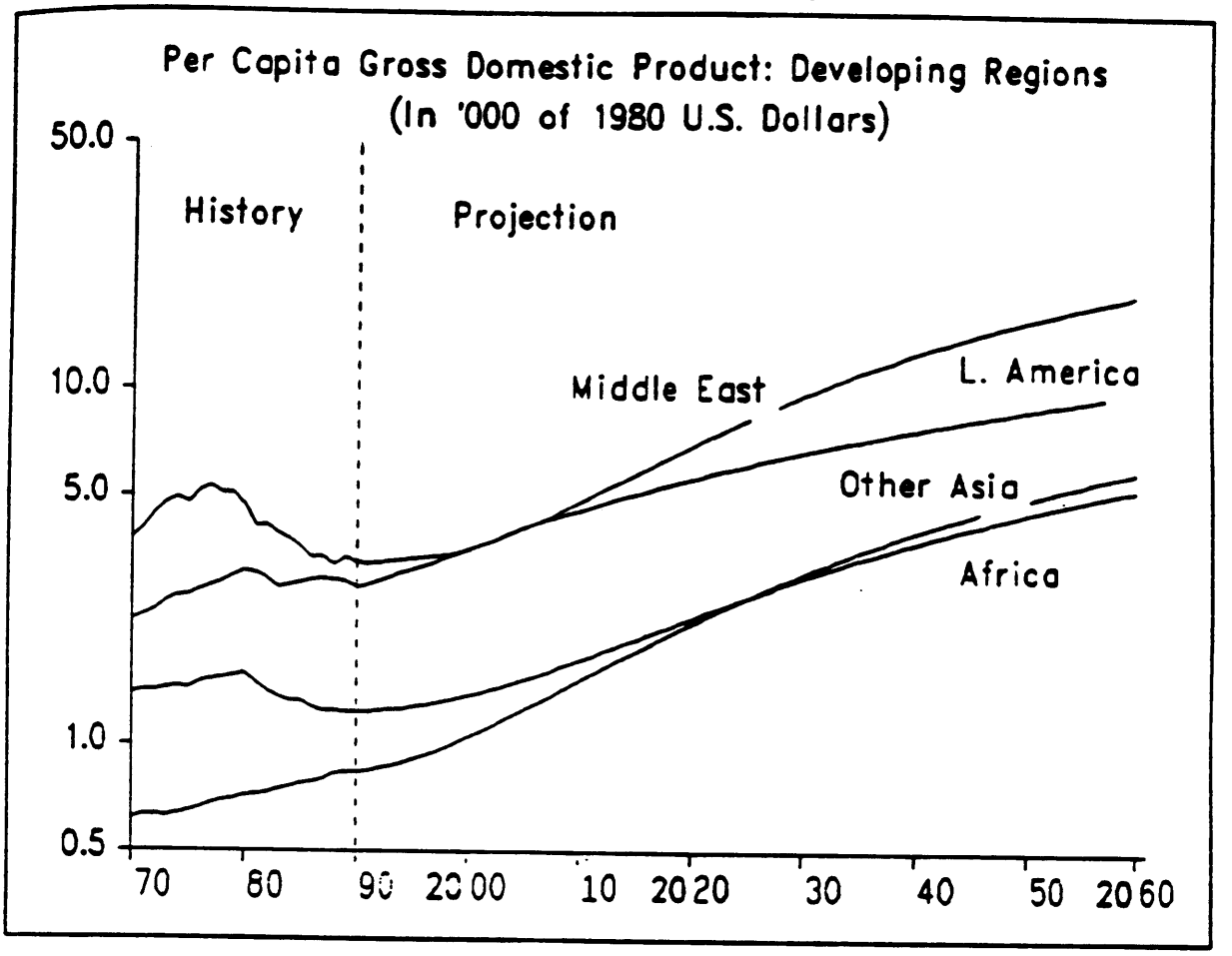
Source: The WEFA Group

Figure 6.9



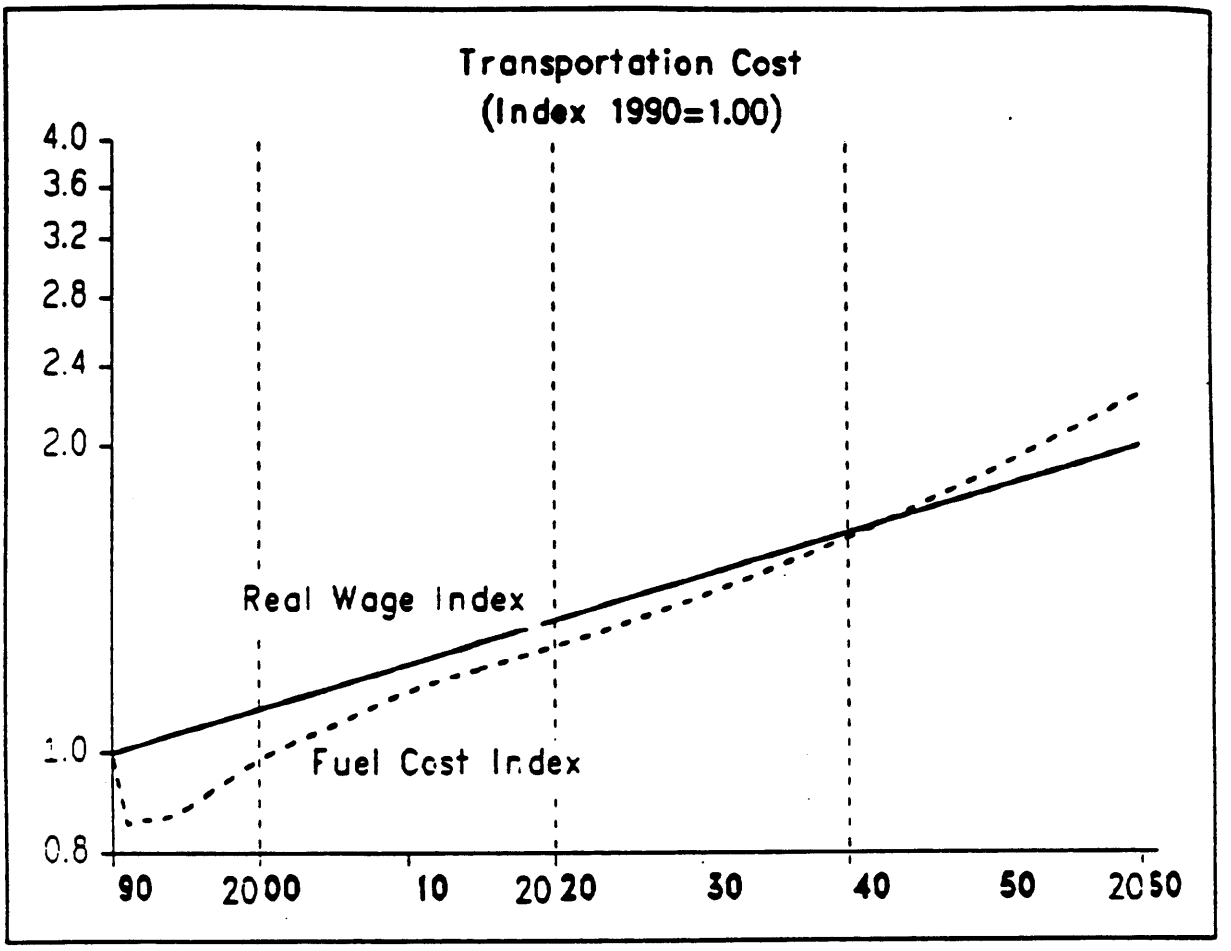
Source: The WEFA Group

Figure 6.10



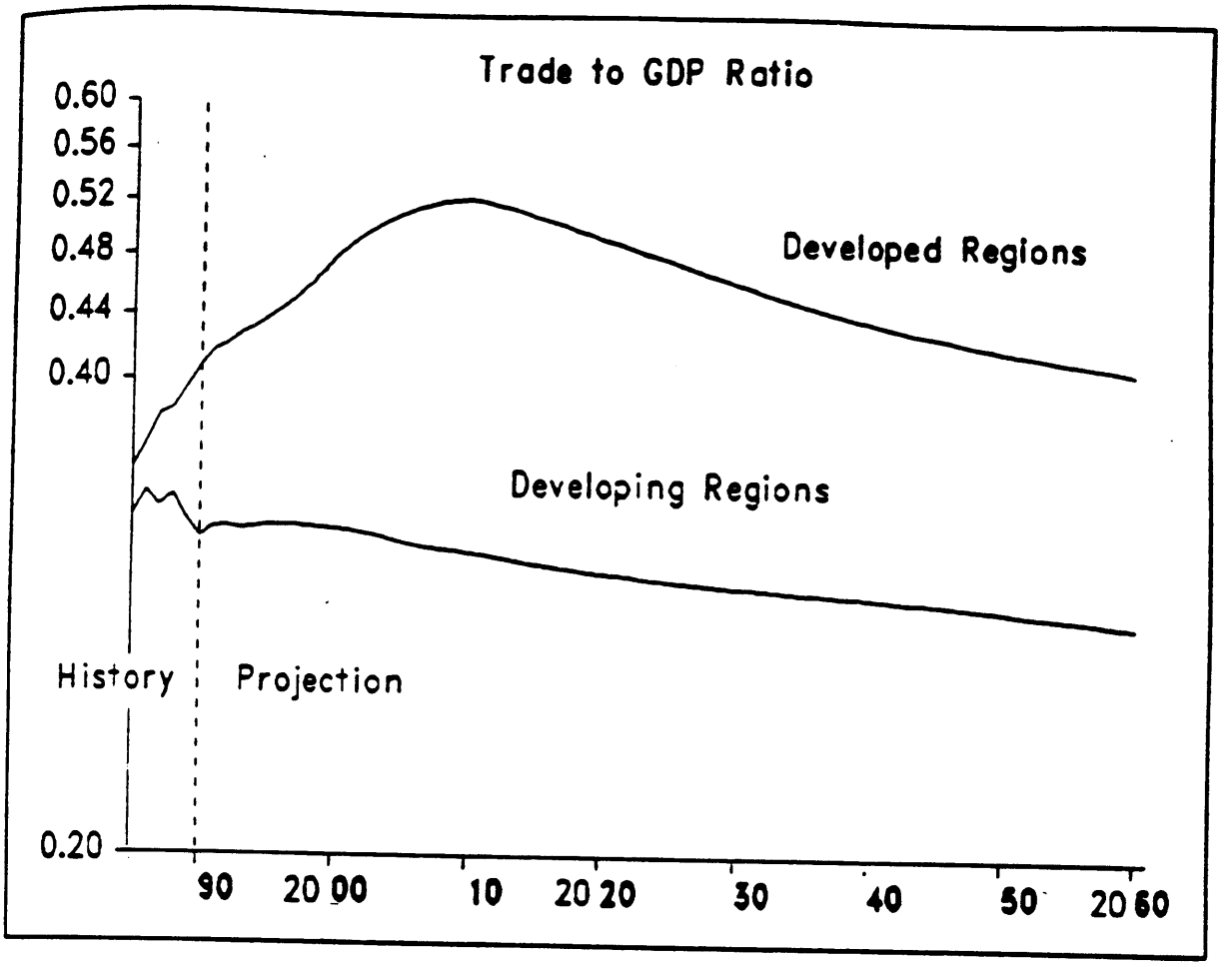
Source: The WEFA Group

Figure 6.11



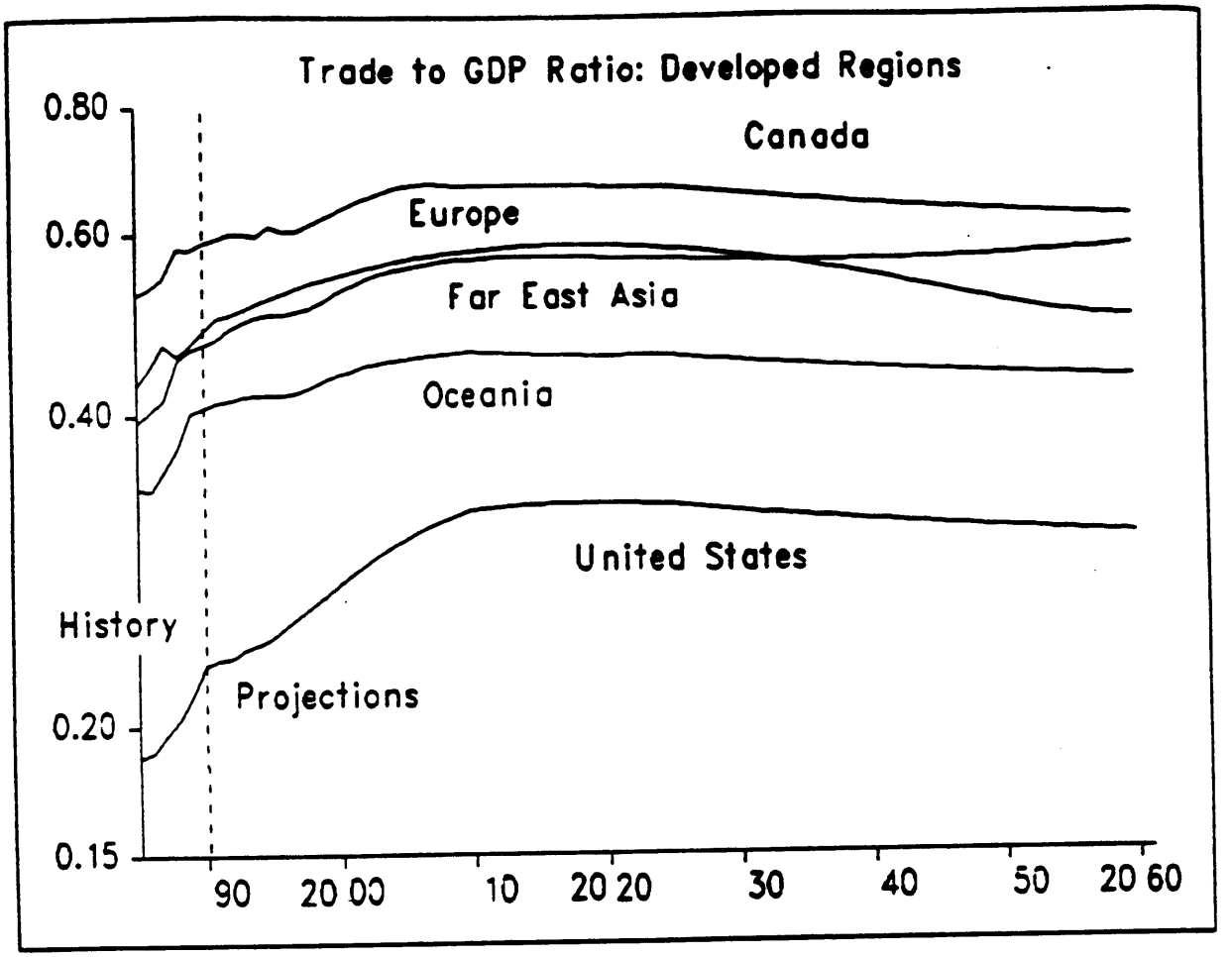
Source: The WEFA Group

Figure 6.12



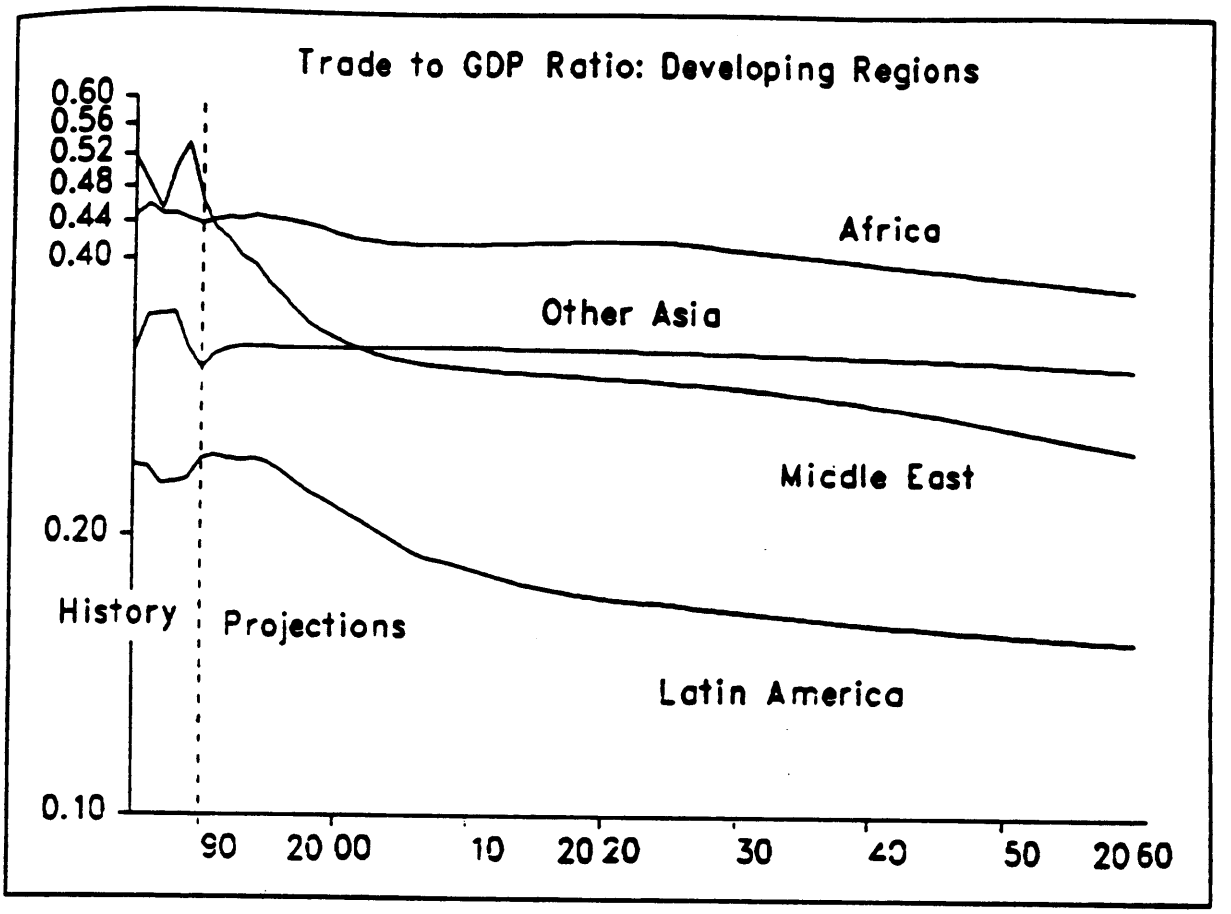
Source: The WEFA Group

Figure 6.13



Source: The WEFA Group

Figure 6.14



Note: All variables are measured as constant 1987/constant 1987 U.S. Dollars

Source: The WEFA Group

Population growth is expected to level off in the industrialized countries, but to continue to increase at a decreasing rate elsewhere (see Table 6.3). Positive population growth is expected to continue in the United States, Canada and Australia because of relatively lenient immigration policies.

Of the developing countries the former CPE countries and China are expected to grow most slowly and the Middle East and Africa most rapidly. This latter clearly assumes that the AIDS problem does not become as overwhelming as some are saying it might in those parts of Africa now with an AIDS epidemic.

Because of the time period we are considering here, between 30 and 70 years in the future, a disaggregate macroeconomic model is not appropriate. All of the relationships become trends and the amount of data often obscures the relevant issues. The approach which we used was to examine the relationship between Gross Domestic Product (GDP) and total population in each country and region historically. Then we determined based on the following considerations what we believe are sensible trajectories for per capita GDP in each country under a given set of assumptions[1]. The results are shown in tables 6.1 and 6.2.

A fundamental assumption underlying the work is that the ranking of countries/regions in terms of per capita GDP remains fixed over the period, but that there is some convergence toward the standard of living of the most developed countries. Because the country for which there is the greatest degree of understanding in terms of the dynamics of growth is the United States, the analysis begins there. At present, per capita U.S. GDP is growing at slightly less than 2%. This is composed of two parts: productivity is growing at about 1% and labor force relative to population is growing at less than 1%. Eventually, we expect labor force and population to grow in tandem, with the result that the growth of per capita GDP drops to the 1% we continue to assume for productivity growth. The average per capita GDP growth over the 70 year period is slightly less than 1.5% per year.

This is not to suggest that the total tons of goods produced, or any such physical measure, grows at this rate. The trend in industrialized societies has been toward a saturation in physical goods and a relative shift to services. We expect this to continue, such that eventually most of the increase in output is in ever more efficiently provided services. These services will continue to require electric power and other energy forms, and other physical

[1] During our investigation of the United Nations population projections, it was apparent that these projections are not consistent, that is, the net emigration implied by births, deaths and population change do not balance for the world as a whole. The implication is that developing countries are assuming greater emigration than are the industrialized nations.

goods associated with them. Thus, trade in physical goods among the developed countries can be expected to grow but at a decreasing rate. Finally, services are assumed to take greater and greater advantage of efficiencies to be gained from electronic advances, as is the case in the U.S. at present, and which we are seeing in Europe, Japan and elsewhere: automatic teller machines, home shopping, etc.

In general, we assume continued movement toward free markets in goods and most services. This underlies both the assumption of per capita GDP convergence and continued improvement in productivity. It also has the implication of freer trade, since trade barriers are merely another form of government interference in the free functioning of markets.

With freer trade, we expect that the rapid growth of an export driven economy such as the Newly Industrialized Countries (NICs) of Asia, for example, will slow and that the per capita GDP ratio for these countries does not exceed that for the United States. The economies of the NICs cannot depend on export driven growth forever - Europe and the U.S. are already insisting on reciprocity or trade quotas.

Scandinavia, on the other hand, slows to some extent so that its higher ratio does not exceed the U.S. by as much in relative terms. Some of the current disparities among industrialized countries are due to exchange rate distortions, for example in Finland. We assume that these are reduced.

For Southern Europe, the GDP outlook reflects convergence toward per capita GDP rates in the rest of Europe, despite stagnant population growth. For Northern Europe, growth is seen as relatively slow because of:

1. stagnant or declining population growth;

2. moderate productivity gains given Northern Europe's current status as a highly industrialized region.

Relative to Northern Europe, the outlook for the United States, Canada and Australia is for somewhat higher growth. This reflects the net immigration assumptions we mentioned above.

In the Non-OECD regions, Turkey and South Africa, strong GDP growth reflects both population increases and convergence of both productivity and labor force participation toward current rates in industrialized countries.

The growth of energy consumption is expected to slow in the industrialized countries and level off after 2020. Passive solar heating of homes, greater energy efficiency and cogeneration in buildings, the aforementioned shifts away from heavy industry, and growth in non-fossil fuel sources of power are all expected to contribute. In the developing countries, on the other hand, the relation of GDP growth and growth in energy consumption is expected to remain.

Table 6.1

GDP LEVELS AND GROWTH FOR SELECTED YEARS OECD COUNTRIES/REGIONS

OECD COUNTY/REGION	GDP (BILLIONS OF 1980 U.S. DOLLARS) 1990	2020	2060	COMPOUND ANNUAL GROWTH RATES 1990-2020	2020-2060	1990-2060
AUSTRALIA	203.2	451.6	918.8	2.70	1.79	2.18
AUSTRIA	95.4	177.6	211.6	2.09	0.44	1.15
BELGIUM/LUXEMBOURG	146.8	270.0	310.2	2.05	0.35	1.07
CANADA	355.5	730.2	1402.5	2.43	1.65	1.98
DENMARK	79.4	135.4	174.1	1.79	0.63	1.13
FINLAND	71.5	129.4	184.6	1.99	0.89	1.36
FRANCE	831.6	1606.7	2282.1	2.22	0.88	1.45
GREECE	46.5	100.8	196.8	2.61	1.69	2.08
GERMANY	1004.4	1794.0	2012.8	1.95	0.29	1.00
ICELAND	4.0	7.2	11.3	1.97	1.14	1.49
IRELAND	25.7	66.3	161.5	3.21	2.25	2.66
ITALY	571.5	1047.3	1288.9	2.04	0.52	1.17
JAPAN	1618.6	3901.7	4778.2	2.98	0.51	1.56
NETHERLANDS	202.9	391.7	586.9	2.22	1.02	1.53
NORWAY	71.3	126.0	196.6	1.92	1.12	1.46
NEW ZEALAND	26.4	61.9	152.4	2.88	2.28	2.54
PORTUGAL	32.6	93.7	221.5	3.58	2.17	2.77
SOUTH AFRICA	85.5	255.3	937.2	3.71	3.30	3.48
SPAIN	282.7	627.5	952.9	2.69	1.05	1.75
SWEDEN	151.5	249.5	355.8	1.68	0.89	1.23
SWITZERLAND	124.2	222.7	270.4	1.96	0.49	1.12
TURKEY	97.9	419.5	1446.4	4.97	3.14	3.92
UNITED KINGDOM	698.1	1331.8	2284.6	2.18	1.36	1.71
UNITED STATES	3539.7	7133.2	13854.7	2.36	1.67	1.97
TOTAL OECD	10366.9	21331.0	35192.8	2.43	1.26	1.76

Source: The WEFA Group

As income rises worldwide, increased trade in foodstuffs can be expected to continue. The countries of the former Soviet Union are expected to get their economies on a reasonable

footing in the period between now and 2020, and especially their agriculture. This should lead to a gradual reduction to zero in its imports of grain, but we do not expect it to become a net exporter.

In this forecast, global warming is assumed not to be an issue affecting fuel choices. Nor do we assume that nuclear power growth slows, outside of the U.S. and those European countries where opposition is currently strong. On the other hand, we are not assuming fusion power or any other exotic source of energy to play any role. The major sources of energy are expected to be coal, rising from 27% of the total in 1990 to 40% in 2060 and natural gas, which should remain at about 23%. Oil is expected to fall from 39% of total energy to 17%, nuclear to rise from 6% of the total in 1990 to 12%, and hydropower and other sources to remain at about 7%.

Table 6.2

GDP LEVELS AND GROWTH FOR SELECTED YEARS NON-OECD REGIONS

	GDP (BILLIONS OF 1980 U.S. DOLLARS)			COMPOUND ANNUAL GROWTH RATES		
NON-OECD REGION	1990	2020	2060	1990-2020	2020-2060	1990-2060
AFRICA *	365.7	1477.4	6753.2	4.76	3.87	4.25
GULF FOUR	291.5	1295.8	6336.4	5.10	4.05	4.50
LATIN AMERICA	1027.8	3298.6	8171.4	3.96	2.29	3.01
OTHER ASIA	454.9	1909.5	6204.1	4.90	2.99	3.80
PACIFIC BASIN	589.4	2397.0	6119.5	4.79	2.37	3.40
CENTRAL PLANNED	2430.6	8881.5	30451.8	4.41	3.13	3.68
TOTAL NON-OECD	5159.9	19259.8	64036.4	4.49	3.05	3.66
TOTAL WORLD	15526.8	40590.8	99229.2	3.26	2.26	2.69

(*) EXCLUDES SOUTH AFRICA

Source: The WEFA Group

Table 6.3

POPULATION LEVELS AND GROWTH RATES

OECD COUNTRY/REGION	(IN THOUSANDS) 1990	2020	2060	COMPOUND ANNUAL GROWTH RATES 1990-2020	2020-2060	1990-2060
OECD	841,485	958,012	1,048,204	0.4%	0.2%	0.3%
AFRICA	331,880	736,549	1,350,644	2.7%	1.5%	2.0%
GULF FOUR	89,699	194,288	333,496	2.6%	1.4%	1.9%
LATIN AMERICA	372,406	583,387	817,142	1.5%	0.8%	1.1%
OTHER ASIA	978,192	1,624,166	2,068,029	1.7%	0.6%	1.1%
PACIFIC BASIN	393,430	578,260	764,932	1.3%	0.7%	1.0%
CENTRALLY PLANNED	1,548,386	1,952,836	2,175,130	0.8%	0.3%	0.5%
TOTAL NON-OECD	3,713,993	5,669,486	7,509,373	1.4%	0.7%	1.0%
TOTAL WORLD	4,555,478	6,627,498	8,557,577	1.3%	0.6%	0.9%

Source: The WEFA Group

To compare WEFA's economic forecast with forecasts generated by other organizations and institutions, we present in the following two tables (Table 6.4 and 6.5) forecasts of the World Bank-IMF and those of CEPII (Centre D' Etudes Prospectives et D' Information Internationale). None of these two forecasts goes beyond the year 2000. In addition, it should be noted that, especially in the case of economic regions, the comparison is not direct due the fact that a slightly different set of countries is used by each organization.

Table 6.4

Comparisons between World Bank-IMF and WEFA's Economic Forecasts

	1990-2000	
	World Bank	WEFA
G5[2] GDP	2.9[3]	2.8
G5 Labor Productivity	1.8	2.0
Nominal LIBOR[4]	7.5	6.5
Real LIBOR	3.7	3.2
G5 GDP Deflator	3.6	3.3
GDP per capita, Developing countries		
Sub-Saharan Africa	0.5	-0.2
East Asia	5.2	6.5
South Asia	2.6	4.0
Europe, Middle East, N Africa	1.5	1.8
Latin America	2.0	2.3

Source: The WEFA Group

[2] G5 are the U.S., Germany, Japan, France and the U.K.

[3] GNP growth rates

[4] LIBOR rates are averages for the corresponding period.

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Table 6.5

Forecast comparisons between CEPII/WEFA[5]

	1991-1995		1996-2000	
	CEPII	WEFA	CEPII	WEFA
GDP Annual Growth Rates				
World	2.8	2.2	3.6	3.5
OECD	2.5	2.4	2.7	3.1
USA	1.9	1.9	2.2	3.0
Germany	3.3	2.7	2.8	2.9
Japan	4.2	4.0	4.3	4.0
France	2.5	2.0	2.9	2.6
Italy	2.3	2.3	3.1	2.8
UK	1.2	1.6	2.3	2.6
Latin America	3.5	3.0	4.2	4.8
Arabian Gulf	3.8[6]	3.0	4.0	4.7
Africa	3.1[7]	2.9	3.2	3.2
Pacific Basin	6.6[8]	7.4	6.6	6.9

	1991-1995		1996-2000	
	CEPII	WEFA	CEPII	WEFA
Unemployment Rate				
USA	7.3	8.2	6.6	7.4
Germany	8.9	8.2	8.8	7.3
Japan	2.2	2.3	2.2	2.3
France	10.0	9.1	9.5	8.2
Italy	12.1	11.1	10.5	10.0
UK	9.8	9.1	9.8	8.0

[5] Based on the World Economic Outlook-20 year extension, February 1992, The WEFA Group.

[6] Middle East

[7] Subsaharan Africa

[8] Four Asian Tigers

Table 6.5 (Cont'd)
Forecast comparison between CEPIIand WEFA

	1991-1995		1996-2000	
	CEPII	WEFA	CEPII	WEFA
Inflation Rate				
USA	3.7	3.2[9]	4.3	3.8
Germany	4.3	3.7	2.5	2.8
Japan	2.3	1.9	1.8	2.5
France	3.1	2.9	3.2	3.0
Italy	4.5	6.5	3.5	4.2
UK	4.9	4.6	3.3	3.8

Source: Centre D' Etudes Prospectives et D' Information Internationale and The WEFA Group.

6.2 Bilateral Trade Forecasts for 2020 and 2060

Based on this economic forecast, we have constructed forecasts of bilateral trade by commodity among the OECD countries and between the OECD countries and the non-OECD countries. For trades among the non-OECD countries which are important the canal. such as iron ore and oil, we have generated special forecasts. The resulting growth in trade for both Panama Canal related traffic and bilateral is shown in Table 6.6.

In general, we expect countries to become more self-sufficient in goods as the technological and labor cost advantages of the newly industrialized countries wanes. However, one of the principal engines of growth in newly industrialized countries is the newer plant and equipment and the lower wages paid. Thus, it is principally as per capita GDP converges that this advantage declines.

Steel production is an example of this trend. As a result of both lower unit demand for steel, as a result of the substitution of other materials, and increased self sufficiency, trade in steel products is expected to grow at less than 1% per year.

[9] Implicit Deflator for GDP

Table 6.6
ANNUAL GROWTH RATES BY COMMODITY TYPE

COMMODITY	PANAMA 1990-2020	PANAMA 2020-2060	PANAMA 1990-2060	BILATERAL 1990-2020	BILATERAL 2020-2060	BILATERAL 1990-2060
BULK CHEMICALS	4.1%	1.0%	2.3%	3.6%	1.1%	2.1%
CONTAINERIZED	2.9%	0.7%	1.6%	3.3%	1.2%	2.1%
CRUDE OIL	-2.7%	-3.9%	-3.4%	1.2%	-1.9%	-0.6%
GENERAL CARGO	2.9%	1.5%	2.1%	3.0%	1.1%	1.9%
MAJOR DRY BULKS	1.3%	1.2%	1.2%	2.8%	0.9%	1.7%
MINOR BULKS	1.6%	1.6%	1.6%	2.1%	1.3%	1.6%
OILS & FATS	1.1%	1.3%	1.2%	1.6%	0.9%	1.2%
PETROLEUM PRODS	0.5%	-2.2%	-1.1%	1.2%	-1.5%	-0.4%
REFRIG CARGOES	3.1%	1.0%	1.9%	2.4%	1.0%	1.6%
VEHICLES	1.1%	0.3%	0.6%	1.6%	-0.1%	0.6%
TOTAL	1.8%	1.1%	1.4%	2.6%	1.1%	1.7%

Source: The WEFA Group, RLA

Further, we do not believe that productivity in agriculture will continue to grow in the next 70 years as rapidly as in the last 70. Thus, the growth in exports from current producers cannot grow indefinitely. The decline in the systemic problems of Eastern Europe and the Soviet Union, moreover, are expected to reduce their import requirements. The same holds true for China and for Southeast Asia.

On the auto issue, WEFA believes that there will be no additional plant built in Germany or Japan, but rather in consuming countries. This is not so much for political reasons but that their labor rates for auto production are getting very high, primarily because of labor shortages. Several of these plants are being located in South America - Brazil and now Argentina. Therefore, auto exports from Germany and Japan should not increase.

In the case of energy, oil trade must clearly fall off during this period because resources will be declining markedly worldwide, falling to 30% of their 1990 value. Coal and natural gas will come into their own during the first part of the next century. Even so, by 2060 coal reserves are expected to be depleted by 50% and natural gas resources by 85% from their

present published estimated values[10]. Natural gas resource estimates are more uncertain that coal or oil, and, as a result, we have assumed that methane resources will be higher than published estimates. So long as extensive reserves of coal and natural gas remain to be exploited, it can be expected that it will be cheaper to transform these into sources of clean energy than to develop more costly technologies.

Therefore, coal trade is expected to become increasingly significant during the first half of the next century as oil reserves fall. The world demand for steam coal imports is projected to increase at an average rate of about 5% per annum over the next thirty years, to over 850 Mtce in 2020[11]. In terms of coal supply, Australia is the world's largest exporter of both steam and metallurgical coals, which are of growing importance to its economy, earning US$4.6 billion in fiscal 1990-91. Steam coal exports are forecast to quadruple from 47 Mtce in 1990 to over 200 Mtce by 2020. Indonesia is expected to become a major exporter of steam coal in the future. Several joint ventures are in progress to develop reserves in East Kalimantan (Borneo), and by 2020 an estimated 50 Mmt of steam coal will be available for export. Coal production in Colombia increased steadily in the 1980s and should continue to grow to over 115 Mtce in 2020. Several new export projects are being developed, as well as the anticipated expansion of El Cerrejon Norte.

Natural gas trade, primarily by pipeline but also in liquified natural gas (LNG) tankers is also expected to be important. However, these latter will not be using the canal to any great extent as we expect most of this trade to be concentrated in the Far East while the Americas and Eurasia depend primarily on pipelines.

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[10] BP Statistical Review of World Energy (June 1991), and C.D. Masters, D.H. Root, and E.D. Attanasi, "World Oil and Gas Resources - Future Production Realities", Annual Review of Energy, Vol. 15, 1990, pp. 23-51.

[11] The Outlook for International Thermal Coal Supply, Demand, Trade Flows and Prices: A proprietary study prepared by The WEFA Group, February 1992.

7.0 PANAMA CANAL COMMODITY FLOWS 2020 AND 2060

7.1 Approach and Results

In the absence of changing factors which affect the relative cost of shipping a commodity through the Panama Canal or by another route, whether all water or partly overland, one would expect that the market share of the Canal on a commodity and route basis would be unchanged. Only if some factor changed in future would we expect a change.

Therefore, we have initially applied global trade growth rates for 1990-2020 and 2020-2060 for a given commodity and pair of trading partners to that commodity and origin/destination pair in the FY 1990 Panama Canal data. Over time, the comparative advantage of the Canal will change. Among the factors which may affect this are the following:

- Size and relative operating costs of ships;
- Value of cargo. affecting the inventory carrying cost;
- Costs of transport across the land bridge.

The full analysis is described in this chapter and chapter 9. The results are presented in Figures 7.4 - 7.14 and Tables 7.1 - 7.8. Figures 7.4 to 7.13 present annual cargo flows, for the total of Northbound and Southbound, and for each of the 10 commodities under investigation. More detailed results. by direction, route and commodity are shown in Tables 7.1 and 7.2. Table 7.3 shows the differentiation across alternatives (cases) by route and commodity.

For Bulk, General Cargo, Minor Dry Bulk. Oils and Fats, Petroleum Products, Refrigerated Cargoes and Vehicles commodities are carried on ships whose size is substantially below that of the limitations of the current canal. For example, General Cargo Ships, Refrigerated ships, and RO-Ros are ships whose size will not be affected by a new Canal. Ships whose size would be affected by the size of the canal are Full Containerships, Tankers in the Crude Oil trade, and Major Dry Bulk Carriers.

There are several alternatives to the Panama Canal of which Landbridge (including mainly mini-landbridge from Asia to New England through West Coast and Europe to Pacific Coast using Atlantic Ports) is only one; others include:

- All water service via Cape - Coal
- All water service via Suez Canal - S.E. Asia containers
- Trans-Siberian Railway - (new but will likely grow)
- Northern Route etc. - (under discussion)

The bypass questions, that is, reasons for change in market share, are discussed in Sections 7.2 and 7.3. Here, we discuss the overall character of the commodity projections.

For the major dry bulk commodities, the principal factor is the capability of the Canal to handle Cape size bulkers of 100,000 - 150,000 DWT carrying primarily coal. Currently, much of the coal from the East Coast of the United States to Asia is going on these size ships, and we have increasing amounts shifting to this trade as the Gulf increases its capability to handle these ships. U.S. grain is not expected to go in ships this large, and the issue of grain is one of rail rates out of the Midwest to the U.S. West Coast versus rail and barge costs to the Gulf. As noted below, very little iron ore is shifted back to the larger alternative Canals because of economics. However, it is possible that Canal toll pricing strategies could be developed that would attract additional cargo through the Canal, for example, in the case of the largest alternative Canals, iron ore shipped from the northern-most area in Brazil into Asia.

All of the other categories, excluding containers and crude oil and petroleum products, are transported in smaller ships and are not affected by Canal enlargement. We expect these grow over the long term pretty much in proportion to world trade in general.

The Canal is expected to lose market share in the case of container trade, giving up about one percent per year (see discussion in section 7.2.1). Thus, U.S. West Coast intermodal container trade is expected to grow at roughly 5% per year, and the Canal at 3% per year in the early part of the forecast, somewhat slower in the latter part. For larger alternatives, there is some shifting back to the Canal, but this is very marginal - equivalent to about 10% of the loss of market share envisaged under the status quo case.

Vehicle trade is expected to grow very slowly as production is moved more and more to the consuming country. Overall, the Canal is expected to maintain its market share of the vehicle trade, as all the U.S. vehicle intermodal trade that can shift has reportedly shifted.

Crude oil and petroleum products trade are influenced primarily by the growth in the period to 2020 and subsequent decline in oil production worldwide and particularly outside the Middle East. Alaskan production will be completely gone by 2020 and most of the oil trade

through the Canal will be local[1]. For the alternatives above 150,000 DWT, the canal captures Venezuelan Orimulsion to the Far East. Supporting analysis related to oil trade and transportation economics is presented at the appendix of this chapter.

7.2 Landbridge Bypass

7.2.1 Introduction

There are three relevant landbridge cargo types that compete with Panama Canal service:

- Grain exports from U.S. Gulf to Asia competing with U.S. West Coast to Asia routing.
- Container imports/exports by Panama Canal as opposed to landbridge (i.e. including both Asian trade through West Coast ports and European trade through East Coast ports with a rail landbridge component).
- Asian auto imports to East and Gulf Coasts as opposed to West Coast entry and landbridge component.

In 1990, landbridge cargo including autos, containers and grain accounted for slightly more than 25% of total Canal traffic. Principal North American landbridge cargoes are presented in the following table. However, as explained in sections 7.2.1 to 7.2.5 of this chapter, not all of this cargo is susceptible to diversions to other trade routes.

After consultation with CAS, the specific assumption was made that the Jones Act, the U.S. regulation that requires intra-United States maritime trade to move in U.S. ships, would remain in force. In accordance with the TOR, no investigation of the future possible impact of the trans-Panama pipeline has been undertaken. In this section we review the issues which will determine whether cargoes are switched between Panama Canal and landbridge routes.

[1] The Economic Impact of the Arctic National Wildlife Refuge (ANWR) Development. A Study Prepared for the American Petroleum Institute, The WEFA Group, May 1990.

Principal North American Landbridge Cargoes
(Million Long Tons - 1990)

	South-bound	% of South-bound	North-bound	% of North-bound	Both Directions	% of Total
Automobiles	.2	0.2%	1.3	1.9%	1.4	0.9%
Grain	24.0	26.4%	NM	0.0%	24.0	15.3%
Containers						
Imports	1.8	2.0%	5.2	8.0%	7.0	4.5%
Exports	1.5	1.6%	6.3	9.6%	7.8	5.0%
Total	3.3	3.6%	11.6	17.6%	14.8	9.5%
Subtotal	27.4	30.3%	12.8	19.5%	40.2	25.7%
Total Trade	90.6		65.9		156.4	

Source: Panama Canal Commission, Annual Report, FY 1990.

Grains

For grains, the key issues are:

- current and potential future port facilities on the U.S. West and Gulf Coasts;

- the requirements of receivers in Asia with respect to parcel sizes;

- the location of U.S. grain-producing areas in relation to rail and barge links to U.S. ports;

- the comparative economics of moving grain from the U.S. Midwest to the U.S. Gulf by rail and/or barge plus sea-borne transportation costs (via Panama or alternative bypass routes) versus the rail cost of moving grain from the Midwest to U.S. West Coast ports for onward seaborne transportation to Asia, in particular Japan.

No grain moves through Los Angeles, Long Beach or Oakland. A very limited volume goes

through Sacramento/Stockton and San Diego (with a very small hinterland).

Seattle can load vessels with drafts up to 65 to 85 feet at grain terminals but most of the grain transits the Columbia River which is limited to 41 feet of vessel draft (sailing on tides and with a specialized "Real time tidal model"). However, a U.S. Army Corps of Engineers feasibility study is currently underway to assess deepening the Columbia River to 43 feet. Given Corps time frames for projects like this, if this project goes forward it would occur prior to 2020.

The competition for Midwest grain exports focuses on Pacific Northwest (PNW) exports. In 1980, West Coast ports accounted for 27.0% of grain railcars unloaded at ports. In 1990, West Coast ports have increased to 42.9% of grain railcars unloaded at ports. One facility at Kalama on the Columbia River now unloads 77,299 railcars (i.e. approximately 8 million tonnes) mainly composed of corn from Nebraska bound for Asia which previously went through the Canal. The next largest rail export port is Houston with only 49,985 railcars unloaded in 1990[2]. Tacoma and Portland are in excess of 40,000 carloads.

The Mississippi river is limited at the mouth to ships of under 47' draft if heavier than 100,000 DWT and 48' if less and at New Orleans to 45' depth. The Mississippi river gets shallower up river where the grain terminals are located - about 40' depth. According to The Army Corps of Engineers[3], the water resources Development Act of 1986 authorized enlargement of the 40-foot channel from the Gulf of Mexico to Baton Rouge to 55 feet deep by 750 feet wide. Although the channel was authorized to this depth, it continues to be maintained to 40 feet. Resistance resulting from environmental impacts are making changes in such mandated dredging very difficult as is seen, for example, in the case of Los Angeles.

Currently, of the 12,404 vessels of all types calling at New Orleans to go up the Mississippi river only 2% are over 100,000 DWT 13% are between 70,000 and 100,000 dwt and 11% are 60,000-70,000 DWT. The shipment of grains from the Mississippi River to North Europe, which for grains represents an importing area which probably has fewer size restrictions at key ports than most, now includes use of up to Cape Size vessels (i.e. up to and around 120,000 dwt) loading 65-90,000 tonnes of grains.

The incidence of use of these large vessels accounts for up to 25% of grain shipments from

[2] American Association of Railroads

[3] The U.S. Army Corps of Engineers, Port Series Handbook Number 20, 1990 revision entitled "The Port of New Orleans, Louisiana", p.4

the U.S. Gulf to Europe. However, vessels can discharge at very few ports in Europe, namely Rotterdam, possibly Amsterdam and Hamburg. The use of Cape sizes is generally restricted to the light grains, for example, soybean meal and pellets.

Currently, there are specific restrictions on the sizes of vessel that the Japanese will accept for grains discharges: 225 - 230 m length in the majority of the approximately 18 Japanese ports, which are supplied in 5 different combinations. South Korea has similar restrictions at around 11.5m draft and Taiwan at 12.4 m draft. Japanese mills prefer to take cargo in lots of around 25,000 tonnes, with 2 grades per shipment, although some will accept 50,000 tonnes. There may be no incentive for the Japanese receivers to expand their facilities to take larger vessels. If there were an incentive, this would already have happened for grain shipments via the U.S. West Coast because of the deeper water facilities in Seattle.

For reasons of operational ease and flexibility and the current infrastructure in Japan, South Korea and Taiwan there may be some resistance to the transportation of larger parcels of grains between the United States and Asia. Some operators have suggested, for example, that quality control becomes more difficult with the use of larger vessels. Against this, it should be remembered that some 20 years ago grain was habitually shipped in vessels of 20,000 dwt. On balance and subject to shipping economics and the easing of Canal restrictions, we consider there is the potential for a drift upwards in the sizes of vessels used to take U.S. grain into the Northern Pacific basin in the same way that there has been into Europe. However, we have assumed that maximum parcels will be around 100,000 tonnes, approximately twice the typical current cargo size between the U.S. Gulf and Japan.

With regard to the location of grain production, the areas in the U.S. Midwest grain belt which are expected to generate growing exports are in Central and Eastern parts of the Mississippi basin. For these regions barge links to the U.S. Gulf are more accessible and the rail links to the U.S. Pacific ports offer no comparative advantage (see below). It is estimated that in 1990, representative barge costs to U.S. Gulf were around $10.35/ton compared with rail costs of $21.69/ton. By comparison, estimated rail costs to the U.S. West Coast were $27.12/ton. It would take a radical change in the cost structure for appreciably more grain to shift to the West Coast and there is nothing seen on the horizon which would effect such a radical change.

Table 7.4 summarizes our estimates of overall grain transportation costs between the U.S. Midwest and the Asian North Pacific basin from the U.S. Gulf and West Coasts respectively. Estimates for the U.S. Gulf are subdivided further between the Panama Canal and alternative all water bypass routes. Although all water bypass routes are the subject of more

detailed discussion in section 7.3, in the case of grains it is considered more appropriate to discuss all alternatives here, in the context of the landbridge.

On the current average 'Panamax' vessel sizes out of the U.S. Gulf and out of the U.S. West Coast, the total costs converted to $/cargo ton are marginally higher for the U.S. West Coast (assuming a weighted average of barge and rail costs into the U.S. Gulf) because the high costs of rail into the U.S. Pacific Northwest (PNW) offset on average the lower costs of the shorter seaborne route. If one compares Cape size vessels (nominally fully loaded) out of the U.S. Gulf via the Cape and from the PNW, there is an apparent advantage of approximately $5.00/ton in favor of the U.S. Gulf. Similarly, if one compares Panamaxes out of the U.S. Gulf with Cape sizes out of PNW, then there is approximately a $1.00-4.00/ton differential in favor of the route from PNW. This increases to between $7.00 and $10.00/ton when comparing nominal Cape sizes out of the PNW (fully loaded vessel of 126,500 dwt as before) to rates out of the U.S. Gulf using a Panamax vessel combined with rail only costs into the Gulf as opposed to the weighted average of rail and barge costs. However, if barge -only costs are assumed into the U.S. Gulf the economics shift back in favor of the U.S. Gulf. If one compares Panamax vessels from the U.S. Gulf through the Canal to Cape size vessels via Cape of Good Hope, there is an incentive to use the larger vessel size. These examples for Cape size vessels assume the ships are fully loaded . As indicated from draft considerations in the Mississippi quoted above, this is not currently practical.

In conclusion therefore, based on these considerations, it is our judgement that grain shipments will not be further switched from U.S. Gulf to U.S. West Coast ports. Moreover, movements from the U.S. Gulf will continue via the Panama Canal, moving in fully laden vessels up to 100,000 dwt under Case 2.

Containers

The major area in which the landbridge is expected to gain market share, as noted in the last section, is in the case of containers. In this context the term landbridge is used to describe the movement of cargo that is brought to a U.S. port on one coast and is railed either to a port on another coast for onward distribution to the hinterland or direct to a hinterland destination which logically could be supplied via more than one coast. The most important trades in the context of the Panama Canal are those to and from the Far East. True "landbridge" which is defined as Asian containers moving to Europe (or vice versa) across North America are currently minimal and are expected to continue to be relatively small volumes relative to all water trade between Asia and Europe.

The major advantage that the landbridge holds over the all water route for getting cargoes from Asia to the U.S. East Coast and from Europe to the U.S. West Coast is the shorter time for transit. Container ships are becoming larger, trains are more often double-stacked, and the commodities in the containers are becoming more and more valuable relative to the transportation costs saved over the all-water route. Since the widespread adoption of double stack trains, diversion to the landbridge has accelerated with time savings from the Far East. Currently, for example from Japan to New York, shipping times (stack to stack) through the Canal typically are 27 days. Via a rail connection from Seattle this time is reduced to 14 days; via rail from Los Angeles/Long Beach, 17 days. These transit times will tend to reduce over time as vessel design speeds are increased. For containers from Asia destined for Chicago, Memphis or other major inland distribution points, the advantage to landbridge via West Coast ports is even greater since these routes require additional inland transfer and hence additional time and cost form East Coast ports.

For the containerizable U.S. imports and exports traded with all world partners, U.S. Pacific Coast has gained approximately 7% in market share during the years from 1984 to 1989. In other words, other competing trade routes (including the Panama Canal) lost market share. This occurred for two primary reasons:

1. Containerized trade with Pacific Rim countries increased at a much faster rate than with European, African or other trading partners. This trend is expected to continue.

2. The value of containerized cargo increased dramatically which led to development of faster means of shipment (i.e. intermodal services) to reduce inventory carrying costs. This is defined in greater detail in other sections of the chapter.

From 1987 to 1990 according to PCC data, containerized imports from Asia and Europe experienced virtually no growth. There was some growth (albeit minor) in containerized export trade via the Canal (Note: the PCC only began reporting containerized trade separately in its 1987 annual report) - see Figures 7.1 and 7.2.

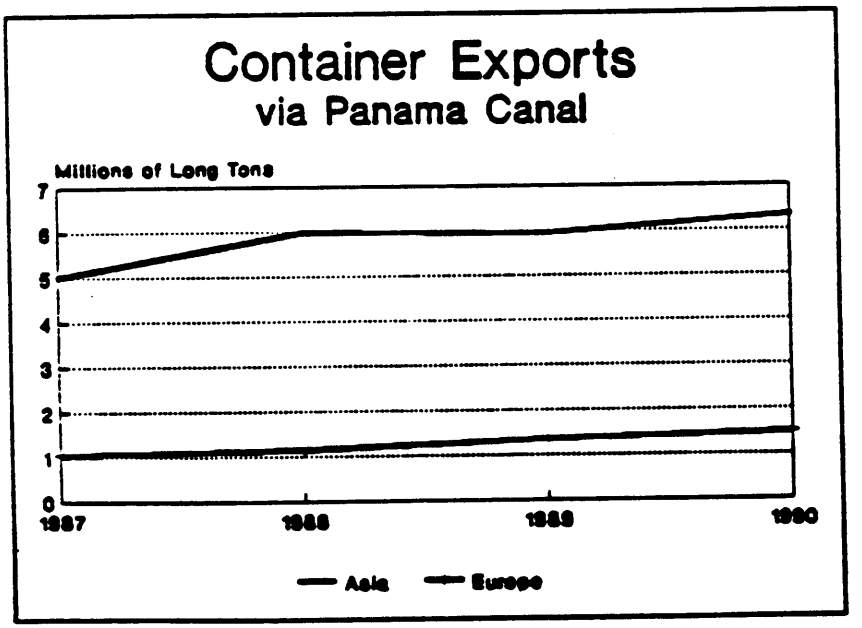
It should be emphasized that the cargoes utilizing intermodal service are light and very high valued compared with all-water U.S. trade. Opportunity costs of inventory are greatly reduced by speedier landbridge routes.

It is estimated that over 93% of import cargoes to, and two thirds of export cargoes from, the Midwest to/from the Far East are moved on the landbridge via U.S. West Coast ports.

It is understood also that some 98% of U.S. Gulf import cargoes and 93% of exports also are routed via the landbridge to the U.S. West Coast[4]. On the U.S. West Coast, Seattle, Tacoma, Los Angeles and Long Beach are currently taking ships with a beam up to 120' and draft up to 42' and Oakland is also deepening their channel.

On the U.S. Atlantic seaboard even import cargoes into Southern ports from the Far East are increasingly diverting to the landbridge from the all water route, up from an estimated 38% in 1988 to 45% in 1990. Of the imports from Asia into the U.S. North East around 37% enter via the port of New York/New Jersey while 55% come in via the U.S. West Coast. By comparison about 35% of exports from the U.S. North East to Asia move via New York/New Jersey, 20% via Mid Atlantic ports and 45% via the U.S. West Coast. Of the cargo entering the port of New York/New Jersey, only 11% of imports and 14% of exports are moved overland to other areas. Reportedly, half or more of imports destined for the East Coast arrives on double-stacked trains, often a mile in length, for the West Coast.

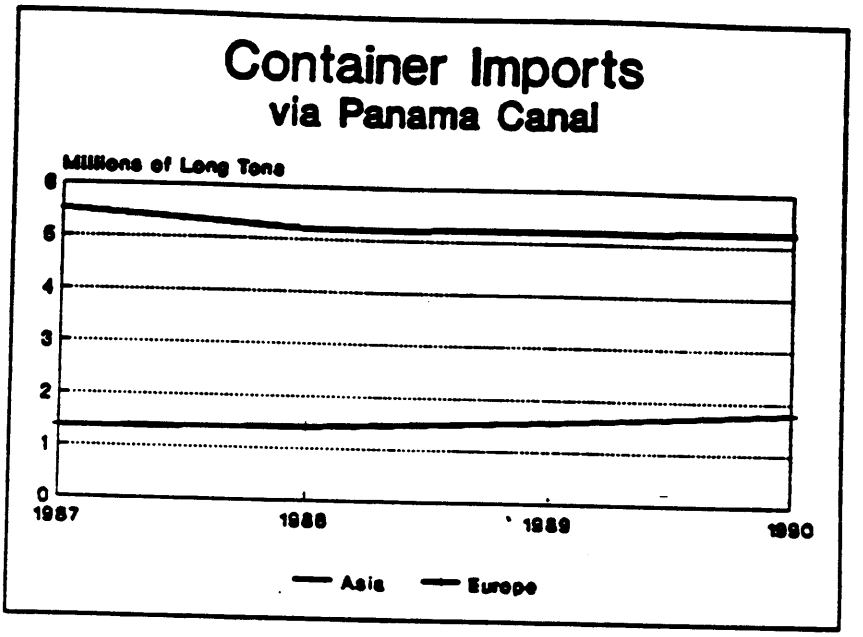
Figure 7.1



Source: BST (Using PCC data)

[4] The New York Port Authority.

Figure 7.2



Source: BST (Using PCC Data)

Based on data provided by the ports and shippers[5], of the container traffic coming into the Pacific Northwest in 1990, an estimated 75% is destined for parts of the United States to the East and of container traffic coming into California ports, 25%. In total, 65% of U.S. West Coast container imports from Asia, or 9.8 million tonnes, were bound for points East. Similarly, 38%, or 5.4 million tonnes of exports from the West Coast for Asia were from regions of the United States outside the West Coast.

In several studies for West Coast ports, WEFA and BST have concluded that the landbridge will have about 2% per year greater growth than the all-water route. This agrees closely with the conclusions of the New York/New Jersey Port Authority. This latter set of ports is now moving to try to capture some trade by taking advantage of Suez routes from Southeast Asia. Whereas they are non-competitive for much of the trade from the Far East,

[5] West Coast Port Authorities (Port of Seattle, Tacoma, Los Angeles and Long Beach).

from Singapore they gain some advantage although this latter area does not represent a source of potential bypass trade[6].

Our conclusions are supported by a detailed evaluation of transportation economics on the key routes for containerized trade from Asia in the U.S. East and West Coasts and from Europe into the U.S. East and West Coasts. Table 7.5 provides a summary of ocean freight estimates for these routes, for vessel sizes ranging from those currently in use up to those sizes which it is assumed will be developed in the longer term.

These freight estimates which are expressed in terms of US$1990 have been developed from assessments of owners' operating costs (as described in section 8.3 below) which for 1990 have been reconciled with quoted tariffs. The results indicate that for cargoes from Asia, for example, and for equivalent ship sizes, freight rates into the U.S. East Coast in 2020 and 2060 are expected to be approximately $40/ton above those for U.S. West Coast while transit times are estimated to be in the region of 11-14 days more. Moreover this excludes consideration of inventory costs which for 2020 into the U.S. East and West coasts are estimated to exceed $20/ton for the seaborne portion only.

To determine the inventory carrying cost advantage, we start with data on the value per ton projected for container cargo on the two important routes. The average value of containerized tonnage from Asia imported to the U.S. is $7,682 per ton while European containerized imports are only valued at $3,484 per ton in the year 2020. These values are expected to decrease because more valuable time sensitive cargoes will continue to be diverted to intermodal service (i.e. Asia to West Coast to U.S. midwest etc). This trend will leave lower value cargoes moving through the Canal.

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[6] Some indication of the location of the breakeven point for Asia to U.S. East Coast trades between Suez and Panama Canal routes, on the basis of mileage only, may be gained from the following comparisons for Singapore, Thailand and Japan:

	Miles (excluding Canal mileages)	
To New York from:	Via Panama	Via Suez
Singapore	12,467	10,133
Thailand	12,556	10,964
Japan	9,659	13,025

Container Cargo
Average Value per Ton (US$ 1990)

Route	2020	2060
Far East Asia to U.S. East Coast	7,682	7,132
Europe to U.S. West Coast	3,484	3,264

Notes: 1. Import data is reported as CIF (it includes the value of cargo per ton, insurance and freight cost).
2. The 1991 calculations were based upon dividing the dollar value of the cargo by its reported tonnage.
Source: BST Associates/The WEFA Group

Average rail transportation costs for containers between the U.S. East and U.S. West Coasts, the final part of this calculus, are projected to be $72/tonne in 2020 and $85/tonne in 2060. U.S. containerized liner imports from Asia had a value of $83 billion and a tonnage of 14.7 million tons in 1990. Approximately 86% by value and 81% by weight of these imports move via the west coast. West Coast dollar value was highest in the North Pacific reflecting the North Pacific port region's strong position in higher valued intermodal cargoes. Approximately 75% of container imports in Seattle/Tacoma are intermodal rail moves[7].

Travel times for double-stacked container trains from the U.S. West Coast are typically two days into the U.S. Midwest and three days to the East Coast. The route through the Canal is 10-14 days longer than by rail across the United States. With this travel time differential, average cargoes through the Canal would bear a higher inventory carrying cost as shown in the two tables below. In calculating opportunity (or inventory) carrying cost, the nominal cost of carrying inventory is placed at 9%. In fact, traders may pay more depending on their size and financial status. As shown in the table below, for Asian cargoes shipped to East Coast locations and for values exceeding $7200 per ton, or for interest rates exceeding 9%, the advantage is landbridge; for shorter landbridge distances these hurdle rates are correspondingly lower.

On the basis of similar comparisons, there is a clear cost advantage for all years for shipping container trade from the Far East bound for the U.S. Midwest through the U.S. West Coast

[7] BST Associates, using Department of Commerce data.

as against through the Panama Canal.

If the Panama Canal were not enlarged, then the potential ocean freight in favor of the landbridge would widen as cargoes, in particular into the U.S. West Coast, would be moved in increasingly larger vessels. Development of the Canal would permit comparable vessel sizes to be employed on both Panama and non-Panama routes although on the important trades from Asia into the United States an easing of port restrictions on the U.S. East Coast in the long term would be required to accommodate the largest vessels contemplated.

REPRESENTATIVE HURDLE RATES AND CARGO VALUES FOR US CONTAINERIZED LINER IMPORTS FROM ASIA (4400 TEU Vessel)

	East Coast	West Coast
Ocean/Port	$185.4	$144.4
Inland	$7.0	$72.0
Advantage in Days:	13.5	
Rate:	9.00%	
Average Value/ton:	$7.200	
Opportunity Cost	$24.0	$0.0
Total Cost	$216.4	$216.4

Source: The WEFA Group

Vehicles

Japanese and Korean fully assembled auto imports are nearly 5 times larger than European auto imports, that is, 3.0 million tonnes from Asia versus 0.6 from Europe. Approximately 38% of Asian auto imports move via U.S. East Coast ports and 58% via U.S. West Coast

ports. Nearly 76% of European imports move via East Coast ports and 24% via West Coast ports.

The major East Coast ports for inbound autos are Jacksonville, Baltimore and New York with 300,000 or more tonnes (the average import weight 1.1 tonnes). Houston brings up a poor fourth. The major West Coast ports are Los Angeles, Portland and Long Beach, which exceed 300,000 tonnes.

East Coast ports serve only their immediate hinterland, roughly to the Mississippi River, by truck. Everything to the West of the Mississippi is served from the West Coast by rail through to rail centers between Chicago and Dallas. Some areas east of the Mississippi, such as Cleveland and Indianapolis are also served by these links from the West Coast. We believe that this system is very stable and do not foresee shifts from and to the Canal from the mini-landbridge. There is no incentive to extend the West Coast rail links into the East

Destination of Autos
Arriving at East & West Coasts Ports

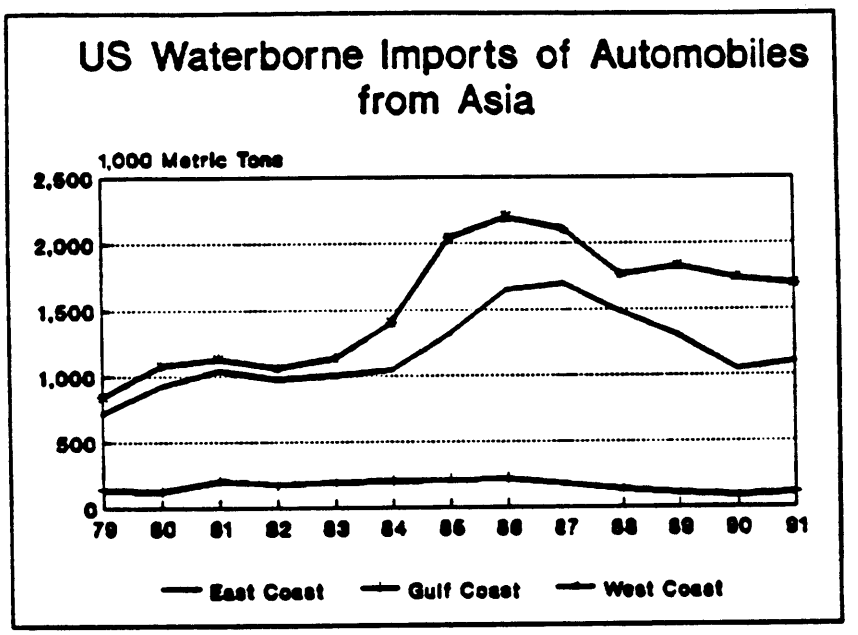
Destination	TOTAL	Arriving East Coast	Percent	Arriving West Coast	Percent
New England	269,120	109,640	5.2	159,480	10.9
South Atlantic	161,080	114,960	5.5	46,120	3.1
Midwest	2,286,720	1,277,920	60.7	1,008,800	68.8
Texas	72,960	51,600	2.5	21,360	1.5
Pacific NW	55,320	53,720	2.6	1,600	0.1
California	217,208	193,424	9.2	23,784	1.6
Canada	508,480	303,480	14.4	204,600	14.0
TOTAL	3,570,888	2,105,144	59.0	1,465,744	41.0

Source: ICC Public Use Waybill Data, 1990

Coast because the Asian auto manufacturers are increasingly locating plants in the United States. More and more, much of the automobile is coming in from Asia as parts in containers, which as we noted above, are coming in greater numbers overland from the West Coast ports.

Auto imports from Asia and Europe to the US peaked in 1986 and have not returned to those peak levels (Figure 7.3). Imports from Asia reached approximately 2.2 million tons in 1986 via the Pacific Coast and 1.7 million tons via the Atlantic Coast.

Figure 7.3



Source: U.S. Department of Commerce and BST Associates

Imports of vehicles into the Atlantic Coast utilize the Panama Canal. These vehicles enter the U.S. primarily at the Ports of Jacksonville, Baltimore and New York. The hinterland for these vehicles is very small. In New York and Baltimore, vehicles remain in the urbanized North Atlantic area. In Jacksonville, imports move to Florida and the South Atlantic to New Orleans and the Mississippi River. Imports via the Gulf Coast have remained flat, serving

only the Houston area. Imports via the Atlantic ports decreased from 1.7 million tons in 1986-87 to approximately 1.0 million in 1990. The main reason for the decrease in imports of fully assembled vehicles as already noted was the increasing presence of Japanese manufacturing facilities in the US. These so-called "transplant" facilities will have the capacity to manufacture approximately 2.5 million units by 1994. Transplant capacity will then exceed the volume of fully assembled import vehicles.

7.2.2 65,000 DWT Design Ship (Status Quo or Case 1)

As discussed above landbridge trades (specifically containerized imports and exports to/from Asia and Europe) have been growing at an accelerated rate during the past ten to fifteen years and are expected to continue to grow at a faster rate than all water services from these regions using the Panama Canal trade.

Container movements were carefully analyzed regarding the actual U.S. origins and destinations of the cargo for specific port hinterland ranges, the cost of mode for inland transport, travel times of inland transport, reduced inventory carrying costs for faster transport service and other related factors to provide a comparison for all water routes.

Auto import trades were analyzed in a similar manner to containers. However, for auto imports, there will be less diversion from all water service through the Panama Canal.

In the dry bulk carrier sector we have examined in particular the potential for possible switching of U.S. grain exports to Asia from the U.S. Gulf Coast ports to U.S. West Coast ports or into larger ship sizes.

The results of the above analyses of landbridge bypass trades (and also of all water bypass trades as described in Section 7.3) in terms of commodity trade projections through the Canal are summarized in Tables 7.1 to 7.3.

Overall, it is estimated that total trade available to the Panama Canal, north and southbound, will grow by the equivalent of 1.8% per annum in the period between 1990 and 2020, and addition of some 109 million tonnes from 156 million tonnes in 1990. Within this, bulk chemicals trade is projected to rise by around 4% per annum and general cargo, containerized and refrigerated cargo volumes by about 3% per annum. Growth for all other commodities with the exception of crude oil, is in the range of 0.5% to 1.6% per annum with crude oil trade actually expected to decline over the period.

Envisaged trends in trade through the Canal between 2020 and 2060 generally reflect the slowdown in the rate of growth in the world economy and trade, although in the case of oil tankers and gas carriers a substantial downturn is envisaged in line with a large projected fall in global oil consumption. Only in the case of the dry bulk trades is the rate of growth in trade through the Canal expected to be similar to that in the period 1990-2020. Total trade through the Canal is projected to increase between 2020 and 2060. Total trade through the Canal is projected to increase between 2020 and 2060 by just over 1% per annum to 412 million tonnes, equivalent to an increase of 147 million tonnes.

The remainder of section 7.2 below highlights specific points arising from landbridge issues in relation to the various Canal alternatives. The overall impact on Canal trade of competing landbridge and all water bypass routes is summarized in the concluding section 7.4.

7.2.3 100,000 DWT Design Ship (Case 2)

2020 Projections

The only general cargo ship type which we envisage as being affected by the year 2020 by a removal of the present Panama Canal size constraint is the full container ship. This also is the only ship type for which we envisage trade will be diverted from the landbridge. New traffic for the Canal from the larger container ships will be drawn from the major world routes which transit Panama and will have been constrained to smaller sizes, and from the relatively minor container routes which pass through the Panama Canal.

We conclude that traffic from the large container ships will arise from only two routes:

- the major world trades between the Far East and the U. S. East Coast:
- the Panama Canal trades between the U.S. West Coast and Europe.

The liner routes, of which container trades are an example, have the characteristic of being served by a variety of operators and different sizes of vessel. For our calculations we have assumed that the large container ships secure about 40% of the traffic on the routes in which they take part.

The effect of the presence of larger container ships on the routes mentioned has been examined from the point of view of the economics of the landbridge. We have concluded

that the low unit cost offered by the larger vessels will attract back to the Canal a certain quantity of cargo, about 10%, which would otherwise use the landbridge. For north and southbound routes in total this amounts to just over 1 million tonnes (Table 7.8).

2060 Projections

It is assumed that the employment of the 6,000 TEU vessels - introduced into the transit forecasts for Case 2, 2020 - will increase further in 2060 on those routes where the volume of trade is sufficient to justify their use. Whereas for 2020 we assumed that these ships secured about 40% of the traffic on such routes, by 2060 we anticipate this proportion will have grown to 60%.

As for Case 2, 2020 we have concluded that the low unit costs offered by these 6,000 TEU vessels will attract back to the Canal a certain quantity of cargo, about 10%, which under the status quo case would otherwise switch to the landbridge. In total this amounts to our additional 3 million tonnes of trade through the Canal. However, the extent to which the Canal could be expected to attract cargo back from the landbridge is assumed to be constrained by the capability of those ocean routes supplying the landbridge to utilize the more competitive 9,000 TEU (148,000 DWT) ships which it is assumed will be employed on major routes by 2060.

7.2.4 150,000 DWT Design Ship (Case 3)

2020 Projections

As for Case 2 potential change in trade volumes between the Canal and the landbridge relate only to full container ships. The new ship size of 148,000 DWT which would in theory be able to take advantage of the larger Canal is not assumed to exist until after 2020 (see discussion about global fleet forecasts in section 8.3.2). Therefore the Panama Canal trade forecast for container ship trade in 2020 under Case 3 and the same as those under Case 2.

2060 Projections

By 2060 it is assumed that the largest size of container ship will have increased to 9,000 TEU (148,000 DWT). Therefore some utilization of 148,000 DWT vessels has been assumed under this case for those Panama routes on which it is expected that the volume of trade will be sufficiently large in both directions to support a viable service using these

larger ships - in particular U.S. East Coast to Far East and Far East to U.S. East Coast. The introduction of these new ships is assumed to be limited to those routes which previously utilized 6,000 TEU (90,000 DWT) vessels, the other new full containership size not currently in existence but which is assumed will be introduced by 2020. The apportionment of the trade assumed available to these larger ship sizes between the 6,000 and 9,000 TEU ships has been determined with reference to the volume of trade on individual routes and the size distributions of larger vessels currently employed on these routes. However, no significant change is envisaged in the volume of trade switched from the landbridge to the Canal as compared with Case 2.

7.2.5 250,000 DWT Design Ship (Case 4)

As it is not envisaged that containerships in the long term will exceed 150,000 dwt, no further changes are considered likely with respect to trade to this ship type, the only case where the landbridge is important. The landbridge is therefore not a considerations for this and the remaining Case 5.

7.3 All Water Bypass

7.3.1 Introduction

The all water bypass trades are characterized by those cargo flows which move on routes for which the Panama Canal offers the shortest voyage but where currently the most economic transportation option involves the utilization of large vessels which exceed Panama dimensions operating on longer hauls. Given, with relatively few exceptions, that all general cargo types are currently capable of transiting the Canal the issue of all water bypass trades is concerned with the movement of bulk cargoes and in particular major dry bulk commodities.

We commenced by identifying, from our extensive data bases of trade and ship movements, all possible route and vessel size combinations which represent all water bypass trade. Where the precise location of the source of specific commodity exports within a broad geographical area is critical to the potential route pattern, analysis of cargo volumes and vessel economics have been focussed in order to take this into account. The apportionment of future trade flows between the Canal and all water bypass routes for each individual case therefore has been determined on a series of detailed evaluations of shipping economics.

Tables 7.5 and 7.6, covering dry bulk and oil trades respectively summarize the results of our

work on shipping economics both for potential bypass trades where cargoes are shifted through the Canal and those for which traffic is not diverted. In order to place the comparison of shipping economics in perspective these tables include also our assessments of Canal tolls and voyage mileages (see also Appendix 7-A). Discussion of the basis for our projections of vessel size developments and shipping economics is covered in more detail in sections 8 and 9. Here we focus solely on the results of these analyses as they reflect on potential Canal trade volumes.

For major dry bulk trades we have considered the following routes for which it has been concluded that cargoes will be diverted through the Canal for one or several of the Canal alternatives:

Route	Commodity
U.S. East Coast - Far East Asia	Coal
U.S. Gulf Coast - Far East Asia	Coal
Canada East Coast - Far East Asia	Iron Ore
Venezuela - Far East Asia	Iron Ore
Columbia - Far East Asia	Coal

Potential bypass traffic not diverted through the Canal, but for which shipping economics have been evaluated are:

Route	Commodity
North Brazil - Far East Asia	Iron Ore
North Chile - Europe	Iron Ore

In addition to the above the major dry bulk trades from Australia into Europe were also considered. However, on the basis of mileages alone it is apparent that the most economic options are via either the Cape of Good Hope or the Suez Canal rather than the Panama Canal.

In the oil sector, there are relatively few potential bypass trades which either currently, or conceivably in future will, employ tankers which exceed existing Panama Canal dimensions. Trades evaluated are summarized below:

Route	Commodity
Potential Bypass Traffic Diverted Through the Canal	
Venezuela - Far East Asia	Orimulsion
Traffic Retained Through the Canal	
Venezuela - Asia	Crude Oil
Potential Bypass Traffic Not Diverted Through the Canal	
S.E Asia - U.S. Gulf	Crude Oil
S.E Asia - Caribbean	Crude Oil

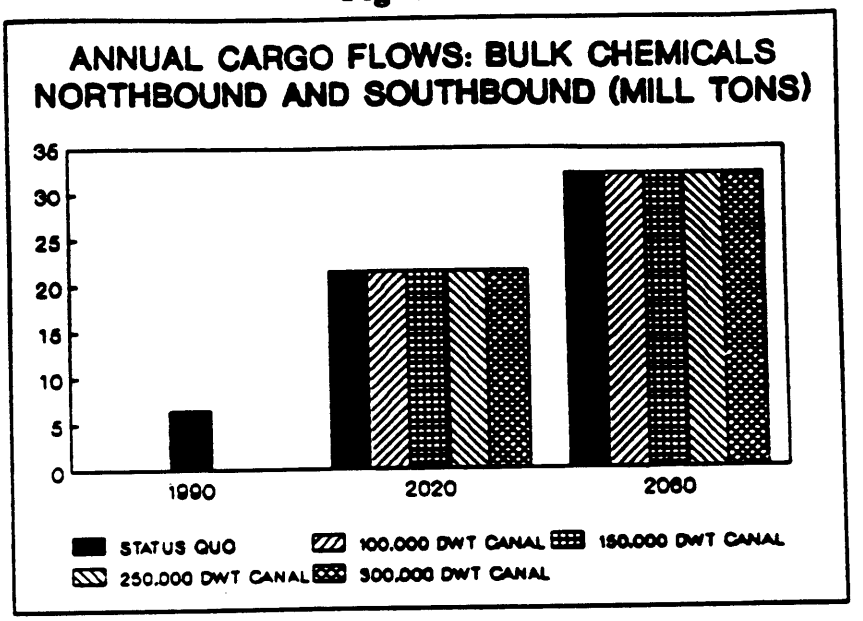
The results of economic comparisons in terms of Canal trade are summarized in the following sections. In general, we have taken a conservative approach when deciding whether or not to shift cargo through the Canal. Therefore, if transportation differentials between the Canal and alternative bypass routes have been marginal, cargo has not been shifted. However, in these instances the assumptions regarding Panama Canal tolls in particular become critical. As a generalization no switches of trade were made from by-pass routes to the Canal if the overall freight differential was less than 10 cents/ton. Although the size of the Canal toll in comparison with the total freight through the Canal varies by ship type, size and the length of voyage, in all cases a differential of less than 10/cents is small in relation to the Canal toll and well within the accuracies of the exercise given that toll structures have still to be determined in the light of further financial studies. Additional supporting analysis on this issue is presented in the appendix of this chapter.

As agreed with CAS, we have assumed that Panama Canal tolls increase at a rate in line with other shipping costs. However, it seems possible that a toll pricing strategy could be structured in such a way as to encourage additional marginal business. The current differential pricing strategy adopted by the Suez Canal Authority provides a good example of the way in which tolls may be levied according to whether trades represent captive markets or marginal business for which different fee structures are required to attract volume. This aspect is best illustrated in the shipping economics estimates for tankers, summarized in Table 7.7. While, for the smallest tanker sizes shown, Suez Canal tolls are

significantly below those for the Panama Canal, for the largest sizes, Canal dues are very similar.

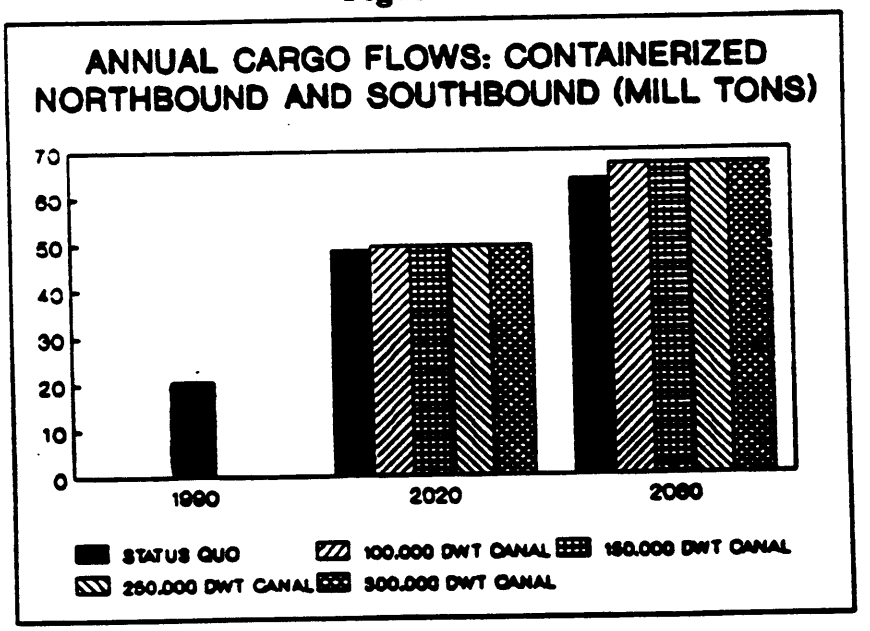
Where relevant, cargo that has not been shifted because the economics are marginal is identified in the following sections which summarize the potential switching of all water bypass trade under different cases.

