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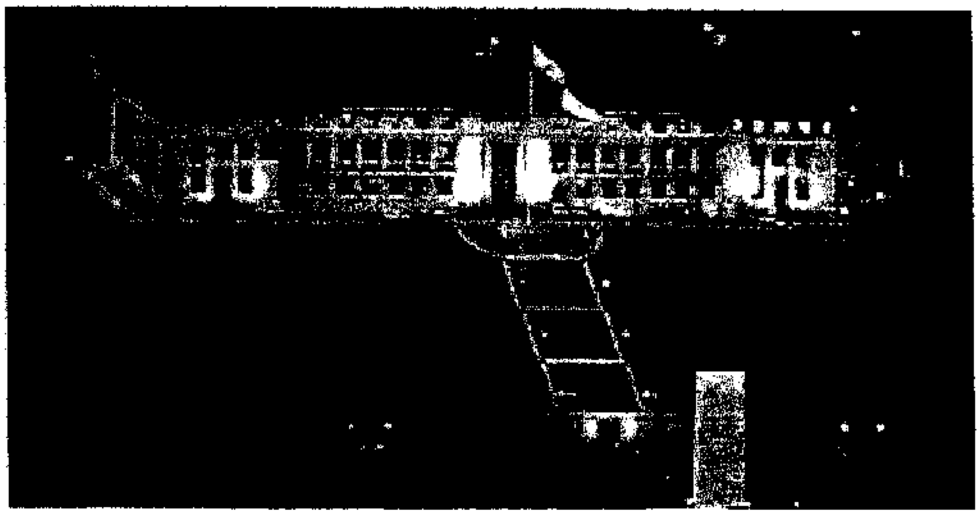
DESARROLLO DE PRONOSTICO LARGO PLAZO DE DEMANDA DE TRAFICO POR EL CANAL DE PANAMA

Contract No. SAA-43915



THE DEVELOPMENT OF LONG TERM TRAFFIC DEMAND FORECASTS FOR THE PANAMA CANAL, 2001-2050

PART 1

PREPARED FOR

AUTORIDAD DEL CANAL DE PANAMA
PANAMA CANAL AUTHORITY

by

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February 2001

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1 Executive Summary and Results

1.1 Introduction

This study provides a series of long term demand forecasts for the Panama Canal for the period to 2050 both for the Canal with its existing size restrictions and capacity constraints and for an expanded Canal. The study has two main purposes. Firstly, it is designed to provide a view of future demand which is totally independent from work previously done by ACP. In this respect its aim is to give a second opinion. It is also intended that this study should be seen as a building block for subsequent studies that are planned as part of the process for determining the feasibility of the proposed expansion of the Canal.

It is important that this study be placed in its proper context. The study terms of reference call for projections of potential toll revenue based on the existing toll structure. It should be recognised that this approach does not take into account potential future changes in toll pricing policies whose objectives may not be limited solely to economic considerations. In any event there will be some trades where the economics are such that higher toll levels could be sustained. Equally, there are some routes for which a marginal pricing policy would enable the Canal to capture more trade. In the absence of an integrated tolls pricing policy and marketing strategy this estimates cannot be used when assessing future investments.

One further consideration is the capacity of the current Canal in terms of the permitted daily maximum number of transits. On agreement with the Client, it has been assumed that this figure remains at the current level of 42 transits a day and, implicitly, ACP would undertake the necessary work to maintain transits at this level, incurring whatever costs were involved. No capacity constraints were assumed in the Expanded Canal Case.

There are some important and fundamental differences between the approaches to short and long term forecasting, in particular when one considers that the latter in this case covers a 50 year time span. For example, in the short term, currency fluctuations and the construction of new plant are significant factors in the determination of trade flows along with other economic indicators. They have to be taken into account but they are not necessarily the result of underlying structural changes. In sectors such as oil and chemicals it can be observed that as demand increases in importing regions, so initially do imports of finished chemicals and petroleum products. However a stage is eventually reached where the construction of new chemical plant or refineries becomes justified which has the result of causing a decline in the import of finished products. This changes the pattern and nature of trade but it is part of a cyclical development which is likely to be repeated several times over in the course of a 50 year time period. In other words short term fluctuations will continue but this does not detract from the fact that an underlying long term trend may also be apparent.

The study provides a base case forecast (Scenario 1) that reflects a continuation of economic trends and developments already in place plus structural developments that have taken place or are still seen to impact on specific trades. A risk analysis, (Scenario 2), has been developed which shows the potential impact of the introduction of global environmental protection and energy conservation policies as represented by the introduction of higher energy taxes. Scenario 2 also considers the potential impact of greater re-location of manufacturing to low cost production areas and the potential migration of labour that results.

Within each of these scenarios, three cases have been developed:

- Case 1 forecasts (Existing Canal) assume that the Canal remains at its existing dimensions and that transits are limited to a maximum of 42 vessels per day. Since the Canal is operating relatively close to capacity, it is clear that if trade were to continue to grow at its present rate a point would be reached in the future where potential demand for the Canal would exceed capacity. With the exception of cruise ships, for which bookings are accepted up to a year in advance, it is assumed that any reduction from potential demand to meet capacity constraints would be apportioned on the basis of the future mixes of vessels taking into account expected changes in trades and ship utilisation patterns. In order to determine potential demand RLA has assessed the future 'generic growth' in the demand for Panama Canal transits in existing trades. Estimates of generic growth are based on the assumption that the Canal remains at its existing dimensions and no account is taken of capacity constraints due to the limit in the number of vessels that can transit the Canal on any given day.

- Case 2 is referred to as the Expanded Canal case and assumes that a third set of locks is developed, permitting transits of vessels up to 180ft beam, 50ft draft and 1,265ft LOA. No capacity constraints in terms of the numbers of daily transits have been assumed.

- Case 3 is the Unrestricted Canal, which assumes no restrictions on either size or numbers of ships.

In line with the study terms of reference, it is assumed that Canal tolls remain at current levels in real terms. Estimates of Canal revenues have been limited to tolls and exclude additional fees.

The study commences with a review of historical trends in regional and global growth in GDP and population. Forecasts to 2050 have been compiled with reference to external forecasts prepared by or adopted, for example, by the UN, OECD, the International Energy Agency and the US Department of Energy.

These forecasts have been used to develop estimates of the generic growth in future trades. This part of the study relates to commercial cargo vessels and excludes passenger ships and other, non-specified, ship types which are both addressed in separate sections. Annual time series from FY1973/4 through FY1998/9 were compiled for each of the specified commodity groups by route. Actual data for the full fiscal year 1999/00 were not available in time to incorporate them in the study.

Forecasts have been developed with reference to regional economic/industry indicators and structural changes that have taken place in individual sectors. In other words forecasts have been developed through a combination of macro-economic forecasting and specific industry changes – often with reference to some major organisations involved in these sectors. Nevertheless in some cases the erratic nature of the data series has left little alternative but to adopt trend analysis techniques. However this last approach applies generally to the less important commodity groups. In order to relate trends in trade as closely as possible to economic indicators, data have been analysed on the basis of individual routes, routes grouped by a common destination, total north/southbound or groups of similar commodities as appropriate.

Forecasts for Case 1, the Existing Canal, have been made by first estimating the total numbers of transits that would result from the generic growth in demand for the Canal transits (see below for an outline of the methodology). For those years in which generic demand would exceed the current capacity of the Canal, and having determined the generic growth in the overall number of laden and ballast transits for all ship types, estimates of future passenger ship transits have been left unchanged on the assumption that these would continue to have priority. In the absence from the terms of reference of a toll pricing strategy or clear trade preferences to determine the allocation of transits when demand exceeds capacity, laden and ballast transits for all other ship types have been reduced pro-rata with the overall cut in the number of transits required to meet the capacity constraint of the Canal.

Under Cases 2 and the 3, the Expanded and Unrestricted Canals, a review of potential 'by pass' trades has been undertaken. By pass trades are defined as those commodities that are shipped on routes which represent alternatives to the Panama Canal and which utilise vessels larger than can be accommodated by the present dimensions. They also represent trades where the economic advantages of using larger vessels - or other service factors - outweigh utilisation of the Panama Canal on what is a shorter route. By pass trades therefore relate to just three vessel types – that is, full container ships, dry bulk carriers and tankers. There are post Panamax cruise ships in existence but there are no by-pass routes, although a larger Canal would permit more positioning voyages. For all of the remaining ship types, vessel sizes are within the current Canal dimensions and are expected to remain so.

By pass trades have been identified for full container ships – principally the US landbridge – dry bulk carriers (iron ore and coal) and tankers (Orimulsion). For each relevant trade a detailed analysis has been undertaken to determine the size of the trade, likely future growth, the economics of these alternative routes versus those for an expanded or unrestricted Canal and other factors likely to persuade shippers to adopt one or other route. The potential impact of an enlarged Canal is analysed from 2010 onwards.

In order to translate cargo forecasts into projections of vessel transits and toll revenue RLA has developed a model, using Microsoft Access, which has in it the following major steps:

- The allocation of commodities by route into ship types;
- The consolidation of commodities by route and ship type into total trade by route and ship type;
- The allocation of trade by route and ship type into dwt size ranges;
- The conversion of trade in terms of cargo tons to laden transits in terms of deadweight by route, ship type and size;
- The translation of laden transits in dwt terms into numbers of ships and also PCUMS;
- The calculation of laden toll revenue from projections of PCUMS;
- The projection of ballast transits for commercial vessels in dwt terms by route, ship type and size, based on relationships to laden transits;
- The translation of ballast transits for commercial cargo vessels in dwt terms into numbers of ships and also PCUMS;
- The calculation of ballast toll revenue from commercial cargo ships from projections of PCUMS;
- The development of transit forecasts by size range and beam.

Projections of ballast transits for other, non-specific vessel types have been handled outside of the model since a large proportion of these on the ACP database have no deadweights and trends in transits – as might be expected - bear no relation to laden transits. Forecasts of these transits have therefore been based on an analysis of historical trends.

Forecasts of passenger ship transits have also been made outside of the main model. These have been based on:

- an analysis of full and partial transits – at a route level more detailed than specified in the terms of reference in order to capture the major cruise line itineraries;
- an extensive series of interviews with companies, agents and the Pier 6 cruise terminal at Colon;

- the identification of expected trends in the cruise sector; and
- developments in Panama which are likely to influence Canal transits relative to general sector trends.

The following sections summarise the assumptions and the results for Scenario 1. The final part, Section 1.9 describes the conclusions from Scenario 2.

1.2 Economic Outlook

Key economic assumptions with respect to GDP growth rates and population trends are shown in Table 1.2.1.

Table 1.2.1

Main Economic Indicators

Period	2000-2005	2005-2010	2010-2015	2015-2020	2020-2030	2030-2040	2040-2050
				Per Cent Per Annum Rate of Change			
GDP							
USA	3.2	2.1	1.9	1.9	1.5	1.5	1.5
Canada	3.1	2.6	1.7	1.7	1.5	1.5	1.5
Latin America	4.5	4.6	4.2	4.2	3.8	3.8	3.8
Europe incl FSU	3.0	2.6	2.5	2.5	2.3	2.3	2.3
Asia excl Middle East	3.9	3.7	3.4	3.4	2.9	2.9	2.9
Middle East	3.7	3.6	3.7	3.7	3.0	3.0	3.0
Africa	4.3	4.2	3.9	3.9	3.3	3.3	3.3
Oceania	3.2	2.2	2.0	2.0	2.0	2.0	2.0
World	3.4	2.9	2.8	2.8	2.4	2.5	2.5
Population							
GDP							
USA	0.9	0.8	0.9	0.8	0.3	0.3	0.3
Canada	1.2	0.6	0.6	1.1	0.4	0.4	0.4
Latin America	1.5	1.3	1.2	1.1	0.7	0.7	0.7
Europe incl FSU	0.2	0.1	0.1	0.0	-0.2	-0.2	-0.2
Asia excl Middle East	1.1	1.1	1.0	0.9	0.4	0.4	0.4
Middle East	2.2	2.1	2.1	1.8	1.1	1.1	1.1
Africa	2.3	2.1	2.1	1.9	1.3	1.3	1.3
Oceania	0.9	0.8	0.8	0.7	0.7	0.7	0.7
World	1.2	1.1	1.1	1.0	0.5	0.6	0.6

World GDP growth rates are assumed to decline steadily over the period from 2000 to 2020 – from around 3.4% per annum to 2.8% per annum – before flattening out at around 2.5% annually over the remainder of the forecast period. Generally economic growth in the developed world is expected to show a more marked slowdown than that in the developing countries. For the USA and Canada, average annual GDP growth rates over the next five years of around 3.2% are projected to ease to levels of around 1.5% per annum between 2020 and 2050. Figures for Latin America for the same periods are estimated at 4.5% and 3.8% per annum respectively and for Asia – excluding the Middle East – 3.9% and 2.9%. Economic growth rates for Europe, including the former Soviet Union (FSU) are projected at 3.0% per annum over the next five years, declining to 2.3% annually from 2020.

The rate of increase in the world's population is expected to roughly halve between now and the period from 2020, that is from 1.2% to 0.6%. The most marked slowdown will be in the developed economies within which the growth for the USA and Canada will fall from around

1.0% per annum to 0.3% per annum from 2020. For Europe as a whole, the population is expected to grow only marginally between 2000 and 2015 and after a period of stagnation is projected to begin to decline slightly from 2020. Population growth in Latin America, currently around 1.5% per annum is estimated to ease to around 0.7% from 2020, while that in Asia is projected to decline from 1.1% now to 0.4% per annum in the long term.

1.3 Generic Growth

Estimates of generic growth in future cargo flows for existing trades were made assuming no capacity constraints. The results are summarised in Table 1.3.1. Total cargo flows are projected to increase from 208 million tons in 2001 to 306 million tons by 2020 and to 431 million tons in 2050. In terms of average annual growth rates, this represents a gradual slowdown from 3.0% in the period from 2001 to 2005, to about 1.5% between 2010 and 2020 and around 1% from 2030.

Growth in passenger ship capacity is expected to slow – in line with international trends – from an estimated annual average of2.6% in the period from 2001 to 2020 to around 1% from 2020. This would still mean a near doubling of passenger ship capacity from 358,000 pax in 2001 to 621,000 pax in 2020, with a further increase to 824,000 pax by 2050.

Projections of total transits in terms of vessel dwt and PCUMS increase at similar growth rates to those for cargo flows, the latter increasing from 236 million net tons in 2001 to 344 million net tons in 2020 and 467 million tons in 2050. However, because of the underlying rising trend in the average vessel size transiting the Canal, growth in the numbers of transits are estimated to rise more slowly, from 15,354 in 2001 (equivalent to 42 ships per day) to 27,127 in 2050 (74 ships per day). In other words, demand for Canal transits is expected to exceed the daily limit of 42 vessels. The toll revenue that would accrue from these levels of transits would be $592 million in 2001, rising to $863 million in 2020 and $1,174 million in 2050.

1.4 The Existing Canal

If it is assumed that the maximum capacity of the Panama Canal is 42 vessels per day, covering all ship types, the opportunity for increasing future revenue in the absence of any toll increases becomes severely constrained. Cargo flows are estimated to reach just 223 million tons by 2020 – an increase of 14 million tons from 2001 – and 238 million tons by 2050 (Table 1.4.1).

Therefore, without even considering the amount of additional cargo that might be attracted by an enlarged Canal, in 2020 about 83 million tons of potential cargo on existing Canal routes – as defined by expected generic growth - would be diverted away from the Canal due to capacity constraints. In 2050, this figure would rise to 193 million tonnes.

As a result, growth in transits in terms of Dwt and PCUMS is projected at 0.5% per annum in the period through 2005, declining gradually to 0.2% per annum from 2020. Overall numbers of transits are estimated to rise to 15,340 in 2001 and remain broadly unchanged over the remainder of the period to 2005, although assuming passenger ships continue to receive priority, transits of these vessels would continue to increase at the expense of other ship types. With average vessel size ranges expected to continue increasing toll revenue would rise modestly from $592 million in 2001 to $639 million in 2020 and $673 million in 2050. These figures represent 'lost' revenue of $224 million and $500 million respectively compared with tolls based on the generic growth in the Canal transits.

Table 1.3.1

Scenario 1, Generic Growth in Existing Canal Trades

	2001	2005	2010	2015	2020	2030	2040	2050
Trade								000's Tons
Northbound	84,474	92,181	102,599	108,300	114,423	126,658	138,687	150,074
Southbound	123,883	142,403	160,945	176,600	191,820	221,316	250,714	280,745
Total	208,357	234,584	263,544	284,901	306,243	347,974	389,401	430,819
Dwt Laden Transits								'000 Dwt
Northbound	136,115	149,390	166,508	176,231	186,666	206,264	225,066	242,632
Southbound	177,168	204,783	232,398	254,516	275,955	317,492	358,306	399,819
Total	313,282	354,173	398,906	430,747	462,620	523,756	583,373	642,452
Dwt Ballast Transits								'000 Dwt
Northbound	31,828	36,367	41,007	45,054	48,908	56,057	63,208	70,418
Southbound	11,841	12,279	13,196	13,373	13,552	13,973	14,355	14,563
Total	43,669	48,645	54,203	58,427	62,459	70,030	77,563	84,981
Total Dwt Transits								'000 Dwt
Northbound	167,943	185,756	207,515	221,285	235,573	262,321	288,274	313,050
Southbound	189,009	217,061	245,594	267,889	289,507	331,465	372,662	414,382
Total	356,951	402,818	453,109	489,173	525,080	593,786	660,936	727,432
No. of Laden Transits								
Northbound	5,600	6,021	6,542	6,845	7,189	7,746	8,279	8,767
Southbound	6,092	7,047	7,989	8,704	9,399	10,746	12,042	13,352
Total	11,692	13,068	14,532	15,548	16,588	18,491	20,321	22,119
No. of Ballast Transits								
Northbound	1,776	1,924	2,077	2,203	2,324	2,558	2,782	3,005
Southbound	1,886	1,923	1,969	1,989	2,005	2,024	2,017	2,003
Total	3,662	3,848	4,046	4,192	4,329	4,580	4,798	5,008
Total No. of Transits								
Northbound	7,376	7,946	8,620	9,048	9,513	10,302	11,060	11,772
Southbound	7,978	8,970	9,958	10,693	11,404	12,769	14,059	15,354
Total	15,354	16,916	18,578	19,741	20,917	23,071	25,119	27,127
PCUMS for Laden Transits								000's Tons
Northbound	94,910	103,971	114,956	121,398	129,380	140,913	152,821	163,979
Southbound	113,353	131,496	149,096	162,691	175,819	201,467	226,604	252,330
Total	208,263	235,467	264,052	284,089	305,199	342,381	379,424	416,309
PCUMS for Ballast Transits								000's Tons
Northbound	18,059	20,514	23,034	25,207	27,290	31,152	35,004	38,870
Southbound	9,961	10,292	10,827	10,995	11,169	11,513	11,797	11,959
Total	28,021	30,806	33,861	36,202	38,459	42,665	46,801	50,829
Total PCUMS for Transits								000's Tons
Northbound	112,969	124,486	137,991	146,604	156,671	172,065	187,825	202,849
Southbound	123,315	141,788	159,923	173,686	186,988	212,980	238,401	264,289
Total	236,284	266,273	297,914	320,291	343,658	385,045	426,225	467,138
Tolls for Laden Transits								000's US$
Northbound	243,918	267,207	295,438	311,992	332,507	362,147	392,749	421,425
Southbound	291,318	337,944	383,176	418,117	451,854	517,771	582,372	648,489
Total	535,236	605,151	678,615	730,109	784,361	879,918	975,121	1,069,913
Tolls for Ballast Transits								000's US$
Northbound	36,841	41,849	46,990	51,422	55,672	63,550	71,408	79,295
Southbound	20,321	20,995	22,087	22,430	22,785	23,486	24,066	24,396
Total	57,162	62,845	69,077	73,851	78,457	87,036	95,474	103,691
Total Tolls for Transits								000's US$
Northbound	280,759	309,056	342,428	363,414	388,179	425,697	464,157	500,720
Southbound	311,639	358,939	405,264	440,546	474,639	541,257	606,438	672,884
Total	592,398	667,995	747,692	803,960	862,818	966,954	1,070,595	1,173,604

Annual Average Growth Rates	2001-2005	2005-2010	2010-2015	2015-2020	2020-2030	2030-2040	2040-2050
Cargo	3.0%	2.4%	1.6%	1.5%	1.3%	1.1%	1.0%
Dwt	3.1%	2.4%	1.5%	1.4%	1.2%	1.1%	1.0%
No. of Vessels	2.5%	1.9%	1.2%	1.2%	1.0%	0.9%	0.8%
PCUMS	3.0%	2.3%	1.5%	1.4%	1.1%	1.0%	0.9%
Tolls	3.0%	2.3%	1.5%	1.4%	1.1%	1.0%	0.9%

Table 1.4.1

Scenario 1, Case 1, Existing Canal

	2001	2005	2010	2015	2020	2030	2040	2050
Trade								000's Tons
Northbound	84,392	83,407	84,341	83,544	83,158	83,003	83,131	82,913
Southbound	123,764	128,848	132,304	136,231	139,408	145,036	150,281	155,106
Total	208,156	212,255	216,646	219,775	222,567	228,039	233,412	238,019
Dwt Laden Transits								'000 Dwt
Northbound	135,985	135,228	136,998	136,114	135,940	135,479	135,308	134,551
Southbound	176,999	185,427	191,330	196,735	201,060	208,779	215,708	222,067
Total	312,983	320,655	328,328	332,849	337,000	344,259	351,016	356,618
Dwt Ballast Transits								'000 Dwt
Northbound	31,797	32,905	33,710	34,755	35,544	36,736	37,888	38,904
Southbound	11,830	11,110	10,848	10,316	9,849	9,157	8,605	8,046
Total	43,627	44,015	44,557	45,071	45,393	45,893	46,492	46,950
Total Dwt Transits								'000 Dwt
Northbound	167,782	168,133	170,708	170,869	171,484	172,215	173,196	173,455
Southbound	188,828	196,537	202,177	207,051	210,909	217,936	224,312	230,112
Total	356,610	364,670	372,885	377,920	382,393	390,151	397,508	403,568
No. of Laden Transits								
Northbound	5,595	5,459	5,401	5,313	5,276	5,135	5,040	4,941
Southbound	6,086	6,399	6,616	6,781	6,916	7,162	7,375	7,573
Total	11,681	11,858	12,017	12,094	12,191	12,297	12,414	12,514
No. of Ballast Transits								
Northbound	1,774	1,741	1,708	1,699	1,689	1,675	1,667	1,660
Southbound	1,885	1,740	1,619	1,535	1,457	1,326	1,209	1,106
Total	3,659	3,482	3,326	3,234	3,146	3,002	2,876	2,767
Total No. of Transits								
Northbound	7,369	7,200	7,109	7,012	6,965	6,810	6,707	6,601
Southbound	7,971	8,139	8,234	8,316	8,373	8,488	8,583	8,680
Total	15,340	15,340	15,343	15,328	15,338	15,299	15,290	15,281
PCUMS for Laden Transits								000's Tons
Northbound	94,821	94,407	95,195	94,615	95,630	94,110	93,901	93,477
Southbound	113,251	119,775	124,232	127,820	130,713	136,187	141,250	146,226
Total	208,072	214,181	219,426	222,434	226,343	230,297	235,152	239,704
PCUMS for Ballast Transits								000's Tons
Northbound	18,042	18,562	18,935	19,445	19,834	20,415	20,982	21,475
Southbound	9,952	9,312	8,900	8,482	8,117	7,545	7,071	6,607
Total	27,994	27,874	27,836	27,926	27,951	27,960	28,053	28,082
Total PCUMS for Transits								000's Tons
Northbound	112,863	112,968	114,130	114,059	115,464	114,525	114,883	114,952
Southbound	123,203	129,087	133,132	136,301	138,831	143,732	148,322	152,833
Total	236,066	242,055	247,262	250,360	254,294	258,257	263,205	267,786
Tolls for Laden Transits								000's US$
Northbound	243,691	242,625	244,650	243,159	245,770	241,863	241,327	240,236
Southbound	291,055	307,820	319,276	328,496	335,933	350,000	363,013	375,802
Total	534,746	550,445	563,926	571,656	581,703	591,863	604,340	616,038
Tolls for Ballast Transits								000's US$
Northbound	36,806	37,866	38,628	39,667	40,461	41,647	42,803	43,809
Southbound	20,301	18,997	18,157	17,302	16,559	15,391	14,425	13,478
Total	57,107	56,863	56,785	56,970	57,020	57,038	57,229	57,287
Total Tolls for Transits								000's US$
Northbound	280,496	280,491	283,278	282,826	286,230	283,509	284,130	284,045
Southbound	311,357	326,817	337,433	345,799	352,492	365,391	377,439	389,280
Total	591,853	607,308	620,711	628,625	638,722	648,901	661,568	673,325

Annual Average Growth Rates	2001-2005	2005-2010	2010-2015	2015-2020	2020-2030	2030-2040	2040-2050
Cargo	1.1%	0.4%	0.3%	0.3%	0.2%	0.2%	0.2%
Dwt	1.3%	0.4%	0.3%	0.2%	0.2%	0.2%	0.2%
No. of Vessels	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PCUMS	1.4%	0.4%	0.2%	0.3%	0.2%	0.2%	0.2%
Tolls	1.4%	0.4%	0.3%	0.3%	0.2%	0.2%	0.2%

1.5 By Pass Trades

1.5.1 Dry Bulk Trades

The following by pass trades have been identified:

- Coal from the US East Coast to Asia;
- Coal from Colombia to Asia;
- Coal from the West Coast of Canada to Europe;
- Iron ore from Venezuela to Asia; and
- Iron ore from the East Coast of Canada to Asia.