Figure 7.4



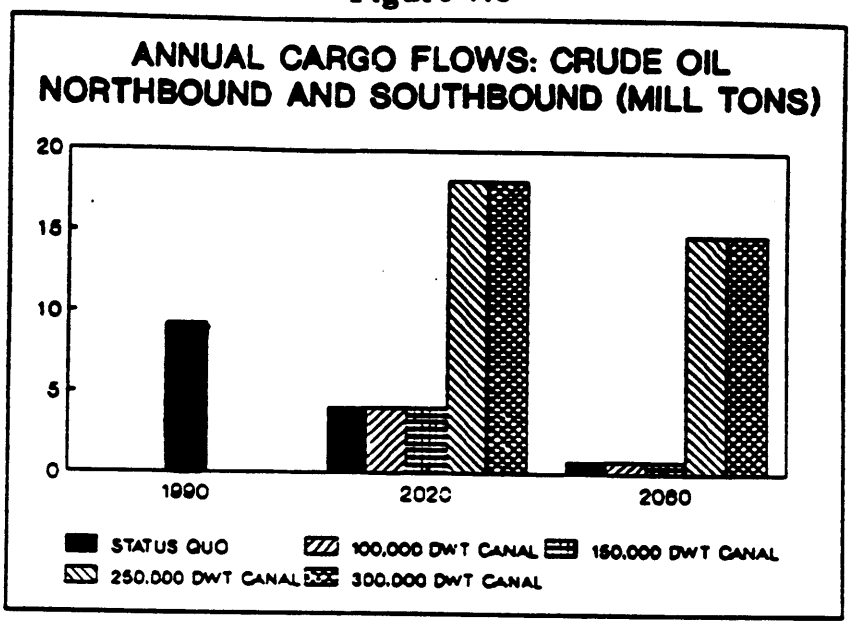
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.5



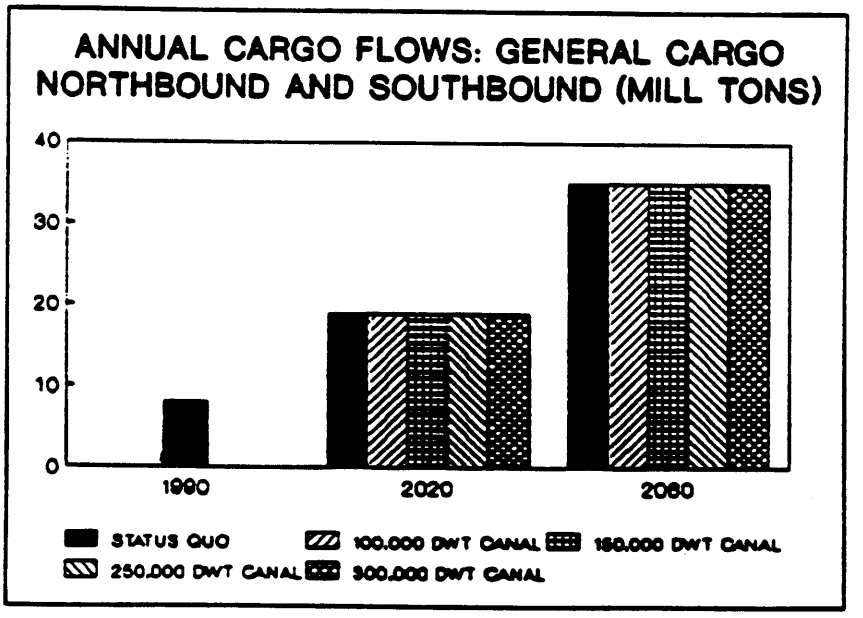
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.6



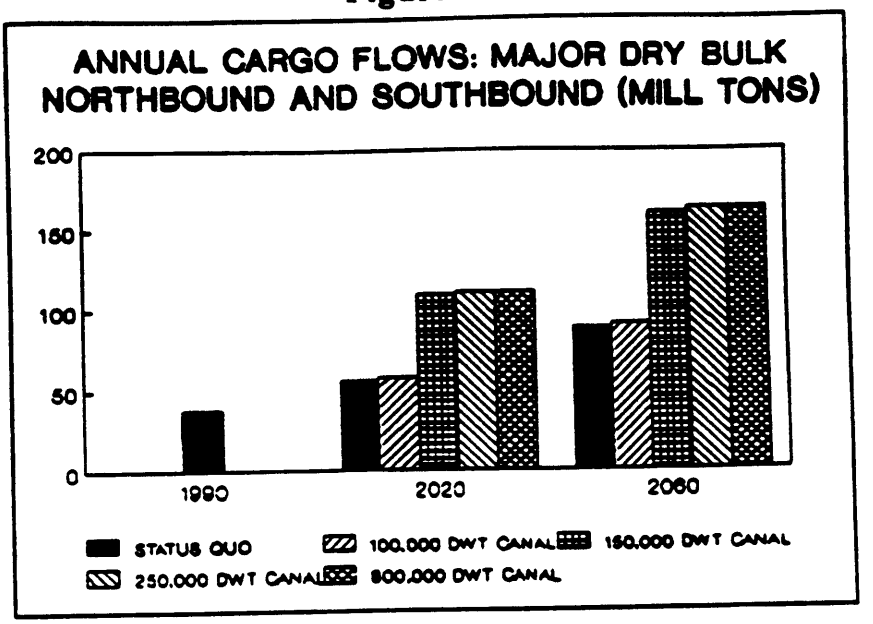
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.7



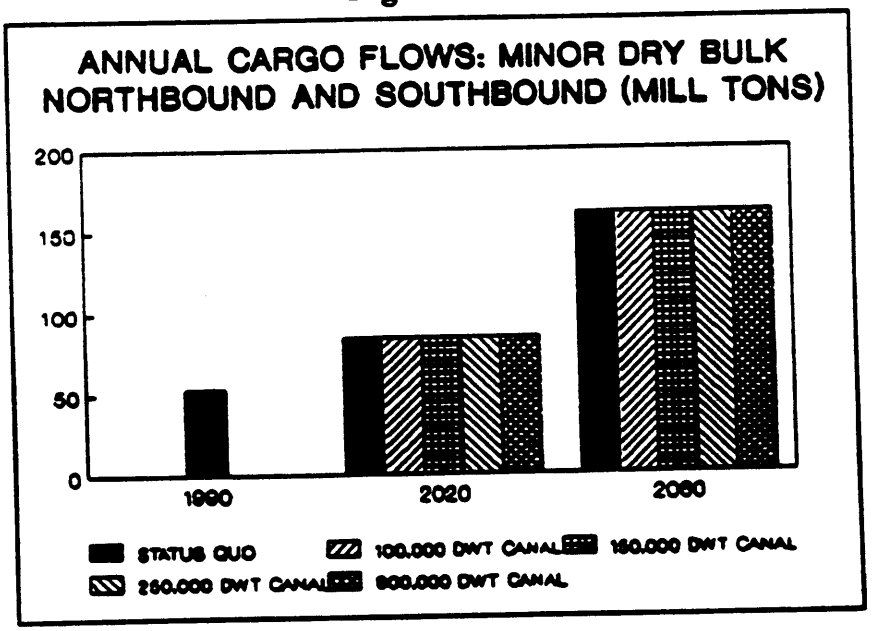
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.8



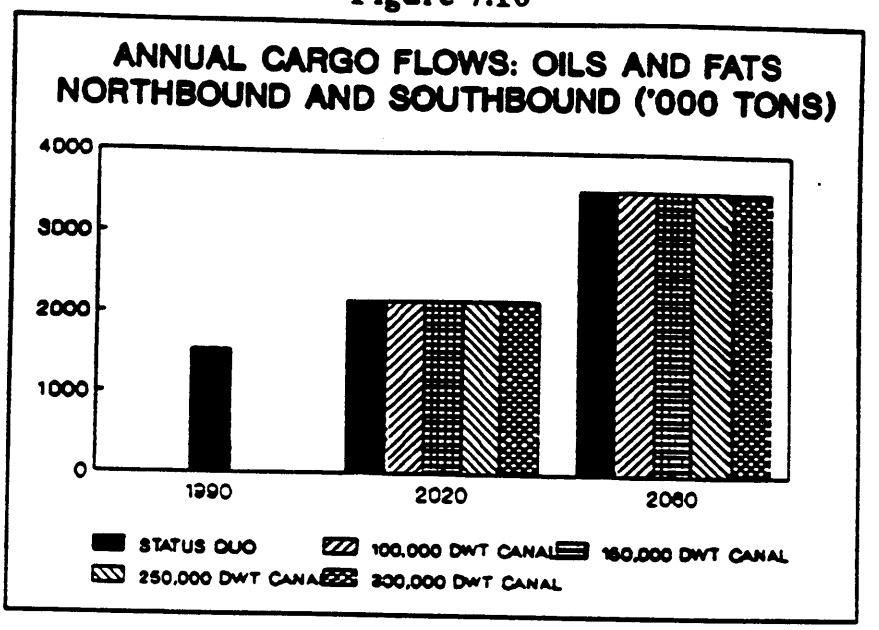
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.9



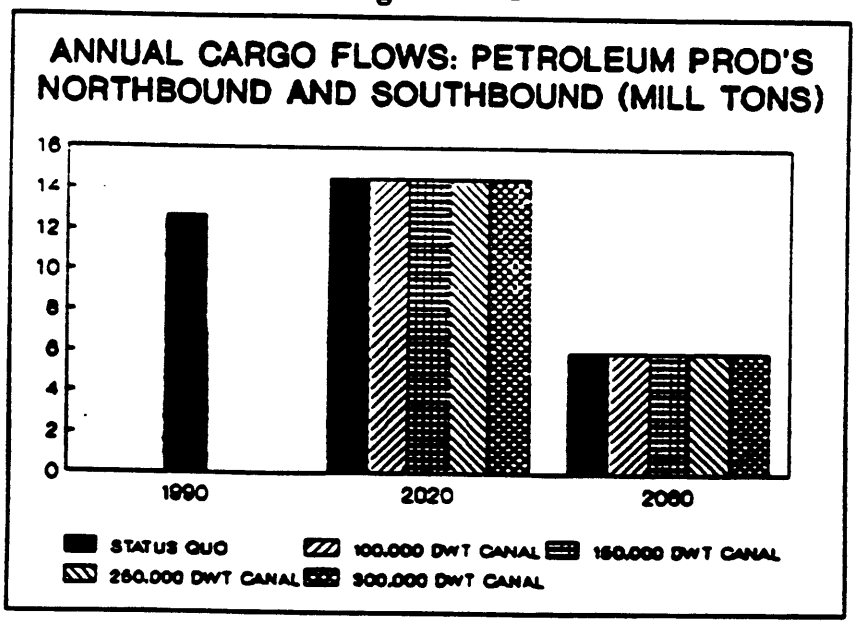
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.10



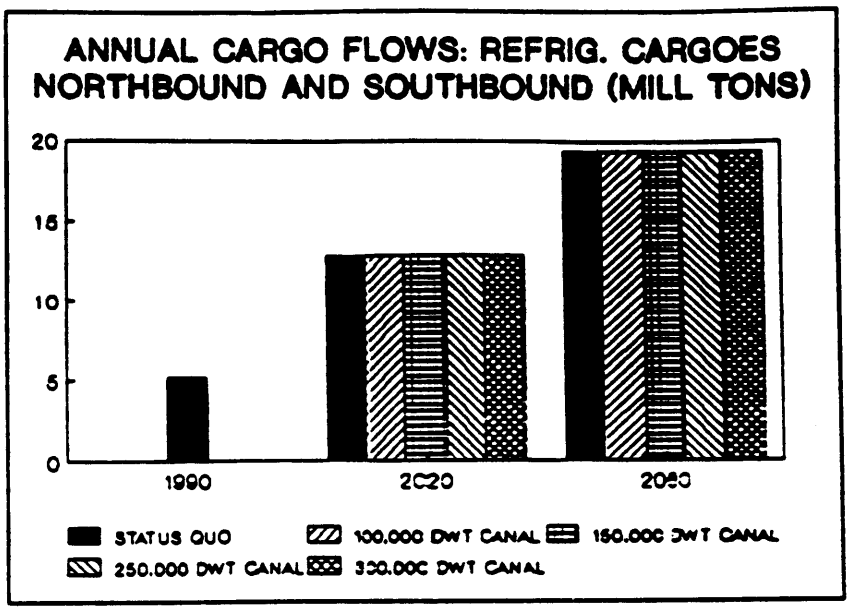
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.11



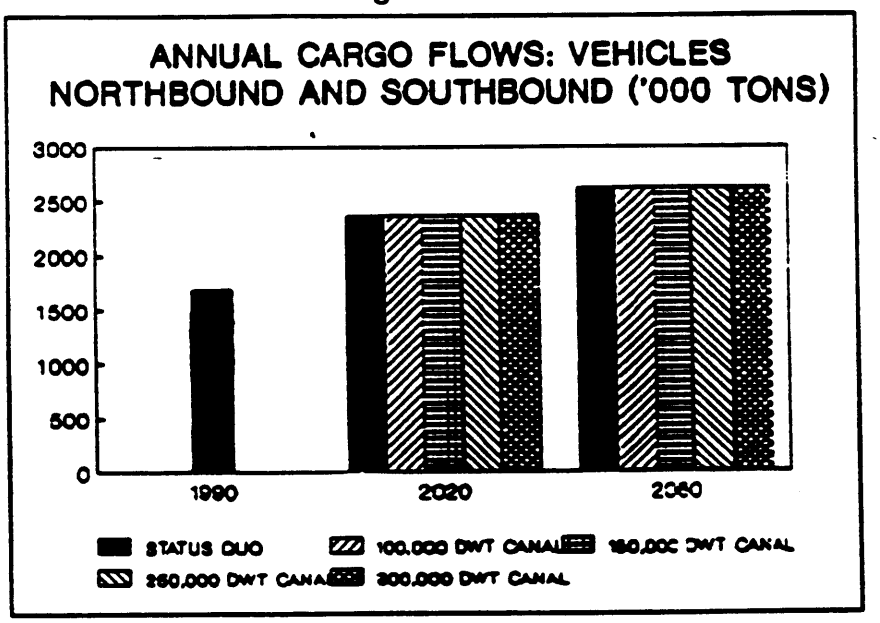
Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.12



Source: The WEFA Group (1990 data compiled from PCC annual reports).

Figure 7.13



Source: The WEFA Group (1990 data compiled from PCC annual reports).

Table 7.1

ANNUAL CARGO FLOWS BY COMMODITY TYPE
NORTHBOUND

COMMODITY	('000 Tonnes) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
STATUS QUO						
BULK CHEMICALS	929.0	2,802.3	4,542.0	3.7%	1.2%	2.3%
CONTAINERIZED	9,172.7	19,898.4	24,878.5	2.6%	0.6%	1.4%
CRUDE OIL	6,574.0	923.5	97.9	-6.3%	-5.5%	-5.8%
GENERAL CARGO	4,777.4	9,588.0	17,303.2	2.3%	1.5%	1.9%
MAJOR DRY BULKS	10,354.3	13,993.6	21,491.3	1.0%	1.1%	1.0%
MINOR BULKS	22,288.1	38,251.7	67,934.5	1.8%	1.4%	1.6%
OILS & FATS	1,262.0	1,533.0	2,539.5	0.7%	1.3%	1.0%
PETROLEUM PRODS	4,466.2	3,907.0	1,513.5	-0.4%	-2.3%	-1.5%
REFRIG CARGOES	4,578.2	11,510.5	17,665.2	3.1%	1.1%	1.9%
VEHICLES	1,387.8	1,982.4	2,219.8	1.2%	0.3%	0.7%
TOTAL	65,789.8	104,390.5	160,185.3	1.6%	1.1%	1.3%
100,000 DWT						
BULK CHEMICALS	929.0	2,802.3	4,542.0	3.7%	1.2%	2.3%
CONTAINERIZED	9,172.7	20,289.3	26,070.5	2.7%	0.6%	1.5%
CRUDE OIL	6,574.0	923.5	97.9	-6.3%	-5.5%	-5.8%
GENERAL CARGO	4,777.4	9,588.0	17,303.2	2.3%	1.5%	1.9%
MAJOR DRY BULKS	10,354.3	13,993.6	21,491.3	1.0%	1.1%	1.0%
MINOR BULKS	22,288.1	38,251.7	67,934.5	1.8%	1.4%	1.6%
OILS & FATS	1,262.0	1,533.0	2,539.5	0.7%	1.3%	1.0%
PETROLEUM PRODS	4,466.2	3,907.0	1,513.5	-0.4%	-2.3%	-1.5%
REFRIG CARGOES	4,578.2	11,510.5	17,665.2	3.1%	1.1%	1.9%
VEHICLES	1,387.8	1,982.4	2,219.8	1.2%	0.3%	0.7%
TOTAL	65,789.8	104,781.4	161,377.3	1.6%	1.1%	1.3%

Table 7.1 (Continued)

ANNUAL CARGO FLOWS BY COMMODITY TYPE

NORTHBOUND

COMMODITY	('000 Tonnes) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
150,000 DWT						
BULK CHEMICALS	929.0	2,802.3	4,542.0	3.7%	1.2%	2.3%
CONTAINERIZED	9,172.7	20,289.3	26,070.5	2.7%	0.6%	1.5%
CRUDE OIL	6,574.0	923.5	97.9	-6.3%	-5.5%	-5.8%
GENERAL CARGO	4,777.4	9,588.0	17,303.2	2.3%	1.5%	1.9%
MAJOR DRY BULKS	10,354.3	13,993.6	21,491.3	1.0%	1.1%	1.0%
MINOR BULKS	22,288.1	38,251.7	67,934.5	1.8%	1.4%	1.6%
OILS & FATS	1,262.0	1,533.0	2,539.5	0.7%	1.3%	1.0%
PETROLEUM PRODS	4,466.2	3,907.0	1,513.5	-0.4%	-2.3%	-1.5%
REFRIG CARGOES	4,578.2	11,510.5	17,665.2	3.1%	1.1%	1.9%
VEHICLES	1,387.8	1,982.4	2,219.8	1.2%	0.3%	0.7%
TOTAL	65,789.8	104,781.4	161,377.3	1.6%	1.1%	1.3%
250,000 DWT						
BULK CHEMICALS	929.0	2,802.3	4,542.0	3.7%	1.2%	2.3%
CONTAINERIZED	9,172.7	20,289.3	26,070.5	2.7%	0.6%	1.5%
CRUDE OIL	6,574.0	923.5	97.9	-6.3%	-5.5%	-5.8%
GENERAL CARGO	4,777.4	9,588.0	17,303.2	2.3%	1.5%	1.9%
MAJOR DRY BULKS	10,354.3	13,993.6	21,491.3	1.0%	1.1%	1.0%
MINOR BULKS	22,288.1	38,251.7	67,934.5	1.8%	1.4%	1.6%
OILS & FATS	1,262.0	1,533.0	2,539.5	0.7%	1.3%	1.0%
PETROLEUM PRODS	4,466.2	3,907.0	1,513.5	-0.4%	-2.3%	-1.5%
REFRIG CARGOES	4,578.2	11,510.5	17,665.2	3.1%	1.1%	1.9%
VEHICLES	1,387.8	1,982.4	2,219.8	1.2%	0.3%	0.7%
TOTAL	65,789.8	104,781.4	161,377.3	1.6%	1.1%	1.3%
300,000 DWT						
BULK CHEMICALS	929.0	2,802.3	4,542.0	3.7%	1.2%	2.3%
CONTAINERIZED	9,172.7	20,289.3	26,070.5	2.7%	0.6%	1.5%
CRUDE OIL	6,574.0	923.5	97.9	-6.3%	-5.5%	-5.8%
GENERAL CARGO	4,777.4	9,588.0	17,303.2	2.3%	1.5%	1.9%
MAJOR DRY BULKS	10,354.3	13,993.6	21,491.3	1.0%	1.1%	1.0%
MINOR BULKS	22,288.1	38,251.7	67,934.5	1.8%	1.4%	1.6%
OILS & FATS	1,262.0	1,533.0	2,539.5	0.7%	1.3%	1.0%
PETROLEUM PRODS	4,466.2	3,907.0	1,513.5	-0.4%	-2.3%	-1.5%
REFRIG CARGOES	4,578.2	11,510.5	17,665.2	3.1%	1.1%	1.9%
VEHICLES	1,387.8	1,982.4	2,219.8	1.2%	0.3%	0.7%
TOTAL	65,789.8	104,781.4	161,377.3	1.6%	1.1%	1.3%

Table 7.1 (Continued)

ANNUAL CARGO FLOWS BY COMMODITY TYPE

SOUTHBOUND

COMMODITY	('000 Tonnes) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
STATUS QUO						
BULK CHEMICALS	5,544.3	18,667.4	27,610.0	4.1%	1.0%	2.3%
CONTAINERIZED	11,287.8	28,674.0	38,754.6	3.2%	0.8%	1.8%
CRUDE OIL	2,646.0	3,184.6	723.2	0.6%	-3.6%	-1.8%
GENERAL CARGO	3,301.3	9,397.7	17,729.7	3.5%	1.6%	2.4%
MAJOR DRY BULKS	27,837.7	41,870.9	66,784.2	1.4%	1.2%	1.3%
MINOR BULKS	30,699.2	46,027.8	92,310.0	1.4%	1.8%	1.6%
OILS & FATS	263.1	615.8	992.9	2.9%	1.2%	1.9%
PETROLEUM PRODS	8,162.7	10,614.5	4,476.9	0.9%	-2.1%	-0.9%
REFRIG CARGOES	557.6	1,293.4	1,718.7	2.8%	0.7%	1.6%
VEHICLES	294.2	384.6	401.6	0.9%	0.1%	0.4%
TOTAL	90,593.9	160,730.6	251,501.7	1.9%	1.1%	1.5%
100,000 DWT						
BULK CHEMICALS	5,544.3	18,667.4	27,610.0	4.1%	1.0%	2.3%
CONTAINERIZED	11,287.8	29,297.1	40,883.9	3.2%	0.8%	1.9%
CRUDE OIL	2,646.0	3,184.6	723.2	0.6%	-3.6%	-1.8%
GENERAL CARGO	3,301.3	9,397.7	17,729.7	3.5%	1.6%	2.4%
MAJOR DRY BULKS	27,837.7	4,3601.4	69,001.6	1.5%	1.2%	1.3%
MINOR BULKS	30,699.2	46,027.8	92,310.0	1.4%	1.8%	1.6%
OILS & FATS	263.1	615.8	992.9	2.9%	1.2%	1.9%
PETROLEUM PRODS	8,162.7	10,614.5	4,476.9	0.9%	-2.1%	-0.9%
REFRIG CARGOES	557.6	1,293.4	1,718.7	2.8%	0.7%	1.6%
VEHICLES	294.2	384.6	401.6	0.9%	0.1%	0.4%
TOTAL	90,593.9	163,084.2	255,848.4	2.0%	1.1%	1.5%

Table 7.1 (Continued)

ANNUAL CARGO FLOWS BY COMMODITY TYPE

SOUTHBOUND

COMMODITY	('000 Tonnes) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
150,000 DWT						
BULK CHEMICALS	5,544.3	18,667.4	27,610.0	4.1%	1.0%	2.3%
CONTAINERIZED	11,287.8	29,297.1	40,883.9	3.2%	0.8%	1.9%
CRUDE OIL	2,646.0	3,184.6	723.2	0.6%	-3.6%	-1.8%
GENERAL CARGO	3,301.3	9,397.7	17,729.7	3.5%	1.6%	2.4%
MAJOR DRY BULKS	27,837.7	95,279.7	139,286.8	4.2%	1.0%	2.3%
MINOR BULKS	30,699.2	46,027.8	92,310.0	1.4%	1.8%	1.6%
OILS & FATS	263.1	615.8	992.9	2.9%	1.2%	1.9%
PETROLEUM PRODS	8,162.7	10,614.5	4,476.9	0.9%	-2.1%	-0.9%
REFRIG CARGOES	557.6	1,293.4	1,718.7	2.8%	0.7%	1.6%
VEHICLES	294.2	384.6	401.6	0.9%	0.1%	0.4%
TOTAL	90,593.9	214,762.5	326,133.6	2.9%	1.0%	1.8%
250,000 DWT						
BULK CHEMICALS	5,544.3	18,667.4	27,610.0	4.1%	1.0%	2.3%
CONTAINERIZED	11,287.8	29,297.1	40,883.9	3.2%	0.8%	1.9%
CRUDE OIL	2,646.0	17,184.6	14,723.2	6.4%	-0.4%	2.5%
GENERAL CARGO	3,301.3	9,397.7	17,729.7	3.5%	1.6%	2.4%
MAJOR DRY BULKS	27,837.7	96,761.0	142,042.3	4.2%	1.0%	2.4%
MINOR BULKS	30,699.2	46,027.8	92,310.0	1.4%	1.8%	1.6%
OILS & FATS	263.1	615.8	992.9	2.9%	1.2%	1.9%
PETROLEUM PRODS	18,162.7	10,614.5	4,476.9	0.9%	-2.1%	-0.9%
REFRIG CARGOES	557.6	1,293.4	1,718.7	2.8%	0.7%	1.6%
VEHICLES	294.2	384.6	401.6	0.9%	0.1%	0.4%
TOTAL	90,593.9	230,243.8	342,889.1	3.2%	1.0%	1.9%
300,000 DWT						
BULK CHEMICALS	5,544.3	18,667.4	27,610.0	4.1%	1.0%	2.3%
CONTAINERIZED	11,287.8	29,297.1	40,883.9	3.2%	0.8%	1.9%
CRUDE OIL	2,646.0	17,184.6	14,723.2	6.4%	-0.4%	2.5%
GENERAL CARGO	3,301.3	9,397.7	17,729.7	3.5%	1.6%	2.4%
MAJOR DRY BULKS	27,837.7	96,761.0	142,042.3	4.2%	1.0%	2.4%
MINOR BULKS	30,699.2	46,027.8	92,310.0	1.4%	1.8%	1.6%
OILS & FATS	263.1	615.8	992.9	2.9%	1.2%	1.9%
PETROLEUM PRODS	8,162.7	10,614.5	4,476.9	0.9%	-2.1%	-0.9%
REFRIG CARGOES	557.6	1,293.4	1,718.7	2.8%	0.7%	1.6%
VEHICLES	294.2	384.6	401.6	0.9%	0.1%	0.4%
TOTAL	90,593.9	230,243.8	342,889.1	3.2%	1.0%	1.9%

Table 7.1 (Continued)

ANNUAL CARGO FLOWS BY COMMODITY TYPE

NORTHBOUND AND SOUTHBOUND

COMMODITY	('000 Tonnes) 1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
STATUS QUO						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	2,0460.5	48,572.5	63,633.1	2.9%	0.7%	1.6%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	55,864.5	88,275.5	1.3%	1.2%	1.2%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	265,121.1	411,687.0	1.8%	1.1%	1.4%
100,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	49,586.5	66,954.4	3.0%	0.8%	1.7%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	57,595.0	90,492.9	1.4%	1.1%	1.2%
MINOR BULKS	52,987.3	84,279.5	16,0244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	267,865.6	417,225.7	1.8%	1.1%	1.4%

Table 7.1 (Continued)
ANNUAL CARGO FLOWS BY COMMODITY TYPE
NORTHBOUND AND SOUTHBOUND

COMMODITY	1990 ('000 Tonnes)	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
150,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	49,586.5	66,954.4	3.0%	0.8%	1.7%
CRUDE OIL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	109,273.3	160,778.1	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	319,543.9	487,510.9	2.4%	1.1%	1.6%
250,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	49,586.5	66,954.4	3.0%	0.8%	1.7%
CRUDE OIL	9,220.0	18,108.1	14,821.1	2.3%	-0.5%	0.7%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	110,754.6	163,533.6	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	335,025.2	504,266.4	2.6%	1.0%	1.7%
300,000 DWT						
BULK CHEMICALS	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%
CONTAINERIZED	20,460.5	49,586.5	66,954.4	3.0%	0.8%	1.7%
CRUDE OIL	9,220.0	18,108.1	14,821.1	2.3%	-0.5%	0.7%
GENERAL CARGO	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%
MAJOR DRY BULKS	38,192.0	110,754.6	163,533.6	3.6%	1.0%	2.1%
MINOR BULKS	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%
OILS & FATS	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%
PETROLEUM PRODS	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%
REFRIG CARGOES	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
VEHICLES	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
TOTAL	156,383.7	335,025.2	504,266.4	2.6%	1.0%	1.7%

Source: The WEFA Group

Table 7.2

ANNUAL CARGO FLOWS BY ROUTE

PANAMA CANAL SOUTHBOUND CARGO
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	1990 TOTAL	2020 TOTAL	2060 TOTAL	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	1,439	2,427	2,321	1.8%	-0.1%	0.7%
US e.c-Canada w.c	242	329	736	1.0%	2.0%	1.6%
US e.c-C.America w.c/Carib	4,396	10,941	25,209	3.1%	2.1%	2.5%
US e.c-S.America w.c	4,359	6,214	12,210	1.2%	1.7%	1.5%
US e.c-Oceania	2,692	4,650	8,495	1.8%	1.5%	1.7%
US e.c-Asia	52,069	90,750	137,191	1.9%	1.0%	1.4%
Canada e.c-US w.c	54	141	256	3.3%	1.5%	2.2%
Canada e.c-C.America w.c	28	36	99	0.9%	2.5%	1.8%
Canada e.c-S.America w.c	227	274	743	0.6%	2.5%	1.7%
Canada e.c-Oceania	206	376	766	2.0%	1.8%	1.9%
Canada e.c-Asia	1,652	3,473	6,066	2.5%	1.4%	1.9%
C.America e.c/Carib-U.S w.	763	534	303	-1.2%	-1.4%	-1.3%
C.America e.c/Carib-C.Amer	1,640	5,389	4,513	4.0%	-0.4%	1.5%
C.America e.c/Carib-S.Amer	1,002	2,323	2,387	2.8%	0.1%	1.2%
C.America e.c/Carib-Oceani	4	8	23	2.4%	2.7%	2.5%
C.America e.c/Carib-Asia	2,215	1,732	1,959	-0.8%	0.3%	-0.2%
S.America e.c-US w.c./Hawa	1,917	2,312	3,347	0.6%	0.9%	0.8%
S.America e.c-Canada w.c	169	220	443	0.9%	1.8%	1.4%
S.America e.c-C.America w.	1,844	2,257	1,521	0.7%	-1.0%	-0.3%
S.America e.c-S.America w.	1,846	3,596	3,529	2.2%	-0.0%	0.9%
S.America e.c-Oceania	5	9	17	1.9%	1.7%	1.8%
S.America e.c-Asia	2,057	3,931	4,260	2.2%	0.2%	1.0%
Europe-US w.c	3,618	8,541	10,953	2.9%	0.6%	1.6%
Europe-Canada w.c	416	603	899	1.2%	1.0%	1.1%
Europe-C.America w.c	781	1,269	2,540	1.6%	1.7%	1.7%
Europe-S.America w.c	2,093	2,565	4,755	0.7%	1.6%	1.2%
Europe-Oceania	1,014	1,818	2,872	2.0%	1.1%	1.5%
Europe-Asia	432	1,339	2,060	3.8%	1.1%	2.3%
Africa-US w.c	165	276	629	1.7%	2.1%	1.9%
Africa-Canada w.c	692	1,194	6,740	1.8%	4.4%	3.3%
Africa-C.America w.c	159	392	957	3.1%	2.3%	2.6%
Africa-S.America w.c	50	117	245	2.9%	1.9%	2.3%
Africa-Oceania	168	336	1,712	2.3%	4.2%	3.4%
Africa-Asia	84	240	488	3.6%	1.8%	2.5%
Middle East-US w.c	98	119	257	0.7%	1.9%	1.4%
TOTAL	90,594	160,731	251,502	1.9%	1.1%	1.5%

Table 7.2 (Continued)

PANAMA CANAL NORTHBOUND CARGO
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US w.c/Hawaii-US e.c	1,019	934	983	-0.3%	0.1%	-0.1%
US w.c-Canada e.c	274	1,159	910	4.9%	-0.6%	1.7%
US w.c-S.America e.c	339	386	459	0.4%	0.4%	0.4%
US w.c-C.America e.c./Cari	380	408	166	0.2%	-2.2%	-1.2%
US w.c/Hawaii-Europe	5,671	9,809	12,793	1.8%	0.7%	1.2%
US w.c-Africa	1,381	4,886	10,127	4.3%	1.8%	2.9%
Canada w.c/U.S. e.c.	1,081	2,590	4,108	3.0%	1.2%	1.9%
Canada w.c-S.America e.c	478	743	1,317	1.5%	1.4%	1.5%
Canada w.c-West Indies	106	130	348	0.7%	2.5%	1.7%
Canada w.c-Europe	7,548	11,100	16,157	1.3%	0.9%	1.1%
Canada w.c-Africa	1,441	2,086	3,179	1.2%	1.1%	1.1%
Canada w.c-Middle East	260	953	2,841	4.4%	2.8%	3.5%
C.America w.c-US e.c	1,576	1,681	2,688	0.2%	1.2%	0.8%
C.America w.c-C.America e.	780	1,806	3,614	2.8%	1.7%	2.2%
C.America w.c-S.America e.	139	338	695	3.0%	1.8%	2.3%
C.America w.c-Europe	993	1,803	2,930	2.0%	1.2%	1.6%
C.America w.c-Africa	119	282	543	2.9%	1.7%	2.2%
S.America w.c-US e.c	8,705	7,470	11,474	-0.5%	1.1%	0.4%
S.America w.c-Canada e.c	51	71	104	1.1%	1.0%	1.0%
S.America w.c-C.America e.	5,003	2,119	1,752	-2.8%	-0.5%	-1.5%
S.America w.c-S.America e.	226	572	1,055	3.1%	1.5%	2.2%
S.America w.c-Europe	6,254	16,987	27,976	3.4%	1.3%	2.2%
S.America w.c-Africa	73	226	451	3.8%	1.7%	2.6%
Oceania-US e.c	3,843	6,437	9,969	1.7%	1.1%	1.4%
Oceania-Canada e.c	573	874	1,551	1.4%	1.4%	1.4%
Oceania-C.America e.c/Cari	337	279	755	-0.6%	2.5%	1.2%
Oceania-S.America e.c	908	1,634	3,084	2.0%	1.6%	1.8%
Oceania-Europe	942	2,123	3,208	2.7%	1.0%	1.8%
Asia-US e.c	2,513	18,624	25,961	1.3%	0.8%	1.0%
Asia-Canada e.c	587	1,054	2,122	2.0%	1.8%	1.9%
Asia-C.America e.c/Carib	1,677	3,462	4,867	2.4%	0.9%	1.5%
Asia-S.America e.c	181	384	610	2.5%	1.2%	1.8%
Asia-Europe	332	982	1,389	3.7%	0.9%	2.1%
TOTAL	65,790	106,390	160,185	1.6%	1.1%	1.3%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	BULK CHEMICALS	469.3	1,506.3	1689.3	4.0%	0.3%	1.8%
US e.c-Canada w.c	BULK CHEMICALS	40.8	35.9	60.4	-0.4%	1.3%	0.6%
US e.c-C.America w.c/Carib	BULK CHEMICALS	23.8	40.2	69.5	1.8%	1.4%	1.5%
US e.c-S.America w.c	BULK CHEMICALS	233.7	383.3	551.5	1.7%	0.9%	1.2%
US e.c-Oceania	BULK CHEMICALS	626.4	401.0	588.9	-1.5%	1.0%	-0.1%
US e.c-Asia	BULK CHEMICALS	3,605.0	14,996.8	227,11.5	4.9%	1.0%	2.7%
Canada e.c-Asia	BULK CHEMICALS	5.9	6.3	10.5	0.2%	1.3%	0.8%
C.America e.c/Carib-C.America w.c	BULK CHEMICALS	2.5	0.3	0.6	-6.7%	1.5%	-2.1%
C.America e.c/Carib-S.America w.c	BULK CHEMICALS	2.5	7.0	13.0	3.4%	1.5%	2.3%
C.America e.c/Carib-Asia	BULK CHEMICALS	146.2	233.9	277.7	1.6%	0.4%	0.9%
S.America e.c-C.America w.c	BULK CHEMICALS	0.8	2.3	4.3	3.5%	1.5%	2.4%
S.America e.c-S.America w.c	BULK CHEMICALS	27.2	74.8	138.1	3.4%	1.5%	2.3%
S.America e.c-Asia	BULK CHEMICALS	18.7	55.0	69.2	3.7%	0.6%	1.9%
Europe-US w.c	BULK CHEMICALS	25.5	94.3	171.6	4.5%	1.5%	2.8%
Europe-C.America w.c	BULK CHEMICALS	21.2	38.9	64.2	2.0%	1.3%	1.6%
Europe-S.America w.c	BULK CHEMICALS	53.5	98.5	155.8	2.1%	1.2%	1.5%
Europe-Oceania	BULK CHEMICALS	81.6	133.0	189.3	1.6%	0.9%	1.2%
Europe-Asia	BULK CHEMICALS	149.3	531.6	792.9	4.3%	1.0%	2.4%
Africa-S.America w.c	BULK CHEMICALS	10.2	28.0	51.8	3.4%	1.5%	2.3%
US w.c/Hawaii-US e.c	BULK CHEMICALS	46.3	61.1	90.2	0.9%	1.0%	1.0%
US w.c/Hawaii-Europe	BULK CHEMICALS	59.7	210.4	263.8	4.3%	0.6%	2.1%
Canada w.c-US e.c	BULK CHEMICALS	194.0	649.9	907.9	4.1%	0.8%	2.2%
Canada w.c-Europe	BULK CHEMICALS	3.9	5.0	7.0	0.9%	0.8%	0.9%
C.America w.c-US e.c	BULK CHEMICALS	144.5	344.0	695.2	2.9%	1.8%	2.3%
C.America w.c-C.America e.c/Carib	BULK CHEMICALS	34.7	95.4	176.2	3.4%	1.5%	2.3%
C.America w.c-S.America e.c	BULK CHEMICALS	6.7	18.5	34.3	3.4%	1.5%	2.3%
C.America w.c-Europe	BULK CHEMICALS	1.9	5.5	11.5	3.6%	1.9%	2.6%
S.America w.c-US e.c	BULK CHEMICALS	92.5	70.3	211.8	-0.9%	2.8%	1.2%
S.America w.c-C.America e.c/Carib	BULK CHEMICALS	3.9	10.6	19.6	3.4%	1.5%	2.3%
S.America w.c-S.America e.c	BULK CHEMICALS	5.8	15.9	29.4	3.4%	1.5%	2.3%
S.America w.c-Europe	BULK CHEMICALS	21.2	51.5	103.0	3.0%	1.7%	2.3%
Oceania-US e.c	BULK CHEMICALS	20.0	192.6	471.6	7.8%	2.3%	4.6%
Oceania-Europe	BULK CHEMICALS	58.8	321.5	533.7	5.8%	1.3%	3.2%
Asia-US e.c	BULK CHEMICALS	141.6	474.5	543.9	4.1%	0.3%	1.9%
Asia-Canada e.c	BULK CHEMICALS	1.0	1.9	2.8	2.3%	1.0%	1.5%
Asia-C.America e.c/Carib	BULK CHEMICALS	21.2	53.0	70.2	3.1%	0.7%	1.7%
Asia-S.America e.c	BULK CHEMICALS	1.9	0.7	0.8	-3.4%	0.3%	-1.3%
Asia-Europe	BULK CHEMICALS	69.4	219.9	369.1	3.9%	1.3%	2.4%
	TOTAL	6,473.3	21,469.7	32,152.0	4.1%	1.0%	2.3%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	CONTAINERIZED	29.7	29.1	29.1	-0.1%	0.0%	-0.0%
US e.c-C.America w.c/Carib	CONTAINERIZED	27.0	76.1	154.4	3.5%	1.8%	2.5%
US e.c-S.America w.c	CONTAINERIZED	546.6	1,427.7	2,942.9	3.3%	1.8%	2.4%
US e.c-Oceania	CONTAINERIZED	555.2	1,925.9	3,690.8	4.2%	1.6%	2.7%
US e.c-Asia	CONTAINERIZED	6,117.0	15,832.0	18,751.3	3.2%	0.4%	1.6%
Canada e.c-US w.c	CONTAINERIZED	53.0	139.9	253.9	3.3%	1.5%	2.3%
Canada e.c-C.America w.c	CONTAINERIZED	0.9	1.5	3.6	1.7%	2.2%	2.0%
Canada e.c-S.America w.c	CONTAINERIZED	3.0	4.8	11.8	1.5%	2.3%	2.0%
Canada e.c-Oceania	CONTAINERIZED	121.0	224.3	435.3	2.1%	1.7%	1.8%
Canada e.c-Asia	CONTAINERIZED	208.7	581.0	965.5	3.5%	1.3%	2.2%
C.America e.c/Carib-U.S w.c	CONTAINERIZED	13.0	12.9	28.6	-0.0%	2.0%	1.1%
C.America e.c/Carib-C.America w.c	CONTAINERIZED	18.1	49.9	91.3	3.4%	1.5%	2.3%
C.America e.c/Carib-S.America w.c	CONTAINERIZED	57.0	157.9	289.0	3.5%	1.5%	2.3%
C.America e.c/Carib-Oceania	CONTAINERIZED	4.0	8.1	23.1	2.4%	2.7%	2.5%
C.America e.c/Carib-Asia	CONTAINERIZED	195.1	126.8	148.2	-1.4%	0.4%	-0.4%
S.America e.c-US w.c./Hawaii	CONTAINERIZED	89.2	229.4	486.4	3.2%	1.9%	2.5%
S.America e.c-Canada w.c	CONTAINERIZED	29.0	52.8	108.2	2.0%	1.8%	1.9%
S.America e.c-C.America w.c	CONTAINERIZED	22.0	60.9	111.5	3.5%	1.5%	2.3%
S.America e.c-S.America w.c	CONTAINERIZED	39.0	108.0	197.7	3.5%	1.5%	2.3%
S.America e.c-Oceania	CONTAINERIZED	1.0	1.7	4.0	1.7%	2.2%	2.0%
S.America e.c-Asia	CONTAINERIZED	61.5	84.9	103.5	1.1%	0.5%	0.7%
Europe-US w.c	CONTAINERIZED	1,573.8	4,719.3	5,365.3	3.7%	0.3%	1.8%
Europe-Canada w.c	CONTAINERIZED	175.8	295.9	434.1	1.8%	1.0%	1.3%
Europe-C.America w.c	CONTAINERIZED	39.0	64.7	116.2	1.7%	1.5%	1.6%
Europe-S.America w.c	CONTAINERIZED	567.7	891.8	1,590.4	1.5%	1.5%	1.5%
Europe-Oceania	CONTAINERIZED	600.5	1,123.8	1,640.7	2.1%	1.0%	1.4%
Europe-Asia	CONTAINERIZED	89.0	296.4	452.1	4.1%	1.1%	2.3%
Africa-US w.c	CONTAINERIZED	7.0	16.2	47.2	2.9%	2.7%	2.8%
Africa-Canada w.c	CONTAINERIZED	1.0	1.7	6.5	1.8%	3.3%	2.7%
Africa-C.America w.c	CONTAINERIZED	1.0	2.8	5.1	3.4%	1.5%	2.3%
Africa-Asia	CONTAINERIZED	4.0	8.9	20.4	2.7%	2.1%	2.3%
Middle East-US w.c	CONTAINERIZED	37.9	117.0	246.6	3.8%	1.9%	2.7%
US w.c/Hawaii-US e.c	CONTAINERIZED	64.8	144.5	281.8	2.7%	1.7%	2.1%
US w.c-Canada e.c	CONTAINERIZED	2.2	4.8	7.0	2.7%	0.9%	1.7%
US w.c-S.America e.c	CONTAINERIZED	10.8	3.6	7.1	-3.6%	1.7%	-0.6%
US w.c-C.America e.c./Carib	CONTAINERIZED	7.0	19.7	41.9	3.5%	1.9%	2.6%
US w.c/Hawaii-Europe	CONTAINERIZED	1,246.0	2,293.7	2,130.2	2.1%	-0.2%	0.8%
US w.c-Africa	CONTAINERIZED	36.1	108.1	316.6	3.7%	2.7%	3.1%
Canada w.c-S.America e.c	CONTAINERIZED	8.5	13.0	31.4	1.4%	2.2%	1.9%
Canada w.c-Europe	CONTAINERIZED	171.6	782.5	644.9	5.2%	-0.5%	1.9%
C.America w.c-C.America e.c/Carib	CONTAINERIZED	17.0	47.1	86.2	3.5%	1.5%	2.3%
C.America w.c-S.America e.c	CONTAINERIZED	1.0	2.8	5.1	3.5%	1.5%	2.3%
C.America w.c-Europe	CONTAINERIZED	37.0	50.3	75.1	1.0%	1.0%	1.0%
S.America w.c-US e.c	CONTAINERIZED	598.0	944.8	2,104.9	1.5%	2.0%	1.8%
S.America w.c-C.America e.c/Carib	CONTAINERIZED	37.0	100.0	183.1	3.4%	1.5%	2.3%
S.America w.c-S.America e.c	CONTAINERIZED	20.3	42.8	78.4	2.5%	1.5%	2.0%
S.America w.c-Europe	CONTAINERIZED	599.0	1,545.4	2,402.0	3.2%	1.1%	2.0%
Oceania-US e.c	CONTAINERIZED	244.0	424.6	617.3	1.9%	0.9%	1.3%
Oceania-Canada e.c	CONTAINERIZED	45.0	78.3	149.4	1.9%	1.6%	1.7%
Oceania-C.America e.c/Carib	CONTAINERIZED	2.9	5.7	14.3	2.3%	2.3%	2.3%
Oceania-Europe	CONTAINERIZED	160.0	356.7	468.8	2.7%	0.7%	1.5%
Asia-US e.c	CONTAINERIZED	4871.0	9,676.3	10,394.4	2.3%	0.2%	1.1%
Asia-Canada e.c	CONTAINERIZED	369.1	693.7	1,332.1	2.1%	1.6%	1.9%
Asia-C.America e.c/Carib	CONTAINERIZED	501.0	2,199.5	2,936.0	5.1%	0.7%	2.6%
Asia-S.America e.c	CONTAINERIZED	36.3	50.5	59.6	1.1%	0.4%	0.7%
Asia-Europe	CONTAINERIZED	87.3	310.1	511.1	4.3%	1.3%	2.6%
	TOTAL	20,460.5	48,572.5	63,633.1	2.9%	0.7%	1.6%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	CRUDE OIL	91.0	0.0	0.0	-100.0%		-100.0%
C.America e.c/Carib-U.S w.c	CRUDE OIL	35.0	26.8	9.9	-0.9%	-2.5%	-1.8%
C.America e.c/Carib-C.America w.c	CRUDE OIL	452.0	594.5	127.9	0.9%	-3.8%	-1.8%
C.America e.c/Carib-S.America w.c	CRUDE OIL	105.0	138.1	29.7	0.9%	-3.8%	-1.8%
S.America e.c-US w.c./Hawaii	CRUDE OIL	286.0	219.4	81.3	-0.9%	-2.5%	-1.8%
S.America e.c-C.America w.c	CRUDE OIL	935.0	1,229.8	264.5	0.9%	-3.8%	-1.8%
S.America e.c-S.America w.c	CRUDE OIL	742.0	976.0	209.9	0.9%	-3.8%	-1.8%
US w.c/Hawaii-US e.c	CRUDE OIL	123.0	0.0	0.0	-100.0%		-100.0%
Canada w.c-US e.c	CRUDE OIL	80.0	102.2	97.9	0.8%	-0.1%	0.3%
S.America w.c-US e.c	CRUDE OIL	2,213.0	285.5	0.0	-6.6%	-100.0%	-100.0%
S.America w.c-C.America e.c/Carib	CRUDE OIL	4,158.0	535.8	0.0	-6.6%	-100.0%	-100.0%
	TOTAL	9,220.0	4,108.1	821.1	-2.7%	-3.9%	-3.4%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	GENERAL CARGO	102.5	240.3	268.3	2.9%	0.3%	1.4%
US e.c-Canada w.c	GENERAL CARGO	7.2	5.7	8.7	-0.8%	1.1%	0.3%
US e.c-C.America w.c/Carib	GENERAL CARGO	68.5	150.5	322.7	2.7%	1.9%	2.2%
US e.c-S.America w.c	GENERAL CARGO	407.4	1,167.7	2,720.8	3.6%	2.1%	2.7%
US e.c-Oceania	GENERAL CARGO	99.4	243.7	412.0	3.0%	1.3%	2.1%
US e.c-Asia	GENERAL CARGO	859.9	3,184.6	5,319.3	4.5%	1.3%	2.6%
Canada e.c-US w.c	GENERAL CARGO	1.0	1.4	1.9	1.1%	0.8%	0.9%
Canada e.c-C.America w.c	GENERAL CARGO	5.5	9.6	23.8	1.9%	2.3%	2.1%
Canada e.c-S.America w.c	GENERAL CARGO	20.5	30.4	84.7	1.3%	2.6%	2.0%
Canada e.c-Oceania	GENERAL CARGO	33.6	64.6	128.1	2.2%	1.7%	1.9%
Canada e.c-Asia	GENERAL CARGO	171.8	513.9	1,145.8	3.7%	2.0%	2.7%
C.America e.c/Carib-C.America w.c	GENERAL CARGO	3.5	10.5	21.8	3.7%	1.8%	2.6%
C.America e.c/Carib-S.America w.c	GENERAL CARGO	43.1	114.4	242.5	3.3%	1.9%	2.5%
C.America e.c/Carib-Asia	GENERAL CARGO	50.2	127.1	208.1	3.1%	1.2%	2.1%
S.America e.c-US w.c./Hawaii	GENERAL CARGO	86.8	424.0	1,044.2	5.4%	2.3%	3.6%
S.America e.c-Canada w.c	GENERAL CARGO	34.9	83.5	207.9	3.0%	2.3%	2.6%
S.America e.c-C.America w.c	GENERAL CARGO	15.9	35.4	67.6	2.7%	1.6%	2.1%
S.America e.c-S.America w.c	GENERAL CARGO	62.6	172.9	348.5	3.4%	1.8%	2.5%
S.America e.c-Oceania	GENERAL CARGO	1.7	4.8	9.6	3.4%	1.8%	2.5%
S.America e.c-Asia	GENERAL CARGO	358.7	569.5	778.3	1.6%	0.8%	1.1%
Europe-US w.c	GENERAL CARGO	204.0	751.0	1,149.3	4.4%	1.1%	2.5%
Europe-Canada w.c	GENERAL CARGO	56.2	114.7	229.7	2.4%	1.8%	2.0%
Europe-C.America w.c	GENERAL CARGO	110.2	231.5	463.6	2.5%	1.8%	2.1%
Europe-S.America w.c	GENERAL CARGO	282.8	623.8	1,376.8	2.7%	2.0%	2.3%
Europe-Oceania	GENERAL CARGO	127.6	287.5	591.4	2.7%	1.8%	2.2%
Europe-Asia	GENERAL CARGO	39.7	122.9	231.0	3.8%	1.6%	2.5%
Africa-US w.c	GENERAL CARGO	18.5	77.3	245.7	4.9%	2.9%	3.8%
Africa-S.America w.c	GENERAL CARGO	8.1	11.8	21.2	1.3%	1.5%	1.4%
Africa-Asia	GENERAL CARGO	18.5	20.5	46.6	0.3%	2.1%	1.3%
Middle East-US w.c	GENERAL CARGO	1.1	2.3	9.9	2.6%	3.7%	3.2%
US w.c/Hawaii-US e.c	GENERAL CARGO	32.4	30.4	58.3	-0.2%	1.6%	0.8%
US w.c-S.America e.c	GENERAL CARGO	17.9	8.3	19.0	-2.5%	2.1%	0.1%
US w.c/Hawaii-Europe	GENERAL CARGO	266.1	679.5	895.0	3.2%	0.7%	1.7%
US w.c-Africa	GENERAL CARGO	65.8	181.8	539.1	3.4%	2.8%	3.1%
Canada w.c-US e.c	GENERAL CARGO	9.4	4.2	8.6	-2.6%	1.8%	-0.1%
Canada w.c-S.America e.c	GENERAL CARGO	64.9	104.5	269.6	1.6%	2.4%	2.1%
Canada w.c-West Indies	GENERAL CARGO	0.8	2.4	6.0	3.7%	2.3%	2.9%
Canada w.c-Europe	GENERAL CARGO	626.8	1,121.2	1,924.2	2.0%	1.4%	1.6%
Canada w.c-Africa	GENERAL CARGO	1.5	4.8	15.4	4.0%	2.9%	3.4%
Canada w.c-Middle East	GENERAL CARGO	0.1	1.6	3.4	9.0%	1.9%	4.9%
C.America w.c-US e.c	GENERAL CARGO	49.8	70.1	148.3	1.1%	1.9%	1.6%
C.America w.c-C.America e.c/Carib	GENERAL CARGO	28.9	70.3	133.3	3.0%	1.6%	2.2%
C.America w.c-S.America e.c	GENERAL CARGO	9.7	21.9	40.3	2.8%	1.5%	2.1%
C.America w.c-Europe	GENERAL CARGO	154.7	206.5	620.1	1.0%	2.8%	2.0%
C.America w.c-Africa	GENERAL CARGO	85.0	200.0	384.0	2.9%	1.6%	2.2%
S.America w.c-US e.c	GENERAL CARGO	431.7	608.8	1,372.4	1.2%	2.1%	1.7%
S.America w.c-Canada e.c	GENERAL CARGO	9.0	15.6	37.8	1.9%	2.2%	2.1%
S.America w.c-C.America e.c/Carib	GENERAL CARGO	36.9	72.7	156.5	2.3%	1.9%	2.1%
S.America w.c-S.America e.c	GENERAL CARGO	40.8	115.3	227.3	3.5%	1.7%	2.5%
S.America w.c-Europe	GENERAL CARGO	1,519.7	3,306.7	5,718.1	2.6%	1.4%	1.9%
S.America w.c-Africa	GENERAL CARGO	25.2	57.4	105.4	2.8%	1.5%	2.1%
Oceania-US e.c	GENERAL CARGO	189.4	279.5	385.1	1.3%	0.8%	1.0%
Oceania-Canada e.c	GENERAL CARGO	23.9	30.9	56.9	0.9%	1.5%	1.2%
Oceania-C.America e.c/Carib	GENERAL CARGO	86.9	53.1	121.2	-1.6%	2.1%	0.5%
Oceania-S.America e.c	GENERAL CARGO	4.3	8.2	20.4	2.2%	2.3%	2.3%
Oceania-Europe	GENERAL CARGO	46.3	116.1	177.4	3.1%	1.1%	1.9%
Asia-US e.c	GENERAL CARGO	503.9	1,312.1	2,192.3	3.2%	1.3%	2.1%
Asia-Canada e.c	GENERAL CARGO	56.7	59.0	103.1	0.1%	1.4%	0.9%
Asia-C.America e.c/Carib	GENERAL CARGO	313.7	643.1	1,210.1	2.5%	1.5%	1.9%
Asia-S.America e.c	GENERAL CARGO	41.8	79.1	177.7	2.1%	2.0%	2.1%
Asia-Europe	GENERAL CARGO	33.4	102.6	177.3	3.8%	1.4%	2.4%
	TOTAL	8,078.6	18,985.7	35,032.9	2.9%	1.5%	2.1%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	MAJOR DRY BULKS	36.0	36.0	36.0	0.0%	0.0%	0.0%
US e.c-C.America w.c/Carib	MAJOR DRY BULKS	1,950.0	7,234.5	16,126.5	4.5%	2.0%	3.1%
US e.c-S.America w.c	MAJOR DRY BULKS	1,775.0	1,472.0	3,032.0	-0.6%	1.8%	0.8%
US e.c-Oceania	MAJOR DRY BULKS	199.0	613.7	722.1	3.8%	0.4%	1.9%
US e.c-Asia	MAJOR DRY BULKS	22,996.1	30,617.7	44,002.8	1.0%	0.9%	0.9%
Canada e.c-C.America w.c	MAJOR DRY BULKS	8.0	6.7	15.1	-0.6%	2.1%	0.9%
Canada e.c-S.America w.c	MAJOR DRY BULKS	98.0	20.6	19.6	-5.1%	-0.1%	-2.3%
Canada e.c-Asia	MAJOR DRY BULKS	106.0	238.5	622.2	2.7%	2.4%	2.6%
C.America e.c/Carib-U.S w.c	MAJOR DRY BULKS	86.0	42.1	110.1	-2.3%	2.4%	0.4%
S.America e.c-US w.c./Hawaii	MAJOR DRY BULKS	66.0	130.0	175.0	2.3%	0.7%	1.4%
S.America e.c-S.America w.c	MAJOR DRY BULKS	164.0	497.7	644.9	3.8%	0.6%	2.0%
S.America e.c-Asia	MAJOR DRY BULKS	227.0	774.5	935.7	4.2%	0.5%	2.0%
Europe-C.America w.c	MAJOR DRY BULKS	45.0	50.0	102.6	0.3%	1.8%	1.2%
Europe-S.America w.c	MAJOR DRY BULKS	33.0	42.2	77.6	0.8%	1.5%	1.2%
Europe-Oceania	MAJOR DRY BULKS	26.0	35.0	45.1	1.0%	0.6%	0.8%
Africa-C.America w.c	MAJOR DRY BULKS	8.5	25.3	49.5	3.7%	1.7%	2.5%
Africa-S.America w.c	MAJOR DRY BULKS	14.0	34.4	67.5	3.0%	1.7%	2.3%
US w.c-Canada e.c	MAJOR DRY BULKS	163.9	1,086.8	903.2	6.5%	-0.5%	2.5%
US w.c-S.America e.c	MAJOR DRY BULKS	9.0	29.5	37.1	4.0%	0.6%	2.0%
US w.c/Hawaii-Europe	MAJOR DRY BULKS	2345.0	34.7	28.0	-13.1%	-0.5%	-6.1%
US w.c-Africa	MAJOR DRY BULKS	904.0	3,118.8	4,646.6	4.2%	1.0%	2.4%
Canada w.c-S.America e.c	MAJOR DRY BULKS	46.5	121.7	295.1	3.3%	2.2%	2.7%
Canada w.c-Europe	MAJOR DRY BULKS	2,205.0	1,571.1	1,232.4	-1.1%	-0.6%	-0.8%
Canada w.c-Africa	MAJOR DRY BULKS	154.6	0.5	2.2	-17.4%	3.7%	-5.9%
C.America w.c-US e.c	MAJOR DRY BULKS	106.0	195.1	201.4	2.1%	0.1%	0.9%
C.America w.c-C.America e.c/Carib	MAJOR DRY BULKS	83.0	204.2	400.1	3.0%	1.7%	2.3%
C.America w.c-Africa	MAJOR DRY BULKS	22.7	56.0	109.6	3.0%	1.7%	2.3%
S.America w.c-US e.c	MAJOR DRY BULKS	173.8	588.3	1,292.0	4.1%	2.0%	2.9%
S.America w.c-Europe	MAJOR DRY BULKS	108.0	198.2	246.3	2.0%	0.5%	1.2%
Oceania-US e.c	MAJOR DRY BULKS	1,809.0	3,190.0	5,576.9	1.9%	1.4%	1.6%
Oceania-Canada e.c	MAJOR DRY BULKS	69.0	211.8	339.5	3.8%	1.2%	2.3%
Oceania-S.America e.c	MAJOR DRY BULKS	841.9	1,512.8	2,739.1	2.0%	1.5%	1.7%
Asia-US e.c	MAJOR DRY BULKS	1,118.0	1,356.4	2,689.6	0.6%	1.7%	1.3%
Asia-Canada e.c	MAJOR DRY BULKS	41.8	47.3	95.0	0.4%	1.8%	1.2%
Asia-C.America e.c/Carib	MAJOR DRY BULKS	43.0	123.2	185.4	3.6%	1.0%	2.1%
Asia-S.America e.c	MAJOR DRY BULKS	20.0	216.4	321.4	8.3%	1.0%	4.0%
Asia-Europe	MAJOR DRY BULKS	52.0	64.5	62.4	0.7%	-0.1%	0.3%
Oceania-Europe	MAJOR DRY BULKS	38.0	66.5	88.2	1.9%	0.7%	1.2%
	TOTAL	38,192.0	55,864.5	88,275.5	1.3%	1.2%	1.2%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	MINOR BULKS	57.0	57.0	57.0	-0.0%	0.0%	-0.0%
US e.c-Canada w.c	MINOR BULKS	193.9	287.1	667.3	1.3%	2.1%	1.8%
US e.c-C.America w.c/Carib	MINOR BULKS	1,659.4	2,746.3	8,154.4	1.7%	2.8%	2.3%
US e.c-S.America w.c	MINOR BULKS	946.0	1,340.0	2,747.3	1.2%	1.8%	1.5%
US e.c-Oceania	MINOR BULKS	1,059.3	1,337.1	3,070.0	0.8%	2.1%	1.5%
US e.c-Asia	MINOR BULKS	16,874.2	24,032.1	44,842.9	1.2%	1.6%	1.4%
Canada e.c-C.America w.c	MINOR BULKS	12.5	17.7	54.7	1.2%	2.9%	2.1%
Canada e.c-S.America w.c	MINOR BULKS	106.0	217.9	626.7	2.4%	2.7%	2.6%
Canada e.c-Oceania	MINOR BULKS	51.3	87.5	202.5	1.8%	2.1%	2.0%
Canada e.c-Asia	MINOR BULKS	975.2	2,027.6	3,170.6	2.5%	1.1%	1.7%
C.America e.c/Carib-U.S w.c	MINOR BULKS	17.0	26.2	22.8	1.4%	-0.3%	0.4%
C.America e.c/Carib-C.America w.c	MINOR BULKS	396.8	961.8	2,345.1	3.0%	2.3%	2.6%
C.America e.c/Carib-S.America w.c	MINOR BULKS	185.4	455.3	1,076.2	3.0%	2.2%	2.5%
C.America e.c/Carib-Asia	MINOR BULKS	1,529.0	992.6	1,208.2	-1.4%	0.5%	-0.3%
S.America e.c-US w.c./Hawaii	MINOR BULKS	827.5	914.3	1,413.3	0.3%	1.1%	0.8%
S.America e.c-Canada w.c	MINOR BULKS	105.1	83.3	126.9	-0.8%	1.1%	0.3%
S.America e.c-C.America w.c	MINOR BULKS	246.9	451.3	793.4	2.0%	1.6%	1.7%
S.America e.c-S.America w.c	MINOR BULKS	355.3	740.7	1,468.1	2.5%	1.7%	2.0%
S.America e.c-Oceania	MINOR BULKS	2.3	2.3	3.8	0.0%	1.3%	0.7%
S.America e.c-Asia	MINOR BULKS	1,194.1	2,279.4	2,311.3	2.2%	0.0%	0.9%
Europe-US w.c	MINOR BULKS	1,179.0	2,417.4	3,804.5	2.4%	1.1%	1.7%
Europe-Canada w.c	MINOR BULKS	166.4	173.1	207.4	0.1%	0.5%	0.3%
Europe-C.America w.c	MINOR BULKS	518.4	864.4	1,765.7	1.7%	1.8%	1.8%
Europe-S.America w.c	MINOR BULKS	702.9	862.7	1,478.6	0.7%	1.4%	1.1%
Europe-Oceania	MINOR BULKS	118.5	185.3	320.0	1.5%	1.4%	1.4%
Europe-Asia	MINOR BULKS	77.9	232.9	382.0	3.7%	1.2%	2.3%
Africa-US w.c	MINOR BULKS	86.3	182.4	335.8	2.5%	1.5%	2.0%
Africa-Canada w.c	MINOR BULKS	690.6	1,192.7	6,733.4	1.8%	4.4%	3.3%
Africa-C.America w.c	MINOR BULKS	149.0	363.5	902.9	3.0%	2.3%	2.6%
Africa-S.America w.c	MINOR BULKS	17.4	42.8	104.8	3.0%	2.3%	2.6%
Africa-Oceania	MINOR BULKS	168.0	336.0	1,712.1	2.3%	4.2%	3.4%
Africa-Asia	MINOR BULKS	30.4	97.3	200.3	4.0%	1.8%	2.7%
US w.c/Hawaii-US e.c	MINOR BULKS	229.3	253.7	297.4	0.3%	0.4%	0.4%
US w.c-S.America e.c	MINOR BULKS	170.9	217.5	352.7	0.8%	1.2%	1.0%
US w.c/Hawaii-Europe	MINOR BULKS	1,480.7	5,894.1	8,791.5	4.7%	1.0%	2.6%
US w.c-Africa	MINOR BULKS	375.1	1,477.2	4,624.9	4.7%	2.9%	3.7%
Canada w.c-US e.c	MINOR BULKS	777.1	1,813.4	3,061.6	2.9%	1.3%	2.0%
Canada w.c-S.America e.c	MINOR BULKS	358.2	503.5	720.5	1.1%	0.9%	1.0%
Canada w.c-West Indies	MINOR BULKS	105.7	127.8	342.3	0.6%	2.5%	1.7%
Canada w.c-Europe	MINOR BULKS	4,496.1	7,520.3	12,221.7	1.7%	1.2%	1.4%
Canada w.c-Africa	MINOR BULKS	1,285.0	2,080.7	3,161.1	1.6%	1.1%	1.3%
Canada w.c-Middle East	MINOR BULKS	259.6	951.8	2,837.9	4.4%	2.8%	3.5%
C.America w.c-US e.c	MINOR BULKS	1,090.6	1,032.3	1,552.7	-0.2%	1.0%	0.5%
C.America w.c-C.America e.c/Carib	MINOR BULKS	357.9	860.4	2,004.2	3.0%	2.1%	2.5%
C.America w.c-S.America e.c	MINOR BULKS	66.6	152.7	300.2	2.8%	1.7%	2.2%
C.America w.c-Europe	MINOR BULKS	191.9	432.9	583.9	2.7%	0.8%	1.6%
C.America w.c-Africa	MINOR BULKS	5.7	10.4	15.4	2.0%	1.0%	1.4%
S.America w.c-US e.c	MINOR BULKS	1,659.8	1,155.5	2,294.0	-1.2%	1.7%	0.5%
S.America w.c-Canada e.c	MINOR BULKS	15.1	28.3	66.7	2.1%	2.2%	2.1%
S.America w.c-C.America e.c/Carib	MINOR BULKS	138.3	298.5	520.5	2.6%	1.4%	1.9%
S.America w.c-S.America e.c	MINOR BULKS	107.2	262.6	475.7	3.0%	1.5%	2.2%
S.America w.c-Europe	MINOR BULKS	2,381.2	6,421.9	11,558.7	3.4%	1.5%	2.3%
S.America w.c-Africa	MINOR BULKS	39.5	113.1	221.7	3.6%	1.7%	2.5%
Oceania-US e.c	MINOR BULKS	704.2	1,601.6	1,720.9	2.8%	0.2%	1.3%
Oceania-Canada e.c	MINOR BULKS	381.2	498.0	903.6	0.9%	1.5%	1.2%
Oceania-C.America e.c/Carib	MINOR BULKS	229.0	194.1	548.7	-0.5%	2.6%	1.3%
Oceania-S.America e.c	MINOR BULKS	53.9	95.0	271.2	1.9%	2.7%	2.3%
Oceania-Europe	MINOR BULKS	232.0	336.8	569.6	1.3%	1.3%	1.3%
Asia-US e.c	MINOR BULKS	4,274.8	3,393.0	7,042.1	-0.8%	1.8%	0.7%
Asia-Canada e.c	MINOR BULKS	118.1	250.3	586.9	2.5%	2.2%	2.3%
Asia-C.America e.c/Carib	MINOR BULKS	622.1	224.1	199.8	-3.3%	-0.3%	-1.6%
Asia-S.America e.c	MINOR BULKS	68.7	16.6	22.4	-4.6%	0.8%	-1.6%
Asia-Europe	MINOR BULKS	13.0	33.7	63.8	3.2%	1.6%	2.3%
	TOTAL	52,987.3	84,279.5	160,244.4	1.6%	1.6%	1.6%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
S.America w.c-S.America e.c	OIL & FATS	25.0	75.4	140.7	3.7%	1.6%	2.5%
US e.c-C.America w.c/Carib	OILS & FATS	60.0	94.8	179.4	1.5%	1.6%	1.6%
US e.c-S.America w.c	OILS & FATS	70.0	19.6	33.6	-4.2%	1.4%	-1.0%
US e.c-Oceania	OILS & FATS	1.0	2.9	5.6	3.6%	1.7%	2.5%
US e.c-Asia	OILS & FATS	78.0	389.3	606.3	5.5%	1.1%	3.0%
Canada e.c-C.America w.c	OILS & FATS	1.0	0.9	2.2	-0.3%	2.2%	1.1%
C.America e.c/Carib-C.America w.c	OILS & FATS	5.1	10.9	20.3	2.6%	1.6%	2.0%
S.America e.c-C.America w.c	OILS & FATS	8.0	17.3	32.4	2.6%	1.6%	2.0%
Europe-US w.c	OILS & FATS	17.0	43.4	46.9	3.2%	0.2%	1.5%
Europe-C.America w.c	OILS & FATS	3.0	5.3	10.9	2.0%	1.8%	1.9%
Europe-S.America w.c	OILS & FATS	6.0	9.2	19.3	1.4%	1.9%	1.7%
Europe-Oceania	OILS & FATS	12.1	17.6	28.5	1.3%	1.2%	1.2%
Europe-Asia	OILS & FATS	2.1	4.5	7.6	2.7%	1.3%	1.9%
US w.c/Hawaii-US e.c	OILS & FATS	21.0	42.2	82.4	2.4%	1.7%	2.0%
US w.c/Hawaii-Europe	OILS & FATS	48.2	19.6	20.2	-3.0%	0.1%	-1.2%
Canada w.c-Europe	OILS & FATS	18.8	52.9	63.7	3.5%	0.5%	1.8%
C.America w.c-US e.c	OILS & FATS	175.0	35.1	80.9	-5.2%	2.1%	-1.1%
C.America w.c-C.America e.c/Carib	OILS & FATS	48.0	97.3	187.5	2.4%	1.7%	2.0%
C.America w.c-Europe	OILS & FATS	82.5	141.8	190.1	1.8%	0.7%	1.2%
S.America w.c-US e.c	OILS & FATS	78.0	36.8	67.6	-2.5%	1.5%	-0.2%
S.America w.c-C.America e.c/Carib	OILS & FATS	45.1	96.6	181.3	2.6%	1.6%	2.0%
S.America w.c-Europe	OILS & FATS	113.0	254.3	414.7	2.7%	1.2%	1.9%
Oceania-US e.c	OILS & FATS	266.0	77.1	111.7	-4.0%	0.9%	-1.2%
Oceania-Europe	OILS & FATS	91.0	92.0	121.0	0.0%	0.7%	0.4%
Asia-US e.c	OILS & FATS	152.0	238.6	617.1	1.5%	2.4%	2.0%
Asia-Canada e.c	OILS & FATS	0.6	1.9	2.2	3.7%	0.4%	1.8%
Asia-C.America e.c/Carib	OILS & FATS	40.0	55.6	83.4	1.1%	1.0%	1.1%
Asia-S.America e.c	OILS & FATS	3.0	9.0	13.0	3.7%	0.9%	2.1%
Asia-Europe	OILS & FATS	54.9	206.8	162.0	4.5%	-0.6%	1.6%
	TOTAL	1,525.1	2,148.8	3,532.3	1.1%	1.3%	1.2%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c/Hawaii	PETROLEUM PRODS	653.2	558.2	240.8	-0.5%	-2.1%	-1.4%
US e.c-C.America w.c/Carib	PETROLEUM PRODS	607.3	598.5	201.7	-0.0%	-2.7%	-1.6%
US e.c-S.America w.c	PETROLEUM PRODS	352.0	351.7	118.0	-0.0%	-2.7%	-1.5%
US e.c-Oceania	PETROLEUM PRODS	141.0	100.6	0.2	-1.1%	-14.0%	-8.7%
US e.c-Asia	PETROLEUM PRODS	1,245.0	903.4	6.0	-1.1%	-11.8%	-7.3%
Canada e.c-Asia	PETROLEUM PRODS	125.0	6.0	10.8	-9.6%	1.5%	-3.4%
C.America e.c/Carib-U.S w.c	PETROLEUM PRODS	612.0	425.6	131.6	-1.2%	-2.9%	-2.2%
C.America e.c/Carib-C.America w.c	PETROLEUM PRODS	762.0	3,760.8	1,906.4	5.5%	-1.7%	1.3%
C.America e.c/Carib-S.America w.c	PETROLEUM PRODS	609.0	1,450.4	737.1	2.9%	-1.7%	0.3%
C.America e.c/Carib-Asia	PETROLEUM PRODS	258.0	213.2	71.8	-0.6%	-2.7%	-1.8%
S.America e.c-US w.c./Hawaii	PETROLEUM PRODS	561.0	395.3	147.1	-1.2%	-2.4%	-1.9%
S.America e.c-C.America w.c	PETROLEUM PRODS	615.2	460.0	247.3	-1.0%	-1.5%	-1.3%
S.America e.c-S.America w.c	PETROLEUM PRODS	456.0	1,026.0	521.4	2.7%	-1.7%	0.2%
S.America e.c-Asia	PETROLEUM PRODS	194.0	160.3	53.7	-0.6%	-2.7%	-1.8%
Europe-US w.c	PETROLEUM PRODS	387.0	187.9	57.9	-2.4%	-2.9%	-2.7%
Europe-C.America w.c	PETROLEUM PRODS	31.8	2.4	3.3	-8.3%	0.8%	-3.2%
Europe-S.America w.c	PETROLEUM PRODS	421.7	13.4	20.5	-10.9%	1.1%	-4.2%
Europe-Oceania	PETROLEUM PRODS	15.9	0.6	0.7	-10.6%	0.7%	-4.3%
Europe-Asia	PETROLEUM PRODS	3.0	0.1	0.1	-11.9%	0.8%	-4.8%
Africa-US w.c	PETROLEUM PRODS	53.6	0.2	0.2	-17.6%	0.0%	-8.0%
Middle East-US w.c	PETROLEUM PRODS	59.0	0.2	0.2	-17.8%	-0.2%	-8.2%
US w.c/Hawaii-US e.c	PETROLEUM PRODS	501.8	401.9	173.4	-0.7%	-2.1%	-1.5%
US w.c-Canada e.c	PETROLEUM PRODS	107.6	67.3	0.0	-1.6%	-100.0%	-100.0%
US w.c-S.America e.c	PETROLEUM PRODS	126.5	126.5	42.2	0.0%	-2.7%	-1.6%
US w.c-C.America e.c./Carib	PETROLEUM PRODS	373.0	388.1	124.3	0.1%	-2.8%	-1.6%
US w.c/Hawaii-Europe	PETROLEUM PRODS	18.0	0.0	0.0	-100.0%		-100.0%
Canada w.c-US e.c	PETROLEUM PRODS	20.9	19.8	31.7	-0.2%	1.2%	0.6%
C.America w.c-US e.c	PETROLEUM PRODS	3.0	0.0	0.0	-100.0%		-100.0%
C.America w.c-C.America e.c/Carib	PETROLEUM PRODS	116.5	193.0	97.8	1.7%	-1.7%	-0.3%
S.America w.c-US e.c	PETROLEUM PRODS	2,380.0	1,656.3	509.6	-1.2%	-2.9%	-2.2%
S.America w.c-Canada e.c	PETROLEUM PRODS	26.9	26.9	0.0	0.0%	-100.0%	-100.0%
S.America w.c-C.America e.c/Carib	PETROLEUM PRODS	542.0	897.9	455.2	1.7%	-1.7%	-0.2%
S.America w.c-S.America e.c	PETROLEUM PRODS	10.0	16.6	8.4	1.7%	-1.7%	-0.2%
S.America w.c-Europe	PETROLEUM PRODS	3.0	0.0	0.0	-100.0%		-100.0%
Oceania-US e.c	PETROLEUM PRODS	159.4	112.7	70.9	-1.1%	-1.2%	-1.2%
Oceania-C.America e.c/Carib	PETROLEUM PRODS	1.0	0.0	0.0	-100.0%		-100.0%
Asia-US e.c	PETROLEUM PRODS	76.7	0.0	0.0	-100.0%		-100.0%
	TOTAL	12,628.9	14,521.5	5,990.4	0.5%	-2.2%	-1.1%

Table 7.2 (Cont'd)

ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

		1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-Asia	REFRIG CARGOES	286.0	783.7	940.7	3.4%	0.5%	1.7%
Canada e.c-Asia	REFRIG CARGOES	59.0	100.3	141.0	1.8%	0.9%	1.3%
C.America e.c/Carib-Asia	REFRIG CARGOES	36.3	38.1	44.7	0.2%	0.4%	0.3%
S.America e.c-Asia	REFRIG CARGOES	3.0	7.0	8.8	2.9%	0.6%	1.5%
Europe-US w.c	REFRIG CARGOES	59.9	82.1	113.3	1.1%	0.8%	0.9%
Europe-Canada w.c	REFRIG CARGOES	8.7	12.8	21.3	1.3%	1.3%	1.3%
Europe-S.America w.c	REFRIG CARGOES	4.0	7.0	14.9	1.9%	1.9%	1.9%
Europe-Oceania	REFRIG CARGOES	10.7	24.2	42.8	2.8%	1.4%	2.0%
Europe-Asia	REFRIG CARGOES	59.0	124.5	170.5	2.5%	0.8%	1.5%
Africa-Asia	REFRIG CARGOES	31.0	113.8	220.7	4.4%	1.7%	2.8%
US w.c/Hawaii-Europe	REFRIG CARGOES	207.0	676.7	664.4	4.0%	-0.0%	1.7%
Canada w.c-Europe	REFRIG CARGOES	25.7	46.7	62.8	2.0%	0.7%	1.3%
C.America w.c-US e.c	REFRIG CARGOES	2.0	1.9	3.0	-0.1%	1.1%	0.6%
C.America w.c-C.America e.c/Carib	REFRIG CARGOES	94.0	238.8	528.3	3.2%	2.0%	2.5%
C.America w.c-S.America e.c	REFRIG CARGOES	55.0	142.2	314.7	3.2%	2.0%	2.5%
C.America w.c-Europe	REFRIG CARGOES	525.0	966.0	1,449.0	2.1%	1.0%	1.5%
C.America w.c-Africa	REFRIG CARGOES	6.0	15.2	33.7	3.2%	2.0%	2.5%
S.America w.c-US e.c	REFRIG CARGOES	1,078.0	2,123.6	3,622.0	2.3%	1.3%	1.7%
S.America w.c-C.America e.c/Carib	REFRIG CARGOES	42.0	106.7	236.0	3.2%	2.0%	2.5%
S.America w.c-S.America e.c	REFRIG CARGOES	17.0	43.2	95.5	3.2%	2.0%	2.5%
S.America w.c-Europe	REFRIG CARGOES	1,509.3	5,209.4	7,533.1	4.2%	0.9%	2.3%
S.America w.c-Africa	REFRIG CARGOES	8.2	55.9	123.6	6.6%	2.0%	4.0%
Oceania-US e.c	REFRIG CARGOES	451.0	559.2	1,014.8	0.7%	1.5%	1.2%
Oceania-Canada e.c	REFRIG CARGOES	54.0	54.5	102.1	0.0%	1.6%	0.9%
Oceania-C.America e.c/Carib	REFRIG CARGOES	16.8	26.1	71.3	1.5%	2.5%	2.1%
Oceania-S.America e.c	REFRIG CARGOES	8.4	18.1	52.7	2.6%	2.7%	2.7%
Oceania-Europe	REFRIG CARGOES	316.2	833.7	1,249.0	3.3%	1.0%	2.0%
Asia-US e.c	REFRIG CARGOES	123.0	257.4	328.2	2.5%	0.6%	1.4%
Asia-C.America e.c/Carib	REFRIG CARGOES	31.0	116.3	155.9	4.5%	0.7%	2.3%
Asia-S.America e.c	REFRIG CARGOES	0.7	1.2	1.5	1.6%	0.6%	1.0%
Asia-Europe	REFRIG CARGOES	8.0	17.8	23.4	2.7%	0.7%	1.5%
	TOTAL	5,135.8	12,803.9	19,383.8	3.1%	1.0%	1.9%
US e.c-S.America w.c	VEHICLES	28.0	52.4	64.1	2.1%	0.5%	1.2%
US e.c-Oceania	VEHICLES	11.0	5.0	4.8	-2.6%	-0.1%	-1.2%
US e.c-Asia	VEHICLES	8.0	10.2	9.8	0.8%	-0.1%	0.3%
Europe-US w.c	VEHICLES	172.0	246.0	244.2	1.2%	-0.0%	0.5%
Europe-Canada w.c	VEHICLES	9.2	6.2	6.4	-1.3%	0.1%	-0.5%
Europe-C.America w.c	VEHICLES	12.0	12.1	13.6	0.0%	0.3%	0.2%
Europe-S.America w.c	VEHICLES	21.1	16.0	21.2	-0.9%	0.7%	0.0%
Europe-Oceania	VEHICLES	21.0	10.9	13.4	-2.2%	0.5%	-0.6%
Europe-Asia	VEHICLES	12.0	25.9	24.0	2.6%	-0.2%	1.0%
US w.c-S.America e.c	VEHICLES	4.0	0.4	0.6	-7.1%	0.8%	-2.7%
C.America w.c-US e.c	VEHICLES	5.1	2.3	6.1	-2.6%	2.5%	0.3%
Asia-US e.c	VEHICLES	1,252.0	1,915.6	2,153.4	1.4%	0.3%	0.8%
Asia-C.America e.c/Carib	VEHICLES	105.0	27.2	26.2	-4.4%	-0.1%	-2.0%
Asia-S.America e.c	VEHICLES	8.0	10.6	13.6	0.9%	0.6%	0.8%
Asia-Europe	VEHICLES	13.7	26.3	19.9	2.2%	-0.7%	0.5%
	TOTAL	1,682.0	2,367.0	2,621.4	1.1%	0.3%	0.6%
	GRAND TOTAL	156,383.7	265,121.1	411,687.0	1.8%	1.1%	1.4%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-US w.c	CRUDE OIL	91.0	0.0	0.0	-100.0%		-100.0%
US e.c-US w.c/Hawaii	PETROLEUM PRODS	653.2	558.2	240.8	-0.5%	-2.1%	-1.4%
US e.c-US w.c/Hawaii	MAJOR DRY BULKS	36.0	36.0	36.0	0.0%	0.0%	0.0%
US e.c-US w.c/Hawaii	MINOR BULKS	57.0	57.0	57.0	-0.0%	0.0%	-0.0%
US e.c-US w.c/Hawaii	BULK CHEMICALS	469.3	1,506.3	1,689.3	4.0%	0.3%	1.8%
US e.c-US w.c/Hawaii	GENERAL CARGO	102.5	240.3	268.3	2.9%	0.3%	1.4%
US e.c-US w.c/Hawaii	CONTAINERIZED	29.7	29.1	29.1	-0.1%	0.0%	-0.0%
US e.c-US w.c/Hawaii	TOTAL	1,438.7	2,426.9	2,320.5	1.8%	-0.1%	0.7%
US e.c-Canada w.c	MINOR BULKS	193.9	287.1	667.3	1.3%	2.1%	1.8%
US e.c-Canada w.c	BULK CHEMICALS	40.8	35.9	60.4	-0.4%	1.3%	0.6%
US e.c-Canada w.c	GENERAL CARGO	7.2	5.7	8.7	-0.8%	1.1%	0.3%
US e.c-Canada w.c	TOTAL	241.9	328.7	736.4	1.0%	2.0%	1.6%
US e.c-C.America w.c/Carib	PETROLEUM PRODS	607.3	598.5	201.7	-0.0%	-2.7%	-1.6%
US e.c-C.America w.c/Carib	MAJOR DRY BULKS	1,950.0	7,234.5	16,126.5	4.5%	2.0%	3.1%
US e.c-C.America w.c/Carib	MINOR BULKS	1,659.4	2,746.3	8,154.4	1.7%	2.8%	2.3%
US e.c-C.America w.c/Carib	BULK CHEMICALS	23.8	40.2	69.5	1.8%	1.4%	1.5%
US e.c-C.America w.c/Carib	OILS & FATS	60.0	94.8	179.4	1.5%	1.6%	1.6%
US e.c-C.America w.c/Carib	GENERAL CARGO	68.5	150.5	322.7	2.7%	1.9%	2.2%
US e.c-C.America w.c/Carib	CONTAINERIZED	27.0	76.1	154.4	3.5%	1.8%	2.5%
US e.c-C.America w.c/Carib	TOTAL	4,396.0	10,941.0	25,208.5	3.1%	2.1%	2.5%
US e.c-S.America w.c	PETROLEUM PRODS	352.0	351.7	118.0	-0.0%	-2.7%	-1.5%
US e.c-S.America w.c	MAJOR DRY BULKS	1,775.0	1,472.0	3,032.0	-0.6%	1.8%	0.8%
US e.c-S.America w.c	MINOR BULKS	946.0	1,340.0	2,747.3	1.2%	1.8%	1.5%
US e.c-S.America w.c	BULK CHEMICALS	233.7	383.3	551.5	1.7%	0.9%	1.2%
US e.c-S.America w.c	OILS & FATS	70.0	19.6	33.6	-4.2%	1.4%	-1.0%
US e.c-S.America w.c	VEHICLES	28.0	52.4	64.1	2.1%	0.5%	1.2%
US e.c-S.America w.c	GENERAL CARGO	407.4	1,167.7	2,720.8	3.6%	2.1%	2.7%
US e.c-S.America w.c	CONTAINERIZED	546.6	1,427.7	2,942.9	3.3%	1.8%	2.4%
US e.c-S.America w.c	TOTAL	4,358.6	6,214.3	12,210.3	1.2%	1.7%	1.5%
US e.c-Oceania	PETROLEUM PRODS	141.0	100.6	0.2	-1.1%	-14.0%	-8.7%
US e.c-Oceania	MAJOR DRY BULKS	199.0	613.7	722.1	3.8%	0.4%	1.9%
US e.c-Oceania	MINOR BULKS	1,059.3	1,357.1	3,070.0	0.8%	2.1%	1.5%
US e.c-Oceania	BULK CHEMICALS	626.4	401.0	588.9	-1.5%	1.0%	-0.1%
US e.c-Oceania	OILS & FATS	1.0	2.9	5.6	3.6%	1.7%	2.5%
US e.c-Oceania	VEHICLES	11.0	5.0	4.8	-2.6%	-0.1%	-1.2%
US e.c-Oceania	GENERAL CARGO	99.4	243.7	412.0	3.0%	1.3%	2.1%
US e.c-Oceania	CONTAINERIZED	555.2	1,925.9	3,690.8	4.2%	1.6%	2.7%
US e.c-Oceania	TOTAL	2,692.3	4,649.8	8,494.6	1.8%	1.5%	1.7%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US e.c-Asia	PETROLEUM PRODS	1,245.0	903.4	6.0	-1.1%	-11.8%	-7.3%
US e.c-Asia	MAJOR DRY BULKS	22,996.1	30,617.7	44,002.8	1.0%	0.9%	0.9%
US e.c-Asia	MINOR BULKS	16,874.2	24,032.1	44,842.9	1.2%	1.6%	1.4%
US e.c-Asia	BULK CHEMICALS	3,605.0	14,996.8	22,711.5	4.9%	1.0%	2.7%
US e.c-Asia	OILS & FATS	78.0	389.3	606.3	5.5%	1.1%	3.0%
US e.c-Asia	REFRIG CARGOES	286.0	783.7	940.7	3.4%	0.5%	1.7%
US e.c-Asia	VEHICLES	8.0	10.2	9.8	0.8%	-0.1%	0.3%
US e.c-Asia	GENERAL CARGO	859.9	3,184.6	5,319.3	4.5%	1.3%	2.6%
US e.c-Asia	CONTAINERIZED	6,117.0	15,832.0	18,751.3	3.2%	0.4%	1.6%
US e.c-Asia	TOTAL	52,069.1	90,749.7	137,190.6	1.9%	1.0%	1.4%
Canada e.c-US w.c	GENERAL CARGO	1.0	1.4	1.9	1.1%	0.8%	0.9%
Canada e.c-US w.c	CONTAINERIZED	53.0	139.9	253.9	3.3%	1.5%	2.3%
Canada e.c-US w.c	TOTAL	54.0	141.3	255.8	3.3%	1.5%	2.2%
Canada e.c-C.America w.c	MAJOR DRY BULKS	8.0	6.7	15.1	-0.6%	2.1%	0.9%
Canada e.c-C.America w.c	MINOR BULKS	12.5	17.7	54.7	1.2%	2.9%	2.1%
Canada e.c-C.America w.c	OILS & FATS	1.0	0.9	2.2	-0.3%	2.2%	1.1%
Canada e.c-C.America w.c	GENERAL CARGO	5.5	9.6	23.8	1.9%	2.3%	2.1%
Canada e.c-C.America w.c	CONTAINERIZED	0.9	1.5	3.6	1.7%	2.2%	2.0%
Canada e.c-C.America w.c	TOTAL	27.9	36.5	99.4	0.9%	2.5%	1.8%
Canada e.c-S.America w.c	MAJOR DRY BULKS	98.0	20.6	19.6	-5.1%	-0.1%	-2.3%
Canada e.c-S.America w.c	MINOR BULKS	106.0	217.9	626.7	2.4%	2.7%	2.6%
Canada e.c-S.America w.c	GENERAL CARGO	20.5	30.4	84.7	1.3%	2.6%	2.0%
Canada e.c-S.America w.c	CONTAINERIZED	3.0	4.8	11.8	1.5%	2.3%	2.0%
Canada e.c-S.America w.c	TOTAL	227.5	273.7	742.8	0.6%	2.5%	1.7%
Canada e.c-Oceania	MINOR BULKS	51.3	87.5	202.5	1.8%	2.1%	2.0%
Canada e.c-Oceania	GENERAL CARGO	33.6	64.6	128.1	2.2%	1.7%	1.9%
Canada e.c-Oceania	CONTAINERIZED	121.0	224.3	435.3	2.1%	1.7%	1.8%
Canada e.c-Oceania	TOTAL	205.9	376.4	765.9	2.0%	1.8%	1.9%
Canada e.c-Asia	PETROLEUM PRODS	125.0	6.0	10.8	-9.6%	1.5%	-3.4%
Canada e.c-Asia	MAJOR DRY BULKS	106.0	238.5	622.2	2.7%	2.4%	2.6%
Canada e.c-Asia	MINOR BULKS	975.2	2,027.4	3,170.6	2.5%	1.1%	1.7%
Canada e.c-Asia	BULK CHEMICALS	5.9	6.3	10.5	0.2%	1.3%	0.8%
Canada e.c-Asia	REFRIG CARGOES	59.0	100.3	141.0	1.8%	0.9%	1.3%
Canada e.c-Asia	GENERAL CARGO	171.8	513.9	1,145.8	3.7%	2.0%	2.7%
Canada e.c-Asia	CONTAINERIZED	208.7	581.0	965.5	3.5%	1.3%	2.2%
Canada e.c-Asia	TOTAL	1,651.7	3,473.4	6,066.4	2.5%	1.4%	1.9%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
C.America e.c/Carib-U.S w.c	CRUDE OIL	35.0	26.8	9.9	-0.9%	-2.5%	-1.8%
C.America e.c/Carib-U.S w.c	PETROLEUM PRODS	612.0	425.6	131.6	-1.2%	-2.9%	-2.2%
C.America e.c/Carib-U.S w.c	MAJOR DRY BULKS	86.0	42.1	110.1	-2.3%	2.4%	0.4%
C.America e.c/Carib-U.S w.c	MINOR BULKS	17.0	26.2	22.8	1.4%	-0.3%	0.4%
C.America e.c/Carib-U.S w.c	CONTAINERIZED	13.0	12.9	28.6	-0.0%	2.0%	1.1%
C.America e.c/Carib-U.S w.c	TOTAL	763.0	533.6	302.9	-1.2%	-1.4%	-1.3%
C.America e.c/Carib-C.America w.c	CRUDE OIL	452.0	594.5	127.9	0.9%	-3.8%	-1.8%
C.America e.c/Carib-C.America w.c	PETROLEUM PRODS	762.0	3,760.8	1,906.4	5.5%	-1.7%	1.3%
C.America e.c/Carib-C.America w.c	MINOR BULKS	396.8	961.8	2,345.1	3.0%	2.3%	2.6%
C.America e.c/Carib-C.America w.c	BULK CHEMICALS	2.5	0.3	0.6	-6.7%	1.5%	-2.1%
C.America e.c/Carib-C.America w.c	OILS & FATS	5.1	10.9	20.3	2.6%	1.6%	2.0%
C.America e.c/Carib-C.America w.c	GENERAL CARGO	3.5	10.5	21.8	3.7%	1.8%	2.6%
C.America e.c/Carib-C.America w.c	CONTAINERIZED	18.1	49.9	91.3	3.4%	1.5%	2.3%
C.America e.c/Carib-C.America w.c	TOTAL	1,640.1	5,388.6	4,513.3	4.0%	-0.4%	1.5%
C.America e.c/Carib-S.America w.c	CRUDE OIL	105.0	138.1	29.7	0.9%	-3.8%	-1.8%
C.America e.c/Carib-S.America w.c	PETROLEUM PRODS	609.0	1,450.4	737.1	2.9%	-1.7%	0.3%
C.America e.c/Carib-S.America w.c	MINOR BULKS	185.4	455.3	1,076.2	3.0%	2.2%	2.5%
C.America e.c/Carib-S.America w.c	BULK CHEMICALS	2.5	7.0	13.0	3.4%	1.5%	2.3%
C.America e.c/Carib-S.America w.c	GENERAL CARGO	43.1	114.4	242.5	3.3%	1.9%	2.5%
C.America e.c/Carib-S.America w.c	CONTAINERIZED	57.0	157.9	289.0	3.5%	1.5%	2.3%
C.America e.c/Carib-S.America w.c	TOTAL	1,002.0	2,323.1	2,387.5	2.8%	0.1%	1.2%
C.America e.c/Carib-Oceania	CONTAINERIZED	4.0	8.1	23.1	2.4%	2.7%	2.5%
C.America e.c/Carib-Oceania	TOTAL	4.0	8.1	23.1	2.4%	2.7%	2.5%
C.America e.c/Carib-Asia	PETROLEUM PRODS	258.0	213.2	71.8	-0.6%	-2.7%	-1.8%
C.America e.c/Carib-Asia	MINOR BULKS	1,529.0	992.6	1,208.2	-1.4%	0.5%	-0.3%
C.America e.c/Carib-Asia	BULK CHEMICALS	146.2	233.9	277.7	1.6%	0.4%	0.9%
C.America e.c/Carib-Asia	REFRIG CARGOES	36.3	38.1	44.7	0.2%	0.4%	0.3%
C.America e.c/Carib-Asia	GENERAL CARGO	50.2	127.1	208.1	3.1%	1.2%	2.1%
C.America e.c/Carib-Asia	CONTAINERIZED	195.1	126.8	148.2	-1.4%	0.4%	-0.4%
C.America e.c/Carib-Asia	TOTAL	2,214.8	1,731.5	1,958.9	-0.8%	0.3%	-0.2%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
S.America e.c-US w.c./Hawaii	CRUDE OIL	286.0	219.4	81.3	-0.9%	-2.5%	-1.8%
S.America e.c-US w.c./Hawaii	PETROLEUM PRODS	561.0	395.3	147.1	-1.2%	-2.4%	-1.9%
S.America e.c-US w.c./Hawaii	MAJOR DRY BULKS	66.0	130.0	175.0	2.3%	0.7%	1.4%
S.America e.c-US w.c./Hawaii	MINOR BULKS	827.5	914.3	1,413.3	0.3%	1.1%	0.8%
S.America e.c-US w.c./Hawaii	GENERAL CARGO	86.8	424.0	1,044.2	5.4%	2.3%	3.6%
S.America e.c-US w.c./Hawaii	CONTAINERIZED	89.2	229.4	486.4	3.2%	1.9%	2.5%
S.America e.c-US w.c./Hawaii	TOTAL	1,916.6	2,312.4	3,347.3	0.6%	0.9%	0.8%
S.America e.c-Canada w.c	MINOR BULKS	105.1	83.3	126.9	-0.8%	1.1%	0.3%
S.America e.c-Canada w.c	GENERAL CARGO	34.9	83.5	207.9	3.0%	2.3%	2.6%
S.America e.c-Canada w.c	CONTAINERIZED	29.0	52.8	108.2	2.0%	1.8%	1.9%
S.America e.c-Canada w.c	TOTAL	169.0	219.5	442.9	0.9%	1.8%	1.4%
S.America e.c-C.America w.c	CRUDE OIL	935.0	1,229.8	264.5	0.9%	-3.8%	-1.8%
S.America e.c-C.America w.c	PETROLEUM PRODS	615.2	460.0	247.3	-1.0%	-1.5%	-1.3%
S.America e.c-C.America w.c	MINOR BULKS	246.9	451.3	793.4	2.0%	1.4%	1.7%
S.America e.c-C.America w.c	BULK CHEMICALS	0.8	2.3	4.3	3.5%	1.5%	2.4%
S.America e.c-C.America w.c	OILS & FATS	8.0	17.3	32.4	2.6%	1.6%	2.0%
S.America e.c-C.America w.c	GENERAL CARGO	15.9	35.4	67.6	2.7%	1.6%	2.1%
S.America e.c-C.America w.c	CONTAINERIZED	22.0	60.9	111.5	3.5%	1.5%	2.3%
S.America e.c-C.America w.c	TOTAL	1,843.8	2,257.1	1,520.9	0.7%	-1.0%	-0.3%
S.America e.c-S.America w.c	CRUDE OIL	742.0	976.0	209.9	0.9%	-3.8%	-1.8%
S.America e.c-S.America w.c	PETROLEUM PRODS	456.0	1026.0	521.4	2.7%	-1.7%	0.2%
S.America e.c-S.America w.c	MAJOR DRY BULKS	164.0	497.7	644.9	3.8%	0.6%	2.0%
S.America e.c-S.America w.c	MINOR BULKS	355.3	740.7	1,468.1	2.5%	1.7%	2.0%
S.America e.c-S.America w.c	BULK CHEMICALS	27.2	74.8	138.1	3.4%	1.5%	2.3%
S.America e.c-S.America w.c	GENERAL CARGO	62.6	172.9	348.5	3.4%	1.8%	2.5%
S.America e.c-S.America w.c	CONTAINERIZED	39.0	108.0	197.7	3.5%	1.5%	2.3%
S.America e.c-S.America w.c	TOTAL	1,846.1	3,596.0	3,528.6	2.2%	-0.0%	0.9%
S.America e.c-Oceania	MINOR BULKS	2.3	2.3	3.8	0.0%	1.3%	0.7%
S.America e.c-Oceania	GENERAL CARGO	1.7	4.8	9.6	3.4%	1.8%	2.5%
S.America e.c-Oceania	CONTAINERIZED	1.0	1.7	4.0	1.7%	2.2%	2.0%
S.America e.c-Oceania	TOTAL	5.0	8.7	17.4	1.9%	1.7%	1.8%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
S.America e.c-Asia	PETROLEUM PRODS	194.0	160.3	53.7	-0.6%	-2.7%	-1.8%
S.America e.c-Asia	MAJOR DRY BULKS	227.0	774.5	935.7	4.2%	0.5%	2.0%
S.America e.c-Asia	MINOR BULKS	1,194.1	2,279.6	2,311.3	2.2%	0.0%	0.9%
S.America e.c-Asia	BULK CHEMICALS	18.7	55.0	69.2	3.7%	0.6%	1.9%
S.America e.c-Asia	REFRIG CARGOES	3.0	7.0	8.8	2.9%	0.6%	1.5%
S.America e.c-Asia	GENERAL CARGO	358.7	569.5	778.3	1.6%	0.8%	1.1%
S.America e.c-Asia	CONTAINERIZED	61.5	84.9	103.5	1.1%	0.5%	0.7%
S.America e.c-Asia	TOTAL	2,057.0	3,930.6	4,260.4	2.2%	0.2%	1.0%
Europe-US w.c	PETROLEUM PRODS	387.0	187.9	57.9	-2.4%	-2.9%	-2.7%
Europe-US w.c	MINOR BULKS	1,179.0	2,417.4	3,804.5	2.4%	1.1%	1.7%
Europe-US w.c	BULK CHEMICALS	25.5	94.3	171.6	4.5%	1.5%	2.8%
Europe-US w.c	OILS & FATS	17.0	43.4	46.9	3.2%	0.2%	1.5%
Europe-US w.c	REFRIG CARGOES	59.9	82.1	113.3	1.1%	0.8%	0.9%
Europe-US w.c	VEHICLES	172.0	246.0	244.2	1.2%	-0.0%	0.5%
Europe-US w.c	GENERAL CARGO	204.0	751.0	1,149.3	4.4%	1.1%	2.5%
Europe-US w.c	CONTAINERIZED	1,573.8	4,719.3	5,365.3	3.7%	0.3%	1.8%
Europe-US w.c	TOTAL	3,618.2	8,541.4	10,953.1	2.9%	0.6%	1.6%
Europe-Canada w.c	MINOR BULKS	166.4	173.1	207.4	0.1%	0.5%	0.3%
Europe-Canada w.c	REFRIG CARGOES	8.7	12.8	21.3	1.3%	1.3%	1.3%
Europe-Canada w.c	VEHICLES	9.2	6.2	6.4	-1.3%	0.1%	-0.5%
Europe-Canada w.c	GENERAL CARGO	56.2	114.7	229.7	2.4%	1.8%	2.0%
Europe-Canada w.c	CONTAINERIZED	175.8	295.9	434.1	1.8%	1.0%	1.3%
Europe-Canada w.c	TOTAL	416.3	602.6	898.9	1.2%	1.0%	1.1%
Europe-C.America w.c	PETROLEUM PRODS	31.8	2.4	3.3	-8.3%	0.8%	-3.2%
Europe-C.America w.c	MAJOR DRY BULKS	45.0	50.0	102.6	0.3%	1.8%	1.2%
Europe-C.America w.c	MINOR BULKS	518.4	864.4	1,765.7	1.7%	1.8%	1.8%
Europe-C.America w.c	BULK CHEMICALS	21.2	38.9	64.2	2.0%	1.3%	1.6%
Europe-C.America w.c	OILS & FATS	3.0	5.3	10.9	2.0%	1.8%	1.9%
Europe-C.America w.c	VEHICLES	12.0	12.1	13.6	0.0%	0.3%	0.2%
Europe-C.America w.c	GENERAL CARGO	110.2	231.5	463.6	2.5%	1.8%	2.1%
Europe-C.America w.c	CONTAINERIZED	39.0	64.7	116.2	1.7%	1.5%	1.6%
Europe-C.America w.c	TOTAL	780.6	1,269.3	2,540.0	1.6%	1.7%	1.7%
Europe-S.America w.c	PETROLEUM PRODS	421.7	13.4	20.5	-10.9%	1.1%	-4.2%
Europe-S.America w.c	MAJOR DRY BULKS	33.0	42.2	77.6	0.8%	1.5%	1.2%
Europe-S.America w.c	MINOR BULKS	702.9	862.7	1,478.6	0.7%	1.4%	1.1%
Europe-S.America w.c	BULK CHEMICALS	53.5	98.5	155.8	2.1%	1.2%	1.5%
Europe-S.America w.c	OILS & FATS	6.0	9.2	19.3	1.4%	1.9%	1.7%
Europe-S.America w.c	REFRIG CARGOES	4.0	7.0	14.9	1.9%	1.9%	1.9%
Europe-S.America w.c	VEHICLES	21.1	16.0	21.2	-0.9%	0.7%	0.0%
Europe-S.America w.c	GENERAL CARGO	282.8	623.8	1,376.8	2.7%	2.0%	2.3%
Europe-S.America w.c	CONTAINERIZED	567.7	891.8	1,590.4	1.5%	1.5%	1.5%
Europe-S.America w.c	TOTAL	2,092.7	2,564.5	4,755.1	0.7%	1.6%	1.2%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
Europe-Oceania	PETROLEUM PRODS	15.9	0.6	0.7	-10.6%	0.7%	-4.3%
Europe-Oceania	MAJOR DRY BULKS	26.0	35.0	45.1	1.0%	0.6%	0.8%
Europe-Oceania	MINOR BULKS	118.5	185.3	320.0	1.5%	1.4%	1.4%
Europe-Oceania	BULK CHEMICALS	81.6	133.0	189.3	1.6%	0.9%	1.2%
Europe-Oceania	OILS & FATS	12.1	17.6	28.5	1.3%	1.2%	1.2%
Europe-Oceania	REFRIG CARGOES	10.7	24.2	42.8	2.8%	1.4%	2.0%
Europe-Oceania	VEHICLES	21.0	10.9	13.4	-2.2%	0.5%	-0.6%
Europe-Oceania	GENERAL CARGO	127.6	287.5	591.4	2.7%	1.8%	2.2%
Europe-Oceania	CONTAINERIZED	600.5	1,123.8	1,640.7	2.1%	1.0%	1.4%
Europe-Oceania	TOTAL	1,013.9	1,817.9	2,871.9	2.0%	1.1%	1.5%
Europe-Asia	PETROLEUM PRODS	3.0	0.1	0.1	-11.9%	0.8%	-4.8%
Europe-Asia	MINOR BULKS	77.9	232.9	382.0	3.7%	1.2%	2.3%
Europe-Asia	BULK CHEMICALS	149.3	531.6	792.9	4.3%	1.0%	2.4%
Europe-Asia	OILS & FATS	2.1	4.5	7.6	2.7%	1.3%	1.9%
Europe-Asia	REFRIG CARGOES	59.0	124.5	170.5	2.5%	0.8%	1.5%
Europe-Asia	VEHICLES	12.0	25.9	24.0	2.6%	-0.2%	1.0%
Europe-Asia	GENERAL CARGO	39.7	122.9	231.0	3.8%	1.6%	2.5%
Europe-Asia	CONTAINERIZED	89.0	296.4	452.1	4.1%	1.1%	2.3%
Europe-Asia	TOTAL	431.9	1,338.7	2,060.2	3.8%	1.1%	2.3%
Africa-US w.c	PETROLEUM PRODS	53.6	0.2	0.2	-17.6%	0.0%	-8.0%
Africa-US w.c	MINOR BULKS	86.3	182.4	335.8	2.5%	1.5%	2.0%
Africa-US w.c	GENERAL CARGO	18.5	77.3	245.7	4.9%	2.9%	3.8%
Africa-US w.c	CONTAINERIZED	7.0	16.2	47.2	2.9%	2.7%	2.8%
Africa-US w.c	TOTAL	165.4	276.1	628.8	1.7%	2.1%	1.9%
Africa-Canada w.c	MINOR BULKS	690.6	1,192.7	6,733.4	1.8%	4.4%	3.3%
Africa-Canada w.c	CONTAINERIZED	1.0	1.7	6.5	1.8%	3.3%	2.7%
Africa-Canada w.c	TOTAL	691.6	1,194.5	6,739.9	1.8%	4.4%	3.3%
Africa-C.America w.c	MAJOR DRY BULKS	8.5	25.3	49.5	3.7%	1.7%	2.5%
Africa-C.America w.c	MINOR BULKS	149.0	363.5	902.9	3.0%	2.3%	2.6%
Africa-C.America w.c	CONTAINERIZED	1.0	2.8	5.1	3.4%	1.5%	2.3%
Africa-C.America w.c	TOTAL	158.5	391.6	957.4	3.1%	2.3%	2.6%
Africa-S.America w.c	MAJOR DRY BULKS	14.0	34.4	67.5	3.0%	1.7%	2.3%
Africa-S.America w.c	MINOR BULKS	17.4	42.8	104.8	3.0%	2.3%	2.6%
Africa-S.America w.c	BULK CHEMICALS	10.2	28.0	51.8	3.4%	1.5%	2.3%
Africa-S.America w.c	GENERAL CARGO	8.1	11.8	21.2	1.3%	1.5%	1.4%
Africa-S.America w.c	TOTAL	49.7	117.1	245.2	2.9%	1.9%	2.3%
Africa-Oceania	MINOR BULKS	168.0	336.0	1,712.1	2.3%	4.2%	3.4%
Africa-Oceania	TOTAL	168.0	336.0	1,712.1	2.3%	4.2%	3.4%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
Africa-Asia	MINOR BULKS	30.4	97.3	200.3	4.0%	1.8%	2.7%
Africa-Asia	REFRIG CARGOES	31.0	113.8	220.7	4.4%	1.7%	2.8%
Africa-Asia	GENERAL CARGO	18.5	20.5	46.6	0.3%	2.1%	1.3%
Africa-Asia	CONTAINERIZED	4.0	8.9	20.4	2.7%	2.1%	2.3%
Africa-Asia	TOTAL	83.9	240.5	488.0	3.6%	1.8%	2.5%
Middle East-US w.c	PETROLEUM PRODS	59.0	0.2	0.2	-17.8%	-0.2%	-8.2%
Middle East-US w.c	GENERAL CARGO	1.1	2.3	9.9	2.6%	3.7%	3.2%
Middle East-US w.c	CONTAINERIZED	37.9	117.0	246.6	3.8%	1.9%	2.7%
Middle East-US w.c	TOTAL	98.0	119.5	256.6	0.7%	1.9%	1.4%
US w.c/Hawaii-US e.c	CRUDE OIL	123.0	0.0	0.0	-100.0%		-100.0%
US w.c/Hawaii-US e.c	PETROLEUM PRODS	501.8	401.9	173.4	-0.7%	-2.1%	-1.5%
US w.c/Hawaii-US e.c	MINOR BULKS	229.3	253.7	297.4	0.3%	0.4%	0.4%
US w.c/Hawaii-US e.c	BULK CHEMICALS	46.3	61.1	90.2	0.9%	1.0%	1.0%
US w.c/Hawaii-US e.c	OILS & FATS	21.0	42.2	82.4	2.4%	1.7%	2.0%
US w.c/Hawaii-US e.c	GENERAL CARGO	32.4	30.4	58.3	-0.2%	1.6%	0.8%
US w.c/Hawaii-US e.c	CONTAINERIZED	64.8	144.5	281.8	2.7%	1.7%	2.1%
US w.c/Hawaii-US e.c	TOTAL	1,018.5	933.8	983.4	-0.3%	0.1%	-0.1%
US w.c-Canada e.c	PETROLEUM PRODS	107.6	67.3	0.0	-1.6%	-100.0%	-100.0%
US w.c-Canada e.c	MAJOR DRY BULKS	163.9	1,086.8	903.2	6.5%	-0.5%	2.5%
US w.c-Canada e.c	CONTAINERIZED	2.2	4.8	7.0	2.7%	0.9%	1.7%
US w.c-Canada e.c	TOTAL	273.6	1 158.9	910.2	4.9%	-0.6%	1.7%
US w.c-S.America e.c	PETROLEUM PRODS	126.5	126.5	42.2	0.0%	-2.7%	-1.6%
US w.c-S.America e.c	MAJOR DRY BULKS	9.0	29.5	37.1	4.0%	0.6%	2.0%
US w.c-S.America e.c	MINOR BULKS	170.9	217.5	352.7	0.8%	1.2%	1.0%
US w.c-S.America e.c	VEHICLES	4.0	0.4	0.6	-7.1%	0.8%	-2.7%
US w.c-S.America e.c	GENERAL CARGO	17.9	8.3	19.0	-2.5%	2.1%	0.1%
US w.c-S.America e.c	CONTAINERIZED	10.8	3.6	7.1	-3.6%	1.7%	-0.6%
US w.c-S.America e.c	TOTAL	339.1	385.8	458.7	0.4%	0.4%	0.4%
US w.c-C.America e.c./Carib	PETROLEUM PRODS	373.0	388.1	124.3	0.1%	-2.8%	-1.6%
US w.c-C.America e.c./Carib	CONTAINERIZED	7.0	19.7	41.9	3.5%	1.9%	2.6%
US w.c-C.America e.c./Carib	TOTAL	380.0	407.8	166.1	0.2%	-2.2%	-1.2%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
US w.c/Hawaii-Europe	PETROLEUM PRODS	18.0	0.0	0.0	-100.0%		-100.0%
US w.c/Hawaii-Europe	MAJOR DRY BULKS	2,345.0	34.7	28.0	-13.1%	-0.5%	-6.1%
US w.c/Hawaii-Europe	MINOR BULKS	1,480.7	5,894.1	8,791.5	4.7%	1.0%	2.6%
US w.c/Hawaii-Europe	BULK CHEMICALS	59.7	210.4	263.8	4.3%	0.6%	2.1%
US w.c/Hawaii-Europe	OILS & FATS	48.2	19.6	20.2	-3.0%	0.1%	-1.2%
US w.c/Hawaii-Europe	REFRIG CARGOES	207.0	676.7	664.4	4.0%	-0.0%	1.7%
US w.c/Hawaii-Europe	GENERAL CARGO	266.1	679.5	895.0	3.2%	0.7%	1.7%
US w.c/Hawaii-Europe	CONTAINERIZED	1,246.0	2,293.7	2,130.2	2.1%	-0.2%	0.8%
US w.c/Hawaii-Europe	TOTAL	5,670.6	9,808.8	12,793.0	1.8%	0.7%	1.2%
US w.c-Africa	MAJOR DRY BULKS	904.0	3,118.8	4,646.6	4.2%	1.3%	2.4%
US w.c-Africa	MINOR BULKS	375.1	1,477.2	4,624.9	4.7%	2.9%	3.7%
US w.c-Africa	GENERAL CARGO	65.8	181.8	539.1	3.4%	2.8%	3.1%
US w.c-Africa	CONTAINERIZED	36.1	108.1	316.6	3.7%	2.7%	3.1%
US w.c-Africa	TOTAL	1,381.0	4,885.8	10,127.2	4.3%	1.8%	2.9%
Canada w.c-US e.c	CRUDE OIL	80.0	102.2	97.9	0.8%	-0.1%	0.3%
Canada w.c-US e.c	PETROLEUM PRODS	20.9	19.8	31.7	-0.2%	1.2%	0.6%
Canada w.c-US e.c	MINOR BULKS	777.1	1,813.4	3,061.6	2.9%	1.3%	2.0%
Canada w.c-US e.c	BULK CHEMICALS	194.0	649.9	907.9	4.1%	0.8%	2.2%
Canada w.c-US e.c	GENERAL CARGO	9.4	4.2	8.6	-2.6%	1.8%	-0.1%
Canada w.c-US e.c	TOTAL	1,081.4	2,589.5	4,107.7	3.0%	1.2%	1.9%
Canada w.c-S.America e.c	MAJOR DRY BULKS	46.5	121.7	295.1	3.3%	2.2%	2.7%
Canada w.c-S.America e.c	MINOR BULKS	358.2	503.5	720.5	1.1%	0.9%	1.0%
Canada w.c-S.America e.c	GENERAL CARGO	64.9	104.5	269.6	1.6%	2.4%	2.1%
Canada w.c-S.America e.c	CONTAINERIZED	8.5	13.0	31.4	1.4%	2.2%	1.9%
Canada w.c-S.America e.c	TOTAL	478.1	742.7	1,316.6	1.5%	1.4%	1.5%
Canada w.c-West Indies	MINOR BULKS	105.7	127.8	342.3	0.6%	2.5%	1.7%
Canada w.c-West Indies	GENERAL CARGO	0.8	2.4	6.0	3.7%	2.3%	2.9%
Canada w.c-West Indies	TOTAL	106.5	130.2	348.3	0.7%	2.5%	1.7%
Canada w.c-Europe	MAJOR DRY BULKS	2,205.0	1,571.1	1,232.4	-1.1%	-0.6%	-0.8%
Canada w.c-Europe	MINOR BULKS	4,496.1	7,520.3	12,221.7	1.7%	1.2%	1.4%
Canada w.c-Europe	BULK CHEMICALS	3.9	5.0	7.0	0.9%	0.8%	0.9%
Canada w.c-Europe	OILS & FATS	18.8	52.9	63.7	3.5%	0.5%	1.8%
Canada w.c-Europe	REFRIG CARGOES	25.7	46.7	62.8	2.0%	0.7%	1.3%
Canada w.c-Europe	GENERAL CARGO	626.8	1,121.2	1,924.2	2.0%	1.4%	1.6%
Canada w.c-Europe	CONTAINERIZED	171.6	782.5	644.9	5.2%	-0.5%	1.9%
Canada w.c-Europe	TOTAL	7,547.7	11,099.6	16,156.7	1.3%	0.9%	1.1%
Canada w.c-Africa	MAJOR DRY BULKS	154.6	0.5	2.2	-17.4%	3.7%	-5.9%
Canada w.c-Africa	MINOR BULKS	1,285.0	2,080.7	3,161.1	1.6%	1.1%	1.3%
Canada w.c-Africa	GENERAL CARGO	1.5	4.8	15.4	4.0%	2.9%	3.4%
Canada w.c-Africa	TOTAL	1,441.1	2,086.0	3,178.6	1.2%	1.1%	1.1%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
Canada w.c-Middle East	MINOR BULKS	259.6	951.8	2,837.9	4.4%	2.8%	3.5%
Canada w.c-Middle East	GENERAL CARGO	0.1	1.6	3.4	9.0%	1.9%	4.9%
Canada w.c-Middle East	TOTAL	259.7	953.4	2,841.3	4.4%	2.8%	3.5%
C.America w.c-US e.c	PETROLEUM PRODS	3.0	0.0	0.0	-100.0%		-100.0%
C.America w.c-US e.c	MAJOR DRY BULKS	106.0	195.1	201.4	2.1%	0.1%	0.9%
C.America w.c-US e.c	MINOR BULKS	1,090.6	1,032.3	1,552.7	-0.2%	1.0%	0.5%
C.America w.c-US e.c	BULK CHEMICALS	144.5	344.0	695.2	2.9%	1.8%	2.3%
C.America w.c-US e.c	OILS & FATS	175.0	35.1	80.9	-5.2%	2.1%	-1.1%
C.America w.c-US e.c	REFRIG CARGOES	2.0	1.9	3.0	-0.1%	1.1%	0.6%
C.America w.c-US e.c	VEHICLES	5.1	2.3	6.1	-2.6%	2.5%	0.3%
C.America w.c-US e.c	GENERAL CARGO	49.8	70.1	148.3	1.1%	1.9%	1.6%
C.America w.c-US e.c	TOTAL	1,576.1	1,680.7	2,687.5	0.2%	1.2%	0.8%
C.America w.c-C.America e.c/Carib	PETROLEUM PRODS	116.5	193.0	97.8	1.7%	-1.7%	-0.3%
C.America w.c-C.America e.c/Carib	MAJOR DRY BULKS	83.0	204.2	400.1	3.0%	1.7%	2.3%
C.America w.c-C.America e.c/Carib	MINOR BULKS	357.9	860.4	2,004.2	3.0%	2.1%	2.5%
C.America w.c-C.America e.c/Carib	BULK CHEMICALS	34.7	95.4	176.2	3.4%	1.5%	2.3%
C.America w.c-C.America e.c/Carib	OILS & FATS	48.0	97.3	187.5	2.4%	1.7%	2.0%
C.America w.c-C.America e.c/Carib	REFRIG CARGOES	94.0	238.8	528.3	3.2%	2.0%	2.5%
C.America w.c-C.America e.c/Carib	GENERAL CARGO	28.9	70.3	133.3	3.0%	1.6%	2.2%
C.America w.c-C.America e.c/Carib	CONTAINERIZED	17.0	47.1	86.2	3.5%	1.5%	2.3%
C.America w.c-C.America e.c/Carib	TOTAL	780.0	1,806.4	3,613.6	2.8%	1.7%	2.2%
C.America w.c-S.America e.c	MINOR BULKS	66.6	152.7	300.2	2.8%	1.7%	2.2%
C.America w.c-S.America e.c	BULK CHEMICALS	6.7	18.5	34.3	3.4%	1.5%	2.3%
C.America w.c-S.America e.c	REFRIG CARGOES	55.0	142.2	314.7	3.2%	2.0%	2.5%
C.America w.c-S.America e.c	GENERAL CARGO	9.7	21.9	40.3	2.8%	1.5%	2.1%
C.America w.c-S.America e.c	CONTAINERIZED	1.0	2.8	5.1	3.5%	1.5%	2.3%
C.America w.c-S.America e.c	TOTAL	139.0	338.2	694.5	3.0%	1.8%	2.3%
C.America w.c-Europe	MINOR BULKS	191.9	432.9	583.9	2.7%	0.8%	1.6%
C.America w.c-Europe	BULK CHEMICALS	1.9	5.5	11.5	3.6%	1.9%	2.6%
C.America w.c-Europe	OILS & FATS	82.5	141.8	190.1	1.8%	0.7%	1.2%
C.America w.c-Europe	REFRIG CARGOES	525.0	966.0	1,449.0	2.1%	1.0%	1.5%
C.America w.c-Europe	GENERAL CARGO	154.7	206.5	620.1	1.0%	2.8%	2.0%
C.America w.c-Europe	CONTAINERIZED	37.0	50.3	75.1	1.0%	1.0%	1.0%
C.America w.c-Europe	TOTAL	993.1	1,803.1	2,929.7	2.0%	[illegible].2%	1.6%
C.America w.c-Africa	MAJOR DRY BULKS	22.7	56.0	109.6	3.0%	1.7%	2.3%
C.America w.c-Africa	MINOR BULKS	5.7	10.4	15.4	2.0%	1.0%	1.4%
C.America w.c-Africa	REFRIG CARGOES	6.0	15.2	33.7	3.2%	2.0%	2.5%
C.America w.c-Africa	GENERAL CARGO	85.0	200.0	384.0	2.9%	1.6%	2.2%
C.America w.c-Africa	TOTAL	119.4	281.7	542.7	2.9%	1.7%	2.2%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
S.America w.c-US e.c	CRUDE OIL	2,213.0	285.5	0.0	-6.6%	-100.0%	-100.0%
S.America w.c-US e.c	PETROLEUM PRODS	2,380.0	1,656.3	509.6	-1.2%	-2.9%	-2.2%
S.America w.c-US e.c	MAJOR DRY BULKS	173.8	588.3	1,292.0	4.1%	2.0%	2.9%
S.America w.c-US e.c	MINOR BULKS	1,659.8	1,155.5	2,294.0	-1.2%	1.7%	0.5%
S.America w.c-US e.c	BULK CHEMICALS	92.5	70.3	211.8	-0.9%	2.8%	1.2%
S.America w.c-US e.c	OILS & FATS	78.0	36.8	67.6	-2.5%	1.5%	-0.2%
S.America w.c-US e.c	REFRIG CARGOES	1,078.0	2,123.6	3,622.0	2.3%	1.3%	1.7%
S.America w.c-US e.c	GENERAL CARGO	431.7	608.8	1,372.4	1.2%	2.1%	1.7%
S.America w.c-US e.c	CONTAINERIZED	598.0	944.8	2,104.9	1.5%	2.0%	1.8%
S.America w.c-US e.c	TOTAL	8,704.9	7,469.8	11,474.2	-0.5%	1.1%	0.4%
S.America w.c-Canada e.c	PETROLEUM PRODS	26.9	26.9	0.0	0.0%	-100.0%	-100.0%
S.America w.c-Canada e.c	MINOR BULKS	15.1	28.3	66.7	2.1%	2.2%	2.1%
S.America w.c-Canada e.c	GENERAL CARGO	9.0	15.6	37.8	1.9%	2.2%	2.1%
S.America w.c-Canada e.c	TOTAL	51.0	70.8	104.5	1.1%	1.0%	1.0%
S.America w.c-C.America e.c/Carib	CRUDE OIL	4,158.0	535.8	0.0	-6.6%	-100.0%	-100.0%
S.America w.c-C.America e.c/Carib	PETROLEUM PRODS	542.0	897.9	455.2	1.7%	-1.7%	-0.2%
S.America w.c-C.America e.c/Carib	MINOR BULKS	138.3	298.5	520.5	2.6%	1.4%	1.9%
S.America w.c-C.America e.c/Carib	BULK CHEMICALS	3.9	10.6	19.6	3.4%	1.5%	2.3%
S.America w.c-C.America e.c/Carib	OILS & FATS	45.1	96.6	181.3	2.6%	1.6%	2.0%
S.America w.c-C.America e.c/Carib	REFRIG CARGOES	42.0	106.7	236.0	3.2%	2.0%	2.5%
S.America w.c-C.America e.c/Carib	GENERAL CARGO	36.9	72.7	156.5	2.3%	1.9%	2.1%
S.America w.c-C.America e.c/Carib	CONTAINERIZED	37.0	100.0	183.1	3.4%	1.5%	2.3%
S.America w.c-C.America e.c/Carib	TOTAL	5,003.1	2,118.8	1,752.2	-2.8%	-0.5%	-1.5%
S.America w.c-S.America e.c	PETROLEUM PRODS	10.0	16.6	8.4	1.7%	-1.7%	-0.2%
S.America w.c-S.America e.c	MINOR BULKS	107.2	262.6	475.7	3.0%	1.5%	2.2%
S.America w.c-S.America e.c	BULK CHEMICALS	5.8	15.9	29.4	3.4%	1.5%	2.3%
S.America w.c-S.America e.c	OIL & FATS	25.0	75.4	140.7	3.7%	1.6%	2.5%
S.America w.c-S.America e.c	REFRIG CARGOES	17.0	43.2	95.5	3.2%	2.0%	2.5%
S.America w.c-S.America e.c	GENERAL CARGO	40.8	115.3	227.3	3.5%	1.7%	2.5%
S.America w.c-S.America e.c	CONTAINERIZED	20.3	42.8	78.4	2.5%	1.5%	2.0%
S.America w.c-S.America e.c	TOTAL	226.0	571.8	1,055.5	3.1%	1.5%	2.2%
S.America w.c-Europe	PETROLEUM PRODS	3.0	0.0	0.0	-100.0%		-100.0%
S.America w.c-Europe	MAJOR DRY BULKS	108.0	198.2	246.3	2.0%	0.5%	1.2%
S.America w.c-Europe	MINOR BULKS	2,381.2	6,421.9	11,558.7	3.4%	1.5%	2.3%
S.America w.c-Europe	BULK CHEMICALS	21.2	51.5	103.0	3.0%	1.7%	2.3%
S.America w.c-Europe	OILS & FATS	113.0	254.3	414.7	2.7%	1.2%	1.9%
S.America w.c-Europe	REFRIG CARGOES	1,509.3	5,209.4	7,533.1	4.2%	0.9%	2.3%
S.America w.c-Europe	GENERAL CARGO	1,519.7	3,306.7	5,718.1	2.6%	1.4%	1.9%
S.America w.c-Europe	CONTAINERIZED	599.0	1,545.4	2,402.0	3.2%	1.1%	2.0%
S.America w.c-Europe	TOTAL	6,254.4	16,987.3	27,975.9	3.4%	1.3%	2.2%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
S.America w.c-Africa	MINOR BULKS	39.5	113.1	221.7	3.6%	1.7%	2.5%
S.America w.c-Africa	REFRIG CARGOES	8.2	55.9	123.6	6.6%	2.0%	4.0%
S.America w.c-Africa	GENERAL CARGO	25.2	57.4	105.4	2.8%	1.5%	2.1%
S.America w.c-Africa	TOTAL	72.9	226.4	450.7	3.8%	1.7%	2.6%
Oceania-US e.c	PETROLEUM PRODS	159.4	112.7	70.9	-1.1%	-1.2%	-1.2%
Oceania-US e.c	MAJOR DRY BULKS	1,809.0	3,190.0	5,576.9	1.9%	1.4%	1.6%
Oceania-US e.c	MINOR BULKS	704.2	1,601.6	1,720.9	2.8%	0.2%	1.3%
Oceania-US e.c	BULK CHEMICALS	20.0	192.6	471.6	7.8%	2.3%	4.6%
Oceania-US e.c	OILS & FATS	266.0	77.1	111.7	-4.0%	0.9%	-1.2%
Oceania-US e.c	REFRIG CARGOES	451.0	559.2	1,014.8	0.7%	1.5%	1.2%
Oceania-US e.c	GENERAL CARGO	189.4	279.5	385.1	1.3%	0.8%	1.0%
Oceania-US e.c	CONTAINERIZED	244.0	424.6	617.3	1.9%	0.9%	1.3%
Oceania-US e.c	TOTAL	3,842.9	6,437.4	9,969.2	1.7%	1.1%	1.4%
Oceania-Canada e.c	MAJOR DRY BULKS	69.0	211.8	339.5	3.8%	1.2%	2.3%
Oceania-Canada e.c	MINOR BULKS	381.2	498.0	903.6	0.9%	1.5%	1.2%
Oceania-Canada e.c	REFRIG CARGOES	54.0	54.5	102.1	0.0%	1.6%	0.9%
Oceania-Canada e.c	GENERAL CARGO	23.9	30.9	56.9	0.9%	1.5%	1.2%
Oceania-Canada e.c	CONTAINERIZED	45.0	78.3	149.4	1.9%	1.6%	1.7%
Oceania-Canada e.c	TOTAL	573.1	873.6	1,551.4	1.4%	1.4%	1.4%
Oceania-C.America e.c/Carib	PETROLEUM PRODS	1.0	0.0	0.0	-100.0%		-100.0%
Oceania-C.America e.c/Carib	MINOR BULKS	229.0	194.1	548.7	-0.5%	2.6%	1.3%
Oceania-C.America e.c/Carib	REFRIG CARGOES	16.8	26.1	71.3	1.5%	2.5%	2.1%
Oceania-C.America e.c/Carib	GENERAL CARGO	86.9	53.1	121.2	-1.6%	2.1%	0.5%
Oceania-C.America e.c/Carib	CONTAINERIZED	2.9	5.7	14.3	2.3%	2.3%	2.3%
Oceania-C.America e.c/Carib	TOTAL	336.5	279.0	755.5	-0.6%	2.5%	1.2%
Oceania-S.America e.c	MAJOR DRY BULKS	841.9	1,512.8	2,739.1	2.0%	1.5%	1.7%
Oceania-S.America e.c	MINOR BULKS	53.9	95.0	271.2	1.9%	2.7%	2.3%
Oceania-S.America e.c	REFRIG CARGOES	8.4	18.1	52.7	2.6%	2.7%	2.7%
Oceania-S.America e.c	GENERAL CARGO	4.3	8.2	20.4	2.2%	2.3%	2.3%
Oceania-S.America e.c	TOTAL	908.4	1,634.0	3,083.5	2.0%	1.6%	1.8%
Oceania-Europe	MAJOR DRY BULKS	38.0	66.5	88.2	1.9%	0.7%	1.2%
Oceania-Europe	MINOR BULKS	232.0	336.8	569.6	1.3%	1.3%	1.3%
Oceania-Europe	BULK CHEMICALS	58.8	321.5	533.7	5.8%	1.3%	3.2%
Oceania-Europe	OILS & FATS	91.0	92.0	121.0	0.0%	0.7%	0.4%
Oceania-Europe	REFRIG CARGOES	316.2	833.7	1,249.0	3.3%	1.0%	2.0%
Oceania-Europe	GENERAL CARGO	46.3	116.1	177.4	3.1%	1.1%	1.9%
Oceania-Europe	CONTAINERIZED	160.0	356.7	468.8	2.7%	0.7%	1.5%
Oceania-Europe	TOTAL	942.2	2,123.3	3,207.6	2.7%	1.0%	1.8%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
Asia-US e.c	PETROLEUM PRODS	76.7	0.0	0.0	-100.0%		-100.0%
Asia-US e.c	MAJOR DRY BULKS	1,118.0	1,356.4	2,689.6	0.6%	1.7%	1.3%
Asia-US e.c	MINOR BULKS	4,274.8	3,393.0	7,042.1	-0.8%	1.8%	0.7%
Asia-US e.c	BULK CHEMICALS	141.6	474.5	543.9	4.1%	0.3%	1.9%
Asia-US e.c	OILS & FATS	152.0	238.6	617.1	1.5%	2.4%	2.0%
Asia-US e.c	REFRIG CARGOES	123.0	257.4	328.2	2.5%	0.6%	1.4%
Asia-US e.c	VEHICLES	1,252.0	1,915.6	2,153.4	1.4%	0.3%	0.8%
Asia-US e.c	GENERAL CARGO	503.9	1,312.1	2,192.3	3.2%	1.3%	2.1%
Asia-US e.c	CONTAINERIZED	4,871.0	9,676.3	10,394.4	2.3%	0.2%	1.1%
Asia-US e.c	TOTAL	12,513.0	18,624.0	25,961.1	1.3%	0.8%	1.0%
Asia-Canada e.c	MAJOR DRY BULKS	41.8	47.3	95.0	0.4%	1.8%	1.2%
Asia-Canada e.c	MINOR BULKS	118.1	250.3	586.9	2.5%	2.2%	2.3%
Asia-Canada e.c	BULK CHEMICALS	1.0	1.9	2.8	2.3%	1.0%	1.5%
Asia-Canada e.c	OILS & FATS	0.6	1.9	2.2	3.7%	0.4%	1.8%
Asia-Canada e.c	GENERAL CARGO	56.7	59.0	103.1	0.1%	1.4%	0.9%
Asia-Canada e.c	CONTAINERIZED	369.1	693.7	1,332.1	2.1%	1.6%	1.9%
Asia-Canada e.c	TOTAL	587.4	1,054.1	2,122.1	2.0%	1.8%	1.9%
Asia-C.America e.c/Carib	MAJOR DRY BULKS	43.0	123.2	185.4	3.6%	1.0%	2.1%
Asia-C.America e.c/Carib	MINOR BULKS	622.1	224.1	199.8	-3.3%	-0.3%	-1.6%
Asia-C.America e.c/Carib	BULK CHEMICALS	21.2	53.0	70.2	3.1%	0.7%	1.7%
Asia-C.America e.c/Carib	OILS & FATS	40.0	55.6	83.4	1.1%	1.0%	1.1%
Asia-C.America e.c/Carib	REFRIG CARGOES	31.0	116.3	155.9	4.5%	0.7%	2.3%
Asia-C.America e.c/Carib	VEHICLES	105.0	27.2	26.2	-4.4%	-0.1%	-2.0%
Asia-C.America e.c/Carib	GENERAL CARGO	313.7	663.1	1,210.1	2.5%	1.5%	1.9%
Asia-C.America e.c/Carib	CONTAINERIZED	501.0	2,199.5	2,936.0	5.1%	0.7%	2.6%
Asia-C.America e.c/Carib	TOTAL	1,677.0	3,462.1	4,867.0	2.4%	0.9%	1.5%
Asia-S.America e.c	MAJOR DRY BULKS	20.0	216.4	321.4	8.3%	1.0%	4.0%
Asia-S.America e.c	MINOR BULKS	68.7	16.6	22.4	-4.6%	0.8%	-1.6%
Asia-S.America e.c	BULK CHEMICALS	1.9	0.7	0.8	-3.4%	0.3%	-1.3%
Asia-S.America e.c	OILS & FATS	3.0	9.0	13.0	3.7%	0.9%	2.1%
Asia-S.America e.c	REFRIG CARGOES	0.7	1.2	1.5	1.6%	0.6%	1.0%
Asia-S.America e.c	VEHICLES	8.0	10.6	13.6	0.9%	0.6%	0.8%
Asia-S.America e.c	GENERAL CARGO	41.8	79.1	177.7	2.1%	2.0%	2.1%
Asia-S.America e.c	CONTAINERIZED	36.3	50.5	59.6	1.1%	0.4%	0.7%
Asia-S.America e.c	TOTAL	180.5	384.1	609.9	2.5%	1.2%	1.8%

Table 7.2 (Cont'd)
ANNUAL CARGO FLOWS BY COMMODITY AND BY ROUTE
(000 TONNES)
STATUS QUO CANAL

TRADE ROUTE	COMMODITY	1990	2020	2060	ANNUAL GROWTH RATE 1990-2020	2020-2060	1990-2060
Asia-Europe	MAJOR DRY BULKS	52.0	64.5	62.4	0.7%	-0.1%	0.3%
Asia-Europe	MINOR BULKS	13.0	33.7	63.8	3.2%	1.6%	2.3%
Asia-Europe	BULK CHEMICALS	69.4	219.9	369.1	3.9%	1.3%	2.4%
Asia-Europe	OILS & FATS	54.9	206.8	162.0	4.5%	-0.6%	1.6%
Asia-Europe	REFRIG CARGOES	8.0	17.8	23.4	2.7%	0.7%	1.5%
Asia-Europe	VEHICLES	13.7	26.3	19.9	2.2%	-0.7%	0.5%
Asia-Europe	GENERAL CARGO	33.4	102.6	177.3	3.8%	1.4%	2.4%
Asia-Europe	CONTAINERIZED	87.3	310.1	511.1	4.3%	1.3%	2.6%
Asia-Europe	TOTAL	331.6	981.7	1,389.0	3.7%	0.9%	2.1%

Source: Historical 1990 data: The Panama Canal Commission. FY 1990 Annual Report; Forecasts: The WEFA Group

Table 7.3

ANNUAL CARGO FLOWS:

DIFFERENTIATION ACROSS ALTERNATIVES

ADDITIONAL DRY BULK CARGO IN ALTERNATIVE CANAL CASES

		2020	2060
100,000 DWT CASE CANAL			
S.America e.c.-Asia	MAJOR DRY BULK	1,731	2,217
150,000 DWT CASE CANAL			
US e.c.-Asia	MAJOR DRY BULK	51,306	70,285
Canada e.c.-Asia	MAJOR DRY BULK	373	0
S.America e.c.-Asia	MAJOR DRY BULK	1,731	2,217
250,000 DWT CANAL			
US e.c.-Asia	MAJOR DRY BULK	51,306	70,285
Canada e.c.-Asia	MAJOR DRY BULK	1,380	2,422
S.America e.c.-Asia	MAJOR DRY BULK	2,205	2,551

ADDITIONAL TANKER CARGO IN ALTERNATIVE CASES (OIL TANKERS ONLY)

250,000 DWT CASE CANAL			
C.America e.c/Carib-Asia	CRUDE OIL	14,000	14,000
300,000 DWT CASE CANAL			
C.America e.c/Carib-Asia	CRUDE OIL	14,000	14,000

ADDITIONAL CONTAINERIZED CARGOES (FOR ALL ALTERNATIVES)

US WC - Europe	69	170
Asia-US ec	322	1,022
U.S East Coast - Asia	543	1,906
Europe - U.S. West Coast	80	223

Source: The WEFA Group

Table 7.4
COMPARISON OF GRAIN SHIPMENT ECONOMICS
U.S. GULF AND PACIFIC NORTHWEST

Route	Year	AVERAGE DWT	SEA COSTS	LAND COSTS	TOTAL COSTS*
SEABORNE COSTS PLUS WEIGHTED AVERAGE OF BARGE AND RAIL COSTS TO THE U.S. GULF					
US GULF N PACIFIC	1990	52370.0	23.3	15.2	38.5
ROUND TRIP	2020	51953.0	25.2	16.3	41.4
	2060	59275.0	26.6	18.8	45.4
US GULF N PACIFIC	1990	69275.0	20.5	15.2	35.7
ROUND TRIP	2020	68745.0	22.0	16.3	38.2
	2060	68745.0	24.7	18.8	43.5
US GULF N PACIFIC	1990	126484.0	15.1	15.2	30.2
RETURN TO CANWC	2020	134700.0	15.3	16.3	31.6
VIA CAPE	2060	140475.0	16.9	18.8	35.7
SEABORNE COSTS PLUS RAIL COSTS ONLY TO US GULF					
US GULF N PACIFIC	1990	52370.0	23.3	21.7	45.0
ROUND TRIP	2020	51953.0	25.2	23.1	48.3
	2060	59275.0	26.6	27.5	54.1
US GULF N PACIFIC	1990	69275.0	20.5	21.7	42.2
ROUND TRIP	2020	68745.0	22.0	23.1	45.1
	2060	68745.0	24.7	27.5	52.2
US GULF N PACIFIC	1990	126484.0	15.1	21.7	36.8
RETURN TO CANWC	2020	134700.0	15.3	23.1	38.4
VIA CAPE	2060	140475.0	16.9	27.5	44.4
US GULF N PACIFIC	1990	52370.0	23.3	10.4	33.6
ROUND TRIP	2020	51953.0	25.2	11.3	36.5
	2060	59275.0	26.6	14.4	41.1
US GULF N PACIFIC	1990	69275.0	20.5	10.4	30.8
ROUND TRIP	2020	68745.0	22.0	11.3	33.3
	2060	68745.0	24.7	14.4	39.2
US GULF N PACIFIC	1990	126484.0	15.1	10.4	25.4
RETURN TO CANWC	2020	134700.0	15.3	11.3	26.6
VIA CAPE	2060	140475.0	16.9	14.4	31.3

[*] Sea, Land and Total Costs are in $1990 per cargo ton.

Table 7.4 (Continued)

SEABORNE COSTS PLUS BARGE COSTS ONLY TO US GULF

Route	Year	AVERAGE DWT	SEA COSTS	LAND COSTS	TOTAL COSTS*
SEABORNE COSTS PLUS RAIL COSTS TO PACIFIC NORTH WEST					
USWC N PACIFIC ROUND TRIP	1990	52370.0	12.2	27.1	39.3
	2020	51953.0	13.1	28.9	42.0
	2060	59275.0	13.7	34.4	48.0
USWC N PACIFIC ROUND TRIP	1990	69275.0	10.7	27.1	37.8
	2020	68745.0	11.5	28.9	40.3
	2060	68745.0	12.8	34.4	47.1
USWC N PACIFIC ROUND TRIP	1990	126484.0	7.8	27.1	34.9
	2020	134700.0	7.9	28.9	36.8
	2060	140475.0	8.7	34.4	43.0

[*] Sea, Land and Total Costs are in $1990 per cargo ton.

Note 1: Route Definitions

US Gulf-N Pacific Round Trip = US Gulf-N Pacific via Panama (laden)
US Gulf-N Pacific via Panama (ballast)

US Gulf-N Pacific Return to CANWC via Cape = US Gulf-N Pacific via Cape (laden)
US Gulf-CANWC (ballast)

USWC-N Pacific Round Trip = USWC-N Pacific (laden)
USWC-N Pacific (ballast)

Note 2: Barge Cost: The weighing of the on-land freight costs into the US Gulf are two thirds barge plus one third rail. The intention is that comparisons should be made between the costs of different DWT sizes for the same year for Panama and non-Panama routes up to the maximum sizes which could be considered for grain shipments. The figures in this table enable comparisons to be made, size for size, and also in those cases where size is constrained by Canal dimensions but not on alternative routes.

Source: RLA

The DWTs shown in Table 7.4 represent the average ship sizes within each size range for vessels utilizing the Canal. In general little change in the average sizes of ship in the 40,000-64,999 DWT and the 65,000-99,999 DWT size ranges is envisaged in the period 1990 to 2020, either in the global fleet or on Panama trades. The minor downward adjustments to Canal ship sizes result simply from assuming that in 2020 the average ship sizes through the Canal will equate to those in Section 8.3.3. The term 'via Cape' (see Table 7.4) is used in the description of one of the representative alternative by-pass routes to the Canal given that in the comparison of bulk shipping economics it is normal practice to base evaluations on the costs for performing the laden voyage plus, following completion of discharge, a ballast journey to the next loading port. In this case the economics have been based on a laden passage from the US Gulf to the North Pacific Basin via the Cape of Good Hope followed by a ballast trip to the Canadian West coast to pick up the next cargo. Throughout the work which we have undertaken on shipping economics great care has been taken to ensure that realistic comparisons have been made on the basis of representative vessel trading patterns.

Table 7.5

Summary of Shipping Economics for Full Containerships (1) on Routes where the Panama Canal is in Competition with the U.S. Landbridge.

Year	Vessel Size Dwt	Vessel Size Teu	$1990/Ton Total	Canal Toll	Toll as % of Total	Voyage Miles (2)	Transit Time (days) (3)
1. Far East to U.S. East Coast							
2020	31400	2200	199.4	5.2	2.6	9115.0	21.4
	48000	3200	195.3	5.6	2.9	9115.0	21.4
	66480	4400	185.4	5.8	3.1	9115.0	22.7
	90000	6000	176.5	5.8	3.3	9115.0	22.7
	148000	9000	170.9	6.4	3.7	9115.0	22.7
2060	31400	2200	200.4	5.7	2.9	9115.0	19.9
	48000	3200	195.3	6.2	3.2	9115.0	19.9
	66480	4400	185.1	6.3	3.4	9115.0	21.1
	90000	6000	176.0	6.3	3.6	9115.0	21.1
	148000	9000	170.3	7.0	4.1	9115.0	21.1
2. Far East to U.S. West Coast							
2020	31400	2200	157.0	0.0	0.0	4857.0	8.8
	48000	3200	153.4	0.0	0.0	4857.0	8.8
	66480	4400	144.0	0.0	0.0	4857.0	9.2
	90000	6000	138.5	0.0	0.0	4857.0	9.2
	148000	9000	133.3	0.0	0.0	4857.0	9.2
2060	31400	2200	157.4	0.0	0.0	4857.0	8.1
	48000	3200	153.0	0.0	0.0	4857.0	8.1
	66480	4400	143.4	0.0	0.0	4857.0	8.4
	90000	6000	137.7	0.0	0.0	4857.0	8.4
	148000	9000	132.4	0.0	0.0	4857.0	8.4
Freight Estimates for Far East to U.S. East Coast less Far East to U.S. West Coast							
2020	31400	2200	42.4	5.2	12.3	4258.0	12.6
	48000	3200	41.9	5.6	13.4	4258.0	12.6
	66480	4400	41.4	5.8	14.0	4258.0	13.5
	90000	6000	38.0	5.8	15.3	4258.0	13.5
	148000	9000	37.6	6.4	17.0	4258.0	13.5
2060	31400	2200	43.0	5.7	13.3	4258.0	11.8
	48000	3200	42.3	6.2	14.7	4258.0	11.8
	66480	4400	41.7	6.3	15.2	4258.0	12.7
	90000	6000	38.3	6.3	16.6	4258.0	12.7
	148000	9000	37.9	7.0	18.4	4258.0	12.7

Table 7.5 (Continued)

Year	Vessel Size Dwt	Vessel Size Teu	$1990/Ton Total	Canal Toll	Toll as % of Total	Voyage Miles (2)	Transit Time (days) (3)
3. Europe to U.S. West Coast							
2020	31400	2200	167.3	5.2	3.1	7526.0	14.4
	48000	3200	164.0	5.6	3.4	7526.0	14.4
	66480	4400	154.3	5.8	3.8	7526.0	15.1
	90000	6000	148.6	5.8	3.9	7526.0	15.1
	148000	9000	144.1	6.4	4.4	7526.0	15.1
2060	31400	2200	168.4	5.7	3.4	7526.0	13.3
	48000	3200	164.2	6.2	3.8	7526.0	13.3
	66480	4400	154.3	6.3	4.1	7526.0	13.9
	90000	6000	148.3	6.3	4.3	7526.0	13.9
	148000	9000	143.8	7.0	4.9	7526.0	13.9
4. Europe to U.S. East Coast							
2020	31400	2200	126.2	0.0	0.0	3196.0	5.8
	48000	3200	123.9	0.0	0.0	3196.0	5.8
	66480	4400	118.3	0.0	0.0	3196.0	6.1
	90000	6000	112.8	0.0	0.0	3196.0	6.1
	148000	9000	109.5	0.0	0.0	3196.0	6.1
2060	31400	2200	126.5	0.0	0.0	3196.0	5.3
	48000	3200	123.7	0.0	0.0	3196.0	5.3
	66480	4400	118.1	0.0	0.0	3196.0	5.5
	90000	6000	112.4	0.0	0.0	3196.0	5.5
	148000	9000	109.0	0.0	0.0	3196.0	5.5

Table 7.5 (Continued)

Year	Vessel Size Dwt	Vessel Size Teu	$1990/Ton Total	Canal Toll	Toll as % of Total	Voyage Miles (2)	Transit Time (days) (3)
Freight Estimates for Europe to U.S. East Coast less Europe to U.S. West Coast							
2020	31400	2200	41.1	5.2	12.7	4330.0	8.6
	48000	3200	40.1	5.6	14.0	4330.0	8.6
	66480	4400	36.0	5.8	16.1	4330.0	9.0
	90000	6000	35.8	5.8	16.2	4330.0	9.0
	148000	9000	34.6	6.4	18.5	4330.0	9.0
2060	31400	2200	41.9	5.7	13.7	4330.0	8.0
	48000	3200	40.5	6.2	15.3	4330.0	8.0
	66480	4400	36.2	6.3	17.5	4330.0	8.4
	90000	6000	35.9	6.3	17.7	4330.0	8.4
	148000	9000	34.8	7.0	20.1	4330.0	8.4

Notes:

(1) Excluding inventory costs.

(2) Mileage from last load port to first discharge port.

(3) Transit times for USEC discharge are based on the time from the last load port to arrival at New York. Transit times for USWC discharge are based on the time from the last load port to arrival at the first U.S. West Coast port.

(4) Shipping economics (freight rate estimates) in this table including estimated Canal tolls are shown in in termd os $1990 per cargo ton. However, Canal tolls are determined in the first instance with reference to Panama Canal Net tonnages by ship type and size and a total toll charge calculated on the basis of the existing tariff structure with future escalation in line with ship operating costs.

Source: RLA

Table 7.6
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
DRY BULK CARRIER TRAFFIC						
POTENTIAL BY PASS TRADE DIVERTED THROUGH THE CANAL						
1.	USEC TO ASIA, COAL. (U.S. ATLANTIC COAST TO NORTHERN PACIFIC BASIN).					
2020	PANAMA, ROUND TRIP	100000	19.0	2.4	12.8%	19496
2020	PANAMA, RETURN TO CANWC	100000	14.0	1.4	9.6%	14298
2020	PANAMA RETURN TO S. AFRICA	100000	16.2	1.4	8.4%	17306
2020	PANAMA, ROUND TRIP	134700	15.9	2.4	15.1%	19496
2020	PANAMA, RETURN TO CANWC	134700	11.6	1.3	11.5%	14298
2020	PANAMA RETURN TO S. AFRICA	134700	13.4	1.3	10.0%	17306
2020	CGH, RETURN TO CANWC	134700	13.3	0.0	0.0%	19676
2020	CGH, RETURN TO S. AFRICA	134700	15.0	0.0	0.0%	22684
2020	PANAMA, ROUND TRIP	183355	13.9	2.4	17.0%	19496
2020	PANAMA, RETURN TO CANWC	183355	10.2	1.3	12.8%	14298
2020	PANAMA RETURN TO S. AFRICA	183355	11.7	1.3	11.2%	17306
2020	CGH, RETURN TO CANWC	183355	11.5	0.0	0.0%	19676
2020	CGH, RETURN TO S. AFRICA	183355	13.0	0.0	0.0%	22684
2060	PANAMA, ROUND TRIP	100000	21.5	2.7	12.4%	19496
2060	PANAMA, RETURN TO CANWC	100000	15.8	1.5	9.4%	14298
2060	PANAMA RETURN TO S. AFRICA	100000	18.3	1.5	8.2%	17306
2060	PANAMA, ROUND TRIP	140475	17.5	2.6	15.0%	19496
2060	PANAMA, RETURN TO CANWC	140475	12.8	1.5	11.4%	14298
2060	PANAMA RETURN TO S. AFRICA	140475	14.8	1.5	9.9%	17306
2060	CGH, RETURN TO CANWC	140475	14.7	0.0	0.0%	19676
2060	CGH, RETURN TO S. AFRICA	140475	16.7	0.0	0.0%	22684
2060	PANAMA, ROUND TRIP	184090	15.7	2.6	16.6%	19496
2060	PANAMA, RETURN TO CANWC	184090	11.4	1.5	12.7%	14298
2060	PANAMA RETURN TO S. AFRICA	184090	13.1	1.5	11.0%	17306
2060	CGH, RETURN TO CANWC	184090	12.9	0.0	0.0%	19676
2060	CGH, RETURN TO S. AFRICA	184090	14.6	0.0	0.0%	22684

Notes:
1. CH : CAPE HORN
2. CGH : CAPE OF GOOD HOPE
3. Route Definitions:
   - Panama Round Trip = via Panama laden and ballast
   - Panama, Return to CANWC = via Panama laden returning to CANWC in ballast
   - Panama, Return to S. Africa = via Panama laden returning to S Africa in ballast
   - CGH, Return to CANWC = via Cape of Good Hope laden returning to CANWC in ballast
   - CGH, Return to S Africa = via Cape of Good Hope laden returning to S Africa in ballast.

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
2.	USEC TO ASIA, COAL. (U.S. GULF COAST TO NORTHERN PACIFIC BASIN).					
2020	PANAMA, ROUND TRIP	100000	17.7	2.4	13.8%	18100
2020	PANAMA, RETURN TO CANWC	100000	13.5	1.4	10.0%	13600
2020	PANAMA RETURN TO S. AFRICA	100000	15.7	1.4	8.6%	16608
2020	PANAMA, ROUND TRIP	134700	15.0	2.4	15.9%	18100
2020	PANAMA, RETURN TO CANWC	134700	11.2	1.3	11.9%	13600
2020	PANAMA RETURN TO S. AFRICA	134700	12.9	1.3	10.3%	16608
2020	CGH, RETURN TO CANWC	134700	13.6	0.0	0.0%	20257
2020	CGH, RETURN TO S. AFRICA	134700	15.4	0.0	0.0%	23265
2020	PANAMA, ROUND TRIP	183355	13.3	2.3		18100
2020	PANAMA, RETURN TO CANWC	183355	9.9	1.3	13.2%	13600
2020	PANAMA RETURN TO S. AFRICA	183355	11.4	1.3	11.4%	16608
2020	CGH, RETURN TO CANWC	183355	11.8	0.0	0.0%	20257
2020	CGH, RETURN TO S. AFRICA	183355	13.3	0.0	0.0%	23265
2060	PANAMA, ROUND TRIP	100000	19.9	2.7	13.4%	18100
2060	PANAMA, RETURN TO CANWC	100000	15.2	1.5	9.8%	13600
2060	PANAMA RETURN TO S. AFRICA	100000	17.7	1.5	8.4%	16608
2060	PANAMA, ROUND TRIP	140475	16.6	2.6	15.8%	18100
2060	PANAMA, RETURN TO CANWC	140475	12.3	1.5	11.9%	13600
2060	PANAMA RETURN TO S. AFRICA	140475	14.3	1.5	10.2%	16608
2060	CGH, RETURN TO CANWC	140475	15.1	0.0	0.0%	20257
2060	CGH, RETURN TO S. AFRICA	140475	17.0	0.0	0.0%	23265
2060	PANAMA, ROUND TRIP	184090	14.9	2.6	17.5%	18100
2060	PANAMA, RETURN TO CANWC	184090	11.0	1.5	13.1%	13600
2060	PANAMA RETURN TO S. AFRICA	184090	12.7	1.5	11.4%	16608
2060	CGH, RETURN TO CANWC	184090	13.2	0.0	0.0%	20257
2060	CGH, RETURN TO S. AFRICA	184090	14.9	0.0	0.0%	23265

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
3.	CANADA EAST COAST TO ASIA, IRON ORE. (CANADA EAST COAST TO NORTHERN PACIFIC BASIN).					
2020	PANAMA, ROUND TRIP	134700	16.9	2.4	14.1%	21476
2020	PANAMA, RETURN TO CANWC	134700	12.1	1.3	11.0%	15288
2020	PANAMA RETURN TO S. AFRICA	134700	13.9	1.3	9.6%	18296
2020	CGH, RETURN TO CANWC	134700	13.4	0.0	0.0%	20030
2020	CGH, RETURN TO S. AFRICA	134700	15.2	0.0	0.0%	23038
2020	PANAMA, ROUND TRIP	183355	15.0	2.4		21476
2020	PANAMA, RETURN TO CANWC	183355	10.7	1.3	12.2%	15288
2020	PANAMA RETURN TO S. AFRICA	183355	12.2	1.3		18296
2020	CGH, RETURN TO CANWC	183355	11.6	0.0	0.0%	20030
2020	CGH, RETURN TO S. AFRICA	183355	13.1	0.0	0.0%	23038
2020	PANAMA, RETURN TO CANWC	268345	8.7	1.3	14.9%	15288
2020	CGH, RETURN TO CANWC	318425	9.9	0.0	0.0%	23038
2060	PANAMA, ROUND TRIP	140475	18.8	2.6	14.0%	21476
2060	PANAMA, RETURN TO CANWC	140475	13.3	1.5	10.9%	15288
2060	PANAMA RETURN TO S. AFRICA	140475	15.3	1.5	9.5%	18296
2060	PANAMA, RT	184090	16.8	2.6	15.5%	21476
2060	PANAMA/R VANCOUVER	184090	12.0	1.5	12.1%	15288
2060	PANAMA/R RICHARDS BAY	184090	13.7	1.5	10.6%	18296
2060	CGH, RETURN TO CANWC	184090	13.1	0.0	0.0%	20030
2060	CGH, RETURN TO S. AFRICA	184090	14.8	0.0	0.0%	23038
2060	PANAMA, RETURN TO CANWC	269420	9.7	1.4		15288
2060	CGH, RETURN TO CANWC	269420	10.2	0.0	0.0%	20030
2060	CGH, RETURN TO S. AFRICA	269420	11.6	0.0	0.0%	23038
2060	CGH, RETURN TO CANWC	319705	9.9	0.0	0.0%	20030

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
4.	S. AMERICA EAST COAST TO ASIA, IRON ORE (VENEZUELA TO NORTHERN PACIFIC BASIN)					
2020	PANAMA, ROUND TRIP	134700	15.1	2.4	15.8%	18102
2020	PANAMA, RETURN TO CANWC	134700	11.3	1.3	11.8%	13601
2020	PANAMA RETURN TO S. AFRICA	134700	13.0	1.3	10.2%	16609
2020	CGH, RETURN TO CANWC	134700	12.6	0.0	0.0%	18337
2020	CGH, RETURN TO S. AFRICA	134700	14.3	0.0	0.0%	21345
2020	PANAMA, ROUND TRIP	183355	13.2	2.4	17.9%	18102
2020	PANAMA, RETURN TO CANWC	183355	9.9	1.3	13.3%	13601
2020	PANAMA RETURN TO S. AFRICA	183355	11.4	1.3	11.5%	16609
2020	CGH, RETURN TO CANWC	183355	10.8	0.0	0.0%	18337
2020	CGH, RETURN TO S. AFRICA	183355	12.3	0.0	0.0%	21345
2020	PANAMA, RETURN TO CANWC	268345	8.1	1.3	16.1%	13601
2020	CGH, RETURN TO CANWC	268345	8.5	0.0	0.0%	18337
2020	CGH, RETURN TO CANWC	318425	8.1	0.0	0.0%	18337
2060	PANAMA, ROUND TRIP	140475	16.7	2.6	15.7%	18102
2060	PANAMA, RETURN TO CANWC	140475	12.4	1.5	11.8%	13601
2060	PANAMA RETURN TO S. AFRICA	140475	14.4	1.5	10.1%	16609
2060	CGH, RETURN TO CANWC	140475	13.9	0.0	0.0%	18337
2060	CGH, RETURN TO S. AFRICA	140475	15.9	0.0	0.0%	21345
2060	PANAMA, ROUND TRIP	184090	14.9	2.6	17.5%	18102
2060	PANAMA, RETURN TO CANWC	184090	11.0	1.5	13.1%	13601
2060	PANAMA RETURN TO S. AFRICA	184090	12.7	1.5	11.4%	16609
2060	CGH, RETURN TO CANWC	184090	12.1	0.0	0.0%	18337
2060	CGH, RETURN TO S. AFRICA	184090	13.8	0.0	0.0%	21345
2060	PANAMA, ROUND TRIP	269420	12.2	2.6	21.1%	18102
2060	PANAMA, RETURN TO CANWC	269420	8.9	1.4	16.0%	13601
2060	PANAMA RETURN TO S. AFRICA	269420	10.3	1.4	13.9%	16609
2060	CGH, RETURN TO CANWC	269420	9.5	0.0	0.0%	18337
2060	CGH, RETURN TO S. AFRICA	269420	10.8	0.0	0.0%	21345
2060	CGH, RETURN TO CANWC	319705	9.1	0.0	0.0%	18337

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
5.	SOUTH AMERICA EAST COAST TO ASIA, COAL. (COLOMBIA TO NORTHERN PACIFIC BASIN).					
2020	PANAMA, ROUND TRIP	100000	16.7	2.4	14.6%	16802
2020	PANAMA, RETURN TO CANWC	100000	12.9	1.4	10.5%	12591
2020	PANAMA RETURN TO S. AFRICA	100000	15.1	1.4	9.0%	15599
2020	PANAMA, ROUND TRIP	134700	14.0	2.4	17.1%	16802
2020	PANAMA, RETURN TO CANWC	134700	10.7	1.3	12.5%	12591
2020	PANAMA RETURN TO S. AFRICA	134700	12.4	1.3	10.7%	15599
2020	SUEZ, RETURN TO CANWC	134700	14.3	0.0	0.0%	18384
2020	SUEZ, RETURN TO S. AFRICA	134700	16.0	0.0	0.0%	21392
2020	PANAMA, ROUND TRIP	183355	12.2	2.4	19.3%	16802
2020	PANAMA, RETURN TO CANWC	183355	9.3	1.3	14.1%	12591
2020	PANAMA RETURN TO S. AFRICA	183355	10.8	1.3	12.1%	15599
2020	SUEZ, RETURN TO CANWC	183355	12.2	0.0	0.0%	18384
2020	SUEZ, RETURN TO S. AFRICA	183355	13.7	0.0	0.0%	21392
2060	PANAMA, ROUND TRIP	100000	18.8	2.7	14.2%	16802
2060	PANAMA, RETURN TO CANWC	100000	14.5	1.5	10.3%	12591
2060	PANAMA RETURN TO S. AFRICA	100000	17.0	1.5	8.8%	15599
2060	PANAMA, ROUND TRIP	140475	15.4	2.6	17.1%	16802
2060	PANAMA, RETURN TO CANWC	140475	11.8	1.5	12.4%	12591
2060	PANAMA RETURN TO S. AFRICA	140475	13.7	1.5	10.6%	15599
2060	SUEZ, RETURN TO CANWC	140475	15.7	0.0	0.0%	18384
2060	SUEZ, RETURN TO S. AFRICA	140475	17.7	0.0	0.0%	21392
2060	PANAMA, ROUND TRIP	184090	13.5	2.6	19.3%	16802
2060	PANAMA, RETURN TO CANWC	184090	10.4	1.5	13.9%	12591
2060	PANAMA RETURN TO S. AFRICA	184090	12.1	1.5	12.0%	15599
2060	SUEZ, RETURN TO CANWC	184090	13.6	0.0	0.0%	18384
2060	SUEZ, RETURN TO S. AFRICA	184090	15.4	0.0	0.0%	21392

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
POTENTIAL Bypass TRAFFIC NOT DIVERTED THROUGH THE CANAL						
6.	SOUTH AMERICA EAST COAST TO ASIA, IRON ORE. (NORTH BRAZIL TO NORTH PACIFIC BASIN).					
2020	PANAMA, ROUND TRIP	134700	16.3	2.4	14.7%	20506
2020	PANAMA, RETURN TO CANWC	134700	12.0	1.3	11.1%	14803
2020	PANAMA, RETURN TO S.AFRICA	134700	13.8	1.3	9.7%	178[illegible]
2020	CGH, RETURN TO CANWC	134700	11.9	0.0	0.0%	172[illegible]
2020	CGH, RETURN TO S.AFRICA	134700	13.7	0.0	0.0%	202[illegible]
2020	PANAMA, ROUND TRIP	183355	14.6	2.4	16.1%	20506
2020	PANAMA, RETURN TO OCEANIA	183355	10.0	1.3	13.2%	13728
2020	PANAMA, RETURN TO S.AFRICA	183355	12.5	1.3	10.5%	18555
2020	CGH, RETURN TO OCEANIA	183355	9.8	0.0	0.0%	16132
2020	CGH, RETURN TO S.AFRICA	183355	12.2	0.0	0.0%	20959
2020	PANAMA, RETURN TO OCEANIA	268345	8.2	1.3	15.9%	13728
2020	PANAMA, RETURN TO S.AFRICA	268345	10.1	1.3	12.9%	18555
2020	CGH, RETURN TO OCEANIA	268345	7.7	0.0	0.0%	16132
2020	CGH, RETURN TO S.AFRICA	268345	9.7	0.0	0.0%	20959
2020	CGH, RETURN TO OCEANIA	318425	7.3	0.0	0.0%	16132
2060	PANAMA, ROUND TRIP	140475	18.3	2.6	14.4%	20506
2060	PANAMA, RETURN TO CANWC	140475	13.2	1.5	11.1%	14803
2060	PANAMA, RETURN TO S.AFRICA	140475	15.2	1.5	9.6%	178[illegible]
2060	CGH, RETURN TO CANWC	140475	13.2	0.0	0.0%	172[illegible]
2060	CGH, RETURN TO S.AFRICA	140475	15.[illegible]	0.0	0.0%	202[illegible]
2060	PANAMA, ROUND TRIP	184090	16.4	2.6	15.9%	20506
2060	PANAMA, RETURN TO OCEANIA	184090	11.2	1.5	12.9%	13728
2060	PANAMA, RETURN TO S.AFRICA	184090	14.0	1.5	10.4%	18555
2060	CGH, RETURN TO OCEANIA	184090	11.0	0.0	0.0%	16132
2060	CGH, RETURN TO S.AFRICA	184090	13.7	0.0	0.0%	20959
2060	PANAMA, ROUND TRIP	269420	13.4	2.6	19.3%	20506
2060	PANAMA, RETURN TO OCEANIA	269420	9.1	1.4	15.8%	13728
2060	PANAMA, RETURN TO S.AFRICA	269420	11.2	1.4	12.7%	18555
2060	CGH, RETURN TO OCEANIA	269420	8.6	0.0	0.0%	16132
2060	CGH, RETURN TO S.AFRICA	269420	10.7	0.0	0.0%	20959
2060	CGH, RETURN TO OCEANIA	319705	8.3	0.0	0.0%	16132

Table 7.6 (Continued)
Summary of Freight Rate Estimates for Dry Bulk Carriers on Bypass Routes.