For all of these trades, the Panama Canal offers the shortest route but the ability to utilise larger vessels on alternative routes provides sufficient economies of scale to keep trade away from the Canal. For the Expanded Canal, total coal shipments captured from by pass trades would be equivalent to 6.4 million tons in 2020 and 11.3 million tons in 2050. This is in addition to the extra trade through the Canal that results from removing the capacity restrictions under Case 1. In the case of the Unrestricted Canal, the by pass trade captured would be 6.8 million tons and 11.8 million tons respectively. Iron ore cargoes attracted from by pass routes would be equivalent to 1.1 million tons in the Expanded Case and 4.5 million tons and 5.8 million tons in 2020 and 2050 respectively in the Unrestricted Case.

Other potential by pass trades were evaluated:

- Grains from the USA to Asia where, in theory at least, shipments via the US Pacific Northwest Coast (PNW) compete with those from the US Gulf;
- Iron ore from northern Brazil to Asia;
- Iron ore from Chile to Europe;
- Coal from the West Coast of Canada to Brazil;
- Soybeans from Brazil to Asia.

In the case of US grains there is little scope for switching cargoes from the US PNW to the US Gulf. Vessels sizes utilised out of the PNW are similar in size to those loaded from the US Gulf, shipments already tend to be moved via the nearest port and certain types of grain are only shipped from one or other location.

For the remaining four trades, the savings in mileages derived from utilisation of the Canal versus non-Canal routes are not sufficiently great to offset the impact of Canal tolls on overall freight costs.

Within the global fleet, the proportions occupied by each size range will generally shift toward the larger sizes. The average dwt of the larger vessels are also expected to increase while the commissioning of an Expanded or Unrestricted Canal would also impact on the average dwts and utilisation of those vessels at the high end of the ranges currently considered as Panamax.

1.5.2 Containerised Cargoes

The Asia/East Coast (EC) USA route is by far the most important Panama Canal container route, and by far the most important competition to the Canal on this route comes from West Coast (WC) USA ports and the intermodal rail landbridge. The landbridge has a larger share of ECUSA container cargo than the Canal, and dominates mid-west traffic.

A few minor routes also use the landbridge, though to a much lesser extent, and also may be affected by enlargement of the Canal.

The Canal also faces competition from the Suez routing for Asia/ECUSA cargoes. Other types of route competition have been proposed but none are plausible. Currently 6% of US bound traffic from Asia uses the Suez routing, but this could increase as the point of origin of cargo shifts from Japan and Korea to India and China. The New York and New Jersey Port Authorities aim to double the route's share of US bound traffic by 2010.

The US rail system is struggling to keep up with Asian volumes. There are growing issues of capacity at both the terminal railheads and on the network itself. There is an acknowledged need to extend the double stack network to accommodate the forecast growth in intermodal traffic, and there are plans to expand capacity. Immediately, however, shipping lines interviewed are responding either by using the Canal with Panamax vessels or developing the Suez routing for current trades. However, they would prefer to use larger vessels through the Canal if it were expanded, and this would generally dissuade them from expanding their use of the Suez routing.

Clearly, under Case 1, the Canal would lose share versus the landbridge due to capacity constraints but even just assuming generic growth in the Canal transits - and despite improvement of the intermodal option - we expect the Canal to gain share against the landbridge. The ability to use the same large vessels through the Canal on routes in one way or another associated with use of the landbridge - either east or westbound - accounts for further expected increases in containerised cargoes under the Expanded Canal.

Containership size is also a critical issue for ACP because it needs to be sure that the expanded Canal will not become obsolete shortly after it is built as a result of increases in vessel size beyond the 'new Panamax' size. We have examined a variety of future containership designs and deployment strategies, as well as considering present newbuilding activity.

We believe that the maximum vessel size will move to around 10,000 TEU in the short to medium term but that within 10-20 years the next step, to ships of up to 12,000 TEU will be taken as technical problems are solved. These will be used on Europe/Far East and the transpacific routes, with the other significant change being that more shuttle services will come into service in preference to transhipment hubs.

This maximum will be determined by absolute physical constraints at ports which cannot economically be overcome, for instance by building superhubs, by potential handling and vessel safety problems, by the need to use twin screws, and by shipping lines' reluctance to become totally dependent on single ports within port ranges.

As a consequence, for containerised cargoes, the by pass traffic that would be attracted through an Unrestricted Canal would be the same as that for the Expanded Canal case. Expansion of the Canal is projected to add a further 17.0 million tons of containerised cargoes in 2020 as compared with the generic growth in the Canal transits. In 2050 this would rise to 21 million tons.

1.5.3 Oil Trades

The patterns of oil flows into and out of the W.Hemisphere are such that enlargement of the Canal is unlikely to result in a significant change in the amounts of conventional crude oil and petroleum products being shipped through the Canal compared with the forecasts generic growth in the Canal transits. Shipments from the two potential sources of rising crude oil exports from the region – Mexico and Venezuela – are expected either to be concentrated on routes which do not represent by pass trades or will continue to move to short haul destinations in the Americas via the Canal in Panamax vessels. In the latter cases, an enlarged Canal would simply permit the transit of slightly larger tankers without necessarily increasing the volumes of trade versus the generic growth in trade via the Canal. For these trades therefore expansion of the Canal would simply permit the passage of additional cargoes that might otherwise be excluded due to capacity constraints in the existing Canal. In other words an Expanded Canal would accommodate all of the generic trade growth.

The one potential growth area is Orimulsion from Venezuela. Currently some 1.5 million tons of Orimulsion are exported to Asia and although some quantities are currently still shipped in Panamax vessels via the Canal an increasing proportion of shipments are made in VLCCs of 280,000 dwt and above. It is estimated that future exports to Asia could reach up to around 15/16 million tons by 2020 but it is likely that these will be moved in either Suezmax (up to around 165,000 dwt) tankers or VLCCs. In any event, if the Canal remains at its existing dimensions it will not capture any of this additional business and will lose most if not all of its current Orimulsion trade in Panamax tankers.

Some of the additional quantities of Orimulsion are expected to be moved to countries located in S E Asia, for which the Panama Canal would still not represent the most economic route, even if it were enlarged. With an unrestricted Canal it is estimated that almost 12.5 million tonnes of Orimulsion could be diverted via the Canal in 2020 as compared with the generic growth in the trade via the Canal. However, since most of this would be likely to be moved in VLCCs, expansion of the Canal to accommodate a small Suezmax tanker of around 140,000 dwt – as in the Expanded Canal Case - would only attract an additional 1.9 million tons from 2010.

1.6 The Expanded Canal

Assuming the Canal was expanded from 2010, total trade in that year is estimated at 290 million tons and is projected to rise to 333 million tons in 2020 and 466 million tons in 2050 (Table 1.6.1). This represents increases of 110 million tons and 228 million tons in 2020 and 2050 respectively versus the Existing Canal after taking into account capacity constraints.

Total numbers of transits would reach 21,141 in 2020 and 27,268 in 2050 with total PCUMS in each of these years amounting to 373 million net tons and 506 million net tons. Toll revenue would reach $936 million in 2020 and $1,272 million in 2050.

1.7 The Unrestricted Canal

An Unrestricted Canal would be expected to attract little more cargo than the expanded Canal, about 4% more in 2020 and an additional 3% in 2050 (see Table 1.7.1). The total numbers of transits would reach 21,194 in 2020 and 27,322 in 2050, that is, not significantly greater than the Expanded Case since it is assumed that in the bulk shipping sectors an Unrestricted Canal would result in even larger vessels being used to transit the Canal and better capacity utilisation.

Total transits in terms of PCUMS are projected to be 378 million net tons in 2020 and 512 million net tons in 2050, resulting in total toll revenues of $951 million and $1,287 million respectively.

Table 1.6.1

Scenario 1, Case 2, Expanded Canal

	2010	2015	2020	2030	2040	2050
Trade						000's Tons
Northbound	112,025	118,219	124,768	137,924	150,523	162,192
Southbound	177,516	194,072	207,776	239,225	270,792	303,561
Total	289,540	312,291	332,543	377,149	421,315	465,754
Dwt Laden Transits						'000 Dwt
Northbound	181,420	192,075	203,319	224,575	244,438	262,630
Southbound	256,971	280,176	299,824	343,731	387,049	431,721
Total	438,391	472,251	503,143	568,306	631,488	694,351
Dwt Ballast Transits						'000 Dwt
Northbound	42,630	47,635	52,167	61,637	71,278	81,215
Southbound	13,318	13,499	13,679	14,106	14,485	14,678
Total	55,949	61,134	65,845	75,742	85,763	95,892
Total Dwt Transits						'000 Dwt
Northbound	224,050	239,710	255,485	286,211	315,717	343,844
Southbound	270,289	293,674	313,503	357,837	401,534	446,399
Total	494,340	533,384	568,988	644,048	717,251	790,244
No. of Laden Transits						
Northbound	6,632	6,930	7,268	7,814	8,332	8,803
Southbound	8,142	8,840	9,496	10,810	12,071	13,346
Total	14,774	15,770	16,764	18,624	20,403	22,149
No. of Ballast Transits						
Northbound	2,105	2,240	2,367	2,619	2,865	3,111
Southbound	1,974	1,994	2,010	2,029	2,022	2,008
Total	4,078	4,234	4,377	4,648	4,887	5,119
Total No. of Transits						
Northbound	8,737	9,170	9,635	10,433	11,198	11,915
Southbound	10,116	10,834	11,506	12,839	14,093	15,353
Total	18,852	20,004	21,141	23,272	25,291	27,268
PCUMS for Laden Transits						000's Tons
Northbound	125,106	132,225	140,799	153,501	166,185	177,863
Southbound	164,872	179,168	191,712	218,807	245,332	272,701
Total	289,978	311,392	332,511	372,308	411,517	450,564
PCUMS for Ballast Transits						000's Tons
Northbound	23,756	26,358	28,748	33,647	38,613	43,697
Southbound	10,970	11,133	11,300	11,638	11,915	12,063
Total	34,726	37,490	40,048	45,285	50,527	55,760
Total PCUMS for Transits						000's Tons
Northbound	148,862	158,582	169,547	187,149	204,798	221,560
Southbound	175,842	190,301	203,013	230,445	257,247	284,764
Total	324,704	348,883	372,559	417,594	462,044	506,324
Tolls for Laden Transits						000's US$
Northbound	321,523	339,817	361,853	394,498	427,095	457,108
Southbound	423,721	460,462	492,700	562,334	630,503	700,842
Total	745,244	800,279	854,553	956,832	1,057,598	1,157,950
Tolls for Ballast Transits						000's US$
Northbound	48,462	53,769	58,646	68,641	78,770	89,141
Southbound	22,379	22,711	23,053	23,742	24,306	24,609
Total	70,841	76,480	81,699	92,382	103,076	113,750
Total Tolls for Transits						000's US$
Northbound	369,985	393,586	420,498	463,139	505,865	546,249
Southbound	446,099	483,172	515,753	586,075	654,809	725,451
Total	816,085	876,759	936,252	1,049,214	1,160,674	1,271,700
Annual Average Growth Rates						
	2005-2010	2010-2015	2015-2020	2020-2030	2030-2040	2040-2050
Cargo	4.3%	1.5%	1.3%	1.3%	1.1%	1.0%
Dwt	4.2%	1.5%	1.3%	1.2%	1.1%	1.0%
No. of Vessels	2.2%	1.2%	1.1%	1.0%	0.8%	0.8%
PCUMS	4.0%	1.4%	1.3%	1.1%	1.0%	0.9%
Tolls	4.5%	1.4%	1.3%	1.1%	1.0%	0.9%

1.8 A Comparison of Cases

Comparisons of the projections of total numbers of vessel transits, PCUMS and toll revenues for each of the above four cases under the base case Scenario 1 is shown in Table 1.8.1 and Figures 1.8.1 to 1.8.3. The figures represent estimates of Canal transits and revenue that could be expected if an enlarged Canal – Expanded or Unrestricted – were to be fully operational from 2010.

Comparing projections for the Expanded Case versus the Existing Canal with current capacity constraints, the total number of transits would be greater by 3,509 (23% in 2010), 5,804 (38%) in 2020 and 11,987 (78%) in 2050. Because of the larger vessel sizes transiting the Canal in the Expanded Case, which overwhelms the impact of improved cargo: dwt ratios for certain ship types and sizes, transits in terms of PCUMS would be up by 31% in 2010, 47% in 2020 and 89% in 2050. Similar percentage increases would be expected in toll revenues resulting in increases of $195 million in 2010, $298 million in 2020 and $598 million in 2050.

The development of an Unrestricted Canal would not be expected to attract significant additional business. In 2020 transits in terms of number of vessels and PCUMS net tonnage would increase versus the Expanded Case by just 0.3% and 1.6% respectively. Toll revenue would rise by $14.9 million. In 2050, numbers of transits and PCUMS net tonnage would show an increase of 0.2% and 1.2% respectively, while toll revenue would increase by $15.9 million.

1.9 Risk Analysis

The risk analyses undertaken consider the potential for both upward and downward revisions from the base case forecasts. As a major sensitivity to the base case a second scenario has been developed which takes into account a number of potential global structural changes that may take place and assesses their potential impact on trade, both internationally and through the Panama Canal.

A global equilibrium model of the world has been employed to study the main effects on international trade of the following structural changes:

- Generally reduced non-tariff barriers to world trade, implemented as a 30% general reduction in non-tariff barriers after 2010, and reduced barriers to trade in agricultural products to 40% of current levels from 2020. Within the next twenty years it is estimated that there a 70% chance of a general reduction in non tariff barriers in manufactures and a 40 to 45% of substantial cuts in non tariff barriers in agriculture. In 50 years these percentages rise to 80%.

- High global taxes on the use of fossil fuels, implemented as a 50% tax on oil and coal and a 20% tax on other fuels and a 20% increase in the efficiency of energy use in all types of economic activity. The chances of such developments having an impact over the next 10 to 15 years is put at 40%, rising to 80% twenty to thirty years out.

- High productivity growth in parts of the world due to efficient use of information and communications technology, implemented as a 2% increase in productivity in the USA from 2005, 1.5% in Europe from 2010, in Japan from 2015 and a 1% increase in Asia from 2030. It is estimated that there is a 60 to 70% chance that this will have a lasting impact.

Table 1.7.1

Scenario 1, Case 3, Unrestricted Canal

	2010	2015	2020	2030	2040	2050
Trade						000's Tonnes
Northbound	112,284	118,488	125,043	138,220	150,828	162,488
Southbound	183,584	203,257	221,705	253,684	285,738	318,966
Total	295,867	321,744	346,748	391,903	436,566	481,454
Dwt Laden Transits						'000 Dwt
Northbound	181,274	191,938	203,190	224,453	244,327	262,532
Southbound	262,661	289,088	313,980	358,252	401,802	446,547
Total	443,935	481,026	517,169	582,705	646,128	709,079
Dwt Ballast Transits						'000 Dwt
Northbound	42,522	47,517	52,343	61,819	71,448	81,346
Southbound	13,312	13,492	13,673	14,100	14,479	14,673
Total	55,834	61,009	66,016	75,919	85,927	96,019
Total Dwt Transits						'000 Dwt
Northbound	223,797	239,455	255,533	286,272	315,774	343,878
Southbound	275,972	302,580	327,652	372,352	416,281	461,220
Total	499,769	542,036	583,185	658,624	732,055	805,098
No. of Laden Transits						
Northbound	6,631	6,929	7,267	7,813	8,331	8,802
Southbound	8,156	8,865	9,549	10,864	12,127	13,400
Total	14,787	15,794	16,815	18,678	20,458	22,203
No. of Ballast Transits						
Northbound	2,103	2,239	2,368	2,620	2,866	3,112
Southbound	1,974	1,994	2,010	2,029	2,022	2,008
Total	4,077	4,233	4,378	4,649	4,888	5,119
Total No. of Transits						
Northbound	8,734	9,167	9,635	10,433	11,198	11,914
Southbound	10,129	10,859	11,559	12,893	14,148	15,408
Total	18,864	20,026	21,194	23,326	25,346	27,322
PCUMS for Laden Transits						000's Tons
Northbound	125,042	132,164	140,742	153,447	166,135	177,819
Southbound	167,167	182,770	197,520	224,773	251,398	278,790
Total	292,210	314,934	338,262	378,220	417,533	456,615
PCUMS for Ballast Transits						000's Tons
Northbound	23,707	26,305	28,824	33,726	38,685	43,752
Southbound	10,967	11,130	11,298	11,635	11,912	12,061
Total	34,674	37,435	40,122	45,361	50,598	55,813
Total PCUMS for Transits						000's Tons
Northbound	148,750	158,469	169,566	187,173	204,821	221,572
Southbound	178,134	193,900	208,818	236,408	263,310	290,857
Total	326,884	352,369	378,384	423,582	468,131	512,429
Tolls for Laden Transits						000's US$
Northbound	321,359	339,662	361,707	394,360	426,968	456,996
Southbound	429,620	469,718	507,627	577,667	646,092	716,505
Total	750,979	809,380	869,334	972,027	1,073,060	1,173,501
Tolls for Ballast Transits						000's US$
Northbound	48,363	53,662	58,800	68,801	78,918	89,255
Southbound	21,496	21,820	22,155	22,833	23,388	23,684
Total	69,859	75,482	80,956	91,633	102,307	112,939
Total Tolls for Transits						000's US$
Northbound	369,722	393,324	420,507	463,161	505,886	546,251
Southbound	451,116	491,538	529,783	600,499	669,481	740,190
Total	820,838	884,862	950,290	1,063,660	1,175,367	1,286,441
Annual Average Growth Rates						
	2005-2010	**2010-2015**	**2015-2020**	**2020-2030**	**2030-2040**	**2040-2050**
Cargo	4.8%	1.7%	1.5%	1.2%	1.1%	1.0%
Dwt	4.4%	1.6%	1.5%	1.2%	1.1%	1.0%
No. of Vessels	2.2%	1.2%	1.1%	1.0%	0.8%	0.8%
PCUMS	4.2%	1.5%	1.4%	1.1%	1.0%	0.9%
Tolls	4.6%	1.5%	1.4%	1.1%	1.0%	0.9%

Table 1.8.1

Comparison of Cases

	2001	2005	2010	2015	2020	2030	2040	2050
Generic Growth								
Total No. of Transits 000s	15354	16916	18578	19741	20917	23071	25119	27127
Total PCUMS 000s Tons	236284	266273	297914	320291	343658	385045	426225	467138
Total Tolls 000's US $	592398	667995	747692	803960	862818	966954	1070595	1173604
Existing Canal with Current Capacity Constraints								
Total No. of Transits 000s	15340	15340	15343	15328	15338	15299	15290	15281
Total PCUMS 000s Tons	236066	242055	247262	250360	254294	258257	263205	267786
Total Tolls 000's US $	591853	607308	620711	628625	638722	648901	661568	673325
Expanded Canal								
Total No. of Transits 000s			18652	20004	21141	23272	25291	27268
Total PCUMS 000s Tons			324704	348883	372559	417594	462044	506324
Total Tolls 000's US $			815561	876208	935677	1048601	1160029	1271029
Changes Versus Existing Canal With Capacity Constraints								
Total No. of Transits 000s			3509	4677	5804	7974	10000	11987
Total PCUMS 000s Tons			77442	98522	118265	159337	198839	238538
Total Tolls 000's US $			194851	247583	296955	399700	498461	597703
Unrestricted Canal								
Total No. of Transits 000s			18864	20026	21194	23326	25346	27322
Total PCUMS 000s Tons			326884	352369	378384	423582	468131	512429
Total Tolls 000's US $			820838	884862	950290	1063660	1175367	1286441
Changes Versus Existing Canal With Capacity Constraints								
Total No. of Transits 000s			3521	4699	5856	8028	10055	12042
Total PCUMS 000s Tons			79622	102008	124089	165325	204926	244643
Total Tolls 000's US $			200128	256236	311567	414759	513798	613115

Figure 1.8.1

Total Number of Transits (000's)

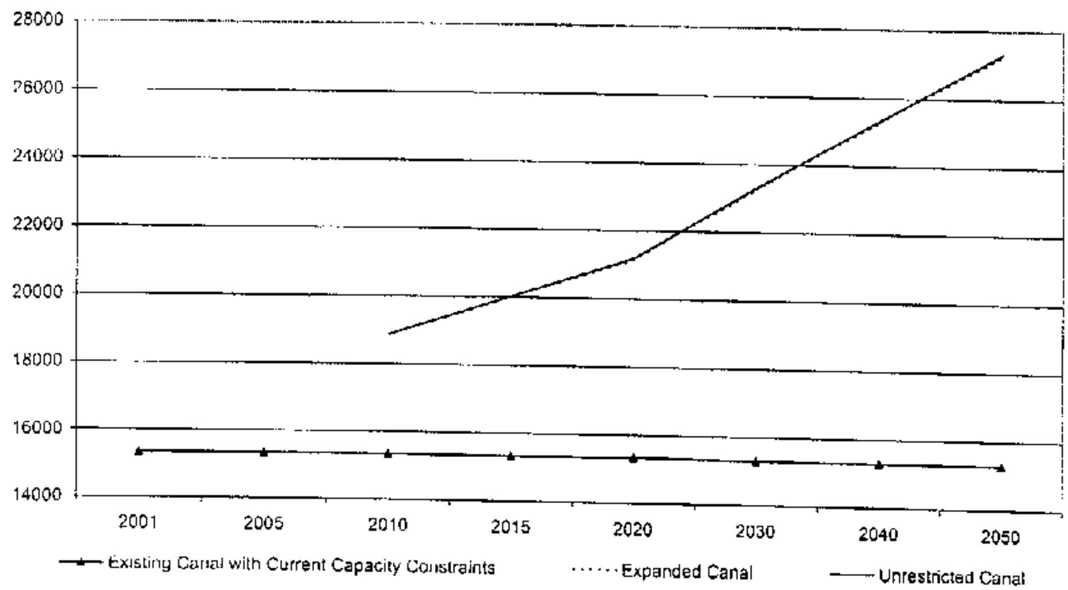


Figure 1.8.2

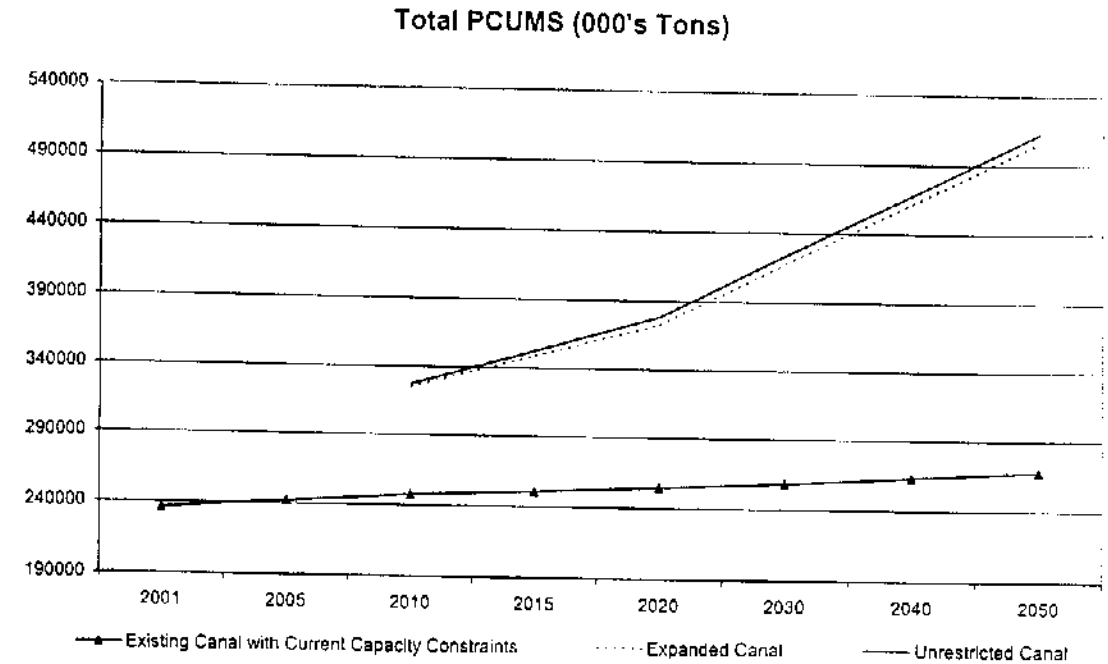
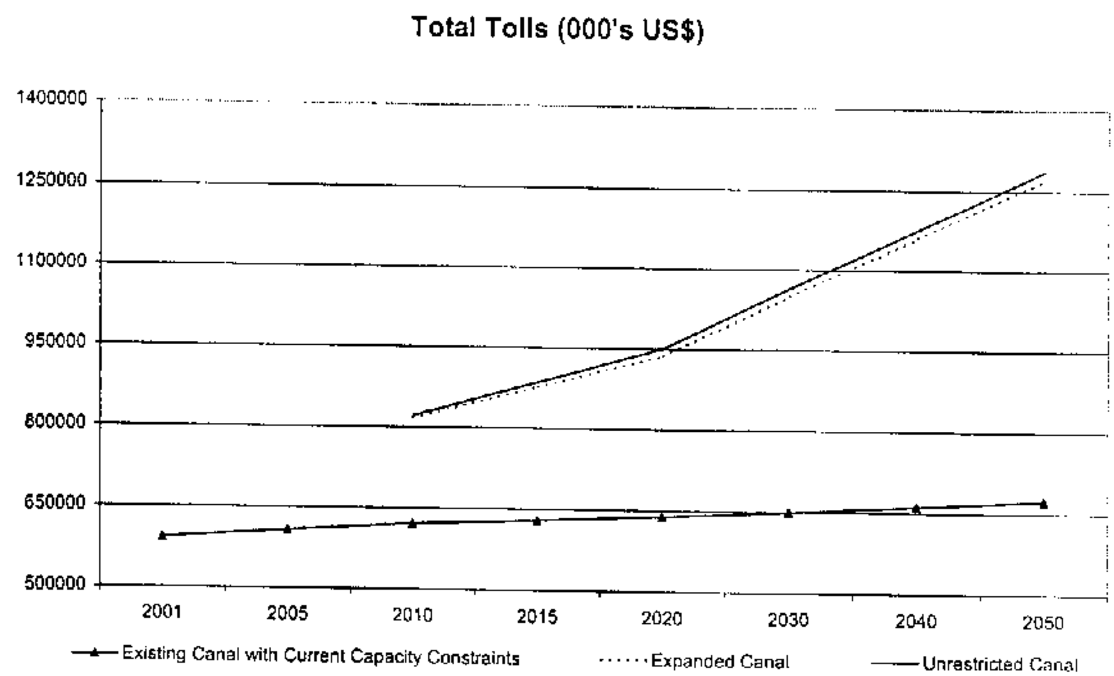