YEAR	ROUTE	VESSEL SIZE	$1990/TON TOTAL	CANAL TOLLS	TOLLS % TOTAL	VOYAGE MILES
7.	SOUTH AMERICA WEST COAST TO EUROPE, IRON ORE. (NORTH CHILE TO EUROPE)					
2020	PANAMA, ROUND TRIP	134700	13.2	2.4	18.1%	14394
2020	PANAMA, RETURN TO S.AFRICA	134700	12.0	1.3	11.1%	14307
2020	CH, RETURN TO S. AFRICA	134700	11.8	0.0	0.0%	16470
2020	PANAMA, RETURN TO S.AFRICA	183355	10.1	1.3	13.0%	20959
2020	CH, RETURN TO S. AFRICA	183355	9.7	0.0	0.0%	16470
2020	PANAMA, RETURN TO S.AFRICA	268345	8.2	1.3	15.9%	20959
2020	CH, RETURN TO S. AFRICA	268345	7.6	0.0	0.0%	16470
2020	CH, RETURN TO S. AFRICA	318425	7.3	0.0	0.0%	16470
2060	PANAMA, ROUND TRIP	140475	14.6	2.6	18.1%	14394
2060	PANAMA, RETURN TO S.AFRICA	140475	13.2	1.5	11.1%	14307
2060	CH, RETURN TO S. AFRICA	140475	12.9	0.0	0.0%	16470
2060	PANAMA, ROUND TRIP	184090	13.0	2.6	20.1%	14394
2060	PANAMA, RETURN TO S.AFRICA	184090	11.2	1.5	12.9%	14307
2060	CH, RETURN TO S. AFRICA	184090	10.8	0.0	0.0%	16470
2060	PANAMA, ROUND TRIP	269420	10.6	2.6	24.2%	14394
2060	PANAMA, RETURN TO S.AFRICA	269420	9.3	1.4	15.3%	14307
2060	CH, RETURN TO S. AFRICA	269420	8.4	0.0	0.0%	16470
2060	CH, RETURN TO S. AFRICA	319700	8.1	0.0	0.0%	16470

Notes:
CH : CAPE HORN
CGH : CAPE OF GOOD HOPE

Source: RLA

Table 7.7

Summary of Freight Rate Estimates for Oil Tanker Bypass Traffic

Year	Route	Vessel Size (Dwt)	$ 1990/Cargo Ton Total	Canal Toll	Toll as % of Total	Round Voyage Miles
Potential Bypass Traffic Diverted through the Canal						
1. Orimulsion from Venezuela to Asia						
2020	via Suez	89730	28.3	3.7	13.0	27122
	via CGH	89730	24.5	0.0	0.0	27612
	via Panama	89730	20.0	2.7	13.6	18320
	via Suez	150000	21.0	3.1	14.7	27122
	via CGH	150000	17.8	0.0	0.0	27612
	via Panama	150000	15.3	2.7	17.7	18320
	via Suez	238000	17.1	2.6	15.4	27122
	via CGH	238000	14.4	0.0	0.0	27612
	via Panama	238000	12.9	2.7	20.9	18320
	via Suez	269000	15.5	2.6	16.6	27122
	via CGH	269000	12.8	0.0	0.0	27612
	via Panama	269000	11.8	2.7	23.0	18320
2060	via Suez	89730	32.5	4.1	12.5	27122
	via CGH	89730	28.3	0.0	0.0	27612
	via Panama	89730	22.9	3.0	13.0	18320
	via Suez	150000	24.4	3.4	13.8	27122
	via CGH	150000	20.9	0.0	0.0	27612
	via Panama	150000	17.8	3.0	16.8	18320
	via Suez	238000	19.6	2.9	14.7	27122
	via CGH	238000	16.6	0.0	0.0	27612
	via Panama	238000	14.8	3.0	20.1	18320
	via Suez	269000	17.7	2.8	16.0	27122
	via CGH	269000	14.8	0.0	0.0	27612
	via Panama	269000	13.4	3.0	22.2	18320

Notes: 1. CGH: Cape of Good Hope
2. "Via" should not be confused with "Return". "Via" is used to denote whether the laden route is through Panama or by an alternative. "Return" is used to describe the ballast trip to the next port of loading. The reason for using simply "Via Panama" etc. in this table is that tanker shipping economics unlike those for dry bulk carriers are conventionally calculated on a round voyage basis.

Table 7.7 (Continued)
Summary of Freight Rate Estimates for Oil Tanker Bypass Traffic

Year	Route	Vessel Size (Dwt)	$ 1990/Cargo Ton Total	Canal Toll	Toll as % of Total	Round Voyage Miles
Traffic Retained through the Canal						
2. South America East Coast (Venezuela) to Asia						
2020	via Suez	54300	38.4	4.9	12.7	27054
	via CGH	54300	34.6	0.0	0.0	28642
	via Panama	54300	24.3	2.7	11.1	16634
	via Suez	74100	32.8	4.2	12.8	27054
	via CGH	74100	29.5	0.0	0.0	28642
	via Panama	74100	21.2	2.7	12.8	16634
	via Suez	89730	28.3	3.7	13.0	27054
	via CGH	89730	25.3	0.0	0.0	28642
	via Panama	89730	18.6	2.7	14.6	16634
	via Suez	131000	24.0	3.2	13.4	27054
	via CGH	131000	21.4	0.0	0.0	28642
	via Panama	131000	16.2	2.7	16.7	16634
	via Suez	238000	17.1	2.6	15.4	27054
	via CGH	238000	14.9	0.0	0.0	28642
	via Panama	238000	12.1	2.7	22.3	16634
	via Suez	269000	15.5	2.6	16.6	27054
	via CGH	269000	13.3	0.0	0.0	28642
	via Panama	269000	11.1	2.7	24.5	16634
2060	via Suez	54300	44.4	5.4	12.0	27054
	via CGH	54300	40.3	0.0	0.0	28642
	via Panama	54300	28.1	3.0	10.6	16634
	via Suez	74100	36.6	4.6	12.6	27054
	via CGH	74100	33.0	0.0	0.0	28642
	via Panama	74100	23.6	3.0	12.6	16634
	via Suez	89730	32.5	4.1	12.5	27054
	via CGH	89730	29.3	0.0	0.0	28642
	via Panama	89730	21.3	3.0	14.0	16634
	via Suez	131000	27.9	3.5	12.7	27054
	via CGH	131000	25.1	0.0	0.0	28642
	via Panama	131000	18.7	3.0	15.9	16634
	via Suez	238000	19.6	2.9	14.8	27054
	via CGH	238000	17.2	0.0	0.0	28642
	via Panama	238000	13.9	3.0	21.5	16634
	via Suez	269000	17.7	2.8	16.0	27054
	via CGH	269000	15.3	0.0	0.0	28642
	via Panama	269000	12.6	3.0	23.7	16634

Table 7.7 (Continued)
Summary of Freight Rate Estimates for Oil Tanker Bypass Traffic

Year	Route	Vessel Size (Dwt)	$ 1990/Cargo Ton Total	Canal Toll	Toll as % of Total	Round Voyage Miles
Potential Bypass Traffic not Diverted through the Canal						
3. Asia to U.S East Coast (S.E. Asia to U.S. Gulf)						
2020	via Suez	54300	33.0	4.9	14.7	22672
	via CGH	54300	30.7	0.0	0.0	25622
	via Panama	54300	32.0	2.7	8.5	23796
	via Suez	74100	28.2	4.2	14.8	22672
	via CGH	74100	26.3	0.0	0.0	25622
	via Panama	74100	27.8	2.7	9.8	23796
	via Suez	89730	24.4	3.7	15.1	22672
	via CGH	89730	22.6	0.0	0.0	25622
	via Panama	89730	24.3	2.7	11.2	23796
	via Suez	131000	20.8	3.2	15.5	22672
	via CGH	131000	19.2	0.0	0.0	25622
	via Panama	131000	21.0	2.7	12.9	23796
	via Suez	238000	14.9	2.6	17.7	22672
	via CGH	238000	13.3	0.0	0.0	25622
	via Panama	238000	15.5	2.7	17.5	23796
	via Suez	269000	13.5	2.6	19.1	22672
	via CGH	269000	11.9	0.0	0.0	25622
	via Panama	269000	14.1	2.7	19.3	23796
2060	via Suez	54300	38.2	5.4	14.0	22672
	via CGH	54300	35.9	0.0	0.0	25622
	via Panama	54300	37.2	3.0	8.0	23796
	via Suez	74100	31.5	4.6	14.6	22672
	via CGH	74100	29.4	0.0	0.0	25622
	via Panama	74100	31.0	3.0	9.6	23796
	via Suez	89730	28.0	4.1	14.5	22672
	via CGH	89730	26.2	0.0	0.0	25622
	via Panama	89730	27.9	3.0	10.7	23796
	via Suez	131000	24.1	3.5	14.7	22672
	via CGH	131000	22.5	0.0	0.0	25622
	via Panama	131000	24.4	3.0	12.2	23796
	via Suez	238000	17.1	2.9	16.9	22672
	via CGH	238000	15.5	0.0	0.0	25622
	via Panama	238000	17.7	3.0	16.8	23796
	via Suez	269000	15.4	2.8	18.3	22672
	via CGH	269000	13.7	0.0	0.0	25622
	via Panama	269000	16.1	3.0	18.5	23796

Table 7.7 (Continued)
Summary of Freight Rate Estimates for Oil Tanker Bypass Traffic

Year	Route	Vessel Size (Dwt)	$ 1990/Cargo Ton Total	Canal Toll	Toll as % of Total	Round Voyage Miles
4.	Asia to East Coast Central America/Caribbean (S.E Asia t					
2020	via Suez	54300	31.2	4.9	15.6	21010
	via CGH	54300	27.4	0.0	0.0	22608
	via Panama	54300	30.3	2.7	8.9	22254
	via Suez	74100	26.6	4.2	15.7	21010
	via CGH	74100	23.4	0.0	0.0	22608
	via Panama	74100	26.3	2.7	10.3	22254
	via Suez	89730	23.0	3.7	16.0	21010
	via CGH	89730	20.1	0.0	0.0	22608
	via Panama	89730	23.0	2.7	11.8	22254
	via Suez	131000	19.6	3.2	16.4	21010
	via CGH	131000	17.0	0.0	0.0	22608
	via Panama	131000	19.9	2.7	13.6	22254
	via Suez	238000	14.0	2.6	18.8	21010
	via CGH	238000	11.8	0.0	0.0	22608
	via Panama	238000	14.6	2.7	18.5	22254
	via Suez	269000	12.7	2.8	22.3	21010
	via CGH	269000	10.5	0.0	0.0	22608
	via Panama	269000	13.3	2.7	20.4	22254
2060	via Suez	54300	36.0	5.4	14.8	21010
	via CGH	54300	31.9	0.0	0.0	22608
	via Panama	54300	35.2	3.0	8.5	22254
	via Suez	74100	29.7	4.6	15.5	21010
	via CGH	74100	26.2	0.0	0.0	22608
	via Panama	74100	29.4	3.0	10.2	22254
	via Suez	89730	26.4	4.1	15.3	21010
	via CGH	89730	23.2	0.0	0.0	22608
	via Panama	89730	26.4	3.0	11.3	22254
	via Suez	131000	22.7	3.5	15.6	21010
	via CGH	131000	20.0	0.0	0.0	22608
	via Panama	131000	23.1	3.0	12.9	22254
	via Suez	238000	16.1	2.9	18.0	21010
	via CGH	238000	13.7	0.0	0.0	22608
	via Panama	238000	16.8	3.0	17.8	22254
	via Suez	269000	14.5	2.8	19.5	21010
	via CGH	269000	12.1	0.0	0.0	22608
	via Panama	269000	15.2	3.0	19.6	22254

Note: CGH = Cape of Good Hope

Source: RLA

7.3.2 65,000 DWT Design Ship (Status Quo or Case 1)

A summary of overall projected trends in trade through the Panama Canal is given in Section 7.2.2 above. Under the status quo case, the drift, in particular of U.S. East and Gulf Coast coal shipments to Asia, away from the Panama Canal as the result of the increasing utilization of larger ships will continue. The expected size of the shift is some 13.2 million tonnes of coal on the route from the U.S. Gulf to the North Pacific Basin.

In terms of the oil and chemicals trades that existed in 1990, vessel size is not a particular consideration in the determination of trade volumes. The more recent development of Venezuelan Orimulsion exports into Japan represents potential Panama trade. Orimulsion is a stabilized bitumen/water emulsion produced in the Orinoco area. It is marketed as a boiler fuel for power generation and is transported in normal oil tankers with characteristics which enable efficient heating and temperature maintenance of the cargo. The volume of cargo moving to the North Pacific (Japan) is currently equivalent to 600,000 tonnes per annum, and this is expected to rise to 14 million tonnes in 2020 and 2060.

Although initially cargoes are being shipped in Panamax size vessels, Bitor - the company which produces Orimulsion - plans to develop its loading facilities such that as the volume of sales increase, VLCCs can eventually be loaded. Therefore, in determining the long term potential for attracting Orimulsion trade through the Panama Canal, the basis for comparison is the maximum size that can be accommodated by the Canal versus a VLCC on the route via the Cape of Good Hope. Under status quo conditions the Panama Canal will not be able to compete.

7.3.3 100,000 DWT Design Ship (Case 2)

2020 Projections

Major Dry Bulks

Calculations of relative freight economics suggest that a Canal of 100,000 DWT would be of insufficient size to attract most dry bulk cargoes which currently bypass the Canal. An exception is the comparatively small volumes of bypass Colombian coal exported into the Northern Pacific Basin. The forecast 1.7 million tonnes of bypass traffic in 2020 has been included in Canal traffic in this case.

Of significantly greater importance is the forecast 13.2 million tonnes of coal from the U.S.

Gulf to the Northern Pacific Basin which, under the status quo case, was diverted to larger vessels on longer haul routes as a continuation of an already apparent trend.

For the 100,000 DWT Canal case, results from calculation of relative freight economics suggest that there are no differences of substance between using Cape size vessels out of the U.S. Gulf on longer haul routes compared with representative sizes up to 100,000 dwt through the Canal. For the purposes of forecasting demand for Canal transits, we have taken a conservative approach, and we have excluded these volumes from the U.S. Gulf. The reasons for this are as follows:

- by 2020 there will be a significant number of established bulk trades around the world which utilize vessels in excess of 125,000 DWT. For shipowners to commit to 100,000 DWT vessels in any extensive way through the Canal constrains their opportunity for profitable trading elsewhere, including routes for which cargo originates in the Pacific Basin.

- the use of larger vessels out of the Gulf is already a perceptible trend. By 2020 this will be a well established operating practice.

Additionally, we feel that a final decision as to whether this trade or proportion of this trade will be attracted back to the Canal under this case will also depend upon actual toll levels and upon final Canal dimensions. The latter could determine the extend to which vessels larger than 100,000 DWT could transit the Canal economically.

Oil

On the basis of estimated transportation economics, there is no case for switching additional cargoes through the Canal from alternative bypass traffic.

2060 Projections

For the 100,000 DWT Canal in 2060, freight calculations suggest that only the comparatively small volumes of Colombian coal into the northern Pacific amounting to 2.2. million tonnes would be attracted to voyages via the Panama Canal. As discussed above, coal from the U.S. Gulf into the Northern Pacific Basin has been excluded at this stage.

[illegible] through the Canal northbound [illegible] routes

7.3.4 150,000 DWT Design Ship (Case 3)

2020 Projections

As for Case 2 (100,000 DWT Canal) the focus for potential changes in trade volumes relates to dry bulk carriers, and oil tankers. In summary, the only significant changes in comparison to 2020, Case 2 relate to the switching of bypass traffic in the dry bulk carrier sector.

Major Dry Bulks

As discussed above, detailed comparisons of vessel economics have been carried out for an additional seven routes where it is possible that dry bulk trades will be attracted through the Canal. Based upon these calculations, cargo from three routes has been assumed to transit the Canal. These are coal from the U.S. East Coast to the Northern Pacific Basin, coal from the U.S. Gulf coast to the Northern Pacific Basin and iron ore from the Canadian East Coast to Asia.

Approximately 65% of coal cargoes in large ships from the U.S. East Coast are loaded in vessels below 150,000 DWT with the remainder in vessels between 150,000 and 250,000 DWT. However, vessels in the larger size range are generally "topped off" elsewhere, and the resulting rate levels from the U.S. East Coast are comparable to those for the smaller vessels. As a result, all of this bypass traffic has been diverted through the Canal. Similarly, around 85% of large vessels loading in the U.S. Gulf are in the size range between 100,000 and 150,000 DWT. The remainder are in the 150,000 to 250,000 range and are also "topped off". For the reasons described above therefore, all of this trade is diverted through the Canal in 2020. Based on loading patterns and relative freight economics, 27% of the volumes of iron ore shipped from the Canadian East Coast to the Northern Pacific Basin are diverted through the Canal in this case. Total additional dry bulk trade under Case 3 amounts to 53.4 million tonnes.

Oil

Potential bypass trades for conventional oil cargoes are essentially limited to trade from S.E. Asia to the U.S. East (Gulf) Coast and the Caribbean. In 1990, sailings on these routes in tankers of over 100,000 DWT totalled 4.6 million Deadweight. However, the freight economics of utilizing vessels up to 150,000 DWT in these trades via the Panama Canal are less favorable than employing similar size tankers via the Cape of Good Hope or the Suez Canal.

Orimulsion

For the case where the Canal is limited to 150,000 DWT, a comparison of potential tanker freight costs alone indicates a clear incentive to utilize the VLCC on the bypass route. If it is assumed that use of the larger vessel will incur additional trans-shipment fees in the importing region, the advantage becomes marginal, although much may depend also on the level of Panama Canal tolls. Therefore in line with our general approach to this study we have not assumed under Case 3, 2020, that Orimulsion trade to Japan and Korea will be routed through the Panama Canal. It may be that toll pricing strategies could be developed that would attract this business as the result of which southbound tanker trade would increase by 14 million tonnes.

2060 Projections

On the basis of detailed comparisons of relative vessel economics, all coal cargoes from the U.S. East and Gulf coasts into the Northern Pacific Basin are routed through the Panama Canal as in 2020 Case 3. These comparisons suggest that carriage of coal in vessels of just under 150,000 DWT through the Canal is marginally less expensive to the shipper than using vessels in the 150,000 to 250,000 DWT range via the Cape as well as being clearly less expensive than using vessels of around 150,000 DWT via the Cape.

For 2060, iron ore from the Canadian East Coast into the Northern Pacific Basin has not been routed through the Canal (as in 2020 Case 3) as the small proportion of vessels originally in this size range on this route is expected to be phased out by 2060.

Detailed vessel economics comparisons for other potential dry bulk and oil by-pass traffic suggest that there are no other trades for which there is a clear-cut case for switching to Canal routings.

7.3.5 250,000 DWT Design Ship (Case 4)

2020 Projections

Major Dry Bulks

There is no additional trade attracted through the Canal northbound. All additions to Canal trade are confined to Southbound routes.

Bypass iron ore from Venezuela to Asia, which amounts to almost 0.5 million tonnes in 2020 and which currently moves in vessels between 150,000 and 250,000 DWT, has been routed through the Canal in this case. Similarly, additional iron ore from the Canadian east coast to Asia, which currently moves in vessels of 150,000 - 250,000 DWT and which amounts to 1.0 m tonnes in 2020, has also been routed through the Canal under this case.

South American Bypass Iron Ore Traffic

Brazil

Exports from Brazil to the Northern Pacific Basin in 1990 amounted to 42.5 million tonnes. These volumes are expected to increase to 89.8 million tonnes in 2020 before falling back to 58.9 million tonnes in 2060. Of the 1990 volumes, it is estimated that 13.5 million tonnes were shipped from Ponta da Madeira, the export port for Carajas production. On the basis of expected future production developments, 29.6 million tonnes of Carajas ore will be shipped to the Northern Pacific Basin in 2020 and 19.4 million tonnes in 2060. It is these latter volumes of Carajas ore which represent Canal bypass traffic[1]. Our best estimate is that these volumes are currently shipped 25% in vessels of 100,000 - 150,000 DWT, 53% in vessels of 150,000 - 250,000, 11% in vessels of 250,000 - 300,000 and 11% in vessels in excess of 300,000 DWT. By 2020 it is expected that the pattern will have shifted further so that around 25% will be shipped in vessels of 150,000 - 250,000 DWT, 53% in vessels of 250,000 - 300,000 DWT and 22% in vessels in excess of 300,000 DWT.

On the basis of relative vessel economics, a decision to shift these trades from voyages via the Cape to using the Canal is very marginal. In line with the approach described previously, where the decision is marginal, the shift has not been made. In line with our terms of reference, existing toll rates, rather than a parametric approach to toll rate definition, are being utilized within voyage calculations. These rates have been increased in real terms in line with real operating cost increases for dry bulk carriers in each of the two time periods under review, also as agreed. It is clear however that with a different toll rate structure from that prevailing in FY1990, iron ore traffic and transits could be attracted through the Canal dependent upon the maximum vessel size that could transit the Canal. On the basis of the vessel distribution patterns described above, there could be a maximum of 26 sailings in the 100,000 - 150,000 DWT size range in 2020 under Case 3 and Case 4 and 77 sailings in the 150,000 - 250,000 DWT size range under Case 4.

[1] Hammersley Iron and Steel, UNCTAD Trust Fund; These sources were supplemented by information on vessel movements from Fearlnley Research, and port information from Fairplay World Ports Directory and Lloyd's Ports of the World.

Chile

It is estimated that there is approximately 1 m tonnes of iron ore being shipped from northern Chile (the Huasco Bay area) into Europe and that around 34% of these volumes are being shipped in vessels of 100,000 - 150,000 DWT and the remainder in vessels of 150,000 - 250,000 DWT. These trades are again marginal from the perspective of a shift through the Canal and comments made above regarding toll levels also apply in this instance.

Oil

No change is envisaged in the conventional oil trades via the Panama Canal as compared with estimates of oil tanker transits under Cases 2 and 3. However, the capability of the Canal, under Case 4, to accept a small VLCC up to 250,000 DWT would mean that it would become economic to transport Venezuelan Orimulsion to the Far East via the Canal rather than the alternative Cape route. As discussed above, it is estimated that shipments of Orimulsion to the Far East will reach 14 million tonnes in 2020.

2060 Projections

Major Dry Bulks

For northbound transits, there is no additional cargo under this case compared to Case 3 2060.

For southbound transits it is assumed that additional cargoes of Venezuelan iron ore to the North Pacific Basin and Canadian East coast iron ore to the North Pacific Basin will be attracted through the Canal in this case. In total, this amounts to an additional 2.8 million tonnes of cargo compared to Case 3 in 2060 and follows the trend described for 2020 above.

As discussed under Case 4, 2020 above, on the basis of relative vessel economics, a decision to shift Brazilian iron ore trades through the Canal is marginal and, as such, the shift, amounting to some 19.4 million tonnes, has not been made in this 'base case'. As for 2020, any shift of cargo from Huasco Bay (Chile) into Europe is also marginal.

Oil

As is the case for 2020 under this Canal alternative, and for reasons described earlier, 14

million tonnes of Orimulsion trade from Venezuela to the North Pacific basin have been added to southbound Canal trade compared with Cases 1-3.

7.3.6 300,000 DWT Design Ship (Case 5) and Comparisons with

Following further detailed evaluations of shipping economics, ship sizes and routing patterns we conclude that for both dry bulk and oil trades there is unlikely to be any significant differences in trade volumes through the canal between Cases 4 and 5, for both 2020 and 2060.

7.4 Conclusion

As a result of the various analyses of bypass traffic described above, it is concluded that total bypass traffic (landbridge and all water) for all cargo types north and southbound shifted to the Canal under Case 2 as compared with the status quo case would amount to 2.7 million tonnes and 5.5 million tonnes in 2020 and 2060 respectively. Under Case 3, these additions to Canal traffic for 2020 and 2060 would be equivalent to 54.4 million tonnes and 75.8 million tonnes. For both Cases 4 and 5 these figures would rise to 69.9 million tonnes and 92.6 million tonnes (Table 7.8).

The effect of these adjustments to projections for the status quo Canal is to increase total Canal trade in 2020 from 265 million tonnes up to 334 million tonnes and in 2060 from 412 million tonnes up to 502 million tonnes as follows:

Total Annual Cargo Flows For Panama Transits (Million Tonnes)

	2020	2060
Case 1 (Status quo)	265.1	411.7
Case 2	267.9	417.2
Case 3	319.5	487.5
Case 4 and 5	335.0	504.3

Table 7.8
Summary of Landbridge and All Water Bypass Traffic Shifted on to Panama Canal Routes and Included in Commodity Projections Shown in Tables 7.1-7.3.
('000 tonnes)

Cargo Type	Route	2020	2060
Case 2, 100,000 Dwt Canal			
Northbound			
Containerized	Asia - US East Coast	322	1022
	US West Coast - Europe	69	170
Southbound			
Containerized	US East Coast - Asia	543	1906
	Europe - US West Coast	80	223
Major Dry Bulks	S America EC - Asia	1731	2217
Total North and Southbound		2745	5538
Case 3, 150,000 Dwt Canal			
Northbound			
Containerized	Asia - US East Coast	322	1022
	US West Coast - Europe	69	170
Southbound			
Containerized	US East Coast - Asia	543	1906
	Europe - US West Coast	80	223
Major Dry Bulks	US East Coast - Asia	51306	70285
	Canada EC - Asia	373	0
	S.America EC - Asia	1731	2217
Total North and Southbound		54424	75823
Cases 4 and 5, 250,000 and 300,000 Dwt Canals			
Northbound			
Containerized	Asia - US East Coast	322	1022
	US West Coast - Europe	69	170
Southbound			
Containerized	US East Coast - Asia	543	1906
	Europe - US West Coast	80	223
Major Dry Bulks	US East Coast - Asia	51306	70285
	Canada EC - Asia	1380	2422
	S America EC - Asia	2205	2551
Orimulsion	S America EC - Asia	14000	14000[1]
Total North and Southbound		69905	92579

[1] Note: Orimulsion is included in the estimates of crude oil trade

Source: RLA

APPENDIX 7-A

7-A-1 EVALUATION OF INDICATIVE
CONTAINER TRANSPORTATION COSTS
PANAMA CANAL VS LANDBRIDGE
ASIA TO US EAST / MIDWEST

7-A-2 EVALUATION OF ALL WATER BY PASS TRAFFIC
GRAINS: US GULF & WEST COAST TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-3 EVALUATION OF ALL WATER BY PASS TRAFFIC
COAL: US EAST AND GULF COASTS TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-4 EVALUATION OF ALL WATER BY PASS TRAFFIC
COAL: COLOMBIA TO ASIA (NORTH PACIFIC BASIN)

7-A-5 EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: VENEZUELA TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-6 EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE:CANADA EAST COAST TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-7 EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: BRAZIL TO ASIA (NORTHERRN PACIFIC BASIN)

7-A-8 EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: BRAZIL TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-9 EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: NORTH CHILE TO EUROPE
REPRESENTATIVE TRANSPORTATION ECONOMICS

7-A-10 EVALUATION OF ALL WATER BY PASS TRAFFIC
ORIMULSION: VENEZUELA TO JAPAN
REPRESENTATIVE TRANSPORTATION COSTS

7-A-11 WORLD OIL DEMAND AND SUPPLY PROJECTIONS

7-A-12 ESTIMATED DEVELOPMENT OF MAIN WORLD OIL TRADES

7-1-16 ESTIMATED GLOBAL FLEET DEVELOPMENTS

EVALUATION OF INDICATIVE
CONTAINER TRANSPORTATION COSTS
PANAMA CANAL VS LANDBRIDGE
ASIA TO US EAST / MIDWEST

DESTINATION		NEW YORK		CHICAGO		
VIA:			USWC	USEC	USWC	USEC
OCEAN FREIGHT	144	185	144	185		
RAIL FREIGHT		72	-	48	24	
INVENTORY						
OCEAN		8	19	8	19	
RAIL			2	-	1	-
TOTAL		226	204	201	228	
			TRANSIT TIMES			
OCEAN		9	23	9	23	
RAIL		3	-	2	1	
TOTAL		12	23	11	24	

a. Ocean freight based on 66,480 DWT (4400 TEU) ship. Assuming vessels of comparable size used into both US West Coast and East Coasts, the differential on ocean freight remains around $40/ton.

b. Transit times exclude time in terminal

c. Cargo value $7,682/ton. Therefore, freight represents just under 1% of cargo value.

EVALUATION OF ALL WATER BY PASS TRAFFIC
GRAINS: US GULF & WEST COAST TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/TON

Year:	2020			2060		
Ship Size (000 DWT)	52	69	135	52	69	135
Source: US Gulf						
Seaborne Costs Plus Wtd. Average of Inland Barge And Rail Costs	41.4	38.2	31.6	45.4	43.5	35.7
Seaborne Costs Plus Inland Rail Costs Only	48.3	45.1	38.4	54.1	52.2	44.4
Seaborne Costs Plus Inland Barge Costs Only	36.5	33.3	26.6	41.1	38.2	31.3
Source: USWC						
Seaborne Costs Plus Inland Rail Costs	42.0	40.3	36.8	48.0	47.1	43.0

Source: Seaborne Costs, RLA
Inland Costs, BST

EVALUATION OF ALL WATER BY PASS TRAFFIC
COAL: US EAST AND GULF COASTS TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/TON

Year:	2020		2060		
Ship Size (000 DWT)	100	135	100	140	184
Source:					
Hampton Roads					
Via Panama	14.0	11.6	5.8	12.8	11.4
Via Panama Excl Toll	12.6	10.3	14.3	11.3	9.9
Via Cape		13.3		14.7	12.9
Mobile					
Via Panama	13.5	11.2	15.2	12.3	11.0
Via Panama Excl Toll	12.1	9.9	13.7	10.8	9.5
Via Cape		13.6		15.1	13.2

ESTIMATED CURRENT SIZE DISTRIBUTION OF VESSELS IN BY PASS COAL TRADES

Shipsize (000 DWT)	65-100	100-150	150-250
% Age	3	70	27

COMISION DE ESTUDIO DE LAS ALTERNATIVAS AL CANAL DE PANAMA
CENTRO DE INFORMACION

EVALUATION OF ALL WATER BY PASS TRAFFIC
COAL: COLOMBIA TO ASIA (NORTH PACIFIC BASIN)

1990 $

Year:	2020			2060		
Ship Size (000 DWT)	100	135	184	100	140	180
Source: Puerto Bolivar						
Via Panama	12.9	10.7	9.3	14.5	11.8	10.4
Via Panama Excl Toll	11.5	9.4	8.0	13.0	10.3	8.9
Via Suez		14.3	12.2		15.7	13.6

ESTIMATEDE CURRENT SIZE DISTRIBUTION OF VESSELS IN BY PASS COAL TRADES

Ship Size (000 DWT)	100-150
% Age	100

EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: VENEZUELA TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/TON

Year:	2020		2040		
Ship Size (000 DWT)	135	184	140	184	269
Via Panama	11.3	9.9	12.4	11.0	8.9
Via Panama Excl Toll	10.0	8.6	10.9	9.5	7.5
Via Cape	12.6	10.8	13.9	12.1	9.5

ESTIMATED CURRENT SIZE DISTRIBUTION OF VESSELS IN BY PASS IRON ORE TRADES

Shipsize (000 DWT)	150-250
% Age	100

EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE:CANADA EAST COAST TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/TON

Year:	2020		2060		
Ship Size (000 DWT)	135	184	140	184	269
Source: Sept. Isles					
Via Panama	12.1	10.7	13.3	12.0	9.7
Via Panama Excl Toll	10.8	9.4	11.8	10.5	8.3
Via Cape	13.4	11.6		13.1	10.2

ESTIMATED CURRENT SIZE DISTRIBUTION OF VESSELS IN BY PASS IRON ORE TRADES

Shipsize (000 DWT)	100-150	150-250
% Age	27	73

EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: BRAZIL TO ASIA (NORTHERN PACIFIC BASIN)

Source		Min Tons	Mileage	Vessel Size Distribution (%) Size (000 DWT):	100-150	150-200	250-300	300+
Ponta Da Madeira								
1990		13.5	10253 (P)					
2020		29.6	12657 (C)					
2060		19.4						
Tubarao								
1990			11764 (P)	1990	25	53	11	11
2020			11524 (C)	2020	10	40	35	15
2060	1990	29.0		2060	--	25	53	22
	2020	60.2						
Sepetiba	2060	39.5						
1990			12014 (P)					
2020			11592 (C)					
2060								
Total								
1990		42.5						
2020		89.8						
2060		58.9						

(P) = Via Panama
(C) = Via Cape Good Hope/Cape Horn

EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: BRAZIL TO ASIA (NORTH PACIFIC BASIN)
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/Ton

Year	2020				2060			
Ship Size (000 DWT)	135	183	268	318	140	184	269	318
Source:								
Ponta Da Madeira								
Via Panama	12.0	10.0	8.2	--	13.2	11.2	9.1	--
Via Panama Excl Toll	10.7	8.7	6.9	--	11.7	9.7	7.7	--
Via Cape	11.9	9.8	7.7	7.3	13.2	11.0	8.6	8.3
Tubarao/Sepetiba								
Via Panama		10.8/10.9				12.1/12.2		
Via Panama Excl Toll		9.5/9.6				10.7/10.8		
Via Cape		9.3				10.4		

MAX CARGO WHICH COULD BE DIVERTED AT LOWER TOLL STRUCTURE (MLN TONS)

					TOTAL					TOTAL
Case 3	3.0	--	--	--	3.0	--	--	--	--	--
Case 4	3.0	11.8	--	--	14.8	--	4.8	--	--	4.9
Case 5	3.0	11.8	10.4	4.4	29.6	--	4.8	10.3	4.3	19.4

EVALUATION OF ALL WATER BY PASS TRAFFIC
IRON ORE: NORTH CHILE TO EUROPE
REPRESENTATIVE TRANSPORTATION ECONOMICS

1990 $/Ton

Year:	2020				2060			
Ship Size (000 DWT)	135	183	268	318	140	184	269	318
Source:								
Huasco Bay								
Via Panama	12.0	10.1	8.3	--	13.2	11.2	9.3	--
Via Panama Excl Toll	10.7	8.8	6.9	--	11.7	9.7	7.9	--
Via Cape	11.8	9.7	7.6	7.3	12.9	10.8	8.4	8.1

ESTIMATED CURRENT SIZE DISTRIBUTION OF VESSELS IN BY PASS IRON ORE TRADES

Ship Size (000 DWT)	100-150	150-250
% Age	34	66

MAX CARGO WHICH COULD BE DIVERTED AT LOWER TOLL STRUCTURE (MLN TONS)

1.8	2.2

EVALUATION OF ALL WATER BY PASS TRAFFIC
ORIMULSION: VENEZUELA TO JAPAN
REPRESENTATIVE TRANSPORTATION COSTS

1990 $/Ton

Year:	2020				2060			
Ship Size (000 DWT)	90	150	238	269	90	150	238	269
Source:								
Puerto La Cruz								
Via Panama	19.2	14.7	12.5	11.4	22.0	17.1	14.2	12.9
Via Panama Excl Toll	16.5	12.0	9.8	8.6	19.0	14.1	11.3	9.9
Via Cape	24.6	17.8	14.4	12.9	28.4	20.9	16.7	14.9

Conclusions:

- ON BASIS OF ASSUMED TOLL STRUCTURE ORIMULSION DIVERTED THROUGH CANAL UNDER CASES 4 & 5 ONLY
- AT LOWER TOLL STRUCTURE ORIMULSION COULD BE DIVERTED THROUGH CANAL UNDER CASE 3

WORLD OIL DEMAND AND SUPPLY PROJECTIONS

AREA	DEMAND	1990 SUPPLY	NET (IMPORTS)	DEMAND	2020 SUPPLY	NET (IMPORTS)	DEMAND	2060 SUPPLY	NET (IMPORTS)
N. AMERICA	854	511	(343)	874	349	(525)	379	210	(169)
LATIN AMERICA	255	374	119	434	527	93	220	240	20
EUROPE	700	217	(483)	613	174	(439)	250	50	(200)
USSR	403	570	(167)	362	415	53	281	300	9
AFRICA	94	314	220	258	353	95	240	150	(90)
JAPAN	245	1	(244)	275	1	(274)	236	-	(235)
OTHER ASIA/ AUSTRALIA	405	320	(85)	808	422	(386)	417	250	(167)
MIDDLE EAST	146	843	697	292	1646	1354	216	1040	822
WORLD	3102	3150	48	3916	3887	(29)	2250	2240	(10)

ESTIMATED DEVELOPMENT OF MAIN WORLD OIL TRADES

000 Tons

FROM	TO	TOTAL (CRUDE + PRODUCTS) 1990	2020	2060	GROWTH RATE 1990-2020	2020-2060	1990-2060
C. AM EC/CARIBS	US EAST COAST	48,400	35,958	12,585	-1.0%	-2.6%	-1.9%
C. AM EC/CARIBS	US GULF COAST	77,000	57,206	20,022	-1.0%	-2.6%	-1.9%
C. AM EC/CARIBS	N. EUROPE	15,100	6,864	2,288	-2.6%	-2.7%	-2.7%
C. AM EC/CARIBS	S. EUROPE	17,900	8,136	2,712	-2.6%	-2.7%	-2.7%
N. EUROPE	US EAST COAST	8,900	5,038	1,679	-1.9%	-2.7%	-2.4%
N. EUROPE	US GULF COAST	11,700	6,623	2,208	-1.9%	-2.7%	-2.4%
N. EUROPE	CANADA EC	16,800	9,767	0	-1.8%	-100.0%	-100.0%
MIDDLE EAST	USEC/USWC/CARIBS	79,413	341,137	60,293	5.0%	-4.2%	-0.4%
MIDDLE EAST	N. EUROPE	77,812	126,584	66,044	1.6%	-1.6%	-0.2%
MIDDLE EAST	S. EUROPE	51,189	83,694	43,666	1.7%	-1.6%	-0.2%
MIDDLE EAST	ASIA EXCL. JAPAN	153,700	356,473	194,440	2.8%	-1.5%	0.3%
MIDDLE EAST	JAPAN	166,200	190,000	195,000	0.4%	0.1%	0.2%
MIDDLE EAST	OCEANIA	12,300	28,527	15,560	2.8%	-1.5%	0.3%
NEAR EAST	USEC/USWC/CARIBS	23,587	23,587	17,908	0.0%	-0.7%	-0.4%
NEAR EAST	N. EUROPE	20,188	32,842	17,135	1.6%	-1.6%	-0.2%
NEAR EAST	S. EUROPE	62,311	101,881	53,155	1.7%	-1.6%	-0.2%
S.E. ASIA	JAPAN	51,000	60,896	30,448	0.6%	-1.7%	-0.7%
N. AFRICA	US EAST COAST	4,100	2,265	566	-2.0%	-3.4%	-2.8%
N. AFRICA	US GULF COAST	10,200	5,635	1,409	-2.0%	-3.4%	-2.8%
N. AFRICA	N. EUROPE	14,600	6,076	1,402	-2.9%	-3.6%	-3.3%
N. AFRICA	S. EUROPE	89,900	37,410	8,633	-2.9%	-3.6%	-3.3%
W. AFRICA	US EAST COAST	29,300	16,188	4,047	-2.0%	-3.4%	-2.8%
W. AFRICA	US GULF COAST	28,800	15,912	3,978	-2.0%	-3.4%	-2.8%
W. AFRICA	N. EUROPE	15,900	6,616	1,527	-2.9%	-3.6%	-3.3%
W. AFRICA	S. EUROPE	35,800	14,898	3,438	-2.9%	-3.6%	-3.3%
TOTAL		1,122,100	1,580,213	760,143	1.1%	-1.8%	-0.6%

Notes

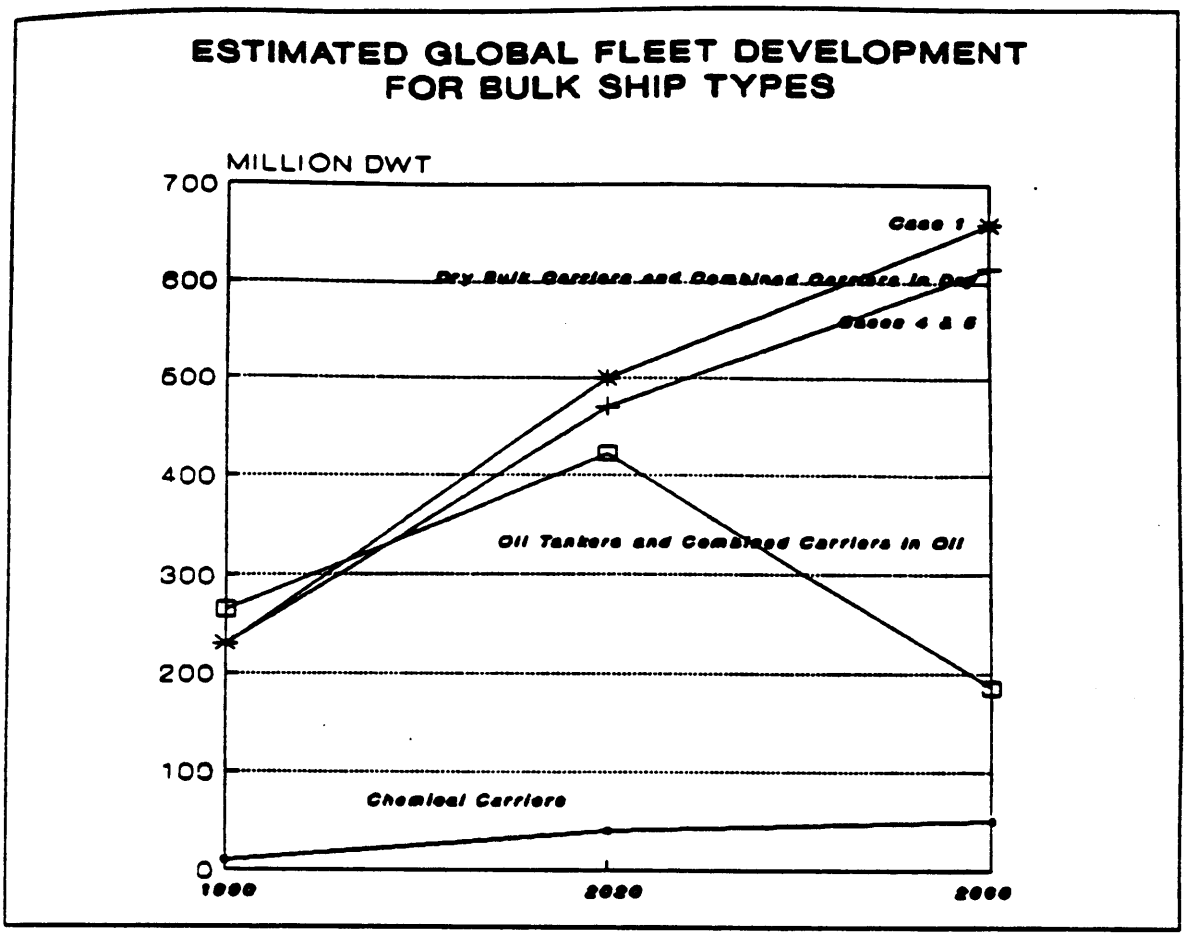
1. Excludes Panama Canal trades which are shown separately.
2. Middle East oil trades to the US East and Gulf Coast are combined as significant quantities of crude oil are shipped into the US via terminals in the Caribbean
3. Middle East and Near East trades have been allocated on the basis of tanker trading patterns

ESTIMATED DEVELOPMENT OF MAIN WORLD OIL TRADES

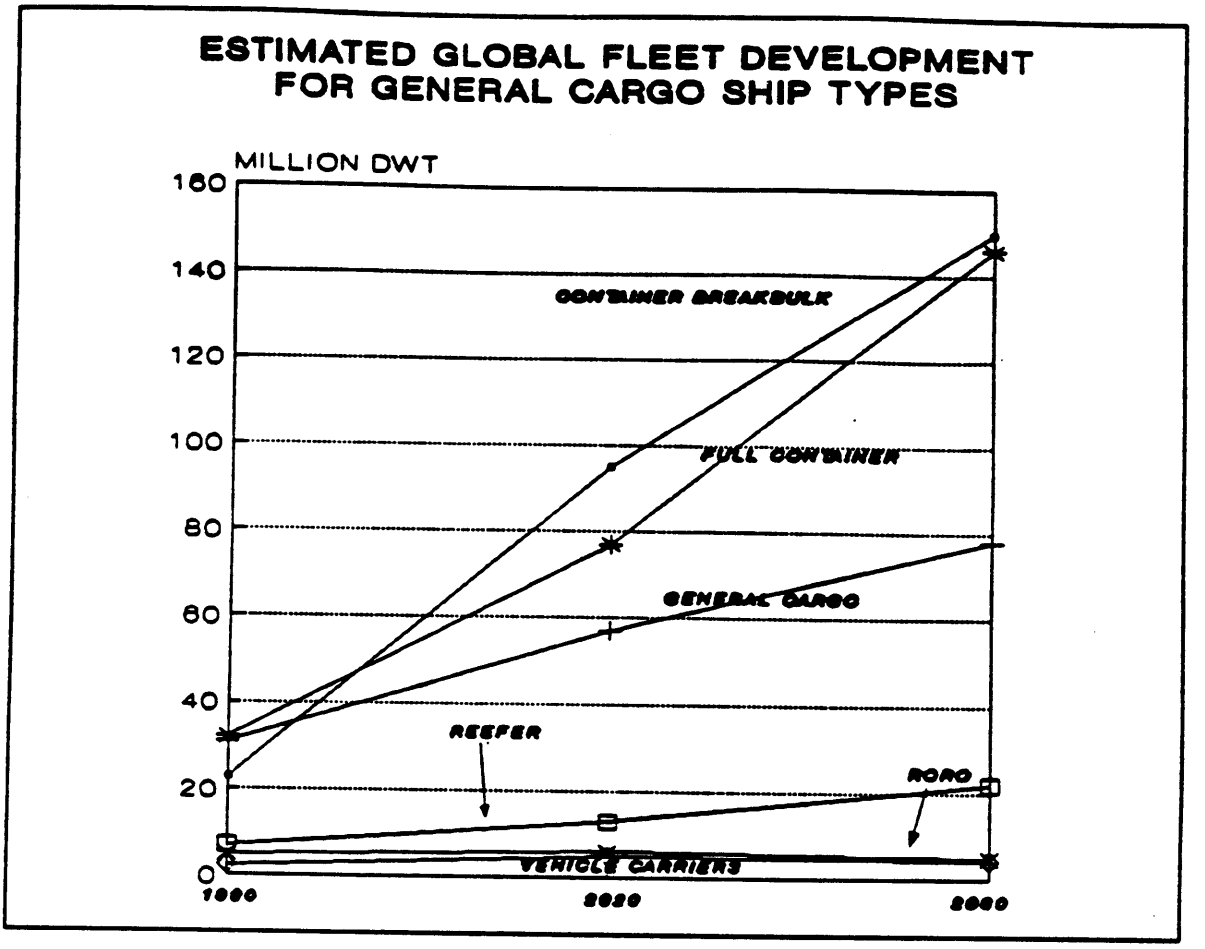
FROM	TO	CRUDE OIL 1990	2020	2060	GROWTH RATE 1990-2020	2020-2060	1990-2060
C. AM EC/CARIBS	US EAST COAST	12,000	10,626	4,791	-0.4%	-2.0%	-1.3%
C. AM EC/CARIBS	US GULF COAST	72,200	53,865	18,993	-1.0%	-2.6%	-1.9%
C. AM EC/CARIBS	N. EUROPE	10,700	3,479	2,288	-3.7%	-1.0%	-2.2%
C. AM EC/CARIBS	S. EUROPE	15,800	6,521	2,712	-2.9%	-2.2%	-2.5%
N. EUROPE	US EAST COAST	2,800	1,450	0	-2.2%	-100.0%	-100.0%
N. EUROPE	US GULF COAST	9,500	5,329	1,446	-1.9%	-3.2%	-2.7%
N. EUROPE	CANADA EC	16,100	6,585	0	-2.9%	-100.0%	-100.0%
MIDDLE EAST	USEC/USWC/CARIBS	72,013	327,262	51,043	5.2%	-4.5%	-0.5%
MIDDLE EAST	N. EUROPE	70,912	113,055	57,024	1.6%	-1.7%	-0.3%
MIDDLE EAST	S. EUROPE	42,789	67,223	32,686	1.5%	-1.8%	-0.4%
MIDDLE EAST	ASIA EXCL. JAPAN	120,000	225,910	115,610	2.1%	-1.7%	-0.1%
MIDDLE EAST	JAPAN	135,300	170,000	182,500	0.8%	0.2%	0.4%
MIDDLE EAST	OCEANIA	11,800	26,590	14,390	2.7%	-1.5%	0.3%
NEAR EAST	USEC/USWC/CARIBS	23,387	23,211	17,658	-0.0%	-0.7%	-0.4%
NEAR EAST	N. EUROPE	20,188	32,842	17,135	1.6%	-1.6%	-0.2%
NEAR EAST	S. EUROPE	62,311	101,881	53,155	1.7%	-1.6%	-0.2%
S.E. ASIA	JAPAN	31,300	34,274	17,137	0.3%	-1.7%	-0.9%
N. AFRICA	US EAST COAST	1,200	2,265	566	2.1%	-3.4%	-1.1%
N. AFRICA	US GULF COAST	3,100	5,635	1,409	2.0%	-3.4%	-1.1%
N. AFRICA	N. EUROPE	8,200	2,025	389	-4.6%	-4.0%	-4.3%
N. AFRICA	S. EUROPE	82,400	32,663	7,446	-3.0%	-3.6%	-3.4%
W. AFRICA	US EAST COAST	27,800	16,188	4,047	-1.8%	-3.4%	-2.7%
W. AFRICA	US GULF COAST	28,800	15,912	3,978	-2.0%	-3.4%	-2.8%
W. AFRICA	N. EUROPE	15,400	6,299	1,448	-2.9%	-3.6%	-3.3%
W. AFRICA	S. EUROPE	34,400	14,011	3,216	-2.9%	-3.6%	-3.3%
TOTAL		930,400	1,305,101	611,067	1.1%	-1.9%	-0.6%

ESTIMATED DEVELOPMENT OF MAIN WORLD OIL TRADES

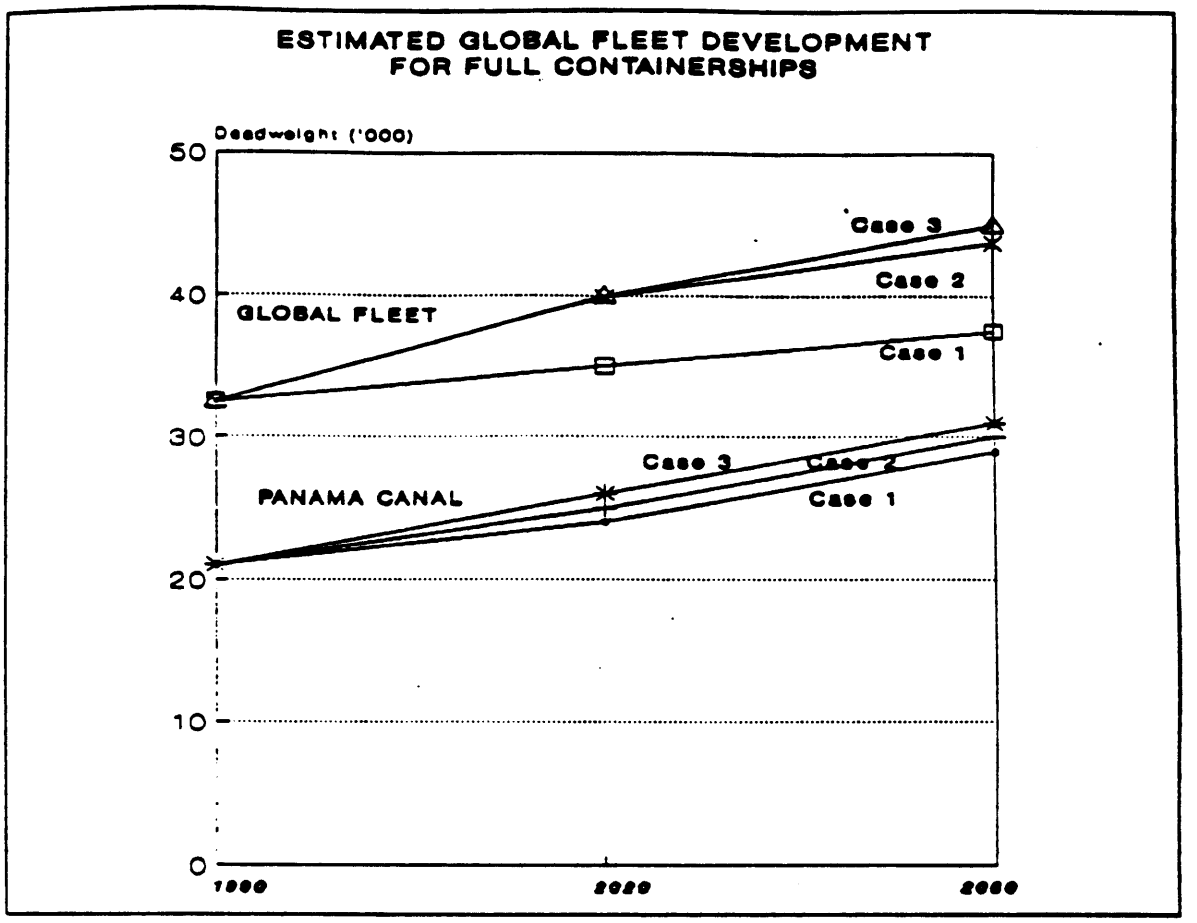
FROM	TO	PETROLEUM PRODUCTS 1990	2020	2060	GROWTH RATE 1990-2020	2020-2060	1990-2060
C. AM EC/CARIBS	US EAST COAST	36,400	25,332	7,794	-1.2%	-2.9%	-2.2%
C. AM EC/CARIBS	US GULF COAST	4,800	3,341	1,029	-1.2%	-2.9%	-2.2%
C. AM EC/CARIBS	N. EUROPE	4,400	3,385	0	-0.9%	-100.0%	-100.0%
C. AM EC/CARIBS	S. EUROPE	2,100	1,615	0	-0.9%	-100.0%	-100.0%
N. EUROPE	US EAST COAST	6,100	3,588	1,679	-1.8%	-1.9%	-1.8%
N. EUROPE	US GULF COAST	2,200	1,294	762	-1.8%	-1.3%	-1.5%
N. EUROPE	CANADA EC	700	3,182	0	5.2%	-100.0%	-100.0%
MIDDLE EAST	USEC/USWC/CARIBS	7,400	13,875	9,250	2.1%	-1.0%	0.3%
MIDDLE EAST	N. EUROPE	6,900	13,529	9,020	2.3%	-1.0%	0.4%
MIDDLE EAST	S. EUROPE	8,400	16,471	10,980	2.3%	-1.0%	0.4%
MIDDLE EAST	ASIA EXCL. JAPAN	33,700	130,563	78,830	4.6%	-1.3%	1.2%
MIDDLE EAST	JAPAN	30,900	20,000	12,500	-1.4%	-1.2%	-1.3%
MIDDLE EAST	OCEANIA	500	1,937	1,170	4.6%	-1.3%	1.2%
NEAR EAST	USEC/USWC/CARIBS	200	376	250	2.1%	-1.0%	0.3%
NEAR EAST	N. EUROPE	0	0	0			
NEAR EAST	S. EUROPE	0	0	0			
S.E. ASIA	JAPAN	19,700	26,622	13,311	1.0%	-1.7%	-0.6%
N. AFRICA	US EAST COAST	2,900	0	0	-100.0%		-100.0%
N. AFRICA	US GULF COAST	7,100	0	0	-100.0%		-100.0%
N. AFRICA	N. EUROPE	6,400	4,051	1,013	-1.5%	-3.4%	-2.6%
N. AFRICA	S. EUROPE	7,500	4,747	1,187	-1.5%	-3.4%	-2.6%
W. AFRICA	US EAST COAST	1,500	0	0	-100.0%		-100.0%
W. AFRICA	US GULF COAST	0	0	0			
W. AFRICA	N. EUROPE	500	317	79	-1.5%	-3.4%	-2.6%
W. AFRICA	S. EUROPE	1,400	887	222	-1.5%	-3.4%	-2.6%
TOTAL		191,700	275,112	149,076	1.2%	-1.5%	-0.4%


ESTIMATED GLOBAL FLEET DEVELOPMENT
FOR BULK SHIP TYPES
MILLION DWT
700
600
500
400
300
200
100
0
Case 1
Dry Bulk Carriers and Combined Carriers in Dry
Cases 4 & 5
Oil Tankers and Combined Carriers in Oil
Chemical Carriers
1990
2020
2050

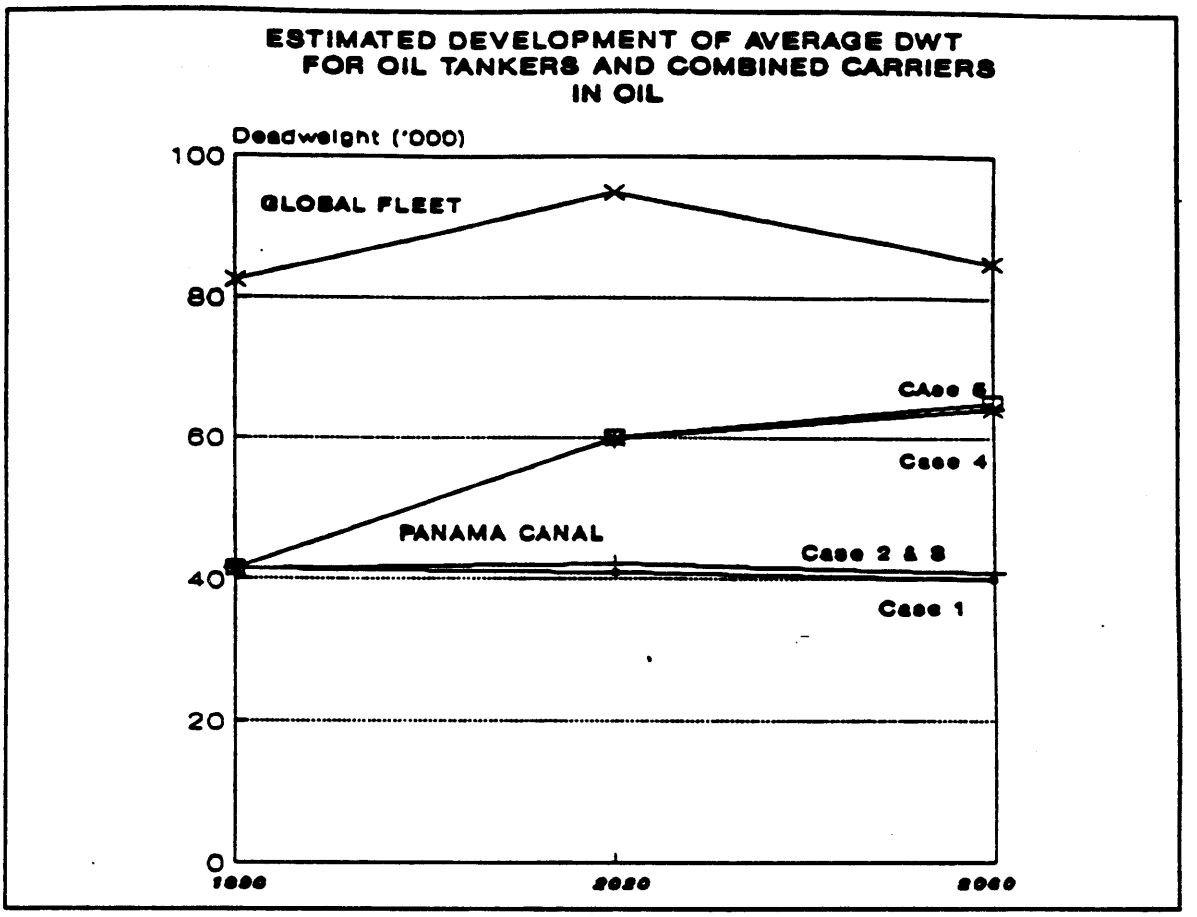
Source: RLA


ESTIMATED GLOBAL FLEET DEVELOPMENT
FOR GENERAL CARGO SHIP TYPES
MILLION DWT
160
140
120
100
80
60
40
20
0
CONTAINER BREAKBULK
FULL CONTAINER
GENERAL CARGO
REEFER
RORO
VEHICLE CARRIERS
1990
2020
2060

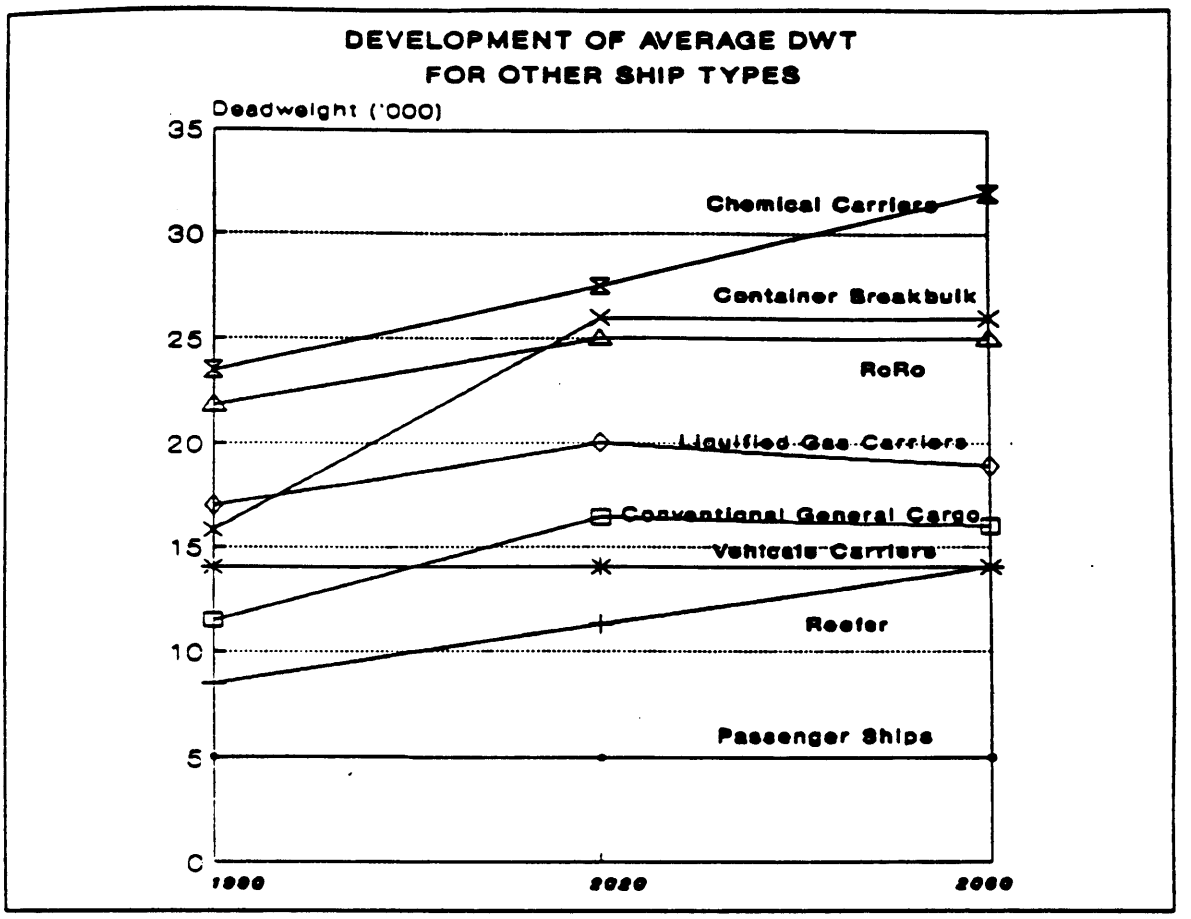
Source: RLA


ESTIMATED GLOBAL FLEET DEVELOPMENT
FOR FULL CONTAINERSHIPS
Deadweight ('000)
50
40
30
20
10
0
GLOBAL FLEET
Case 3
Case 2
Case 1
PANAMA CANAL
Case 3
Case 2
Case 1

Source: RLA


ESTIMATED DEVELOPMENT OF AVERAGE DWT
FOR OIL TANKERS AND COMBINED CARRIERS
IN OIL
Deadweight ('000)
100
80
60
40
20
0
GLOBAL FLEET
PANAMA CANAL
Case 4
Case 2 & 3
Case 1

Source: RLA



Source: RLA

[illegible] interviews were held [illegible] Planning and Development Department [illegible] Burmeister & Wain Salesmen [illegible] Leif Hoegh & Co. A/S Oslo Precious [illegible] manning study in which they were involved [illegible] and liner departments)

[illegible]

[illegible] thirty and seventy years hence is [illegible] [illegible] economies of scale in the 1960s and 1970s [illegible] [illegible] of containerization for the liner trades in the 1970s [illegible] and labor substituting automation [illegible]

[illegible]

8.0 WORLD VESSEL FLEET PROJECTIONS

8.1 Introduction

This section on world vessel fleet projections provides the basis for future estimates of vessel mix by ship type and size for Panama Canal transits (section 9), the evaluation of shipping economics on Canal and alternative by pass routes (the results of which have been discussed in section 7) and additional costs considerations - hourly delay costs, transportation costs by ship type, size and route and annual closure costs - described in section 10. This section therefore covers, ship technology, global fleet forecasts and projections of vessel operating costs and earnings.

8.2 Ship Technology Developments to the Year 2060

8.2.1 Introduction

The following sections describe the approach to and the conclusions drawn from the evaluation of future technological and size developments for the various ship types under study. While the focus is on technical aspects these cannot be entirely divorced from commercial considerations and, for some sectors in particular, rising concerns over environmental and safety issues. These factors therefore have been taken into account where relevant.

8.2.2 Approach

The initial material gathered for this part of the study is based on a literature search of technical, academic and commercial material through two main international maritime data bases (TRIS and MARNA). Relevant articles are referenced in the bibliography included at the end of section 8. However it will be seen that the articles are relatively few in number simply because most of the material found proved to give little perspective beyond 5-10 years. The literature search therefore has been supplemented through a series of interviews[1], including an extensive meeting with senior design and propulsion technology

[1] The following are some of the companies with whom interviews were held:
Lloyds Register of Shipping, London (Technical Planning and Development Department. Propulsion, Performance and Environmental Technology Group); Burmeister & Wain Skibsvaert A/S, Copenhagen; BIMCO, Copenhagen; Lauritzen Reefers A/S, Copenhagen; Leif Hoegh & Co. A/S, Oslo; Precious Associates, UK (for discussions on the conclusions of the BIMCO manning study in which they were involved); The East Asiatic Company Ltd, Copenhagen (Bulk shipping and liner departments).

experts from Lloyd's Register of Shipping, one of the world's foremost classification societies.

8.2.3 Shipping and Technology

Shipping is an industry with a long history. It is economically, socially and technologically mature. Change occurs, but it is the selective adoption of appropriate, and commercially viable, technology rather than the rapid, technology-driven change which characterizes a new industry, such as those of computers or of aeronautics. The risk to an individual shipowner contemplating investment in new technology can be substantial. As a result it is fair to say that in terms of mechanical engineering developments, the marine sector lags general industry by around 5 to 10 years.

The rate of change in shipping is also constrained by the life of ships, which under normal circumstances is at least twenty years. At any given time, the average level of technology of the fleet is usually at least ten years old. Some of the ships on the order book in 1991 will still be afloat in the year 2020. In the earlier part of the study period, the availability of shipyard capacity itself may place additional constraints on the system, particularly as there are likely to be fairly large scale requirements to replace much of the existing tanker and dry bulk carrier fleet within this time frame. These are also the ship types which seem the least likely to undergo dramatic technological change within the initial time frame.

At any given time the shipping industry is saturated with new technological ideas, most of which are technically possible, and few of which win through to adoption by commercial shipowners. In postulating a "scenario" for the long term future of shipping one might chose to be imaginative, adopting dramatic concepts being expounded by their proponents, but which might nevertheless find themselves relegated to fringe technology in the future. Alternatively, one might choose to take a more measured view, adopting only concepts which appear today to have a reasonable chance of being economically viable, and therefore of being adopted by shipowners. The latter approach has been chosen, partly because only one scenario is to be developed, partly because it is felt that in so doing the assumptions will be less wrong than if one adopts an overly imaginative approach.

8.2.4 The Potential for New Technology

To reach firm conclusions on ship technology thirty and seventy years hence is intrinsically impossible. The achievement of massive economies of scale in the 1960s and 1970s in the wet and dry bulk trades, the adoption of containerization for the liner trades in the 1970s, and developments in propulsion efficiency and labor- substituting automation under the

influence of the oil price rises of 1973 and 1978 together amount to a far-reaching technological revolution in shipping in just 30 years. Shipowners themselves are pragmatic commercial people. They tend not to look ahead more than one vessel generation. The general impression in 1991 is that those technological changes which have recently been made have largely exhausted those possibilities which are economically viable. The shipping industry generally does not appear to be on the threshold of dramatic new developments.

On the basis of current research there could be significant changes, however. in propulsion in the period after 2020. The near term is in for a period of consolidation, of progressive improvements to the latest ideas which have already been implemented on the newest ships, and their more widespread adoption as old ships are scrapped, and replaced by new buildings.

This scenario is not inconsistent with changes in specific sectors of the industry. Possible changes include fast ferries (catamaran or SWATH) for short distance routes or, with the modification of existing but still new technology, a second generation of ISO standards for containers. In general. however, the view of the future adopted here is without changes as dramatic as those implemented in the industry in the 1960s and 1970s.

8.2.5 Size and Speed

The growth in ship sizes to attain ever-increasing economies of scale which characterized the 1960s and 1970s for some ship types -in particular tankers and dry bulk carriers - has been halted, or even reversed, by changes in sourcing patterns and in the structure of costs which have occurred in the past twenty years. It is in the containerized sector that it is envisaged that developments of the Panama Canal could have the most fundamental impact on size in that without existing constraints there remains considerable scope for achieving further economies of scale with these ships. It is envisaged that a larger Panama Canal could precipitate a step increase in the size of the largest container ships from the present Panamax size of 3,700 to 4,400 TEU (approximately 47,000 to 55,000 DWT) to ships able to carry 6,000+ TEU (about 90,000+ DWT). It is anticipated that as vessels become larger, length to beam ratios broadly will be maintained. Changes to canal dimensions will also impact significantly on the size composition of the world dry bulk fleet although not on maximum vessel sizes.

Changes in the size and speed of ships depend more on the commercial requirements of the shippers of cargo than on marine technology. At most periods in the history of power driven vessels, the technology has existed to drive ships faster than the speed actually chosen by

shipowners for their new buildings. At the same time technology is important, but it shows itself more in determining an optimal speed in relation to the size and other design parameters specified by the shipowner, than in selecting a speed in the first place.

Size and speed are considered together in relation to facts which they have in common. Change in each is of two types:

- First, there is a tendency for each ship type for successive generations of ships to be larger and faster than their predecessor. Change of this type is relatively modest. Until the 1960s, it had been the received wisdom of port authorities worldwide that their dredging programs should provide about an extra foot of depth every 25 years or so. It is not considered that port developments in the years 2020 and 2060 will represent constraints to ship size per se as it is envisaged that both port capacities and ship sizes will change as a function of commercial trade considerations and shipping economics. Successive generations of the same ship type in the past were typically about one knot faster.

- Secondly, there is change arising from market forces which ultimately reflects the wishes of shippers. This has frequently been dramatic. The growth in tanker sizes is the best example. Prior to the 1974 oil price rises, tankers of 500,000 DWT had been ordered. Subsequent market events have reversed the trend, with future new buildings likely to be typically of a maximum size of about 300,000 DWT. High fuel costs precipitated the adoption of low speed diesel engines and the phase out of steam turbine driven vessels. In the liner or general cargo sector, speeds were increasing dramatically in the early phase of containerization, but again the trend was reversed in the era of high oil prices.

8.2.6 Hull Forms

No changes are envisaged with respect to bulk ship types as mono-hulls are considered to be the most serviceable. With regard to containerships, it is possible to envisage the development of multi-hull vessels as dimensions widen and given the need also for higher speeds than in the bulk sector. The trend in vessels such as passenger ships is towards higher superstructures and faster multi-hull craft. The development of SWATH (small water plane twin hull) ships is particularly relevant to ferries and ships designed for naval purposes where stability is a particular requirement. [illegible] catamarans will lead to [illegible]

However such vessels are not very fast (around 15 knots) and not suitable for container ships. Neither is the design appropriate for bulk ship types. There is seen to be a rising trend in the employment of fast semi-displacement type craft, for example on short haul ferry routes. However, currently these operate successfully only in calm seas and vessels will need deeper hulls and more power to operate in the deep sea. It is not believed that this type of design could replace, for example, small conventional general cargo ships. The latter retain all the advantages of low costs, simplicity and reliability.

8.2.7 Size of Ships and Number of Crew

Technology must be economically and/or commercially viable before it is adopted by practical shipowners. The size of ships and the number of the crew are two decisions which are based on these criteria. They also have important technical aspects, and are considered in this study.

Reduction in crew numbers has been universal, but the current size of crew on new ships depends on the ship type and the particular shipowner's policy on the trade-off between crew cost and the cost of the automation which replaces crew members. Even in a conservative scenario, it is important to address the question of whether, in the long time-scale to 2020 and 2060, it is likely that the process will be taken to its ultimate, and crewless ships will make their appearance. The assumption, for the purposes of this single scenario, is that they will not. While there are already, for example, large reefers operating with 6 crew it is likely to be a long time before manning levels generally fall below 10-12. Further out in time crew sizes of around 5-6 people may become the norm. However, difficulties currently experienced in the automation of main propulsion machinery and the psychological problems associated with crew leading an isolated existence at sea for long periods make it doubtful that crews realistically could be reduced below this number.

With respect to full automation, the critical point is whether the marine collision avoidance function can be automated with 100% certainty of there being no accidents. There is also the question of whether the concept will be politically acceptable.

Aircraft and submarines are able to manoeuver in three dimensions, because each operates within a fluid environment. Ships operate at the interface of two fluids, air and water, which constrains their manoeuvering to two dimensions. In narrow seas, and even occasionally in the open ocean, multiple collision risks must be dealt with at any one moment. Indications are that the collision avoidance function at sea is nowhere near being automated to the degree of security which a safety- and pollution- conscious public demands.

It might be argued that existing technology could be used to bring about crewless ships if the regulatory environment of shipping were to be replaced by a new system which imposed rigorous traffic separation and control on ships at sea. This is, however, a political and economic question, for traffic separation and control require international agreement and impose cost penalties. There is no indication that governments are willing to change the traditional freedom of the high seas in the interest of creating an environment in which crewless ships would be possible, nor is there any indication that such an attempt would be successful. Neither is there any indication that shipowners or their customers are ready, or will be ready in the future, to accept the implied cost penalties.

8.2.8 Environmental Impact and Safety Issues

This is one important area in which governments and public opinion are ready to force technological change on shipowners - that is, change in the interests of preserving the environment from damage and, to a lesser extent be it said, in the interests of the safety of life at sea. In 1991, attention focuses on anti-pollution measures being enforced unilaterally by the United States. These measures are already affecting the world tanker fleet, and a version of them is likely to be adopted by all the economically advanced nations well before 2020. Controls on emissions from ship stacks both within port areas and at sea also can be envisaged, particularly in view of the generally high sulphur content of main engine marine fuels.

One of the major safety issues is the high number of losses of dry bulk carriers recorded in the past two years. While the findings of investigations to date may result in a tightening up of loading and ship inspection procedures and possible changes in the design of larger dry bulk carriers, it is difficult to envisage the adoption of measures having sufficient international support to significantly impact on the phase out with age of the existing fleet. In the tanker sector, larger and older vessels do not represent a greater environmental/safety risk per se and this can be supported by the results of investigations into collisions and other incidents. However, over and above the requirements of the US Oil Pollution Act (OPA). and similar legislation likely to be enacted elsewhere - recent tanker accidents will result in the progressive introduction of more stringent inspection and operating procedures.

8.2.9 Marine Fuels

The availability and cost of present marine fuels must be considered in this general discussion. The assumptions of this report on the future energy scenario are discussed in the context of the trade forecasts. Increasing scarcity of liquid hydrocarbons will lead to

higher prices for marine fuel oil and marine diesel, to the point where alternative sources of propulsive power are substituted for them. Wind power and nuclear power are two possible alternatives, the technological viability of both being well-proven. Wind power however has insuperable disadvantages for modern shipping. Its contribution will be marginal at most. Nuclear power is not trusted by a public opinion which will in future be more, not less, environmentally conscious. Given the advances that are being made in automobile engine technology it is conceivable that the long term will see the development of hydrogen powered marine propulsion units. However, it is too early to assess realistically what this will mean in terms of speeds, fuel consumption and costs.

The remaining alternative to oil fuels is coal. The coal is there. The technology is practically identical to that used by coal-fired power stations. Several coal fired ships have in fact been built, for specific services in which the advantages of coal made themselves felt, since the oil price rises of 1973-4 and 1978-9. Any return to coal-firing would not amount to dramatic technological change. The infrastructure is not in place, but if the relative costs of oil and coal for marine propulsion were right its creation would not be a particularly demanding task.

The cost of a coal burner will always be higher - up to 30% - than the diesel engined ship because of coal handling, ash handling and loss in deadweight earnings due to heavier and more spacious bunkers. Under the energy scenario utilized in this study it is not envisaged that there will be an economic incentive for coal fired vessels. For this reason, although intrinsically interesting, it is not a significant consideration with respect to the development of an alternative Panama Canal.

8.2.10 Speed and Propulsion

The effects of the oil prices rises of 1973-74 and 1978-9 were far-reaching, affecting national economies in many ways, leading to changes in world-wide sourcing patterns for fuels, and to other, more general effects on the pattern of world seaborne trade. From the point of view of the shipping industry, the key facts about the price rises were their magnitude - a step increase each time - and their suddenness. Between 1978 and 1984, many separate measures were taken to achieve significant propulsion cost savings in commercial ships. In the cases of some ship types, it is possible to say that ships built before about 1984 have an element of economic obsolescence, which is reflected in their second-hand prices. In the tanker sector, there has been a progressive phase out of turbine powered vessels in favor of motor ships.

It is believed that the dramatic changes in propulsion economics which have been embodied in the most modern ships being built in 1991 embrace all that is easily possible. From now on, some progressive improvements are foreseen, but no step increase in propulsion efficiency such as distinguishes ships designed before 1984 from those designed after that year.

It is predicted, for example that the development of further energy saving devices, associated with vessel hydrodynamics, in bulk ship types could improve fuel efficiency by something of the order of 13%. For higher speed vessels with a conventional hull form, such as reefers, the potential savings might be in the region of 5-6%. For passenger ships this figure is likely to be as low as 1 or 2%. Potential improvements in engine room efficiency may be limited as current technology is be-devilled by high implementation and maintenance costs, and savings may be relatively small unless there are significant fuel price increases.

In considering alternative propulsion systems, for bulk ship types there is as yet no serious competition to the slow speed diesel. For high speed ship types where weight is a consideration, the development of gas turbines with their improved power to weight ratios may offer an alternative to medium speed diesels. Emerging technologies such as super-conducting electro-magnetic propulsion - also known as magneto hydro dynamic propulsion - are not expected to have any significant impact until at least after 2030. In the meantime the very significant problem of how to screen crews and marine life from the effects of the magnetic waves remains to be solved.

Provided future changes to oil prices are gradual and progressive, it is thought for general cargo ship types that the trend of ship speed increasing moderately as generations of ship types succeed each other will be resumed, but starting from the new base. This is defined by assuming that the ships on order in 1991 will represent the average technology of the commercial fleet in the year 2020. Thereafter, it is assumed that, other things being equal, average speeds increase by one knot every twenty years. Between 2020 and 2060 this trend in speeds of general cargo ships is expected to be continued accompanied by further savings in fuel consumption rates. Significant changes in the speeds of bulk ship types, for which vessel transit times are of lesser importance, are not envisaged although on-going improvements in full consumption efficiencies are envisaged.

8.2.11 Fundamental Principles of our Scenario

In light of the above discussion, it has been decided to adopt the following principles in developing, for particular ship types, a scenario on technical, or, to be more exact, techno-

economic, changes likely to be achieved during the period for which we are developing forecasts allowing for reductions in fuel consumption and increases in vessels speeds where relevant;

- remembering that some ships on order in 1991 will still be operational in the year 2020, we assume that the levels of technology incorporated in the newest ships of 1991 will be the average level of technology in the year 2020 allowing for reductions in fuel consumption and increases in vessel speeds where relevant;

- Between 2020 and 2060, it is assumed that the 2020 level of technology will persist, excepting only cases where good reasons can be seen, now, to assume that change will be made or continue. One thing that can be said now is that there is likely to be a continuing change in the area of crew costs for all ship types through a combination of rising economic standards in developing countries, an increasing level of technical training required for crews and a reduction of crew sizes. This will see the eventual disappearance of cheap, third world labor from the global fleet. There may not be a return to employing nationals aboard national ships, but there will no longer be good reasons for not employing them.

8.3 Global Fleet Forecasts

8.3.1 Introduction

In this section we describe the potential development of the global fleet by ship type and size and likely influences which worldwide developments will have on the size and type of ship using the Panama Canal, both for the status quo and alternative cases. In addition, consideration is given to the extent to which the development of the Canal under cases 2 to 5 could influence the size and composition of the world fleet, although it is thought that this will only be significant in the case on dry bulk carriers and full container ships. The results of this work are used to determine also the vessel sizes for which estimated freight costs are required for Panama and alternative by pass routes.