Figure 1.8.3



- Globalisation and fragmentation of world trade, with high foreign direct investments in Asia, implemented as a shift in the capital base in Asia, combined with technology shifts in sectors using semi-skilled and skilled labour intensively. This is just an amplification of the Scenario 1, where Asia is gaining competitive advantage in skilled and semi-skilled manufactured products. As a result the likelihood of seeing the impact of this effect over the next twenty years is put as high as 80 to 90%

The model used to develop Scenario 2 is fairly rich in economic relations, and the above changes induce a number of effects. The mechanisms involved work through changes in comparative advantage, but also changes in competition levels in sectors with imperfect competition. An underlying input-output structure captures some agglomeration effects, thus incorporating some effects of the so-called "new geography of trade". Model output has been converted to adjustment factors by using detailed statistics from the COMTAP database.

The dominating effects which influence trade flows through the Panama Canal are:

High US productivity from 2005 leads to high export performance and somewhat reduced imports 2005-2020 due to higher domestic production. The import reductions are found particularly for trade with Europe and Asia.

This trend is turned around from 2030 as the Asian economies attain higher productivity, leading to higher exports and somewhat lower imports, particularly in trades with the US.

The energy tax and increased energy efficiency reduces trades in energy dramatically. It also affects the steel industry, which reduces both the use of iron ore and coal. The increased energy efficiency increases economic growth, however, and creates more trade in manufactures, affecting particularly containerised goods and the residual group "all other cargoes". The model has an underlying input-output structure, so any direct effect on particular sectors (like the steel industry) will have secondary effects through reductions in sectors delivering to the steel industry.

The lower non-tariff barriers have a general positive effect on trade flows, and particularly after 2030, world trade in agricultural products increases substantially. This is mostly exports from third world countries to Europe, but also a notable increase in Asian imports due to the high barriers existing in some countries (particularly Japan).

The model output has been converted to adjustment factors from the generic growth (Scenario 1) forecasts. The overall effects on total trade projections for the Panama Canal are relatively small with reductions in industrial commodity trade flows being partly offset by increases in agricultural product trade flows. In 2010, the first time period, when it is assumed that these structural changes will begin to have an impact, there would be an overall increase in commodity trade flows 2.4 million tons, before taking into account the effect of by-pass trade. By 2050 the generic growth forecasts for Scenario 2 would be 13 million tons lower than that forecast under Scenario 1.

Looking at only the figures for generic growth, by 2050 total transits under Scenario 2 are 2% below the Scenario 1 numbers but this encompasses some substantial changes for individual ship types and also by direction. Under Scenario 2, northbound laden transits in 2050 increase by 4% compared to Scenario 1, while southbound the number of laden transits declines by 5%. The most notable differences for individual ship types are:

- Northbound and southbound increases for full containerships;
- Southbound reductions for both tankers and dry bulk carriers;
- Northbound increases for reefers.

Overall figures for Case 1 under Scenario 2 - the existing Canal - are little different from those under Scenario 1 since in both cases it is expected that the Canal would be capacity constrained The limitations of the existing Canal would be the determining factor for trade and transits under both Scenarios.

For the Expanded Canal, transits are marginally in excess of the Scenario 1, Expanded Canal case (that is varying between 0.3% and 1.3% annually) through 2030 but by 2050 transits are down by nearly 2%. For the Unrestricted Canal, in comparison with Scenario 1, the number of laden transits is marginally increased through 2030 and then declines by a total of 1.5% in 2050.

2 Study Approach

The study provides a base case forecast (Scenario 1) which can best be described as 'business as usual' in that it assumes a continuation of trends and developments already in place. As a major part of the risk analysis, a second case (Scenario 2) has been developed which shows the potential impact of the introduction of global environmental protection and energy conservation policies as represented by the introduction of higher energy taxes. Scenario 2 also considers the potential impact of greater re-location of manufacturing to low cost production areas and the potential migration of labour that results.

Within each of these scenarios, three cases have been developed:

- Case 1 forecasts (Existing Canal) assume that the Canal remains at its existing dimensions but that transits are limited to a maximum of 42 vessels per day.
- Case 2 is referred to as the Expanded Canal case and assumes that a third set of locks is developed, permitting transits of vessels up to 180ft beam, 50ft draft and 1,000ft LOA. No capacity constraints in terms of the numbers of daily transits have been assumed.
- Case 3 is the Unrestricted Canal, which assumes no restrictions on either size or numbers of ships.

Additionally, generic growth in the demand for Panama Canal transits has also been developed. This is based on the assumption that the Canal remains at its existing dimensions, but no account is taken of capacity constraints due to the limit in the number of vessels that can transit the Canal on any given day.

In line with the study terms of reference, it is assumed that Canal tolls remain at current levels in real terms.

The study commences with a review of historical trends in regional and global growth in GDP and population. Forecasts to 2050 have been compiled with reference to external forecasts prepared or adopted, for example, by the UN, OECD, the International Energy Agency and the US Department of Energy.

These forecasts have been used to develop estimates of the generic growth of potential future trades. This part of the study relates to commercial cargo vessels and excludes passenger ships and other, non-specified, ship types which are both addressed in separate sections. Annual time series from FY1973/4 through FY1998/9 were compiled for each of the specified commodity groups by route. Forecasts have been developed with reference to regional economic/industry indicators and structural changes that have taken place in individual sectors. In other words forecasts have been developed through a combination of macro-economic forecasting and specific industry changes – often with reference to some major organisations involved in these sectors. Nevertheless in some cases the erratic nature of the data series has left little alternative but to adopt trend analysis techniques. However this last approach applies generally to the less important commodity groups. In order to relate trends in trade as closely as possible to economic indicators, data have been analysed on the basis of individual routes, routes grouped by a common destination, total north/southbound or groups of similar commodities as appropriate.

Forecasts for Case 1, the Existing Canal, have been made by first estimating the generic growth in the total numbers of transits (see below for an outline of the methodology). Having determined the overall number of laden and ballast transits for all ship types, estimates of future passenger ship transits have been deducted from the totals on the assumption that these would continue to have priority. In the absence from the terms of reference of a toll pricing strategy or clear trade preferences to determine the allocation of transits when demand exceeds capacity, laden and ballast transits for all other ship type have been reduced pro-rata with the overall cut in the number of transits required.

Under Cases 2 and the 3, the Expanded and Unrestricted Canals, a review of potential 'by pass' trades has been undertaken. By pass trades are defined as those commodities that are shipped on routes which represent alternatives to the Panama Canal and which utilise vessels larger than can be accommodated by the present dimensions. They also represent trades where the economic advantages of using larger vessels or other service factors outweigh utilisation of the Panama Canal on what is a shorter route. By pass trades therefore relate to just three vessel types – that is, full container ships, dry bulk carriers and tankers. There are post Panamax cruise ships in existence, but there are no by pass routes, although a larger Canal would permit more positioning voyages. For all of the remaining ship types, vessel sizes are within the current Canal dimensions and are expected to remain so.

By pass trades have been identified for full container ships – principally the US landbridge – dry bulk carriers (iron ore and coal) and tankers (Orimulsion). For each relevant trade a detailed analysis has been undertaken to determine the size of the trade, likely future growth, the economics of these alternative routes versus those for an expanded or unrestricted Canal and other factors likely to persuade shippers to adopt one or other route. The potential impact of an enlarged Canal is analysed from 2010 onwards.

In order to translate cargo forecasts into projections of vessel transits and toll revenue RLA has developed a model, using Microsoft Access, which has in it the following major steps:

- The allocation of commodities by route into ship types;
- The consolidation of commodities by route and ship type into total trade by route and ship type;
- The allocation of trade by route and ship type into dwt size ranges;
- The conversion of trade in terms of cargo tons to laden transits in terms of deadweight by route, ship type and size;
- The translation of laden transits in dwt terms into numbers of ships and also PCUMS;
- The calculation of laden toll revenue from projections of PCUMS;
- The projection of ballast transits for commercial vessels in dwt terms by route, ship type and size, based on relationships to laden transits;
- The translation of ballast transits for commercial cargo vessels in dwt terms into numbers of ships and also PCUMS;
- The calculation of ballast toll revenue from commercial cargo ships from projections of PCUMS;
- The development of transit forecasts by size range and beam.

Projections of ballast transits for other, non-specific vessel types have been handled outside of the model since a large proportion of these on the ACP database have no deadweights and trends in transits – as might be expected - bear no relation to laden transits. Forecasts of these transits have therefore been based on an analysis of historical trends.

Forecasts of passenger ship transits have also been made outside of the main model. These have been based on:

- an analysis of full and partial transits – at a route level more detailed than specified in the terms of reference in order to capture the major cruise line itineraries;
- an extensive series of interviews with companies, agents and the Pier 6 cruise terminal at Colon;
- the identification of expected trends in the cruise sector; and

- developments in Panama which are likely to influence Canal transits relative to general sector trends.

Construction of the main model required the development of a number of input assumptions at various stages. These are summarised below:

- **The breakdown of commodity trade flows within route by vessel type.** The ACP database was used to develop annual time series data back to FY1985/6 showing the proportions of each commodity shipped by different vessel types within each route. The results were used to develop assumptions on the future breakdown of commodity trade flows by ship type at a route level, taking into account in particular the potential for greater levels of containerisation in certain trades.

- **The allocation of trade by route and ship type to dwt vessel size ranges.** The ACP database was used to generate – for each ship type and route - percentage breakdowns of cargo tons by dwt size range. Trends were analysed and the results used to develop similar breakdowns for the generic growth in the transits via the Canal. For Cases 2 and 3 these projected trends were modified to take account of:
  - The potential size redistribution for the generic growth in trades under the Expanded and Unrestricted Canal Cases;
  - The potential size distribution of cargoes attracted from the by pass trades.

  Redistribution of cargoes by vessel size ranges was made with reference to trends in the international containership, dry bulk carrier and tanker fleets, including the introduction of increasingly larger post Panamax container vessels.

- **Conversion of Cargo Tons to Dwt.** Using the ACP database, cargo ton/dwt conversion factors by ship type, route and size range were developed. These factors were applied in the model to forecasts of cargo tons by ship type, route and size to derive projections of transits in terms of dwt.

- **Trends in average vessel sizes by dwt size range** as required to convert projections of transits in dwt into number of transits. In the first instance, trends on existing Canal routes were analysed from the ACP database. These were used to develop assumptions on average size ranges for vessel sizes below current Canal limitations. For vessel size ranges above existing Panamax limits, trends in average ship sizes by dwt size range in the world fleets were used.

- **Dwt/PCUMS Ratios.** These factors were used to convert transits in terms of dwt to transits expressed as PCUMS. Factors were calculated for the average relationships, derived from the ACP database, between dwt and PCUMS over the past five years by ship type and dwt size range. For vessels greater than the existing Panama Canal size limits, PCUMS Net tonnages were calculated for the average vessel dwts in each dwt size range from regressions of PCUMS versus dwt from the ACP data.

- **Laden/Ballast Ratios.** For commercial ship types, relationships have been developed between ballast transits and laden transits by ship type, route and size based on an analysis of the ACP database over the past five years. There are no consistent trends apparent from scrutiny of data going back over the last 14 years. The ratios calculated for each ballast route relate to the laden transits in terms of dwt on the reverse route – that is, ballast transits from Asia to US East Coast are related to laden transits from the US East Coast to Asia. Laden/ballast ratios for larger vessel sizes have been based on the ratios for the largest sizes currently utilising the Canal.

- **Transits by Dwt Size Range and Beam.** Based on data from the ACP database over the past five years a table has been developed showing the percentage breakdown of the numbers of vessel transits by beam size range within each dwt size range by ship type. The model applies these percentages to derive projections of total transits – laden and ballast – by ship type and dwt size range.

The following sections describe the various assumptions made in the forecasting of trade flows and their conversion to vessel transits, the qualitative issues surrounding the forecasts and provide summaries of the study results. Detailed quantitative analyses and forecasts are contained in a separate statistical appendix to this study.

3 Conversion of the ACP Trade and Transits Database

3.1 The Databases

All three of the ACP databases (SDB94-00, SDB85-97 and CARGA) were used to extract data for the analyses, SDB94-00 for the period 1994/5 to 1998/9, SDB85-97 for the period 1985/6 to 1993/4 and CARGA for the period 1773/4 to 1984/5.

The databases SDB94-00 and SDB85-97 were used to obtain the necessary details of transit and cargo data, including ship characteristics, whereas the database CARGA was only used to provide additional historical data on commodity trades by route.

The databases were large and different in structure and naming conventions. Considerable care was thus required to ensure that the data extracted for analysis was consistent throughout. In particular, rigorous comparisons were made on 1994/5 data extracted separately from the SDB94-00 and SDB85-97 databases to validate consistency of interpretation of database fields.

In such large databases, it was not surprising to find a few corrupt records, data inconsistencies and data omissions. ACP resupplied records that were found to be corrupt and these were reincorporated into the database and thus the integrity of the data was not compromised. Apparent inconsistencies were sometimes noticed during the analysis and these were tracked back to the appropriate table records. In some cases these turned out to be real anomalies, in other cases obvious data inconsistency and it was possible to rectify the inconsistency in an appropriate manner. Again the integrity of the data was not compromised.

Data omissions mainly affected ship characteristics, eg deadweight. Since these were an integral part of the analysis requirements, considerable effort was expended examining the effect of these omissions on the analysis and appropriate remedial measures were taken. It is believed that the integrity of the data was not compromised by these remedial measures.

3.2 The Coding Structure

New coding tables were introduced to the databases in order to convert the more detailed ACP coding structure to the grouped structure required by the study. In some cases subgroups of the ACP groups were introduced if it was thought that this would assist the analysis. These new coding tables covered:

- Ship Type: The 12 ACP groups were increased to 13 in order to keep Dry/Liquid Bulk Carriers as a separate type.

- Routes: Separate route tables were created for SDB94-00 and SDB85-97 due to the different coding structures. In addition certain ACP groups were sub-divided to facilitate the analyses. For the purposes of analysis, Asia was divided into N. Pacific, S.E.Asia, Indian sub-Continent and the Middle East; the US East Coast into US Atlantic and Gulf Coasts and East Coast South America into Caribbean and Atlantic Coasts. Special route tables were created for the passenger ship analysis as 3 main routes fell into the Other to Other categories. Also, for this ship type, transits were divided into full and partial. On confirmation from ACP, Balboa was included in West Coast Central America and Cristobal was included in East Coast Central America.

- Commodities: The ACP grouping was used.

- Toll Type: No change to ACP table

- Transit Type: No change to ACP table

- Fiscal Year: Special tables were created to assign a fiscal year to a billing sequence number or ship number/arrival date.

- Size Range: Special tables were also created to assign deadweights to the ACP specified size ranges.

3.3 Extraction Method

The normal extraction method was to group the data as much as possible in Microsoft Access, using the coding tables, and then to create cross tabulations for exporting to Excel. Initially this was done for SDB94-00 only, in order to produce some data quickly for analysis, and then for SDB85-97. (Many of these separate analyses were used for validation purposes on 1994/5 as described above). Latterly, the separate grouped tables were combined in Access before exporting to Excel.

For the commodity by route analyses, the commodity and route groupings were found to hide the impact of individual commodities and/or route trades (and thus structural changes which might affect them) and in many cases it was necessary to return to the databases to produce less aggregated analyses.

3.4 Time Series Data

Time series data were prepared for:

- Commodities by route;
- Commodities by route and ship type;
- Containerised cargoes by route in TEU;
- Laden and ballast ship transits in terms of dwt, PCUMS, and numbers of vessels;
- Charges for laden and ballast vessels by ship type;
- Trends in average vessel sizes by ship type and dwt size range;
- Trends in the distribution of cargoes by dwt size range within vessel type;
- Trends in vessel transits by beam within dwt size ranges.

3.5 Other Data

To assist in the analysis, other data was extracted from the databases. This included:

- PCUMS to DWT averages;
- Full/empty container details including container weight;
- Specific details on "Other Ships" in ballast;
- Specific details on Passenger Ships including capacity and transit type;
- Ship names to link to RLA data on ship managers and owners.

4 Economic Data and Forecasts

4.1 Historical Data

Section 4 focuses on the two main variables impacting on trade, that is, trends in economic growth and population changes. Apart from structural developments, the other key factors are currency exchanges, which affect competivity. While the impact of exchange rates has been taken into account in the interpretation of historical trends in trade – both through the Panama Canal and on By Pass routes – forecasts of long term exchange rates have not been developed owing to the great uncertainty which attaches to such forecasts even in the relatively short term.

Table 4.1.1 summarises trends in real GDP growth rates since 1973 for the geographical regions specified in the study terms of reference. These have been extracted from RLA's database of real GDP by country, based on data published by Barclays Bank and supplemented by data from the World Bank. Over the last twenty five years world GDP growth has averaged about 3% per annum. Average rates for North America and Latin America were 3.2% and 2.8% respectively, while the figure for East Asia was 4.2%. Economic growth in Europe, including the FSU and Eastern Europe, averaged just 2.2%.

Table 4.1.1

Real GDP Growth Rates, 1973-2000

% per annum

	1973-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
USA	-0.4%	3.3%	3.1%	3.2%	2.4%	4.3%
Canada	3.2%	3.7%	2.7%	2.9%	1.7%	3.7%
Total North America	-0.1%	3.3%	3.1%	3.2%	2.3%	4.3%
East Coast Central America	5.5%	6.7%	1.7%	1.4%	1.2%	5.3%
West Coast Central America	5.5%	6.5%	1.6%	1.4%	1.3%	5.2%
Total Central America	5.5%	6.5%	1.6%	1.4%	1.3%	5.2%
West Indies	0.5%	4.6%	1.4%	4.0%	2.6%	4.1%
East Coast South America	5.2%	5.2%	0.2%	1.6%	3.8%	2.2%
West Coast South America	2.6%	4.9%	0.9%	3.2%	6.0%	2.4%
Total South America	4.9%	5.2%	0.2%	1.7%	4.0%	2.3%
Total Latin America	4.9%	5.4%	0.5%	1.7%	3.4%	3.0%
Europe	1.1%	3.1%	1.7%	3.0%	0.6%	2.4%
Africa	5.3%	5.3%	2.6%	3.0%	2.0%	3.9%
Asia - Middle East	5.6%	5.0%	0.3%	3.0%	4.2%	2.7%
Asia - Indian sub Continent	4.9%	3.6%	5.3%	6.1%	5.4%	5.9%
Asia - S E Asia	5.5%	7.7%	4.0%	7.1%	7.2%	2.3%
Asia - N Pacific	1.3%	4.9%	4.3%	5.3%	2.9%	2.4%
Total Asia excl. FSU	2.0%	5.0%	4.1%	5.4%	3.4%	2.6%
Total East Asia excl. FSU	1.7%	5.0%	4.3%	5.5%	3.4%	2.6%
Oceania	2.2%	2.3%	3.3%	2.9%	2.8%	3.8%
OECD	0.6%	3.4%	2.6%	3.5%	1.9%	2.9%
Total World	**1.3%**	**3.7%**	**2.6%**	**3.6%**	**2.1%**	**3.0%**

Source: Barclays Bank, World Bank, RLA

Historical growth rates for the world population by region – based on UN data - are summarised in Table 4.1.2. The rate of overall world population growth has been on a declining trend since 1987, although for Europe, Latin America and Asia the decline in the average annual growth rate set in even earlier. Overall growth in the world population has slowed down from 1.7% per annum in the period from 1975 to 1990 to 1.4% per annum in the past five years.

Table 4.1.2

World Population Growth Rates, 1973-2000

% per annum

	1973-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
USA	0.9%	0.9%	1.0%	1.0%	1.0%	0.6%
Canada	1.6%	1.2%	1.1%	1.5%	1.1%	1.0%
N America	1.0%	0.9%	1.0%	1.0%	1.0%	0.6%
Europe	0.8%	0.7%	0.6%	0.7%	0.3%	0.2%
Latin America	2.4%	2.3%	2.1%	1.9%	1.7%	1.5%
Asia	2.2%	1.8%	1.8%	1.8%	1.5%	1.5%
Africa	2.6%	2.8%	2.8%	2.8%	2.5%	2.3%
Middle East	3.1%	3.3%	3.8%	3.4%	2.5%	2.3%
Oceania	1.8%	0.9%	1.3%	1.3%	1.3%	1.0%
Total	1.9%	1.7%	1.7%	1.7%	1.5%	1.4%

Source: United States: Energy Information Administration. Others: United Nations

4.2 Forecasts

Forecasts of real GDP growth rates in the period to 2020 have been based on a combination of projections published in the US Energy Information Administration (EIA) 'International Energy Outlook 2000' and the Economic Growth Assumptions used in the International Energy Agency's 'World Energy Outlook 2000', which are based on figures from the OECD, World Bank and IMF. Forecasts have been developed at a country level to enable estimates of GDP to be developed for each of the regions defined by the trades specified in the TOR. Projections from 2020 have been made on the basis that growth in GDP per capita remains unchanged. This means marginally lower rates of GDP growth, in line with projections of falling population growth.

Projections of world population growth are based primarily on the United Nations' estimates of world population by area, medium scenario, 1995-2150, published in 1999 and based on the 1998 Revision. Further work was undertaken to breakdown the population estimates into the greater level of detail required by the study by analysing the UN projections for 2050 by country. Estimates for the period up to 2050 are shown in Table 4.2.1. These figures were broken down into the time frames required for the study by reference to the projections to 2020 by region and five year intervals included in the US EIA 'International Energy Outlook 2000'. The UN geographical regions were adjusted to the regions required for this study with reference to UN estimates of population by country for 1998 and 2050. Estimates of population growth rates for intervening years were made with reference to the US EIA projections in its 'International Energy Outlook 2000'.