The results of the RLA analysis for Panama-specific and World fleet projections are presented in Tables 8.1 to 8.21. For each ship type and alternative case, fleet projections, average vessel sizes and vessel size distributions for 2020 and 2060 are shown by DWT size range.

The following sections provide descriptions of anticipated developments by ship type. However, for each ship type a general approach has been taken to the development of 2020 and 2060 scenarios for vessel supply which is summarized below:

- A detailed analysis of the 1990 fleet has been undertaken for each of the cargo carrying ship types defined in this study in order to determine the composition of the global fleet in terms of average deadweight and deadweight distribution by size range and year of build. For most ship types analyses have been compiled from individual ship listings. For container/breakbulk vessels in particular this has been essential as published aggregated data for this ship type vary significantly by source dependent on the exact definition adopted. For the purpose of this study container/breakbulk or 'semi-container' ships are defined as vessels with or without fixed cell guides which according to their owners or operators have rated TEU capacities. Individual ship data have also been used to determine relationships between deadweight and, variously, Panama Canal Net Tonnage, Gross Registered Tonnage, Net Registered Tonnage, TEU capacity, speed and consumption by age range.

- Global trade data have been organized into groupings that broadly match ship type definitions and vessel movements data.

- Global trade estimates for 1990, 2020 and 2060, by ship type, size and route have been multiplied by representative mileages for each trade and vessel size to determine estimates of ship demand by size expressed in ton-miles. The results have been used to project the growth in global vessel supply for each of the cases considered.

- For general cargo ship types, consideration has been given in the development of supply projections to the extent to which certain vessels - such as full container and container/breakbulk ships - will continue to displace others, for example RoRo and conventional general cargo ships.

- Historical trends in vessel size distributions and changes in average deadweights within size ranges have been analyzed to determine potential future developments. Analyses have been based on the composition of the existing world fleet, the new construction order book and historical time series data provided by the Japanese delegation to CAS which is understood to be based on information provided by Lloyds. In some instances it has been

necessary to amend and supplement this information with other data from RLA.

- Because simple trend analysis does not adequately capture structural changes in the shipping industry, consideration has also been given to future changes in the components of trade flows which would impact upon future vessel size distributions and changes in average deadweights within size ranges. The results of the analyses of vessel size distributions are input into both the projections of global ship demand by route and size and Panama Canal transit forecasts, as are the conclusions relating to average deadweights within size ranges.

8.3.2 General Cargo Ship Types

The term general cargo ship types as defined here covers container/break bulk ships, full container ships, conventional general cargo vessels, refrigerated ships (reefers), roll-on roll-off (roro) ships and vehicle carriers. These vessels are considered as a group since there is a degree of interchangeability between these ship types. Taking into account the relative merits of each ship type and the potential for further substitution of one vessel type for another, anticipated trends may be summarized as follows:

- continuing penetration of containerization;

- a relative decline for RoRo ships which, on long international voyages, have failed to live up to the original expectations of operators once the special circumstances for which they were best suited, such as port congestion, had been ended;

- continuing development of larger container ships as trade volumes increase and as economic factors allow. In 1990, the largest container ship could carry about 4,400 TEU. There are technical reasons why a gradual development beyond this size is unlikely and the industry expects the next development to be a step increase to ships of about 6,000 TEU when conditions are right;

- a continuing role for smaller ships. As trade on particular routes grows, it is tempting to postulate trade moving to ever larger ship sizes, with a decline in the role of the smaller ones. It is our view that as today's routes develop, so economic growth will lead to a new set of lesser ports and routes joining

international trade. These ports and routes will continue to offer employment to the smaller classes of ship.

Projections of global supply were determined on the basis of estimates of future demand growth as described in section 8.3.1 initially applying global trade growth rates for 1990-2020 and 2020-2060 for a given commodity and pair of trading partners to that commodity and origin/destination pair in the FY 1990 Panama Canal data. These market shares were then adjusted in line with the above assumptions with the result that some demand for conventional general cargo ships and roro's was transferred to container/break bulk and full container ships. The net result, after adjusting for different vessel efficiency factors is summarized below:

Global Fleet Development of General Cargo Ship Types

million DWT

Ship Type	CB	F*	G	R	RO	V
1990	23.3	31.1	30.3	7.4	5.2	2.7
2020	91.8	79.1	58.5	13.5	5.8	4.6
2060	149.8	147.5	80.6	21.1	5.9	5.0

% per annum

1990-2020	4.7	3.2	2.2	2.0	0.4	1.8
2020-2060	1.2	1.6	0.8	1.1	"	0.2
1990-2060	2.7	2.2	1.4	1.5	0.2	0.9

* status quo Canal
" less than 0.05% per annum

Container/Break Bulk Ships (Tables 8.1 and 8.2)

Container breakbulk, or semi-container ships, are one of the two beneficiaries of our assumptions of a relative decline in the roro and conventional general cargo ships in the period to 2020 and 2060. We envisage them as the future general purpose or residual ship. In spite of the assumed increase in their importance, we envisage no dramatic increase in size. This is because of the following factors:

- a major role for these ships is that of feeder vessels to the major containerized trades. Being largely intra-regional, this role does not show up significantly in our inter-regional trade statistics. Relative smallness is implied in this role. As volumes increase, the answer is not bigger container/breakbulk ships but a switch to full container ships;

- the ships are designed to carry a mixture of containerized and conventional cargo. Similar constraints to those described in relation to conventional general cargo ships (see below) apply to the container/breakbulk ships in so far as they are laden or part laden with conventional cargo.

Full Container Ships (Tables 8.3 and 8.4)

In the last twenty to twenty five years, containerization has become the normal method of transporting high value general cargo by sea. Considerable quantities of low value or otherwise apparently unsuitable goods are also carried in containers, depending on the circumstances of particular trades. We do not foresee any new development in deep sea general cargo shipping in the period to 2060 which may reasonably be postulated to have an impact equivalent to that of the container revolution which is still in progress.

The original container ships were conversions. Since purpose designed container ships began to be built, there has been a steady evolution in size to the present 4400 TEU 'post Panamax' vessels. (There are also Panamax designs with this rated capacity but it is uncertain the extent to which these are able to transit the Canal fully laden). At the same time, a wide spread of sizes of vessels is deployed by operators on the world's major routes. This to some extent is a function of supply and the existence of modern smaller vessels since the full container ship fleet is relatively young and very few purpose built container ships have been scrapped. It is also likely that the major trade routes offer opportunities for different sized vessels to pursue different market segments.

The present largest class of vessels, and there are not many of them, appear to stand at a break point of size evolution. Any significant increase in size would require a switch to twin screw propulsion, the extra cost of which could not be recouped without a step increase in capacity. The expectation in the industry is that the next generation of full container ships above 4400 TEU will be about 6000TEU.

For our forecast of the future fleet of full container ships we have carefully considered technical factors and the potential development of future trade, paying particular attention

to the world's top twenty routes. In summary, we envisage:

- full container ships of 6000 TEU will be at sea by 2020, and of 9000 TEU capacity by 2060;

- in 2020, the 6000 TEU ships will be carrying cargo equivalent to 30% of the annual cargo on the top twenty global routes, excluding those which transit the Panama Canal. This assumption is consistent with the share which the current largest class of ship has on these route in 1990.

- in 2060, forty years' experience of larger vessels will lead to their having a larger market share, 60%, again calculated by reference to the top twenty routes excluding those which pass through Panama. Containerships of 9000 teu will be at sea before 2060, but their activities will be confined to the busiest routes. We assume that in 2060 the participation of 6,000 teu ships in the carriage of containers will be equal to 35% of 60% of the cargo on the top twenty routes excluding those which transit Panama, and that 25% of 60% will be taken by the 9,000 teu ships.

Within size classes, excluding those which contain the postulated new, very large sizes, we in general assume little change in the average deadweight. This is because containerships 'cluster' around certain popular size classes expressed in teu's. These size classes relate to the sizing of berth and terminal facilities, and in particular to the dimensions of gantry container cranes. Such factors are likely to be fairly static, and we expect future world containership fleets to compromise a mixture of sizes, as is the case in 1990.

Globally, the variables which determine the future demand and supply of Full Container ships are trade volumes on major routes, the extent to which there will be further switches from other general cargo ship types to Full Container vessels in the future and techno-economic changes. There are a few major general cargo routes which involve substantial Panama Canal transits for Full Container vessels. On these major routes however, consideration has been given to the effects of Panama Canal constraints on the global fleet in the status quo case together with the further switching of cargo from the Canal routes to by-pass routes because of a further deterioration in the competitive position of the Panama Canal. For Cases 2 and 3, consideration has been given to the extent to which cargo may be revert to all water routes through the Canal through changes in relative transportation economics between the Canal and by-pass routes. In these instances, the global vessel supply forecasts reflect the changes in vessel demand that result from changes in the vessel

size distribution of Full Container transits through the Canal.

Conventional General Cargo Ships (Tables 8.5 and 8.6)

Conventional general cargo ships are difficult to deal with in this, or any other, forecast. They take part in a number of markets. They may be used on a liner operation, or at the other extreme they may carry homogeneous cargoes of bulk commodities on a voyage charter basis. They may be thought of as a residual, in that they carry what is not carried by the other ship types. The type is disproportionately important within some regions. This applies for example in the intra-regional trades of the Far East, SE Asia and the Mediterranean, but the inter-regional statistics used in this study do not bring out this role. World-wide, there is a current surplus of such tonnage, one specialized container ship is able to do the work of eight to fifteen conventional ships. The ships are old by world standards, three quarters of them being over 10 years of age in 1990. The demise of the type has been predicted for years.

It is our view that the ship has a future. As the ports and regions taking part in world trade in the 1990's expand under the influence of economic growth, new ports and regions will begin taking part in world trade, so that the demand for non-specialized ships to trade to smaller and less well equipped ports will always be there. Similarly, there will be a need for ships for intrinsically or commercially uncontainerizable cargoes. We do postulate, however, increasing penetration by containerships, and it follows that the role in 2020 and 2060 of conventional general cargo ships will be relatively less than in 1990.

In 1990, well over 99% of general cargo ships were in the two lower categories of deadweight, and we see no reason to make different assumptions for the future. Within those deadweight classes, we postulate slow growth of the average deadweight of the smallest class, and an average deadweight in 2020 in the 10,000 to 24,999 deadweight class, equal to that of the larger such ships being built in recent years. This is because of the economic constraints on the size of this ship type arising from the time in port needed for loading and discharging by conventional handling methods. This constraint on general cargo ships will not disappear. Insofar as a particular trade is released from the constraint, it will be because the commodities have switched to unitised packaging, such as containers, and a different ship type will be in use.

Refrigerated (Reefer) Ships (Tables 8.7 and 8.8)

The world fleet of reefer ships in 1990 was confined to the two smaller size classes used in our analysis. This relatively small size for the ship type is the result of the need for many types of refrigerated produce to be loaded at relatively small ports with small quantities of accumulated exports, of the quantity of perishable foodstuffs which are demanded at any one time at the point of destination, and of refrigeration technology both on the ship and ashore. These factors have limited the expansion of ship size in the past and, with some movement from the smaller to the larger size range is expected to continue in the future. Average deadweights are also expected to increase slightly over the period under review.

Of current concern in the industry is the extent to which refrigerated containers will take over some of the role of dedicated reefer ships in the future. The mass transport of bananas in containers for example could drastically alter the quantity of reefer ships demanded in the future. We note that reefer ships are already being built to carry a significant number of containers, and that containerization cannot be expected ever totally to replace dedicated reefer vessels. Our assumptions on tonnages available to reefer ships allows for some increase in reefer containers carried by container ships, but our general view is conservative in retaining a large role for reefers in the future.

RoRo Ships (Tables 8.9 and 8.10)

The deep-sea - as opposed to the short-sea - roro ship is an expensive ship type, able to carry containers and other cargo as well as vehicles and trailers. In the 1970's the ship type became popular in trades, such as those of the Arabian Gulf countries, where high volumes of high value goods were being imported at a time of congested ports. It competes with container ships for high-value cargoes, and is able to carry uncontainerizable project cargo. However, we note that:

- the whole concept of containerisable and non-containerisable cargo has evolved in a manner different from that foreseen in the early days of containerization. Whether a particular commodity is containerized or not is in practice dependent on the particular circumstances of a trade route rather that the inherent properties of a commodity. The roro's claimed advantage for non-containerisable cargo is not of overwhelming importance for the future.

- there is a near-consensus in the industry that, now that port congestion has been ended, roro ships for long international voyages are too capital intensive to compete

satisfactorily with other ship types.

We therefore postulate a relative decline for these ships in the future, as noted above. For the smallest size class we foresee some increase in average size, but for the larger size classes in which roro's are represented, we postulate a near static picture of the average DWT by size class.

Vehicle Carriers (Tables 8.11 and 8.12)

The world trade in motor vehicles is expected to change dramatically in the longer term. Regional production and distribution is expected to replace the 1990 pattern of trans-global trade. In these circumstances, we expect a continuing role for this ship type, but with much reduced average voyage lengths. This will not encourage significant increases in the average size of vehicle carrier, and we therefore assume no increase in the average size within DWT classes, nor any movement to larger size classes between now and 2060.

8.3.3 Dry Bulk Carriers and Combined Carriers in Dry Bulk (Tables 8.13, 8.14 and 8.15).

As it is intrinsically impossible to determine for such long term forecasts, the split in the global fleet between custom built drybulk carriers and combined carriers operating in the dry bulk trades, RLA have amalgamated the 1990 dry bulk carrier fleet with those combined carriers estimated to be operating in dry bulk during 1990 and have forecast developments in future global supply of these vessels together. It was calculated that, on average during 1990, 63% of the combined carrier fleet was trading in dry bulk. This compares to an annual average of 61% in the period from 1977 to 1990 which varied between 44% as a minimum to 72% as a maximum. The snapshot analysis of the 1990 fleet therefore represents a reasonable average in this respect.

Similarly, it is calculated that, in 1990, there was broadly a 16% surplus in vessel supply in this sector. This compares to an average of 18%, which varied between a minimum of 10% to a maximum of 24%, in the time period from 1977 to 1990. Again therefore, the 1990 average data represent a reasonable starting point for long term global fleet forecasts.
In order to determine future supply in total and by size range, the major routes from the WEFA trade data were amalgamated with data on laden dry bulk carrier and combined carrier sailings in dry by size range on a route by route basis. The data are predominantly a combination of proprietary information from Fearnley's database and RLA data.

These data were compared and combined with information on Panama Canal trades and

vessel size distributions for 1990 and the status quo Canal trade forecasts for 2020 and 2060. Assuming a 'status quo' Panama Canal, changes in the proportions of vessel size ranges on a route by route basis were made with reference to historical trends in the proportions of size ranges in the world fleet and to trends in volumes of future trade. In particular, the large forecast increases in coal trades suggests that there will be a continuing trend towards the use of larger vessels. It is estimated that on the major intercontinental routes, approximately 33% of coal is transported in vessels of 65,000 to 100,000 DWT. By 2020, this percentage is expected to reduce to broadly 11 percent and by 2060 to be reduced to virtually nil. This shift in coal trades is expected to counterbalance a trend for minor bulk and grain cargoes to be moved in vessels in this size and is responsible for the reduced proportion of the total, fleet occupied by these vessels in 2020 compared to 1990. By 2060 however, it is expected that the proportion occupied by these vessels will again increase. By 2060 it is also expected that the majority of trade in coal on major routes will be carried in vessels of 150,000 to 250,000 DWT and that this trend will already be apparent by 2020. A more gradual upward trend is expected in the proportions of large vessels carrying iron ore intercontinentally because of the lower growth rates expected in these trades.

At the lower end of the scale, the trend for vessels of 10,000 to 40,000 DWT to occupy a reducing proportion of the total fleet is continued. It is expected that this trend will not be so pronounced over the long term thirty year and seventy year forecasts as is apparent over, say, the past ten years. This is in part because of the substantial shift away of grain cargoes that has already taken place. It is also because experience from other shipping sectors suggests that while smaller vessels may decline as a proportion of the total fleet, continuing new demand arising from combinations of new products and new sub routes tends to support a continuing supply of smaller ships.

The proportion of vessels in the 40,000 to 65,000 DWT size range in the world fleet is expected to increase to 2020, assuming a status quo Canal but to decline marginally thereafter in response to the continuing shift of minor bulks and grains cargoes from this size range to vessels of 65,000 to 100,000 DWT.

Panama Canal trades occupy a small proportion of demand for vessels below 100,000. It is estimated that in 1990, on a laden ton mile basis, demand from dry bulk trades which involved Canal transits represented the following percentages of global demand on main routes which encompass over 90% of dry bulk trade:

[illegible]

Size Range (DWT)	Percentage
10,000 - 40,000	14.5
40,000 - 65,000	30.0
65,000 - 100,000	17.0
Total	**19.0**

From the table above it can be seen that, for dry bulk carriers and combined carriers in dry bulk trades within the size ranges 10,000 to 100,000 DWT inclusive, the total ton miles of routes which transit the Canal represent 19% in total of the global ton miles demand of vessels in this size range.

Nevertheless the Canal has an impact on average deadweights in the world fleet. As a result there is little discernible trend in the average deadweight of dry bulk carriers in the 40,000 - 65,000 DWT range globally and the deadweight of vessels in the 65,000 - 100,000 DWT size range has declined slightly in order to reflect more closely maximum Canal dimensions. Over the period to 2020 therefore, it is assumed that there will be little shift in the average deadweight of either of these size ranges of vessel in the global fleet. For the period 2020 to 2060, it has been assumed that there would be some, albeit slow, increase in the average deadweight of vessels in the 40,000 - 65,000 DWT size range.

With a 100,000 DWT Canal, there is likely to be an impact on the average deadweight of vessels in the global fleet in the 65,000 - 100,000 DWT size range. This would also be likely to shift some demand from 40,000 - 65,000 DWT ships into this size range.

For vessels in excess of 100,000 DWT, where major bulk demand and vessel supply is, as previously discussed, already established, the potential development of the Panama Canal is unlikely to have any significant impact on average deadweights. Based on historical analyses we do consider it likely that average deadweights in these larger size ranges will be subject to a secular drift upwards rather than be subject to dynamic change.

Variations in the fleet forecasts are therefore largely a function of the extent to which by pass traffic is routed through the Canal in each succeeding case and the subsequent impact on ton-mile demand.

8.3.4 Chemical Carriers (Tables 8.16 and 8.17).

WEFA trade data and forecasts on major routes have been analyzed and converted to global ton miles in order to determine the overall percentage increases in demand for these vessels over the time period. On this basis, demand is likely to increase by 200% between 1990 and 2020 and by 70% between 2020 and 2060.

There appears to be little discernible historical trend in changes in average deadweights or distribution shifts between size ranges in this fleet. However, within the size range 10,000 - 40,000 DWT in particular there is a multiplicity of vessel designs and sizes that reflect commercial requirements in specific geographical and product sectors. On specific routes, we expect that there will be a distribution shift from vessels towards the upper end of this size range to vessels in the range of 40,000 to 65,000 DWT. In particular, this is likely to occur on routes where there is a high incidence of lower value commodity chemicals carriage rather than specialty products.

The global distribution shift away from vessels of under 10,000 DWT is largely caused by the pattern of trade increases although demand for these vessels is underpinned by continuing commercial requirement for smaller vessels to carry higher value products.

There is no discernible trend in the average deadweight of vessels of 5,000 to 10,000 DWT. The increase in average deadweight of vessels in the 10,000 to 40,000 DWT range is based on the long term trend in the tanker sector to 2020 because of the interchangeability of these ship types at the margin, with continuing strong growth thereafter.

For the large vessels there is no trend and too few observations to develop a historical analysis. In addition, structural differences between the chemicals and oil tanker sectors are such that trends from the oil tanker sector cannot be applied. For 2020, an average deadweight of 45,250 tons has been assumed, which is the average of vessels delivered in this size range since 1980. Between 2020 and 2060, the same growth rates are assumed as for the 10,000 to 40,000 DWT vessels.

8.3.5 Gas Carriers (Tables 8.18 and 8.19)

Gas carrier trade which encompass a wide range of commodities - liquified natural gas (LNG), liquified petroleum gas (LPG), petrochemical gases and ammonia - are relatively insignificant in the context of Panama Canal Traffic and this is expected to remain the case

in future. Developments in LPG trade, the predominant component, are expected to follow the same trend apparent in the oil trades while it is not envisaged that any LNG trades will be attracted through the Canal. There is one LNG project under construction in Venezuela being developed jointly by Lagoven, Shell, Exxon and Mitsubishi. However the natural market for this gas is the Atlantic Basin with Far East markets seemingly well provided for by developments in the Middle and South East Asia. Moreover in discussions with Shell it became apparent that even to consider shipping LNG through the Canal would require some assurances with regard to the political and economic (toll charges) stability. As LNG projects are intrinsically long term (20 years) but require a large amount of front end investment they need stable environments in which to ensure a pay back.

For the above reasons and in the context of the study overall it is not considered to be justified to undertake detailed analyses of global developments in gas carrier demand and supply. It is considered sufficient to consider only potential developments in the average size of gas carriers in the global fleet and on Panama routes together with the distribution of deadweight by size range for Canal transits.

Size developments in the global fleet are not an appropriate model. Evaluation of historical time series data from 1977 - 1990, indicate substantial growth in the size ranges above 40,000 deadweight due to the growth of long haul LPG trades out of the Arabian Gulf and the development of LNG trades. Thus, above 10,000 deadweight the distribution of gas carriers by size range globally bears little resemblance to the percentage distribution for Canal trades.

Standard sizes of LPG and LNG carriers for certain types of business have become fairly well established globally and - particularly in the case of LPG vessels for which a downturn in trade in line with the oil sector in envisaged between 2020 and 2060 - no major developments on ship sizes are contemplated. Therefore for Panama routes, little or no change in average deadweights by size range or percentage distribution by size range are envisaged.

8.3.6 Crude Oil and Petroleum Products Tankers including Combined Carriers in Oil Trades (Tables 8.20 and 8.21)

For reasons described in section 8.3.3, the projection of the global fleet for oil tankers includes combined carriers trading in oil. As background, the existing world fleet of combined carriers is analyzed is Table 8.15. It is assumed that those combined carriers not employed in the dry bulk trades are actively employed in the carriage of oil.

The methodology employed in determining the potential future development of the global oil tanker fleet is the same as that adopted for dry bulk carriers although it is unlikely that the expansion of the Panama Canal will impact significantly on the size and composition of the global fleet. It is estimated that tanker demand on Canal routes represents between 1% and 2% of total world tanker demand. Therefore only one projection of the global tanker fleet for 2020 and 2060 has been made to cover all cases.

As with dry bulk carriers, 1990 is a representative year in terms of the balance in the market and is therefore a good reference point from which to project future developments. Based on global demand for tankers and combined carriers in oil trades alone, the surplus in this sector was equivalent to about 18% of supply. However, in overall market terms the surplus was slightly less due to the utilization of a portion of the fleet for floating storage. This is considered broadly representative of the average surplus that could be expected in the long term.

As the starting point in determining future supply, in total and by size range, RLA oil trade data for major routes were amalgamated with data on laden tanker and combined carrier sailings in oil by size range and on a route by route basis. Again, these data are predominantly a combination of proprietary information from Fearnleys and RLA databases. Trade forecasts for 2020 and 2060 were then sub-divided by ship size route by route on the basis of the 1990 tanker size distributions, adjusted for potential changes in future size distribution. These changes, in turn, were determined by evaluating time series data on the size and composition of the global fleet, the structure of the existing fleet and the new construction order book as well changes in the trade volumes.

Tanker demand by size range, expressed in terms of ton-miles, was determined for 1990, 2020 and 2060 for both these major global routes and the Canal trades previously identified in the transit database. The results were amalgamated to obtain total estimates of world tanker demand by size range. As described in section 4.3 these estimates have been used to determine tanker demand by size which have then been applied to actual 1990 tanker demand as determined by RLA's top down model. Global tanker supply projections are based on the resulting demand figures, allowing for a 15% market surplus.

Between 1990 and 2020 growth in Middle East oil exports and in imports into the developed and newly industrialized countries is projected to result in an increase in the proportion of tankers in the world fleet in excess of 250,000 deadweight from 34% to 45%. Between 65,000 deadweight and 250,000 deadweight the proportion is expected to fall from 47% to 37% with the decline particularly apparent at the upper end of this broad size band. Below

65,000 deadweight, it is anticipated that there will be only a marginal decline to about 18% in 2020. These trends are expected to be reversed in the period between 2020 and 2060 as the predominance of long haul trades between the Middle East and the developed countries - in particular those West of Suez - is eroded.

For tankers below 100,000 deadweight, future projections of average vessel size, by size range, have been determined largely from historical trends identified from the time series data provided by CAS. This means no expected change in the below 10,000 deadweight size range, but further growth in the sizes of tanker in the 10,000-39,999 and 65,000 - 99,999 deadweight size ranges. For vessels between 40,000 and 64,999 deadweight there are conflicting indicators. Historical data suggest a further increase in size but the new tankers in this size range are being built smaller than the 1990 average. Therefore no change has been assumed. For the larger vessel size ranges, historical data are less of a guide due to the rapid evolution of the fleet over the past twenty years. Above 250,000 deadweight little or no change is envisaged. Between 100,000 and 250,000 deadweight some increase in size is assumed based on observations of more modern ships and new construction orders.

8.4 Development of Ship Operating Costs and Seaborne Freight Costs

8.4.1 Introduction

The development of estimates of future seaborne freight costs on routes relevant to the Panama Canal serves a number of purposes:

- the determination of optimum routing patterns and ship sizes for trades relevant to the Canal;
- transportation costs;
- comparison of costs for different competing ship types within certain trades;
- in combination with land based transportation costs, the determination of the economics of utilizing the Canal versus alternative landbridge options;
- the assessment of Canal delay costs; and
- the costs of closing the Canal

The results of this work are used in the economic evaluations of by pass traffic described in section 7. The results giving hourly vessel delay costs, transportation costs by ship type, size and route for all cases for 2020 and 2060 and the annual cost of closure are included in section 10.

8.4.2 Approach

A detailed description of the proposed approach was included in both our initial proposal and the Inception Report. What follows is a brief re-statement of the philosophy behind the adopted approach and a more detailed description of the work that has been done in the development of the necessary operating cost data.

The approach is based on the fact that, where choice exists, decisions on whether or not to use the Canal are based on marginal economics - i.e. from the perspective of seaborne transportation costs they reflect market rates rather than owners' actual fully built up operating costs.

Ship market rates are of course related to operating cost structures. However, a review of market rates versus fully built up costs, including capital costs based on prevailing new construction costs as a yard stick, reveals that rates seldom represent full recovery of costs at the time. Over time average market rates for all ship types are at a discount to full operating costs.

Therefore the approach that has been adopted is based in the first instance on the estimation and projection of ship operating costs for the years 1990, 2020 and 2060. These estimates were adjusted to reflect 'market' rates. For bulk ship types (for example, tankers and dry bulk carriers) the basis for this adjustment were the historical relationships between market rates and operating costs for a representative operator by ship type and size. In order to take into account the inevitable peaks and troughs in these markets data has been assembled for the period 1978 to date in order to establish these relationships. A description of the RLA models used to develop long term freight costs is provided in the initial proposal and the Inception Report.

For the general cargo ship types market rate data are not as readily available and certainly not amenable to the construction of consistent time series data. Therefore an alternative methodology has been adopted but one that still is based on the premise that market rates do not equate to fully built up costs for new buildings. Wherever possible this approach has been validated by comparison with market data such as is available.

In the absence of comprehensive rate data it is argued that market levels reflect the operating costs of the representative vessel for each size range - in terms of age and operating characteristics - within each sector. Capital costs for these ships in 1990 are calculated on the basis of the vessels' second hand values taking into account the vessels' remaining lives. For future time periods account was taken of potential changes in the nature of these representative vessels. Future second hand values (and therefore capital costs) were projected with reference to forecast new building prices using the results of regression analyses that have already been undertaken to establish the relationship between second hand values and new building prices for given vessel ages.

Throughout the development of freight costs, consideration is also given to the phasing out of existing vessels and the introduction of ship types involving new technology and changed average sizes.

8.4.3 Development of Costs Estimates

In the course of analyzing the 1990 fleet, weighted average ships for each ship type/size range and age group have been determined. The mid point of each age range was weighted by number of ships and deadweight, and the average of averages was taken. These averages were examined to ensure that they were not obviously in disagreement with what may be called representative ships. For the container carrying ship types, the average TEU's and the relationship between TEU's and deadweights were calculated.

In summary therefore, for each size range of each ship type, the statistical average ship (age/size) is calculated. Cost estimates are for this average ship, unless it is obviously unrepresentative, in which case common sense selection of a representative ship has been made.

The classification of shipping costs is virtually standardized world-wide but:

- liner operations incur a different pattern of costs from that of the tramp or bulk trades; and

- the distribution of responsibility for individual cost categories varies depending on the nature of the charter arrangements if any.

A standardized approach is presented below.

Capital costs

Where appropriate these are based on secondhand values. The life of the ship (for financial purposes only) is assumed to be 20 years. Ships older than 20 years are represented by their 1990 scrap value.

The annual capital cost is entered for X years where X = [20 - age of ship]. The annual capital cost is the secondhand value * Annuity Factor * years at a discount rate of Y%. Y is determined as follows:

	Libor Rate	OECD Inflation	Real Interest Rate (Rounded)
1990	8.2	5.3	3.0
2020	5.9	3.4	2.5
2060	5.9	3.4	2.5

For all time periods, in addition to the real interest rate, the capital cost will have an additional 1.5% spread and a 5% profit margin. Therefore for 1990, the rate is 9.5% and for both 2020 and 2060 the rate is 9%.

The fleet in 2020 and 2060 has a different vessel mix from 1990. Current and historical newbuilding prices are regressed against secondhand prices to derive a relationship for use in forecasting future real second hand prices. An active second-hand market exists for most ship types, and usually sufficient prices are reported for them to be analyzed for study purposes. However, for the general cargo ship types, relevant data are not so readily available and additional statistical analyses were carried out. Reported prices of sales of vessels for further trading were subject to regression analysis, with scrap prices being taken as a 'floor' at and after the 20th year of the ship's life. Use was also made of a theoretical model of the way in which a new ship's price might be expected to decline to scrap value in year 20. This model took account of ships built since about 1984 being at a premium due to their improved propulsion and other efficiency.

Future newbuilding prices in real terms in the absence of technological changes could be expected to be as 1990 on the basis that:

- there will be a continuing shift of shipbuilding facilities to developing countries with relative low income per capita;

- no real price increases are forecast in shipbuilding raw materials;

- real increases in energy prices will be at least offset by production efficiency increases, for example, through the use of computer aided technology.

There will be additional newbuilding costs associated with the development of new shipboard technology. This is a small part of ship costs and, on a 1990 basis, is unlikely to exceed 5% of the capital cost of the vessel. Potential changes in tanker construction costs from the real 1990$ level (based on double hull construction) on the possible basis of additional steel for the hull structure and other effects of environmental legislation have also been taken into account.

Operating Costs

For purposes of this study, these are summarized into 4 main categories:

Manning
Repairs and Maintenance, Stores and Supplies
Insurance
Other and Overheads

(i) **Manning (includes wages, overtime, social security, leave, subsistence, training and catering costs).**

Unit costs are linked into assumptions on developments in ship technology and manning levels. Unit costs are forecast to increase in real terms to 2020 by 2% pa on average. This reflects decreases in manning levels caused by increasing levels of automation on board ship, an associated lack of availability of trained personnel and significant real salary increases over the shorter term above this average level already under negotiation. There will be a narrowing of the gap between developed and developing country crew costs but developed country crew costs will not remain the same in real terms for the reasons discussed above. Social security requirements for developing country crew wills be increased.

Between 2020 and 2060, manning costs are expected to increase by a further 1% pa in real terms.

Developments in manning levels are derived from the Bimco/International Shipping Federation report of 1990 entitled 'The Demand for and Supply of Seafarers'. Manning levels in 2020 for the average ship are assumed to decrease in line with changes in the 'standard' crewing assumptions for officers and ratings separately as provided for a range of existing ships and vessels built up to and around 2000. The level of decrease varies between ship type and size range. RLA have applied changes in costs for officers and ratings to assumptions on changes in manning levels to develop overall manning costs for each ship type/size range.

Between 2020 and 2060, it is assumed that there will be no further reductions in manning levels. This may well be a conservative assumption. However, this assumption is again linked to the assumption on the costs of changes in ship technology.

(ii) **Repairs and Maintenance, Stores and Supplies**

This includes drydocking on an annualized 2.5 year cycle, maintenance carried out by the crew, engine room and other spares.

Significant real increases are expected in this costs element over each of the next five years due to both cutbacks in maintenance expenditure by owners over the second half of the 1980s and due to real increases in costs of shiprepair work as the shiprepair yards seek to recover from previous low income levels. On an annualized basis, these costs are forecast to increase by 1% pa in real terms between 1990 and 2020 and to remain constant in real terms thereafter.

(iii) **Insurance**

Hull and machinery and protection and indemnity insurance are included here. The extent of P&I cover taken depends on the individual shipping company's policy but liner operators typically need more cover than do bulk operators. Shipowners practices on insured vessel value vary widely. Premia in all cases vary with the casualty record of the individual operator. As with other ship operating cost elements, 1990 values derive from RLA databases on ship operating costs which are themselves derived from empirical market research with a wide range of operators. Large increases in both H&M and P&I insurance premia are expected in the next two years assuming no policy changes on 'deductible' items. These large increases are translated into an assumption of 2% pa real increases between 1990 and 2020 and constant insurance costs in real terms thereafter.

(iv) Other and Overheads

Liner companies have a large commercial department, considerable port terminal expenditure, marketing and related expenses on and their overheads are much higher than those of bulk or tramp operators. Overhead cost levels for 1990 are derived from empirical market research with individual owners. Overhead costs for bulk or tramp operators are based on a combination of management fees and costs assuming a medium sized shipping company of around 8 vessels. It is assumed that cost items under this heading remain constant in real terms throughout the forecast period.

Voyage Costs

(i) Bunkers

Fuel oil and diesel oil costs for 1990 are a calculated average from monthly spot prices for 8 major bunkering ports worldwide. For 2020 and 2060, bunker prices are calculated from a combination of WEFA forecasts of crude oil prices and an RLA regression model which relates crude oil prices to bunker prices. For simplicity, it has been assumed that all vessels will burn one grade of main propulsion fuel oil, that is, 380cst. Values are as follows:

$1990/ton	1990	2020	2060
380cst	111.8	149.0	257.0
MDO	223.3	268.0	438.0

Over the forecast period it is assumed that there will be changes in fuel efficiency. Based on current technological research, for bulk vessels ie those vessels with low relative speeds, fuel efficiency is expected to improve by +/- 13% between vessels built in 1990 and the average vessel in 2020. For higher speed vessels such as container vessels a +/- 6% fuel efficiency is expected and for passenger vessels a +/- 2% improvement is expected. By the year 2060, a further 20% improvement in fuel efficiency across all ship types is expected due to engine room and other changes.

For container vessels, it is assumed that there will be a 2 knot increase in average speeds between 1990 and 2020 and a further increase in average speeds of 2 knots between 2020 and 2060.

(ii) **Port Costs**

1990 port costs have been derived from individual operator's experience in relevant areas. These costs are assumed to remain the same in real terms over the forecast period. For liner vessels operations, stevedoring costs are for the account of the line operator. For relevant vessels with a container capability and vehicle carriers, at import ports, delivery to the stack is a ship cost, inland costs are from the stack onwards. For exporting ports, this procedure works in reverse. For bulk vessels, all port costs are for the ship operator, landside delivery or collection to/from the port are inland costs.

(iii) **Cargo Claims and Commissions.**

The cost to a liner operator of cargo claims and commissions is too high to be ignored. They are difficult to estimate, because there is a trade-off between commissions and the shipowner conducting his own sales/marketing with higher overheads. We take a notional percentage of revenue of 9% in total.

System Costs

(i) **Container Acquisition (purchase or leasing) and Maintenance.**

For the liner operator, the total cost of acquiring and maintaining containers is significant, and it cannot be left out of a cost estimate. In reality, an operator acquires his containers from a mix of sources, one of them being short term leasing in order to be able to vary his costs under this item at short notice. Owners may operate their container fleet(s) as a whole for the company, or by route or service. We have assumed that the liner companies operate their container fleet in relation to the service, and treat it as a system cost allocated to the individual ship. Container acquisition costs have been included in the hourly delay costs provided in Table 10.1.

The cost assumptions are:

- all the containers are leased;

- 90% of the containers are dry cargo, general purpose boxes, and 10% are reefers;

- the daily cost (leasing and operating including insurance) is taken at US$3 per day for the dry cargo, and US$15 per day for the reefer containers. These costs have been pitched

between the actuals for 20 ft and 40 ft boxes, to make some arbitrary allowance for a mixture of sizes being used in practice.

Costs for 2020 and 2060 are assumed to be stable in real terms.

Table 8.1

ANALYSIS AND PROJECTIONS FOR THE GLOBAL CONTAINER/BREAK-BULK FLEET

Fleet as at 1990

Size (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
Year of Build							
Pre-1965	30172	407157	0	0	0	0	437329
1965 to 1969	188087	719742	25503	0	0	0	933332
1970 to 1974	587215	2763366	111892	0	0	0	3462473
1975 to 1979	1162893	8192376	81576	166666	0	0	9603511
1980 to 1984	866943	4534793	226125	123951	0	0	5751812
1985 to 1989	929953	1411430	28386	0	0	0	2369769
1990	271229	327092	0	0	0	0	598321
Total	4036492	18355956	473482	290617	0	0	23156547
% Distribution	17.4%	79.3%	2.0%	1.3%	0.0%	0.0%	100.0%
Average Age (Years)	11	13	13	12	0	0	12
Fleet Projections							
Year							
2020	15998231	72758447	1872426	1156499	0	0	91785603
% Distribution	17.4%	79.3%	2.0%	1.3%	0.0%	0.0%	100.0%
2060	26110029	118745953	3055907	1887472	0	0	149799361
% Distribution	17.4%	79.3%	2.0%	1.3%	0.0%	0.0%	100.0%

Source: RLA

Table 8.2

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: CONTAINER/BREAKBULK

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 100,000
AVERAGE DWT					
CASE 1 TO CASE 5 INCLUSIVE 65,000 DWT TO 300,000 DWT CANAL					
GLOBAL FLEET					
1990	4989	16316	27852	41517	
2020	5071	23500	28385	41690	
2060	5130	23500	28470	41810	
PANAMA CANAL					
1990 N	6250	15004	31124	41691	
1990 S	7663	15001	33919	0	
2020	7665	23500	28385	41690	
2060	7810	23500	28470	41810	

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 100,000
% DISTRIBUTION					
CASE 1 TO CASE 5 INCLUSIVE 65,000 DWT TO 300,000 DWT CANAL					
GLOBAL FLEET					
1990	17.4	79.3	2.0	1.3	
2020	17.4	79.3	2.0	1.3	
2060	17.4	79.3	2.0	1.3	
PANAMA CANAL					
1990 N	1.2	80.8	2.3	15.7	
1990 S	3.7	94.8	1.5	0.0	
2020 N	0.0	69.0	7.1	23.9	
2020 S	0.4	77.1	7.5	15.0	
2060 N	0.0	71.1	5.1	23.8	
2060 S	0.0	77.7	6.7	15.6	

Source: RLA

Table 8.3

ANALYSIS AND PROJECTIONS FOR THE GLOBAL FULL CONTAINERSHIP FLEET

Fleet as at 1990

Vessel Size (DWT) / Year of Build	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
pre-1965	23659	176231	0	0	0	0	199890
1965 to 1969	70651	554707	416692	0	0	0	1042050
1970 to 1974	468204	1477874	1870603	850792	0	0	4667473
1975 to 1979	778875	2124031	1548716	934616	0	0	5386238
1980 to 1984	861020	1438003	3520213	1723662	0	0	7542898
1985 to 1989	427844	1315880	2454343	5019481	0	0	9217548
1990	61763	754568	526831	1616286	132960	0	3092408
Total	2692016	7841294	10337398	10144837	132960	0	31148505
% Distribution	8.6%	25.2%	33.2%	32.6%	0.4%	0.0%	100.0%
Average Age (Years)	13	12	11	7	1	0	11

Fleet Projections

Year							
Case 1: 65,000 DWT Canal							
2020	6269098	18246001	24056578	23613867	6869920	0	79055464
% Distribution	7.9%	23.1%	30.4%	29.9%	8.7%	0.0%	100.0%
2060	10445466	30406928	40085213	39332785	15564924	11699512	147534829
% Distribution	7.1%	20.6%	27.2%	26.7%	10.5%	7.9%	100.0%
Case 2: 100,000 DWT Canal							
2020	6269098	18246001	20602378	20179987	13709920	0	79007384
% Distribution	7.9%	23.1%	26.1%	25.5%	17.4%	0.0%	100.0%
2060	10445466	30406928	33530333	34527985	27084924	11699512	147695148
% Distribution	7.1%	20.6%	22.7%	23.4%	18.3%	7.9%	100.0%
Case 3: 150,000 DWT Canal							
2020	6269098	18246001	16987588	16588697	20867920	0	78959304
% Distribution	7.9%	23.1%	21.5%	21.0%	26.4%	0.0%	100.0%
2060	10445466	30406928	26742163	29193835	33834924	16879512	147502828
% Distribution	7.1%	20.6%	18.1%	19.8%	22.9%	11.4%	100.0%

Source: RLA

Table 8.4
DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: FULL CONTAINERSHIPS

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
AVERAGE DWT						
CASE 1: 65,000 DWT						
GLOBAL FLEET						
1990	5764	17158	31231	48080	66480	0
2020	6620	19340	31230	48080	90000	0
2060	7160	19370	36400	56000	90000	148000
PANAMA CANAL						
1990 N	9141	19969	32800	46483		
1990 S	6856	18592	32509	49651		
2020	8740	19340	32660	48080		
2060	0	19370	36400	56000		
CASE 2: 100,000 DWT						
GLOBAL FLEET						
2020	6620	19340	31230	48080	90000	0
2060	7160	19370	36400	56000	90000	148000
PANAMA CANAL						
2020	8740	19340	32660	48080	90000	
2060	0	19370	36400	56000	90000	
CASE 3 TO CASE 5 INCLUSIVE 150,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
2020	6620	19340	31230	48080	90000	0
2060	7160	19370	36400	56000	90000	148000
PANAMA CANAL						
2020	8740	19340	32660	48080	90000	0
2060	0	19370	36400	56000	90000	148000

Table 8.4 (Cont'd)

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: FULLY CONTAINERISED

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
% DISTRIBUTION						
CASE 1: 65,000 DWT						
GLOBAL FLEET						
1990	8.6	25.2	33.2	32.6	0.4	0.0
2020	7.9	23.1	30.4	29.9	8.7	0.0
2060	7.1	20.6	27.2	26.7	10.5	7.9
PANAMA CANAL						
1990 N	0.3	12.3	52.9	34.5		
1990 S	0.5	16.0	58.9	24.6		
2020 N	0.0	11.6	37.8	50.6		
2020 S	0.2	10.0	44.8	45.0		
2060 N	0.0	14.6	35.5	49.9		
2060 S	0.0	10.3	43.4	46.3		
CASE 2: 100,000 DWT						
GLOBAL FLEET						
2020	7.9	23.1	26.1	25.5	17.4	0.0
2060	7.1	20.6	22.7	23.4	18.3	7.9
PANAMA CANAL						
2020 N	0.0	11.5	29.5	30.4	28.6	
2020 S	0.2	9.7	41.3	22.0	26.8	
2060 N	0.0	13.5	28.9	26.4	31.2	
2060 S	0.0	8.1	34.7	24.8	32.4	
CASE 3 TO CASE 5 INCLUSIVE 150,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
2020	7.9	23.1	21.5	21.0	26.4	0.0
2060	7.1	20.6	18.1	19.8	22.9	11.4
PANAMA CANAL						
2020 N	0.0	11.5	29.5	30.4	28.6	0.0
2020 S	0.2	9.7	41.3	22.0	26.8	0.0
2060 N	0.0	13.5	28.9	26.4	19.0	12.2
2060 S	0.0	8.1	34.7	24.8	20.8	11.5

Source: RLA

Table 8.5

ANALYSIS AND PROJECTIONS FOR THE GLOBAL CONVENTIONAL GENERAL CARGO FLEET

Fleet as at 1990

Vessel Size (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
Year of Build							
pre-1965	1513915	1165614	0	0	0	0	2679529
1965 to 1969	2999620	3125276	0	0	0	0	6124896
1970 to 1974	4128777	4551636	0	0	0	0	8680413
1975 to 1979	4058233	2777942	80917	0	0	0	6917092
1980 to 1984	3606254	39210	0	0	0	0	3645464
1985 to 1989	1577708	193910	116531	0	0	0	1888149
1990	329440	23000	0	0	0	0	352440
Total	18213947	11876588	197448	0	0	0	30287983
% Distribution	60.1%	39.2%	0.7%	0.0%	0.0%	0.0%	100.0%
Average Age (Years)	15	19	8	0	0	0	16

Fleet Projections

Year							
2020	35206633	22953975	380517.3	0	0	0	58541125
% Distribution	60.1%	39.2%	0.7%	0.0%	0.0%	0.0%	100.0%
2060	48467261	31599622	523839.7	0	0	0	80590723
% Distribution	60.1%	39.2%	0.7%	0.0%	0.0%	0.0%	100.0%

Source: RLA

Table 8.6

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: CONVENTIONAL GENERAL CARGO

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
AVERAGE DWT						
CASE 1 TO CASE 5 INCLUSIVE 65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	3725	14005	32908			
2020	3835	22000	36230			
2060	3915	22000	36230			
PANAMA CANAL						
1990 N	5689	15275	29913			
1990 S	5778	15158	30658			
2020	5735	22000	36230			
2060	5810	22000	36230			

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
% DISTRIBUTION						
CASE 1 TO CASE 5 INCLUSIVE 65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	60.1	39.2	0.7			
2020	60.1	39.2	0.7			
2060	60.1	39.2	0.7			
PANAMA CANAL						
1990 N	22.1	68.8	9.1			
1990 S	22.0	70.1	7.9			
2020 N	12.3	74.3	13.4			
2020 S	15.2	70.2	14.6			
2060 N	14.1	73.2	12.7			
2060 S	17.3	70.3	12.4			

Source: RLA

Table 8.7

ANALYSIS AND PROJECTIONS FOR THE GLOBAL REFRIGERATED SHIPS (REEFERS)

Fleet as at 1990

Vessel Size (DWT)	0 – 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
Year of Build							
pre-1965	274317	10014	0	0	0	0	284331
1965 to 1969	775047	152739	0	0	0	0	927786
1970 to 1974	853812	521555	0	0	0	0	1375367
1975 to 1979	915363	391284	0	0	0	0	1306647
1980 to 1984	1209577	517670	0	0	0	0	1727247
1985 to 1989	996340	418862	0	0	0	0	1415202
1990	262460	147823	0	0	0	0	410283
Total	5286916	2159947	0	0	0	0	7446863
% Distribution	71.0%	29.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Average Age (Years)	13	11	0	0	0	0	13

Fleet Projections

Year							
2020	6878802	6609046	0	0	0	0	13487848
% Distribution	51.0%	49.0%	0.0%	0.0%	0.0%	0.0%	100.0%
2060	8221896	12859888	0	0	0	0	21081784
% Distribution	39.0%	61.0%	0.0%	0.0%	0.0%	0.0%	100.0%

Source: RLA

Table 8.8

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: REEFERS

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
AVERAGE DWT						
CASE 1 TO CASE 5 INCLUSIVE						
65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	4789	11868				
2020	5545	13730				
2060	6130	15540				
PANAMA CANAL						
1990 N	7264	12177				
1990 S	7262	12122				
2020	8415	13730				
2060	9530	15540				

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
% DISTRIBUTION						
CASE 1 TO CASE 5 INCLUSIVE						
65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	71.0	29.0				
2020	51.0	49.0				
2060	39.0	61.0				
PANAMA CANAL						
1990 N	54.8	43.7				
1990 S	54.3	45.7				
2020 N	35.5	64.5				
2020 S	31.1	68.9				
2060 N	16.6	83.4				
2060 S	14.8	85.2				

Source: RLA

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Table 8.9

ANALYSIS AND PROJECTIONS FOR THE GLOBAL BORO FLEET

Fleet as at 1990

Vessel Size (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
Year of Build							
pre-1965	5283	0	0	0	0	0	5283
1965 to 1969	77738	0	0	0	0	0	77738
1970 to 1974	395142	221519	0	0	0	0	616661
1975 to 1979	921481	885059	434745	0	0	0	2241285
1980 to 1984	518181	553588	105731	302479	0	0	1479979
1985 to 1989	348308	249344	26523	0	0	0	624175
1990	71754	40912	0	0	0	0	112666
Total	2337887	1950422	566999	302479	0	0	5157787
% Distribution	45.3%	37.8%	11.0%	5.9%	0.0%	0.0%	100.0%
Average Age (Years)	13	11	13	9	0	0	13

Fleet Projections

Year							
2020	2452882	2219274	350142	817627	0	0	5840195
% Distribution	42.0%	38.0%	6.0%	14.0%	0.0%	0.0%	100.0%
2060	2498210	2260285	356887	832737	0	0	5948118
% Distribution	42.0%	38.0%	6.0%	14.0%	0.0%	0.0%	100.0%

Source: RLA

Table 8.10

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: RORO

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
AVERAGE DWT						
CASE 1 TO CASE 5 INCLUSIVE 65,000 TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	4362	16529	31500	43211		
2020	5785	16550	31115	44190		
2060	6990	16550	31120	44190		
PANAMA CANAL						
1990 N	5350	16116	32020	44029		
1990 S	5234	17059	30253	44034		
2020	5785	16550	31115	44190		
2060	6140	16550	31120	44190		

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
% DISTRIBUTION						
CASE 1 TO CASE 5 INCLUSIVE 65,000 TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	45.3	37.8	11.0	5.9		
2020	42.0	38.0	6.0	14.0		
2060	42.0	38.0	6.0	14.0		
PANAMA CANAL						
1990 N	4.8	38.9	28.4	27.9		
1990 S	3.3	36.9	36.0	23.8		
2020 N	0.0	54.2	40.2	5.6		
2020 S	0.1	27.8	27.3	44.8		
2060 N	0.0	54.2	40.4	5.4		
2060 S	0.0	28.1	26.5	45.3		

Source: RLA

Table 8.11

ANALYSIS AND PROJECTIONS FOR THE GLOBAL VEHICLE CARRIERS FLEET

Fleet as at 1990

Vessel Size (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	Total
Year of Build							
pre-1965	1400	0	0	0	0	0	1400
1965 to 1969	4656	0	0	0	0	0	4656
1970 to 1974	58844	47774	0	0	0	0	106618
1975 to 1979	212678	643119	30400	40999	0	0	927196
1980 to 1984	126524	914988	84373	0	0	0	1125885
1985 to 1989	87309	426290	28070	0	0	0	541669
1990	9654	17914	0	0	0	0	27568
Total	501065	2050085	142843	40999	0	0	2734992
% Distribution	18.3%	75.0%	5.2%	1.5%	0.0%	0.0%	100.0%
Average Age (Years)	11	10	9	14	0	0	10

Fleet Projections

Year							
2020	883101	3532406	232395	0	0	0	4647902
% Distribution	19.0%	76.0%	5.0%	0.0%	0.0%	0.0%	100.0%
2060	944780	3779121	248626	0	0	0	4972527
% Distribution	19.0%	76.0%	5.0%	0.0%	0.0%	0.0%	100.0%

Source: RLA

Table 8.12

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: VEHICLE CARRIERS

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
AVERAGE DWT						
CASE 1 TO CASE 5 INCLUSIVE						
65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	4074	13579	28569	40999		
2020	4070	13760	28570	0		
2060	4070	13760	28570	0		
PANAMA CANAL						
1990 N	8231	14336	0			
1990 S	7209	14708	29692			
2020	7760	14500	29690			
2060	7760	14500	29690			

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999
% DISTRIBUTION						
CASE 1 TO CASE 5 INCLUSIVE						
65,000 DWT TO 300,000 DWT CANAL						
GLOBAL FLEET						
1990	18.3	75.0	5.2	1.5		
2020	19.0	76.0	5.0	0.0		
2060	19.0	76.0	5.0	0.0		
PANAMA CANAL						
1990 N	5.8	94.2	0.0			
1990 S	4.9	83.5	11.7			
2020 N	5.3	94.7	0.0			
2020 S	5.6	84.3	10.1			
2060 N	5.7	94.3	0.0			
2060 S	8.1	83.5	8.3			

Source: RLA

Table 8.13

ANALYSIS AND PROJECTIONS FOR THE GLOBAL DRY BULK CARRIER FLEET INCLUDING COMBINED CARRIERS IN DRY BULK TRADES

Fleet as at 1990

Vessel Size (DWT)	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	300,000+	Total
Year of Build								
pre-1965	2554144	83603	0	0	0	0	0	2637747
1965 to 1969	5992114	2844302	1760538	642412	160242	0	0	11399658
1970 to 1974	18290154	7435104	4188569	10374246	7571584	1888339	0	49748296
1975 to 1979	23968835	10609164	5124391	9362745	2121652	270384	0	51457171
1980 to 1984	20877854	17365762	6444520	8616436	3701967	519143	0	57525682
1985 to 1989	12367096	10824730	4985990	3791313	11276542	228798	1342055	44816524
1990	742661	1387240	1851623	3983010	1530041	256858	0	9751433
Total	84792858	50549905	24355981	36770162	26362028	3163522	1342055	227336511
% Distribution	37.3%	22.2%	10.7%	16.2%	11.6%	1.4%	0.6%	100.0%
Average Age (Years)	13	10	10	11	9	12	3	12

Fleet Projections

Case 1: 65,000 DWT Canal

Year								
2020	133413083	135271546	41772943	98102792	69163417	13947652	9371033	501042466
% Distribution	26.6%	27.0%	8.3%	19.6%	13.8%	2.8%	1.9%	100.0%
2060	146407517	163408027	125510985	83652251	113268927	17518251	12744605	662510564
% Distribution	22.1%	24.7%	18.9%	12.6%	17.1%	2.6%	1.9%	100.0%

Case 2: 100,000 DWT Canal

Year								
2020	120159959	104709073	73981292	98021898	68963065	13856226	9285142	488976656
% Distribution	24.6%	21.4%	15.1%	20.0%	14.1%	2.8%	1.9%	100.0%
2060	138916929	113033445	163017778	83651888	113147701	17327211	12590652	641685603
% Distribution	21.6%	17.6%	25.4%	13.0%	17.6%	2.7%	2.0%	100.0%

Table 8.13 (Cont'd)

ANALYSIS AND PROJECTIONS FOR THE GLOBAL DRY BULK CARRIER FLEET INCLUDING COMBINED CARRIERS IN DRY BULK TRADES

Vessel Size (DWT)	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	300,000+	Total
Case 3: 150,000 DWT Canal								
Year								
2020	119897101	102580922	67965365	101029697	64012276	13857492	9285142	478627995
% Distribution	25.1%	21.4%	14.2%	21.1%	13.4%	2.9%	1.9%	100.0%
2060	139260483	112120948	150719993	97251186	97388277	17328793	12590652	626660334
% Distribution	22.2%	17.9%	24.1%	15.5%	15.5%	2.8%	2.0%	100.0%
Case 4: 250,000 DWT Canal								
Year								
2020	119591847	102580922	67941009	100702443	64650237	13832816	9261656	478560930
% Distribution	25.0%	21.4%	14.2%	21.0%	13.5%	2.9%	1.9%	100.0%
2060	138917889	112120948	150679570	73835031	120624413	17299320	12568067	626045238
% Distribution	22.2%	17.9%	24.1%	11.8%	19.3%	2.8%	2.0%	100.0%

Source: RLA

Table 8.14

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: DRY BULK CARRIERS AND COMBINED CARRIERS IN DRY BULK TRADES.

VESSEL SIZE RANGE (DWT)	10,000-40,000	40,000-65,000	65,000-100,000	100,000-150,000	150,000-250,000	250,000-300,000	300,000+
AVERAGE DWT							
CASE 1: 65,000 DWT							
GLOBAL FLEET							
1990	26235	51955	72525	126484	182260	266740	316527
2020	32000	51955	68745	134700	183355	268345	318425
2060	36500	59275	68745	140475	184090	269420	319705
PANAMA CANAL							
1990 N	29802	49794	68713				
1990 S	29098	52369	69255				
2020	32000	51955	68745				
2060	36500	59275	68745				
CASE 2: 100,000 DWT							
GLOBAL FLEET							
2020	32000	51955	82120	134700	183355	268345	318425
2060	36500	59275	93685	140475	184090	269420	319705
PANAMA CANAL							
2020 N	32000	51955	82120				
2020 S	32000	51955	82959				
2060	36500	59275	93685				
CASE 3: 150,000 DWT							
GLOBAL FLEET							
2020	32000	51955	82120	134700	183355	268345	318425
2060	36500	59275	93685	140475	184090	269420	319705
PANAMA CANAL							
2020	32000	51955	82120	134700			
2060	36500	59275	93685	140475			

Table 8.14 (Cont'd)

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: DRY BULK CARRIERS AND COMBINED CARRIERS IN DRY BULK TRADES.

VESSEL SIZE RANGE (DWT)	10,000-to 40,000	40,000-to 65,000	65,000 to 100,000	100,000-to 150,000	150,000-to 250,000	250,000 to 300,000	300,000+
AVERAGE DWT							
CASE 4: 250,000 DWT							
GLOBAL FLEET							
2020	32000	51955	82120	134700	183355	268345	318425
2060	36500	59275	93685	140475	184090	269420	319705
PANAMA CANAL							
2020	32000	51955	82120	134700	183355		
2060	36500	59275	93685	140475	184090		
CASE 5: 300,000 DWT							
GLOBAL FLEET							
2020	32000	51955	82120	134700	183355	268345	318425
2060	36500	59275	93685	140475	184090	269420	319705
PANAMA CANAL							
2020	32000	51955	82120	134700	183355		
2060	36500	59275	93685	140475	184090		

Table 8.14 (Cont'd)

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: DRY BULK CARRIERS AND COMBINED CARRIERS IN DRY BULK TRADES.

VESSEL SIZE RANGE (DWT)	10,000-40,000	40,000-65,000	65,000-100,000	100,000-150,000	150,000-250,000	250,000-300,000	300,000+
	to 40,000	to 65,000	to 100,000	to 150,000	to 250,000	to 300,000	
% DISTRIBUTION							
CASE 1: 65,000 DWT							
GLOBAL FLEET							
1990	37.3	22.2	10.7	16.2	11.6	1.4	0.6
2020	26.6	27.0	8.3	19.6	13.8	2.8	1.9
2060	22.1	24.7	18.9	12.6	17.1	2.6	1.9
PANAMA CANAL							
1990 N	51.3	39.2	9.3				
1990 S	36.2	42.8	20.8				
2020 N	44.7	46.7	8.7				
2020 S	30.5	50.9	18.7				
2060 N	31.5	46.6	21.9				
2060 S	23.8	41.6	34.6				
CASE 2: 100,000 DWT							
GLOBAL FLEET							
2020	24.6	21.4	15.1	20.0	14.1	2.8	1.9
2060	21.6	17.6	25.4	13.0	17.6	2.7	2.0
PANAMA CANAL							
2020 N	40.7	35.3	24.0				
2020 S	24.3	38.1	37.6				
2060 N	31.8	41.3	26.9				
2060 S	21.0	35.4	43.6				
CASE 3: 150,000 DWT							
GLOBAL FLEET							
2020	25.1	21.4	14.2	21.1	13.4	2.9	1.9
2060	22.2	17.9	24.1	15.5	15.5	2.8	2.0
PANAMA CANAL							
2020 N	40.7	35.3	21.2	2.8			
2020 S	14.9	23.3	21.7	40.1			
2060 N	31.8	41.3	25.7	1.3			
2060 S	14.1	23.9	28.4	33.6			

Table 8.14 (Cont'd)

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: DRY BULK CARRIERS AND COMBINED CARRIERS IN DRY BULK TRADES.

VESSEL SIZE RANGE (DWT)	10,000-40,000	40,000-65,000	65,000-100,000	100,000-150,000	150,000-250,000	250,000-300,000	300,000+
% DISTRIBUTION							
CASE 4: 250,000 DWT							
GLOBAL FLEET							
2020	25.0	21.4	14.2	21.0	13.5	2.9	1.9
2060	22.2	17.9	24.1	11.8	19.3	2.8	2.0
PANAMA CANAL							
2020 N	40.7	35.3	21.2	1.4	1.4		
2020 S	14.7	23.1	21.5	39.0	1.7		
2060 N	31.8	41.3	25.7	0.0	1.3		
2060 S	13.9	23.6	28.1	0.0	34.4		
CASE 5: 300,000 DWT							
GLOBAL FLEET							
2020	25.0	21.4	14.2	21.0	13.5	2.9	1.9
2060	22.2	17.9	24.1	11.8	19.3	2.8	2.0
PANAMA CANAL							
2020 N	40.7	35.3	21.2	1.4	1.4		
2020 S	14.7	23.1	21.5	39.0	1.7		
2060 N	31.8	41.3	25.7	0.0	1.3		
2060 S	13.9	23.6	28.1	0.0	34.4		

Source: RLA

Table 8.15

ANALYSIS OF THE GLOBAL COMBINED CARRIER FLEET

Fleet as at 1990

Vessel Size (DWT)	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	300,000+	Total
Year of Build									
pre-1965	0	0	0	0	0	0	0	0	0
1965 to 1969	0	0	123808	257531	0	0	0	0	381339
1970 to 1974	0	0	192895	1580463	4414493	6035129	1328165	0	13551145
1975 to 1979	0	55908	336956	635708	6096101	1620624	0	0	8745297
1980 to 1984	0	13149	792658	1893219	1539705	0	0	0	4238731
1985 to 1989	0	0	586490	844697	149895	313837	282467	1213641	3391027
1990	0	0	0	0	0	0	0	0	0
Total	0	69057	2032807	5211618	12200194	7969590	1610632	1213641	30307539
% Distributio	0.0%	0.2%	6.7%	17.2%	40.3%	26.3%	5.3%	4.0%	100.0%
Average Age (Years)	0	12	8	12	14	16	15	3	13

Source: RLA

Table 8.16

ANALYSIS AND PROJECTIONS FOR THE GLOBAL CHEMICAL CARRIER FLEET

Fleet as at 1990

Vessel Size (DWT)	5,000 to 9,999	10,000 to 39,999	40,000 to 64,999	Total
Year of Build				
pre-1965	6349	168542	0	174891
1965 to 1969	42994	106200	110681	259875
1970 to 1974	234238	1159399	0	1393637
1975 to 1979	369191	1942747	54906	2366844
1980 to 1984	853642	3336981	315942	4506565
1985 to 1989	474701	1070390	81380	1626471
1990	68722	161269	0	229991
Total	2049837	7945528	562909	10558274
% Distribution	19.4%	75.3%	5.3%	100.0%
Average Age (Years)	9	11	11	10

Fleet Projections

Year				
2020	3490257	20646455	6952771	31089482
% Distribution	11.2%	66.4%	22.4%	100.0%
2060	5109388	30224345	16592787	51926519
% Distribution	9.8%	58.2%	32.0%	100.0%

Source: RLA

Table 8.17

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: CHEMICAL CARRIERS

VESSEL SIZE RANGE (DWT)	5,000 to 9,999	10,000- to 39,999	40,000- to 64,999
AVERAGE DWT			
CASE 1 TO CASE 5 INCLUSIVE			
65,000 DWT TO 300,000 DWT CANAL			
GLOBAL FLEET			
1990	6972	23647	46909
2020	6972	31710	45250
2060	6972	35120	50120
PANAMA CANAL			
1990 N	8031	27533	
1990 S	7850	30588	
2020	7920	31710	45250
2060	7920	35120	50120

VESSEL SIZE RANGE (DWT)	5,000 to 9,999	10,000- to 39,999	40,000- to 64,999
% DISTRIBUTION			
CASE 1 TO CASE 5 INCLUSIVE			
65,000 DWT TO 300,000 DWT CANAL			
GLOBAL FLEET			
1990	19.4	75.3	5.3
2020	11.2	66.4	22.4
2060	9.8	58.2	32.0
PANAMA CANAL			
1990 N	11.0	89.0	
1990 S	9.0	91.0	
2020 N	8.7	83.8	7.5
2020 S	5.8	84.6	9.6
2060 N	8.2	76.6	15.2
2060 S	2.6	78.1	19.3

Source: RLA

Table 8.18

ANALYSIS OF THE GLOBAL GAS CARRIER FLEET

Fleet as at 1990

Vessel Size (DWT)	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	Total
Year of Build					
pre-1965	25324	68819	0	0	94143
1965 to 1969	181437	371487	0	0	552924
1970 to 1974	184414	545663	641803	0	1371880
1975 to 1979	301462	307386	2240627	1268494	4117969
1980 to 1984	402959	503387	976073	1312085	3194504
1985 to 1989	228819	206074	379986	269398	1084277
1990	85754	169223	298637	220656	774270
Total	1410169	2172039	4537126	3070633	11189967
% Distribution	12.6%	19.4%	40.5%	27.4%	100.0%
Average Age (Years)	13	13	11	9	12

Source: RLA

Table 8.19

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: GAS CARRIERS

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000- to 39,999	40,000- to 64,999	65,000 to 99,999
AVERAGE DWT				
CASE 1 TO CASE 5 INCLUSIVE				
65,000 DWT TO 300,000 DWT INCLUSIVE				
GLOBAL FLEET				
1990	2518	20299	51558	71410
2020	4300	18900	51560	71410
2060	4300	18900	51560	71410
PANAMA CANAL				
1990 N	5464	15526	40605	
1990 S	5036	16472	40605	
2020	5070	18900	40600	
2060	7930	18900	40600	

VESSEL SIZE RANGE (DWT)	0 to 9,999	10,000- to 39,999	40,000- to 64,999	65,000 to 99,999
% DISTRIBUTION				
CASE 1 TO CASE 5 INCLUSIVE				
65,000 DWT TO 300,000 DWT INCLUSIVE				
GLOBAL FLEET				
1990	12.6	19.4	40.5	27.4
PANAMA CANAL				
1990 N	12.1	47.0	40.9	0.0
1990 S	8.0	59.9	32.1	0.0
2020 N	11.6	47.3	41.1	0.0
2020 S	6.4	43.9	49.7	0.0
2060 N	10.7	43.1	46.2	0.0
2060 S	7.8	47.4	44.8	0.0

Source: RLA

Table 8.20

ANALYSIS AND PROJECTIONS FOR THE GLOBAL OIL TANKER FLEET INCLUDING COMBINED CARRIERS IN OIL TRADE

Fleet as at 1990

Vessel Size (DWT)	5,000 to	10,000 to 9,999	40,000 to 39,999	65,000 to 64,999	100,000 to 99,999	150,000 to 149,999	250,000 to 249,999	300,000+ 299,999	Total
Year of Build									
pre-1965	126815	3467325	1440713	147002	0	0	0	0	5181855
1965 to 1969	187422	2774679	912729	3990903	2064875	382506	0	0	10313114
1970 to 1974	681339	5973471	730428	6191707	10974212	13302958	23869851	2262118	63986084
1975 to 1979	496985	8039753	2524658	10667814	18175282	15567031	25928070	25166597	106566190
1980 to 1984	441340	4798831	7801521	9946898	2462751	1313211	1372339	1027851	29164742
1985 to 1989	300599	4631582	3562893	8670211	4814757	6397652	4494316	547946	33419956
1990	87888	588391	309310	2503468	1701730	714986	2960435	0	8866208
Total	2322388	30274032	17282252	42118003	40193607	37678344	58625011	29004512	257498149
% Distribution	0.9%	11.8%	6.7%	16.4%	15.6%	14.6%	22.8%	11.3%	100.0%
Average Age (Years)	13	15	10	11	13	13	13	14	13

Fleet Projections

Year									
2020	3753786	44302070	25553326	62917539	55036294	36497553	108349409	80677395	417087372
% Distribution	0.9%	10.6%	6.1%	15.1%	13.2%	8.8%	26.0%	19.3%	100.0%
2060	1645059	23050367	14120768	32540951	24160933	25588435	44477433	17200421	182784367
% Distribution	0.9%	12.6%	7.7%	17.8%	13.2%	14.0%	24.3%	9.4%	100.0%

Note: Changes to Panama trades under cases 4 and 5 do not have a significant impact on global fleet projections.

Source: RLA

Table 8.21

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: TANKERS

	VESSEL SIZE RANGE (DWT)							
	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	300,000+
AVERAGE DWT								
CASE 1: 65,000 DWT CANAL								
GLOBAL FLEET								
1990	6433	26463	52849	82880	125884	211249	266308	368264
2020	6430	31710	52850	89730	131000	238000	269000	368300
2060	6430	31710	52850	89730	131000	238000	269000	368300
PANAMA CANAL								
1990 N	5254	31167	55065	72603				
1990 S	5799	29184	53591	73893				
2020	5630	31710	54300	74100				
2060	5630	31710	54300	74100				
CASE 2 AND 3: 100,000 DWT AND 150,000 DWT CANAL								
GLOBAL FLEET								
2020	6430	31710	52850	89730	131000	238000	269000	368300
2060	6430	31710	52850	89730	131000	238000	269000	368300
PANAMA CANAL								
2020	5630	31710	54300	89730				
2060	5630	31710	54300	89730				
CASE 4: 250,000 DWT								
GLOBAL FLEET								
2020	6430	31710	52850	89730	131000	238000	269000	368300
2060	6430	31710	52850	89730	131000	238000	269000	368300
PANAMA CANAL								
2020	5630	31710	54300	89730				
2060	5630	31710	54300	89730				
CASE 5: 300,000 DWT								
GLOBAL FLEET								
2020	6430	31710	52850	89730	131000	238000	269000	368300
2060	6430	31710	52850	89730	131000	238000	269000	368300
PANAMA CANAL								
2020	5630	31710	54300	89730				
2060	5630	31710	54300	89730				

Table 8.21 (Cont'd)

DEVELOPMENT OF VESSEL SIZE DISTRIBUTION AND AVERAGE DEADWEIGHT
SHIP TYPE: TANKERS

% DISTRIBUTION

	VESSEL SIZE RANGE (DWT)							
	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	300,000+
CASE 1: 65,000 DWT CANAL								
GLOBAL FLEET								
1990	0.9	11.8	6.7	16.4	15.6	14.6	22.8	11.3
2020	0.9	10.6	6.1	15.1	13.2	8.8	26.0	19.3
2060	0.9	12.6	7.7	17.8	13.2	14.0	24.3	9.4
PANAMA CANAL								
1990 N	0.9	23.7	59.0	16.4				
1990 S	1.8	26.7	52.9	18.6				
2020 N	1.5	26.0	56.9	15.6				
2020 S	1.9	20.7	60.2	17.2				
2060 N	3.4	34.1	53.5	9.0				
2060 S	1.8	23.0	63.6	11.6				
CASE 2 AND 3: 100,000 DWT TO 150,000 DWT CANAL								
GLOBAL FLEET								
2020	0.9	10.6	6.1	15.1	13.2	8.8	26.0	19.3
2060	0.9	12.6	7.7	17.8	13.2	14.0	24.3	9.4
PANAMA CANAL								
2020 N	1.5	25.9	49.8	22.7				
2020 S	2.0	21.3	46.9	29.8				
2060 N	3.4	34.1	53.5	9.0				
2060 S	1.8	22.8	58.3	17.1				
CASE 4: 250,000 DWT								
GLOBAL FLEET								
2020	0.9	10.6	6.1	15.1	13.2	8.8	26.0	19.3
2060	0.9	12.6	7.7	17.8	13.2	14.0	24.3	9.4
PANAMA CANAL								
2020 N	1.5	26.0	49.8	22.7				
2020 S	1.2	13.3	29.2	18.5		37.8		
2060 N	3.4	34.1	53.5	9.0				
2060 S	0.9	11.6	29.7	8.7		49.1		
CASE 5: 300,000 DWT								
GLOBAL FLEET								
2020	0.9	10.6	6.1	15.1	13.2	8.8	26.0	19.3
2060	0.9	12.6	7.7	17.8	13.2	14.0	24.3	9.4
PANAMA CANAL								
2020 N	1.5	26.0	49.8	22.7				
2020 S	1.2	13.3	29.2	18.5			37.8	
2060 N	3.4	34.1	53.5	9.0				
2060 S	0.9	11.6	29.7	8.7			49.1	

Source: RLA

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Comisión de Estudio
de las Alternativas
al Canal de Panamá
CENTRO DE INFORMACION

9.0 PANAMA CANAL VESSEL TRANSITS 2020 AND 2060

9.1 General Approach

Commodity and Cargo Flows

The general approach which we have used in this study is outlined in Figure 4.1 "Panama Canal Vessel Transit and Commodity Flow Methodology". Our first step is a constant-share projection of Panama Canal Commodity Flows. To accomplish this, we first put the Panama Canal and world trade commodity flows on the same commodity and trade route basis. The commodity and route definitions are provided in Tables B.7 and B.8 of Appendix B. Because there are 7 origin/destinations to the east of the canal and 6 to the west in Table B.8, there are 42 combinations and thus 42 potential northbound and 42 southbound routes.

To accomplish the constant share projection, the growth rates for the world trade forecast were used to project Panama Canal trade for each commodity and route. This provides a first-cut projection of Panama Canal commodity flows for 2020 and 2060 before adjustment for by pass traffic.

This first-cut commodity flow forecast was then transformed to a cargo forecast by applying the commodity allocation matrices for 1988 presented in the 1989 TBS report. This provides a forecast of cargo tonnage for each route by ship type.

Distribution of Ship Transits

The second part of this approach was to assemble the 1990 synthesized Panama Canal Vessel transit database. To accomplish this, the average DWT in each size range and the total DWT in each size range were computed. This provided two sets of parameters:

- average DWT by size range and ship type on each route
- percentage distribution of total DWT across size range for each ship type on each route

The average DWT and the percentage distribution of tonnage were then shifted according to the world fleet forecast as described in Section 8.

Ship Utilization

By combining the cargo tonnage by ship type and route and the 1990 synthetic ship transit database, it was possible to assess ship utilization. The first step was to compare the total cargo tonnage flowing through the Canal, as assigned to ships, and the total DWT tonnage of the ships transiting the Canal. This was the most difficult part of the project in that route and ship definitions were clearly not the same between the PCC commodity flow data and the synthetic database which we constructed. There were commodities shown on routes where we had no ships and ships on routes where we had no commodities. This can be attributed to the difficulty in identifying trade routes from the Lloyds voyage records and variations in the precise definitions of ship types used by the PCC, Lloyds and other internationally accepted data sources.

Because of the problems regarding vessel definitions, utilizations initially were sometimes very small or very large. To correct this, we shifted both routes and ship identifications in the synthetic vessel transit database. The identification of laden versus ballast also was responsible for some of the difficulties. In our assignment of laden and ballast vessel transits, we had assumed the same ratios for all routes northbound and southbound, varying by vessel type, for vessels within the aggregate vessel types shown in the PCC data.

The matching of commodity and transit databases for 1990 enables relationships between cargo flows and transit by ship type and route to be established which form the basis for future projections of laden transits for each time period and case. Modifications to these relationships which arise in future are due to potential changes in the average DWT of each vessel within a size range by ship type and in the percentage allocations of total DWT tons to each size range within a ship type. This is discussed in more detail in the section on 'decisions rules' below. Modifications also arise due to the switching of cargo between general cargo ship types over time.

Ballast Transits

The ship movements data which we have been forced to use to produce our sample of transits does not indicate whether the ship is in a ballast or laden condition. Only the PCC ship data provide this information. Therefore, we have adopted the only realistic approach available, which is to project ballast transits on the basis of aggregate data by using:

- aggregate PCC data for FY1990 from its annual report giving numbers of vessels by broad ship type, laden and ballast, north and south bound in order to divide up our

1990 synthesized transit database between laden and ballast movements;

- the same aggregate published PCC data for FY1978-1990 inclusive to try and establish, through statistical techniques, a relationship between numbers of laden and ballast transits.

Moreover in developing laden versus transit splits we have had to make two important assumptions:

- in allocating numbers of transits for vessels described by the PCC as 'general cargo ships' and 'containerships' between conventional general cargo vessels, container/breakbulk ships, full containerships and ro-ro's, there are no ballast transits for the last two ship types;

- for all other ship types the size distribution of laden ships is the same as that of ballast ships.

Looking at the results of our statistical analyses of historical transit data, it is evident that, to the extent that any correlation exists, there is a closer relationship for any given ship type between laden transits in one direction and ballast transits in the opposite direction than there is taking laden and ballast movements in the same direction. However, with the exception of tankers northbound laden/southbound ballast, correlations are insufficiently robust for forecasting purposes and even in this case developments followed divergent trends during 1989-90.

For dry bulk carriers, vehicle carriers, reefers and the three ship types grouped within PCC's definition of 'tankers' (i.e. oil tankers, chemical carriers and liquefied gas carriers) it is concluded that the 1990 PCC ratios of northbound ballast to southbound laden transits and southbound ballast to northbound laden transits should be used to project future ballast transits from forecasts of laden transits by ship type. For container/breakbulk ships and conventional general cargo ships the same relationships have been derived but based on average ratios for the period 1978-1990 assuming there are no ballast transits for full containerships and ro-ro's.

Decision Rules

We have developed a set of generalized 'decision rules' in order to assess the extent to which numbers of vessel transits will be affected by changes in the size and composition both of the world fleet and those ships transiting the Canal. Potential changes in ship size are also a consideration when evaluating the future capacity of the Canal under different cases. These decision rules, which we describe below, have been applied to all ship types. In specific instances, the decision rules have been over-ridden where it is deemed appropriate because of the changing structure of individual shipping sectors. These instances are described in the discussion of individual ship types.

As befits a study involving long term forecasting but encompassing only one economic/technological scenario to describe global developments, moderately conservative, consensus views have been adopted.

Attention has been focussed on two issues:

- the potential changes in the average DWT of each vessel within a size range by ship type;

- potential changes in percentage allocations of total deadweight tons to each size range within a ship type.

Within both considerations, attention has been given to the information provided in the synthesized 1990 Panama Canal transit database, developments in the world fleet for each ship type and the context of the former within the latter.

Analyses have been carried out for all of the cargo carrying ship types included in the synthesized Panama Canal FY90 database. The results of these analyses, both in terms of the world fleet and vessels utilizing the Canal, are provided in Table 8. Anticipated trends in average deadweight and size distribution for the world fleet have been discussed in Section 8.3 above. Below, and in the discussion of expected transit developments under each case, we comment on the potential trends in average deadweight and vessel size distributions of ships transiting the Canal.

Potential Changes in the Average Deadweight Tons of each Vessel within a Size Range

A review of historical global trends in the average deadweight of a ship type within a size range was first carried out. Where a statistically significant time trend or correlation with historical shipping demand was found, this relationship was applied to provide average global deadweights for 2020. Results were utilized for the Panama Canal average 'transit deadweight' both northbound and southbound in 2020.

This approach ensures that Panama Canal trades and transit demand are viewed within the context of global developments. It also acts as a substitute for PCC historical data on average deadweights, by ship type and size range, of vessels transiting the Canal.

It should be noted that, for some vessels significant historical trends were established that could not be used for future developments because of the extreme nature of results from the application of historical trends to long term forecasts. In these instances, the trend was modified in the light of market research, the developing structure of individual trades and calculations of economies of scale for individual ship types and sizes. As discussed in Chapter 8, vessel size trends were discussed with a number of experts. This augmented in-house RLA information.

If no significant global trends could be established, we reviewed trends in recent vessel deliveries and current newbuildings. The global trend in current newbuildings and recent deliveries (if any) was substituted as the average for 1990. This broadly reflects our established methodology which takes the best current technological practice as a starting point for reviewing the average technological developments by ship type (hull form, speed and consumption, changes in automation).

The weighted average deadweight of north and southbound transits for each ship type within a given size range from the synthesized FY90 transit database was calculated. If this average deadweight was in excess of the average deadweight from the current world fleet, then:

- either the trend analyses established globally were applied to the Panama Canal average deadweights or,

- the weighted average deadweights through the Panama Canal in 1990 were used for 2020.

The decision on which of these two approaches was taken depended upon:

- the extent to which trades through the Canal relevant to a specific ship type were major arterial routes compared to the global range of trades for the ship type. If this were the case, then any trend established globally was applied to the Panama Canal weighted average deadweight;

- if Panama Canal trades appeared to broadly reflect global trades and no trend could be established for changes in average deadweight, the weighted average deadweight from 1990 was used for 2020.

Potential Changes in the Percentage Allocation of Total Deadweight Tons to each Size Range within a Ship Type.

Historical trends in the proportion of the global fleet by ship type occupied by individual size ranges of vessel by ship type were reviewed. The development of ton miles demand for ships of varying sizes globally to 2020 were also reviewed. Where a statistically significant time trend or correlation with historical shipping demand was found, the resulting relative changes globally were applied on a route by route basis to the FY90 synthesized transit database. Application of global trends was necessarily modified as the relative proportions of deadweight tonnage in each size category for Canal transits in FY90 do not uniformly reflect the size distribution of individual ship types globally in 1990, not least because of the existing Canal size constraints.

As with the development of trends in average deadweights, some trend data were established that could not be applied to calculate future developments because of unacceptably exaggerated results. In these instances, the trend was modified in the light of our market research[1] and the developing structure of individual trades.

If no significant trends could be established that could reasonably be applied to transit data for a ship type/size range, the relative proportion was left unchanged from the FY90 synthesized database. The FY 1990 transit database is summarized in Table 9.1.

In the remaining parts of this section we present the results of our transit forecasts and discuss the related technical and technoeconomic factors that have a direct impact on these transits. Specifically, section 9.2 presents the Status Quo case for 2020 and 2060. Section 9.3 covers Case 2 (100,000 DWT Design Ship) for 2020 and 2060, section 9.4 presents the results for Case 3 (150,000 DWT Design Ship). Cases 4 (250,000 DWT Design Ship) and

[1] A list of the companies with whom these issues were discussed is referenced in Chapter 8.

Case 5 (300,000 DWT Design Ship) are discussed in sections 9.5 and 9.6 respectively.

9.2 Status Quo Canal (65,000 DWT Design Ship)

9.2.1 Demand for Panama Canal Transits, Status Quo case, 2020.

The following describes, by ship type, projections of laden transits for 2020 under the status quo case, The results in terms of numbers of transits and average deadweight by ship type and size, laden and ballast, northbound and southbound are shown in Table 9.2.

Container Breakbulk Ships

Average deadweights by size range for Panama are assumed to move into line with those for the world fleet, with the exception of the smallest size range for which the average for Panama is significantly above that for the global fleet. This results in increases of between 10% and 50% in the average sizes of vessels in the two smallest size ranges for this ship type on Panama Canal routes and a slight fall in the average size of ship between 25,000 and 39,999 deadweight. The average size of container breakbulk carrier in the 40,000 to 64,999 deadweight size range using the Canal in 2020 is expected to be little changed from that in 1990 (Table 8.2).

The size distribution of container/breakbulk ships passing through the Canal in 2020 is expected to show a shift towards the larger size ranges compared with 1990, as a consequence of the route structures on which these ships are prevalent, with the proportions of vessels in excess of 25,000 DWT transiting the canal northbound reaching in 2020 31% in deadweight terms compared to 18% in 1990 (Table 8.2). Similarly, the proportion of vessels in excess of 25,000 DWT transiting the Canal southbound is 22.5% in 2020 compared to 1.5% in 1990.

In comparison with 1990 data the overall average dwt for container breakbulk ships transiting the Canal increases by 60% and 73% for northbound and southbound transits respectively. As a result, despite an almost 150% increase in cargo volumes, the number of transits both north and southbound is projected to increase by about 45%, equivalent approximately to the addition of 200 transits in each direction (Table 9.2).

Full Containerships

For full containerships transiting the Canal average deadweights by size range in 2020 are assumed to be the same or marginally above the averages for north and south bound movements in 1990. However in line with global fleet developments the deadweight distribution by size range is expected to shift towards larger sizes such that the size ranges above 25,000 deadweight in Case 1 represent almost 90% of the deadweight passing through the Canal in 2020 compared with between 83% and 87% in 1990. Virtually no full container traffic is assumed in vessels below 10,000 deadweight (Table 8.4).

The net result of these changes is to increase the overall average, vessel size by about 7% northbound and 14% southbound with total transits rising by 733 northbound and 691 southbound, equivalent to increases of around 130% compared with 1990 (Table 9.2).

Conventional General Cargo Ships

With the exception of the smallest size range, for which no change is assumed, average deadweights by size range are projected to increase in line with those for the world fleet. The proportion by deadweight of vessel transits in the below 10,000 deadweight size range is projected to decline from 22% in 1990 to between 12% to 12% northbound and 15% southbound by 2020. This is accompanied by increases of 6% (northbound) and 0% (southbound) for the 10,000-24,999 deadweight size range and changes of +4% and +7%. north and south bound respectively, for the 25,000 - 39,999 deadweight size range (Table 8.6).

The net effect of these developments means that northbound, between 1990 and 2020, the effect of an overall 62% increase in cargo for conventional general cargo ships will be offset by a rise of 48% in average deadweight such that the number of transits increases by just 37 or 9%. Southbound laden transits are projected to fall by 1% as the 38% increase in cargo moving through the canal is more than offset by a 39% rise in the overall average deadweight (Table 9.1 and 9.2).

Refrigerated Cargo Ships

This ship type is confined to vessels below 25,000 deadweight and this is expected to remain the case in the future. In the 10,000 to 24,999 deadweight size range the average size of ship transiting the Canal in 1990 is similar to that in the world fleet. Therefore, as the average deadweight for the global fleet rises in the period to 2020, vessels on Canal trades will

increase in size to equal the world average. The average size of reefers below 10,000 deadweight is projected to grow at the same rate as that for the global fleet, leaving vessels on Panama routes larger than the worldwide average. As the deadweight proportion of reefers in the 10,000 - 24,999 deadweight size range in the global fleet continues to increase, so the proportion in this size range for Panama trades will rise from 44/46% in 1990 to between 64% and 69% in 2020, reflecting both the importance of Panama Canal trades in global demand for reefers overall and the structure of the individual Panama trades (see Table 8.8).

As may be seen from a comparison of reefer transit data in Table 9.1 and Table 9.2, the overall average size of reefers transiting the Canal increases by 25% and 29% respectively for north and southbound transits by 2020 (Table 9.1 and 9.2). Similarly, as reefer trade is projected to increase by 151% northbound and 132% southbound between 1990 and 2020 (Table 7.1), northbound laden transits are estimated to almost double to 2546 while those southbound increase by almost 57% to 1253 (Table 9.1 and 9.2).

Roll-on Roll-off Ships (RoRo's)

Average deadweight by size range for roro's in Panama trades are expected to change little between 1990 and 2020 in line with global supply and demand developments for these ships. Deadweight distribution by size range is expected to follow different trends northbound and southbound as substitution by other ship types impacts differently on existing roro trades. For northbound routes as a whole the proportion of roro tonnage above 25,000 deadweight is projected to decline from 56% to 46% in the period to 2020 while for southbound transits vessels in excess of 25,000 deadweight will increase from 60% to 72% of the total (Table 8.10).

Between 1990 and 2020, northbound roro transits are projected to increase by just 5% based on a 7% increase in cargo and marginal rise in the overall average vessel size utilizing the Canal. Southbound the number of laden roro transits estimated to increase by 54% to 201.

Vehicle Carriers

No significant changes are envisaged in average deadweights by size range nor deadweight distribution by size range for vehicle carriers operating through the Panama Canal (Table 8.12). For northbound voyages this means that the number of transit increases by about 30% between 1990 and 2020, broadly in line with the projected increase in cargoes. In the case of southbound voyages, poorer deadweight utilization associated with the employment

of larger vessels results in a small increase in the number of transits despite a marginal decline in cargo flows.

Dry Bulk Carriers

Vessels in the below 10,000 deadweight size range occupied 0.1% of total deadweight southbound and 0.16% of northbound in FY90. There were no individual routes where vessels in this size range represented a predominant proportion. As a result, these vessels have been removed from consideration for the 2020 transits. The proportion of tonnage in the 10-39,999 deadweight range has been reduced by up to 10% on a route by route basis. The proportion in the 40-64,999 deadweight size range has been similarly increased. these changes reflect changes established from historical data globally. Globally the proportion of vessels in 65,000-99,999 dwt size range is declining reflecting the establishment of specific major bulk trades utilizing vessels in a larger size range. For Panama trades only, allocations were kept at the 1990 level. For northbound transits this is a small proportion of total deadweight (8%). For southbound, the proportion is higher in total (20.5%) due to the incidence of use of such tonnage on the high volume USEC to Asia route (Table 8.14).

For the 10,000-39,999 deadweight size range the increase in the average deadweight to 32,000 reflects a historical time trend. Current average deadweights through the Canal are higher than the global average but the global average for 2020 has been used due to the declining importance of Panama Canal trades for this size of ship as referenced in Table 8.14. There is no significant historical trend in changes in average deadweight in the 40,000-64,999 deadweight size range. Current newbuilding orders represent a wide spread. The 1990 average of dry bulk carriers and combined carriers in dry has been utilized.

As with the preceding size class, there is no significant historical trend for ships of 65,000-99,999 dwt. Recent vessel deliveries and the newbuilding order book converge at around 68,400 deadweight. The current weighted average deadweight of vessels transiting the Canal-ie-68745-has been used for 2020 transit purposes (Table 8.14).

As a result of these changes average deadweights, north and southbound, are expected to increase by the order of 10%. Growth in cargo flows for dry bulk carriers, in both directions is projected to increase between 1990 and 2020 by around 55%. The net effect of this is that the number of transits rise by about 40%.

Chemical Carriers

For 1990, all chemical carriers transiting the Canal were less than 40,000 deadweight. In 2020 the average size of ship below 10,000 DWT is not expected to change from the average for north and southbound transits in 1990. This reflects both historical global developments and the deployment profile of vessels in this size range. For the 10,000 - 39,999 deadweight size range, the average size of chemical carrier is projected to increase by about 9% to equal the expected average for the global fleet in 2020. By 2020 it is anticipated also that some traffic will be in vessels in the 40,000 - 64,999 deadweight range with average deadweights of just over 45,000 deadweight, equal to that of the global fleet (Table 8.17).

Changes in the size distribution of the global fleet, leading to a gradual decline in the proportions of vessels in the below 10,000 deadweight and 10,000 - 39,999 deadweight size ranges, are reflected in the shifts in the percentage size distribution towards larger chemical carriers for both north and southbound trades (Table 8.17).

As a result of these changes, and the drift towards the utilization of larger vessels, the projected 105% increase in northbound cargo between 1990 and 2020 is accompanied by a 61% rise in the number of transits as may be seen in the comparison of chemical tanker transit data in Table 9.2 with the chemical tanker transit data in Table 9.1. For southbound transits the expected 240% increase in trade results in a 195% rise in the number of transits as may be seen by review of Tables 9.1 and 9.2.

Gas Carriers

Gas carrier traffic through the Canal is not significant and this is expected to remain the case in future. For vessels below 10,000 deadweight and between 40,000 and 64,999 deadweight average sizes are not expected to change in the period to 2020. In the 10,000-39,999 deadweight size range, the average size of a gas carrier is projected to increase to the equivalent of the global average by 2020 (Table 8.19).

Based on these developments, northbound laden gas carrier transits in 2020 are projected to decline by 17% to just 5 while those for southbound movements are estimated to increase by 9% to 123 although trade is forecast to rise by 36%.

Tankers

Based on the decision rules provided in section 9.1 o this report, average deadweights in 2020 in each size range for crude oil and petroleum products tankers transiting the Canal are expected to be at or marginally above 1990 averages. On a route by route basis we assume there will be a marginal shift in deadweight size distribution from the 10,000-39,999 deadweight size range up to the 40,000 - 64,999 deadweight range. However, because of changes in the relative importance of routes within the north and southbound totals caused by changes in absolute and relative volumes of trade through the Canal, a divergent picture emerges leading to a marginally greater concentration of vessels below 40,000 deadweight northbound and the opposite trend for southbound transits (Table 8.21).

As the overall average deadweight for northbound transits declines by 5% between 1990 and 2020 the reduction in trade of 51% results in a fall in the number of transits by around 48% Southbound, the conclusion is totally the reverse. The amount of cargo increases by 51% but, with a 5% rise in average deadweight, the number of transits are just 44% higher.

9.2.2 Status Quo Case, 2060

The methodology and underlying assumptions for 2060 and for each of the vessel types is elaborated below and the results shown in Table 9.3.

Container Breakbulk Ships

For 2060, little change is assumed in either the size distribution or the average deadweight by size range for this ship type on routes via the Panama Canal reflecting the unchanged position globally (Table 8.2). Therefore the number of transits are expected to increase in line with the overall growth in trade - about +55% northbound and 80% southbound compared to the 2020 forecasts.

Full Container Ships

The proportion of full container ships on Panama routes in the 40,000-65,000 DWT category is expected to be similar to that in 2020 while average sizes of ships in the 25,000 -39,999 deadweight and 40,000-65,000 DWT size ranges are expected to increase by 11.5% and 16.5% respectively. Both these trends reflect global developments (Table 8.4). As a result the projected growth in vessel transits is in the region of +15% while trade is estimated to

increase by around +25%. It is assumed that the gradual drift in trade towards the landbridge will continue to constrain growth in full container traffic through the Canal.

Conventional General Cargo Ships

We have assumed no further significant changes in the size distribution and average sizes of ships through the Canal in line with expectations regarding the development of the world fleet (Table 8.6). Nevertheless the aggregate effect of changes in trade developments on individual routes is such as to marginally reduce the overall average size of ships using the Canal. As a result, growth in the number of transits is expected to be slightly greater than that for trade volumes.

Refrigerated Cargo Ships

Due to the concentration of major, high volume refrigerated cargo routes via the Canal it is assumed that there will be an even greater concentration of vessels in the 10,000-25,000 DWT size range together with a continuing upward drift in ship sizes (Table 8.8). The rate of growth in the number of transits in both directions is estimated to be significantly below that for forecast trade.

Roll-On Roll-Off Ships

As a result of the expected reduced significance of these ships in terms of both global and Panama Canal trades, no growth is anticipated in the average size a vessel trading through the Canal. Numbers of transits therefore are expected to rise in line with trade estimates.

Vehicle Carriers

Growth in automobiles trade through the Canal will continue to be constrained by competition from the landbridge. Due to changes in the relative importance of vehicle carrier routes through the Canal, the overall average size of vehicle carrier on Canal routes is expected to decline marginally such that the expected rate of growth in transits is slightly greater than that for trade (Table 9.3).

Dry Bulk Carriers

The average deadweight for vessels in the range of 10-40,000 DWT has been increased by a lower rate than previously to reflects the comparative slowdown in global trade which has

a more significant impact on demand for ships in this size range than Panama Canal trades alone.

For this very long term scenario, the historical trend of no increase in the average deadweight for vessels up to 65,000 DWT has been over-ridden. The same growth rate as that applied to the smaller vessels from 2020 onwards has been utilized to represent a secular drift upwards in global size trends.

The average deadweight tonnage in the largest size range remains unchanged but there is a shift in deadweight distribution toward these vessels as the impact of earlier coal trade diversion is counter balanced by growth in grains and the more significant minor bulk trades. Underlying all of these assumptions is a long term view of greater convergence between global and Panama Canal transit fleet developments.

These assumptions result in an increased demand for transits of 53.7% southbound and 36% northbound with an increase in average vessel size of 18.6% southbound and 23% northbound.

Chemical Carriers

Growth of around 50% between 2020 and 2060 in chemicals trades through the Canal is expected to be accompanied by increases in the number of vessel transits by around 22% and 37% in southbound and northbound transits respectively. This is a consequence of both increases in average deadweights and proportional distribution in the size ranges above 10,000 DWT reflecting global trends.

Oil Tankers and Liquefied Petroleum Gas Carriers

Trades in crude oil/petroleum products and liquefied petroleum gases on routes through the Panama Canal are estimated to decline by 36-39% and 14-29% respectively in line with general developments in world oil trade. For oil tankers it is assumed that this downturn, in particular in crude oil trades through the Canal, will result in a lowering of the average size of vessel operating through the Canal. The relative decline in the number of vessel transits overall is therefore less than the fall in trade.

Table 9.1

1990 Vessel Transits (Status Quo)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	2	43	1	3	0	0	49
Average DWT	CB	6250	15004	31124	41691	0	0	16599
Transits	G	20	22	2	0	0	0	44
Average DWT	G	5689	15275	29913	0	0	0	11496
Transits	R	25	9	0	0	0	0	34
Average DWT	R	7416	14239	0	0	0	0	9410
Transits	V	5	51	0	0	0	0	56
Average DWT	V	8231	14336	0	0	0	0	13744
Transits	P	2	0	0	0	0	0	2
Average DWT	P	4641	0	0	0	0	0	4641

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	3	168	77	13	1	262
Average DWT	CD	4868	29802	49794	67960	83518	37325
Transits	CT	11	25	0	0	0	36
Average DWT	CT	8031	27533	0	0	0	21724
Transits	LP	38	55	18	0	0	111
Average DWT	LP	5464	15526	40605	0	0	16001
Transits	T	6	28	39	7	2	81
Average DWT	T	5254	31167	55065	69179	88008	44974
TOTAL TRANSITS		111	125** 278	137	19	3	676

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

1990 Vessel Transits (Status Quo)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	3	36	0	0	0	0	39
Average DWT	CB	7663	15001	33919	0	0	0	14605
Transits	G	19	23	1	0	0	0	43
Average DWT	G	5778	15158	30658	0	0	0	11509
Transits	R	359	182	0	0	0	0	541
Average DWT	R	7262	12122	0	0	0	0	8896
Transits	V	14	116	9	0	0	0	139
Average DWT	V	7209	14708	29692	0	0	0	14823
Transits	P	4	0	0	0	0	0	4
Average DWT	P	5497	0	0	0	0	0	5497

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	2	85	57	20	1	165
Average DWT	CD	4025	29079	52369	69008	83518	41785
Transits	CT	12	33	0	0	0	45
Average DWT	CT	7850	30588	0	0	0	24272
Transits	LP	6	14	3	0	0	23
Average DWT	LP	5036	16472	40605	0	0	16638
Transits	T	11	31	35	6	2	85
Average DWT	T	5799	29184	53591	69096	85885	40649
TOTAL TRANSITS		430	357**	173	95	26	3	1084

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

1990 Vessel Transits (Status Quo)

Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	14	399	6	28	0	0	447
Average DWT	CB	6250	15004	31124	41691	0	0	16599
Transits	F	6	118	310	143	0	0	577
Average DWT	F	9141	19969	32800	46483	0	0	33308
Transits	G	179	206	14	0	0	0	399
Average DWT	G	5689	15275	29913	0	0	0	11496
Transits	R	865	412	0	3	0	0	1280
Average DWT	R	7264	12177	0	61988	0	0	8965
Transits	RO	22	58	22	16	0	0	118
Average DWT	RO	5350	16116	32020	44029	0	0	20735
Transits	V	25	237	0	0	0	0	262
Average DWT	V	8231	14336	0	0	0	0	13744
Transits	P	34	0	0	0	0	0	34
Average DWT	P	4641	0	0	0	0	0	4641

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	15	780	357	59	3	1214
Average DWT	CD	4868	29802	49794	67960	83518	37325
Transits	CT	42	100	0	0	0	142
Average DWT	CT	8031	27533	0	0	0	21724
Transits	LP	2	3	1	0	0	6
Average DWT	LP	5464	15526	40605	0	0	16001
Transits	T	24	112	158	27	6	327
Average DWT	T	5234	31167	55065	69179	88009	44974
TOTAL TRANSITS		1228	1429**	1346	705	86	4806

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

1990 Vessel Transits (Status Quo)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	31	410	3	0	0	0	444
Average DWT	CB	7663	15001	33919	0	0	0	14605
Transits	F	12	139	295	81	0	0	527
Average DWT	F	6856	18592	32509	49651	0	0	30843
Transits	G	211	256	14	0	0	0	481
Average DWT	G	5778	15158	30658	0	0	0	11509
Transits	R	531	270	0	0	0	0	801
Average DWT	R	7262	12122	0	0	0	0	8896
Transits	RO	19	62	34	15	0	0	130
Average DWT	RO	5234	17059	30253	44034	0	0	22037
Transits	V	27	231	16	0	0	0	274
Average DWT	V	7209	14708	29692	0	0	0	14832
Transits	P	86	0	0	0	0	0	86
Average DWT	P	5497	0	0	0	0	0	5497

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	19	767	504	183	3	1476
Average DWT	CD	4025	29098	52369	69008	83518	41785
Transits	CT	60	155	0	0	0	215
Average DWT	CT	7850	30588	0	0	0	24272
Transits	LP	30	69	15	0	0	114
Average DWT	LP	5036	16472	40605	0	0	16638
Transits	T	51	152	163	30	12	408
Average DWT	T	5799	29184	53591	69096	85885	40649
TOTAL TRANSITS		1076	1368**	1505	778	213	15	4956

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

Table 9.2

2020 Vessel Transits (Status Quo)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	1	86	7	9	0	0	103
Average DWT	CB	7665	23500	28385	41690	0	0	25281
Transits	G	32	39	5	0	0	0	76
Average DWT	G	5734	22000	36229	0	0	0	16004
Transits	R	23	31	0	0	0	0	53
Average DWT	R	8415	13730	0	0	0	0	11476
Transits	V	10	82	5	0	0	0	97
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	158	163	45	0	366
Average DWT	CD	0	32000	51955	68745	0	45401
Transits	CT	22	78	6	0	0	106
Average DWT	CT	7920	31710	45250	0	0	27644
Transits	LP	32	58	31	0	0	120
Average DWT	LP	5070	18900	40600	0	0	20811
Transits	T	17	32	55	0	11	116
Average DWT	T	5630	31710	54300	0	74100	42664
TOTAL TRANSITS		142	237**	344	264	45	11	1043

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (Status Quo)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	67	6	13	0	0	86
Average DWT	CB	7665	23500	28385	41690	0	0	26600
Transits	G	20	33	3	0	0	0	56
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	509	567	0	0	0	0	1076
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	V	19	178	0	0	0	0	197
Average DWT	V	7760	14500	0	0	0	0	13866
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	136	88	12	0	236
Average DWT	CD	0	32000	51955	68745	0	41323
Transits	CT	20	49	3	0	0	72
Average DWT	CT	7920	31710	45250	0	0	25598
Transits	LP	7	8	4	0	0	19
Average DWT	LP	5070	18900	40600	0	0	17229
Transits	T	5	15	20	0	4	44
Average DWT	T	5630	31710	54300	0	74100	42592
TOTAL TRANSITS		586	845** 217	127	12	4	1790

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2020 Vessel Transits (Status Quo)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	511	43	100	0	0	654
Average DWT	CB	7665	23500	28385	41690	0	0	26600
Transits	F	2	280	538	490	0	0	1310
Average DWT	F	8740	19340	32660	48080	0	0	35109
Transits	G	159	250	27	0	0	0	436
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	1205	1341	0	0	0	0	2546
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	RO	0	86	34	3	0	0	123
Average DWT	RO	5785	16550	31115	44190	0	0	21302
Transits	V	35	336	0	0	0	0	371
Average DWT	V	7760	14500	29692	0	0	0	13866
Transits	P	106	0	0	0	0	0	106
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	1001	645	90	0	1736
Average DWT	CD	0	32002	51955	68745	0	41323
Transits	CT	64	154	10	0	0	228
Average DWT	CT	7920	31712	45250	0	0	25592
Transits	LP	2	2	1	0	0	5
Average DWT	LP	5070	18902	40600	0	0	17229
Transits	T	20	59	75	0	15 *	169
Average DWT	T	5630	31710	54300	0	74100 *	42592
TOTAL TRANSITS		1593	2804**	1858	1324	90	15	7684

Note: Due to rounding, totals may not be equal to the sum of the elements.

The asterisk (*) denotes that the relevant DWT range is 65,000 to 99,999

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2020 Vessel Transits (Status Quo)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	8	535	43	58	0	0	644
Average DWT	CB	7665	23500	28385	41690	0	0	25281
Transits	F	11	220	586	401	0	0	1218
Average DWT	F	8740	19340	32660	48080	0	0	35109
Transits	G	201	242	31	0	0	0	475
Average DWT	G	5734	22000	36229	0	0	0	16004
Transits	R	532	722	0	0	0	0	1253
Average DWT	R	8415	13730	0	0	0	0	11476
Transits	RO	1	94	49	57	0	0	201
Average DWT	RO	5783	16550	31115	44190	0	0	27898
Transits	V	50	402	24	0	0	0	476
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	159	0	0	0	0	0	159
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	891	916	254	0	2062
Average DWT	CD	0	32000	51955	68745	0	45401
Transits	CT	130	468	37	0	0	635
Average DWT	CT	7920	31710	45250	0	0	27644
Transits	LP	32	59	31	0	0	123
Average DWT	LP	5070	18900	40600	0	0	20811
Transits	T	88	163	277	0	58 *	587
Average DWT	T	5630	31710	54300	0	74100 *	42664
TOTAL TRANSITS		1212	2215** 2315	1778	254	58	4426

Note: Due to rounding, totals may not be equal to the sum of the elements.

The asterisk (*) denotes that the relevant DWT range is 65,000 to 99,999

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

Table 9.3

2060 Vessel Transits (Status Quo)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	125	9	14	0	0	148
Average DWT	CB	7810	23500	28470	41810	0	0	25544
Transits	G	57	61	7	0	0	0	125
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	20	70	0	0	0	0	90
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	V	19	104	5	0	0	0	129
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	196	211	152	0	559
Average DWT	CD	0	36500	59275	68745	0	53842
Transits	CT	15	98	17	0	0	129
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	27	45	20	0	0	92
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	9	22	35	5	0	71
Average DWT	T	5630	31710	54300	74100	0	42214
TOTAL TRANSITS		**154**	**361****	**381**	**297**	**156**	**0**	**1349**

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Status Quo)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	92	5	17	0	0	114
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	G	33	46	5	0	0	0	83
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	316	973	0	0	0	0	1289
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	V	24	211	0	0	0	0	234
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	141	128	52	0	321
Average DWT	CD	0	36500	59275	66745	0	50827
Transits	CT	29	61	9	0	0	99
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	6	7	2	0	0	16
Average DWT	LP	5070	18900	40600	0	0	18088
Transits	T	7	13	12	1	0	33
Average DWT	T	5630	31710	54300	74100	0	35863
TOTAL TRANSITS		423	1321**	232	167	53	0	2197

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Status Quo)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	830	49	156	0	0	1035
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	F	0	430	558	509	0	0	1497
Average DWT	F	0	19370	36400	56000	0	0	38179
Transits	G	308	424	45	0	0	0	777
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	748	2302	0	0	0	0	3050
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	RO	0	157	62	6	0	0	226
Average DWT	RO	6140	16550	31120	44190	0	0	21290
Transits	V	45	397	0	0	0	0	442
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	134	0	0	0	0	0	134
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	1035	944	382	0	2362
Average DWT	CD	0	36500	59275	66745	0	50827
Transits	CT	92	194	27	0	0	313
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	2	2	0	0	0	4
Average DWT	LP	5070	18900	40600	0	0	18088
Transits	T	28	48	45	6	0	127
Average DWT	T	5630	31710	54300	74100	0	35863
TOTAL TRANSITS		1357	4539**	1994	1688	388	0	9967

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Status Quo)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CB	0	975	69	110	0	0	1154
Average DWT	CB	7810	23500	28470	41810	0	0	25544
Transits	F	0	287	681	449	0	0	1418
Average DWT	F	0	19370	34600	56000	0	0	38296
Transits	G	446	478	52	0	0	0	976
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	466	1645	0	0	0	0	2111
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	RO	0	156	79	95	0	0	330
Average DWT	RO	6140	16550	31120	44190	0	0	27945
Transits	V	93	511	25	0	0	0	629
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	202	0	0	0	0	0	202
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 79,999	80,000+	TOTAL
Transits	CD	0	1106	1188	854	0	3148
Average DWT	CD	0	36500	59275	68745	0	53842
Transits	CT	87	584	101	0	0	772
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	28	46	20	0	0	94
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	48	110	177	24	0	359
Average DWT	T	5630	31710	54300	74100	0	42214
TOTAL TRANSITS		1370	4053**	2751	2140	878	0	11193

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

9.3 100,000 DWT Design Ship (Case 2)

9.3.1 2020 Projections (Table 9.4)

Because of the size distribution of the world fleet, the only changes from the status quo case (65,000 DWT design ship) for the year 2020 are in the categories of oil tankers, combined and dry bulk carriers, and full container ships. All other ships are well within the design specifications of the status quo canal.

We have assumed that the future Canal tolls rise in real terms in line with ship operating costs. Moreover for those freight evaluations where potential by-pass trades are via the Suez Canal we have assumed that the future increases from present tariff levels increase at the same rate as those for the Panama Canal. One interesting observation which has come out of this analysis, and an issue that would need to be addressed in any subsequent evaluation of toll pricing strategies, is that for equivalent vessel sizes Suez toll structures are increasingly more favorable for the larger the ship.

The approach to developing transit forecasts for 2020 for a 100,000 DWT Canal follows that previously described for the status quo case. Compared with the status quo case, potential changes in estimates in the volumes of trade and numbers of transits through the Canal arise through a combination of switching cargoes from by-pass landbridge and all-water routes together with a tendency - where such opportunities exist - for larger average ship sizes to transit the Canal. Decisions regarding cargo switching are made on the basis of estimated transportation economics for different alternatives. The shift towards the use of larger vessels has been determined with reference to anticipated global fleet developments.

Full Container Ships

The only general cargo ship type which we envisage as being affected by the year 2020 by a removal of the present Panama Canal size constraint is the full container ship.

In the global fleet in 1990, the largest container ship sizes are a little larger than the Panamax. There are technical and technoeconomic reasons why a gradual expansion of ship sizes beyond this point is unlikely in the case of full container ships. We and the shipping industry are of the opinion that a major step increase to ships very much larger than the present Panamax will eventually occur.

By the year 2020, we envisage considerable numbers of very large container ships with a

capacity of about 6000 TEU and a deadweight tonnage of about 90,000. In the case of the Panama Canal being enlarged to take 100,000 dwt ships, new traffic for the Canal from the larger container ships will be drawn from the major world routes which transit Panama and will have been constrained to smaller sizes, and potentially from the relatively minor container routes which pass through the Panama Canal.

We have carefully examined the routes in question and conclude that traffic from the large container ships will arise from only two routes:

- the major world route from the Far East to the United States East coast;
- the Panama Canal route US West coast to Europe.

It is in the nature of the liner trades for services to be generally in both directions. We therefore assume that scheduled services by the large container ships takes place both in the direction with largest trade volumes and in the reverse.

The liner routes, of which container trades are an example, have the characteristic of being served by a variety of operators and different sizes of vessel. For our calculations we have assumed that the large container ships secure about 40% of the traffic on the routes in which they take part.

The effect of the presence of larger container ships on the routes mentioned has been examined from the point of view of the economics of the landbridge. We have concluded that the low unit cost offered by the larger vessels will attract back to the Canal a certain quantity of cargo, about 10%, which would otherwise use the landbridge.

Dry Bulk Carriers.

By Pass Traffic.

Calculations of relative freight economics suggest that a Canal of 100,000 DWT would be of insufficient size to attract most dry bulk cargoes which currently bypass the Canal. An exception is the comparatively small volumes of bypass Colombian coal exported into the Northern Pacific Basin. The forecast 1.7305 m tonnes of bypass traffic in 2020 has been included in Canal traffic in this case.

For the 100,000 DWT Canal case, results from calculation of relative freight economics

suggest that there are no differences of substance between using Cape size vessels for the carriage of coal out of the U.S. Gulf on longer haul routes through the Canal. For the purposes of forecasting demand for Canal transits we have taken a conservative approach, and we have excluded these volumes from the U.S. Gulf. The reasons for this are as follows:

- by 2020 there will be a significant number of established bulk trades around the world which utilize vessels in excess of 125,000 DWT. For shipowners to commit to 100,000 DWT vessels in any extensive way through the Canal constrains their opportunity for profitable trading elsewhere, including routes for which cargo originates in the Pacific Basin.

- the use of larger vessels out of the Gulf is already a perceptible trend. By 2020 this will be a well established operating practice.

Additionally, we feel that a final decision as to whether this trade or a proportion of this trade will be attracted back to the Canal under this case will also depend upon actual toll levels and upon final Canal dimensions. The latter could determine the extent to which vessels larger than 100,000 DWT could transit this Canal economically.

Vessel size upgrading.

(1) Average deadweight for 65,000 - 100,000 DWT size.

We have assumed that once implementation of the larger Canal commences in or around 2000, the shipping industry will begin to construct larger "Panamax' tonnage to take account of the new Canal dimensions. At this point, the average size of vessel in this size range which is assumed to remain unchanged up to this point. will begin to increase in line with vessel size growth rates for smaller dry bulk carriers.

(2) Distribution of trade by ship size range.

For the status quo, the Canal represents a constraint on the amount of tonnage that can be shipped in vessels above 65,000 DWT. Nevertheless, as a proportion of the world dry bulk carrier fleet ships in the 40,000 - 70,000 DWT size range have increased in proportion by around 8% in the period 1978 - 1990. We assume that with the 100,000 DWT Canal a similar growth trend could be expected in the period up to 2020 for the 65,000 - 100,000 DWT size range as a whole.

Oil Tankers.

On the basis of estimated transportation economics, there is no case for switching additional cargoes through the Canal from alternative bypass traffic. Therefore, the only adjustments we have made are those which reflect a general drift towards the utilization of larger vessels which will result simply by virtue of a larger Canal. The average size of tanker in the 65,000 - 100,000 DWT size range is the equivalent of the estimated average size for the world fleet in this size range.

In line with normal commercial and operating practices, it is assumed that larger vessels will be utilized only in crude oil trades, and therefore we have effected adjustments on a route by route basis with crude oil shipments generally distributed in this large size range.

9.3.2. 2060 Projections (Table 9.5)

For the year 2060, as in the case of the 2020 projections, it is estimated that the development of the Panama Canal to accommodate vessels up to 100,000 DWT will affect estimates of future transits for dry bulk carriers, full container ships and oil tankers only.

Dry Bulk Carriers

For the 100.000 DWT Canal in 2060. freight calculations suggest that only the comparatively small volumes of Colombian coal into the northern Pacific would be attracted to voyages via the Panama Canal. As discussed previously, coal from the US Gulf into the Northern Pacific Basin has been excluded at this stage.

Vessel Size Upgrading

(1) Average Deadweights

The average sizes of vessels in the 10,000 - 40,000 DWT range and the 40.000 - 65,000 DWT range are as in the 2060 status quo canal forecast. It is assumed that the average size of vessels in the 65,000 - 100,000 DWT range will continue to increase in line with vessel size growth rates for smaller dry bulk carriers.

(2) Distribution of Trade by Ship Type

For southbound vessel sailings, it is assumed that there will continue to be a shift towards

the larger size range. For northbound transits there is a similar shift but at a decreased rate, given the significance of minor bulk trades on the route.

Full Container Ships

It is assumed that the employment of the 6,000 TEU vessels - introduced into the transit forecasts for Case 2, 2020 - will increase further in 2060 on those routes where the volume of trade is sufficient to justify their use. Whereas for 2020 we assumed that these ships secured about 40% of the traffic on such routes, by 2060 we anticipate this proportion will have grown to 60%.

As for Case 2, 2020 we have concluded that the low unit costs offered by these 6,000 TEU vessels will attract back to the Canal a certain quantity of cargo, about 10%, which under the status quo case would otherwise switch to the landbridge. However, the extent to which the Canal could be expected to attract cargo back from the landbridge is assumed to be constrained by the capability of those ocean routes supplying the landbridge to utilize the more competitive 9.000 TEU (148.000 DWT) ships which it is assumed will be employed on major routes by 2060.

Oil Tankers

As for Case 2, 2020 there is no case for switching additional cargoes through the Canal compared with the status quo case. The 100,000 DWT Canal is not sufficient, on the basis of estimated transportation economics, to attract traffic from the limited amount of by pass traffic that exists.

It is assumed that average tanker sizes by deadweight size range will be the same as those for Case 2, 2020 in line with global fleet developments. As a consequence of the general trend of falling oil trade volumes between 2020 and 2060 upward adjustments to vessel size distribution as compared with the status quo, 2060 case, are limited to those few trades on which there remains some crude oil trade.

Table 9.4

2020 Vessel Transits (CASE 2: 100,000 DWT CANAL)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	1	83	7	9	0	0	99
Average DWT	CB	7665	23500	28385	41690	0	0	25281
Transits	G	31	37	5	0	0	0	73
Average DWT	G	5734	22000	36229	0	0	0	16004
Transits	R	23	31	0	0	0	0	53
Average DWT	R	8415	13730	0	0	0	0	11476
Transits	V	10	82	5	0	0	0	97
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	130	126	78	0	334
Average DWT	CD	0	32000	51955	82959		51371
Transits	CT	22	78	6	0	0	106
Average DWT	CT	7920	31710	45250	0	0	27644
Transits	LP	32	58	31	0	0	120
Average DWT	LP	5070	18900	40600	0	0	20811
Transits	T	17	32	41	16	0	107
Average DWT	T	5430	31710	54300	89730	0	44838
TOTAL TRANSITS		141	233**	316	213	94	0	995

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 2: 100,000 DWT CANAL)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	63	5	12	0	0	81
Average DWT	CB	7665	23500	28385	41690	0	0	26600
Transits	G	19	31	3	0	0	0	52
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	509	567	0	0	0	0	1076
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	V	19	178	0	0	0	0	197
Average DWT	V	7760	14500	0	0	0	0	13866
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	121	65	28	0	213
Average DWT	CD	0	32000	51955	82120		44584
Transits	CT	20	49	3	0	0	72
Average DWT	CT	7920	31710	45250	0	0	25598
Transits	LP	7	8	4	0	0	19
Average DWT	LP	5070	18900	40600	0	0	17229
Transits	T	5	15	17	5	0	42
Average DWT	T	5630	31710	54300	89730	0	42592
TOTAL TRANSITS		585	839**	202	101	33	0	1758

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2020 Vessel Transits (CASE 2: 100,000 DWT CANAL)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	511	43	100	0	0	654
Average DWT	CB	7665	23500	28385	41690	0	0	26600
Transits	F	2	281	428	299	151	0	1161
Average DWT	F	8740	19340	32660	48080	90000	0	40814
Transits	G	159	250	27	0	0	0	436
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	1205	1341	0	0	0	0	2546
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	RO	0	86	34	3	0	0	123
Average DWT	RO	5785	16550	31115	44190	0	0	21302
Transits	V	35	336	0	0	0	0	371
Average DWT	V	7760	14500	29692	0	0	0	13866
Transits	P	106	0	0	0	0	0	106
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,000	100,000+	TOTAL
Transits	CD	0	889	475	205		1569
Average DWT	CD	0	32000	51955	82120		44584
Transits	CT	64	154	10	0	0	228
Average DWT	CT	7920	31710	45250	0	0	25598
Transits	LP	2	2	1	0	0	5
Average DWT	LP	5070	18900	40600	0	0	17229
Transits	T	20	59	66	18	0	163
Average DWT	T	5630	31710	54300	89730	0	42592
TOTAL TRANSITS		1593	2805**	1637	954	374	0	7362

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 2: 100,000 DWT CANAL)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	8	535	43	58	0	0	644
Average DWT	CB	7665	23500	28385	41690	0	0	25281
Transits	F	11	220	557	202	131	0	1121
Average DWT	F	8740	19340	32660	48080	90000	0	39315
Transits	G	201	242	31	0	0	0	475
Average DWT	G	5734	22000	36229	0	0	0	16004
Transits	R	532	722	0	0	0	0	1253
Average DWT	R	8415	13730	0	0	0	0	11476
Transits	RO	1	94	49	57	0	0	201
Average DWT	RO	5783	16550	31115	44190	0	0	27898
Transits	V	50	402	24	0	0	0	476
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	159	0	0	0	0	0	159
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,000	100,000+	TOTAL
Transits	CD	0	735	708	438		1881
Average DWT	CD	0	32000	51955	82959		51371
Transits	CT	130	468	37	0	0	635
Average DWT	CT	7920	31710	45250	0	0	27644
Transits	LP	32	59	31	0	0	123
Average DWT	LP	5070	18900	40600	0	0	20811
Transits	T	88	163	209	81	0	541
Average DWT	T	5630	31710	54300	89730	0	44838
TOTAL TRANSITS		1212	2215**	2130	1303	649	0	7509

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

Table 9.5

2060 Vessel Transits (Case 2:100,000 DWT)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	121	9	14	0	0	143
Average DWT	CB	7810	23500	28470	41810	0	0	25564
Transits	G	55	59	6	0	0	0	121
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	20	70	0	0	0	0	90
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	V	19	104	5	0	0	0	129
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	176	183	143	0	502
Average DWT	CD	0	36500	59275	93892	0	61135
Transits	CT	15	98	17	0	0	129
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	27	45	20	0	0	92
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	9	22	32	6	0	70
Average DWT	T	5630	31710	54300	89730	0	43556
TOTAL TRANSITS		153	355** 360	266	149	0	1281

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 2:100,000 DWT)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	89	5	17	0	0	111
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	G	32	45	5	0	0	0	80
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	316	973	0	0	0	0	1289
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	V	24	211	0	0	0	0	234
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	141	113	46	0	300
Average DWT	CD	0	36500	59275	93685	0	53926
Transits	CT	29	61	9	0	0	99
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	6	7	2	0	0	16
Average DWT	LP	5070	18900	40600	0	0	18088
Transits	T	7	13	12	1	0	33
Average DWT	T	5630	31710	54300	89730	0	36137
TOTAL TRANSITS		422	1317**	231	151	48	0	2169

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 2:100,000 DWT)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	830	49	156	0	0	1035
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	F	0	415	473	281	207	0	1376
Average DWT	F	0	19370	36400	56000	90000	0	43312
Transits	G	308	424	45	0	0	0	777
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	748	2302	0	0	0	0	3050
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	RO	0	157	62	6	0	0	226
Average DWT	RO	6140	16550	31120	[illegible]190	0	0	21290
Transits	V	45	397	0	0	0	0	442
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	134	0	0	0	0	0	134
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	1035	830	342	0	2207
Average DWT	CD	0	36500	59275	93685	0	53926
Transits	CT	92	194	27	0	0	313
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	2	2	0	0	0	4
Average DWT	LP	5070	18900	[illegible]0600	0	0	18088
Transits	T	28	48	45	5	0	126
Average DWT	T	5630	31710	54300	89730	0	36137
TOTAL TRANSITS		1357	4525	1908	1345	553	0	9690

Note: Due to rounding, totals may not be equal to the sum of the elements.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 2:100,000 DWT)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	975	69	110	0	0	1154
Average DWT	CB	7810	23500	28470	41810	0	0	25544
Transits	F	0	245	583	258	209	0	1294
Average DWT	F	0	19370	34600	56000	90000	0	44941
Transits	G	446	478	52	0	0	0	976
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	466	1645	0	0	0	0	2111
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	RO	0	156	79	95	0	0	330
Average DWT	RO	6140	16550	31120	44190	0	0	27945
Transits	V	93	511	25	0	0	0	629
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	202	0	0	0	0	0	202
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	990	1033	804	0	2827
Average DWT	CD	0	36500	59275	93892	0	61135
Transits	CT	87	584	101	0	0	772
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	28	46	20	0	0	94
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	48	110	164	29	0	351
Average DWT	T	5630	31710	54300	89730	0	43556
TOTAL TRANSITS		1370	4011**	2537	1781	1043	0	10740

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

9.4 150,000 DWT Design Ship (Case 3)

9.4.1 2020 Projections (Table 9.6)

As for Case 2 (100,000 DWT Canal) the focus for potential changes in trade volumes, vessel size and distribution and average ship deadweight passing through the Canal relates to dry bulk carriers, full container ships and oil tankers. In summary, the only significant changes in comparison to 2020, Case 2 relate to the switching of by-pass traffic in the dry bulk carrier sector. For full container ships, the new ship size of 148,000 DWT which would in theory be able to take advantage of the larger Canal is not assumed to exist until after 2020. For oil tankers no changes have been assumed either in the volume of trade or size composition of the fleet passing through the Canal.

Full Container Ships

Based on WEFA's estimates of global container trade, it has been assumed that the development of our hypothesized 148,000 DWT, 9,000 TEU full container ship will not take place until after 2020. It is assumed that the largest ship size in the global fleet in 2020 will be 90,000 DWT - 6.000 TEU - and therefore will already be able to transit the Canal under Case 2. The transit forecasts for full container ships in 2020 are therefore the same in Case 3 as under Case 2.

Oil Tankers

(i) Existing Trade

For reasons as described under case 2, 2020 it is assumed that only the limited number of crude oil trades estimated to pass through the Canal could be considered for potential employment of larger tankers. Under Case 2 it is considered reasonable to assume the use of vessels approaching 100,000 DWT on these routes. However, either because the volume of trade on individual routes is too small or because the nature of the trade - in most cases short haul and/or involving restricted port facilities - it is assumed that there will not be significant opportunities on existing Panama trades to utilize oil tankers in the 100,000 - 149,999 DWT size range.

(ii) By Pass Trade

Potential by pass trades for conventional oil cargoes are essentially limited to trade from S.E.

Asia to the U.S. East Coast and the Caribbean. In 1990 sailings on these routes in tankers of over 100,000 DWT totalled 4.6 million deadweight. However the freight economics of utilizing vessels up to 150,000 DWT in these trades via the Panama Canal are less favorable than employing similar size tankers via the Cape of Good Hope or the Suez Canal.

(iii) Orimulsion

Orimulsion is a stabilized bitumen/water emulsion produced in the Orinoco area. It is marketed as a boiler fuel for power generation and is transported in normal oil tankers with characteristics which enable efficient heating and temperature maintenance of the cargo. The volume of cargo moving to the North Pacific (Japan) is currently equivalent to 600,000 tonnes per annum and this is expected to rise to 14 million tonnes in 2020.

Although initially cargoes are being shipped in Panamax size vessels, Bitor - the company which produces Orimulsion - plans to develop its loading facilities such that as the volume of sales increase, VLCCs can eventually be loaded. Therefore, in determining the long term potential for attracting orimulsion trade through the Panama Canal, the basis for comparison is the maximum size that can be accommodated by the Canal versus a VLCC on the route via the Cape of Good Hope. For the case where the Canal is limited to 150,000, DWT a comparison of potential tanker freight costs alone indicates a clear incentive to utilize the VLCC on the by pass route. If it is assumed that use of the larger vessel will incur additional trans-shipment fees in the importing region, the advantage becomes marginal, although much may depend also on the level of Panama Canal tolls. Therefore in line with our general approach to this study we have not assumed under Case 3, 2020, that Orimulsion trade to Japan and Korea will be routed through the Panama Canal. It may be that toll pricing strategies could be developed that would attract this business as the result of which southbound laden tanker traffic would increase by around 100 vessels.

Dry Bulk Carriers

(i) Average Deadweight

It has been assumed that the average deadweight of vessels between 100,000 and 150,000 transiting the Canal will be the same as the global average deadweight in 2020. This average deadweight, at 134,700 DWT, represents a secular drift upwards from the 1990 figure of 126,484 DWT in line with historical increases in the size of vessels in this range and reflecting aggregate global demand increases over this time period.

The average deadweight of vessels between 100,000 and 150,000 transiting the Canal are derived from the global average deadweight in 2020.

(ii) Distribution by Size Range.

For all but two existing Canal trades, it is assumed that there will be no further shifts in the distribution of cargoes between size ranges of vessel due to the nature and volume of these cargoes. The exceptions are coal and coke from Canada West Coast into Europe and coal from Colombia to Asia. Both of these trades are of sufficient volumes to support the use of larger vessels and both areas currently load vessels in excess of 100,000 DWT.

Detailed comparisons of vessel economics have been carried out for an additional seven routes where it is possible that dry bulk trades will be attracted through the Canal (see Section 7). Based upon these calculations, cargo from three routes has been assumed to transit the Canal. These are coal from the U.S. East Coast to the Northern Pacific Basin, coal from the US Gulf coast to the Northern Pacific Basin and iron ore from the Canadian East Coast to Asia.

65% of coal cargoes in large ships from the U.S. East Coast are loaded in vessels below 150,000 DWT with the remainder in vessels between 150,000 and 250,000 DWT. However, vessels in the larger size range are generally "topped off" elsewhere, and the resulting rate levels from the US East Coast are comparable to those for the smaller vessels. As a result, all of this by-pass traffic has been diverted through the Canal. Similarly, around 85% of large vessels loading in the U.S. Gulf are in the size range between 100,000 and 150,000 DWT. The remainder are in the 150,000 to 250,000 range and are also "topped off". For the reasons described above therefore, all of this trade is diverted through the Canal in 2020. Based on loading patterns and relative freight economics, 27% of the volumes of iron ore shipped from the Canadian East Coast to the Northern Pacific Basin are diverted through the Canal in this case.

9.4.2 2060 Projections (Table 9.7)

In comparison with our 2060 estimates for Case 2 (100,000 DWT canal) it is estimated that only in respect of full containerships and dry bulk carriers will the expansion of the canal to accommodate ships up to 150,000 DWT result in changes in vessel sizes and the number of transits. For oil tankers, no changes are envisaged by comparison with our estimates for Case 2, 2060. This is the same conclusion reached in our comparison of Case 2 and 3 for 2020. The reasons for assuming no change in Case 3, 2060 are the same as those described

in the presentation of our results for Case 3, 2020. If anything, the envisaged downturn in oil trade in the period between 2020 and 2060 makes it even more likely that enlargement of the Canal from 100,000 DWT to 150,000 DWT would have no impact on oil tanker transits.

Full Container Ships

By 2060 it is assumed that the largest size of container ship will have increased to 9,000 TEU (148,000 DWT). Therefore some utilization of 148,000 DWT vessels has been assumed under this case for those Panama routes on which it is expected that the volume of trade will be sufficiently large in both directions to support a viable service using these larger ships - in particular USEC to Far East and Far East to USEC. The introduction of these new ships is assumed to be limited to those routes which previously utilized 6,000 TEU (90,000 DWT) vessels, the other new full containership size not currently in existence but which it is assumed will be introduced by 2020. The apportionment of the trade assumed available to these larger ship sizes between the 6,000 and 9,000 TEU ships has been determined with reference to the volume of trade on individual routes and the size distribution of larger vessels currently employed on these routes.

Dry Bulk Carriers

(i) Average Deadweights

As for 2020, the average deadweight of vessels in the 100,000 to 150,000 deadweight range are derived from the global average deadweight. The average deadweight, at 140,475 tons, has been derived as part of an exercise to derive average deadweights of all relevant ship sizes to ensure consistency of approach. While the size continues to increase from 2020, the rate of increase is lower, reflecting the lower trade growth rates in the period 2020 to 2060.

The average deadweights of other size ranges of vessel remain as in the previous Canal case for 2060.

(ii) Distribution by Size Range.

As for 2020, it has been assumed that two existing Canal trades, coal from Canada West Coast into Europe and coal from Colombia into Asia, will move in vessels averaging 140,475 deadweight.

On a basis of detailed comparisons of relative vessel economics, all coal cargoes from the US East and Gulf coasts into the Northern Pacific Basin are routed through the Panama Canal as in 2020 Case 3. These comparisons suggest that carriage of coal in vessels of 140,475 deadweight through the Canal is marginally less expensive to the shipper than using vessels in the 150,000 to 250,000 deadweight range via the Cape as well as being clearly less expensive than using vessels of 140,475 deadweight via the Cape.

For 2060, iron ore from the Canadian East Coast into the Northern Pacific Basin has not been routed through the Canal (as in 2020 Case 3) as the small proportion of vessels originally in this size range on this route is expected to be phased out by 2060.

Detailed vessel economics comparisons for other potential by-pass traffic suggest that there are no other trades for which there is a clear-cut case of switching to Canal routings.

Table 9.6

2020 Vessel Transits (CASE 3: 150,000 DWT CANAL)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CB	1	83	7	9	0	0	99
Average DWT	CB	7665	23500	28385	41690	0	0	2528[illegible]
Transits	G	31	37	5	0	0	0	73
Average DWT	G	5734	22000	36229	0	0	0	160[illegible]
Transits	R	23	31	0	0	0	0	53
Average DWT	R	8415	13730	0	0	0	0	1147[illegible]
Transits	V	10	82	5	0	0	0	97
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	0 to 9,999	DWT Range 10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CD	0	130	126	74	83	[illegible]
Average DWT	CD	0	32000	51955	82120	134700	677[illegible]
Transits	CT	22	78	6	0	0	106
Average DWT	CT	7920	31710	45250	0	0	276[illegible]
Transits	LP	32	58	31	0	0	121
Average DWT	LP	5070	18900	40600	0	0	208[illegible]
Transits	T	17	33	41	16	0	107
Average DWT	T	5630	31710	54300	89730	0	44833
TOTAL TRANSITS		141	233**	317	213	90	1075

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 3: 150,000 DWT CANAL)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CB	0	63	5	12	0	0	81
Average DWT	CB	0	23500	28385	41690	0	0	26600
Transits	G	19	31	3	0	0	0	52
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	509	567	0	0	0	0	1076
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	V	19	178	0	0	0	0	197
Average DWT	V	7760	14500	0	0	0	0	13866
Transits	P	5	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CD	0	121	65	25	2	212
Average DWT	CD	0	32000	51955	82120	137400	44860
Transits	CT	20	49	3	0	0	72
Average DWT	CT	7920	31710	45250	0	0	25598
Transits	LP	7	8	4	0	0	19
Average DWT	LP	5070	18900	40600	0	0	17229
Transits	T	5	15	17	5	0	42
Average DWT	T	5630	31710	54300	89730	0	42592
TOTAL TRANSITS		585	839**	202	101	29	1757

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 3: 150,000 DWT CANAL)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CB	0	511	43	100	0	0	654
Average DWT	CB	0	23500	28385	41690	0	0	26600
Transits	F	2	281	428	299	151	0	1161
Average DWT	F	8740	19340	32660	48080	90000	0	40814
Transits	G	159	250	27	0	0	0	436
Average DWT	G	5735	22000	36230	0	0	0	16969
Transits	R	1205	1341	0	0	0	0	2546
Average DWT	R	8415	13730	0	0	0	0	11214
Transits	RO	0	86	34	3	0	0	123
Average DWT	RO	0	16550	31115	44190	0	0	21302
Transits	V	35	336	0	0	0	0	371
Average DWT	V	7760	14500	29692	0	0	0	13866
Transits	P	106	0	0	0	0	0	106
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CD	0	890	475	181	14	1560
Average DWT	CD	0	32000	51955	82120	137400	44860
Transits	CT	64	154	10	0	0	228
Average DWT	CT	7920	31710	45250	0	0	25598
Transits	LP	2	2	1	0	0	5
Average DWT	LP	5070	18900	40600	0	0	17229
Transits	T	20	59	66	18	0	163
Average DWT	T	5630	31710	54300	89730	0	42592
TOTAL TRANSITS		1593	2805**	1638	954	350	14	7353

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 3: 150,000 DWT CANAL)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CB	8	535	43	58	0	0	644
Average DWT	CB	7665	23500	28385	41690	0	0	25281
Transits	F	11	220	557	202	131	0	1121
Average DWT	F	8740	19340	32660	48080	90000	0	39315
Transits	G	201	242	31	0	0	0	475
Average DWT	G	5730	22000	36229	0	0	0	16004
Transits	R	532	722	0	0	0	0	1253
Average DWT	R	8715	13730	0	0	0	0	11476
Transits	RO	1	94	49	57	0	0	201
Average DWT	RO	5753	16550	31115	44190	0	0	27898
Transits	V	50	402	24	0	0	0	476
Average DWT	V	7760	14500	29692	0	0	0	14539
Transits	P	159	0	0	0	0	0	159
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 150,000	TOTAL
Transits	CD	0	735	708	417	470	2330
Average DWT	CD	0	32000	51955	82120	134700	67754
Transits	CT	130	468	37	0	0	635
Average DWT	CT	7920	31710	45250	0	0	27644
Transits	LP	32	59	31	0	0	123
Average DWT	LP	5070	18900	40600	0	0	20811
Transits	T	88	163	209	81	0	541
Average DWT	T	5630	31710	54300	89730	0	44838
TOTAL TRANSITS		1212	2215**	2130	1303	629	470	7958

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

Table 9.7

2060 Vessel Transits (Case 3:150,000 DWT)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	120	9	14	0	0	143
Average DWT	CB	7810	23500	28470	41810	0	0	25544
Transits	G	55	59	6	0	0	0	120
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	20	70	0	0	0	0	90
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	V	19	104	5	0	0	0	127
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	176	183	138	109	606
Average DWT	CD	0	36500	59275	93685	140475	75064
Transits	CT	15	98	17	0	0	130
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	27	45	20	0	0	92
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	9	22	32	6	0	70
Average DWT	T	5630	31710	54300	89730	0	43556
TOTAL TRANSITS		152	354**	360	266	144	109	1384

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Case 3:150,000 DWT)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	88	5	17	0	0	110
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	G	32	44	5	0	0	0	81
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	316	973	0	0	0	0	1289
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	V	24	211	0	0	0	0	235
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	7	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	141	113	44	1	299
Average DWT	CD	0	36500	59275	93685	140475	54058
Transits	CT	29	61	9	0	0	99
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	6	7	2	0	0	15
Average DWT	LP	5070	15900	40600	0	0	18088
Transits	T	7	13	12	1	0	33
Average DWT	T	5630	31710	54300	89730	0	36137
TOTAL TRANSITS		421	1315**	231	151	45	2168

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 3:150,000 DWT)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	830	49	156	0	0	1035
Average DWT	CB	7810	23500	28470	41810	0	0	26498
Transits	F	0	415	473	281	126	49	1344
Average DWT	F	0	19370	36400	56000	90000	148000	44330
Transits	G	308	424	45	0	0	0	777
Average DWT	G	5810	22000	36230	0	0	0	16391
Transits	R	748	2302	0	0	0	0	3050
Average DWT	R	9530	15540	0	0	0	0	14064
Transits	RO	0	157	62	6	0	0	225
Average DWT	RO	6140	16550	31120	44190	0	0	21290
Transits	V	45	397	0	0	0	0	442
Average DWT	V	7760	14500	0	0	0	0	13816
Transits	P	134	0	0	0	0	0	134
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	1035	830	326	10	2201
Average DWT	CD	0	36500	59275	93685	140475	54058
Transits	CT	92	194	27	0	0	313
Average DWT	CT	7920	35120	50120	0	0	28423
Transits	LP	2	2	0	0	0	4
Average DWT	LP	5070	18900	40600	0	0	18088
Transits	T	28	48	45	5	0	126
Average DWT	T	5630	31710	54300	89730	0	36137
TOTAL TRANSITS		1357	4525**	1908	1345	456	59	9652

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 3:150,000 DWT)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CB	0	975	69	110	0	0	1154
Average DWT	CB	7810	23500	28470	41810	0	0	25544
Transits	F	0	245	583	258	135	45	1265
Average DWT	F	0	19370	34600	56000	90000	148000	45979
Transits	G	446	478	52	0	0	0	976
Average DWT	G	5810	22000	36230	0	0	0	15357
Transits	R	466	1645	0	0	0	0	2111
Average DWT	R	9530	15540	0	0	0	0	14213
Transits	RO	0	156	79	95	0	0	330
Average DWT	RO	6140	16550	31120	44190	0	0	27945
Transits	V	93	511	25	0	0	0	629
Average DWT	V	7760	14500	29690	0	0	0	14103
Transits	P	202	0	0	0	0	0	202
Average DWT	P	5069	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000+	TOTAL
Transits	CD	0	990	1033	777	612	3412
Average DWT	CD	0	36500	59275	93685	140475	75064
Transits	CT	87	584	101	0	0	772
Average DWT	CT	7920	35120	50120	0	0	34006
Transits	LP	28	46	20	0	0	94
Average DWT	LP	5070	18900	40600	0	0	19411
Transits	T	48	110	164	29	0	351
Average DWT	T	5630	31710	54300	89730	0	43556
TOTAL TRANSITS		1370	4011**	2537	1781	941	657	11296

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

9.5 250,000 DWT Design Ship (Case 4)

9.5.1 2020 Projections (Table 9.8)

For this case potential changes in the demand for ship transits as compared with the projections already provided under Case 3 (150,000 DWT Canal). 2020 are confined only to dry bulk carriers and tankers. No further changes are considered likely with respect to full container ships. In 2020 it is assumed that the largest size of full container ship will be 90.000 DWT which therefore will be already capable of transiting the Canal under Cases 2 and 3. Even by 2060 we do not envisage a ship size exceeding 148,000 DWT which will already be able to transit the Canal under Case 3.

Dry Bulk Carriers

(i) **Average Deadweights**

As previously, it has been assumed that the average of vessels between 150.000 and 250.000 DWT transiting the Canal will be the same as the global average deadweight in 2020. This average, at 183355 DWT compares with a figure of 182260 DWT in 1990 for dry bulk carriers plus combined carriers trading in the dry bulk markets. The increase from the 1990 figure reflects the historical trend.

The average deadweights of other size ranges of vessel remain as in the previous Canal case for 2020.

(ii) **Distribution by Size Range and Additional By Pass Traffic**

For southbound transits, it is expected that there will be a change in the distribution of vessels carrying Colombian coal into Asia. This reflects the global trend of a significant shift in the size of vessels carrying coal on main routes from the 100.000 - 150.000 DWT size range to 150,000 - 250,000 DWT. As a result 0.86 m tonnes of coal is shifted to this larger size range. It should be noted however that it has been assumed that coal from the USEC to Asia will remain in vessels averaging 134,700 DWT because of the likelihood of continuing port constraints. If port developments did take place however, we would expect 50% of the 51 m tonnes of coal on this route in 2020 shifting to the 150.000 - 250,000 DWT size range. This would have the impact of total southbound sailings of reducing transits in the 100,000 - 150.000 DWT range to 237, increasing transits in the 150,000 - 250.000 DWT range to 181 and reducing total transits to 2279.

By pass iron ore from Venezuela to Asia, which amounts to 0.47 m tonnes in 2020 and which currently moves in vessels between 150.000 and 250.000 DWT, has been routed through the Canal in this case. Similarly, additional iron ore from the Canadian east coast to Asia, which currently moves in vessels of 150.000 - 250,000 DWT and which amounts to 1.0 m tonnes in 2020, has also been routed through the Canal under this case.

There is no additional trade attracted through the Canal northbound. Following the global trend in coal shipments, 50% of the 1.5 m tonnes shipped from the Canadian West coast to Europe is shifted from vessels averaging 134,700 DWT to vessels averaging 1183,355 DWT.

(iii) South American By Pass Iron Ore Traffic

Brazil

Exports from Brazil to the Northern Pacific Basin in 1990 amounted to 42.5 m tonnes. These volumes are expected to increase to 89.78 m tonnes in 2020 before falling back to 58.87 m tonnes in 2060. Of the 1990 volumes, it is estimated that 13.5 m tonnes were shipped form Ponta da Madeira, the export port for Carajas production. On the basis of expected future production developments, 29.62 m tonnes of Carajas ore will be shipped to the Northern Pacific Basin in 2020 and 19.43 m tonnes in 2060. It is these latter volumes of Carajas ore which represent Canal by pass traffic. Our best estimate is that these volumes are currently shipped 25% in vessels of 100.000 - 150.000 DWT, 53% in vessels of 150.000 - 250,000, 11% in vessels of 250.000 - 300.000 DWT and 11% in vessels in excess of 300.000 DWT. By 2020 it is expected that the pattern of vessel distribution will have shifted to 10%, 40%, 35% and 15% respectively. By 2060, it is expected that the pattern will have shifted further so that around 25% will be shipped in vessels of 150,000 - 250,000 DWT, 53% in vessels of 250,000 - 300,000 DWT and 22% in vessels in excess of 300,000 DWT.

On the basis of relative vessel economics, a decision to shift these trades from voyages via the Cape to using the Canal is very marginal. In line with the approach described previously, where the decision is marginal, the shift has not been made. In line with our terms of reference existing toll rates, rather than a parametric approach to toll rate definition, are being utilized within voyage calculations. These rates have been increased in real terms in line with real operating cost increases for dry bulk carriers in each of the two time periods under review. It is clear however that with a different toll rate structure from that prevailing in FY1990, iron ore traffic and transits could be attracted through the Canal dependent upon the maximum vessel size that could transit the Canal.[1] On the basis

of the vessel distribution patterns described above, there could be a maximum of 26 sailings in the 100,000 - 150,000 DWT size range in 2020 under Case 3 and Case 4 and 77 sailings in the 150,000 - 250,000 DWT size range under Case 4.

Chile

It is estimated that there is approximately 1 m tonnes of iron ore being shipped from northern Chile (the Huasco Bay area) into Europe and that around 34% of these volumes are being shipped in vessels of 100,000 - 150,000 DWT and the remainder in vessels of 150,000 - 250,000 DWT. These trades are again marginal from the perspective of a shift through the Canal and comments made above regarding toll levels also apply in this instance.

Oil Tankers

No change is envisaged in the conventional oil trades via the Panama Canal as compared with estimates of oil tanker transits under Cases 2 and 3. However the capability of the Canal, under Case 4, to accept a small VLCC (Very Large Crude Carrier) up to 250,000 DWT would mean that it would become economic to transport Venezuelan Orimulsion to the Far East via the Canal rather than the alternative Cape route.

As discussed above, it is estimated that shipments of Orimulsion to the Far East will reach 14 million tonnes in 2020. On the basis of expected developments on tanker sizes in the range 150,000 to 249,999 DWT a representative size of 238,000 DWT in 2020 has been assumed. As a result, the number of projected southbound laden tanker transits in 2020 under Case 4 is estimated to be 62 more than indicated for Cases 2 and 3.

9.5.2 2060 Projections (Table 9.9)

Dry Bulk Carriers

It has been assumed that the average vessel size between 150,000 and 250,000 deadweight transiting the Canal will be the same as the global average deadweight in 2060. This average is 184090 deadweight.

The average deadweights of other size ranges of vessel remain as in the previous Canal case for 2060.

For southbound transits it is assumed that additional cargoes of Venezuelan iron ore to the North Pacific Basin and Canadian East coast iron ore to the North Pacific Basin will be attracted through the Canal in this case. In total, this amounts to an additional 2755.5 m tonnes of cargo in vessels averaging 184090 deadweight compared to Case 3 in 2060 and follows the trend described above for Case 4 in 2020.

By 2060 it is assumed that there will have been further developments in US ports stimulated by the availability of a Panama Canal that allows transits of vessels up to 250,000 deadweight such that coal from the US to the Northern Pacific Basin is shipped in vessels averaging 184090 deadweight, following the trend previously for Case 4 in 2020. As a result there is a re-distribution of vessel sizes on these trades compared to Case 3 2060. Similarly, it is assumed that Colombian coal to the Far East will move in vessels averaging 184090 deadweight via the Canal compared to vessels averaging 140075 deadweight in the previous case.

These re-distributions bring these Canal coal trades more into line with expected global trends in the size range of vessels expected to carry coal on major routes by 2060.

For northbound transits, there is no additional cargo under this case compared to Case 3 2060. There is however a shift in the size distribution of vessels carrying coal from the Canadian West coast into Europe from vessels averaging 140475 deadweight to vessels averaging 184090 deadweight reflecting the expected global trend.

As discussed above under Case 4 in 2020, on the basis of relative vessel economics, a decision to shift Brazilian iron ore trades through the Canal is marginal and, as such, the shift has not been made in this 'base case'. By 2060, as referenced in our previous note, it is expected that around 25% of sailings from the northern exporting area could be in vessels of 150,000 to 250,000 deadweight. On this basis there could be a further 31 sailings of vessels averaging 184090 deadweight. As for 2020, any shift of cargo from Huasco Bay (Chile) into Europe is also marginal.

Oil Tankers

As for Case 4 2020, the only change for 2060 under this case compared with transit projections for the 150,000 deadweight Canal in 2060 is the addition of 14 million tons of Orimulsion moving from Venezuela to the Far East, equivalent to an additional 62 transits. No change in vessel deadweight is contemplated between 2020 and 2060 ie for Orimulsion it is representative of the size of tanker in the world fleet at 238,000 deadweight.

Table 9.8

2020 Vessel Transits (CASE 4: 250,000 DWT CANAL)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	1	83	7	9	0	0	0	0	99
Average DWT	CB	7665	23500	28385	41690	0	0	0	0	25281
Transits	G	31	37	5	0	0	0	0	0	73
Average DWT	G	5734	22000	36229	0	0	0	0	0	16004
Transits	R	23	31	0	0	0	0	0	0	53
Average DWT	R	8415	13730	0	0	0	0	0	0	11476
Transits	V	10	82	5	0	0	0	0	0	97
Average DWT	V	7760	14500	29692	0	0	0	0	0	14539
Transits	P	5	0	0	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	130	126	74	82	3	0	415
Average DWT	CD	0	32000	51955	82120	134700	183355	0	68286
Transits	CT	22	78	6	0	0	0	0	106
Average DWT	CT	7920	31710	45250	0	0	0	0	27644
Transits	LP	32	58	31	0	0	0	0	120
Average DWT	LP	5070	18900	40600	0	0	0	0	20811
Transits	T	17	33	42	16	0	12	0	120
Average DWT	T	5630	31710	54300	89730	0	238000	0	64664
TOTAL TRANSITS		141	233**	317	213	90	82	15	1088

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 4: 250,000 DWT CANAL)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	63	5	12	0	0	0	0	81
Average DWT	CB	0	23500	28385	41690	0	0	0	0	26600
Transits	G	19	31	3	0	0	0	0	0	52
Average DWT	G	5735	22000	36230	0	0	0	0	0	16969
Transits	R	509	567	0	0	0	0	0	0	1076
Average DWT	R	8415	13730	0	0	0	0	0	0	11214
Transits	V	19	178	0	0	0	0	0	0	197
Average DWT	V	7760	14500	0	0	0	0	0	0	13866
Transits	P	5	0	0	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	121	65	25	1	1	0	212
Average DWT	CD	0	32000	51955	82120	137400	183355	0	44912
Transits	CT	20	49	3	0	0	0	0	72
Average DWT	CT	7920	31710	45250	0	0	0	0	25598
Transits	LP	7	8	4	0	0	0	0	19
Average DWT	LP	5070	18900	40600	0	0	0	0	17229
Transits	T	5	15	17	5	0	0	0	42
Average DWT	T	5630	31710	54300	89730	0	0	0	42592
TOTAL TRANSITS		585	839**	202	101	29	1	1	0	1756

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 4: 250,000 DWT CANAL)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	511	43	100	0	0	0	0	654
Average DWT	CB	0	23500	28385	41690	0	0	0	0	26600
Transits	F	2	281	428	299	151	0	0	0	1161
Average DWT	F	8740	19340	32660	48080	90000	0	0	0	40814
Transits	G	159	250	27	0	0	0	0	0	436
Average DWT	G	5735	22000	36230	0	0	0	0	0	16969
Transits	R	1205	1341	0	0	0	0	0	0	2546
Average DWT	R	8415	13730	0	0	0	0	0	0	11214
Transits	RO	0	86	34	3	0	0	0	0	123
Average DWT	RO	0	16550	31115	44190	0	0	0	0	21302
Transits	V	35	336	0	0	0	0	0	0	371
Average DWT	V	7760	14500	29692	0	0	0	0	0	13866
Transits	P	106	0	0	0	0	0	0	0	106
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	889	475	181	7	5	0	1558
Average DWT	CD	0	32000	51955	82120	137400	183355	0	44912
Transits	CT	64	154	10	0	0	0	0	228
Average DWT	CT	7920	31710	45250	0	0	0	0	25598
Transits	LP	2	2	1	0	0	0	0	5
Average DWT	LP	5070	18900	40600	0	0	0	0	17229
Transits	T	20	59	66	18	0	0	0	163
Average DWT	T	5630	31710	54300	89730	0	0	0	42592
TOTAL TRANSITS		1593	2805**	1637	954	350	7	5	0	7351

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 4: 250,000 DWT CANAL)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	8	535	43	58	0	0	0	0	644
Average DWT	CB	7665	23500	28385	41690	0	0	0	0	25281
Transits	F	11	220	557	202	131	0	0	0	1121
Average DWT	F	8740	19340	32660	48080	90000	0	0	0	39315
Transits	G	201	242	31	0	0	0	0	0	475
Average DWT	G	5734	22000	36229	0	0	0	0	0	16004
Transits	R	532	722	0	0	0	0	0	0	1253
Average DWT	R	8415	13730	0	0	0	0	0	0	11476
Transits	RO	1	94	49	57	0	0	0	0	201
Average DWT	RO	5783	16550	31115	44190	0	0	0	0	27898
Transits	V	50	402	24	0	0	0	0	0	476
Average DWT	V	7760	14500	29692	0	0	0	0	0	14539
Transits	P	159	0	0	0	0	0	0	0	159
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	735	708	417	463	15	0	2338
Average DWT	CD	0	32000	51955	82120	134700	183355	0	68286
Transits	CT	130	468	37	0	0	0	0	635
Average DWT	CT	7920	31710	45250	0	0	0	0	27644
Transits	LP	32	59	31	0	0	0	0	123
Average DWT	LP	5070	18900	40600	0	0	0	0	20811
Transits	T	88	163	210	51	0	62	0	603
Average DWT	T	5630	31710	54300	89730	0	238000	0	64664
TOTAL TRANSITS		1212	2215**	2130	1303	629	463	77	8028

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

Table 9.9

2060 Vessel Transits (Case 4:250,000 DWT)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	120	9	14	0	0	0	0	143
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	25544
Transits	G	55	59	6	0	0	0	0	0	120
Average DWT	G	5810	22000	36230	0	0	0	0	0	15357
Transits	R	20	70	0	0	0	0	0	0	90
Average DWT	R	9530	15540	0	0	0	0	0	0	14213
Transits	V	19	104	5	0	0	0	0	0	128
Average DWT	V	7760	14500	29690	0	0	0	0	0	14103
Transits	P	7	0	0	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	176	183	138	0	87	0	583
Average DWT	CD	0	36500	59275	93685	0	184090	0	78964
Transits	CT	15	98	17	0	0	0	0	130
Average DWT	CT	7920	35120	50120	0	0	0	0	34006
Transits	LP	27	45	20	0	0	0	0	92
Average DWT	LP	5070	18900	40600	0	0	0	0	19411
Transits	T	9	22	32	6	0	12	0	82
Average DWT	T	5630	31710	54300	89730	0	238000	0	72724
TOTAL TRANSITS		152	354**	360	266	144	0	99	0	1374

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Case 4:250,000 DWT)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	88	5	17	0	0	0	0	110
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	26498
Transits	G	32	44	5	0	0	0	0	0	81
Average DWT	G	5810	22000	36230	0	0	0	0	0	16391
Transits	R	316	973	0	0	0	0	0	0	1289
Average DWT	R	9530	15540	0	0	0	0	0	0	14064
Transits	V	24	211	0	0	0	0	0	0	235
Average DWT	V	7760	14500	0	0	0	0	0	0	13816
Transits	P	7	0	0	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	141	113	44	0	1	0	299
Average DWT	CD	0	36500	59275	93685	0	184090	0	54120
Transits	CT	29	61	9	0	0	0	0	99
Average DWT	CT	7920	35120	50120	0	0	0	0	28423
Transits	LP	6	7	2	0	0	0	0	15
Average DWT	LP	5070	18900	40600	0	0	0	0	18088
Transits	T	7	13	12	1	0	0	0	33
Average DWT	T	5630	31710	54300	89730	0	0	0	36137
TOTAL TRANSITS		421	1315**	231	151	45	0	1	2167

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Case 4:250,000 DWT)
Laden Northbound Estimates

		DWT Range								
	Type	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	830	49	156	0	0	0	0	1035
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	26498
Transits	F	0	415	473	281	126	49	0	0	1344
Average DWT	F	0	19370	36400	56000	90000	148000	0	0	44330
Transits	G	308	424	45	0	0	0	0	0	777
Average DWT	G	5810	22000	36230	0	0	0	0	0	16391
Transits	R	748	2302	0	0	0	0	0	0	3050
Average DWT	R	9530	15540	0	0	0	0	0	0	14064
Transits	RO	0	157	62	6	0	0	0	0	226
Average DWT	RO	6140	16550	31120	44190	0	0	0	0	21290
Transits	V	45	397	0	0	0	0	0	0	442
Average DWT	V	7760	14500	0	0	0	0	0	0	13816
Transits	P	134	0	0	0	0	0	0	0	134
Average DWT	P	5069	0	0	0	0	0	0	0	5069

		DWT Range								
	Type	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	1035	830	326	0	8	0	2199
Average DWT	CD	0	36500	59275	93625	0	184090	0	54120
Transits	CT	92	194	27	0	0	0	0	313
Average DWT	CT	7920	35120	50120	0	0	0	0	28423
Transits	LP	2	2	0	0	0	0	0	4
Average DWT	LP	5070	18900	40600	0	0	0	0	18088
Transits	T	28	48	45	5	0	0	0	126
Average DWT	T	5630	31710	54300	89730	0	0	0	36137
TOTAL TRANSITS		1357	4525**	1908	1345	456	49	8	0	9650

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Case 4:250,000 DWT)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	975	69	110	0	0	0	0	1154
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	25544
Transits	F	0	245	583	258	135	45	0	0	1265
Average DWT	F	0	19370	34600	56000	90000	148000	0	0	45979
Transits	G	446	478	52	0	0	0	0	0	976
Average DWT	G	5810	22000	36230	0	0	0	0	0	15357
Transits	R	466	1645	0	0	0	0	0	0	2111
Average DWT	R	9530	15540	0	0	0	0	0	0	14213
Transits	RO	0	156	79	95	0	0	0	0	330
Average DWT	RO	6140	16550	31120	44190	0	0	0	0	27945
Transits	V	93	511	25	0	0	0	0	0	629
Average DWT	V	7760	14500	29690	0	0	0	0	0	14103
Transits	P	202	0	0	0	0	0	0	0	202
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	990	1033	777	0	488	0	3285
Average DWT	CD	0	36500	59275	93655	0	184090	0	78964
Transits	CT	87	584	101	0	0	0	0	772
Average DWT	CT	7920	35120	50120	0	0	0	0	34006
Transits	LP	28	46	20	0	0	0	0	94
Average DWT	LP	5070	18900	40600	0	0	0	0	19411
Transits	T	48	110	164	29	0	61	0	413
Average DWT	T	5630	31710	54300	89730	0	238000	0	72724
TOTAL TRANSITS		1370	4011**	2537	1781	941	45	549	0	11231

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

9.6 300,000 DWT Design Ship (Case 5) - Tables 9.10 and 9.11

Following further detailed evaluations of shipping economics, ship sizes and routing patterns it is concluded that for dry bulk carriers there is unlikely to be any significant difference between Cases 4 and 5 - the 250,000 DWT and 300,000 DWT Canals - for either 2020 and 2060. For oil tankers, and in line with our projections for Case 4, 2020, the only potential changes envisaged are those which relate to southbound shipments of Venezuelan Orimulsion. Here, the only difference projected between Cases 4 and 5 are a slight decline in the number of transits as it is assumed that in the latter case slightly larger VLCCs would be employed.

Oil Tankers

It has been estimated that the total trade in Orimulsion from Venezuela to the Far East in both 2020 and 2060 will be 14 million tonnes. Furthermore, on the basis of shipping economics and given plans to ship this product in VLCCs, the whole of this quantity would be moved via the Panama Canal under Cases 5 and as in Case 4. The only difference expected in the number of transits results from the assumption under Case 5 that slightly larger vessels would be employed.

It is assumed for Case 5 that the average DWT for VLCCs transporting Orimulsion will be representative of the size of vessel in the world fleet at the time. Therefore under Case 5 a ship of 269,000 DWT has been assumed compared with 238.000 DWT under Case 5. The results indicate that whereas the potential number of transits under Cases 4. 2020 and 2060. are 62 more than the corresponding estimates for Cases 2 and 3, the number of transits under Cases 5, 2020 and 2060, are 7 less than those for corresponding estimates under Case 4.

Dry Bulk Carriers

For Case 5 in 2020 and 2060, it is not envisaged that there would be any change in transits or trade from that already described for Case 4 in those years. Vessel sizes for coal trades are expected to consolidate in the size range of 150,000 to 250,000 DWT and additional iron ore traffic is not expected to be attracted to an enlarged Panama Canal because of the vessel economics reasons described above.