Key economic assumptions with respect to GDP growth rates and population trends are shown in Table 4.2.2. Table 4.2.3 provides a table of GDP, population and GDP per capita forecasts which relate to the growth rates shown in previous tables. GDP and population growth are both key determinants of future trade. In the very short term, currency fluctuations are a major influence but to rely on forecasts of future rates in the long term is hazardous. Similarly comparative commodity prices present difficulties since these are susceptible to political influence. The purpose of this base case forecast is to present a neutral view 'that reflects a continuation of economic trends and developments already in place plus structural developments that have taken place or are still seen to impact on specific trades'. Consideration of the potential impact of future major structural changes on trade – the extent of which carry a fair degree of uncertainty while representing realistic scenarios - are dealt with in the Risk Analysis. Importantly, RLA has considered the potential for changes from the base case forecasts both up and down.

World GDP growth rates are assumed to decline steadily over the period from 2000 to 2020 – from around 3.4% per annum to 2.8% per annum – before flattening out at around 2.5% annually over the remainder of the forecast period. Generally economic growth in the developed world is expected to show a more marked slowdown than that in the developing countries. For the USA and Canada, average annual GDP growth rates over the next five years of around 3.2% are projected to ease to levels of around 1.5% per annum between 2020 and 2050. Figures for Latin America for the same periods are estimated at 4.5% and 3.8% per annum respectively and for Asia – excluding the Middle East – 3.9% and 2.9%. Economic growth rates for Europe, including the former Soviet Union (FSU) are projected at 3.0% per annum over the next five years, declining to 2.3% annually from 2020.

The rate of increase in the world's population is expected to roughly halve between now and the period from 2020, that is from 1.2% to 0.6%. The most marked slowdown will be in the developed economies within which the growth for the USA and Canada will fall from around 1.0% per annum to 0.3% per annum from 2020. For Europe as a whole, the population is expected to grow only marginally between 2000 and 2015 and after a period of stagnation is projected to begin to decline slightly from 2020. Population growth in Latin America, currently around 1.5% per annum is estimated to ease to around 0.7% from 2020, while that in Asia is projected to decline from 1.1% now to 0.4% per annum in the long term.

These economic forecasts, compiled at the end of the 3rd quarter/beginning 4th quarter 2000 are designed, as far as possible, to maximise longer term accuracy rather than to reflect shorter term cycles. Qualitatively, the outlook for key economies may be summarised as follows:

In N America, the **US** economy appears to have moved onto a higher sustainable economic growth path, due in particular to rising labour productivity. A rapid rise in the role of information and communication technology (ICT) has contributed. **Canada** has also been growing strongly due to links with the US economy, rising world commodity prices and a booming manufacturing sector.

The outlook assumes soft landings for both economies in the near term with GDP slowing from recent high levels to a more sustainable long term trend. GDP growth rates are expected to decline over the longer term. A key element is the estimated lower rate of increase in the active population, with a decline in immigration and a progressive ageing of the population implying a deceleration in the rate of growth of labour productivity.

In **OECD Europe** recent growth has been boosted by buoyant global trade and investment despite high oil prices. The service sector, which accounts for two thirds of GDP, is driving growth, industry's share has dropped to 30% and agriculture has levelled off at 4%. Enlargement of the EU will encourage stronger economic and political ties.

Table 4.2.1

World Population by Major Area				
				millions
	1995	2000	2025	2050
Africa	697	784	1298	1766
Europe	728	729	702	628
Latin Am & Caribbean	480	519	697	809
N America	297	310	364	392
Oceania	28	30	40	46
Asia excl China/India	1282	1391	1912	2262
China	1221	1278	1480	1478
India	934	1014	1330	1529
Total Asia	3437	3683	4722	5269
Total	**5666**	**6055**	**7824**	**8909**

Source: United Nations

Table 4.2.2

Main Economic Indicators							
Period	**2000-2005**	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2030**	**2030-2040**	**2040-2050**
				Per Cent Per Annum Rate of Change			
GDP							
USA	3.2	2.1	1.9	1.9	1.5	1.5	1.5
Canada	3.1	2.6	1.7	1.7	1.5	1.5	1.5
Latin America	4.5	4.6	4.2	4.2	3.8	3.8	3.8
Europe incl FSU	3.0	2.6	2.5	2.5	2.3	2.3	2.3
Asia excl Middle East	3.9	3.7	3.4	3.4	2.9	2.9	2.9
Middle East	3.7	3.6	3.7	3.7	3.0	3.0	3.0
Africa	4.3	4.2	3.9	3.9	3.3	3.3	3.3
Oceania	3.2	2.2	2.0	2.0	2.0	2.0	2.0
World	3.4	2.9	2.8	2.8	2.4	2.5	2.5
Population							
GDP							
USA	0.9	0.8	0.9	0.8	0.3	0.3	0.3
Canada	1.2	0.6	0.6	1.1	0.4	0.4	0.4
Latin America	1.5	1.3	1.2	1.1	0.7	0.7	0.7
Europe incl FSU	0.2	0.1	0.1	0.0	-0.2	-0.2	-0.2
Asia excl Middle East	1.1	1.1	1.0	0.9	0.4	0.4	0.4
Middle East	2.2	2.1	2.1	1.8	1.1	1.1	1.1
Africa	2.3	2.1	2.1	1.9	1.3	1.3	1.3
Oceania	0.9	0.8	0.8	0.7	0.7	0.7	0.7
World	1.2	1.1	1.1	1.0	0.5	0.6	0.6

Table 4.2.3

Estimated Development of World GDP, Population and Per Capita GDP

	USA			Canada			Latin America			Europe incl FSU			Asia excl Middle East		
	GDP (bln) 1996$	Pop (mln)	Per Capita GDP	GDP (bln) 1996$	Pop (mln)	Per Capita GDP	GDP (bln) 1996$	Pop (mln)	Per Capita GDP	GDP (bln) 1996$	Pop (mln)	Per Capita GDP	GDP (bln) 1996$	Pop (mln)	Per Capita GDP
1973	3955	216	18300	311	22	13843	923	304	3035	6329	755	8378	2981	2142	1392
1974	3940	218	18059	324	23	14167	983	311	3159	6478	761	8507	2975	2190	1359
1975	3973	220	17820	331	23	14269	1015	319	3182	6470	767	8433	3086	2236	1380
1976	4115	222	18521	349	24	14848	1069	327	3273	6754	773	8741	3223	2280	1414
1977	4290	224	19137	361	24	15161	1121	334	3353	6955	782	8898	3389	2318	1462
1978	4503	226	19905	376	24	15599	1156	342	3378	7174	783	9159	3594	2363	1521
1979	4616	228	20220	391	24	16076	1241	350	3544	7420	788	9413	3788	2405	1575
1980	4605	230	19987	397	25	16130	1323	358	3694	7533	793	9499	3947	2448	1612
1981	4718	233	20284	409	25	16452	1319	366	3604	7573	798	9492	4114	2492	1651
1982	4623	235	19684	397	25	15808	1304	374	3488	7652	803	9532	4262	2537	1680
1983	4823	237	20337	408	25	16077	1272	382	3334	7807	808	9667	4430	2582	1716
1984	5173	239	21600	431	26	16804	1321	389	3391	8009	813	9856	4661	2629	1773
1985	5372	242	22212	454	26	17503	1359	397	3419	8210	618	10040	4878	2677	1822
1986	5556	244	22748	466	26	17737	1424	405	3514	8432	825	10227	5076	2725	1863
1987	5745	247	23292	485	27	18214	1473	413	3564	8653	829	10433	5350	2775	1928
1988	5984	249	24027	509	27	18830	1479	421	3512	8995	835	10771	5737	2826	2030
1989	6194	252	24625	522	27	19035	1492	429	3479	9287	840	11053	6039	2875	2100
1990	6303	254	24817	523	28	18681	1478	437	3383	9502	845	11245	6370	2924	2179
1991	6274	257	24444	513	28	18219	1534	445	3450	9524	848	11227	6660	2972	2241
1992	6465	259	24934	518	29	18143	1579	453	3489	9514	851	11176	6855	3019	2271
1993	6636	262	25338	530	29	18323	1638	460	3557	9442	854	11059	7036	3065	2296
1994	6905	265	26103	555	29	18954	1724	468	3682	9598	856	11212	7262	3110	2335
1995	7089	267	26548	570	30	19253	1745	476	3666	9809	859	11420	7530	3154	2388
1996	7342	269	27294	579	30	19300	1810	484	3741	9945	860	11564	7931	3201	2478
1997	7654	268	28560	604	30	20143	1902	492	3865	10193	863	11811	8151	3291	2477
1998	7984	270	29537	624	30	20563	1940	499	3886	10428	864	12063	8030	3327	2414
1999	8315	273	30500	653	31	21243	1947	507	3842	10654	866	12302	8232	3364	2447
2000	8756	275	31843	684	31	21999	2025	514	3940	11022	867	12706	8555	3400	2516
2001	9080	277	32740	708	31	22499	2108	522	4041	11383	869	13099	8898	3438	2588
2002	9325	280	33337	726	32	22788	2192	529	4141	11756	870	13505	9241	3475	2659
2003	9623	282	34110	747	32	23194	2290	537	4264	12103	872	13880	9601	3514	2733
2004	9980	285	35071	777	33	23636	2402	545	4407	12415	873	14213	9998	3552	2815
2005	10229	287	35641	797	33	24143	2519	553	4555	12758	875	14580	10378	3591	2890
2010	11349	298	38084	906	34	26641	3151	591	5332	14505	879	16501	12450	3784	3290
2015	12500	311	40192	985	35	28155	3877	627	6183	16411	882	18606	14686	3968	3701
2020	13767	323	42622	1072	37	28974	4770	661	7216	18567	883	21028	17333	4142	4185
2030	15901	332	47931	1249	39	32360	6949	707	9829	23239	865	26856	23114	4321	5349
2040	18367	341	53901	1455	40	36141	10125	756	13387	29086	848	34300	30824	4507	6838
2050	21215	350	60615	1695	42	40365	14751	809	18234	36404	831	43808	41105	4702	8742

Table 4.2.3 (continued)

Estimated Development of World GDP, Population and Per Capita GDP

	Middle East GDP (bln) 1996$	Middle East Pop (mln)	Middle East Per Capita GDP	Africa GDP (bln) 1996$	Africa Pop (mln)	Africa Per Capita GDP	Oceania GDP (bln) 1996$	Oceania Pop (mln)	Oceania Per Capita GDP	World GDP (bln) 1996$	World Pop (mln)	World Per Capita GDP
1973	174	79	2210	220	386	571	246	19	12661	15139	3924	3858
1974	182	81	2246	237	395	599	251	20	12684	15370	4000	3843
1975	194	84	2319	244	406	602	257	20	12760	15520	4075	3809
1976	219	86	2538	259	417	621	263	20	12935	16252	4148	3918
1977	226	89	2542	267	429	623	264	21	12843	16875	4221	3998
1978	226	92	2456	279	441	632	276	21	13301	17582	4293	4096
1979	238	95	2501	293	454	646	282	21	13500	18269	4366	4185
1980	248	98	2518	316	467	676	288	21	13656	18656	4440	4201
1981	253	102	2474	328	480	683	298	21	13986	19011	4517	4209
1982	247	106	2324	328	493	665	299	22	13870	19111	4594	4160
1983	254	110	2310	331	507	652	302	22	13789	19627	4674	4200
1984	255	114	2227	344	522	660	325	22	14637	20519	4755	4316
1985	252	119	2121	358	536	668	338	22	15031	21220	4837	4387
1986	243	123	1980	366	551	663	344	23	15107	21907	4922	4451
1987	249	127	1954	377	567	665	357	23	15458	22688	5008	4530
1988	262	132	1990	391	583	671	371	23	15855	23727	5095	4657
1989	263	136	1939	403	599	672	386	24	16275	24585	5182	4745
1990	292	140	2084	415	615	674	390	24	16236	25273	5267	4798
1991	316	144	2200	422	631	669	388	24	15947	25632	5349	4792
1992	330	147	2242	429	647	664	396	25	16046	26087	5430	4804
1993	336	151	2226	437	664	658	412	25	16495	26466	5509	4804
1994	345	155	2234	449	680	659	433	25	17127	27271	5588	4880
1995	359	158	2269	459	697	658	448	26	17509	28010	5666	4943
1996	374	162	2312	486	714	681	465	26	17973	28933	5746	5035
1997	386	166	2324	504	731	690	478	26	18307	29872	5867	5091
1998	391	170	2305	520	748	696	498	26	18887	30415	5935	5125
1999	397	173	2290	537	765	702	519	27	19512	31253	6004	5205
2000	410	177	2315	555	782	709	540	27	20092	32547	6074	5358
2001	424	181	2346	579	800	723	553	27	20396	33732	6145	5489
2002	441	185	2388	601	819	734	572	27	20895	34853	6217	5606
2003	457	189	2419	626	837	747	594	28	21510	36042	6291	5730
2004	473	193	2455	654	856	764	620	28	22249	37320	6365	5863
2005	491	197	2492	684	876	781	633	28	22523	38488	6440	5976
2010	586	219	2676	840	973	864	705	29	24106	44492	6807	6536
2015	704	243	2898	1020	1078	946	781	30	25662	50964	7174	7104
2020	847	266	3182	1238	1187	1043	864	32	27392	58457	7531	7763
2030	1140	297	3837	1716	1355	1267	1052	34	31210	74361	7950	9354
2040	1536	332	4626	2380	1547	1539	1280	36	35560	95053	8408	11305
2050	2069	371	5577	3301	1766	1859	1558	38	40517	122098	8909	13704

Growth expectations for the future show a slow down. As with N America, this continues the well established long run slowing of growth in the most mature economies. Differences between countries within Europe are seen to diminish with convergence and economic and monetary integration. The population is assumed to grow very slowly in the period to 2020 and thereafter begin to contract.

The **Japanese** economy appears to be on a path of cyclical recovery with budget stimulus packages and a policy of low interest rates boosting activity. Exports and fixed investment – propelled by spending in ICT – lead the recovery with an improvement also in corporate profits from restructuring.

Uncertainties remain about the solidity of the recovery near term and over long term growth potential given the need for further restructuring. In addition, Japan's economy remains dependent on trade with the dynamic Asian countries, where expected growth is estimated to be less rapid over the longer term. An economic recovery is projected for Japan but with slower growth than in the 1970s and 1980s. Japan's working age population which peaked at about 90 million could shrink to around 70 million by 2030.

GDP growth in **China** recently picked up with the encouragement of private consumption and government expenditure on social programmes and infrastructure projects. Restructuring state controlled enterprises and returning them to profitability is a major priority.

Downsizing and restructuring is expected to accelerate with WTO membership. This could also increase transparency in the economy and augment direct foreign investment flows. Future growth is assumed to be supported by rising domestic demand, and expansionary fiscal policy and strong export growth. It is assumed also that there will be a gradual removal of energy price subsidies.

India is the world's fifth largest economy and will be among the fastest growing in the future. It has a low GDP per capita and a population growing faster than that of China. Economic growth in the 1990s accelerated through market orientated fiscal and structural reforms, including the restructuring of the energy markets. The recent slowdown in growth has been due in part to delays in reforms and a higher public deficit plus constrained investment. Higher oil prices have aggravated fiscal and trade deficits.

India's GDP is expected to almost triple by 2020, assuming the broadening and deepening of economic and energy sector reforms. GDP growth will be led by investment in energy intensive industries and in badly needed infrastructure. The prospects for continued reform represent a key uncertainty.

Brazil represents one third of Latin American GDP, with 60% of its activity accounted for by the service sector. Reforms initiated in 1994 accelerated the opening of the economy to international competition. In 1999, Brazil's monetary crisis raised external financing costs, limited capital inflows and contributed to the recession in Latin America as a whole.

In the future both private consumption and investment should support a relatively robust growth but as the economy matures they will become less buoyant. As a result, GDP growth rates are expected to decline over the longer term. It is also assumed that energy prices will become more market orientated.

5 Commodity Trade Forecasts – Demand for the Existing Canal

5.1 General Approach

This section describes the approach to projections of the generic growth of commodity trade flows . These forecasts represent the trades, which would flow through the existing Canal, in the absence of capacity constraints. In other words these projections indicate the potential demand for trade through the Canal before adjustments are made to reflect the daily limit of vessel transits.

Commodity trade forecasts were based on the available historical data for all trades by route from fiscal year 1973/74 to 1998/99. Complete data for FY1999/00 were not available at the time this part of the study was undertaken. The forecasting steps are detailed below:

- The data was organised by commodity into Northbound and Southbound directions and by route;

- Data for each commodity was scrutinised at a route level in order to determine the likelihood of potential links between trade flows and the economic and other industry indicators used in the study. For a number of the major commodities, developments in Panama Canal trades have been related to broader sector changes. Apparent structural shifts have been researched with industrial organisations, shippers, shipping companies, US government departments and terminal operators. In the particular case of containerised cargo flows a detailed analysis of the competing US landbridge has been undertaken.

- For those commodities where reliance was made on regression and trend analysis, all the Northbound and Southbound trades were summarised into blocks by the areas of destination – that is, the USA, Canada, Central and South America, Asia, other North, other South, Africa, Oceania, and Europe – if no clear trend could be discerned at an individual route level. In some instances it proved necessary to aggregate some commodities together in order to derive good statistical relationships.

- For these routes, commodities or groups of commodities, the next step was the statistical single and linear regression analysis of the historical data against the appropriate economic growth indicators (for example, real GDP, GDP per capita, population, oil consumption and production) or functions thereof, and other relevant criteria. Where no dependable correlations were revealed, linear and logarithmic trend analysis was applied. At this stage, structural changes that occurred in the markets in the 1973/74 to 1998/99 period were also taken into account for forecasting purposes, and some research was performed to gather information on the future development of specific markets. In addition to structural changes account was also taken of potential changes in the time series data brought about by the re-classification of cargoes. The most obvious example being in the reefer products sector and commodities such as bananas which have become increasingly containerised. (Once cargoes are shipped in boxes the precise contents are not generally known). The above methods were used to produce forecasts either at a route or aggregate level by the areas of destination.

- The above aggregate forecasts were split between the individual routes using the relationships of average cargo volumes by individual trades to the corresponding blocks of trades by the areas of destination for the past 5 or 10 fiscal years as deemed appropriate.

The results are summarised in Table 5.3.17 at the end of this section.

5.2 Analysis of Panama Canal Trades, FY1973/74 to 1998/99

The main basis for the analysis and forecasting of Panama Canal Trades was the time series produced from the databases for commodity cargoes by ACP route. As mentioned in section 3 above, some of the ACP specified routes were sub-divided to facilitate the analysis, this being particularly true for containerised cargo and passenger ships. For the latter, Balboa and Cristobal were re-introduced as specific origins and destinations.

For some commodity groups, such as coal and ores, it was necessary to consider the effect of by-pass trades. This involved disaggregation of three types:

- Other North to Other South/Other South to Other North into their individual routes;
- ACP Route into country rather than region origin/destination;
- Commodity group into the individual commodities.

For other commodity groups, such as grains, lumber and iron & steel, significant quantities of trade fell into the Other to Other routes and it was prudent to disaggregate these into the specific regional origins and destinations to identify the larger trades buried in the Other to Other totals. Although disaggregation of routes and commodity groups was often required, in one case, namely minor bulks, several commodity groups were aggregated in order to identify any trends in their total trade.

For comparisons with world trade data, it was necessary to extract additional information from the databases concerning containerised cargo. This information related to total and empty containers in the transit records (for full container ships and other ships with containerised cargo) which were then linked to the detailed cargo records for containerised cargo.

5.3 Forecasts by Commodity or Commodity Group

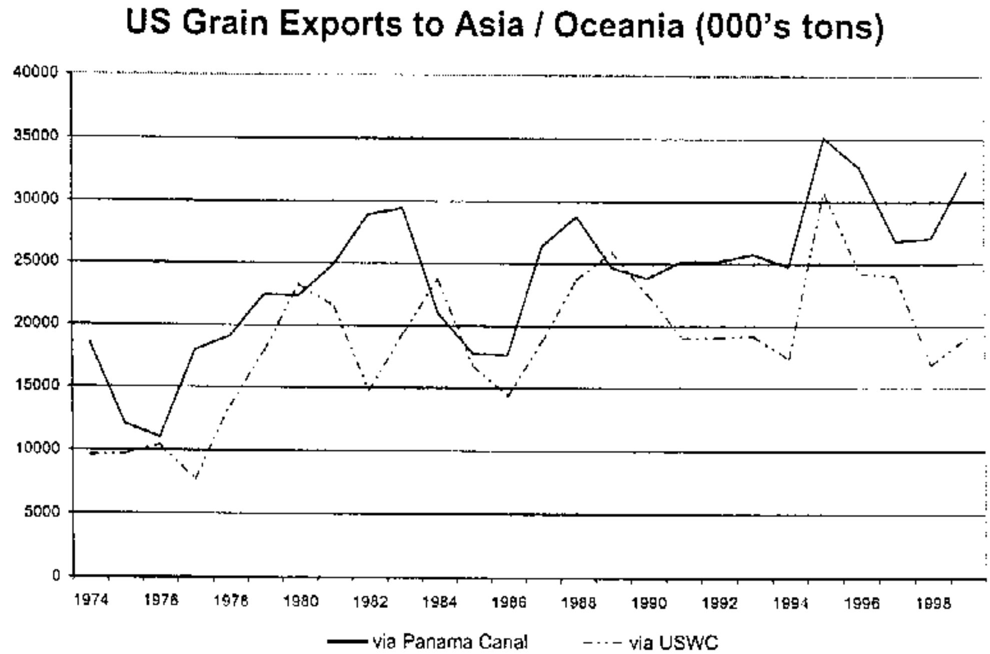
5.3.1 Corn, Wheat, Soybeans, Other Grains

5.3.1.1 For ease of reference, the terms 'grains' is used here to denote this group of products as a whole. Panama Canal trade in these products is dominated by US exports. Of the 40.65 million tons of southbound trade recorded for 1998/1999, 32.4 million tons were US exports to Asia and Oceania and a further 7.1 million tons were US exports to West Coast Central and South America.

Northbound trade is small by comparison at 3.5 million tons in 1998/1999.

5.3.1.2 The forecast of US exports to the Pacific Basin encompassed two approaches. In the first instance, the consultants developed a historical time series of total exports to Asia and Oceania in all four of these products from a combination of Panama Canal data and US Department of Agriculture data. These data were utilised in an initial forecasting framework which modelled total US grains exports against Asian economic developments through 2050. On this basis, US exports would be expected to increase by an average of 1.2% per annum through the time period. Additionally, broad assessments were made of the share of trade utilising the Canal. It was apparent that over the long term, the rate of increase of trade through the Canal was marginally below the overall trend although, in more recent years, the proportion being exported through the Canal had increased a little.

Figure 5.3.1.1



Source: RLA, US Dept. of Agriculture, Panama Canal Authority

In the second approach market research was combined with a more detailed assessment on a product by product basis. Expected import requirements for Asia and Oceania for each product through 2010 were sourced from US Department of Agriculture assessments (USDA Agricultural Baseline Projections). On this basis, US exports of corn, wheat, soybeans and other grains were forecast to increase on average by 2.2%, 1.9%, 3.3% and 0.4% respectively per annum between 2000 and 2010 although with annual fluctuations for individual products. This resulted in total exports increasing by an average of 2.3% per annum over this time period compared to 2.1% in the period between 1974 and 2000. Thereafter, total exports were forecast on the basis of Asian economic developments which resulted in average increases of 1.1% per annum giving an average of 1.4% per annum overall.

Exports from the US East and Gulf coasts are forecast to increase by similar levels that is by 2% per annum on average between 2000 and 2010 and 1.2% per annum on average between 2010 and 2050.

5.3.1.3 The following should be noted about the forecasts and the approach:

- Grain trades in particular are subject to short term fluctuations due to unforecastable developments (except in the very short term) such as the impact of climatic conditions on crop levels. By definition, it is not possible to take this into account in medium/long term forecasting.
- Nevertheless, the consultants undertook market research, data gathering and data reconciliation on the short term situation which pointed to both a downward trend in 2000 for three of the product groups, the exception being soybeans, and variations in the degree to which individual products would increase again over the short term.

- The forecast of US total exports in 2050 is higher in the second approach than the first but still represents a slowdown in the growth rate compared to the period between 1975 and 2000. The consultants have accepted this second model result recognising that the proportion of income spent on basic food products tends to decline as per capita income increases.

- At one stage it was thought possible that the volume of trades through the Canal was significantly impacted by fluctuations in internal US transportation costs between growing areas and the US Gulf and Pacific North West ports in particular. While at the margin this may be the case it now seems more likely that variations are caused by fluctuations in demand for different grades of agricultural products which tend to be shipped from different ports plus the short term impact of external conditions. The consultants have therefore assessed the future share of Canal trade on the basis of historical market share.

5.3.1.4 In total, exports to Asia and Oceania combined are forecast to increase to 95 million tons in 2050 of which 60.3 million tonnes would be from the East and Gulf coasts. Of this over 99% would be destined for Asia.

5.3.1.5 US exports to the West Coasts of Central and South America through the Canal appear to be larger than those reported by the US Bureau of Commerce. While the consultants have accepted and utilised the Panama Canal Authority data in order to provide a continuous time series of forecasts there is therefore a caveat over the data.

The framework for import requirements through 2010 was based on US Department Agriculture assessments for Latin America. US exports via the Canal are forecast to increase from 7.1 million tons in 1998/1999 to 9.4 million tons in 2010. The forecast was extended to 2050 using a statistical relationship with Latin American economic growth. This results in a forecast of 17.4 million tons in 2050. As with US exports to Asia, a slowdown in the rate of growth is expected in the longer term with trade on these routes increasing by an average of 2.5% per annum through 2010 and 1.5% per annum thereafter.

5.3.1.6 Consideration has been given to the issue of Brazil's soybeans exports - which have increased considerably in the recent past – and the potential impact on Panama Canal trade. These are currently carried in Panamax vessels and therefore do not qualify as by pass trade.

In calendar year (CY) 1996 exports totalled 3.6 million tons, 1997 exports totaled 8.3 million tons, in 1998 exports totalled 9.3 million tons, 1999 exports totalled 8.9 million tons, and in CY 2000 they totalled 11.5 million tons. Around 1.0 million tons were exported from the northern ports in 1999 and a little more than this in 2000. In other words, exports from the northern ports constitute around 10% of Brazilian exports. Current prospects are for an additional maximum 10% in total.

Most Brazilian exports are shipped to Europe. Between 1997 and 2000, the proportion shipped across the Atlantic varied between a low of 74% and a high of 85%. This is in contrast to US soybean exports where proportions to Europe in recent years have varied between 20% and 33% annually. Additional Brazilian volumes are shipped to Asian destinations and South American/Caribbean destinations which do not constitute potential traffic for the Canal on a mileage basis.

The destination profile for shipments from the northern ports is not significantly different from the overall profile of Brazilian exports. This means that, as matters currently stand, there is a maximum of around 250 thousand tons per annum that could be shipped through the Canal to northern Asia and the West Coast of South America/Central America with the potential for a small increase. It should be noted that in the data provided by ACP to the consultants, very few soyabeans from Brazil have been shipped through the Canal to these destinations. These volumes constituted 0.14 million tons in 1996/1997, 0.05 million tons in 1997/1998 and 0.04 million tons in 1998/1999.

In 1996/1997 exports from the USA to Asia and West Coast Central and South America totalled 10.0 million tons, in 1997/1998 9.9 million tons and in 1998/1999 11.25 million tons. The maximum calculated by the Consultants that is likely to be shipped from Brazil to these destinations does not represent significant competition on these routes, being approximately 2% of US volumes. Should, for some reason, the direction of Brazilian trade flows change drastically from their historic pattern, then an increase of trade through the Canal will substitute for the US exports forecast here to some Asian destinations and West Coast Latin America. However, given that this trade is maximum Panamax trade there will be no material impact on the bottom line in Panama Canal transits.

5.3.1.7 Southbound trade for grains and soybeans on all other routes is intermittent with no statistically acceptable pattern over time or relationships with economic criteria. The most important route is from the East Coast of Canada to Asia but even here trade flows are erratic both for individual products and in total. After consideration, it was decided to forecast Canadian exports to Asia on the basis of the trend in US exports to Asia assuming the historical medium term (1990/1991 through 1998/1999) relationship between US and Canadian exports. The result is trade volumes which are very similar in 2050 - at 0.7 million tons - as those in 1998/1999 recognising that the latter year represented an unprecedented increase in imports for which there does not appear to be any fundamental long term support.

The remaining trade has fluctuated substantially over the past 25 years from just over 80 thousand tons to nearly 1.0 million tons with 364 thousand tons for 1998/1999. This trade has been developed with reference to the trend in total US exports.

5.3.1.8 Total southbound grain trades through the Panama Canal are forecast to decline in the shorter term but increase to 48.4 million tons by 2010, 56.2 million tons in 2020 and 79.1 million tons in 2050. This represents an average rate of growth over the time period of 1.4% per annum with a higher rate of just over 2% per annum through 2010 decreasing to 1.2% per annum thereafter.

5.3.1.9 Northbound grains have been on a generally rising trend over the past 25 years. However, given the range of annual variation in volumes, there are no statistically acceptable relationships with economic indicators either on a product basis, a route basis or on an importing region basis that can be used for forecasting purposes. The consultants have therefore addressed the first 10 years of the forecast by applying year on year trend data in global trades for each of these product groups as indicated by the US Department of Agriculture. For the remainder of the forecast period, this trend has been extended in combination with relationships with RLA's global GDP per capita forecasts. In order to develop forecasts on a route by route basis trade by product group has been allocated utilising market shares that reflect trends in the past 10 years.

The result is that northbound trade increases by just under 2% per annum between 2000 and 2010 and by just under 1.5% per annum on average over the forecast time period through 2050. In absolute terms, trade more than doubles from 3.5 million tons to 7.2 million tons.

5.3.2 Coal and Coke

5.3.2.1 For ease of presentation, coal and coke trades are referenced here as coal trades. The main features of these trades from a Panama Canal perspective have been:

- Southbound, a gradual diminution of volumes on the US to Asia route. This has been caused in part by a lack of competivity of US product, increasing intra-regional supplies and in part by the use of larger vessels which have been routed via the Cape of Good Hope and which generally load top up cargoes of either iron ore or coal in South Africa.

- Northbound, a gradual increase in volumes as competitively priced Asian steam coal has found a place in the US market and high quality metallurgical coal from the West Coast of Canada has been exported in increasing volumes to Europe.

5.3.2.2 East Asian coal consumption is forecast to increase substantially assuming a 'business as usual' economic scenario. Utilising a combination of US Department of Energy (DOE) forecasts for specific years through 2020 and RLA economic data and forecasts suggests that Asian consumption could increase from under 2,500 million tons to over 11,000 million tons by 2050. This does not necessarily imply a resurgence in US exports however. Import requirements are predominantly met by exporters from within the region – Australia, China and Indonesia – and US exports, including those from the west coast and volumes shipped around the Cape of Good Hope, currently constitute less than 5% of import requirements. Current US DOE forecasts suggest that this proportion will continue to decline through 2020. This means that US exports to Asia, while fluctuating on a year on year basis, are unlikely to exhibit a fundamentally increasing trend until the second half of the forecast period with exports in 2030 of a similar order of magnitude to those recorded in 1999 - or 8.0 million tons - but still below those prevailing in most of the 1990s. By 2050, exports are forecast to be of a similar order of magnitude as in the early and mid 1990s, that is, around 15 million tons.

Demand to move coal through the existing Canal varies around 1.0 million tonnes per annum for each year in the forecast period until 2030 when trade starts to increase fundamentally, reaching 2.4 million tonnes by 2050.

5.3.2.3 There is one other exporting area which is a source of Asian imports and which constitutes potential Canal trade and that is the East Coast of South America. However, these volumes are virtually all carried in Cape size vessels and therefore this is discussed further in Section 6 which encompasses trade demand for the Expanded and Unrestricted Canals.

5.3.2.4 On the basis of the US DOE forecasts through 2020 and RLA's long term economic forecasts, coal consumption in the West Coast of Central and South America is also expected to be on an upward trend. Import requirements from the East Coast of South America (Colombia and Venezuela) and the USA are expected to increase from 2005 reaching a total of nearly 4.8 million tons in 2050 compared to 1.2 million tons in 1998/1999. All of these trades constitute demand for the Canal at its existing capacity.

5.3.2.5 Other southbound trades through the Canal are small by comparison and, in a number of cases, intermittent. Forecasts are therefore based on the historical trend of these trades in total. Overall, the rate of growth in total trade demand for the existing Canal southbound is substantial at 2.7% per annum on average but the numbers remain comparatively low, reaching nearly 3.0 million tons by 2030 and 8.6 million tons by 2050.

5.3.2.6 According to ACP data, US imports from Asia have been on a steadily increasing trend over the last 25 years and this generally matches the historical data on coal trades maintained by RLA although it should be pointed out that the volumes transiting the Canal are apparently in excess of US Department of Commerce numbers. Current US DOE forecasts suggest a slowdown in the rate of increase in US coal consumption from 2005 onwards. Extending this trend on the basis of the likely trend in US coal consumption means that coal imports in total are likely to increase from 8.0 million tonnes currently to 20.8 million tons in 2050. This compares to the US DOE forecast of 17.9 million tons for 2020. Coal trade demand for the existing Canal from Asia and Oceania into the USA is therefore likely to increase from just over 2.5 million tons in 1998/1999 to just over 7.1 million tons in 2050.

5.3.2.7 Over the forecast time period, European coal consumption is likely to decline although this will not necessarily have a direct, concomitant impact on import volumes as production levels are expected to decline also. Exports from the West Coast of Canada (included in the 'Other South to Other North' route as defined in the terms of reference), are expected to increase although at a low rate through 2040 before declining a little towards the end of the forecast period. (It should be noted that current US DOE forecasts suggest much higher volumes but this is predicated upon the basis that Canadian coal will be exported as steam coal. The consultants have, on consideration and after discussion with market participants, decided not to accept this assumption). Some of this trade is already carried in Cape size vessels but, due to port limitations at some European steel mills, there is still a substantial Panamax trade. As a result, trade demand for the existing Canal is forecast to increase from 3.3 million tons in 1998/1999 to 4.4 million tons in 2030 and 2040 with a small decline in 2050. Exports from the West Coast of the USA to Europe are substantially smaller and are expected to follow a similar pattern.

5.3.2.8 The remaining northbound trades are small in volume and, in a number of cases, intermittent. These trades have therefore been forecast on a trend basis and allocated to individual routes in proportion to historical market shares. Total northbound trades are forecast to increase from 6.6 million tons in 1998/1999 to nearly 13 million tons in 2050.

5.3.3 Minor Bulks

5.3.3.1.1 On a year on year basis, individual minor bulk trades through the Canal are generally extremely volatile and clearly subject to very short term influences. This is illustrated in Figures 5.3.3.1 to 5.3.3.5. This situation is exacerbated when the data are reviewed on an individual route basis. Nevertheless, it is axiomatic that long term trade developments are predominantly a function of economic trends.

Individual minor bulk industries have been considered where the Consultants deemed this appropriate. However, within long term dry bulk trade analysis and forecasting generally, a number of products tend to be grouped together under the generic term minor bulks. This aggregation generally facilitates the development of robust statistical relationships and therefore, the accuracy of the forecasts. This approach, adopted by RLA is accepted practice for long term minor bulk trade forecasting, particularly where the bottom line requirement is to forecast total vessel movements and demand.

Figure 5.3.3.1

Southbound Minor Bulk Trades (Tons 000)
(Fertilisers, Phosphates)

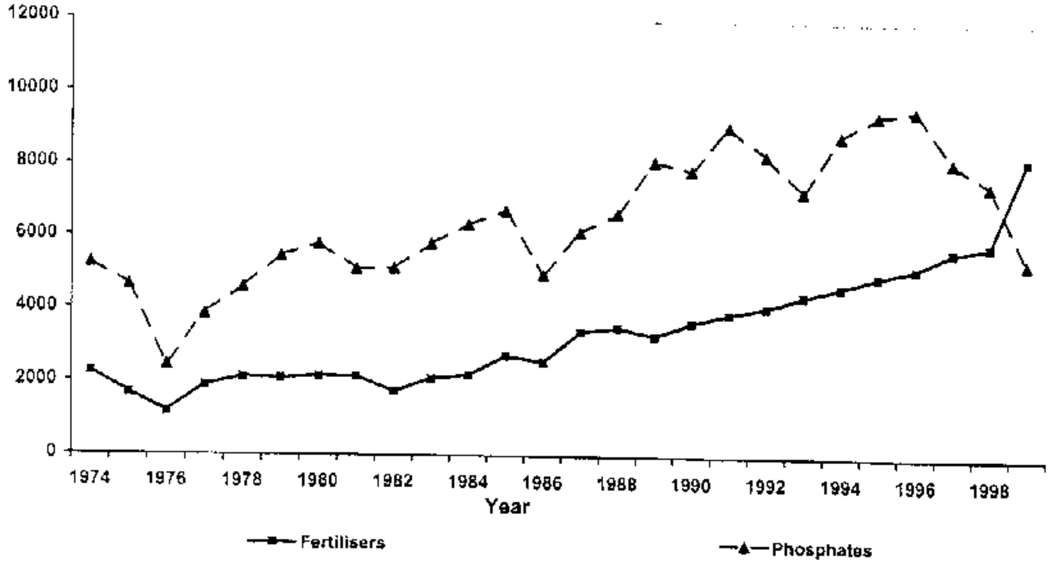


Figure 5.3.3.2

Southbound Minor Bulk Trades (Tons 000)
(Iron & Steel, Lumber Products, Misc Materials, Pulpwood, Scrap Metal)

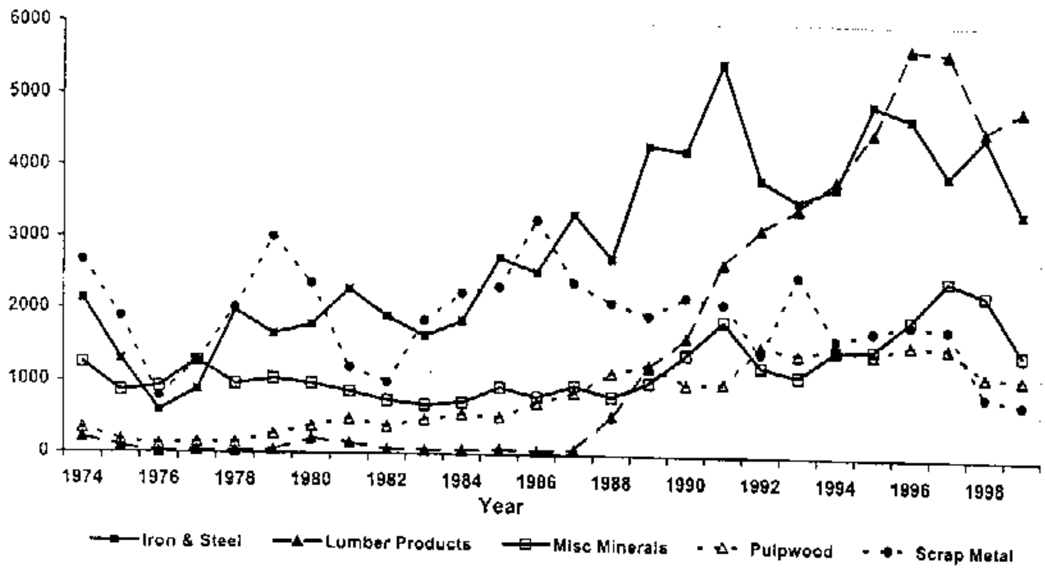


Figure 5.3.3.3

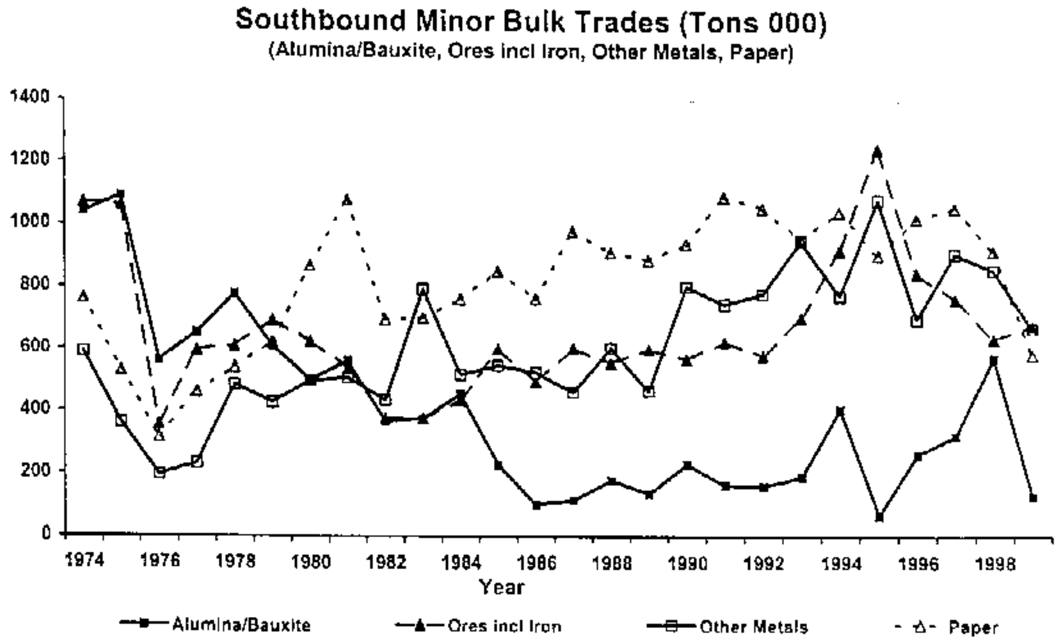


Figure 5.3.3.4

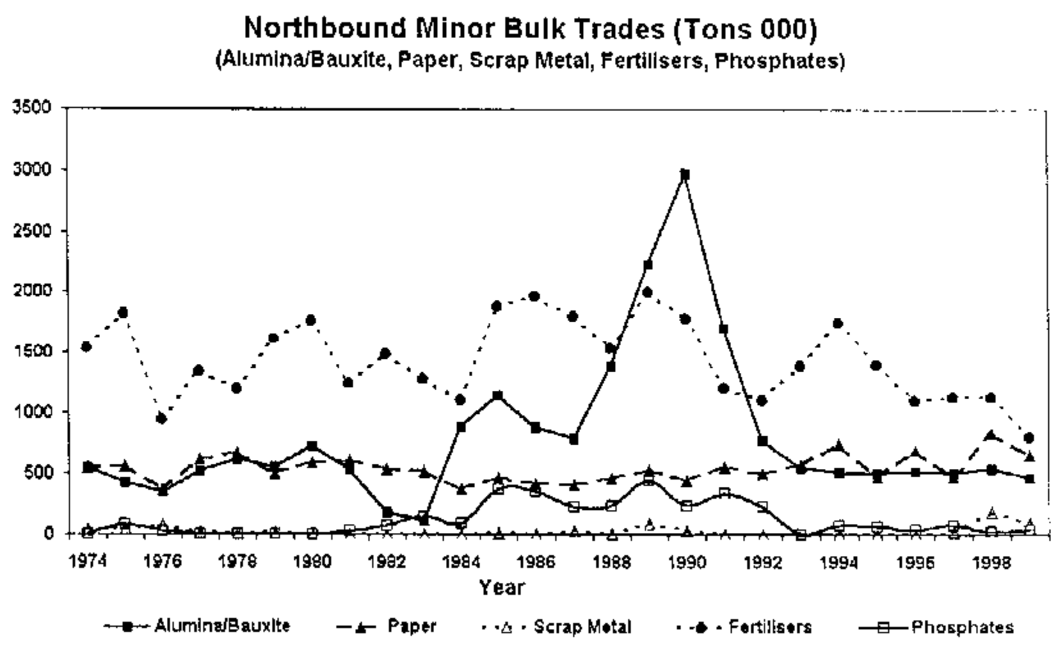
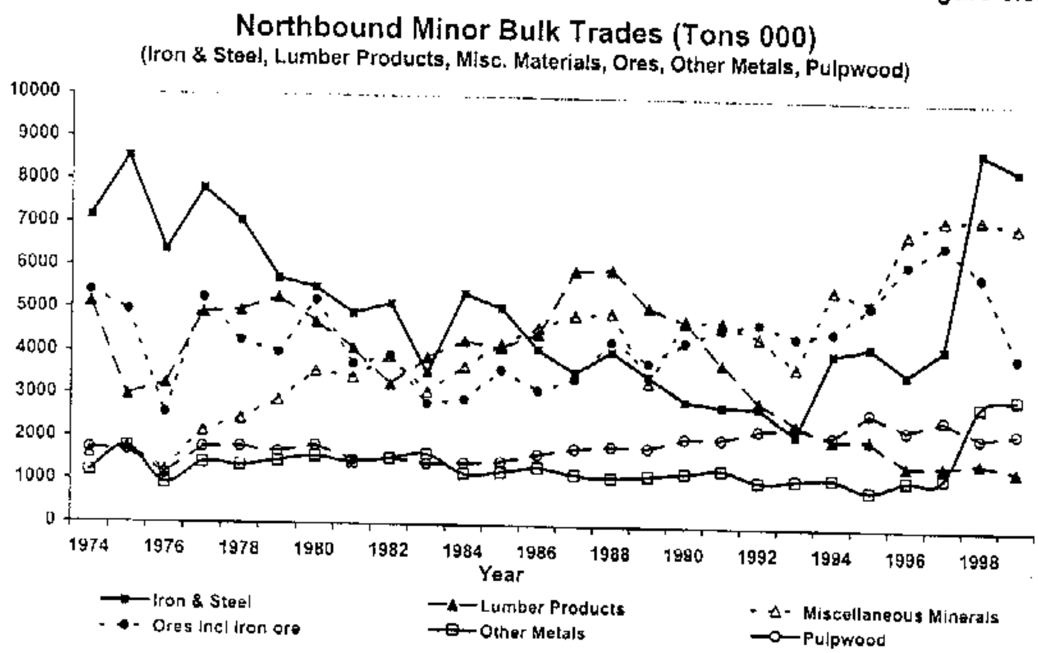


Figure 5.3.3.5



Review of the ACP data suggests that the most appropriate product groups for inclusion under this term are:

- alumina/bauxite
- fertilisers
- iron and steel
- lumber
- miscellaneous minerals
- ores
- other metals
- paper
- phosphates
- pulp
- scrap metal

5.3.3.2 The consultants have reviewed these trades both individually, in product sub groups and in total and by route and/or importing areas. The following are apparent:

- Southbound, both industrials and fertilisers/phosphates have generally exhibited a strong upward trend although trade in industrials in particular has declined in 1997/1998 and 1998/1999 as a consequence of the Asian economic crisis and, possibly, water capacity problems at the Canal.

- Asia/Oceania is the most important importing area but this proportion has declined in the last three years, varying between 54% and 59%

- Southbound volumes have generally been higher than northbound although in 1998/1999 total volumes were very similar. Further, as one might expect, the constituent elements are different with northbound volumes characterised by a significantly higher proportion of industrials than southbound.

- Historically, the long term trend northbound does not exhibit such a strong upward pattern although a more consistent profile emerges if iron and steel trades are excluded from the data.

- Unlike southbound movements, northbound trade peaked in 1997/1998 before declining again in 1998/1999. If iron and steel volumes are removed from the data series, trade increased in 1997/1998 over the previous year but only very marginally.

5.3.3.3 The following sections describe how the various minor bulks have been grouped together. Separate consideration was given also to the lumber trades On the issue of European imports of forest products from the West Coast of Canada there are two over riding factors. In the first instance, restrictions were introduced in the EU in the early 1990s which impacted on imports from the West Coast of Canada. These restrictions were mainly concerned with the quality and specifications for the products. Insofar as the Canadian producers could not comply with them there was a change in the source of forestry products supply into Europe from Canada to Scandinavia, Baltic countries and FSU.

Another reason was a decline in the availability of timber and associated products on the Western Coast of Canada. For the future, we have taken the view that volumes on this trade could reasonably be expected to increase over the long term as a function of economic growth. Market views on this are mixed although certainly some of the market research undertaken supports our view. ACP should additionally bear in mind that business analysts employed in individual industrial sectors do not focus on the very long term from the perspective of market structure and growth rates. It is therefore accepted that long term trade forecasting as undertaken for this study will have at its core economic developments. In reality this is a relatively small issue in the context of minor bulk trades and trade and traffic through the Canal generally.

Southbound, the main reason for the more recent downturn in Japanese lumber imports is economic, that is the Asian economic crisis in general and low growth in the Japanese economy coupled with low investment activity in particular. Southbound lumber trade is not the only minor bulk product to be impacted in this way.

South Australia, New Zealand and Chile produce different types of lumber to the US with fibre of less quality. They do not therefore necessarily represent a direct competitive threat in the Asian market. Additionally although some (but not all) analysts believe that, over the shorter term, prospects for Japanese imports from the US are limited, it is understood that China will be playing a more important role in the market and that consumption of forest products will increase.