Table 9.10

2020 Vessel Transits (CASE 5: 300,000 DWT CANAL)
Ballast Northbound Estimates

		DWT Range								
	Type	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	1	83	7	9	0	0	0	0	99
Average DWT	CB	7665	23500	28385	41690	0	0	0	0	25281
Transits	G	31	37	5	0	0	0	0	0	73
Average DWT	G	5734	22000	36229	0	0	0	0	0	16004
Transits	R	23	31	0	0	0	0	0	0	53
Average DWT	R	8415	13730	0	0	0	0	0	0	11476
Transits	V	10	82	5	0	0	0	0	0	97
Average DWT	V	7760	14500	29692	0	0	0	0	0	14539
Transits	P	5	0	0	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	0	0	5069

		DWT Range							
	Type	0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	130	126	74	82	3	0	415
Average DWT	CD	0	32000	51955	82120	134700	183355	0	68286
Transits	CT	22	78	6	0	0	0	0	106
Average DWT	CT	7920	31710	45250	0	0	0	0	27644
Transits	LP	32	58	31	0	0	0	0	120
Average DWT	LP	5070	18900	40600	0	0	0	0	20811
Transits	T	17	33	42	16	0	0	11	118
Average DWT	T	5630	31710	54300	89730	0	0	269000	65438
TOTAL TRANSITS		141	233**	317	213	90	82	3	11	1087

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2020 Vessel Transits (CASE 5: 300,000 DWT CANAL)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	63	5	12	0	0	0	0	81
Average DWT	CB	0	23500	28385	41690	0	0	0	0	26600
Transits	G	19	31	3	0	0	0	0	0	52
Average DWT	G	5735	22000	36230	0	0	0	0	0	16969
Transits	R	509	567	0	0	0	0	0	0	1076
Average DWT	R	8415	13730	0	0	0	0	0	0	11214
Transits	V	19	178	0	0	0	0	0	0	197
Average DWT	V	7760	14500	0	0	0	0	0	0	13866
Transits	P	5	0	0	0	0	0	0	0	5
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	121	65	25	1	1	0	212
Average DWT	CD	0	32000	51955	82120	137400	183355	0	44912
Transits	CT	20	49	3	0	0	0	0	72
Average DWT	CT	7920	31710	45250	0	0	0	0	25598
Transits	LP	7	8	4	0	0	0	0	19
Average DWT	LP	5070	18900	40600	0	0	0	0	17229
Transits	T	5	15	17	5	0	0	0	42
Average DWT	T	5630	31710	54300	89730	0	0	0	42592
TOTAL TRANSITS		585	839**	202	101	29	1	1	0	1756

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 5: 300,000 DWT CANAL)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	511	43	100	0	0	0	0	654
Average DWT	CB	0	23500	28385	41690	0	0	0	0	26600
Transits	F	2	281	428	299	151	0	0	0	1161
Average DWT	F	8740	19340	32660	48080	90000	0	0	0	40814
Transits	G	159	250	27	0	0	0	0	0	436
Average DWT	G	5735	22000	36230	0	0	0	0	0	16969
Transits	R	1205	1341	0	0	0	0	0	0	2546
Average DWT	R	8415	13730	0	0	0	0	0	0	11214
Transits	RO	0	86	34	3	0	0	0	0	123
Average DWT	RO	0	16550	31115	44190	0	0	0	0	21302
Transits	V	35	336	0	0	0	0	0	0	371
Average DWT	V	7760	14500	29692	0	0	0	0	0	13866
Transits	P	106	0	0	0	0	0	0	0	106
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	889	475	181	7	5	0	1558
Average DWT	CD	0	32000	51955	82120	137400	183355	0	44912
Transits	CT	64	154	10	0	0	0	0	228
Average DWT	CT	7920	31710	45250	0	0	0	0	25598
Transits	LP	2	2	1	0	0	0	0	5
Average DWT	LP	5070	18900	40600	0	0	0	0	17229
Transits	T	20	59	66	18	0	0	0	163
Average DWT	T	5630	31710	54300	89730	0	0	0	42592
TOTAL TRANSITS		1593	2805**	1637	954	350	7	5	0	7351

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2020 Vessel Transits (CASE 5: 300,000 DWT CANAL)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	8	535	43	58	0	0	0	0	644
Average DWT	CB	7665	23500	28385	41690	0	0	0	0	25281
Transits	F	11	220	557	202	131	0	0	0	1121
Average DWT	F	8740	19340	32660	48080	90000	0	0	0	39315
Transits	G	201	242	31	0	0	0	0	0	475
Average DWT	G	5734	22000	36229	0	0	0	0	0	16004
Transits	R	532	722	0	0	0	0	0	0	1253
Average DWT	R	8415	13730	0	0	0	0	0	0	11476
Transits	RO	1	94	49	57	0	0	0	0	201
Average DWT	RO	5783	16550	31115	44190	0	0	0	0	27898
Transits	V	50	402	24	0	0	0	0	0	476
Average DWT	V	7760	14500	29692	0	0	0	0	0	14539
Transits	P	159	0	0	0	0	0	0	0	159
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	735	708	417	463	15	0	2338
Average DWT	CD	0	32000	51955	82120	134700	183355	0	68286
Transits	CT	130	468	37	0	0	0	0	635
Average DWT	CT	7920	31710	45250	0	0	0	0	27644
Transits	LP	32	59	31	0	0	0	0	123
Average DWT	LP	5070	18900	40600	0	0	0	0	20811
Transits	T	88	163	210	81	0	0	55	596
Average DWT	T	5630	31710	54300	89730	0	0	269000	65438
TOTAL TRANSITS		1212	2215**	2130	1303	629	463	15	55	8021

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

Table 9.11

2060 Vessel Transits (Case 5:380,000 DWT)
Ballast Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	120	9	14	0	0	0	0	143
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	25544
Transits	G	55	59	6	0	0	0	0	0	120
Average DWT	G	5810	22000	36230	0	0	0	0	0	15357
Transits	R	20	70	0	0	0	0	0	0	90
Average DWT	R	9530	15540	0	0	0	0	0	0	14213
Transits	V	19	104	5	0	0	0	0	0	128
Average DWT	V	7760	14500	29690	0	0	0	0	0	14103
Transits	P	7	0	0	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	176	183	138	0	86	0	583
Average DWT	CD	0	36500	59275	93685	0	184090	0	78964
Transits	CT	15	98	17	0	0	0	0	130
Average DWT	CT	7920	35120	50120	0	0	0	0	34006
Transits	LP	27	45	20	0	0	0	0	92
Average DWT	LP	5070	18900	40600	0	0	0	0	19411
Transits	T	9	22	32	6	0	0	11	80
Average DWT	T	5630	31710	54300	89730	0	0	269000	74004
TOTAL TRANSITS		152	354** 360	266	144	0	86	11	1373

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 5:300,000 DWT)
Ballast Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	88	5	17	0	0	0	0	110
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	26498
Transits	G	32	44	5	0	0	0	0	0	81
Average DWT	G	5810	22000	36230	0	0	0	0	0	16391
Transits	R	316	973	0	0	0	0	0	0	1289
Average DWT	R	9530	15540	0	0	0	0	0	0	14064
Transits	V	24	211	0	0	0	0	0	0	235
Average DWT	V	7760	14500	0	0	0	0	0	0	13816
Transits	P	7	0	0	0	0	0	0	0	7
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	141	113	44	0	1	0	299
Average DWT	CD	0	36500	59275	93685	0	184090	0	54120
Transits	CT	29	61	9	0	0	0	0	99
Average DWT	CT	7920	35120	50120	0	0	0	0	28423
Transits	LP	6	7	2	0	0	0	0	15
Average DWT	LP	5070	18900	40600	0	0	0	0	18088
Transits	T	7	13	12	1	0	0	0	33
Average DWT	T	5630	31710	54300	89730	0	0	0	36137
TOTAL TRANSITS		421	1315**	231	151	45	0	1	2167

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB:	Container Breakbulk Ships	F:	Full Container Ships
G:	Conventional General Cargo Ships	R:	Refrigerated Cargo Ships
RO:	Roll-On Roll-Off Ships	V:	Vehicle Carriers
P:	Passenger Ships	CD:	Combined and Dry Bulk Carriers
CT:	Chemical Tankers	LP:	Liquified Propane Tankers
T:	Oil Tankers		

2060 Vessel Transits (Case 5:300,000 DWT)
Laden Northbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	830	49	156	0	0	0	0	1035
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	26498
Transits	F	0	415	473	281	126	49	0	0	1344
Average DWT	F	0	19370	36400	56000	90000	148000	0	0	44330
Transits	G	308	424	45	0	0	0	0	0	777
Average DWT	G	5810	22000	36230	0	0	0	0	0	16391
Transits	R	748	2302	0	0	0	0	0	0	3050
Average DWT	R	9530	15540	0	0	0	0	0	0	14064
Transits	RO	0	157	62	6	0	0	0	0	226
Average DWT	RO	6140	16550	31120	44190	0	0	0	0	21290
Transits	V	45	397	0	0	0	0	0	0	442
Average DWT	V	7760	14500	0	0	0	0	0	0	13816
Transits	P	134	0	0	0	0	0	0	0	134
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	1035	830	326	0	8	0	2199
Average DWT	CD	0	36500	59275	93685	0	184090	0	54120
Transits	CT	92	194	27	0	0	0	0	313
Average DWT	CT	7920	35120	50120	0	0	0	0	28423
Transits	LP	2	2	0	0	0	0	0	4
Average DWT	LP	5070	18900	40600	0	0	0	0	18088
Transits	T	28	48	45	5	0	0	0	126
Average DWT	T	5630	31710	54300	89730	0	0	0	36137
TOTAL TRANSITS		1357	4525**	1908	1345	456	49	8	0	9650

Note: Due to rounding, totals may not be equal to the sum of the elements.

(**) Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

2060 Vessel Transits (Case 5:300,000 DWT)
Laden Southbound Estimates

	Type	DWT Range 0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CB	0	975	69	110	0	0	0	0	1154
Average DWT	CB	7810	23500	28470	41810	0	0	0	0	25544
Transits	F	0	245	583	258	135	45	0	0	1265
Average DWT	F	0	19370	34600	56000	90000	148000	0	0	45979
Transits	G	446	478	52	0	0	0	0	0	976
Average DWT	G	5810	22000	36230	0	0	0	0	0	15357
Transits	R	466	1645	0	0	0	0	0	0	2111
Average DWT	R	9530	15540	0	0	0	0	0	0	14213
Transits	RO	0	156	79	95	0	0	0	0	330
Average DWT	RO	6140	16550	31120	44190	0	0	0	0	27945
Transits	V	93	511	25	0	0	0	0	0	629
Average DWT	V	7760	14500	29690	0	0	0	0	0	14103
Transits	P	202	0	0	0	0	0	0	0	202
Average DWT	P	5069	0	0	0	0	0	0	0	5069

	Type	DWT Range 0 to 9,999	10,000 to 39,999	40,000 to 64,999	65,000 to 99,999	100,000 to 149,999	150,000 to 249,999	250,000 to 299,999	TOTAL
Transits	CD	0	990	1033	777	0	485	0	3285
Average DWT	CD	0	36500	59275	93685	0	184090	0	78964
Transits	CT	87	584	101	0	0	0	0	772
Average DWT	CT	7920	35120	50120	0	0	0	0	34006
Transits	LP	28	46	20	0	0	0	0	94
Average DWT	LP	5070	18900	40600	0	0	0	0	19411
Transits	T	48	110	164	29	0	0	55	406
Average DWT	T	5630	31710	54300	89730	0	0	269000	74004
TOTAL TRANSITS		1370	4011**	2537	1781	941	45	485	55	11224

Note: Due to rounding, totals may not be equal to the sum of the elements.

[**] Total of transits for the 10,000-24,999 DWT range and for CB, G, R, V and P ship types only.

CB: Container Breakbulk Ships
G: Conventional General Cargo Ships
RO: Roll-On Roll-Off Ships
P: Passenger Ships
CT: Chemical Tankers
T: Oil Tankers
F: Full Container Ships
R: Refrigerated Cargo Ships
V: Vehicle Carriers
CD: Combined and Dry Bulk Carriers
LP: Liquified Propane Tankers

9.7 Conclusion

Table 9.12 summarizes the total numbers of laden and ballast ship transits north and southbound for each of the cases reviewed above. Overall, for all cases, the projected growth rate in transits between 1990 and 2020 lies between 1.4% and 1.6% per annum. The average annual growth rate over the period 1990-2060, for all cases, is between 1 and 1.1%.

Table 9.12
Summary of Laden and Ballast Transits for all Cases

Status Quo Canal

1990	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate
CB	49	39	447	444	496	483	88	891	979	
F			577	527	577	527	0	1,104	1,104	
G	44	43	399	481	443	524	87	880	967	
R	34	541	1,280	801	1,314	1,342	575	2,081	2,656	
RO			118	130	118	130	0	248	248	
V	56	139	262	274	318	413	196	536	732	
P	2	4	34	86	36	90	6	120	126	
CD	262	165	1,214	1,476	1,476	1,641	426	2,690	3,116	
CT	36	45	142	215	178	260	81	357	438	
LP	111	23	6	114	117	137	134	120	254	
T	81	85	327	408	408	493	166	735	901	
TOTAL	675	1,084	4,806	4,956	5,481	6,040	1,760	9,762	11,521	

2020	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2020
CB	103	86	654	644	757	730	188	1,298	1,486	1.4%
F			1,310	1,218	1,310	1,218	0	2,528	2,528	2.8%
G	76	56	436	475	512	531	131	911	1,042	0.3%
R	53	1,076	2,546	1,253	2,599	2,329	1,129	3,799	4,928	2.1%
RO			123	201	123	201	0	324	324	0.9%
V	97	197	371	476	468	673	294	847	1,141	1.5%
P	5	5	106	159	111	164	10	265	275	2.6%
CD	366	236	1,736	2,062	2,102	2,298	602	3,798	4,400	1.2%
CT	106	72	228	635	334	707	179	863	1,042	2.9%
LP	120	19	5	123	125	142	139	128	267	0.2%
T	116	44	169	587	285	631	160	756	916	0.1%
TOTAL	1,043	1,790	7,684	7,833	8,727	9,623	2,833	15,517	18,350	1.6%

2060	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2060
CB	148	114	1,035	1,154	1,183	1,269	262	2,190	2,452	1.3%
F			1,497	1,418	1,497	1,418	0	2,915	2,915	1.4%
G	125	83	777	976	902	1,059	208	1,753	1,961	1.0%
R	90	1,289	3,050	2,111	3,140	3,400	1,379	5,161	6,540	1.3%
RO			226	330	226	330	0	557	557	1.2%
V	129	234	442	629	570	863	363	1,071	1,433	1.0%
P	7	7	134	202	141	209	14	336	350	1.5%
CD	559	321	2,362	3,148	2,920	3,469	880	5,509	6,389	1.0%
CT	129	99	313	772	443	871	229	1,086	1,314	1.6%
LP	92	16	4	94	96	110	108	98	206	-0.3%
T	71	33	127	359	198	391	104	485	589	-0.6%
TOTAL	1,349	2,197	9,967	11,193	11,316	13,390	3,546	21,160	24,706	1.1%

Note: Due to rounding, totals may not be equal to the sum of the elements.

Table 9.12 (Cont'd)

Summary of Laden and Ballast Transits for all Cases

Case 2: 100,000

1990

	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate
CB	49	39	447	444	496	483	88	891	979	
F			577	527	577	527	0	1,104	1,104	
G	44	43	399	481	443	524	87	880	967	
R	34	541	1,280	801	1,314	1,342	575	2,081	2,656	
RO			118	130	118	130	0	248	248	
V	56	139	262	274	318	413	196	536	732	
P	2	4	34	86	36	90	6	120	126	
CD	262	165	1,214	1,476	1,476	1,641	426	2,690	3,116	
CT	36	45	142	215	178	260	81	357	438	
LP	111	23	6	114	117	137	134	120	254	
T	81	85	327	408	408	493	166	735	901	
TOTAL	675	1,084	4,806	4,956	5,481	6,040	1,760	9,762	11,521	

2020

	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2020
CB	99	81	654	644	753	725	180	1,298	1,478	1.4%
F			1161	1121	1,161	1,121	0	2,282	2,282	2.5%
G	73	52	436	475	509	527	125	911	1,036	0.2%
R	53	1076	2546	1253	2,599	2,329	1,129	3,799	4,928	2.1%
RO			123	201	123	201	0	324	324	0.9%
V	97	197	371	476	468	673	294	847	1,141	1.5%
P	5	5	106	159	111	164	10	265	275	2.6%
CD	334	213	1569	1881	1,903	2,094	547	3,450	3,997	0.8%
CT	106	72	228	635	334	707	179	863	1,042	2.9%
LP	120	19	5	123	125	142	139	128	267	0.2%
T	107	42	163	541	270	583	149	704	853	-0.2%
TOTAL	995	1758	7362	7509	8,357	9,267	2,753	14,871	17,624	1.4%

2060

	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2060
CB	143	111	1035	1154	1,178	1,264	254	2,189	2,443	1.3%
F			1376	1294	1,376	1,294	0	2,670	2,670	1.3%
G	121	80	777	976	898	1,056	201	1,753	1,954	1.0%
R	90	1289	3050	2111	3,140	3,400	1,379	5,161	6,540	1.3%
RO			226	330	226	330	0	556	556	1.2%
V	129	234	442	629	570	863	363	1,071	1,433	1.0%
P	7	7	134	202	141	209	14	336	350	1.5%
CD	502	300	2207	2827	2,708	3,127	802	5,034	5,835	0.9%
CT	129	99	313	772	443	871	229	1,085	1,314	1.6%
LP	92	16	4	94	96	109	108	98	205	-0.3%
T	70	33	126	351	196	384	102	477	580	-0.6%
TOTAL	1281	2169	9690	10740	10,971	12,909	3,451	20,430	23,880	1.0%

Note: Due to rounding, totals may not be equal to the sum of the elements.

Table 9.12 (Cont'd)

Summary of Laden and Ballast Transits for all Cases

Case 3: 150,000 DWT Canal

1990	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate
CB	49	39	447	444	496	483	88	891	979	
F			577	527	577	527	0	1,104	1,104	
G	44	43	399	481	443	524	87	880	967	
R	34	541	1,280	801	1,314	1,342	575	2,081	2,656	
RO			118	130	118	130	0	248	248	
V	56	139	262	274	318	413	196	536	732	
P	2	4	34	86	36	90	6	120	126	
CD	262	165	1,214	1,476	1,476	1,641	426	2,690	3,116	
CT	36	45	142	215	178	260	81	357	438	
LP	111	23	6	114	117	137	134	120	254	
T	81	85	327	408	408	493	166	735	901	
TOTAL	675	1,084	4,806	4,956	5,481	6,040	1,760	9,762	11,521	

2020	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2020
CB	99	81	654	644	753	725	180	1,298	1,478	1.4%
F			1161	1121	1,161	1,121	0	2,282	2,282	2.5%
G	73	52	436	475	509	527	125	911	1,036	0.2%
R	53	1076	2546	1253	2,599	2,329	1,129	3,799	4,928	2.1%
RO			123	201	123	201	0	324	324	0.9%
V	97	197	371	476	468	673	294	847	1,141	1.5%
P	5	5	106	159	111	164	10	265	275	2.6%
CD	414	212	1560	2330	1,973	2,542	626	3,890	4,515	1.2%
CT	106	72	228	635	334	707	179	863	1,042	2.9%
LP	120	19	5	123	125	142	139	128	267	0.2%
T	107	42	163	541	270	583	149	704	853	-0.2%
TOTAL	1075	1757	7353	7958	8,427	9,715	2,831	15,311	18,142	1.5%

2060	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2060
CB	143	110	1035	1154	1,178	1,264	252	2,190	2,442	1.3%
F			1344	1265	1,344	1,265	0	2,609	2,609	1.2%
G	120	81	777	976	897	1,057	201	1,753	1,953	1.0%
R	90	1289	3050	2111	3,140	3,400	1,379	5,161	6,540	1.3%
RO			225	330	225	330	0	556	556	1.2%
V	127	235	442	629	569	864	363	1,070	1,433	1.0%
P	7	7	134	202	141	209	14	336	350	1.5%
CD	606	299	2201	3412	2,807	3,711	905	5,613	6,518	1.1%
CT	130	99	313	772	444	871	230	1,085	1,315	1.6%
LP	92	15	4	94	96	109	107	98	205	-0.3%
T	70	33	126	351	195	384	102	477	579	-0.6%
TOTAL	1384	2168	9652	11296	11,036	13,464	3,552	20,948	24,500	1.1%

Note: Due to rounding, totals may not be equal to the sum of the elements.

Table 9.12 (Cont'd)

Summary of Laden and Ballast Transits for all Cases

Case 4: 250,000 DWT Canal

1990	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate
CB	49	39	447	444	496	483	88	891	979	
F			577	527	577	527	0	1,104	1,104	
G	44	43	399	481	443	524	87	880	967	
R	34	541	1,280	801	1,314	1,342	575	2,081	2,656	
RO			118	130	118	130	0	248	248	
V	56	139	262	274	318	413	196	536	732	
P	2	4	34	86	36	90	6	120	126	
CD	262	165	1,214	1,476	1,476	1,641	426	2,690	3,116	
CT	36	45	142	215	178	260	81	357	438	
LP	111	23	6	114	117	137	134	120	254	
T	81	85	327	408	408	493	166	735	901	
TOTAL	675	1,084	4,806	4,956	5,481	6,040	1,760	9,762	11,521	

2020	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2020
CB	99	81	654	644	753	725	180	1,298	1,478	1.4%
F			1161	1121	1,161	1,121	0	2,282	2,282	2.5%
G	73	52	436	475	509	527	125	911	1,036	0.2%
R	53	1076	2546	1253	2,599	2,329	1,129	3,799	4,928	2.1%
RO			123	201	123	201	0	324	324	0.9%
V	97	197	371	476	468	673	294	847	1,141	1.5%
P	5	5	106	159	111	164	10	265	275	2.6%
CD	415	212	1558	2338	1,973	2,550	627	3,896	4,522	1.2%
CT	106	72	228	635	334	707	179	863	1,042	2.9%
LP	120	19	5	123	125	142	139	128	267	0.2%
T	120	42	163	603	283	646	162	766	928	0.1%
TOTAL	1088	1756	7351	8028	8,439	9,785	2,845	15,379	18,224	1.5%

2060	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2060
CB	143	110	1035	1154	1,178	1,264	252	2,190	2,442	1.3%
F			1344	1265	1,344	1,265	0	2,610	2,610	1.2%
G	120	81	777	976	897	1,057	201	1,753	1,953	1.0%
R	90	1289	3050	2111	3,140	3,400	1,379	5,161	6,540	1.3%
RO			226	330	226	330	0	556	556	1.2%
V	128	235	442	629	569	864	363	1,071	1,433	1.0%
P	7	7	134	202	141	209	14	336	350	1.5%
CD	583	299	2199	3285	2,782	3,584	882	5,484	6,366	1.0%
CT	130	99	313	772	444	871	230	1,086	1,315	1.6%
LP	92	15	4	94	96	108	107	98	204	-0.3%
T	82	33	126	413	208	445	114	538	653	-0.5%
TOTAL	1374	2167	9650	11231	11,024	13,399	3,541	20,881	24,422	1.1%

Note: Due to rounding, totals may not be equal to the sum of the elements.

Table 9.12 (Cont'd)

Summary of Laden and Ballast Transits for all Cases

Case 5: 300,000 DWT Canal

1990	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate
CB	49	39	447	444	496	483	88	891	979	
F			577	527	577	527	0	1,104	1,104	
G	44	43	399	481	443	524	87	880	967	
R	34	541	1,280	801	1,314	1,342	575	2,081	2,656	
RO			118	130	118	130	0	248	248	
V	56	139	262	274	318	413	196	536	732	
P	2	4	34	86	36	90	6	120	126	
CD	262	165	1,214	1,476	1,476	1,641	426	2,690	3,116	
CT	36	45	142	215	178	260	81	357	438	
LP	111	23	6	114	117	137	134	120	254	
T	81	85	327	408	408	493	166	735	901	
TOTAL	675	1,084	4,806	4,956	5,481	6,040	1,760	9,762	11,521	

2020	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2020
CB	99	81	654	644	753	725	180	1,298	1,478	1.4%
F			1161	1121	1,161	1,121	0	2,282	2,282	2.5%
G	73	52	436	475	509	527	125	911	1,036	0.2%
R	53	1076	2546	1253	2,599	2,329	1,129	3,799	4,928	2.1%
RO			123	201	123	201	0	324	324	0.9%
V	97	197	371	476	468	673	294	847	1,141	1.5%
P	5	5	106	159	111	164	10	265	275	2.6%
CD	415	212	1558	2338	1,973	2,550	627	3,896	4,522	1.2%
CT	106	72	228	635	334	707	179	863	1,042	2.9%
LP	120	19	5	123	125	142	139	128	267	0.2%
T	118	42	163	596	281	639	161	759	920	0.1%
TOTAL	1087	1756	7351	8021	8,438	9,778	2,843	15,372	18,216	1.5%

2060	Ballast North	Ballast South	Laden North	Laden South	North Total	South Total	Ballast Total	Laden Total	TOTAL	Average Annual Growth Rate 1990-2060
CB	143	110	1035	1154	1,178	1,264	252	2,190	2,442	1.3%
F			1344	1265	1,344	1,265	0	2,610	2,610	1.2%
G	120	81	777	976	897	1,057	201	1,753	1,953	1.0%
R	90	1289	3050	2111	3,140	3,400	1,379	5,161	6,540	1.3%
RO			226	330	226	330	0	556	556	1.2%
V	128	235	442	629	569	864	363	1,071	1,433	1.0%
P	7	7	134	202	141	209	14	336	350	1.5%
CD	583	299	2199	3285	2,782	3,584	882	5,484	6,366	1.0%
CT	130	99	313	772	444	871	230	1,086	1,315	1.6%
LP	92	15	4	94	96	109	107	98	205	-0.3%
T	80	33	126	406	206	438	113	532	645	-0.5%
TOTAL	1373	2167	9650	11224	11,022	13,392	3,540	20,874	24,414	1.1%

Note: Due to rounding, totals may not be equal to the sum of the elements.

10. ADDITIONAL VESSEL ECONOMICS

10.1 Introduction

This section covers the following areas:

- Vessel Delay Costs Per Hour, in 1990 US$ values, by:
  - Ship type and size range, for
  - 1990, 2020, 2060.
- Transportation Costs, in 1990 US$ per cargo ton, by:
  - Ship type and size range, for
  - 1990, 2020, and 2060, by
  - trade route.
- Annual closure costs of the Status Quo Canal, comprising transportation diversion costs and toll revenue losses, for the year 2020.

The results given in this section are based on the assumptions and analyses relating to vessel characteristics and operating costs as described in Sections 8 and 9. Transportation cost evaluations are calculated assuming the average vessel sizes by deadweight size range for ships transiting the Panama Canal as described in these two preceding sections.

10.2 Vessel Delay Costs

In Section 8.4.2 we described the way in which rate estimates representing market levels have been developed from ship operating cost projections and, in the case of bulk ship types, projections of demand and supply balances. These rate estimates originally expressed in terms of 1990 $/day have been converted into $/hour cost of lost time and exclude the costs of the small quantities of bunker fuel that would be consumed at anchor. Moreover, since they relate specifically to the vessel, they exclude inventory costs.

As would be expected, given the numerous variations in the development of ship size by size range and ship type and also the differing relative importance of individual cost components and market rates, there is no regular pattern to estimated future trends across all ship types.

Nevertheless, for all ship types, hourly rates (delay costs) by size range are projected to increase in real terms throughout the period under review.

10.3 Transportation Costs

Ocean transportation costs by ship type, size range and route for 1990, 2020, 2060 are shown in Tables 10.2 to 10.11. These costs, as in Section 7, are based on the daily (or hourly) rates referenced in Section 10.2 above and include the costs of bunker fuel, port costs and Canal tolls for specific routes.

In contrast to the evaluations of bypass economics, the transportation costs shown in Tables 10.2 to 10.11 are calculated on the basis of single voyage mileages in order to provide consistency and to avoid the potential distortions associated with the necessarily arbitrary assignment of complex ballast trading patters by route, type and size range for individual vessels on laden transits through the Canal. Moreover, for some ship types, it would be normal practice in any event to calculate transportation costs on the basis of laden voyage mileages only. For bypass trade, freight economics were examined for a number of different vessel route patterns in order to ensure no potential bypass traffic was overlooked.

10.4 Annual Closure Costs

The approach we have followed is first to establish, for the 2020 Status Quo case. the total transportation cost of ships transiting the Canal, identifying, separately, the element relating to Canal tolls. (The total cost of Canal tolls represents the potential loss of revenue to the Canal.) This is being done by multiplying out the cargo transiting the Canal by the transportation cost as identified in Section 10.3 above by route, ship type and size range and aggregating the results to arrive at total costs of laden transits. Alternative costs are being determined in a similar manner by substitution in the calculation of transportation costs different mileages which represent routes which would be employed in the event of Canal closure. The cost of Canal closure for laden transits is determined simply by deducting one total cost from the other.

In substituting alternative mileages in the event of closure, it is assumed in the case of general cargoes originating in or destined for the United States that there will be sufficient capacity on the landbridge to accommodate additional volumes.

Estimates of the costs of closure with respect to ballast transits are made by pro-rating from the results for laden transits using the relationships between laden and ballast transits

derived in Section 9. Individual assessments of the loss of Canal revenue from ballast transits are being determined by multiplying out numbers of transits by ship size by size range and type by the relevant Canal toll. The results indicate (see Table 10.12) that toll losses in 2020 will be more than 734 million U.S. dollars and diversion costs will be almost $3 billion.

TABLE 10.1

HOURLY DELAY COSTS: $1990

SIZE RANGE (DWT)	0-9999	10000-24999	25000-39999	10000-39999	40000-64999	65000-99999
YEAR/SHIP TYPE						
CASE 1 CANAL, MAXIMUM DESIGN SHIP: 65,000 DWT						
1990						
CONTAINER BREAKBULK	373	441	806		1063	
CONTAINER SHIP	520	1026	1737		2496	
CONVENTIONAL GENERAL CARGO	169	262	389			
REFRIGERATED SHIPS (REEFERS)	459	782				
RORO	365	753	1181		1539	
VEHICLE CARRIER	299	463	721			
DRY BULK CARRIER				304	417	500
CHEMICAL CARRIER	333			639		
TANKER	194			457	562	624
2020						
CONTAINER BREAKBULK	423	692	776		1119	
CONTAINER SHIP	611	1076	1823		2605	
CONVENTIONAL GENERAL CARGO	192	425	500			
REFRIGERATED SHIPS (REEFERS)	573	975				
RORO	413	802	1244		1611	
VEHICLE CARRIER	344	521	804			
DRY BULK CARRIER				379	505	588
CHEMICAL CARRIER	398			732	860	
TANKER	220			541	638	709
2060						
CONTAINER BREAKBULK	458	721	811		1154	
CONTAINER SHIP		1127	1849		2926	
CONVENTIONAL GENERAL CARGO	218	471	536			
REFRIGERATED SHIPS (REEFERS)	693	1148				
RORO	467	834	1275		1643	
VEHICLE CARRIER	374	552	835			
DRY BULK CARRIER				480	596	647
CHEMICAL CARRIER	457			881	990	
TANKER	272			626	710	747

Source: The WEFA Group

Table 10.1 (Cont'd)
HOURLY DELAY COSTS: $1990

CASE 2 CANAL, MAXIMUM DESIGN SHIP: 100,000 DWT

SIZE RANGE (DWT)	0-9999	10000-24999	25000-39999	10000-39999	40000-63999	65000-99999	100000-149999
YEAR/SHIP TYPE							
2020							
CONTAINER BREAKBULK	423	692	776		1119		
CONTAINER SHIP	611	1076	1823		2605	4116	
CONVENTIONAL GENERAL CARGO	192	425	500				
REFRIGERATED SHIPS (REEFERS)	573	975					
RORO	413	802	1244		1611		
VEHICLE CARRIER	344	521	804				
DRY BULK CARRIER				379	505	639	
CHEMICAL CARRIER	398			732	860		
TANKER	220			541	638	765	
2060							
CONTAINER BREAKBULK	458	721	811		1154		
CONTAINER SHIP		1127	1849		2926	4142	
CONVENTIONAL GENERAL CARGO	218	471	536				
REFRIGERATED SHIPS (REEFERS)	693	1148					
RORO	467	834	1275		1643		
VEHICLE CARRIER	374	552	835				
DRY BULK CARRIER				480	596	766	
CHEMICAL CARRIER	457			881	990		
TANKER	272			626	710	842	

CASE 3 CANAL, MAXIMUM DESIGN SHIP: 150,000 DWT

2020							
CONTAINER BREAKBULK	423	692	776		1119		
CONTAINER SHIP	611	1076	1823		2605	4116	
CONVENTIONAL GENERAL CARGO	192	425	500				
REFRIGERATED SHIPS (REEFERS)	573	975					
RORO	413	802	1244		1611		
VEHICLE CARRIER	344	521	804				
DRY BULK CARRIER				379	505	639	788
CHEMICAL CARRIER	398			732	860		
TANKER	220			541	638	765	
2060							
CONTAINER BREAKBULK	458	721	811		1154		
CONTAINER SHIP		1127	1849		2926	4142	5911
CONVENTIONAL GENERAL CARGO	218	471	536				
REFRIGERATED SHIPS (REEFERS)	693	1148					
RORO	467	834	1275		1643		
VEHICLE CARRIER	374	552	835				
DRY BULK CARRIER				480	596	766	876
CHEMICAL CARRIER	457			881	990		
TANKER	272			626	710	842	

Source: The WEFA Group

Table 10.1 (Cont'd)
HOURLY DELAY COSTS: $1990

CASE 4 CANAL, MAXIMUM DESIGN SHIP: 250,000 DWT

SIZE RANGE (DWT)	0-9999	10000-24999	25000-39999	10000-39999	40000-63999	65000-99999	100000-149999	150000-249999	250000-300000
YEAR/SHIP TYPE									
2020									
CONTAINER BREAKBULK	423	692	776		1119				
CONTAINER SHIP	611	1076	1823		2605	4116			
CONVENTIONAL GENERAL CARGO	192	425	500						
REFRIGERATED SHIPS (REEFERS)	573	975							
RORO	413	802	1244		1611				
VEHICLE CARRIER	344	521	804						
DRY BULK CARRIER				379	505	639	788	907	
CHEMICAL CARRIER	398			732	860				
TANKER	220			541	638	765		1129	
2060									
CONTAINER BREAKBULK	458	721	811		1154				
CONTAINER SHIP		1127	1849		2926	4142	5911		
CONVENTIONAL GENERAL CARGO	218	471	536						
REFRIGERATED SHIPS (REEFERS)	693	1148							
RORO	467	834	1275		1643				
VEHICLE CARRIER	374	552	835						
DRY BULK CARRIER				480	596	766		976	
CHEMICAL CARRIER	457			881	990				
TANKER	272			626	710	842		1242	
CASE 5 CANAL, MAXIMUM DESIGN SHIP: 300,000 DWT									
2020									
CONTAINER BREAKBULK	423	692	776		1119				
CONTAINER SHIP	611	1076	1823		2605	4116			
CONVENTIONAL GENERAL CARGO	192	425	500						
REFRIGERATED SHIPS (REEFERS)	573	975							
RORO	413	802	1244		1611				
VEHICLE CARRIER	344	521	804						
DRY BULK CARRIER				379	505	639	788	907	
CHEMICAL CARRIER	398			732	860				
TANKER	220			541	638	765			1185
2060									
CONTAINER BREAKBULK	458	721	811		1154				
CONTAINER SHIP		1127	1849		2926	4142	5911		
CONVENTIONAL GENERAL CARGO	218	471	536						
REFRIGERATED SHIPS (REEFERS	693	1148							
RORO	467	834	1275		1643				
VEHICLE CARRIER	374	552	835						
DRY BULK CARRIER				480	596	766		976	
CHEMICAL CARRIER	457			881	990				
TANKER	272			626	710	842			1298

NB.
1 COSTS ARE FOR INTERNATIONAL FLAG TONNAGE ONLY.
2 CONTAINER ACQUISITION COSTS ARE INCLUDED FOR ALL VESSELS WITH RATED TEU CAPACITY IE CONTAINER BREAKBULK VESSELS, CONTAINER SHIPS RORORO, REFRIGERATED CARGO SHIPS
3. COSTS FOR CONTAINER BREAKBULK VESSELS, CONTAINER SHIPS, AND RORORO ASSUME THAT THESE VESSELS ARE DEPLOYED IN LINER TRADES
4 COSTS EXCLUDE BUNKER CONSUMPTION IE VESSELS ARE AT ANCHOR.
5 TANKER AND DRY BULK CARRIER COSTS INCLUDE COSTS FOR COMBINED CARRIERS IN OIL AND DRY BULK TRADES RESPECTIVELY.

Source: The WEFA Group

Table 10.2

PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

DRY BULK CARRIERS + COMBINED CARRIERS (CD)

		1990			2020			2060		
		10,000 to 39,999	40,000 to 64,999	65,000 to 100,000	10,000 to 39,999	40,000 to 64,999	65,000 to 100,000	10,000 to 39,999	40,000 to 64,999	65,000 to 100,000
FROM	TO									
US EAST COAST	CANADA WEST COAST	12.9	10.0		13.1	10.9		14.0	11.2	10.5
US EAST COAST	WEST COAST CENTRAL AMERI	8.4	6.5		8.6	7.1		9.1	7.3	6.8
US EAST COAST	SOUTH AMERICA WEST COAST	11.3	8.7		11.5	9.5		12.3	9.8	9.0
US EAST COAST	OCEANIA	19.2	14.7	12.7	19.3	15.9	13.6	21.0	16.6	15.4
US EAST COAST	ASIA	17.9	13.3	11.6	18.1	14.5	12.5	19.7	15.2	14.1
CANADA EAST COAST	US WEST COAST	13.7	10.5		13.8	11.5		14.9	11.9	11.1
CANADA EAST COAST	WEST COAST CENTRAL AMERI	9.8			10.0	8.4		10.6	8.7	8.1
CANADA EAST COAST	SOUTH AMERICA WEST COAST	12.8			13.0	10.8		14.0	11.2	10.5
CANADA EAST COAST	OCEANIA	19.4	14.7	13.0	19.5	16.1	14.0	21.4	16.7	15.7
CANADA EAST COAST	ASIA	18.8	14.4		19.1	15.6		21.0	16.5	15.3
E COAST CENT AMER/CARIB	US WEST COAST	11.2	8.8		11.4	9.5		12.2	9.8	9.2
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	6.9			7.2	6.4		7.7	6.5	6.1
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	10.3	8.[illegible]		10.5	8.8		11.1	9.1	8.4
E COAST CENT AMER/CARIB	ASIA	16.4	12.6		16.7	13.7		18.4	14.4	13.4
SOUTH AMERICA EAST COAST	US WEST COAST	15.9	11.8	10.2	16.1	12.8	11.0	17.4	13.3	12.4
SOUTH AMERICA EAST COAST	CANADA WEST COAST	16.2	12.[illegible]	10.9	16.4	13.5	11.7	17.8	14.0	13.1
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI	11.5	8.9		11.6	9.7		12.4	10.0	9.3
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	10.3	7.9		10.5	8.6		11.3	9.0	8.3
SOUTH AMERICA EAST COAST	OCEANIA	17.4	13.3	11.7	17.6	14.5	12.6	19.1	15.1	14.1
SOUTH AMERICA EAST COAST	ASIA	17.2	12.8		17.4	13.9		19.1	14.0	13.6
EUROPE	US WEST COAST	16.6	12.9	11.1	16.8	13.9	11.9	18.2	14.5	13.4
EUROPE	CANADA WEST COAST	16.9	13.3	11.6	17.1	14.4	12.4	18.7	15.1	14.0
EUROPE	WEST COAST CENTRAL AMERI	12.1	9.[illegible]		12.3	10.6		13.4	11.0	10.2
EUROPE	SOUTH AMERICA WEST COAST	15.0			15.2	12.9		16.6	13.4	12.5
EUROPE	OCEANIA	21.9	16.5	14.7	22.0	18.1		24.2	18.9	17.7
EUROPE	ASIA	22.0			22.1	18.2		24.3	18.9	17.8
AFRICA	US WEST COAST		13.[illegible]			14.3			14.8	13.9
AFRICA	CANADA WEST COAST	17.5	13.5		17.8	14.7		19.6	15.5	14.4
AFRICA	WEST COAST CENTRAL AMERI	14.4	11.[illegible]	9.7	14.5	12.0	10.4	15.7	12.5	11.7
AFRICA	SOUTH AMERICA WEST COAST	17.3			17.5	14.4		19.0	15.0	14.0
AFRICA	OCEANIA	20.2			20.3	16.7		22.3	17.4	16.3
AFRICA	ASIA			13.6			14.6			16.4
MIDDLE EAST	US WEST COAST	18.7	14.2	12.6	18.9	15.6	13.5	20.6	16.2	15.2

Source: The WEFA Group

Table 10.2 (Cont'd)

PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

DRY BULK CARRIERS + COMBINED CARRIERS (CD)

FROM	TO	1990 10,000 to 39,999	1990 40,000 to 64,999	1990 65,000 to 100,000	2020 10,000 to 39,999	2020 40,000 to 64,999	2020 65,000 to 100,000	2060 10,000 to 39,999	2060 40,000 to 64,999	2060 65,000 to 100,000
US WEST COAST	CANADA EAST COAST	13.8	11.0		14.1	11.7		15.2	12.1	11.3
US WEST COAST	SOUTH AMERICA EAST COAST	14.9	11.9		15.4	12.7		16.6	13.2	12.3
US WEST COAST	E COAST CENT AMER/CARIB	11.1	8.9	7.4	11.4	9.5	8.2	12.2	9.8	9.2
US WEST COAST	EUROPE	16.5	13.1	11.0	16.8	13.9	11.9	18.2	14.5	13.4
US WEST COAST	AFRICA	17.3	13.4	11.3	17.6	14.3	12.3	19.2	15.0	13.9
CANADA WEST COAST	US EAST COAST	13.0			13.3	10.9		14.4	11.3	10.6
CANADA WEST COAST	S AMERICA EC	15.9	12.4	10.5	16.2	13.3	11.4	17.8	13.9	12.9
CANADA WEST COAST	E COAST CENT AMER/CARIB	12.1	9.7		12.4	10.3		13.3	10.7	10.0
CANADA WEST COAST	EUROPE	16.7	13.6	11.4	17.1	14.4	12.4	18.7	15.1	14.0
CANADA WEST COAST	AFRICA	17.4	13.7		17.8	14.7		19.6	15.5	14.4
CANADA WEST COAST	MIDDLE EAST	18.9	15.0	13.1	19.4	16.0	14.2	21.4	16.8	15.7
WEST COAST CENTRAL AMERI	US EAST COAST	8.3	6.6		8.6	7.1		9.1	7.3	6.8
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB	6.9	5.9		7.2	6.4		7.7	6.5	6.2
WEST COAST CENTRAL AMERI	SOUTH AMERICA EAST COAST	11.3	9.1	7.6	11.6	9.7	4.1	12.4	10.0	9.3
WEST COAST CENTRAL AMERI	EUROPE	12.2	9.8		12.5	10.4		13.4	10.8	10.1
WEST COAST CENTRAL AMERI	AFRICA	14.1	11.3	9.5	14.5	12.0	10.4	15.7	12.5	11.7
SOUTH AMERICA WEST COAST	US EAST COAST	11.1			11.5	9.5		12.3	9.8	9.1
SOUTH AMERICA WEST COAST	CANADA EAST COAST	12.6	10.1	8.5	13.0	10.8	9.4	14.0	11.2	10.5
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	10.2	8.2	6.5	10.5	8.8		11.1	9.1	8.4
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	10.3	8.3	6.9	10.6	8.9		11.2	9.1	8.5
SOUTH AMERICA WEST COAST	EUROPE	14.6	12.1		15.2	12.9		16.6	13.4	12.5
SOUTH AMERICA WEST COAST	AFRICA	17.0	13.5	11.5	17.5	14.4	12.5	19.0	15.0	14.0
OCEANIA	US EAST COAST	19.0	14.9	12.5	19.3	15.9	13.6		16.5	15.4
OCEANIA	CANADA EAST COAST	18.7			19.3	16.3		21.3	17.0	15.8
OCEANIA	E COAST CENT AMER/CARIB	17.7			18.3	15.5		20.1	16.2	15.0
OCEANIA	SOUTH AMERICA EAST	17.4	13.8	11.7	17.9	14.7	12.7	19.6	15.4	14.3
OCEANIA	EUROPE	21.6			22.2	18.6		24.4	19.5	18.1
ASIA	US EAST COAST	17.5	13.6	11.5	18.1	14.5	12.5	19.7	15.2	14.1
ASIA	CANADA EAST COAST	19.0	15.0	12.9	19.5	16.1	14.0	21.3	16.7	15.7
ASIA	E COAST CENT AMER/CARIB	16.1	12.8		16.7	13.7		18.4	14.4	13.8
ASIA	SOUTH AMERICA EAST COAST	20.6	16.3		21.1	17.4		23.2	18.1	16.9
ASIA	EUROPE	21.5			22.1	18.2		24.3	18.9	17.8

Source: The WEFA Group

Table 10.2 (Cont'd)

PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

PANAMA CANAL: $/CARGO TON - CASE 2 - DIFFERENTIATION FROM STATUS QUO CANAL
DRY BULK CARRIERS + COMBINED CARRIERS (CD)

FROM	TO	2020 65,000 to 100,000	2060 65,000 to 100,000
US EAST COAST	CANADA WEST COAST	8.6	9.2
US EAST COAST	WEST COAST CENTRAL AMERI	5.5	5.9
US EAST COAST	SOUTH AMERICA WEST COAST	7.5	7.9
US EAST COAST	OCEANIA	12.5	13.4
US EAST COAST	ASIA	11.5	12.4
CANADA EAST COAST	US WEST COAST	9.1	9.7
CANADA EAST COAST	WEST COAST CENTRAL AMERI	6.6	7.0
CANADA EAST COAST	SOUTH AMERICA WEST COAST	8.5	9.1
CANADA EAST COAST	OCEANIA	12.7	13.7
CANADA EAST COAST	ASIA	12.4	16.5
E COAST CENT AMER/CARIB	US WEST COAST	7.5	8.0
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	5.0	5.3
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	6.9	7.3
E COAST CENT AMER/CARIB	ASIA	10.9	11.8
SOUTH AMERICA EAST COAST	US WEST COAST	10.1	10.8
SOUTH AMERICA EAST COAST	CANADA WEST COAST	10.7	11.5
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI	7.7	8.1
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	6.9	7.3
SOUTH AMERICA EAST COAST	OCEANIA	11.5	12.4
SOUTH AMERICA EAST COAST	ASIA	10.1	11.2
EUROPE	US WEST COAST	10.9	11.7
EUROPE	CANADA WEST COAST	14.4	12.3
EUROPE	WEST COAST CENTRAL AMERI	8.4	8.9
EUROPE	SOUTH AMERICA WEST COAST	10.2	10.9
EUROPE	OCEANIA	14.3	15.5
EUROPE	ASIA	14.4	15.6
AFRICA	US WEST COAST	11.3	12.1
AFRICA	CANADA WEST COAST	11.7	12.6
AFRICA	WEST COAST CENTRAL AMERI	9.5	10.2
AFRICA	SOUTH AMERICA WEST COAST	11.4	12.3
AFRICA	OCEANIA	13.2	14.3
AFRICA	ASIA	13.3	14.3
MIDDLE EAST	US WEST COAST	12.3	13.3

Source: The WEFA Group

Table 10.2 (Cont'd)
PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

PANAMA CANAL: $/CARGO TON - CASE 2 - DIFFERENTIATION FROM STATUS QUO CANAL
DRY BULK CARRIERS + COMBINED CARRIERS (CD)

FROM	TO	2020 65,000 to 100,000	2060 65,000 to 100,000
US WEST COAST	CANADA EAST COAST	9.2	9.8
US WEST COAST	SOUTH AMERICA EAST COAST	9.9	10.8
US WEST COAST	E COAST CENT AMER/CARIB	7.5	8.0
US WEST COAST	EUROPE	10.9	11.7
US WEST COAST	AFRICA	11.3	12.2
CANADA WEST COAST	US EAST COAST	8.7	9.2
CANADA WEST COAST	S AMERICA EC	10.5	11.4
CANADA WEST COAST	E COAST CENT AMER/CARIB	8.2	8.7
CANADA WEST COAST	EUROPE	11.4	12.3
CANADA WEST COAST	AFRICA	17.8	12.6
CANADA WEST COAST	MIDDLE EAST	12.7	13.8
WEST COAST CENTRAL AMERI	US EAST COAST	5.6	5.9
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB	5.1	5.3
WEST COAST CENTRAL AMERI	SOUTH AMERICA EAST COAST	7.7	8.1
WEST COAST CENTRAL AMERI	EUROPE	8.2	8.8
WEST COAST CENTRAL AMERI	AFRICA	9.5	10.2
SOUTH AMERICA WEST COAST	US EAST COAST	7.5	7.9
SOUTH AMERICA WEST COAST	CANADA EAST COAST	8.5	9.1
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	6.9	7.3
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	7.0	7.4
SOUTH AMERICA WEST COAST	EUROPE	10.2	10.9
SOUTH AMERICA WEST COAST	AFRICA	11.4	12.3
OCEANIA	US EAST COAST	12.5	13.4
OCEANIA	CANADA EAST COAST	12.8	13.8
OCEANIA	E COAST CENT AMER/CARIB	12.2	13.1
OCEANIA	SOUTH AMERICA EAST	11.6	12.5
OCEANIA	EUROPE	14.7	15.8
ASIA	US EAST COAST	11.5	12.4
ASIA	CANADA EAST COAST	12.7	13.7
ASIA	E COAST CENT AMER/CARIB	11.2	11.8
ASIA	SOUTH AMERICA EAST COAST	13.7	14.9
ASIA	EUROPE	14.4	15.6

PANAMA CANAL: $/CARGO TON: CASE 3 - DIFFERENTIATION FROM CASE 2
SHIP TYPE: DRY BULK CARRIERS + COMBINED CARRIERS (CD)

FROM	TO	2020 65,000 to 99,999	2020 100,000 to 150,000	2060 65,000 to 99,999	2060 100,000 to 150,000
US EAST COAST	ASIA		8.9		9.7
CANADA EAST COAST	ASIA		9.6		
SOUTH AMERICA EAST COAST	ASIA	11.1	8.2	11.0	8.9
CANADA WEST COAST	EUROPE		8.8		9.2

Source: The WEFA Group

Table 10.2 (Cont'd)

PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

PANAMA CANAL: $/CARGO TON: CASE 4 AND 5 - DIFFERENTIATION FROM CASE 3
SHIP TYPE: DRY BULK CARRIERS + COMBINED CARRIERS (CD)

FROM	TO	2020 100,000 to 149,999	2020 150,000 to 250,000	2060 150,000 to 250,000
US EAST COAST	ASIA	8.9		8.8
CANADA EAST COAST	ASIA	9.6	8.5	9.4
SOUTH AMERICA EAST COAST	ASIA			7.9
CANADA WEST COAST	EUROPE		7.7	8.6

Source: The WEFA Group

Table 10.3

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Container Breakbulk Ships: CB

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999
US EAST COAST	CANADA WEST COAST	105.6	62.8	54.4			59.9	56.1	54.3	65.3	62.0	59.0
US EAST COAST	CENTL AM WC	83.6	51.0	45.1			49.2	46.4	45.1	54.4	52.1	49.9
US EAST COAST	SOUTH AMERICA WEST COAST	92.0	55.6				53.3	50.1	48.6	58.6	55.9	53.4
US EAST COAST	OCEANIA		96.2				90.2	83.9	80.5	96.2	89.5	84.3
US EAST COAST	ASIA	158.4	91.5				85.7	79.7	76.4	90.9	85.0	79.9
CANADA EAST COAST	US WEST COAST	108.4	64.3				61.3	57.4		66.7	63.3	
CANADA EAST COAST	S AMERICA WC	102.6	61.2	53.2			58.4	54.8	53.0	63.8	60.7	57.7
CANADA EAST COAST	OCEANIA	165.8	95.0	79.9			89.0	82.7	79.2	95.2	89.0	83.6
CANADA EAST COAST	ASIA	156.9	90.3				84.7	78.8	75.6	90.8	85.0	80.0
E COAST CENT AMER/CARIB	US WEST COAST		59.0				56.4			61.7		
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	75.6	46.8				45.4	42.9	41.8	50.4	48.6	46.7
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	95.4	57.4				55.0	51.6		60.2	57.4	54.8
E COAST CENT AMER/CARIB	ASIA		85.9				80.7	75.2		86.7	81.3	
SOUTH AMERICA EAST COAST	US WEST COAST		70.3				66.6	62.3	60.0	61.5	58.6	55.8
S AMERICA EC	CANADA WC	141.2	81.9	69.5			77.1	71.9		83.0	78.0	
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI		63.8				60.7	56.9	55.0	66.2	62.8	59.7
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	110.5	65.4				62.3	58.3	56.3	67.7	64.2	61.0
S AMERICA EC	OCEANIA		80.4				75.8	70.7		81.6	76.7	
SOUTH AMERICA EAST COAST	ASIA	173.1	98.9				92.5	86.0		98.8	92.2	86.6
EUROPE	US WEST COAST		76.3	64.4			71.9	66.9		76.6	71.6	
EUROPE	CANADA WEST COAST	138.7	80.6	68.5			75.9	70.8		81.8	76.9	
EUROPE	CENTL AMERICA WC	99.6	59.6	51.9			57.0	53.5	51.8	62.3	59.3	56.5
EUROPE	SOUTH AMERICA WEST COAST	157.0	91.6				87.2	81.5	78.5	92.2	86.4	
EUROPE	OCEANIA		100.9				94.3	87.6	83.8	100.7	93.9	88.1
EUROPE	ASIA	167.8				162.9	90.0	83.6		96.2	89.9	84.5
AFRICA	US WEST COAST	142.0	82.3	69.8			77.5	72.2	69.4	83.4	78.3	73.9
AFRICA	SOUTH AMERICA WEST COAST		89.1				83.6	77.8		89.6	84.0	79.1
AFRICA	OCEANIA	176.3	100.7	84.4			94.1	87.4		100.4	93.7	
AFRICA	ASIA	172.2	98.5				92.1	85.6		98.4	91.8	
MID EAST	US WEST COAST	160.8	92.3				86.6	80.5	77.2	92.7	86.7	81.6

Source: The WEFA Group

Table 10.3 (Cont'd)

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL
Container Breakbulk Ships: CB

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999
US WEST COAST	SOUTH AMERICA EAST COAST		70.3				66.6	62.3	51.1	72.2	68.2	64.7
US WEST COAST	E COAST CENT AMER/CARIB	98.4	59.0				56.4	52.9		61.7	58.8	
US WEST COAST	EUROPE		76.3	64.4			71.9	66.9	64.1	76.6	71.6	67.5
US WEST COAST	AFRICA	142.0	82.3	69.8	67.7		77.5	72.2	69.4	83.4	78.3	73.9
CANADA WEST COAST	US EAST COAST	105.6	62.8	54.4	53.1		59.9	56.1	54.3	65.3	62.0	59.0
CANADA WEST COAST	S AMERICA EC	110.5	65.4	56.5	55.0		62.3	58.3	56.3	67.7	64.2	61.0
CANADA WEST COAST	E COAST CENT AMER/CARIB		59.0				56.4	52.9		61.7	58.8	56.0
CANADA WEST COAST	EUROPE	133.5	77.8	66.2	6[illegible].3		73.4	68.5	65.9	79.2	74.5	70.4
CANADA WEST COAST	AFRICA	149.8	86.5	73.2	7[illegible].8		81.3	75.7	72.6	87.3	81.8	77.1
WEST COAST CENTRAL AMERI	US EAST COAST						49.2	46.4	45.1	54.4	52.1	49.9
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB		43.9				45.4	42.9	41.8	50.4	48.6	46.7
WEST COAST CENTRAL AMERI	SOUTH AMERICA EAST COAST		63.8				60.7			66.2	62.8	59.7
WEST COAST CENTRAL AMERI	EUROPE	99.6					57.0	53.5	51.8	62.3	59.3	56.5
WEST COAST CENTRAL AMERI	AFRICA		77.9				73.5	68.5		79.3	74.6	70.5
SOUTH AMERICA WEST COAST	US EAST COAST		55.6				53.3	50.1		58.6	55.9	53.4
S AMERICA WC	CANADA EC	102.6	61.2		5[illegible].9		58.4	54.8	53.0	63.8	60.7	57.7
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB		57.4				55.0	51.6		60.2	57.4	
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST		65.4	56.5			62.3	58.3		67.7	64.2	61.0
SOUTH AMERICA WEST COAST	EUROPE	157.0	91.6				87.2	81.5	78.5	92.2	86.4	81.8
S AMERICA WC	AFRICA	154.6	129.1		72.7		83.6	77.8	74.6	89.6	84.0	79.1
OCEANIA	US EAST COAST		140.3		77.8		90.2		80.5	96.2		84.3
OCEANIA	CANADA EC	156.8	95.0	79.9	7[illegible].2		87.2	81.5	78.5	95.2	89.0	83.6
OCEANIA	E COAST CENT AMER/CARIB		83.2				78.3	73.0	70.1	84.2	79.1	74.6
OCEANIA	SOUTH AMERICA EAST COAST		80.3				75.7	70.5		81.5	76.6	
OCEANIA	EUROPE	176.8	100.9				94.3	87.6		100.7	93.9	
ASIA	US EAST COAST		91.5		73.6		85.7		76.4	90.7		79.9
ASIA	CANADA EC	156.9	90.3	76.1	73.7		84.7	78.8	75.6	90.8	85.0	80.0
ASIA	E COAST CENT AMER/CARIB		85.9				80.7	75.2	72.1	86.7	81.3	76.6
ASIA	SOUTH AMERICA EAST COAST		98.9				92.5	86.0		98.8	92.2	
ASIA	EUROPE		96.1				90.0	83.6		96.2	89.9	

Source: The WEFA Group

Table 10.4

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Full Container Ships : F

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10;000 to 24,999	25,000 to 39,999	40,000 to 64,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999
US EAST COAST	S AMERICA WC	210.2	161.7	135.4	133.4		160.6	137.1	134.1	166.9	138.2	132.6
US EAST COAST	OCEANIA		271.7	188.7			266.6	190.6	185.8	269.6	199.5	187.6
US EAST COAST	ASIA		258.4	198.4	194.9		254.1	199.4	195.3	257.8	200.4	190.2
CANADA EAST COAST	OCEANIA	359.1	268.1	195.4			263.2	196.7	192.2	267.5	198.2	186.4
CANADA EAST COAST	ASIA	341.3	255.4	185.3	184.4		250.9	189.6	185.3	255.5	191.0	180.0
E COAST CENT AMER/CARIB	US WEST COAST		170.9	140.6	138.4		169.4	142.3	139.1	175.6	143.3	137.2
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST			138.2				139.9	136.8	171.5	140.9	135.0
CENTL AMERIC EC & CARIB	OCEANIA		236.3	177.4	174.1		232.5	178.9	174.9	237.4	180.3	170.3
CENTL AMERIC EC & CARIB	ASIA	324.5	243.4	181.4	177.9		239.4	182.9	178.7	244.2	184.3	173.9
SOUTH AMERICA EAST COAST	US WEST COAST			138.9				159.3	155.8		160.5	152.6
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	247.5	188.3				186.3	152.0		192.1	153.2	146.0
EUROPE	US WEST COAST		215.4	166.2			212.1	167.3	164.0	228.0	174.6	165.2
EUROPE	CANADA WEST COAST			173.4				174.9	171.0		176.2	166.7
EUROPE	SOUTH AMERICA WEST COAST		264.1	209.2			261.6	211.8	208.0	227.6	174.4	165.0
EUROPE	OCEANIA		284.0				278.5	205.6		282.6		194.5
WEST COAST	CANADA EAST COAST			148.7	146.3		183.4	150.4		189.3	151.5	
US WEST COAST	SOUTH AMERICA EAST COAST			157.7				159.3	155.8		160.5	152.6
US WEST COAST	E COAST CENT AMER/CARIB		170.9	140.6	138.4		169.4	142.3	139.1	175.6	143.3	137.2
US WEST COAST	EUROPE		215.4	166.2	163.1		212.1	167.3	164.0	215.9	168.4	159.3
CANADA WEST COAST	EUROPE			169.1				170.6	166.8	223.5	171.9	162.9
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB		138.0				137.8	123.9		215.9	168.4	159.3
WEST COAST CENTRAL AMERI	SOUTH AMERICA EAST COAST			147.9				149.5	146.2		150.6	143.7
WEST COAST CENTRAL AMERI	EUROPE		172.6				171.1	143.2		177.2		138.1
SOUTH AMERICA WEST COAST	US EAST COAST		161.7				160.6	137.1		166.9	138.2	132.6
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB			138.2				139.9	136.8	171.5	140.9	135.0
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	247.5	188.3			236.1	186.3	152.0		192.1	153.2	146.0
SOUTH AMERICA WEST COAST	EUROPE	350.8		209.2			261.6	211.8	208.0	270.1	213.4	202.0
OCEANIA	US EAST COAST		307.8	188.7			266.6	190.6	185.8	271.1	192.6	180.2
OCEANIA	CANADA EAST COAST			195.4				196.7	192.2		198.2	186.4
OCEANIA	E COAST CENT AMER/CARIB		236.3				232.5	178.9		237.4	180.3	170.3
OCEANIA	EUROPE		284.0	204.3	200.0		278.5	205.6	200.9	282.6	207.2	194.5
ASIA	US EAST COAST		258.4	198.4	194.9			199.4	195.3		190.8	190.2
ASIA	CANADA EC		255.3	188.2	184.4		250.9	189.5	185.3	255.4	191.0	180.0
ASIA	E COAST CENT AMER/CARIB		243.4				239.4	182.9		244.2		173.9
ASIA	EUROPE		271.0	197.0	193.0		266.0	198.3	193.9	270.3	199.9	187.9

Source: The WEFA Group

Table 10.4 (Cont'd)
PANAMA CANAL:$/CARGO TON
CASE 2-DIFFERENTIATION FROM STATUS QUO CANAL

FULL CONTAINERSHIPS

FROM	TO	2020 90,000	2060 90,000	2060 148,000
US EAST COAST	ASIA	176.5	176.0	
ASIA	US EAST COAST	176.5	176.0	
EUROPE	US WEST COAST	148.6	148.3	
US WEST COAST	EUROPE	148.6	148.3	

CASE 3-DIFFERENTIATION FROM CASE 2

US EAST COAST	ASIA	170.3
ASIA	US EAST COAST	170.3

Source: The WEFA Group

Table 10.5
PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL
Conventional General Cargo Ships: G

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999
US EAST COAST	US WEST COAST	41.0				41.7	21.1			48.2	23.9	
US EAST COAST	CANADA WEST COAST	41.0				41.7	21.1			48.2	23.9	
US EAST COAST	WEST COAST CENTRAL AMERI	26.0	14.1			27.1	13.7	10.7		30.8	15.3	11.6
US EAST COAST	SOUTH AMERICA WEST COAST	35.7	19.2			36.1	18.3	13.8		42.0	20.8	15.3
US EAST COAST	OCEANIA		31.7				30.1	22.1			34.4	24.6
US EAST COAST	ASIA	55.6	29.8	21.4			28.4	20.8			32.4	23.2
CANADA EAST COAST	WEST COAST CENTRAL AMERI		17.0				16.4				18.4	
CANADA EAST COAST	ASIA	61.3	32.8	23.5		61.6	31.2	22.7		71.7	35.6	25.3
E COAST CENT AMER/CARIB	US WEST COAST	35.8	19.3			36.7	18.5			42.1	20.9	
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	24.1	13.1			25.3	12.8			28.7	14.3	
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	32.9	17.7			33.8	17.1	13.0		38.8	19.3	14.2
E COAST CENT AMER/CARIB	ASIA		28.9				27.5	20.2			31.4	22.4
SOUTH AMERICA EAST COAST	US WEST COAST	48.3				48.9	24.7			56.6	28.1	
S AMERICA EC	CANADA WC	51.4	27.6	19.8		51.9	26.3	19.3		60.2	29.9	21.5
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI	36.4	19.6			37.3	18.9	14.2		42.9	21.3	15.6
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	33.2	17.9			34.1	17.2	13.1		39.1	19.4	14.4
SOUTH AMERICA EAST COAST	ASIA		35.5				33.7	24.4		77.6	38.5	27.3
EUROPE	US WEST COAST	51.8				52.3	26.3			60.5	29.9	
EUROPE	CANADA WEST COAST	54.4	29.2	20.9		54.9	27.8	20.3		63.7	31.7	22.6
EUROPE	WEST COAST CENTRAL AMERI	39.3	21.1			40.1	20.3	15.2		46.2	23.0	16.7
EUROPE	SOUTH AMERICA WEST COAST	46.7	25.6	18.7		47.3	24.3	17.8		55.0	27.7	19.8
EUROPE	OCEANIA	69.4	37.1			69.4	35.2	25.4		81.0	40.2	28.4
EUROPE	ASIA	69.6				69.7	35.3	25.5		81.3	40.4	28.5
AFRICA	CANADA WEST COAST	57.5	30.8	22.0		57.8	29.3	21.4		67.2	33.4	23.8
AFRICA	CENTL AMERICA WC	45.6	24.5	17.7		46.3	23.4	17.3		53.5	26.6	19.2
AFRICA	SOUTH AMERICA WEST COAST		29.4				28.0	20.5			31.9	22.8
US WEST COAST	SOUTH AMERICA EAST COAST	48.3				48.9	24.7			56.6	28.1	
US WEST COAST	E COAST CENT AMER/CARIB		19.3				18.5	13.8			20.9	15.4
US WEST COAST	EUROPE		27.7	19.6			26.3	19.3			29.9	21.4
US WEST COAST	AFRICA	54.3				54.8	27.7			63.6	31.6	
CANADA WEST COAST	E COAST CENT AMER/CARIB	38.9	21.0			39.8	20.1			45.8	22.8	
CANADA WEST COAST	MID EAST	62.5	33.5	23.9		62.8	31.8	22.9		73.1	36.3	25.8
WEST COAST CENTRAL AMERI	US EAST COAST	26.0	14.1			27.1	13.7	10.5		30.8	15.3	11.6
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB	24.1	13.1			25.3	12.8	9.8		28.7	14.3	10.8
CANADA WEST COAST	SOUTH AMERICA EAST COAST	36.4	19.6			37.3	18.9	14.0		42.9	21.3	15.6
WEST COAST CENTRAL AMERI	EUROPE	39.3	21.1			40.1	20.3	15.0		46.2	23.0	16.7
WEST COAST CENTRAL AMERI	AFRICA		24.5				23.4	17.1			26.6	19.2
SOUTH AMERICA WEST COAST	US EAST COAST	35.7	19.2			36.6	18.4	14.0		42.0	20.8	15.3
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	32.9	17.7			33.8	17.1	12.8		38.8	19.3	14.2
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	33.2	17.9			34.1	17.2	12.9		39.1	19.4	14.4
SOUTH AMERICA WEST COAST	EUROPE	46.7	25.3	18.7		42.3	24.3	17.8		55.0	27.7	19.8
SOUTH AMERICA WEST COAST	AFRICA	54.8	29.4			55.3	28.0	20.3		64.2	31.9	22.8
OCEANIA	E COAST CENT AMER/CARIB	58.4	31.3			58.8	29.8			68.3	34.0	
OCEANIA	SOUTH AMERICA EAST COAST	55.6	29.8			56.0	28.4	20.7		65.1	32.3	23.1
OCEANIA	EUROPE	69.4	37.1	26.4		69.4	35.2	25.4		81.0	40.2	28.4
ASIA	US EAST COAST	55.6	29.8	21.4			30.1	22.1			32.4	23.2
ASIA	CANADA EC	61.3	32.8	23.5		61.6	31.2	22.7		71.7	35.6	25.3
ASIA	E COAST CENT AMER/CARIB		28.9				27.5	20.2		21.0	35.5	25.2
ASIA	SOUTH AMERICA EAST COAST		35.5				33.7	24.4			38.5	27.3
ASIA	EUROPE	69.6				69.7	35.3			81.3	40.4	8.2

Source: The WEFA Group

Table 10.6

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Refrigerated Cargo Ships: R

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999
US EAST COAST	WEST COAST CENTRAL AMERI	62.1	49.0			63.1	51.9				54.8	
US EAST COAST	SOUTH AMERICA WEST COAST	86.8	71.4			88.2	75.3			94.6	79.9	
US EAST COAST	ASIA	138.1	119.0			140.9	124.6			153.6	132.9	
CANADA EAST COAST	US WEST COAST										98.5	
CANADA EAST COAST	ASIA	152.6				155.7	134.2			170.8	143.7	
E COAST CENT AMER/CARIB	US WEST COAST	87.2	70.8			88.7	74.7				79.4	
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	57.4	44.8			58.3	47.6				50.1	
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	79.8	64.4			81.2	68.0			87.8	72.1	
E COAST CENT AMER/CARIB	ASIA	133.6				136.2	116.9			149.2	125.0	
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI	88.9				90.5	76.3			98.2	81.1	
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	80.5	65.0			81.9	68.6			88.7	72.8	
SOUTH AMERICA EAST COAST	ASIA	165.6				169.0	146.0			185.6	156.5	
EUROPE	US WEST COAST	127.7	105.6			129.9	111.0			140.9	118.6	
EUROPE	WEST COAST CENTRAL AMERI	96.2	78.7			98.0	82.9				88.3	
EUROPE	SOUTH AMERICA WEST COAST	115.8	96.6			118.6	102.2			129.5	109.7	
EUROPE	ASIA	173.7				177.3	153.4			194.9	164.5	
AFRICA	SOUTH AMERICA WEST COAST	135.9	113.4			138.6	119.1			151.9	127.4	
AFRICA	ASIA	159.7				163.0	140.7			179.0	150.7	
US WEST COAST	EUROPE	127.7	105.6			129.9	111.0			140.9	118.6	
WEST COAST CENTRAL AMERI	US EAST COAST	62.1				63.1	51.9			66.9	54.8	
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB	57.4	44.8				47.6				50.1	
WEST COAST CENTRAL AMERI	SOUTH AMERICA EAST COAST	88.9	72.3			90.5	76.3			97.4	81.1	
WEST COAST CENTRAL AMERI	EUROPE	96.2	78.7			98.0	82.9				88.3	
WEST COAST CENTRAL AMERI	AFRICA	112.3	92.8			114.5	97.6			124.1	104.1	
SOUTH AMERICA WEST COAST	US EAST COAST	86.8	71.4			88.2	75.3			93.9	78.0	
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	79.8	64.4			81.2	68.0			87.0	72.1	
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	80.5	65.0			81.9	68.6			87.8	72.8	
SOUTH AMERICA WEST COAST	EUROPE	115.8	96.6			118.6	102.2			132.3	111.2	
SOUTH AMERICA WEST COAST	AFRICA	135.9										
OCEANIA	US EAST COAST	146.3	122.4			150.1	128.9			163.6	138.1	
OCEANIA	EUROPE	147.3	122.6			176.7	152.9				163.9	
ASIA	E COAST CENT AMER/CARIB	133.6				136.2	116.9			149.2	125.0	
ASIA	SOUTH AMERICA EAST COAST	165.6				169.0	146.0			185.6	156.5	
ASIA	EUROPE	173.7				177.3	153.4			194.9	164.5	

Source: The WEFA Group

Table 10.7

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Roll On / Roll Off Ships:RO-RO

		1990				2020				2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999	10,000 to 24,999	25,000 to 39,999	40,000 to 64,999
US EAST COAST	SOUTH AMERICA WEST COAST	236.4	158.9			235.0	163.0	144.5		176.5	148.4	
US EAST COAST	OCEANIA		272.7	229.4	211.0		280.8	236.7	217.0	300.8	249.8	226.6
US EAST COAST	ASIA		256.6				265.4	224.0		284.0	235.6	
CANADA EAST COAST	ASIA	397.3	255.0	214.8	197.7		263.2	223.1	203.6	282.1	234.1	212.5
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI		134.6				137.7	124.7		147.2	126.7	
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	244.8	163.9				168.2	148.6		180.1	152.8	
S AMERICA EC	CANADA WC	358.4	231.8	196.1	181.0		239.0	204.1	186.0	256.1	213.3	194.4
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	282.1					191.5	93.4	83.7	205.1		
EUROPE	CANADA WEST COAST	352.2					235.1			251.9		
EUROPE	WEST COAST CENTRAL AMERI		170.1				174.7	153.7		187.0	158.3	
EUROPE	OCEANIA		284.4	238.4			293.9	247.1	225.8	315.0	260.2	235.5
EUROPE	ASIA		271.1				280.0	236.2		300.1	248.4	
US WEST COAST	CANADA EAST COAST		183.2	157.1	146.1		188.3	164.4	149.3	201.6	170.0	154.3
US WEST COAST	E COAST CENT AMER/CARIB		168.3				172.8	152.2		185.0	156.7	144.7
US WEST COAST	EUROPE		215.3				222.9			239.4		
WEST COAST CENTRAL AMERI	US EAST COAST		146.4				150.0	134.3		160.5	137.2	127.5
WEST COAST CENTRAL AMERI	E COAST CENT AMER/CARIB		134.6				137.7	124.7		147.2	126.7	
WEST COAST CENTRAL AMERI	EUROPE		170.1				174.7	153.7		187.0	158.3	146.1
SOUTH AMERICA WEST COAST	US EAST COAST	236.4	158.9			235.0	163.0	144.5				
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	244.8	163.9				168.2	148.6		180.1	152.8	
SOUTH AMERICA WEST COAST	SOUTH AMERICA EAST COAST	282.1					191.5			205.1		
SOUTH AMERICA WEST COAST	EUROPE	396.4					269.2			248.1		
OCEANIA	US EAST COAST	424.5					280.8			300.8		
OCEANIA	EUROPE	446.5	284.4	238.4	218.9		293.9	247.1	225.8	315.0	260.2	235.5
ASIA	US EAST COAST		256.6				265.4	224.0		284.0	235.6	
ASIA	E COAST CENT AMER/CARIB		242.7				250.4	213.0		241.2	201.5	

Source: The WEFA Group

Table 10.8

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

TANKERS:T

FROM	TO	1990 0 to 9,999	1990 10,000 to 39,999	1990 40,000 to 64,999	1990 65,000 to 79,999	2020 0 to 9,999	2020 10,000 to 39,999	2020 40,000 to 64,999	2020 65,000 to 79,999	2060 0 to 9,999	2060 10,000 to 39,999	2060 40,000 to 64,999	2060 65,000 to 79,999
US EAST COAST	US WEST COAST		20.9				21.2				25.5		
US EAST COAST	CANADA WEST COAST		13.8					10.4				11.7	
US EAST COAST	WEST COAST CENTRAL AMERI	12.2	7.4	5.6		13.6	7.9	6.0	5.4	16.7	9.3	6.8	6.0
US EAST COAST	SOUTH AMERICA WEST COAST	21.1	11.4	8.3	7.1	23.0	12.0	8.7	7.6	28.7	14.3	9.8	
US EAST COAST	OCEANIA	43.5	21.4	15.3		47.6	22.5	15.6		59.7	27.2	17.5	
US EAST COAST	ASIA	40.5	20.1	14.4	11.8	44.3	21.1	14.7	12.5	55.6	25.5	16.5	13.9
E COAST CANADA	US WEST COAST			10.7				11.1				12.5	10.6
E COAST CANADA	WEST COAST CENTRAL AMERICA		9.8	7.2	6.2			7.5	6.7			8.6	7.4
E COAST CANADA	SOUTH AMERICA WEST COAST		13.8	10.0	8.4			10.3	8.9			11.6	9.9
E COAST CANADA	OCEANIA	45.9	22.5	16.1	13.1			16.4	13.8	63.0	28.6	18.3	15.4
E COAST CANADA	ASIA	45.8	22.5	16.0	13.1			16.4	13.8			18.3	15.3
E COAST CENT AMER/CA	US WEST COAST	21.2	11.4	8.4	7.2	23.4	12.1	8.7	7.8	29.2	14.5	10.0	8.6
E COAST CENT AMER/CA	WEST COAST CENTRAL AMERI	10.6		5.1		11.7	7.3	5.6		14.4	8.5	6.3	
E COAST CENT AMER/CA	SOUTH AMERICA WEST COAST	18.5	10.4	7.6	6.5	20.5	11.1	8.0	7.1	25.5	13.1	9.1	7.8
E COAST CENT AMER/CA	ASIA		19.3	13.8		42.4	20.3	14.2			24.5	15.9	
SOUTH AMERICA EAST C	US WEST COAST		16.5	11.8				12.2				14.0	
SOUTH AMERICA EAST C	CANADA WEST COAST	36.4	18.3	13.1	10.8	39.8	19.2	13.4	11.4		23.1	15.1	12.7
SOUTH AMERICA EAST C	WEST COAST CENTRAL AMERI	21.8	11.9	8.6		24.1	12.6	9.0		30.1	15.0	10.3	
SOUTH AMERICA EAST C	SOUTH AMERICA WEST COAST	18.8	10.6	7.7	6.6	20.8	11.2	8.1	7.1	25.9	13.3	9.2	7.2
SOUTH AMERICA EAST C	ASIA			14.1				14.4				16.1	13.4
EUROPE	US WEST COAST	35.8	18.0	12.9	10.7	39.2	18.9	13.3	11.3	49.1	22.8	14.9	12.5
EUROPE	CANADA WEST COAST		19.6					14.3			24.8		
EUROPE	WEST COAST CENTRAL AMERI	24.9	13.1	9.5	8.0	27.2	13.8	9.9	8.6	34.0	16.6	11.1	9.5
EUROPE	SOUTH AMERICA WEST COAST	33.7	17.6			37.0	18.5	13.1		46.2	22.1	14.9	
EUROPE	OCEANIA	53.4				58.4	27.2	18.7		73.4			
EUROPE	ASIA	53.6	26.0	18.5	14.9	58.7	27.3	18.8	15.7		33.0	20.9	17.2
AFRICA	US WEST COAST	39.1	19.5	14.0	11.4	42.8	20.5	14.3	12.1	53.7	24.7	16.0	13.5
AFRICA	CANADA WEST COAST	42.1	20.8	14.9	12.2	46.1	21.9	15.2	12.9	57.8	26.4	17.0	14.3
AFRICA	WEST COAST CENTRAL AMERICA		15.8	11.4	9.5			11.7	10.1			13.2	11.3
AFRICA	SOUTH AMERICA WEST COAST		19.7	14.1				14.6	12.3			16.2	13.6
AFRICA	OCEANIA		23.6	16.8	13.6			17.1	14.4			19.1	16.4
MIDDLE EAST	US WEST COAST	43.9	21.6	15.5	12.6	48.0	22.7	15.8			27.4	17.6	14.8

Source: The WEFA Group

Table 10.8 (Cont'd)

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

TANKERS (Cont'd)

FROM	TO	1990 0 to 9,999	1990 10,000 to 39,999	1990 40,000 to 64,999	1990 65,000 to 79,999	2020 0 to 9,999	2020 10,000 to 39,999	2020 40,000 to 64,999	2020 65,000 to 79,999	2060 0 to 9,999	2060 10,000 to 39,999	2060 40,000 to 64,999	2060 65,000 to 79,999
US WEST COAST	US EAST COAST		23.5				23.8				28.6		
US WEST COAST	CANADA EAST COAST			10.1				11.1					
US WEST COAST	SOUTH AMERICA EAST COAST		14.7	11.3	10.1			12.5	10.7			14.0	11.9
US WEST COAST	E COAST CENT AMER/CARIB		10.9	8.2				8.7				10.0	
US WEST COAST	EUROPE		15.5		10.7			13.3	11.3			14.9	12.5
US WEST COAST	AFRICA			12.9	11.4			14.3	12.1			16.0	13.5
CANADA WEST COAST	US EAST COAST		12.5	9.5				10.4				11.7	
CANADA WEST COAST	SOUTH AMERICA EAST COAST	36.4	15.7	12.1	10.8	39.8	19.2	13.4	11.4	49.9	23.1	15.1	12.7
CANADA WEST COAST	EUROPE	39.3	16.7	12.9	11.5	43.0	20.6	14.3	12.1		24.8	16.0	13.5
CANADA WEST COAST	AFRICA	42.1	17.6	13.7	12.2	46.1	21.9	15.2	12.9		26.4	17.0	14.3
WEST COAST CENTRAL	AUS EAST COAST	12.3	7.9	5.8		13.4	7.9	6.0	5.4	16.6	9.3	6.8	6.0
WEST COAST CENTRAL	AE COAST CENT AMER/CARIB	10.6		5.3		11.5	7.1	5.4		14.2	8.3	6.2	
WEST COAST CENTRAL	ASOUTH AMERICA EAST COAST		11.1	8.4	7.4			9.0				10.2	
WEST COAST CENTRAL	AEUROPE	24.9	12.0	9.1	8.0	27.2	13.8	9.9	8.6	34.0	16.6	11.1	9.5
WEST COAST CENTRAL	AAFRICA	30.9	13.9	10.7	9.5	33.8	16.6	11.7	10.1	42.3	20.0	13.2	11.2
SOUTH AMERICA WEST	CUS EAST COAST		10.7	8.1	7.1			8.6	7.6			9.8	8.4
SOUTH AMERICA WEST	CCANADA EAST COAST	26.3	12.4	9.5	8.4	28.8	14.5	10.3	8.9				
SOUTH AMERICA WEST	CE COAST CENT AMER/CARIB	20.4	10.0	7.5	6.6	20.6	11.1	8.0	7.1	25.7	13.1	9.1	
SOUTH AMERICA WEST	CSOUTH AMERICA EAST COAST		10.1	7.6				8.1				9.8	
SOUTH AMERICA WEST	CEUROPE	33.5	14.8			36.7	17.9	12.6		45.9	21.5	14.1	
SOUTH AMERICA WEST	CAFRICA		16.8	13.0	11.6			14.4	12.2	54.4		16.2	13.6
OCEANIA	US EAST COAST		18.0	14.0				15.6				17.5	
OCEANIA	E COAST CENT AMER/CARIB		17.9	13.9	12.4			15.5				17.3	
OCEANIA	EAST COAST SOUTH AMERICA	40.3	17.0	13.2	11.7	44.1	21.1	14.7	12.4	55.3	25.4	16.4	13.8
OCEANIA	EUROPE	53.4	21.3	16.6	14.9	58.4	27.2	18.7		73.4	32.9	20.9	17.5
ASIA	US EAST COAST		17.1	13.2	11.8	44.3	21.1	14.7	12.5		25.5	16.5	13.9
ASIA	CANADA EAST COAST	45.8	18.8	14.6	13.1	50.1	23.6	16.4	13.8		28.5	18.3	15.3
ASIA	E COAST CENT AMER/CARIB	38.8	16.5	12.8		42.4	20.3	14.2		53.2	24.5	15.9	
ASIA	SOUTH AMERICA EAST COAST		20.4	15.9				17.9				19.9	
ASIA	EUROPE		21.3					18.8				20.9	

Source: The WEFA Group

Table 10.8 (Cont'd)

PANAMA CANAL: $/CARGO TON -CASE 2- DIFFERENTIATION FROM STATUS QUO

TANKERS

From	To	2020	2060
		DWT Range	
		65,000 to 99,999	65,000 to 99,999
US EAST COAST	WEST COAST CENTRAL AMERI	5.0	5.6
US EAST COAST	SOUTH AMERICA WEST COAST	6.8	
US EAST COAST	ASIA	11.0	12.6
E COAST CENT AMER/CARIB	US WEST COAST	7.0	7.9
E COAST CENT AMER/CARIB	WEST COAST CENTRAL AMERI	4.6	5.1
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST	6.3	
SOUTH AMERICA EAST COAST	US WEST COAST	9.5	
SOUTH AMERICA EAST COAST	WEST COAST CENTRAL AMERI	7.1	8.0
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	6.4	7.2
EUROPE	US WEST COAST	10.0	11.4
EUROPE	WEST COAST CENTRAL AMERI	7.7	8.7
AFRICA	US WEST COAST	10.7	12.2
AFRICA	CANADA WEST COAST	11.3	13.0
US WEST COAST	SOUTH AMERICA EAST COAST	9.5	10.8
US WEST COAST	EUROPE	10.0	11.4
US WEST COAST	AFRICA	10.7	12.2
CANADA WEST COAST	SOUTH AMERICA EAST COAST	10.1	
CANADA WEST COAST	EUROPE	10.7	
CANADA WEST COAST	AFRICA	11.3	
WEST COAST CENTRAL AMERI	US EAST COAST	5.0	5.6
WEST COAST CENTRAL AMERI	EUROPE	7.7	8.7
WEST COAST CENTRAL AMERI	AFRICA	60.3	
SOUTH AMERICA WEST COAST	US EAST COAST	6.8	7.7
SOUTH AMERICA WEST COAST	CANADA EAST COAST	8.0	
SOUTH AMERICA WEST COAST	E COAST CENT AMER/CARIB	6.3	
SOUTH AMERICA WEST COAST	AFRICA	10.8	
OCEANIA	EAST COAST SOUTH AMERICA	11.0	
OCEANIA	EUROPE	13.8	
ASIA	US EAST COAST	11.0	12.6