It should also be noted that the approach undertaken to forecast southbound lumber trades (see below) minimises the impact of errors in historical Panama Canal trade data which suggests that exports from the USA to Asia really only started in any significant way in 1987/1988. In contrast, industry sources indicate that this trade had been rising for some time.

5.3.3.4 All of the comments made above as to the advisability of grouping minor bulk products together apply equally to the northbound and southbound routes. On grouping and scrutiny of the northbound data and testing the data against economic variables it became clear that results would be improved if iron and steel trades were removed from the analyses. The reason for this, the market research undertaken on iron and steel trades and the solutions adopted in order to produce forecasts for iron and steel trades are explained and discussed in detail in Sections 5.3.3.5 and 5.3.3.6. The approach taken to forecasting the other northbound minor bulk trades is provided below.

Given the importance of the USA and secondly Europe as destination areas for northbound trades, various combinations of industrials imports were initially analysed from the perspective of relationships with US and European economic developments. However, although there are clearly relationships, none of these was considered sufficiently robust for long term forecasting purposes. Instead the most robust forecasting relationship was found between total northbound industrials trade, excluding iron and steel, and global economic developments. On northbound trades, phosphates and fertilisers constitute a very small proportion (less than 3% in 1998/1999) of total trade and therefore it was not necessary to split these trades out from the totality of minor bulk trades.

This resulted in northbound minor bulk trade demand for the existing Canal – excluding iron and steel and lumber - increasing from 18.6 million tons in 1998/1999 to 44.8 million tons in 2050. This reflects an underlying increase averaging 1.5% per annum (which is very similar to the long term trend in Canal trade) although shorter term increases through 2010 are likely to be above those seen in the later period. With the inclusion of lumber trades, where data for the most recent years available suggests some stabilisation, total minor bulk trades, with the exception of iron and steel are expected to reach 48.5 million tons by 2050.

5.3.3.5 Northbound iron and steel trades peaked in 1997/1998 at 8.8 million tons and declined marginally to 8.4 million tons in 1998/1999. This compared to volumes of only 4.2 million tons in 1996/1997 and annual volumes which had not reached 5.0 million tons since 1980. It was clear therefore that a structural change had taken place in the last two years and RLA sought to identify whether this would persist or whether trade volumes would revert to more 'normal' levels.

US imports of iron and steel transported via the Panama Canal increased from 3.7 million tons in 1996/1997 to 7.2 million tons in 1997/1998 and 6.8 million tons in 1998/1999. These figures were borne out by RLA's trade data for these products which are compiled and provided by ISSB Ltd.

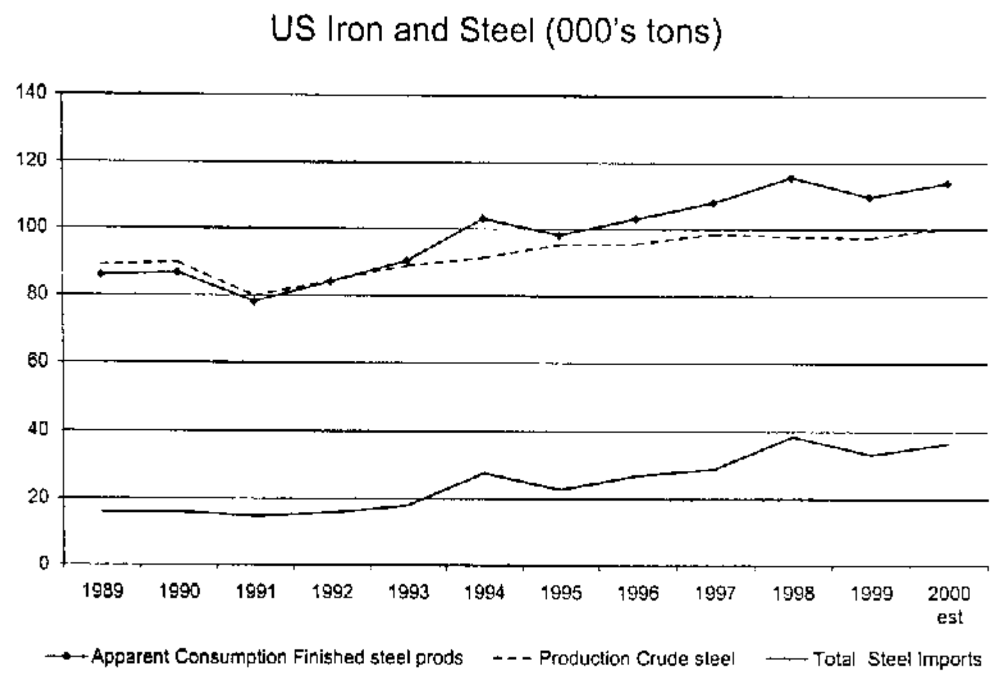
The ratio of imports to apparent consumption has been on a steadily rising trend in the US over the 1990s. Until the Asian economic crisis, 80% of Japanese and South Korean exports were to fellow East Asian countries. However, the downturn in economic activity in Asia and relative US$ strength, caused a re-orientation in trade flows away from Asia towards those economies still enjoying robust or reasonable economic growth such as the US and Europe. In other words, the standing excess of capacity over demand globally was exacerbated by the economic developments of 1998. Through the first nine months of 2000, US imports moved upwards again and, despite various anti-dumping measures that have either been prosecuted or are in the pipeline, this included imports from East Asia. Views concerning future developments appear to be mixed. Short term forecasts published by the International Iron and Steel Institute (IISI) suggest that US apparent consumption is likely to increase by less than 5% between 2000 and 2005. Long term apparent consumption has been assessed on the basis of the relationship between historical US economic developments and apparent consumption. This suggests an average consumption increase per annum between 2000 and 2050 of 0.7% per annum or marginally below the short term annual average forecast by the IISI. Assuming that the ratio of imports to consumption will ease but remain at historically high levels, suggests that imports from those areas which export to the USA through the Canal will fall back over the short term to 2005 but increase over the long term. On this basis trade demand for the Canal at its current capacity will increase to 9.3 million tons in 2050.

5.3.3.6 Other northbound iron and steel trades totalled 1.6 million tons in 1998/1999. These trades again exhibited a sharp upturn in the last two years. No satisfactory statistical relationship could be found for these trades against economic and exchange rate criteria.

The most robust relationship was found to be against US trade developments. On this basis, trade demand for the existing Canal is expected to increase to 2.4 million tons by 2050.

5.3.3.7 The most robust forecasting relationships for southbound cargoes were found by grouping the southbound trades into industrials – including lumber - and phosphates/fertilisers separately. Again this is accepted practice. 'Industrials' are subject to the same long term economic influences. Grouping products together in this way captures potential substitution effects between these products. Grouping products together in this way minimises the potential impact of any 'mis-categorising' of products by ACP which is easy to do considering that most of these products themselves constitute a wide range of individual items. This approach does however capture the inescapable fact that specific volumes of minor bulk industrial products are shipped through the Canal. Combining this with the fact that minor bulk products are not shipped in vessel sizes too large to transit the current Canal, means that volumes in total represent a sound forecasting base for the purposes of this study. The forecasting approach taken was a statistical one and reflects the relationship between these trades in total and global economic developments.

Figure 5.3.3.6



Source: IISI, ISSB Ltd., RLA

Long term relationships versus world per capita economic developments resulted in industrials trade increasing from 13.6 million tons in 1998/1999 to 43.3 million tons in 2050. The long term trend in industrials trade growth at 2.2% per annum is lower than seen over the past 15 years and also lower than the historical long term average. The growth rate is expected to decline from an average of 3% between now and 2020 to an average of 1.7% thereafter.

Similar orders of magnitude resulted from a statistical regression between Asian economic developments and trade flows. On this basis trade would increase to 39.6 million tons by 2050. This was rejected however given that a relatively high proportion of imports (47% in

1998/1999) were destined for the West Coasts of Central and South America. Despite this, the introduction of Latin American growth rates did not improve the forecasting relationship.

Phosphates, which include products such diammonium phosphate and triple super phosphate, are of course fertilisers. Grouping these two products together therefore deals with any data problems associated with any potential 'mis-categorisation' of product between these two groups. For phosphates and fertilisers, a robust forecasting relationship was also found between historical trade and long term economic growth trends. On the basis of this relationship, trade is forecast to increase from 13.6 million tons to 40.9 million tons or by a growth rate a little over 2% in the long term which is marginally below the long term historical trend. As with industrials, the rate of growth is more robust in the shorter term with the period from 1998/99 – 2020 characterised by an annual average of 3% which declines to 1.6% per annum on average thereafter.

5.3.3.8 The result of these generic growth forecasts is that northbound minor bulk trades are anticipated to reach 60.2 million tons by 2050 with the southbound trades continuing to exhibit stronger growth rates and to reach 84.2 million tons in the same time scale. Trade shares have been allocated to individual routes utilising historical proportions.

5.3.4 Petroleum Coke

In FY1998/99, total petroleum coke trade via the Panama Canal amounted to 3.2 million tons, of which 2.5 million tons was northbound and 0.7 million tons southbound. The predominant trade is between WCUSA and Europe for which the figure in 1999 totalled 1.9 million tons. Trends in this trade are extremely volatile and although recent developments suggest an underlying levelling off in cargo flows, a single linear regression over time gives a better result than a log regression although there is not a really close correlation. Because of the volatile nature of the trade, there is no link with, for example, GDP in Europe. Northbound, the Asia to ECUSA trade – amounting to 0.3 million tons in FY1998/99 – has also been subject to significant fluctuation although there is a better linear correlation with US GDP and a reasonable underlying linear rising trend over time. The forecasts of trade resulting from the relating future cargo flows to US GDP appear slightly on the high side and therefore the results of the linear regression over time have been applied, consistent with the approach taken for the main WCUSA-Europe route. Other northbound routes were treated in aggregate in a similar fashion.

Southbound trade is dominated by product sourced from ECUSA. In FY1998/99, 0.4 million tons were shipped to Asia, 0.2 million tons to WC South America and 0.05 million tons to Oceania. Cargoes have been moved on other routes intermittently but these three are essentially the ones that comprise total southbound cargo flows. Because of the fluctuating nature of these trades at both an aggregate and individual route level, projections of future trade have been based on the underlying linear trend over time.

As a result, total petroleum coke trade via the Canal is projected to increase from 3.2 million tons in 1998/99 to 4.4 million tons in 2020 and 6.0 million tons in 2050. Northbound trade is estimated to grow at a slightly faster rate, from 2.5 million tons in 1998/99 to 3.6 million tons in 2020 and 5.0 million tons in 2050.

5.3.5 Containerised Cargoes

Definitions

Container cargo was initially defined as all cargo carried on fully cellular vessels, whether identified in commodity terms or not, plus all cargo identified as containerised on other ships. Cargo identified as containerised accounts for about 90% of fully cellular vessel cargo, with almost all the difference identified as reefer. It is reasonable to assume that reefer cargo on fully cellular vessels is reefer container cargo.

This definition was used for the main forecast run in both TEU and tonnage, and for the forecasts of cargo tonnage by route and DWT band.

Separate tonnage forecasts were required for container cargoes, in any vessel type, defined by the ACP as containerised, because of the need to produce separate consistent commodity forecasts.

The TEU Forecast

World container handling data for the period 1970-1999 was assembled and was used to forecast world container trade (loaded plus empty) to 2050 in TEU. This required reducing container handlings by estimated transhipment volumes, and dividing by two, as each TEU is handled twice for a single movement.

Using ACP TEU transit data for total loaded and empty traffic (representing single movements) for containerships and non-containerships, Panama's notional share in years for which comparable data was available was calculated and forecast. This share was then applied to world forecasts to generate a forecast of the generic growth in overall Panama Canal trade in terms of TEU to 2050.

Cargo route forecasts were then generated, in total matching the above forecast. This part of the process was complex, as forecasts were required in TEU but:

- ACP-sourced container cargo data provided cargo tonnages on a true origin and destination basis , but gave no TEU information.

- The ACP transit data provided TEU information but gave route detail for ships rather than cargo, and could therefore only be used in aggregate.

The container cargo data for 1985-1999 gave container cargo tonnages for required routes. The major routes accounted for 80% of all container cargo in 1999 and were selected for individual evaluation. These were:

- ECUSA to Asia
- Asia to ECUSA
- Other South to Other North
- Europe to WCUSA
- Europe to WC South America.
- WCUSA to Europe
- ECUSA to WC South America.
- WC South America. to ECUSA
- WC South America. to Europe
- Europe to Oceania

- Other North to Other South
- ECUSA to Oceania
- All Other

These runs of data were individually forecast to 2050 using appropriate statistical functions, giving the first step forecasts in tonnage terms. These tonnage forecasts then required conversion into TEU.

The transit data provided cargo/TEU relationships for transit routes for the period 1985-1999. These relationships showed a clear declining trend over time, partly because container stowage factors are declining as higher value, lighter, goods increase their share in the mix, and partly because of an increase in the number of empty containers carried on the Panama routing. Appropriate functions were used to forecast cargo/TEU relationships but the function was not permitted to reduce the 2050 relationship to below 10 tons per TEU.

Appropriate cargo/TEU forecasts were applied to the cargo tonnage forecasts to generate TEU forecasts by route. These forecasts were then converted into shares, and these shares applied to the overall Panama TEU forecast generated separately.

The remaining minor routes were forecast as constant 1999 shares of the 'Others" TEU forecast.

The Tonnage Forecast

TEU forecasts were converted back into tonnages utilising the earlier assembled tonnage/TEU relationship forecasts for individual routes. Minor routes were again forecast as constant shares of the 'other' tonnages.

The Containerised Tonnage Forecast.

A route by commodity database for the period 1985-1999 was derived for 'non-container' cargo carried on fully cellular vessels. This was subtracted from the total container cargo database used in the main TEU forecast, and the process described above for the TEU and tonnage forecasts repeated. The aggregate TEU forecast was modified by applying the 'containerised' share of total container traffic in tonnage terms for each forecast year.

The Containerised Cargo Tonnage Forecast By Route And Vessel DWT Category.

Separate forecasts were made for the impact of an enlarged Canal on Panamax vessels assuming the generic growth in transit demand, as an enlarged Canal would allow some of this cargo volume to be moved in larger ships, and for the new Case 2 trade (see Section 6.2) generated by the enlargement.

The forecasts related only to the eight routes identified as affected by enlargement of the Canal. Strictly, the enlargement would also affect the generic growth figures for all other routes operating Panamax vessels as well, but the importance of this change is in practice very small, not least because ACP's major routes are among the eight individually assessed.

Background and Key Assumptions on World Container Trade

Strong growth is forecast for world container traffic over at least the next 10 years, both as cargo becomes containerised, and with increased transhipment.

Overall average growth of 3 – 4% p.a. is likely for the US market over the medium term, but with expansion of intra-Americas trade, including both coasts of South America.

The transpacific route is the largest single trade in the container market and it is forecast that container penetration will not reach its maximum until the second decade. There is still enormous potential for containerisation in China, Indonesia, India, Vietnam, with increases in direct China calls. Westbound trade from the US offers more long term potential, as the Asian markets reach a higher standard of living and their consumption increases. Consumption is currently growing at 8% p.a.

The container market in North America is mature and the market itself is looking to alternative sources of supply from Asia, i.e. Central America, Mexico, so import penetration from the Far East is likely to stabilise over time.

Development of world container trade is best measured by port handling data as this is in TEU and includes loaded and empty containers, so that it most closely reflects demand for vessels. Although world container trade has grown consistently at around 9% per annum since 1982, we do not believe that this rate can be maintained forever and have used a declining growth rate, falling from 4% per annum after 2005 to 1.4% in the years before 2050. Container handling volumes have never fallen year on year, and there seems no reason to assume that there will be an actual decline in volumes over the period forecast.

Transhipment has increased, however, and container handling growth therefore exaggerates trade growth. Transhipment was estimated at less than 5% in 1974, and has increased to around 20% in the late 1990s. Moreover, the rate of increase in transhipment volumes increased sharply in the 1990s as major carriers developed their use of transhipment hubs.

While it is likely that Panama will carry some transhipped cargo it cannot carry the same cargo both as transhipment and as a main haul move, so that it is reasonable to exclude transhipment volumes from the basic comparative analysis.

Increasing the rate of transhipment in the model has the effect of reducing the real rate of growth of container traffic, and our forecast for the increased use of hubs with larger and larger containerships - there is a clear trend for the number of ports called to reduce as vessel size increases, with more transhipment - is that primary and secondary transhipment will have increased to 60% by 2050.

The growth rate of real container trade after these adjustments have been made is estimated to have declined from around 11% pa in 1982 to about 7% in 1999. Future growth is forecast to fall to about 3.5% pa in the period before 2010, and then to 1.3% by 2050. These forecasts closely match forecasts for world economic growth.

Panama Share

The Panama share of world container trade as calculated above ranged between 3.2% and 4.3% in the period 1986-1998, with no trend over the period. The figures can however be explained, as Panama trade is determined largely by traffic between EC North America and Asia, and while US trade with Asia has increased sharply, Panama shares it with West Coast US ports. The period from 1984, when doublestack services began, has been characterised by the growth of Intermodalism and, since 1995, its inability to successfully accommodate increasing volumes, so that Panama won back share of the overall US/Asia market. Recent share has been particularly high, reflecting the trade effects of the Asia crisis.

Although there are and will be continuing attempts to increase intermodal capacity, it is not likely that intermodalism will be able to keep up with growth and win back what it has lost.

This would suggest that Panama's share of world trade will continue to increase, as long as the US is one of the engines of world container growth.

On the other hand, as a mature economy, the US may be expected to slowly lose share of total container trade, and there is a probability that Asian trade through the Canal will be partly substituted by growth in north-south trade, much of which will not require Canal transit.

There will certainly be more growth in container trade which does not involve the US or Panama at all, as economically undeveloped regions grow and mature. We have selected an equation giving a long term trend figure of about 4 per cent for Panama share, to best reflect these opposing tendencies.

5.3.6 Crude Oil

In FY1998/99, total crude oil shipped through the Panama Canal was almost 9.0 million tons. Northbound trade amounted to 4.3 million tons, of which nearly 4.1 million tons was from the WC South America and some 0.2 million tons in Other South to Other North. Southbound trade totalled 4.7 million tons with 3.9 million tons being sourced from EC South America.

In order to develop projections of future crude oil trades, northbound cargo flows from WC South America and for Other South to Other North have been linked to crude oil production trends in Ecuador and Peru. Those from EC South America – the predominant sources of southbound crude oil trade - have been related to expected developments in oil output from Venezuela and Colombia. In both cases there was found to be a good correlation between crude oil production in the named producer countries and trade. The crude oil production time series used are shown in Table 5.3.6.1. Figures for oil production forecasts are based on data from the IEA's long range outlook, taking into account expected depletion rates. Trade on minor routes, either north- or southbound, which is sparse and erratic, has been added into the forecasts on the basis of average annual volumes over the past nine years.

On the basis of these assumptions, the total amount of crude oil shipped through the Canal is projected to rise from just under 9.0 million tons in 1998/99 to a peak of 13.3 million tons in 2010 before declining gradually to 7.4 million tons in 2050. Trade on southbound routes is projected to peak at around 6.4 million tons. Thereafter declining production from Ecuador and Peru is expected to cause annual trade to fall to around 0.4 million tons by 2020. Trade on northbound routes is estimated to peak in 2015 at about 7.5 million tons, after which time declining output from Colombia and no further growth from Venezuela would cause trade to fall back to around 7.1 million tons.

5.3.7 Petroleum Products

Total petroleum products trade in FY1998/99 was 14.6 million tons. The Southbound trades accounted for 13.1 million tons, of which the trade flows to Central and South America and the USA were 9.1 million tonnes. The Northbound trades were 1.5 million tons, of which 0.8 million tons was the trade to the USA.

Table 5.3.6.1

Estimated Crude Oil and NGLs Production

	Colombia	Ecuador	Peru	000 b/d Venezuela
1974	175	175	80	3060
1975	165	160	75	2420
1976	155	190	75	2370
1977	145	185	90	2315
1978	135	205	150	2225
1979	130	215	195	2425
1980	130	205	195	2230
1981	140	215	195	2165
1982	145	215	195	1955
1983	160	240	170	1850
1984	175	260	185	1855
1985	185	285	190	1745
1986	305	300	180	1885
1987	390	175	165	1910
1988	380	310	140	2000
1989	405	285	130	2010
1990	445	290	130	2245
1991	430	305	115	2500
1992	440	330	115	2500
1993	460	355	125	2590
1994	460	390	130	2750
1995	590	395	125	2960
1996	635	395	120	3135
1997	665	395	120	3320
1998	775	385	120	3510
1999	840	380	110	3125
2000	763	411	98	3070
2001	760	400	90	3264
2002	733	391	83	3458
2003	706	374	76	3652
2004	669	358	88	3846
2005	633	343	113	4040
2010	484	426	132	4765
2015	330	376	82	5307
2020	177	326	32	5356
2030	0	226	0	5356
2040	0	126	0	5356
2050	0	26	0	5356

Source: BP Amoco, International Energy Agency (IEA), RLA

Table 5.3.7.1

Development of W. Hemisphere Oil Consumption

	USA	Canada	000 b/d Latin Am.
1974	16150	1765	3365
1975	15875	1735	3435
1976	16980	1790	3645
1977	17925	1795	3820
1978	18255	1830	4070
1979	17910	1915	4295
1980	16460	1855	4360
1981	15550	1760	4400
1982	14765	1565	4420
1983	14745	1475	4320
1984	15170	1425	4340
1985	15170	1490	4375
1986	15665	1540	4760
1987	16025	1580	4940
1988	16630	1665	5040
1989	16665	1740	4955
1990	16305	1690	5000
1991	16000	1630	5125
1992	16260	1625	5280
1993	16470	1680	5365
1994	16950	1720	5665
1995	16950	1665	5710
1996	17470	1710	5930
1997	17770	1800	6220
1998	18030	1820	6445
1999	18490	1800	6450
2000	18720	1822	6628
2001	18953	1845	6811
2002	19189	1868	6998
2003	19428	1891	7191
2004	19670	1915	7390
2005	19915	1939	7594
2010	21186	2062	8700
2015	22094	2151	9738
2020	23040	2243	10900
2030	22508	2225	12753
2040	19876	1996	14605
2050	15849	1616	16458

Source: BP Amoco, IEA, RLA

For forecasting purposes, regression analyses of historical trade volumes against oil consumption in the importing country/area (Table 5.3.7.1) and GDP were performed. However, due to the Northbound trade being relatively small and sporadic no dependable regression relationships were identified for the Northbound routes. These were forecast first at the total Northbound trade level using the logarithmic trend analysis. The results for total Northbound routes were then apportioned between the individual routes by applying the percentage share of each individual route in the total Northbound trade for the past 5 years (from 1994/95 to 1998/99) to the total annual Northbound trade.

Regression analysis for the dominant Southbound trades revealed a very strong relationship between the cargo volumes shipped to Central and South America and oil consumption in these regions. Historical time series data were extracted from BP Amoco's 'Annual Statistical Reviews' In order to place future projections of oil consumption in a global context, forecasts of world oil consumption by region were made with reference to the IEA's 'World Energy Outlook 2000' which provides forecasts through 2020, economic growth rates described in Section 4 and expected reductions in oil consumed per unit of GDP. The resulting estimates of world oil consumption are shown in Table 5.3.7.2, of which the estimates for W Hemishere regions shown in Table 5.3.7.1 are a subset.

These forecasts have been developed also against a background in which recent USGS (US Geological Survey) resource estimates for conventional oil, unconventional oil, NGLs and processing gains suggest a peak in supplies might be reached around 2025, although more dramatic gains in vehicle efficiencies in the intervening period could mean a plateau would not be reached until around 2040. It is recognised that there are those that consider that there are ample reserves of oil sufficient to sustain world oil demand growth of 2% per annum beyond 2050. Equally there are views that a supply crunch may develop before 2025.

The assumptions on which this study is based represent the generally accepted view that world oil consumption is likely to peak some time between about 2025 and 2040 – as determined by available supply and the extent of improvements in vehicle efficiencies in the intervening period. The assumptions adopted here were also based on an extensive interview with a senior individual in the long range strategic planning and environmental group in one of the major international oil companies. The forecasts developed of world oil consumption by region are provided here as Table 5.3.7.2 for information. It can be seen both from this attachment and Table 5.3.7.1 that although oil consumption in the OECD areas is expected to start declining from 2020, demand in the developing world – including Latin America is seen to continue rising. As a result, the report envisages steady growth in the important southbound petroleum products trades. Northbound trade is relatively minor since the Caribbean area represents a major refining centre and source of product on the Atlantic side of the Canal.

Table 5.3.7.1 shows historical data plus forecasts of oil consumption for the W. Hemisphere. It should be noted that the time series, based on BP Amoco data, differ from IEA estimates since the former exclude, for example, US processing gains, non-petroleum additives and substitute fuels.

The regression results were used to forecast totals for the trades to Central and South America. These were then apportioned between individual routes to Central and South America using the percentage share of each route within the total trade to Central and South America as measured over the past five years.

For the other southbound trades, Orimulsion was treated separately (see Section 6.3 below) and the remaining cargo regressed against oil consumption for the importing regions. The results were apportioned between individual routes according to their average weightings over the past five years. Estimates of future Orimulsion trade via Panama were added back in on the EC South America to Asia route.

Table 5.3.7.2

	USA	Canada	Latin Am.	Europe incl. FSU	Asia excl. Mid East	Mid East	Africa	Oceania	World
Development of World Oil Consumption									
									000 b/d
1974	16150	1765	3365	22350	8390	1465	915	685	55085
1975	15875	1735	3435	22055	8395	1425	955	695	54570
1976	16980	1790	3645	23315	8965	1565	1080	710	58050
1977	17925	1795	3820	23545	9470	1720	1145	735	60155
1978	18255	1830	4070	24595	10160	1815	1215	740	62680
1979	17910	1915	4295	25115	10430	2070	1295	755	63785
1980	16460	1855	4360	24410	9900	2040	1380	720	61125
1981	15550	1760	4400	23520	9690	2205	1480	710	59315
1982	14765	1565	4420	22765	9360	2405	1590	695	57565
1983	14745	1475	4320	22345	9505	2670	1645	670	57375
1984	15170	1425	4340	22445	9840	2830	1670	695	58415
1985	15170	1490	4375	22220	9790	2980	1715	670	58410
1986	15665	1540	4760	22800	10275	3015	1695	695	60445
1987	16025	1580	4940	22960	10590	3105	1765	720	61685
1988	16630	1665	5040	23010	11425	3085	1840	745	63440
1989	16665	1740	4955	23060	12145	3215	1920	780	64480
1990	16305	1690	5000	23375	12905	3390	1975	800	65440
1991	16000	1630	5125	22970	13510	3485	2015	780	65515
1992	16260	1625	5280	22000	14490	3550	2045	790	66040
1993	16470	1680	5365	20545	15100	3660	2095	830	65745
1994	16950	1720	5665	19760	16200	3825	2145	875	67140
1995	16950	1665	5710	19650	17115	3990	2215	905	68200
1996	17470	1710	5930	19395	17900	4150	2250	920	69725
1997	17770	1800	6220	19590	18665	4260	2310	955	71570
1998	18030	1820	6445	19735	18245	4310	2380	955	71920
1999	18490	1800	6450	19645	18950	4465	2445	970	73215
2000	18720	1822	6628	19883	19625	4552	2513	980	74722
2001	18953	1845	6811	20171	20330	4640	2582	989	76322
2002	19189	1868	6998	20464	21065	4731	2653	999	77969
2003	19428	1891	7191	20762	21833	4823	2727	1009	79665
2004	19670	1915	7390	21065	22634	4916	2802	1019	81412
2005	19915	1939	7594	21373	23471	5012	2879	1029	83211
2010	21186	2062	8700	22986	28239	5519	3300	1081	93074
2015	22094	2151	9738	24162	32422	6116	3536	1089	101308
2020	23040	2243	10900	25445	37387	6777	3789	1097	110678
2030	22508	2225	12753	24936	42585	7826	4357	1172	118362
2040	19876	1996	14605	22100	47783	8875	4925	1023	121183
2050	15849	1616	16458	17695	52982	9923	5493	806	120823

Source: BPAmoco, IEA, RLA

For northbound routes total cargoes are projected to grow very modestly from 1.5 million tons in 1998/1999 to 1.9 million tons in 2020 and 2.0 million tons in 2050. Trade growth is estimated to be more vigorous on southbound routes, rising from 13.1 million tons in 1998/99 to 20.1 million tons in 2020 and 22.9 million tons in 2050.

As indicated above the point at which the expected plateau in the supply of oil is reached – and therefore the peak in oil consumption – is dependent of the development of alternative energy forms. The principal alternative energy sources relate to gas - this would still be impacted by future energy/hydrocarbon taxes – fuel cell technology, biofuels and renewables such as wind, wave or hydro power. Trade in liquefied natural gas (LNG) is not seen as a significant growth prospect for the Panama Canal with Asian markets being supplied from the Middle East and S E Asia and markets in the Atlantic Basin being supplied from the same broad area or the Middle East. Venezuela's priority is to develop its gas reserves to supply its Latin American neighbours but not via seaborne transportation. Fuel cell technology may require increases in methanol trades. However given the likely major sources on supply and areas of consumption, the pattern of trades is unlikely to impact significantly on the Canal. Other forms of energy are consumed close to the point of production.

In summary, the development of alternative energy sources is not seen to have a significant impact on Canal traffic other than its substitution effect on oil. The location of current and likely future sources of natural gas in relation to main markets do not require transit of the Canal. As oil consumption is concentrated increasingly in the transportation sector the development of advanced internal combustion engines and hybrid vehicles will limit oil demand growth. In the longer term, past 2020, fuel cells offer promising alternatives although there is still some question over the choice of fuel. This could lead to increased trade in gas or methanol but on routes that are unlikely to involve Canal transits. Biofuels are expensive now but prices are coming down and they could become competitive with oil in twenty years time. However these will likely go to meet energy requirements in local markets. The same comment applies to renewable energy forms such as wind, wave and hydro power.

5.3.8 Residual Petroleum

Residual fuel trade flows are relatively minor and will remain so as fuel oil demand is seen to account for an ever decreasing proportion of the demand barrel – both as the result of being substituted by natural gas as a boiler fuel and anticipated growth in the demand for transportation fuels.

In FY1998/99 residual petroleum trade via the Panama Canal totalled 1.9 million tons, of which over 1.5 million tons were shipped southbound and some 331 thousand tons – northbound.

Due to low volumes shipped northbound and the volatile nature of the trade, regression techniques and time trend analysis were not considered to be appropriate. Forecasts for northbound routes are based using 5 year averages for trades grouped by their destination, and these levels are assumed to stay the same to year 2050. Then the forecasts at a grouped level were split between the individual routes according to the percentage share of each individual route in the total trade to a specific destination for the past 10 years from 1989/90 to 1998/99.

Historically, main southbound trades were the trades to Central and South America and to the USA. However, no significant correlation was observed between the trade volumes and appropriate independent variables, such as oil consumption in importing country or economic indicators. The forecasts were based on logarithmic trend analysis of the data series from FY1974/75. It should be noted that although data for FY1973/74 was also available, trade volumes for this year were not considered to be representative as they peaked significantly in that year and such a high level of activity was not observed in later years. Therefore, 1973/74 data was not used in the analysis. As a further step, forecasts at the aggregate trade level were apportioned between the individual routes on the basis of their percentage share in the total for the southbound trade for the past 10 years from 1989/90 to 1998/99.

The forecasts based on the above methodology show a slight decrease in southbound residual petroleum trades to 1.7 million tons in 2020 and 1.6 million tons in 2050. The northbound trade was estimated to be 805 thousand tons in 2000 and was assumed to remain flat thought the forecast period.

5.3.9 Chemicals

RLA examined the historical ACP database for both chemicals and petroleum chemicals trade and compared these data with in house data on chemical trades. No significant definitional differentiation between the two groups of products could be discerned As a result, the same forecasting methodology was applied to both product groups.

Total chemicals trade in FY1998/99 reached almost 9 million tons of which southbound trade flows were 6.6 million tons and northbound 2.4 million tons. The dominant southbound trade was US to Asia which accounted for 4.3 million tons of the total and, northbound, Asia to the USA which was 1.1 million tons in 1998/99.

RLA's chemicals database and latest medium range outlook were used to produce annual changes in chemical carrier trade for individual routes from 1999 to 2005. Forecasts from 2005 to 2050 were based on the statistical relationship between RLA's long term historical data on global chemicals trades and global economic growth.

Although northbound trades are not expected to increase in the short term through 2005, the resulting forecasts generally show significant growth. Southbound volumes are forecast to increase to 23.1 million tons in 2050 while northbound the increase is to 7.7 million tons in 2050.

5.3.10 Petroleum Chemicals

A very similar structure is apparent in petroleum chemicals trades as in chemicals trades with southbound volumes significantly in excess of northbound (1.7 million tons and 0.4 million tons respectively in FY1998/99) and the routes between the US and Asia predominant at 1.4 million tons southbound and 0.2 million tons northbound.

Using the same methodology as described in 5.3.9 above, southbound trades are forecast to increase to 3.8 million tons in 2020 and 6.8 million tons in 2050 while northbound volumes increase to 0.7 million tons and 1.3 million tons respectively. These figures represent average annual growth rates of 2.4% and 2.1% per annum respectively over the forecast period. These are similar to the projected growth rate for chemicals.

5.3.11 Reefer Products

From FY1973/74 to FY1998/99, trade in reefer products has grown steadily from 2.1 million tons to 4.8 million tons. This growth has been consistent year on year except for small decreases at the start, during the mid-eighties and again during the early nineties. Northbound trade has accounted for 70-80% of total trade throughout the period, although the southbound share is showing a small increase in the later years. The major trades are:

- West Coast South America to Europe
- West Coast South America to East Coast USA
- Oceania to Europe
- Oceania to East Coast USA
- East Coast USA to Asia

These five trades have increased their share of total trades from about a half to about two thirds during the 1974 to 1999 period. The approach to forecasting reefer cargo flows through the Panama Canal has therefore been to treat the above five routes separately and to project the remaining groups of north and southbound trades as two residual series, which have then been apportioned by route on the basis of historical trade shares.

The West Coast South America to Europe and East Coast USA trades exhibited strong correlations to the natural logarithm of Europe GDP and USA GDP respectively, particularly in the case of the latter, which had an R squared above 0.97. Projections of future trade have thus been calculated using forecasts of Europe and USA GDP. These projections showed trade to Europe increasing from just under 0.8 million tons in 1998/99 to 1.9 million in 2020 and 3 million in 2050, with trade to East Coast USA increasing from 0.67 million tons to 1.2 million and 1.6 million for the same years.

No significant relationships could be found between the other two major northbound trades (Oceania to Europe and East Coast USA) and economic indicators. These trades had been fairly flat during 1974-1999 and statistical trends were therefore used to forecast future trade. This resulted in trade to Europe decreasing marginally from 0.32 million tons in 1998/99 to 0.25 million tons in 2020 and 0.23 million tons in 2050 and trade to East Coast USA decreasing marginally from 0.5 million tons to 0.48 million tons prior to increasing again to 0.52 million tons.

The one major southbound route (East Coast USA to Asia) exhibited a strong correlation with Asia GDP and this was used to forecast future trade which gave results of 0.8 million tons in 1998/99, 1.7 million tons in 2020 and 4.4 million tons in 2050.

The residual northbound trades showed a strong correlation with the GDP of their major destinations (US and Europe) and this was used to forecast future trade volumes. Trade is therefore forecast to increase to 1.7 million tons in 2020 and 2.9 million tons in 2050. The residual southbound trades also showed a strong correlation with their major destination area (Asia) with the result that trade is forecast to increase to 0.9 million tons in 2020 and 2.1 million tons in 2050.

In total, potential reefer cargo trade through the Canal is therefore estimated at 4.8 million tons in 1998/99, 8 million tons in 2020 and 14.7 million tons in 2050. Northbound share falls from 72% in 1998/99 to 67% in 2020 and 56% in 2050 mainly due to the sharp increase in East Coast USA to Asia trade.

5.3.12 Bananas

Total banana trade in FY1998/99 was 2.24 million tons, of which northbound routes accounted for 2.20 million tons, and the rest was shipped southbound.

No reliable regression relationships against main economic indicators were identified. Forecasts for the Northbound trades are based on logarithmic trend analysis of the data series starting from 1992/93 due to a combination of factors affecting northbound banana trade via the Panama Canal in the early 90's. These factors include a general worldwide tendency towards containerisation of banana cargoes from the early 90's; introduction of new regulations on banana quotas and banana import taxes in Europe from 1 January 1993 which lead to a slight decrease of banana exports to Western Europe and significant increase in banana volumes to Eastern Europe; a considerable decrease of banana exports to the EC USA via the Panama Canal from 1992/93 due to a change of sourcing from WC South America to EC.

The new European Union policy which was adopted only very recently encompasses an annual quota for Asia, Caribbean and Pacific banana producers. If this quota is exceeded producers in these areas must pay import duty. 'First Come, First Served' licences will be granted for the $ banana producers. The system has yet to be implemented and the EU Commission are still working on the details of the legislation.

The views of major banana producers and exporters on this regime vary extremely widely. Chiquita firmly opposes the new system, arguing that it is 'World Trade-inconsistent', ignores 8 years of successive GATT and WTO rulings and will result in an unnecessary extension of the transatlantic trade dispute. The US government, virtually all of the Latin American banana supplying countries and Caribbean nations also consider the new EU scheme to be WTO-illegal. Most of these countries continue to believe that the only lasting solution to the dispute is a licensing system recognising historical operators.

Dole Food Company Inc, however, announced its support for the new system, pointing out that it gives clearer guidelines for competing within the European market, preserves imports from Asia, Caribbean and Pacific countries, and is a non-discriminatory method for allocating import rights for Latin American bananas to the EU.

The only element to be seen clearly at this stage is that it is not clear as to what the impacts are going to be. In any event this stage of the policy is currently only scheduled to last until 2006. Moreover we would point out as a point of principle that there are continuous changes in the organisation of international trade.

It should also be noted that ACP banana trade data is allocated 100% to reefer vessels in the ACP database and the Consultants are well aware that bananas are in fact carried in both reefer vessels and container vessels. The banana trade forecast therefore follows ACP's data structure and includes cargoes in reefers only. Bananas transported in containerised cargo are implicitly covered in the forecasts for this commodity group.

The shifting effect of reefer cargo – including bananas - from reefer vessels to containerized vessels has been analyzed in detail. Historic data on the reefer container share of reefer trades via Panama was assessed on an individual basis for key routes and 'others' as a group. As in other sectors, these proportions were extrapolated according to best-fit statistical curves, taking into account to the extent possible known developments in trades and in the reefer/container industries. This was undertaken as part of the work described in Section 7, 'Commodity Trade Flows by Vessel Type'.

It should be also noted that according to the information provided by some major banana shipping companies (Lauritzen, Klaveness, Orion Shipping) banana consumption in Europe will not increase substantially in the future. Taking into account all the above factors, it was believed that logarithmic trend analysis is the most appropriate technique to forecast northbound banana trades.

As for the southbound trade, according to the same sources of information (Lauritzen, Klaveness, Orion Shipping) banana volumes are unlikely to increase as shipping bananas to the South via the Panama Canal is not economically efficient provided EC South and Central America are the major source of bananas. Due to this fact combined with the quite volatile and erratic nature of the southbound banana trades, forecasts of the southbound trade are based on the average cargo volumes for the past 10 years from 1989/90 to 1998/99, which are assumed to remain the same to 2050.

The resulting forecasts for the northbound banana trades are an increase from 2.2 million tons in 1998/99, rising to 2.5 million tons in 2020 and 2.6 million tons in 2050. The southbound trades are assumed to stay broadly flat to 2050.

5.3.13 Food and Agricultural Products

Total trade for FY1998/99 was 3.1 million tons. Southbound trade in the same period was 1.2 million tons of which 0.8 million tons were shipped to Asia. Northbound trade amounted to 1.9 million tons almost a half of which was the trade to the USA.

No reliable regression relationships against main economic indicators were identified. Forecasts for the major trades are based on logarithmic trend analysis of the data series starting from 1973/74. Forecasts for the northbound trade to Canada, and the southbound trades to Oceania, other South, and USA are based on the average cargo volumes for the past 10 years from 1989/90 to 1998/99, which are assumed to remain the same to 2050. Due to very low volumes moved on the southbound trade to Canada to 1989/90 and no trades in this direction for the past 10 years, this trade is assumed to be at a zero level in perpetuity.

The forecast trade volumes for northbound routes are seen to gradually decrease to 1.67 million tons in 2020 and 1.40 million tons in 2050. Southbound trade is forecast to decrease to 893 thousand tons in 2020 and 881 thousand tons in 2050.

5.3.14 Sugar

Sugar volumes shipped in FY1998/99 via the Panama Canal were almost 2.9 million tons. The bulk of 1998/99 sugar trade (2.5 million tons) was northbound, where the majority of the volume went to the USA with some to Europe and Canada. The southbound sugar trades were volatile and erratic, amounting to 428 thousand tonnes in FY1998/99. The main southbound trade was from West Indies to Asia.

For sugar trades, no reliable regression relationships against main economic indicators were identified. Forecasts for the Northbound routes are based on logarithmic trend analysis of the data series starting from 1973/74. The Southbound trade to Asia, which accounts for 87% of the total southbound sugar trade is forecast using a logarithmic trend from 1992/93, as in the early 90's there was a structural change on the market when China significantly reduced volumes of sugar imported from Cuba. According to informed market sources at Tate&Lyle, this trade is likely to decrease in future. Other Southbound trades were forecast as the averages from 1992/93.

The forecasts based on the above assumptions show the northbound sugar trade slightly decreasing to 1.96 million tonnes in 2020 and 1.88 million tons in 2050. The southbound trade forecasts show a larger decrease to 0.34 million tons in 2020 and 0.25 million tons in 2050.

5.3.15 Automobiles

Since FY1973/74, total automobile trade via the Canal has fluctuated between 0.9 million tons and 2.4 million tons. In FY1998/99 it totalled 1.7 million tons having risen for the third consecutive year. The key trades are Asia to ECUSA, which accounted for almost 1.0 million tons out of the total 1.3 million tons of northbound cargo, and Europe to WCUSA, which represented around a half of the southbound.

There has been a certain pick up in US auto imports from Asia in the last two years. However it is not expected that an expansion will be seen from the past two years' high levels. In general it is expected that imports from Asia will remain high in the short term but decline in the long term. There has been a pause in Japanese manufacturers' trans-plant activity following the impact of the Asian economic and financial crisis on investment. With capacity utilisation levels of existing trans-plants high, a strong US currency and a downturn in manufacturers' domestic markets, Asian exports have risen. However, new investments in trans-plants are likely to take place, which will have a negative impact on exports to the USA. South Korean manufacturers are likely to follow the lead of the Japanese producers and Hyundai, for example, is planning to start producing in the USA.

Another factor in the future will be the continuing strong expansion of exports from Mexico into the USA and to a slightly lesser extent those from Canada. Mexico is also seen increasing its exports to other destinations, possibly backing out exports from Asia into the W Indies. Brazil is also seen as an increasing source of exports. Manufacturers are looking at Brazil with an eye to exports and although the economic climate in the country may be seen as volatile in the short term possible closer ties between the Mercosur countries and the USA in the future are likely to encourage increased trade.

Trade in automobiles between Europe and WCUSA is expected to remain rather stable. There is an ongoing market for European models not available in the US West Coast and trans-plant activities are not expected to alter this.

There are also expected to be increases in imports of automobiles into the West Coast of South America where production capacity is not expected to meet a strong expansion in ownership. Additional imports could come from Asia, the East and West Coasts of the USA and East and Central Europe.

The approach to forecasting automobile cargo flows through the Panama Canal has been to treat Asia to ECUSA and Europe to WCUSA separately and to project the remaining groups of north and southbound trades as two residual series, which have then been apportioned by route on the basis of historical trade shares.

Data on US imports of autos and trucks by importing coastline and origins back to 1989 have been obtained from the US Bureau of Commerce. A regression of total US imports versus US GDP per capita has been used as the basis for projections of future US imports. Time series data also indicate a clear declining trend in the share, which the Asia to ECUSA trade represents of the overall US import market. Future projections of this trend have been applied to forecasts of total US imports in order to derive estimates of trade on the Asia to ECUSA route.

The Europe to WCUSA route, since 1989, has fluctuated between 2% and 3% of the overall US import market. This is assumed to remain the case over the forecast period and, as a result, trade in autos between Europe and WCUSA is projected to increase over time. Forecasts for the remaining north- and southbound trades have been derived using trend analysis.

As the result of these trends total automobile trade through the Panama Canal is projected to increase slightly to 1.8 million tons in 2020 and 2.1 million tons in 2050. Overall northbound trade is estimated to remain close to 1.2 million tons with the growth concentrated in southbound routes.

5.3.16 All Other Products

Since FY1973/74, total trade in other cargoes via the Canal has fluctuated between 1.9 million tons and 4.0 million tons. In FY1998/99 it totalled 2.5 million tons with northbound trade exceeding southbound trade for the only time in the series. The fluctuations in southbound trade mirrored those in northbound trade until 1986 when northbound trade continued on a downward trend before increasing significantly in 1997 and 1998, whilst southbound trade reversed the decline before decreasing significantly in 1998 and 1999. The major trades are ECUSA to and from Asia and West Coast Latin America, which accounted for around 50% of the total trade each year, and Other South to Other North/ Other North to Other South.

No significant relationships could be found between the major trades and economic indicators (nor in fact between total trade and economic indicators) and it was decided to investigate further by examining individual commodities and ship types used, in order to see if significant relationships could be established at these levels. Miscellaneous cargo accounted for around 50% of the trade as did general cargo ships and dry bulk carriers. However, no significant relationships could be established and the general trend seemed to be well represented by logarithmic trend lines, one for the northbound routes and one for the southbound routes. Individual routes were then estimated by apportioning the north and southbound estimates according to historical shares.

As the result of these trends total other cargo trade through the Panama Canal is projected to decrease slightly to 2.1 million tons in 2020 and 1.9 million tons in 2050. It is considered that the sudden change in the northbound/southbound shares in 1997 to 1999 will revert back to earlier figures with southbound trade once again being the major element.

5.3.17 Summary

Individual commodity forecasts are summarised at the level of total north and southbound transits in Table 5.3.17.1. Overall, total cargo flows representing demand for the Existing Canal are estimated to increase from 208.4 million tons in 2001 to 306.2 million tons in 2020 and 430.8 million tons in 2050. Growth in southbound routes is projected to exceed that in northbound trades with the result that southbound trade represents 59% of the total in 2001 but 65% by 2050. The growth rate in total trade is seen to ease over the period, from 3.0%/2.4% in the period to 2010, to around 1.5% between 2010 and 2020 and slightly lower in the following period to 2050.