Source: The WEFA Group

PANAMA CANAL: $/CARGO TON : STATUS QUO CANAL

PANAMA CANAL: $/CARGO TON: CASE 4 AND 5 - DIFFERENTIATION FROM CASE 3
ORIMULSION TRADE

2020		2060	
150,000 to 249,999	250,000 to 299,999	150,000 to 249,999	250,000 to 299,999
7.16	6.4	8.13	7.25

Source: The WEFA Group

Table 10.9

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

CHEMICAL TANKERS:CT

FROM	TO	1990 0 to 9,999	1990 10,000 to 39,999	1990 40,000 to 64,999	1990 65,000 to 79,999	2020 0 to 9,999	2020 10,000 to 39,999	2020 40,000 to 64,999	2020 65,000 to 79,999	2060 0 to 9,999	2060 10,000 to 39,999	2060 40,000 to 64,999	2060 65,000 to 79,999
US EAST COAST	CANADA WEST COAST	52.1	29.0			59.0	29.7			67.5	32.1		
US EAST COAST	WEST COAST CENTRAL AMERI		20.0			39.1	20.7			44.3	22.2		
US EAST COAST	SOUTH AMERICA WEST COAST	52.5	28.9			58.7	29.7	23.8		67.1	32.1	24.9	
US EAST COAST	OCEANIA	73.2	39.3			82.0	40.2	32.0		94.4	43.8	33.7	
US EAST COAST	ASIA	71.3	38.1			79.6	39.0	31.0			42.3	32.6	
E COAST CANADA	ASIA	76.1	41.1			86.0	41.9			99.0	45.6		
E COAST CENT AMER/CA	SOUTH AMERICA WEST COAST	42.6				48.3	24.9			41.4	21.0		
E COAST CENT AMER/CA	OCEANIA	54.9	26.8										
E COAST CENT AMER/CA	ASIA	67.3	36.7			76.2	37.5			87.5	40.7		
SOUTH AMERICA EAST C	US WEST COAST					68.7	34.1						
SOUTH AMERICA EAST C	ASIA		37.2			77.2	38.0			88.7	41.2		
EUROPE	US WEST COAST	63.7	34.8			72.1	35.6			82.7	38.6		
EUROPE	WEST COAST CENTRAL AMERI	50.2	28.0			56.8	28.7			64.9	31.0		
EUROPE	SOUTH AMERICA WEST COAST	61.5	33.4			68.8	34.4			78.9	37.2		
EUROPE	OCEANIA	85.5	45.9			96.7	46.7			111.4	50.9		
EUROPE	ASIA	87.0	46.1			97.4	47.2	37.4		112.1	51.3	39.3	
AFRICA	SOUTH AMERICA WEST COAST	68.4				77.9	38.3			57.8	41.3		
US WEST COAST	CANADA EAST COAST	55.0	31.4			62.2	31.2						
US WEST COAST	SOUTH AMERICA EAST COAST	60.7	34.4			68.7	34.1			78.7	36.9		
US WEST COAST	EUROPE		35.6				35.2	28.1			38.3	29.6	
CANADA WEST COAST	US EAST COAST		29.5				29.5	23.5			31.8	24.7	
CANADA WEST COAST	EUROPE	68.0	38.2			76.9	37.8			88.3	41.0		
WEST COAST CENTRAL A	US EAST COAST	35.6	21.5			40.4	21.4	17.2		45.6	22.9	17.9	
WEST COAST CENTRAL A	E COAST CENT AMER/CARIB	30.6				35.0				39.8	20.8		
WEST COAST CENTRAL A	SOUTH AMERICA EAST COAST		27.1				27.0				29.1		
WEST COAST CENTRAL A	EUROPE	50.2	28.9			56.8	28.7			64.9	31.0		
SOUTH AMERICA WEST C	US EAST COAST	48.2	26.8			54.6	26.6	21.3		61.8	28.7	22.3	
SOUTH AMERICA WEST C	CANADA EAST COAST		29.8				29.6						
SOUTH AMERICA WEST C	E COAST CENT AMER/CARIB	39.9	24.3			45.8	24.2			52.5	26.3		
SOUTH AMERICA WEST C	SOUTH AMERICA EAST COAST		25.1				25.0			55.4	26.9		
SOUTH AMERICA WEST C	EUROPE	60.9	34.5			68.8	33.5			78.9	36.4		
OCEANIA	US EAST COAST		40.9				40.2	32.0			43.8	33.7	
OCEANIA	EUROPE	83.4	47.3			95.6	46.5	36.9		110.3	50.6	38.9	
ASIA	US EAST COAST		39.7				39.0	31.0			42.3	32.6	
ASIA	CANADA EAST COAST	76.1	42.5			86.0	41.9			99.0	45.6		
ASIA	E COAST CENT AMER/CARIB		37.9				37.5			87.5	40.7		
ASIA	SOUTH AMERICA EAST COAST	82.0	45.6			92.8	45.0			106.8	48.9		
ASIA	EUROPE	85.1	48.0			97.4	47.1			112.1	51.2		

Source: The WEFA Group

Table 10.10

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Liquified Propane Tankers:LP

		1990			2020			2060		
		0 to 9,999	10,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 39,999	40,000 to 64,999	0 to 9,999	10,000 to 39,999	40,000 to 64,999
FROM	TO									
US EAST COAST	WEST COAST CENTRAL A	51.5	26.3	15.9	53.9	27.4	17.0	62.9	30.4	18.8
US EAST COAST	S AMERICA WC	88.1	41.4		91.7	43.2		107.6	48.2	
US EAST COAST	OCEANIA		79.9			83.6			93.7	
US EAST COAST	ASIA	169.2	74.8		175.6	78.3		207.1	87.7	
CANADA EAST COA	ASIA	191.2	83.9	46.1	198.4	87.8	48.5	234.1	98.4	54.2
E COAST CENT AM	WEST COAST CENTRAL A	44.3	23.3	14.3	46.4	24.3	15.4	54.0	26.9	17.0
E COAST CENT AM	ASIA	161.8	71.8		168.0	75.1		198.1	84.1	
SOUTH AMERICA E	US WEST COAST	139.5	62.6	34.9	144.9	65.4	36.8	170.7	73.3	41.1
SOUTH AMERICA E	WEST COAST CENTRAL A	92.9	43.4	24.8	96.7	45.3	26.3	113.6	50.6	29.3
SOUTH AMERICA E	SOUTH AMERICA WEST COAST		38.0			39.7			44.3	
EUROPE	US WEST COAST	149.7	66.8	37.1	155.4	69.8	39.1	183.2	78.2	43.7
EUROPE	SOUTH AMERICA WEST C	140.1	62.8	35.0	145.5	65.7	37.0	171.4	73.5	41.2
AFRICA	US WEST COAST	163.4	72.5	40.1	169.7	75.8	42.2	200.0	84.9	47.2
AFRICA	CANADA WC	175.9	77.6	42.8	182.6	81.2	45.0	215.4	91.0	50.3
S AMERICA WC	US EAST COAST	81.7	43.7		92.1	43.1		108.2	48.2	
OCEANIA	US EAST COAST	167.8	84.6	44.0	188.8	83.6	46.3	222.8	93.7	51.7

Source: The WEFA Group

Table 10.11

PANAMA CANAL: $/CARGO TON -STATUS QUO CANAL

Vehicle Carriers:V

		1990			2020			2060		
		0 to 9,999	10,000 to 24,999	25,000 to 39,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999	0 to 9,999	10,000 to 24,999	25,000 to 39,999
FROM	TO									
US EAST COAST	US WEST COAST		263.0			290.0			304.9	
US EAST COAST	CANADA WEST COAST		263.0			290.0			304.9	
US EAST COAST	WEST COAST CENTRAL AMERI	230.3	214.1		250.1	223.2		264.0	243.5	
US EAST COAST	S AMERICA WC	268.9	244.3		291.4	258.7	241.8	312.5	281.3	
US EAST COAST	ASIA	354.7	311.4		414.4	366.2	329.6	454.9	394.8	348.8
CANADA EAST COAST	US WEST COAST		270.9			290.0			314.7	
E COAST CENT AMER/CARIB	SOUTH AMERICA WEST COAST		236.6			249.7				
E COAST CENT AMER/CARIB	ASIA	346.9	305.3		374.9	330.5		410.8	357.9	
SOUTH AMERICA EAST COAST	US WEST COAST	323.3			349.6			381.1		
SOUTH AMERICA EAST COAST	SOUTH AMERICA WEST COAST	260.2			282.1			301.7		
EUROPE	US WEST COAST		295.2	264.7		314.0	280.5			
EUROPE	S AMERICA WC	323.9	287.3		350.2	309.3	281.4	381.8	335.3	300.3
EUROPE	ASIA		356.6			390.8			422.1	
AFRICA	US WEST COAST	348.6	306.6	273.0	376.7	332.1	299.1	412.9	359.5	318.1
US WEST COAST	SOUTH AMERICA EAST COAST		286.8			308.8			334.7	
US WEST COAST	E COAST CENT AMER/CARIB							315.4	283.5	
CANADA WEST COAST	EUROPE	349.2	307.1		377.3	332.6		413.6	360.1	
WEST COAST CENTRAL AMERI	US EAST COAST		214.1			223.2			243.5	
ASIA	US EAST COAST	373.6	326.7		414.4	366.2	329.6	454.9	394.8	348.8
ASIA	CENTL AM EC	346.9	305.3					410.8	357.9	
ASIA	S AMERICA EC	399.2	346.2		430.8	378.6		476.5	409.1	
ASIA	EUROPE		356.6			390.8			422.1	
ASIA	AFRICA									

Source: The WEFA Group

Table 10.12
PANAMA CANAL CLOSURE COST (IN 2020)

SHIP TYPE: CD						
DWT RANGE		0-9,999	10-39,999	40-64,999	65-100,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$0	$228,208,024	$317,455,812	$80,048,150	$625,711,985
TOTAL		$0	$82,770,013	$103,866,359	$29,494,433	$216,130,806
SHIP TYPE: T						
DWT RANGE		0-9,999	10-39,999	40-64,999	65-100,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$11,890,473	$16,076,499	$56,528,978	$9,278,928	$93,774,879
TOTAL		$844,523	$9,831,178	$26,717,772	$7,522,262	$44,915,734
SHIP TYPE: CT						
DWT RANGE		0-9,999	10-39,999	40-64,999	65-100,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$30,937,596	$230,211,314	$19,012,706	$0	$280,161,616
TOTAL		$2,152,767	$27,403,592	$2,929,168	$0	$32,485,527
SHIP TYPE: LP						
DWT RANGE		0-9,999	10-39,999	40-64,999	65-100,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$29,596,350	$51,773,925	$45,518,108	$0	$126,888,383
TOTAL		$260,178	$3,232,203	$4,125,577	$0	$7,617,958
SHIP TYPE: G						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$30,413,313	$60,259,481	$4,524,592	$0	$95,197,386
TOTAL		$1,605,090	$15,633,510	$4,434,938	$0	$21,673,537
SHIP TYPE: CB						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$907,758	$234,922,597	$54,898,578	$59,881,638	$350,610,571
TOTAL		$88,637	$33,453,155	$3,268,534	$8,744,644	$45,554,971
SHIP TYPE: RO						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$0	$17,487,868	$13,033,481	$1,292,523	$31,813,572
TOTAL		$0	$8,258,980	$2,311,011	$2,384,025	$12,954,015
SHIP TYPE: F						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$0	$193,101,451	$364,697,053	$383,467,720	$941,266,224
TOTAL		$0	$13,866,780	$64,397,422	$77,507,048	$155,771,249
SHIP TYPE: R						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$100,051,416	$175,866,768	$0	$0	$275,918,184
TOTAL		$34,766,458	$66,663,675	$0	$0	$101,430,133
SHIP TYPE: V						
DWT RANGE		0-9,999	10-24,999	25-39,999	40-65,000	
TOTAL DIVERSION COSTS	(LADEN + BALLAST)	$518,548	$102,669,919	$7,877,053	$0	$111,065,520
TOTAL		$5,413,284	$88,434,369	$1,697,548	$0	$95,545,202
TOTAL DIVERSION COSTS		$204,315,454	$1,310,577,846	$883,546,362	$515,969,210	$2,932,408,621
TOTAL PC TOLL LOSSES		$45,130,937	$349,547,455	$213,748,329	$125,652,412	$734,079,133
TOTAL CLOSURE COSTS		$249,446,391	$1,660,125,301	$1,097,294,691	$641,621,622	$3,666,487,754

Source: The WEFA Group

11.0 CONCLUSIONS AND RECOMMENDATIONS FOR PHASE II

This study is part of a group of studies, including preliminary engineering, capacity and operating characteristics studies, designed to provide sufficient information for the prescreening and selection of a very few Canal alternatives for full study. It is expected that the more detailed forecasts to be carried out in Phase II will take into account these capacity estimates as well as other Canal characteristics such as the toll structure.

The alternative Canals for the purposes of Phase I of the CTP were defined only in terms of maximum design ship size. These were defined by CAS as:

65,000 DWT (Status Quo)
100,000 DWT (Case 2)
150,000 DWT (Case 3)
250,000 DWT (Case 4)
300,000 DWT (Case 5)

The scope of Phase I CTP study excluded several issues, both from necessity and from the limited needs of the prescreening process. The study explicitly did not take into account the following issues:

- The constraints of the Panama Canal and of other pertinent parts of the world transportation system, such as the U.S. rail system;
- The effect of an enlarged or alternative Canal on the world economy, on global trade in aggregate and on patterns of world trade;
- The effect of the Canal construction itself on the world economy and on world trade;
- The effects of projected improvements in infrastructure in Panama, such as the Centerport project;
- Alternative assumptions to those which define our baseline scenario.

The base year for the study is 1990 and the forecast periods are the years 2020 and 2060. The results of the study are portrayed in Figures 11.1 and 11.2. Figure 11.1 presents the

total (Southbound and Northbound) cargo flows through the Canal by each of the five alternatives. A detailed break down by direction, route and commodity is presented in Chapter 7. Figure 11.2 presents the total number of transits by alternative. Detailed information for ship type, ship range and direction is presented in Chapter 8.

Total cargo tonnage for the status quo Canal is projected to grow 1.8% per year on average for the next 30 years and 1.1% per year thereafter, averaging 1.4% annual growth over the entire period. For the largest two alternative Canals, these growth rates climb to 2.6%, 1.0%, and 1.7%, respectively. The shift to lower growth in the latter period is because of bypass capture in the first part of the projections.

In our approach to determining bypass traffic shifting onto or away from the Canal, we have only moved traffic when the transportation economics showed significant departure from current relationships. This is because the aggregations across commodities of very different values and other approximations necessary in this work obviate precise cost comparisons. In any case, extensive discussions were held with shippers, port personnel, WEFA's commodity experts, and others each step of the way in order to provide CAS with the most informed judgements possible on these issues.

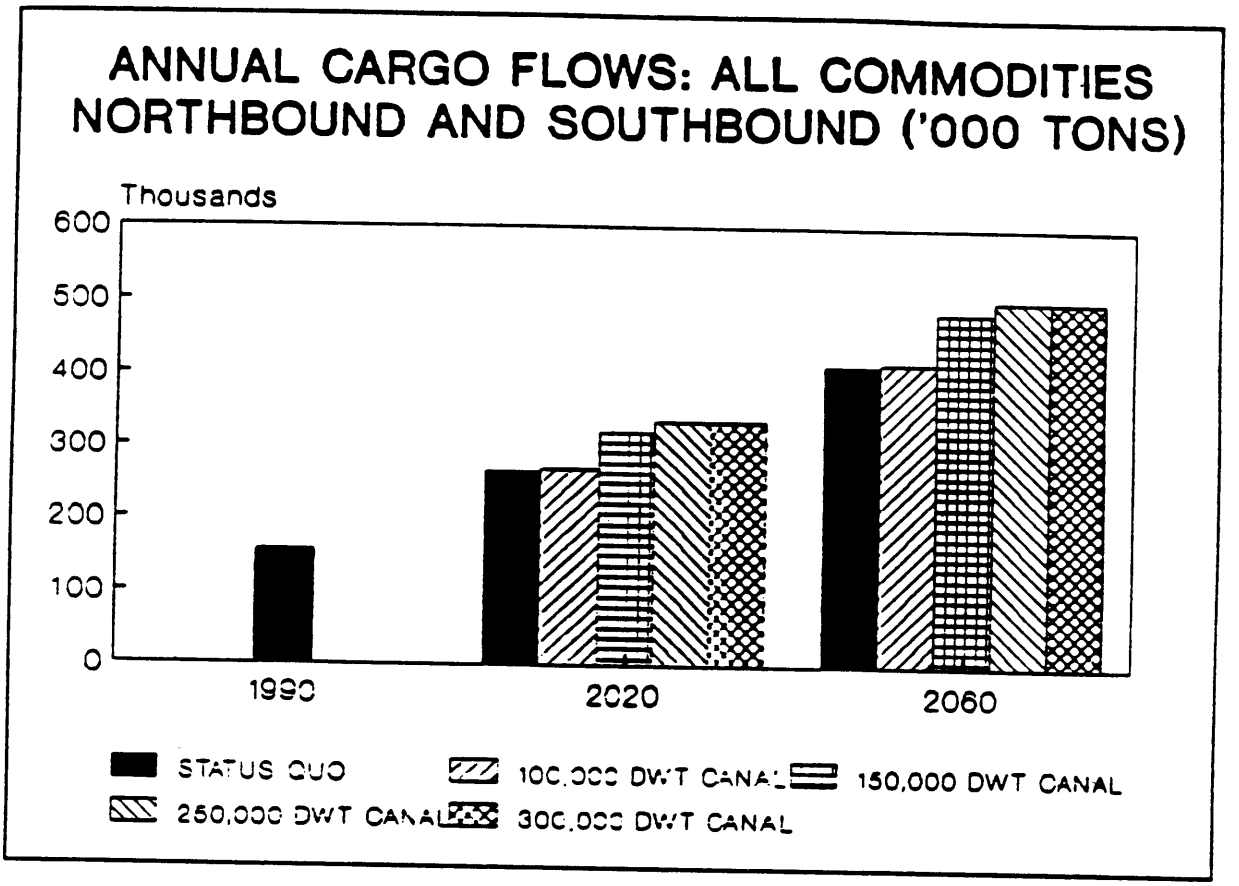
Because each larger Canal involved larger ships in the World Fleet, the increase in the growth in the number of transits from one size Canal to the next is less than the increase in the commodity tonnage flows. In fact, between 2020 and 2060, the average growth rate for Case 2 (100,000 DWT design ship) is less than that for the Status Quo Canal. A surprising result of the entire study is that the average annual growth in vessel transits over the entire forecast period, 1990 - 2060, is between 1 and 1.1% for all cases.

As already noted, commodity flows were only shifted between Canal routes and bypass routes if there were significant differences in the transportation economics. The calculations of the transportation economics included, among other things, the Canal tolls. Lower tolls for some ships/commodities could possibly attract significant bypass traffic. Conversely, higher tolls could discourage other traffic. One conclusion we have drawn from Phase I is that potential designs for optimal toll structures, drawing on the experience of the Suez Canal inter alia, should be an integral part of Phase II.

Another set of issues for Phase II is the question of sensitivity analyses. In constructing the global scenario which we have used for Phase I, we have been conservative in our approach. Issues such as global warming, exotic hull designs and propulsion systems, as well as unmanned ships, are among the questions we have had to avoid. In designing Phase II, CAS

should be cognizant of criticisms which might arise as to these and other issues, which could clearly result in quite different results and possibly different conclusions.

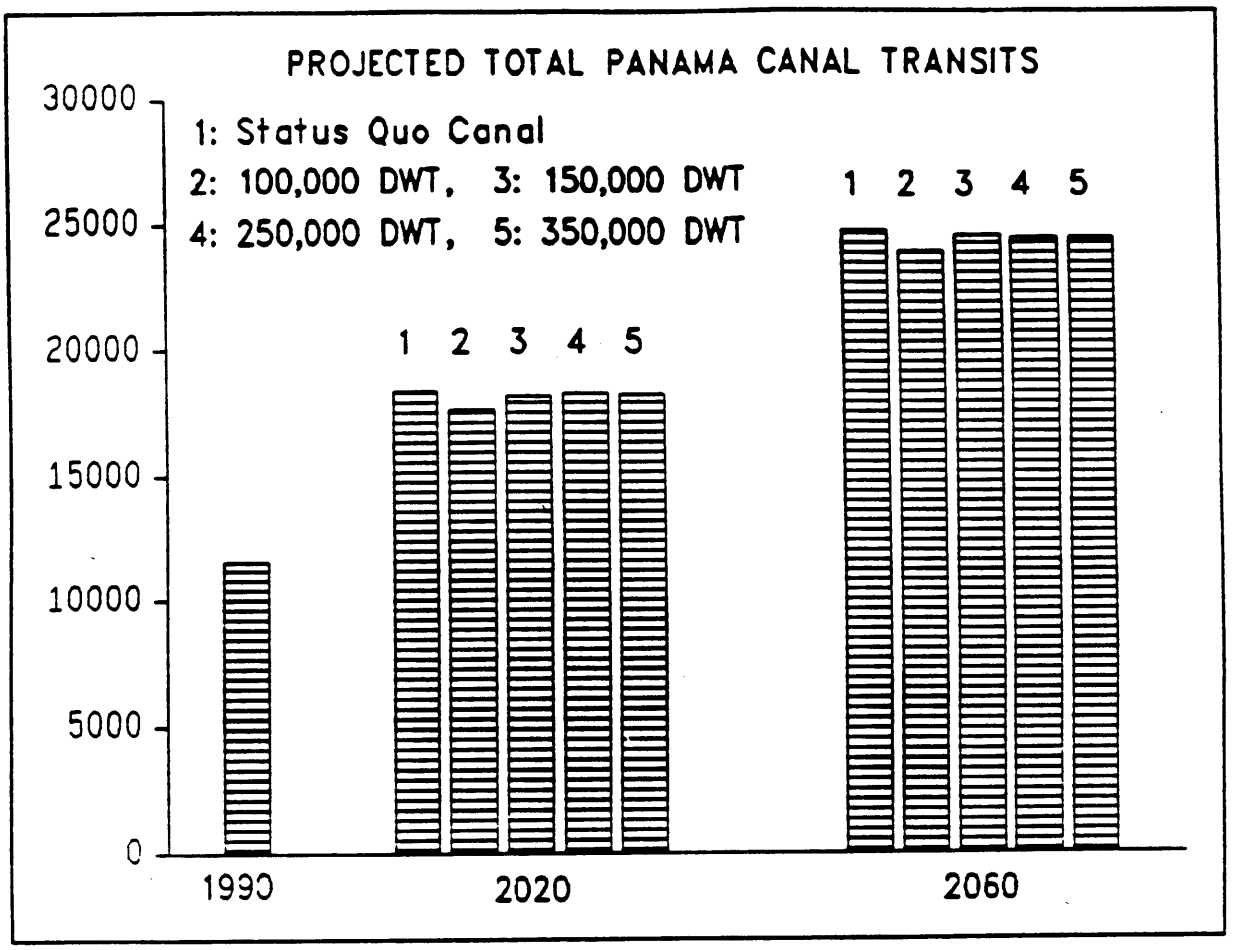
Figure 11.1



Note: Figure 11.1 and Figure 1 of the Executive Summary are the same.

Source: The WEFA Group

Figure 11.2



Note: Figure 11.2 and Figure 2 of the Executive Summary are the same.

Source: The WEFA Group

After consideration of all aspects of this study, we present below our thoughts on those issues which we believe should be addressed in Phase II of the Commodity and Transits Projections Study. They fall into two categories, those that have to do with the fine tuning of the Phase I results and those that have to do with providing a sensitivity analysis of those results.

FINE TUNING OF PHASE I

(1) **Incorporation of the detailed PCC data which we received on magnetic tape.** This work should begin as soon as possible, assuming that the PCC have corrected the data. We estimate several months work to develop the information which we require. The contract should be for time and materials with a cap, as we cannot estimate the costs precisely until we are well into the process. Introduction of actual PCC trade and transit data for FY90 may not improve results significantly but would shield CAS (and ourselves) from criticism in not using the data. It would remove the need for assumptions on the annualization of ship type transits by route by size and should provide a link between cargo and ship type by route. Although we do not believe that incorporation of PCC data into study results would significantly alter the transit forecasts, it is possible that some amendment to forecast data for specific, agreed cases would be necessary. We cannot emphasize too strongly the need for work on these data to begin as soon as possible.

(2) We believe that a second data enhancement, not included in Phase I due to time constraints, would be to acquire PIERS data for 1990 to check loadings and load factors and to determine container contents. As with the PCC data, we do not believe the results would change in any significant way, but rather that their acceptance would be more assured.

(3) **Effects of the Canal on World Trade.** An expanded Canal will reduce costs for shippers and thus increase income in the exporting country and reduce costs in the importing country. This will increase both world GDP and that in the trading countries. While these effects are expected to be small, consideration of this issue has already come up in the discussions of our Phase I report. The WEFA World Model System has the capability to incorporate reduced shipping costs.

(4) **Effects of Projected Capacity Constraints of the Panama Canal and of the U.S. Landbridge.** The incorporation of the TAMS Phase I results have always been considered a part of Phase II. In the review of our Phase I Draft Final Report (DFR) in Panama, consideration of the capacity of the U.S. landbridge also was raised by several members of CAS and SINBOL.

Once capacity considerations are introduced, both the number of transits through the Canal and the vessel mix through the Canal could change. In order to determine the revised vessel mix it is necessary to calculate, on the basis of comparative delay costs

and transportation economics, the ordering of those vessels most likely to be diverted away from the Canal.

(5) **Effects of Projected Improvements in Infrastructure in Panama.** This includes such projects as the Centerport project. To the extent that costs to shippers are reduced by other ongoing projects in Panama, these might be included in the analysis.

(6) **The Addition of Other Periods (2015, 2030) to the Study.** We believe this would be helpful to Phase II for two reasons. First, in its DFR, the Operating Characteristics/Capacity Evaluation (OC/CE) Component Contractor points out that two points in time were insufficient to determine the delay curves for several of the cases. Secondly, to carry out both the cost-benefit and financial analyses, a better notion of the time development of the benefits to world shipping may be useful.

(7) **Results by Beam and Draft.** In order to review more closely the capacity of specific Canal cases, it is recommended that transit results be produced by beam and draft as well by deadweight class. This could be accomplished using analyses from incorporation of PCC data and/or fleet data into the study results and subsequent transformation of transit forecasts to include beam categories. This would fine tune the summaries that it is understood the TAMS Group have already provided in that closer concordance between ship types and beam distributions could be achieved.

SENSITIVITY ANALYSES

(1) **High and Low Scenarios to Provide a Range of Potential Uncertainty.** During the discussions in Panama on the DFR, a number of reviewers expressed the need for a range of economic, trade and vessel scenarios. Such demand scenarios are comparable to the alternatives being considered for the supply side, that is, the Canal alternatives.

(2) A differentiation of the toll rate structure would provide the operators of the Canal with the ability to optimize revenue. Differentiation can be considered in a number of ways. Firstly, a recognition of marginal as compared to captive traffic: traffic on routes which are marginal can be attracted through the Canal by attractive pricing of toll rates for vessels on those routes. Traffic on captive routes may pay a high premium that recognizes their diversion costs but is not so high that trade is prohibited or local economies disrupted. Secondly, evaluations could be made of the effect of differentiating tolls further by ship type. Finally, because ship transit times

through the locks rapidly increases as the size of the ship approaches the beam/draft limits, CAS may also wish to investigate the increased transits possible from sliding premium related to beams and draft. Such a component to the study would have to be developed closely with the OC/CE Component Contractor.

(3) **Relationship to the Cost-Benefit and Financial Studies.** The data that we have developed in Phase I and that we would fine tune in Phase II provide demand curves for transits by route, ship type and size range. The cost-benefit and financial analyses must use these results, in different ways and in combination with the results of the Engineering and OC/CE Studies, to do their work. It is inevitable that we will be called upon to assist in these studies.

APPENDIX A

[illegible] Hanna Brown
The significance
[illegible] of [illegible] contribution

INFORMATION ON PRESCREENING & SELECTION OF ALTERNATIVES

A brief narrative together a series of Tables from a draft document entitled "Prescreening and Selection of Alternatives" prepared by SINBOL is contained herein. Some Tables have been revised on July 18, 1991, resulting from discussions with the Engineering Component Contractor.

Table	Title
1	Concept of Alternatives
2	Principal Features of Alternatives
3	Major Feasibility Check Items of Alternatives
4	Conceptual Alternatives (for Prescreening)
5	Complementary System (for Detailed Analysis)
6	Study Case (for Prescreening)
7	Major Feasibility Check Items for Study Case (for Prescreening)

PRESCREENING & SELECTION OF ALTERNATIVES

INTRODUCTION

This document on the subject of prescreening and selection of alternatives to the Panama Canal is being drafted by S.I.N.B.O.L. to serve as a working paper in order that we may convey current thinking as a step in the development of our draft in the clarification and identification of previously proposed alternatives. An evolving thought process, developed during the tabulation and evaluation of information from the various reports, has led to certain concepts outlined herein.

CLARIFICATION & IDENTIFICATION

A systematic compilation of information for the clarification and identification of each of the following alternatives listed in the detailed Plan of study has been essentially completed.

A. Improvements to the Existing Canal

(1) Status quo
(2) Non-lock improvements
(3) Third Locks Plan
(4) Terminal Lake Plan
(5) Deep Draft Lock Plan
(6) Lopez-Moreno Plan (Panamanian Alternative)

B. Sea-Level Canal Alternatives

(7) Route 10 of the IOCS Study
(8) Route 14S of the IOCS Study
(9) Vergara Plan
(10) Nagano Plan

C. Non-Canal Complementary Transportation System

(11) Oil pipeline
(12) Landbridge system
(13) Centerport Plan

This compilation has been based upon many sources including previous reports, historical documents, and information from interviews with key persons. The clarification and identification process has given consideration to the significance of various contributions.

This compilation and review has resulted in the recognition of major concepts or ideas that govern a substantial part of the canal project (i.e. substantial concepts) as well as other concepts or ideas that relate to only portion of the project (i.e. partial concepts). The following listing of substantial concepts and partial concepts is valuable in further discussion of the prescreening process.

SUBSTANTIAL CONCEPTS

Those primary concepts on which various alternatives are based may be identified as follows:

Widening and deepening the canal
Raising the canal water level above sea level
Water control measures (for a lock canal);

- By natural yield, or
- By pumping sea water to save fresh water

Tidal control (for a sea level canal) accomplished;

- By tidal gates
- By tidal basin
- By natural control

PARTIAL CONCEPTS

Those secondary concepts which really supplement or relate to only a partial solution may be identified to include:

- Improved ship maneuvering measures
- Improved navigation aids
- Improved lockage system
- Complimentary transportation systems relating to non-ship means of transport

The prescreening process can be approached most efficientively in two steps: Preliminary Screening and Secondary Screening. A first step will be to make an initial prescreening of conceptual alternatives on the basis of substantial concepts.

In using this approach, Table 1 has been developed to relate the various concepts listed

above with the alternatives previously listed in The Detailed Plan of Study (DPS). It is further recognized that the concept of complementary transportation system must later be combined with those prescreened alternatives which need an additional function and/or capacity in order to compete with other alternatives. This can best be accomplished by considering complementary systems in a second step of the prescreening process.

The principal features of the various alternatives proposed for The Panama Canal are summarized on Table 2. This tabulation is a convenient summary from the compilation of information for clarification and identification of alternatives.

The information in Table 2 serves as a convenient reference for the prescreening process.

An initial step in the prescreening process will be to verify major items listed on Table 3 as they relate to the various alternatives. Should a careful review of these items indicate major constraints that can not be overcome, such items may serve as a basis to limit the further evaluation of an alternative.

CONCEPTUAL ALTERNATIVES & STUDY CASES

"Substantial Concepts" relate to major portions of the project and will be taken into consideration for the initial prescreening of alternatives. "Partial Concepts" relate to only a portion of the project and will be removed from the prescreening process. They will be studied later during the detailed analysis of prescreened alternatives as a compliment to a major concept.

The alternatives having such partial concepts and being eliminated from prescreening include:

a) The Gaillard Cut Widening proposed by the P.C.C.
b) Non-Lock Improvements
c) "A Terminal Lake" except for the 100,000 DWT locks and waterway involved in the plan
d) Lock Consolidation

Based on the alternatives involving substantial concepts, conceptual alternatives are to be formulated by grouping those which have similar concepts or ideas. There are two such schemes for the lock canal system and two for the sea level canal system. All the studies and analysis for prescreening, are to be made for these four conceptual alternatives. Also, as a baseline alternative the existing canal (Status Quo) is added for comparison.

Conceptual alternatives for prescreening are summarized in Table 4 together with their principal features for further studies and analysis (engineering study, cost estimates and capacity evaluation) by the Component Study Contractors.

Although the identified complementary transportation systems will not be prescreened, they may be combined with selected alternatives immediately after prescreening. Therefore, the preliminary costs for each of the systems will be estimated (by the component Study Contractor) with respect to a possible range of their capacity as indicated in Table 5.

The prescreening process is to be carried out for the basic conceptual Alternatives listed in Table 4 by using a combination of principal features associated with route, size of design ship, rise in water level, number of lifts and number of lanes. Each combination can be referred to as a study case for Prescreening. The appropriate study cases are listed on Table 6 and can be compared efficiently using a computer and appropriate input from the component contractors.

Prior to the evaluation of study cases, the major feasibility items listed in Table 3 are to be given consideration using the major feasibility check items presented in Table 7 for each study case.

TABLE 1: CONCEPTS OF ALTERNATIVES

Alternative	Concepts										
				Water control		Tidal control					
	Widening and Deepening	Raising WL	Natural yield	Pumping sea water/ Saving	Tidal gate	Tidal basin	No control	Improve ship maneuvering	Improve navigation aids	Improve locks	Complementary systems
I. Lock Canal Alternatives											
a) Status Quo (baseline)		O	O								
b) Gaillard Cut Widening	O	O	O						O		
c) Non-lock Improvement											
d) Third Locks (1939 Plan/IOCS)	O	O	O								
d') Third Locks (1946 Revision)	O	O	O					O			
e) Terminal Lake (Plan II - Initial)	O	O	O					O			
e') Terminal Lake (Plan II-Ultimate/IOCS v)	O	O		O				O			
e") Terminal Lake (Plan III)	O	O		O				O			
e"') Terminal Lake (IOCS)	O	O	O								
f) Deep Draft Lock	O	O		O						O	
g) Panamanian Alternative	O	O		O							
h) Lock Consolidation											
II. Sea Level Canal Alternatives											
a) IOCS Route 10	O	X			O						
b) IOCS Route 14B	O	X			O						
c) Vergara	O	X				O					
d) New Panama Canal (Nagano Plan)	O	X					O				
III. Complementary System											
a) Oil Pipeline											O
b) Landbridge, railway											O
c) Landbridge, road											O
d) Part of Centerport concept											O
Considered in processing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
	SUBSTANTIAL CONCEPT							PARTIAL CONCEPT			

TABLE 2: PRINCIPAL FEATURES OF ALTERNATIVES

Alternative	Route: Route 10	Route: Route 14S	Route: Route 15	Route: Third Locks Route	Size (Design Ship) (DWT): 65,000	100,000	150,000	250,000	300,000	500,000	Rise (Summit Lake WL) (Ft. R.): 90	85	55	30	0		No. of lifts: 3	2	1	No. of lane: 2	1	Water Control: Natural yield	Pumping sea water /Saving	Tidal Control: Tidal gate	Tidal basin	No control
I. Lock Canal Alternatives																										
a) State Ops (baseline)			●		●							●								●	●	●				
b) Gaillard Cut Widening			●		●							●					●									
c) Non-lock Improvement			●		●							●					-			-		-				
d) Third Locks (1970 Plan/IOCS			●	●			●					●					-			-		-				
d') Third Locks (1946 Revision)			●	●			●					●	(87-89)/(87-92)				●			●	●	●				
e) Terminal Lake (Plan II-Initial)			●	●			●					●	(87-89)				●			●	●	●				
e') Terminal Lake (Plan II-Ultimate/IOCS v)			●	●			●					●	(88-92)				●	●		●	●	●				
e") Terminal Lake (Plan III)			●	●			●				●		(92-92)					●		●	●		●			
e"') Terminal Lake (IOCS)			●	●			●				●		(92-92)					●		●	●		●			
f) Deep Draft Lock			●	●				●				●	(87-92)				●			●	●	●				
g) Panamax Alternative			●						●			●	(87-87)				●			●	●		●			
h) Lock Conditioning			●										●					●		●			●			
II. Sea Level Canal Alternatives																										
a) IOCS Route 10	●							●		^ (under favorable current)				●						●				●		
b) IOCS Route 14S		●						●		^ (under favorable current)				●						●				●		
c) Vergara	●							●		^ (under favorable current)				●						●					●	
d) New Panama Canal	●								●	^ (under favorable current)				●						●						●
III. Complementary System (Nagano Plan)					Capacity to be studied:																					
a) Oil pipeline				Western Panama	0.5/1.0/1.5/2.0 million barrels/day																					
b) Landbridge, railway				Central Panama	10/20/30/40 million tons/year																					
c) Landbridge, road				Central Panama	10/20/30/40 million tons/year																					
d) Part of Centerport concept				Central Panama	10/20/30/40 million tons/year																					

TABLE 3: MAJOR FEASIBILITY CHECK ITEMS OF ALTERNATIVES

Alternative	Engineering Feasibility	Major Impact on Existing Canal	Major Socioeconomic Impacts	Relative Environmental	Relative Size of Investment
I Lock Canal Alternatives					
a) Status Quo (base line)	None	None	None	–	–
b) Gaillard Cut Widening	--	--	--	–	–
c) Non-lock Improvements	–	None	None	–	–
d) Third Locks (1939 Plan/IOCS)	Ship maneuvering in lock and Lock gate design	--	--	•	–
d') Third Locks (1946 Revision)	Ship maneuvering in lock and Lock gate design	--	--	•	–
e) Terminal Lake (Plan II - Initial)	Ship maneuvering in lock and Lock gate design	--	--	•	–
e') Terminal Lake (Plan III)	Ship maneuvering in lock, Lock gate design, and Sea water pumping	-	--	•	–
e'') Terminal Lake (IOCS)	Ship maneuvering in lock and Lock gate design	--	--	•	–
f) Deep Draft Lock	Ship maneuvering in lock, Lock gate design and Sea water pumping	--	--	•	–
g) Panamanian Alternative	Ship maneuvering in lock, Lock gate design, Water saving, Water sources	Effect due to lowering summit lake water level	–	•	To be checked
h) Lock Consolidation	--	--	--	•	--
II Sea Level Canal Alternatives					
a) IOCS Route 10	Tidal current analysis, Ship maneuvering in canal under tidal current, and Tidal gate design	Effect due to additional new capacity of canal	Separation of the country by canal, etc.	•	To be checked
b) IOCS Route 14B	Tidal current analysis, Ship maneuvering in canal under tidal current, and Tidal gate design	Effect due to additional new capacity of canal	Separation of the country by canal, etc.	•	To be checked
c) Vergara	Tidal current analysis, Ship maneuvering in entrance and in canal, and Tidal basin design	Effect due to additional new capacity of canal	Separation of the country by canal, etc.	•	To be checked
d) New Panama Canal (Nagano Plan)	Tidal current analysis and Ship maneuvering in canal under no control	Effect due to additional new capacity of canal	Separation of the country by canal, etc.	•	To be checked

• To be assessed

TABLE 4: CONCEPTUAL ALTERNATIVES (FOR PRESCREENING)

Conceptual Alternative	Corresponding Alternative/Plan	Route	Size 3 (10 DWT)	Rise (WL - ft)	No. of lift	No. of lane	Estimated Model Runs
A. High Rise Lock Canal	I-d Third Locks I-e Terminal Lake Plan (except terminal lake I-f Deep Draft	15 + Third Locks Route	100 150 250	90/85 use 90	2	2	6 (t_3 and t_7)
B. Low Rise Lock Canal	I-g Panamanian Alternative	15 + Third Locks Route	100 150 250	55/30 use 55	1	2	6 (t_3 and t_7)
C. Route 10 Sea Level Canal and 14S Sea Level Canal	II-a IOCS Route 10 II-b IOCS Route 14S II-c Vergara II-d New Panama Canal	10, or 14S	100 250 300	0	0	1 2 [50% - 1] [50% - 2]	24 (t_3 and t_7) Includes 3 runs for tidal control
D. Status Quo	I-a Status Quo	15	65	85	3	2	2 (t_3 and t_7)

where;
t_3 = year 2010
t_7 = year 2060

Note: This table revised July 26, 1991 reflects the applicability of model runs to study cases for use in the evaluation of total transit times, canal capacity, transit delay times, and tidal hydraulics for navigational purposes.

TABLE 5 COMPLEMENTARY SYSTEM (FOR DETAILED ANALYSIS)

Complementary Systems	Route	Capacity
		(mil. b./day)
F. Oil Pipeline & Associated Mooring Facilities	Western Panama Near Existing Petro Terminaless Location	0.5 1.0 1.5 2.0
G. Landbridge, Railway & Associated Port and Terminal Facilities using Centerport Concepts	Central Panama; Panama City to Colon	(mil. ton/yr) 10 20 30 40
H. Landbridge, Road & Associated Port and Terminal Facilities using Centerport Concepts	Central Panama	(mil. ton/yr) 10 20 30 40

TABLE 6 STUDY CASE (FOR PRESCREENING)

CASE	ROUTE	SIZE 3 (10 DWT)	RISE (El. ft.)	NO. OF lift	NO. OF lane	REMARKS
	(Lock Canal)					
L-1	15 + Third L.	100	90	2	2	
L-2	15 + Third L.	100	85	2	2	*
L-3	15 + Third L.	100	55	1	2	
L-10	15 + Gatun + Third L	100	85	2	2	
L-11	15 + Gatun + Third L	100	55	1	2	
L-12	15 + Gatun + Third L	100	30	1	2	
L-13	15 + Gatun + Third L	150	85	2	2	
L-14	15 + Gatun + Third L	150	55	1	2	
L-15	15 + Gatun + Third L	150	30	1	2	
L-16	15 + Gatun + Third L	250	85	2	2	
L-17	15 + Gatun + Third L	250	55	1	2	
L-18	15 + Gatun + Third L	250	30	1	2	
	(Sea Level Canal)					
S-1	10	150	0	0	1	
S-2	10	150	0	0	2	
S-3	10	250	0	0	1	
S-4	10	250	0	0	2	
S-5	10	300	0	0	1	
S-6	10	300	0	0	2	
S-7	14S	150	0	0	1	
S-8	14S	150	0	0	2	
S-9	14S	250	0	0	1	
S-10	14S	250	0	0	2	
S-11	14S	300	0	0	1	
S-12	14S	300	0	0	2	
S-13	10	150	0	0	50%-1 50%-2	
S-14	10	250	0	0	50%-1 50%-2	
S-15	10	300	0	0	50%-1 50%-2	
S-16	14S	150	0	0	50%-1 50%-2	
S-17	14S	250	0	0	50%-1 50%-2	
S-18	14S	300	0	0	50%-1 50%-2	
SQ	15	65	85	3	1 or 2	

* Also perform a Major Feasibility Check for a single Lift Gate Design for Case L-2.

TABLE 7 MAJOR FEASIBILITY CHECK ITEMS FOR STUDY CASE (FOR PRESCREENING)

Study Case	I. Engineering Feasibility	Route	Size (10 DWT)	Rise (El - ft)	No. of lift	No. of lane	Remarks
L-1 to L-18	1. Ship guidance in lock changer including mule opeations or other innovative systems *	- - -	All cases	- - -	- - -	- - -	
	2. Lock gate concept design: gate type, structural system, alloy, allowable stress, buoyancy provisions, size limitation, corrosion protection, drive mechanism, bearings, seals and failures modes. *	- - - - - - - - -	All cases	- - - - - - - -	All cases	- - - - - -	
	3. Water saving plan including new water sources, development, and reservoir operation. *	-	All cases	All cases	All cases	-	
	4. Sea water pumping *	-	All cases	All cases	All cases	-	
	5. Deep water dredging operation, *	-	All cases	All cases	All cases	-	
S-1 to S-18	6. Tidal current analysis with gate **	10 and 14S	All cases	-	-	All cases	
	7. Ship maneuvering in canal under tidal current with gate. **	10 and 14S	All cases	-	-	All cases	
8.	Tidal gate design (including items in 2 above) *	10 and 14S	All cases	-	-	1 and 2	

* To be done by Engineering and Cost Component Contractor

** To be done by Operating Characteristics and Capacity Evaluation Component Contractor

TABLE 7: MAJOR FEASIBILITY CHECK ITEMS FOR STUDY CASE (FOR PRESCREENING) CONT.

Study Case	I. Engineering Feasibility	Route	Size (10 DWT)	Rise (El - ft)	No. of lift	No. of lane	Remarks
S-1 to S-18	9. Tidal current analysis with tidal basin *	10	All cases	-	-	All cases	
	10. Ship maneuvering in canal under current with tidal basin **	10	All cases	-	-	All cases	
	11. Tidal basin design *	10	All cases	-	-	All cases	
	12 Tidal current analysis under no control condition *	10	All cases	-	-	All cases	
	13 Ship maneuvering in canal under no tidal current control **	10	All cases	-	-	All cases	
	II. Major Socioeconomic Impacts	Route	Size	Rise	No. of lift	No. of lane	
L-1 to S-18	1. Possible major socioeconomic impacts from various view points, both favorable and adverse	All cases	All cases	All cases	-	-	
	III. Ability to be financed	Route	Size	Rise	No. of lift	No. of lane	
L-1 to S-18	1. Ability to be financed under present and near future financial market including governments subsidy	By size of investment: 1) US$ 1 billion size 2) US$ 5 billion size 3) US$ 10 billion size 4) US$ 50 billion size 5) US$ 100 billion size					
	IV Major Impacts on Existing Canal	Route	Size	Rise	No. of lift	No. of lane	
L-1 to S-18	1. Possible major impacts on the existing canal from various viewpoints, both favorable and adverse *	All cases	All cases	All cases	-	-	

* To be done by Engineering and Cost Component Contractor
** To be done by Operating Characteristics and Capacity Evaluation Component Contractor.

APPENDIX B

DEFINITIONS

The following tables (Tables B.1 and B.2) contain the country, U.S. coastal and commodity definitions available in the annual WEFA short-term Trade Analysis forecasts. These forecasts are carried out once a year for a twenty-year time horizon. These are the basic definitions from which all other definitions in the study were derived.

TABLE B.1

MASTER COUNTRY SCHEDULE FOR WEFA TRADE DATABASE

CODE	COUNTRY	CODE	COUNTRY
100	United States	497	Poland/East Germany
122	Canada	498	Eastern Europe NEC
201	Mexico	509	Near East NEC
299	Caribbean/Central America	517	Saudi Arabia
301	Colombia	519	Iran/Iraq/Kuwait
307	Venezuela	529	Arabian Gulf NEC
337	Chile	533	India
351	Brazil	535	Pakistan
357	Argentina	549	Thailand
397	Peru/Ecuador/Bolivia	557	Malaysia
398	Uruguay/Paraguay	559	Singapore
400	Iceland	560	Indonesia
401	Sweden	565	Philippines
403	Norway	568	Southern Asia NEC
405	Finland	570	China (PRC)
409	Denmark	580	Republic of Korea
412	United Kingdom	582	Hong Kong
419	Ireland	583	Taiwan
421	Netherlands	588	Japan
423	Belgium/Luxembourg	599	Far East Asia NEC
427	France	602	Australia
428	Federal Republic of Germany	614	New Zealand
433	Austria	699	Oceania NEC
441	Switzerland	701	North Africa NEC
461	Soviet Union	702	West Africa NEC
470	Spain	703	East Africa NEC
471	Portugal	729	Egypt
475	Italy	748	Ivory Coast
484	Greece	753	Nigeria
489	Turkey	791	South Africa

U.S. COASTAL CODES

0	Total for all Coasts (non-U.S countries)
1	North Atlantic
2	South Atlantic
3	Gulf
4	Great Lakes
5	South Pacific (California and Hawaii)
6	North Pacific (Oregon, Washington, and Alaska)

TABLE B.2

COMMODITIES COVERED BY TRADE ANALYSIS SERVICE

Code	Description
0010	Live Animals
0110	Meat, Reefer
0220	Dairy, Reefer
0300	Fish, Reefer
0390	Meat, Fish and Dairy, Dry
0410	Wheat
0420	Rice
0430	Barley, Rye, Oats, Meal and Flour
0440	Corn
0450	Sorghum and Unmilled Cereals NES
0480	Other Cereal Preparations
0540	Vegetables, Dry
0550	Vegetables, Reefer
0570	Fruits and Nuts, Reefer
0580	Fruits and Nuts, Dry
0600	Sugar and Molasses
0710	Coffee and Cocoa
0740	Tea and Spices
0830	Oilseed Cake
0890	Other Feedstuff for Animals
0970	Miscellaneous Edibles. Dry
1110	Non-Alcoholic Beverages
1130	Beer, Ale, Stout and Porter
1140	Wine and Distilled Spirits
1200	Tobacco
2100	Hides and Skins
2220	Soybeans
2290	Other Oilseeds
2300	Crude Rubber
2410	Softwood Lumber
2470	Hardwood Logs and Lumber
2490	Pulpwood, Softwood Logs, Other Wood
2510	Wastepaper
2590	Woodpulp
2630	Cotton
2660	Synthetic Fibers
2680	Other Textile Fibers
2710	Crude Fertilizers
2730	Gypsum
2740	Sulphur
2780	Other Crude Minerals

2810	Iron Ores and Concentrates
2820	Iron or Steel Waste and Scrap
2830	Bauxite and Alumina
2840	Bauxite
2850	Alumina
2860	Other Metal Ores and Concentrates
2880	Nonferrous Metal Waste and Scrap
2920	Cut Flowers & Nursery Stock, Reefer
2990	Other Crude Animal/Veg Materials
3200	Coal and Coke
3300	Crude Petroleum
3410	Gasoline and Other Light Oils
3420	Jet Fuel, Kerosene, Medium Oils
3430	Other Fuel Oil and Motor Fuel
3440	Heavy Fuel Oils
3450	Lubricating Oil
3540	Petroleum Coke
3580	Residual Petroleum Products NES
3600	Gas. Natural and Manufactured
4100	Animal Oils and Fats
4200	Vegetable Oils and Fats
4300	Processed Oils/Fats, and Waxes NES
5110	Hydrocarbons NES
5150	Nitr-Fctn, Organo-Inorg. Heterocyclic
5170	Specified Acyclic Organic Chemicals
5180	Other Organic Chemicals (Exc 515)
5190	Other Organic Chemicals (Exc 517)
5240	Radioactive and Assoc. Materials
5280	Other Inorganic Chemicals (Exc 524)
5400	Medicines and Drugs
5500	Paints. Dyes. Soaps. Perfumes
5630	Potash
5690	Other Manufactured Fertilizers
5800	Synthetic Resins, Plastics. Film
5990	Other Chemical Materials/Products
6100	Leather, Mfrs, Dressed Furskins
6200	Tires and Inner Tubes
6340	Plywood and Veneers
6390	Other Wood/Cork Mfrs, Exc Furniture
6410	Newsprint
6420	Kraftpaper and Paperboard
6490	Other Articles of Paper
6520	Cotton Woven Fabrics and Yarn
6540	Synthetic Woven Fabrics and Yarn
6560	Other Woven Textile Fabrics & Yarn
6590	Carpets. Other Fabrics, Textile Prods
6610	Cement

6650	Pottery and Glassware
6690	Other Nonmetallic Mineral Mfrs
6730	Iron & Steel Plates, Pipes, Shapes
6790	Other Iron and Steel Products
6820	Copper
6840	Aluminum
6890	Other Nonferrous Metals
6910	Structures NES of Iron, Steel, Alum
6930	Wire Products and Expanded Metal
6940	Nails, Screws, Nuts, Bolts & Rivets
6950	Metal Cont, Tools, Household Eqpt
6990	Other Mineral Manufactures
7140	Jet, Gas Turbine & Reaction Engines
7180	Power Generating Machinery/Eqpt
7210	Tractors, Harvesters, Rollers(RORO)
7230	Oversized/Heavy-Lift Equipment
7290	Other Specialized Indust. Machinery
7300	Metalworking Machinery
7430	Pumps
7440	Mechanical Handling Eqpt (RORO)
7490	Other Genl Indust. Machinery/Eqpt
7520	Computers, Peripheral Eqpt & Parts
7590	Other Office Machines and Parts
7610	Television Receivers
7620	Radio Broadcast Receivers
7630	Sound and Television Recorders
7640	Telecommunications Equipment
7710	Electrical Ind. Eqpt and Parts NES
7750	Household Elect. Appliances/Eqpt
7760	Integrated Circuits/Semiconductors
7770	Other Electronic Components
7780	Electrical Machinery/Apparatus NES
7810	Passenger Automobiles (RORO)
7820	Trucks, Except Tractors (RORO)
7830	Truck Tractors, Buses. Etc (RORO)
7840	Parts of Road Vehicles
7850	Motorcycles and Scooters
7920	Aircraft and Parts
7930	Ships and Boats
8120	Light Fixtures
8200	Furniture and Parts
8300	Travel Goods and Handbags
8420	Male Garments, Not Knit/Crocheted
8430	Female Garments, Not Knit/Crocheted
8450	Garments, Knitted or Crocheted
8460	Undergarments
8490	Other Articles of Apparel

8600	Footwear
8750	Instruments
8820	Photo Film, Papers, Chem, Reefer
8890	Cameras, Watches and Clocks
8910	Rubber and Plastic Articles
8920	Printed Matter
8940	Toys, Games and Decorations
8950	Sporting Goods
8960	Precious Stones, Jewelry, Artworks
8980	Musical Instruments, Tapes, Records
8990	Other Manufactured Articles
9100	Postal Packages
9500	Military Arms, Ammunition, Vehicles
9900	Commodities and Transactions NEC

The following key definitions have been developed for the purposes of this study. This is the level of detail of the final long-term forecasts, a level of detail greater than shown in the PCC published data and therefore greater than that of the final result. This was done to support the work on the world vessel fleet and the transportation economics.

TABLE B.3

DEFINITION OF COMMODITIES IN WORLD COMMODITY LONG-TERM TRADE FORECAST CARRIED OUT FOR THIS STUDY

Bulk Grains
- 0410 Wheat
- 0440 Corn
- 0450 Sorghum and Unmilled Cereals NES

Iron Ores and Concentrates
- 2810 Iron Ores and Concentrates

Bauxite and Alumina
- 2840 Bauxite
- 2850 Alumina

Coal and Coke
- 3200 Coal and Coke
- 3540 Petroleum Coke

Sugar and Molasses
- 0600 Sugar and Molasses

Logs and Lumber
- 2410 Softwood Lumber
- 2470 Hardwood Logs and Lumber
- 2490 Pulpwood, Softwood Logs, Other Wood
- 6340 Plywood and Veneers

Minor Bulks
- o Other Grains
  - 0420 Rice
  - 0430 Barley, Rye, Oats, Meal and Flour
- o Food, SE Asia-Europe
- o Oilseed Cake
  - 0830 Oilseed Cake
- o Other Animal Feeds
  - 0890 Other Feedstuff for Animals
- o Oil Seeds
  - 2220 Soybeans
  - 2290 Other Oilseeds
- o Woodpulp
  - 2590 Woodpulp

- o Fertilizers, Crude/Mfgd
  - 2710 Crude Fertilizers
  - 5630 Potash
  - 5690 Other Manufactured Fertilizers
- o Other Crude Minerals
  - 2730 Gypsum
  - 2740 Sulphur
  - 2780 Other Crude Minerals
- o Metal Waste and Scrap
  - 2820 Iron or Steel Waste and Scrap
  - 2880 Nonferrous Metal Waste and Scrap
- o Paper and Paperboard
  - 6410 Newsprint
  - 6420 Kraftpaper and Paperboard
- o Cement
  - 6610 Cement
- o Iron and Steel Products
  - 6730 Iron & Steel Plates, Pipes, Shapes
  - 6790 Other Iron and Steel Products
  - 6910 Structures NES of Iron. Steel. Alum
- o Nonferrous Metals
  - 6820 Copper
  - 6840 Aluminum
  - 6890 Other Nonferrous Metals

Live Animals

- 0010 Live Animals

Refrigerated Cargo

- 0110 Meat. Reefer
- 0220 Dairy. Reefer
- 0300 Fish. Reefer
- 0550 Vegetables. Reefer
- 0570 Fruits and Nuts, Reefer
- 2920 Cut Flowers & Nursery Stock. Reefer
- 8820 Photo Film. Papers, Chem, Reefer

Vehicles

- 7210 Tractors, Harvesters, Rollers(RORO)
- 7440 Mechanical Handling Eqpt. (RORO)
- 7810 Passenger Automobiles (RORO)
- 7820 Trucks, Except Tractors (RORO)
- 7830 Truck Tractors, Buses, Etc. (RORO)

General Cargo, Foods

- o Other Grains
  - 0420 Rice
  - 0430 Barley, Rye. Oats. Meal and Flour

- o General Cargo. Foods
  - 0390 Meat. Fish and Dairy. Dry
  - 0480 Other Cereal Preparations
  - 0540 Vegetables, Dry
  - 0580 Fruits and Nuts, Dry
  - 0710 Coffee and Cocoa
  - 0740 Tea and Spices
  - 0970 Miscellaneous Edibles, Dry
  - 1110 Non-Alcoholic Beverages
  - 1130 Beer. Ale, Stout and Porter
  - 1140 Wine and Distilled Spirits

General Cargo, Crude Materials

- o Woodpulp
  - 2590 Woodpulp
- o General Cargo. Crude Materials
  - 2100 Hides and Skins
  - 2300 Crude Rubber
  - 2510 Wastepaper
  - 2630 Cotton
  - 2660 Synthetic Fibers
  - 2680 Other Textile Fibers
  - 2860 Other Metal Ores and Concentrates
  - 2990 Other Crude Animal Veg. Materials

General Cargo, Chemical Products

- o Petroleum Products
  - 3410 Gasoline and Other Light Oils
  - 3420 Jet Fuel. Kerosene. Medium Oils
  - 3430 Other Fuel Oil and Motor Fuel
  - 3440 Heavy Fuel Oils
  - 3450 Lubricating Oil
  - 3580 Residual Petroleum Products NES
- o Bulk Chemicals
  - 5110 Hydrocarbons NES
  - 5150 Nitr-Fctn.Organo-Inorg.Heterocyclic
  - 5180 Other Organic Chemicals (Exc 515)
  - 5280 Other Inorganic Chemicals (Exc 524)
- o General Cargo. Chemicals
  - 5240 Radioactive and Assoc. Materials
  - 5400 Medicines and Drugs
  - 5500 Paints. Dyes. Soaps, Perfumes
  - 5800 Synthetic Resins, Plastics, Film
  - 5990 Other Chemical Materials/Products

General Cargo, Manufactures

- o Paper and Paperboard

6410 Newsprint
6420 Kraftpaper and Paperboard

- Nonferrous Metals
  - 6820 Copper
  - 6840 Aluminum
  - 6890 Other Nonferrous Metals
- General Cargo, Manufactures
  - 6100 Leather, Mfrs, Dressed Furskins
  - 6200 Tires and Inner Tubes
  - 6390 Other Wood/Cork Mfrs, Exc Furniture
  - 6490 Other Articles of Paper
  - 6520 Cotton Woven Fabrics and Yarn
  - 6540 Synthetic Woven Fabrics and Yarn
  - 6560 Other Woven Textile Fabrics & Yarn
  - 6590 Carpets,Other Fabrics.Textile Prods
  - 6650 Pottery and Glassware
  - 6690 Other Nonmetallic Mineral Mfrs.
  - 6930 Wire Products and Expanded Metal
  - 6940 Nails, Screws, Nuts, Bolts & Rivets
  - 6950 Metal Cont., Tools, Household Eqpt.
  - 6990 Other Metal Manufactures

General Cargo, Mechanical Equipment

- 7140 Jet, Gas Turbine & Reaction Engines
- 7180 Power Generating Machinery/Eqpt.
- 7290 Other Specialized Indust. Machinery
- 7300 Metalworking Machinery
- 7430 Pumps
- 7490 Other Genl Indust. Machinery/Eqpt.
- 7840 Parts of Road Vehicles
- 7850 Motorcycles and Scooters
- 9500 Military Arms, Ammunition, Vehicles

General Cargo, Electrical Equipment

- 7520 Computers, Peripheral Eqpt. & Parts
- 7590 Other Office Machines and Parts
- 7610 Television Receivers
- 7620 Radio Broadcast Receivers
- 7630 Sound and Television Recorders
- 7640 Telecommunications Equipment
- 7710 Electrical Ind. Eqpt. and Parts NES
- 7750 Household Elect. Appliances/Eqpt.
- 7760 Integrated Circuits/Semiconductors
- 7770 Other Electronic Components
- 7780 Electrical Machinery/Apparatus NES
- 8750 Instruments

General Cargo, Other

- o General Cargo, Other
  - 1200 Tobacco
  - 8120 Light Fixtures
  - 8200 Furniture and Parts
  - 8300 Travel Goods and Handbags
  - 8420 Male Garments, Not Knit/Crocheted
  - 8430 Female Garments, Not Knit/Crocheted
  - 8450 Garments, Knitted or Crocheted
  - 8460 Undergarments
  - 8490 Other Articles of Apparel
  - 8500 Footwear
  - 8890 Cameras, Watches and Clocks
  - 8910 Rubber and Plastic Articles
  - 8920 Printed Matter
  - 8940 Toys, Games, and Decorations
  - 8950 Sporting Goods
  - 8960 Precious Stones, Jewelry, Artworks
  - 8980 Musical Instruments, Tapes. Records
  - 8990 Other Manufactured Articles
- o Commodities NEC
  - 9100 Postal Packages
  - 9900 Commodities and Transactions NEC

General Cargo, Total Containerizable

- General Cargo, Foods
- General Cargo, Crude Materials
- General Cargo, Chemical Products
- General Cargo, Manufactures
- General Cargo, Mechanical Equipment
- General Cargo, Electrical Equipment
- General Cargo, Other

General Cargo, Non-Containerizable

- o Metal Waste and Scrap
  - 2820 Iron or Steel Waste and Scrap
  - 2880 Nonferrous Metal Waste and Scrap
- o Oversized/Heavy-Lift Equipment
  - 7230 Oversized/Heavy-Lift Equipment
- o Ships, Boats, Aircraft and Parts
  - 7920 Aircraft and Parts
  - 7930 Ships and Boats

Crude Petroleum

- 3300 Crude Petroleum

Petroleum Products

- 3410 Gasoline and Other Light Oils

3420 Jet Fuel, Kerosene, Medium Oils
3430 Other Fuel Oil and Motor Fuel
3440 Heavy Fuel Oils
3450 Lubricating Oil
3580 Residual Petroleum Products NES

Gas, Natural and Manufactured

3600 Gas, Natural and Manufactured

Bulk Chemicals

5110 Hydrocarbons NES
5150 Nitr-Fctn,Organo-Inorg,Heterocyclic
5180 Other Organic Chemicals (Exc 515)
5280 Other Inorganic Chemicals (Exc 524)

Oils and Fats

4100 Animal Oils and Fats
4200 Vegetable Oils and Fats
4300 Processed Oils/Fats, and Waxes NES

TABLE B.4

DEFINITION OF ORIGIN/DESTINATION REGIONS IN THE BASIC LONG-TERM WORLD TRADE FORECAST PREPARED FOR THIS STUDY

101 U.S. East Coast
- 1001 U.S. North Atlantic
- 1002 U.S. South Atlantic
- 1005 U.S. Great Lakes

102 102 U.S. Gulf Coast
- 1003 U.S. Gulf

103 U.S. West Coast
- 1006 U.S. South Pacific
- 1007 U.S. Pacific Northwest

122 Canada
- 122 Canada
- 161 St. Pierre And Miquelon
- 822 U.S. Grain Transshipped Through Canada

201 Mexico
- 201 Mexico

299 Carib./Cent. America
- 205 Guatemala
- 208 Belize
- 211 El Salvador
- 215 Honduras
- 219 Nicaragua
- 223 Costa Rica
- 225 Panama
- 227 Canal Zone
- 232 Bermuda
- 236 Bahamas
- 239 Cuba
- 241 Jamaica
- 243 Turks And Caicos Isl.
- 244 Cayman Islands
- 245 Haiti
- 247 Dominican Republic
- 248 Leeward And Windward Isl.
- 272 Barbados
- 274 Trinidad And Tobago
- 277 Netherlands Antilles
- 283 French West Indies
- 312 Guyana
- 315 Surinam
- 317 French Guiana
- 903 Puerto Rico
- 911 Virgin Islands

301 Colombia
301 Colombia

307 Venezuela
307 Venezuela

391 South America East Coast
351 Brazil
357 Argentina
353 Paraguay
355 Uruguay
372 Falkland Islands

392 South America West Coast
331 Ecuador
333 Peru
335 Bolivia
337 Chile

491 North Europe
101 Greenland
400 Iceland
401 Sweden
403 Norway
405 Finland
409 Denmark
412 United Kingdom
419 Ireland
421 Netherlands
423 Belgium/Luxembourg
427 France
428 Fed. Rep. Of Germany
429 German Dem. Republic
430 Monaco
447 Estonia
449 Latvia
451 Lithuania
455 Poland
461 Soviet Union

492 South Europe
433 Austria
435 Czechoslovakia
437 Hungary
441 Switzerland
467 Azores
470 Spain
471 Portugal
472 Gibraltar
475 Italy
479 Yugoslavia
481 Albania
484 Greece
485 Romania
487 Bulgaria
489 Turkey

510 Middle East
505 Iraq
507 Iran
513 Kuwait
517 Saudi Arabia
518 Qatar
520 United Arab Emirates
521 Yemen (Sana)
522 Yemen (Aden)
523 Oman
525 Bahrain

530 South Asia
531 Afghanistan
533 India
535 Pakistan
536 Nepal
538 Bangladesh
542 Sri Lanka (Ceylon)
546 Burma
561 Brunei
567 Timor & SSE Asia

550 Southeast Asia
549 Thailand
552 Vietnam
553 Laos

555 Cambodia
557 Malaysia
559 Singapore
560 Indonesia
565 Philippines
566 Macao
574 Mongolia
579 North Korea

590 Far East Asia
570 China (PRC)
580 Republic Of Korea
582 Hong Kong
583 Taiwan
588 Japan
590 Nansei Islands

600 Oceania
602 Australia
604 Papua New Guinea
614 New Zealand
615 Western Samoa
622 Southern Pacific Islands
631 Fiji
632 Togo
633 Tonga
634 Vanuatu
641 French Pacific Islands
684 Trust Pacific Islands
686 Other Pacific Isl. NEC
931 Midway Island
933 Wake Island
935 Guam
941 Canton And Enderbury Isl.
951 American Somoa

791 South Africa
791 South Africa

792 North Africa/East Med
473 Malta And Gozo
491 Cyprus
502 Syria
504 Lebanon
508 Israel
511 Jordan
512 Gaza Strip
714 Morocco
721 Algeria
723 Tunisia
725 Libya
729 Egypt

793 West Africa
- 733 Canary Islands
- 735 Spanish Africa NEC
- 737 Western Sahara
- 738 Equatorial Guinea
- 741 Mauritania
- 742 Cameroon
- 744 Senegal
- 745 Mali
- 746 Guinea
- 747 Sierra Leone
- 748 Ivory Coast
- 749 Ghana
- 750 Gambia
- 751 Niger
- 752 Togo
- 753 Nigeria
- 754 Central African Republic
- 755 Gabon
- 756 Chad
- 757 Western Africa NEC
- 758 St. Helena
- 759 Madeira Islands
- 760 Upper Volta
- 761 Benin
- 762 Angola
- 763 Congo (Brazziville)
- 764 Western Africa NEC
- 765 Liberia
- 766 Zaire
- 792 Namibia

794 East Africa
- 732 Sudan
- 767 Burundi
- 769 Rwanda
- 770 Somalia
- 774 Ethiopia
- 777 Djibouti
- 778 Uganda
- 779 Kenya
- 780 Seychelles
- 781 British Indian Ocean
- 783 Tanzania
- 785 Mauritius
- 787 Mozambique
- 788 Malagasy Republic
- 789 Comoros
- 790 French Indian Ocean
- 793 Botswana
- 794 Zambia
- 795 Swaziland
- 796 Zimbabwe
- 797 Malawi
- 799 Lesotho

The following concordance conveys our understanding of the relationship among the commodity groups in the PCC annual reports, the TBS/DRI studies, and those we are using.

TABLE B.5

COMMODITY GROUP CONCORDANCE

PCC REPORTS	TBS/DRI DATA	CORRESP. WEFA TRADE FILE
Canned Foods:		
Canned Fish	All Other	General Cargo, Foods
Canned Fruit	All Other	General Cargo, Foods
Canned Mild	All Other	General Cargo, Foods
Canned Other	All Other	General Cargo, Foods
	All Other	General Cargo, Foods
REFRIGERATED FOODS:		Reefer Cargo
Bananas	Bananas	Reefer Cargo
Dairy Products	Other Reefers	Reefer Cargo
Fish	Other Reefers	Reefer Cargo
Other Fruit	Other Reefers	Reefer Cargo
Meat	Other Reefers	Reefer Cargo
Other	Other Reefers	Reefer Cargo
CANNED AND REFRIGERATED FOODS, MISC.	N/A	Split between Reefer and General Cargo/Other
CHEMICALS AND PETROLEUM CHEMICALS:		
Caustic Soda	Chemicals	Bulk Chemicals
Benzene	Petroleum Chemicals	Bulk Chemicals
Toluene	Petroleum Chemicals	Bulk Chemicals
Chemicals Other	Chemicals	Bulk Chemicals; Gen Cargo
Crude Mats; Gas Natural & Manuf.	Petroleum Chemicals	PL Chems; Gen Cargo Crude
Petroleum Chemicals Misc.		
Mats; Gas Natural & Manuf.		
COAL AND COKE (EXCL. PET. COKE)	Coal and Coke	Coal & Coke (Incl.
Briquettes/Peat)		
Coal	Coal and Coke	Coal & Coke (Incl.
Briquettes/Peat)		
GRAINS		
Barley	Grains, Other	Minor Bulks/Other Grains
Corn	Grains, Other	Bulk Grains
Oats	Grains, Other	Minor Bulks/Other Grains
Sorghum	Grains, Other	Bulk Grains
Soybeans	Soybeans	Minor Bulks/Oilseeds
Wheat	Wheat	Bulk Grains
Other and Unclassified	Grains, Other	Minor Bulks/Grains
LUMBER AND PRODUCTS		
Boards and Planks	Lumber Products	Logs & Lumber
Plywood, Veneers, Composition Board	Lumber Products	Logs & Lumber
Pulpwood	Pulpwood	Minor Bulks/Woodpulp; Gen.
Cargo Crude Materials	Lumber Products	Logs & Lumber
Other, Misc.		
MACHINERY & EQUIPMENT		
Agricultural Machinery & Implements	All Other	Gen. Cargo Mech Equipment
Autos, Trucks, Accessories and Parts	Autos (Excl Parts Etc)	Gen. Cargo Mech Equipment
Construction Machinery & Implements	All Other	Vehicles (Excl Parts)
Electrical Machinery and Apparatus	All Other	Gen. Cargo Mech Equipment
Motorcycles, Bicycles and Parts	All Other	Gen. Cargo Electrical
Other	All Other	Gen. Cargo Mech Equipment
	All Other	Gen. Cargo Mech Equipment

MANUFACTURERS OF IRON & STEEL		
Angles, Shapes and Sections	Iron and Steel	Gen. Cargo Manufacturers
Nails, Tacks and Spikes	Iron and Steel	Gen. Cargo Manufacturers
Plates, Sheets and Coils	Iron and Steel	Gen. Cargo Manufacturers
Tubes, Pipes and Fittings	Iron and Steel	Gen. Cargo Manufacturers
Wire, Bars, and Rods	Iron and Steel	Gen. Cargo Manufacturers
Other and Unclassified	Iron and Steel	Gen. Cargo Manufacturers
	Iron and Steel	Gen. Cargo Manufacturers
MATERIALS, MISCELLANEOUS		
Minerals		Minor Bulks/Other Crude
Asbestos		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
Borax		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
Infusorial Earth		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
Salt		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
Soda and Sodium Compounds		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
Sulfur		
Minerals	Minerals, Misc.	Minor Bulks/Other Crude
NITRATES, PHOSPHATES, AND POTASH		
Crude & Manufactured		Minor Bulks/Fertilizers
Ammonium Compounds		
Crude & Manufactured	Other Fertilizers	Minor Bulks/Fertilizers
Fishmeal		
Crude & Manufactured	Other Fertilizers	Minor Bulks/Fertilizers
Nitrate of Soda		
Crude & Manufactured	Other Fertilizers	Minor Bulks/Fertilizers
Phosphates		
Crude & Manufactured	Phosphates	Minor Bulks/Fertilizers
Potash		
Crude & Manufactured	Other Fertilizers	Minor Bulks/Fertilizers
Fertilizers, Unclassified		
Crude & Manufactured	Other Fertilizers	Minor Bulks/Fertilizers
ORES AND METALS		
Ores		
Alumina/Bauxite	Alumina/Bauxite	Alumina/Bauxite
Chrome	Other Ores	Minor Bulks
Copper	Other Ores	Minor Bulks
Iron	Other Ores	Iron Ore and Concentrates
Lead	Other Ores	Minor Bulks
Manganese	Other Ores	Minor Bulks
Tin	Other Ores	Minor Bulks
Zinc	Other Ores	Minor Bulks
Others and Unclassified	Other Ores	Minor Bulks
METALS		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Aluminum		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Copper		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Iron		
Prods; Gen. Cargo Man	Other Metals	Minor Bulks/Iron & Steel
Lead		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Scrap		
Scrap; Gen. Cargo Man	Scrap	Minor Bulks/Metal Waste &
Tin, Incl. Tinplate		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Zinc		
Metals: Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous
Other and Unclassified		
Metals; Gen. Cargo Man	Other Metals	Minor Bulks/Non Ferrous

OTHER AGRICULTURAL COMMODITIES		
Beans, Edible	Food and Agriculture	Gen Cargo Foods
Cocoa and Cocoa Beans	Food and Agriculture	Gen Cargo Foods
Coffee, Raw and Processed	Food and Agriculture	Gen Cargo Foods
Copra and Coconuts	Food and Agriculture	Gen Cargo Foods&/Or Gen
Cargo Crude Mats.		
Cotton, Raw	Food and Agriculture	Gen Cargo Crude Materials
Molasses	Food and Agriculture	Sugar & Molasses
Oilseeds	Food and Agriculture	Minor Bulks/Oilseeds
Peas, Dry	Food and Agriculture	Gen Cargo Foods
Rubber, Raw	Food and Agriculture	Gen Cargo Crude Materials
Skins and Hides	Food and Agriculture	Gen Cargo Crude Materials
Wool, Raw	Food and Agriculture	Gen Cargo Crude Materials
PETROLEUM AND PRODUCTS		
Asphalt	Petroleum Products	Petroleum
Crude Oil	Petroleum	Crude Petroleum
Diesel Oil	Petroleum Products	Petroleum Products
Fuel Oil, Residual	Petroleum Resid?	Petroleum Products
Gasoline	Petroleum Products	Petroleum Products
Jet Fuel	Petroleum Products	Petroleum Products
Kerosene	Petroleum Products	Petroleum Products
Liquified Gas	Petroleum Products	Gas, Natural & Manufactured
Lubricating Oil	Petroleum Products	Petroleum Products/Gen Cargo
Chemical Prods		
Petroleum Coke	Petroleum Coke	Coal and Coke
Other and Unclassified	Petroleum Resid?	Petroleum Products
MISCELLANEOUS		
Bricks and Tile	All Other	Gen. Cargo/Other
Carbon Black	All Other	Gen. Cargo/Other
Cement	All Other	Minor Bulks/Cement
Clay, Fire and China	All Other	Gen. Cargo/Other
Fibers Plant	All Other	Gen Cargo Crude Materials
Flour, Wheat	All Other	Minor Bulks
Glass and Glassware	All Other	Gen Cargo Manufactures
Groceries, Miscellaneous	All Other	Gen Cargo Foods
Liquors and Wines	All Other	Gen Cargo Foods
Marble and Stone	All Other	Minor Bulks
Oil, Coconut	All Other	Oils & Fats
Oil, Fish	All Other	Oils & Fats
Oil, Vegetable	All Other	Oils & Fats
Paper and Paper Products	All Other	Minor Bulks/Paper &
Paperboard; Gen Cargo Man		
Porcelain ware	All Other	Gen Cargo Manufs
Resin	All Other	Gen Cargo/Other
Rubber, Manufactured	All Other	Gen Cargo/Other
Seeds, Excluding Oilseeds	All Other	Gen Cargo/Other
Slag, Clinkers, and Dross	All Other	Minor Bulks
Tallow	All Other	Oils & Fats
Textiles	All Other	Gen Cargo Manufactures
Tobacco and Manufactures	All Other	Gen Cargo Other
Wax, Paraffin	All Other	Petroleum Products
Container Cargo	Containerized Cargo	Containerized Cargo
All Other and Unclassified	All Other	Gen Cargo/Other
Total		

PANAMA CANAL COMMISSION COMMODITY DATA
WEFA TRADE FLOW DATA

Notes:

1) The published PCC data have been aggregated into the product groups used in the TBS/DRI report to ascertain if this will facilitate use of the percentage allocations in Exhibit A5. These groupings have also been compared with the WEFA files. Some PCC data is in more than 1 WEFA file; conversely, WEFA file data may represent a range of PCC commodities.

2) In its published form at least, PCC data do not necessarily correspond to terminology and product definitions generally in use in the public domain e.g. in OECD trade statistics, Eurostats etc. Certain data are idiosyncratically described. The concordance has been carried out using a combination of obvious relationships and common sense.

3) In the PCC data by route, there is containerized cargo as well as individual commodities/commodity groups. Based on the TBS March/April 1989 report, Exhibit A5, products are allocated to container and container break bulk ships apparently in addition to containerized cargo (Exhibit A6).

4) In producing the Panama Canal trade and traffic database a major aim is to provide the commodity flow data in groupings that can be used within the framework of the UEFA groupings/by ship types used in the project.

TABLE B.6

SHIP SIZE RANGES USED IN THE STUDY

In order to readily develop Panama Canal transit forecasts for each of the five cases under study, global demand and global supply databases for each cargo carrying ship type were reconstructed from existing databases into size ranges which were both relevant to this project and which reflect major market determinants.

For full container vessels, container breakbulk, refrigerated cargo ships, vehicle carriers and conventional general cargo ships:

DWT Size Range		
<10,000 DWT		
10	-	25,000 DWT
25	-	40,000 DWT
40	-	65,000 DWT
65	-	100,000 DWT
100	-	150,000 DWT (if and as appropriate).

For other cargo carrying ships, that is oil tankers, chemical tankers, combined carriers, dry bulk carriers and gas ships, the following compatible size ranges were used:

DWT Size Range		
<10,000 DWT		
10	-	40,000 DWT
40	-	65,000 DWT
65	-	100,000 DWT
100	-	150,000 DWT
250	-	300,000 DWT

In order to determine the constraints (if any) of a maximum design ship of 300,000 DWT, fleet forecasts include assessments of vessels above this size.

To mesh with the PCC Data and other available data on Panama Canal transits and to provide assignments to ship types, we aggregated the categories shown in the preceding tables to the classifications of Tables B.6, B.7 and B.8.

TABLE B.7

FINAL SET OF COMMODITY CATEGORIES

Crude Oil	-	the major heading from Table B.3 "crude oil"
Petroleum Products	-	the major heading from Table B.3 "petroleum products"
Major Dry Bulks	-	includes from Table B.3 bulk grains, iron ore and concentrates, bauxite and alumina, coal and coke
Minor Bulks	-	includes from Table B.3 minor bulks plus sugar & molasses and logs & limber
Bulk Chemicals	-	the major heading from Table B.3 "bulk chemicals"
Oils & Fats	-	the major heading from Table B.3 "oils and fats"
Refrigerated Cargoes		the major heading from Table B.3 "refrigerated cargoes"
Vehicles	-	the major heading from Table B.3 "vehicles"
General Cargo	-	the sum of all the "general cargo headings", except "containerizable"
Containerized	-	the major heading from Table B.3 "general cargo, total containerizable"

TABLE B.8

FINAL SET OF ORIGINS AND DESTINATIONS

U.S. East Coast	-	includes Great Lakes and Gulf Coast
U.S. West Coast	-	includes Alaska and Hawaii
Canada East Coast		
Canada West Coast		
Central America East Coast, including Caribbean		
Central America West Coast		
South America East Coast		
South America West Coast		
Europe	-	includes North and South Europe
Africa	-	includes North, South, East, and West Africa
Oceania		
Asia	-	Far East Asia and Southeast Asia
Middle East		

TABLE B.9

FINAL SET OF SHIP CATEGORIES

Container Breakbulk Ships (CB)

Full Container Ships (F)

Conventional General Cargo Ships (G)

Refrigerated Cargo Ships (R)

Roll-On Roll-Off Ships (RO)

Vehicle Carriers (V)

Passenger Ships (P)

Combined and Dry Bulk Carriers (CD)

Chemical Tankers (CT)

Liquified Propane Tankers (LP)

Oil Tankers (T)

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