Table 5.3.17.1

Scenario 1, Generic Growth of Panama Canal Trades Excluding By-Pass

Commodity	Direction	2001	2005	2010	2015	2020	2030	tons/% per annum growth 2040	2050
All Other Cargoes	N	835726	809046	780039	754714	732241	693698	661402	633608
			-0.8%	-0.7%	-0.7%	-0.6%	-0.5%	-0.5%	-0.4%
All Other Cargoes	S	1449651	1427845	1404137	1383439	1365071	1333570	1307174	1284457
			-0.4%	-0.3%	-0.3%	-0.3%	-0.2%	-0.2%	-0.2%
Alumina/Bauxite	N	533383	593396	656556	715303	777909	909488	1043159	1178923
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Alumina/Bauxite	S	242702	285682	330916	372990	417828	507500	597173	686847
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Automobiles	N	1241780	1244980	1222272	1200318	1192170	1190173	1197158	1206337
			0.1%	-0.4%	-0.4%	-0.1%	0.0%	0.1%	0.1%
Automobiles	S	425703	471273	520514	567564	616717	717955	823507	933910
			2.6%	2.0%	1.7%	1.7%	1.5%	1.4%	1.3%
Bananas	N	2326690	2372597	2413224	2443825	2468383	2506507	2535672	2559298
			0.5%	0.3%	0.3%	0.2%	0.2%	0.1%	0.1%
Bananas	S	17318	17318	17318	17318	17318	17318	17318	17318
			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chemicals	N	2877685	2728891	3249101	3732967	4248610	5332341	6586068	7730976
			-1.3%	3.6%	2.8%	2.6%	2.3%	2.1%	1.6%
Chemicals	S	6560156	8274198	9873548	11361159	12946489	16278325	19663193	23101029
			6.0%	3.6%	2.8%	2.6%	2.3%	1.9%	1.6%
Coal & Coke	N	8759609	9943170	10571029	10960659	11626965	12144679	12677054	12955305
			3.2%	1.2%	0.7%	1.2%	0.4%	0.4%	0.2%
Coal & Coke	S	2171846	2818588	2779825	2917176	3177092	4339884	6047047	8570524
			6.7%	-0.3%	1.0%	1.7%	3.2%	3.4%	3.5%
Containerised Cargo	N	17029433	20258747	24007123	26104425	28011496	31605988	34286840	36555984
			4.4%	3.5%	1.7%	1.4%	1.2%	0.8%	0.6%
Containerised Cargo	S	18547437	22465197	26217060	28198638	30019590	33541601	36225521	38563997
			4.9%	3.1%	1.5%	1.3%	1.1%	0.8%	0.6%
Corn	N	185156	204975	231314	239787	257927	296051	334782	374119
			2.6%	2.4%	0.7%	1.5%	1.4%	1.2%	1.1%
Corn	S	21333958	23326233	25601938	27589064	29586632	33581768	37576904	41572040
			2.3%	1.9%	1.5%	1.4%	1.3%	1.1%	1.0%
Crude Oil	N	5598171	5215380	6374794	5242121	4109449	2617233	1484561	351888
			-1.8%	4.1%	-3.8%	-4.8%	-4.4%	-5.5%	-13.4%
Crude Oil	S	4897288	5948507	6880590	7509459	7340439	7053762	7053762	7053762
			5.0%	3.0%	1.8%	-0.5%	-0.4%	0.0%	0.0%
Fertilisers	N	1178723	1311345	1450923	1580748	1719100	2009875	2305277	2605301
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Fertilisers	S	5822839	6778376	7784027	8719416	9716239	11709883	13703527	15697172
			3.9%	2.8%	2.3%	2.2%	1.9%	1.6%	1.4%
Food & Agricultural Prod	N	1943066	1871957	1794643	1727144	1667246	1564519	1478440	1404358
			-0.9%	-0.8%	-0.8%	-0.7%	-0.6%	-0.6%	-0.5%
Food & Agricultural Prod	S	905392	902121	898564	895458	892703	887977	884017	880609
			-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%
Iron & Steel	N	6885677	7398747	8002989	8477849	8978655	9932277	10828335	11673385
			1.8%	1.6%	1.2%	1.2%	1.0%	0.9%	0.8%
Iron & Steel	S	4119845	4849422	5617280	6331453	7082551	8614748	10136944	11659140
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Lumber Products		1707596	1899723	2101926	2290002	2490430	2911671	3339814	3774253
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Lumber Products	S	3896033	4585975	5312100	5987494	6707246	8146748	9586250	11025753
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Miscellaneous Minerals	N	7232238	8045960	8902358	9698922	10547802	12331897	14144379	15985222
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Miscellaneous Minerals	S	1624281	1911922	2214648	2496224	2796293	3398431	3996569	4596706
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Ores	N	5998189	6673065	7383334	8043979	8748013	10227686	11730900	13257638
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Ores	S	738028	868724	1006274	1134215	1270557	1543243	1815929	2088615
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Other Grains	N	745885	796863	880037	946282	1017867	1168319	1321184	1476402
			1.7%	2.0%	1.5%	1.5%	1.4%	1.2%	1.1%
Other Grains	S	2642811	2800671	2888971	3291347	3539510	4035835	4532161	5028487
			1.5%	0.6%	2.6%	1.5%	1.3%	1.2%	1.0%

Table 5.3.17.1 (continued)

Scenario 1, Generic Growth of Panama Canal Trades Excluding By-Pass

Commodity	Direction	2001	2005	2010	2015	2020	2030	tons/% per annum growth 2040	2050
Other Metals	N	1968651	2190150	2423266	2640095	2871164	3356804	3850170	4351257
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Other Metals	S	806992	949801	1100306	1240201	1389284	1687451	1985618	2283784
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Paper	N	665711	740612	819441	892763	970901	1135123	1301957	1471403
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Paper	S	933823	1099192	1273233	1435115	1607629	1952657	2297685	2642713
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Petroleum Chemicals	N	474471	449357	536214	617004	703099	884046	1092862	1283934
			-1.4%	3.6%	2.8%	2.6%	2.3%	2.1%	1.6%
Petroleum Chemicals	S	1890833	2437426	2908565	3346787	3813790	4795294	5792413	6805136
			6.6%	3.6%	2.8%	2.6%	2.3%	1.9%	1.6%
Petroleum Coke	N	2675392	2867920	3108581	3349241	3589902	4071223	4552544	5033865
			1.8%	1.6%	1.5%	1.4%	1.3%	1.1%	1.0%
Petroleum Coke	S	732642	764346	798817	828911	855616	901417	938795	972824
			1.1%	0.9%	0.7%	0.6%	0.5%	0.4%	0.3%
Petroleum Products	N	1756087	1794264	1835771	1872010	1904167	1959318	2005532	2045304
			0.5%	0.5%	0.4%	0.3%	0.3%	0.2%	0.2%
Petroleum Products	S	11721946	13119775	15116937	16636370	18221404	19563992	20374769	20885427
			2.9%	2.9%	1.9%	1.8%	0.7%	0.4%	0.2%
Phosphates	N	49049	54566	60376	65778	71536	83635	95928	108412
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Phosphates	S	9365963	10902933	12620508	14025071	15628447	18835199	22041950	25248702
			3.9%	2.8%	2.3%	2.2%	1.9%	1.6%	1.4%
Pulpwood	N	2565225	2853846	3157805	3440141	3741233	4374039	5016914	5669648
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Pulpwood	S	1289500	1517656	1756187	1981727	2219949	2696392	3172835	3649279
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Reefer Products	N	3622913	4043990	4492221	4935923	5398441	6240853	7159083	8169782
			2.8%	2.1%	1.9%	1.8%	1.5%	1.4%	1.3%
Reefer Products	S	1240227	1482782	1822322	2188775	2622472	3569789	4833074	6517714
			4.6%	4.2%	3.7%	3.7%	3.1%	3.1%	3.0%
Residual Petroleum	N	804829	804829	804829	804829	804829	804829	804829	804829
			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Residual Petroleum	S	1815148	1781320	1744704	1712658	1684681	1636512	1632178	1592597
			-0.5%	-0.4%	-0.4%	-0.3%	-0.3%	0.0%	-0.2%
Scrap Metal	N	62340	69354	76736	83602	90919	106298	121921	137788
			2.7%	2.0%	1.7%	1.7%	1.6%	1.4%	1.2%
Scrap Metal	S	1641506	1932187	2238134	2522696	2825947	3432449	4038950	4645452
			4.2%	3.0%	2.4%	2.3%	2.0%	1.6%	1.4%
Soybeans	N	11998	12546	13036	14988	16122	18505	20926	23385
			1.1%	0.8%	2.8%	1.5%	1.4%	1.2%	1.1%
Soybeans	S	13513586	14840656	16131211	17458092	18668962	21090701	23512440	25934179
			2.4%	1.7%	1.6%	1.4%	1.2%	1.1%	1.0%
Sugar	N	2049473	2026644	2001823	1980154	1960924	1927945	1900310	1876527
			-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.1%	-0.1%
Sugar	S	480480	434801	394377	363928	339493	301558	272538	249031
			-2.6%	-1.9%	-1.6%	-1.4%	-1.2%	-1.0%	-0.9%
Wheat	N	2688487	2906401	3247713	3444680	3705267	4252945	4809337	5374436
			2.0%	2.2%	1.2%	1.5%	1.4%	1.2%	1.1%
Wheat	S	3055030	3407315	3789953	4087492	4440456	5146384	5852311	6558239
			2.8%	2.2%	1.5%	1.7%	1.5%	1.3%	1.1%
Total Northbound		**84473630**	**92181323**	**102599272**	**108300261**	**114422765**	**126657963**	**138687117**	**150073767**
Total Southbound		**123882968**	**142402548**	**160944962**	**176600436**	**191820383**	**221316342**	**250713555**	**280745441**
Grand Total		**208356598**	**234583871**	**263544234**	**284900687**	**306243148**	**347974306**	**389400672**	**430819207**
Annual % Change									
Total Northbound			**2.2%**	**2.2%**	**1.1%**	**1.1%**	**2.1%**	**1.8%**	**1.6%**
Total Southbound			**3.5%**	**2.5%**	**1.9%**	**1.7%**	**2.9%**	**2.5%**	**2.3%**
Grand Total			**3.0%**	**2.4%**	**1.6%**	**1.5%**	**2.6%**	**2.3%**	**2.0%**

6. Commodity Trade Forecasts – Demand for Expanded and Unrestricted Canals

6.1 Dry Bulk Cargoes

6.1.1 Identification and Description of By Pass Trades

By pass trades are defined here as those trades which are currently undertaken by vessels larger than those that can utilise the Canal at its current dimensions and which on the basis of mileage considerations could potentially utilise an expanded or unrestricted Canal.

These trades have been identified on the basis of:

- the consultants knowledge of global dry bulk trades and data; individual trades through the Canal have therefore been compared, where appropriate, with total trade data on the specified route;
- market research with port agents and terminal operators and investigation of ship movements data in order to determine the size of vessel utilised on these by pass trades. These include but are not limited to Westshore Terminals, T. Parker Host, Dominion Terminal, Neptune Terminals, Naves SA and Strachan Shipping.

Specific by pass trades can therefore be defined as:

- Coal: US East and Gulf Coasts to Asia,
  Canada West Coast to Europe
  Canada West Coast to East Coast South America
  South America East Coast to Asia.
- Iron Ore: South America East Coast to Asia
  Canada East Coast to Asia
  Chile to Europe
  North Brazil to Asia.

Consideration was also given to the possibility of some US grain exports constituting by pass opportunities. However, recognising that the principle Pacific North West (PNW) grains loading area cannot accommodate larger vessels than can be accommodated in US Gulf load ports and that utilisation of US ports is largely a question of grain production locations, this was not pursued. The use of panamax vessels is also a function of both receivers' facilities and receivers' requirements for specific cargo lots of up to 50,000 to 55,000 tons.

All other dry bulk trades on relevant routes are carried in vessels that can utilise the Canal at its current dimensions.

6.1.2 By Pass Trade Volumes

6.1.2.1 The total volumes of dry bulk carrier by pass trade volumes are indicated in Table 6.1.2.1 and have been calculated at 10.4 million tons in 2000 and 17.6 million tons in 2050. These exclude three of the routes indicated above, that is Canada West Coast to East Coast South America, Chile to Europe and North Brazil to Asia, where the economics of transiting the Canal are not favourable compared to the longer haul alternative once freight costs are taken into account. This is discussed further in Section 6.1.3 Vessel Economics.

Table 6.1.2.1

Dry Bulk By Pass Trades at Current Toll Levels

Year Product/Route	2010	2015	2020	2030	2040	000's tons 2050
Coal						
ECUSA to Asia						
Demand for Existing Canal	857	933	943	1,280	1,749	2,409
Additional Demand for Expanded Canal	2,571	2,799	2,829	3,840	5,246	7,228
Additional Demand for Unrestricted Canal	2,571	2,799	2,829	3,840	5,246	7,228
EC South America to Asia						
Demand for Existing Canal	32	35	35	47	64	88
Additional Demand for Expanded Canal	359	391	392	520	707	970
Additional Demand for Unrestricted Canal	423	462	466	622	849	1,171
Canada West Coast to Europe (1)						
Demand for Existing Canal	4,270	4,274	4,255	4,391	4,376	4,123
Additional Demand for Expanded Canal	3,235	3,229	3,206	3,296	3,275	3,077
Additional Demand for Unrestricted Canal	3,494	3,497	3,482	3,592	3,581	3,373
Iron Ore						
EC South America to Asia						
Demand for Existing Canal	-	-	-	-	-	-
Additional Demand for Expanded Canal	437	438	436	435	427	416
Additional Demand for Unrestricted Canal	1,441	1,551	1,655	1,838	1,994	2,131
EC Canada to Asia						
Demand for Existing Canal	-	-	-	-	-	-
Additional Demand for Expanded Canal	2,471	2,659	701	697	683	665
Additional Demand for Unrestricted Canal	2,471	2,659	2,838	3,151	3,419	3,654
Total (2)						
Additional Demand for Expanded Canal	9,073	9,516	7,565	8,788	10,338	12,356
Additional Demand for Unrestricted Canal	10,400	10,970	11,269	13,043	15,089	17,556

(1) Included in Other South to Other North
(2) Trade demand for the Expanded Canal and Unrestricted Canal respectively are each additional to demand for the existing Canal

6.1.2.2 Reference is made to Section 5.3.2 above where forecasts of US East Coast to Asia and Canada West Coast coal to Europe are discussed. Coal from South America East Coast (Colombia) to North Asia totalled around 400 thousand tons in 1999 and is anticipated to reach 1.2 million tons by 2050. Virtually all of this is by pass trade.

6.1.2.3 Iron ore exports from South America East Coast (Venezuela) to Asia (Japan) are forecast to increase from 1.2 million tons to 2.1 million tons over the forecast period. Exports from the East Coast of Canada are forecast to increase from 1.5 million tons to 3.7 million tons through 2050. All of these volumes are by pass trades.

6.1.2.4 The by pass trade carried on vessels transiting the Expanded Canal, at 9.1 million tons increasing to 12.4 million tons, is less than the total by pass trade. This is also a function of comparative vessel economics which is also discussed in Section 6.1.3 below.

6.1.3 Vessel Economics

6.1.3.1 Tables 6.1.3.1 and 6.1.3.2 illustrate the freight costs the consultants have calculated for cargo to be carried in each of the relevant size ranges for coal and iron ore respectively. These calculations have been undertaken on the basis of current (2000) average one year time charter market or other equivalent rates, for the relevant sizes, port costs, speed and consumption and cargo carrying factors. The data are derived from RLA's database of dry bulk carrier market data plus additional market research undertaken for this project.

Table 6.1.3.1

Evaluation of All Water By Pass Traffic
Representative Transportation Economics

Coal US$2000/Ton						
Ship Size (dwt)	**116990**	**142500**	**162865**	**186335**		**Mileage**
Coal: West Coast Canada to North Continent Source: Vancouver						
Via Panama - fully loaded	8.2	8.1	7.8	7.7		8,826
Via Panama - part loaded	8.4	9.3	9.2	9.6		8,826
Via Cape		10.6	9.4	9.1		15,124
Ship Size (dwt)	**73220**	**116990**	**142500**	**162865**		**Mileage**
Coal: West Coast Canada to Brazil Source: Vancouver						
Via Panama - fully loaded	18.1			12.8		8,310
Via Panama - part loaded				15.0		8,310
Via Cape	17.4			11.9		9,381
Ship Size (dwt)	**116990**	**142500**	**162865**	**186335**	**213350**	**Mileage**
Coal: USEC to Asia (North Pacific) Source: Hampton Roads						
Via Panama - fully loaded	8.6	8.4	7.8	7.3		9,473
Via Panama - part loaded	8.7	9.6	9.1	9.7		9,473
Via Cape/S. Africa		11.1	10.3	9.5	9.4	15,271
Ship Size (dwt)	**116990**	**142500**	**162865**	**186335**	**213350**	**Mileage**
Coal: Colombia to Asia (North Pacific) Source: Puerto Bolivar						
Via Panama - fully loaded	7.9	7.7	7.3	6.8		8,259
Via Panama - part loaded	8.0	8.8	8.5	9.0		8,259
Via Cape		9.4	8.7	8.4		14,234

For vessels transiting the Expanded Canal, the proposed maximum beam of 180' does not represent a material constraint. All but one vessel up to 250,000 dwt complies with this as do most of the vessels in the 250,000 – 300,000 dwt range. Only vessels in excess of 300,000 dwt generally have a larger beam. Similarly, the length overall (LOA) constraint of 1265' does not impact on any vessels in the dry bulk carrier fleet currently. It is clear however, that the critical proposed dimension is the 50' loaded draft. Most vessels in the 100,000 – 125,000 dwt range cannot comply with this although the extent to which this loaded draft is exceeded is generally marginal. On the basis of mid 2000 fleet data, RLA have calculated that vessels with an average dwt of 116,990 have an average draft of 51.4'. Further, it would not be unreasonable to assume that any new vessels built in this size range would be built to comply with a Panama loaded draft of 50' assuming that this would be announced well in advance of the completion of a major expansion.

Table 6.1.3.2

Evaluation of All Water By Pass Traffic

Representative Transportation Economics

Iron Ore						
US$2000/Ton						
Ship Size (dwt)		**162865**	**186335**	**213350**	**330775**	**Mileage**
Iron Ore: Brazil to Asia (North Pacific)						
Source: Ponta da Madeira						
Via Panama - fully loaded		10.4	9.2	9.4	7.5	10,551
Via Cape		9.9	8.6	8.7	6.7	11,977
Ship Size (dwt)		**116990**	**142500**	**162865**	**186335**	**Mileage**
Iron Ore: Venezuela to Asia (North Pacific)						
Source: Puerto Ordaz						
Via Panama - fully loaded		9.0	8.7	7.4	6.9	9,581
Via Panama - part loaded		9.0	9.4	8.2	8.7	9,581
Via Cape		9.6	9.1	7.8	7.1	13,324
Ship Size (dwt)		**116990**	**142500**	**162865**		**Mileage**
Iron Ore: East Coast Canada to Asia (North Pacific)						
Source: Port Cartier						
Via Panama - fully loaded		9.9	9.4	8.9		10,936
Via Panama - part loaded		9.9	10.2	9.9		10,936
Via Cape		10.5	9.9	9.3		14,775
Ship Size (dwt)	**73220**	**116990**	**142500**	**162865**		**Mileage**
Iron Ore: Chile to North Continent						
Source: Huasco Bay						
Via Panama - fully loaded	11.67	7.59	7.31	7.38		7,177
Via Panama - part loaded		7.59	8.36	8.19		7,177
Via Cape		7.21	6.93	6.90		9,341

Vessels in the 125,000 – 150,000 dwt range have an average draft of 55.5' and those in the size range 150,000 – 175,000 dwt have an average draft of 56.8'.

For routes/cargoes as necessary, vessel economics calculations for Panama Canal transits have been undertaken assuming that the subject vessel can be fully loaded or part loaded as necessary. The part loaded cargoes have been calculated on the basis of tons per inch (TPI) for specific vessels.

For each route/commodity, vessel economics calculations have been undertaken for the range of vessel sizes that the consultants have identified as being utilised plus, if appropriate, additional larger sizes where these would develop over time.

By pass coal from the West Coast of Canada to Europe is currently carried predominantly in vessels in the 125,000 – 150,000 dwt range and the 150,000 – 175,000 dwt range with the remainder in vessels up to 200,000 dwt. It can be seen that voyages in all of these ship sizes result in a lower $/cargo ton when vessels transit the Canal fully loaded compared to when vessels are routed round the Cape. However, fully loaded vessels in the size range of 150,000 –175,000 dwt on the Cape route result in a lower $/cargo ton than vessels in this size range transiting the Canal part loaded.

The dry bulk carriers used to carry coal from Canada West Coast to South America East Coast (Brazil) are moving predominantly in vessels in the 150,000 – 175,000 dwt range with around 25% in the 70,000 – 80,000 dwt range. Generally, vessels in the 70,000 – 80,000 dwt size range do not utilise the Canal as, even if vessels were to transit the Canal fully loaded, this is still a more expensive option than the longer route. For the larger vessels, the Cape route is still the most economic option. On this basis, no trade has been diverted under either the Expanded or Unrestricted Canal cases.

Based on Hampton Roads data, by pass coal is shipped to Asia in vessels in the 125,000 - 150,000 dwt, 150,000 – 175,000 dwt range and the 175 – 200,000 dwt range. Most of the sailings are in the two smaller size ranges. Generally, these vessels load top up cargoes in South Africa. Fully loaded vessels transiting the Canal in all size ranges are less expensive in terms of the landed cost of the product than routeing via the Cape. This means that all of the by pass trade has been included in the Unrestricted Canal case. Additionally, sailing vessels of 100,000 – 125,000 dwt fully loaded through the Canal is less expensive than the option of routeing vessels of 125,000 + dwt via the Cape. On this basis, all of the by pass trade is included in the Expanded Canal case.

Coal transported from Colombia to Asia is less expensive shipped fully laden on Cape size vessels via the Panama Canal than via the Cape. On this basis, all of the by pass trade would be routed via the Unrestricted Canal. However, large vessels of 170,000 dwt+ are less costly routed via the Cape than part loaded transiting the Canal. As a result forecast quantities via the Expanded Canal are reduced by volumes shipped in this size range.

6.1.3.2 Vessels loading iron ore at Ponta da Madeira in North Brazil encompass the full range of large dry bulk carriers from 125,000 - 150,000 dwt and above. Even assuming fully loaded vessels transiting the Panama Canal, the route via the Cape is less expensive. No other iron ore loading ports in Brazil can be considered as they do not qualify on the basis of comparative mileage.

Iron ore shipped from Venezuela to Asia is less expensive on fully loaded vessels transiting the Canal than routed via the Cape. All by pass trade is therefore included in the Unrestricted Canal case. Vessels in the 100,000 – 125,000 dwt range are also marginally less expensive than fully loaded vessels in the 125,000 – 150,000 dwt size range via the Cape. For the Expanded Canal therefore, a calculated proportion of total by pass trade is expected to transit the Canal in the smallest of the Cape size vessels.

All fully loaded dry bulk carriers transiting the Canal are less expensive than vessels routed via the Cape on the East Coast Canada to Asia route. On a part loaded basis, this relationship holds only for vessels up to 125,000 dwt. The cargo transiting the Expanded Canal is therefore reduced from the Unrestricted Canal.

From Chile to Europe there are no size ranges of vessel which are more competitive via the Canal compared to the Cape route.

6.1.4 Trade Forecasts for the Expanded Canal

These are based on a combination of total by pass trade, vessel economics, the size ranges of vessel in which by pass trades are carried and the allocation of cargoes to these size ranges. The allocation of size ranges over time is itself a function of vessel economics plus changing proportions of size ranges in the global fleet and assumptions on port developments (if any). Additional dry bulk trade through the Expanded Canal is forecast to increase from 9.1 million tons in 2010 to 12.4 million tons in 2050.

6.1.5 Trade Forecasts for the Unrestricted Canal

This is based on the same range of data and calculations as described above. Additional dry bulk trade through the Unrestricted Canal is forecast to increase from 10.4 million tons in 2010 to 17.6 million tons in 2050.

6.2 Containerised Cargoes

6.2.1 Identification and Description of By Pass Trades

By far the most important bypass trade is the US landbridge, with a section to itself. Second is the Suez Canal all water route. Others, such as the plan to move Japanese cargo to New York via the Trans Siberian Railroad and St Petersburg, which is now recognised to be a dream, are also dreams.

Suez Canal All Water Route or Reverse Landbridge:

Currently 6% of US bound traffic from Asia uses this route, but it is anticipated that use of this route could increase as the point of origin of cargo shifts from Japan and Korea to India and China. As the major destination locations are on the East Coast of America, it is likely that an increased percentage of trade could pass through the Suez and East Coast of the US, although in terms of total trans-pacific cargo, it is a small though growing market. The development of this route is being encouraged by the New York and New Jersey Port Authorities as an alternative route from Hong Kong and they see this traffic as their primary engine for growth over the next 10 to 20 years. The objective is to double the 6% of US bound traffic by 2010. The hinterland target for this business is the 10 state region around the ports, which accounts for 35% of total US import and export traffic. Of the South East Asia traffic (from Indonesia, Malaysia, Philippines, Singapore and Thailand), the US East Coast ports handled 22% in 1999, of which New York and New Jersey have 42%. (Source: Journal of Commerce)

The argument has always been that the journey takes 7 days longer and is therefore more costly in terms of time although it is 5 – 7% cheaper. There is an extra cost to Maersk customers, for example, of between $150 - $500 per container for using the rail landbridge, based on the Asia – North America Eastbound Rate Agreement (Source: USDoT). However, if the goods are coming from Singapore, using the all-water route takes the same length of time with an estimated cost saving of between US$600 and US$1,000 per container. (Source: Shipping Times).

Use of the route has certainly increased. All water trade between E. Asia and the US East coast rose to 979,000 TEU's in 1999 compared with 591,000 in 1993 and is forecast to reach 1 million this year (Source: Financial Times). The Port Authorities on the East Coast believe that the balance of route could be tipped by the inability of the West Coast ports and their intermodal landside links to handle the booming traffic and the fact that there is a better labour-management environment on the East Coast.

The Northeast Passage between Europe – Asia:

(Source: The Norway Post, Journal of Commerce)

A Conference was held in November 1999 on opening up this route as possible future competition to the Panama and Suez Canals. It would cut the distance in half and consultants in the project run by the Fridtjof Nansen Institute in Norway believe that freight costs will be reduced by 40% compared with the Suez route and 14 days' sailing would be saved. However, there are a number of outstanding issues, including:

1. Maintaining year-long opening – although the Siberian ice sheet is already shrinking – and consequent slow speeds of between 5 and 10 knots which would mean that in practise transits would be longer
2. Environmental impact
3. The need for the Russians to improve their facilities along the route
4. Ship size would be restricted to 30 metre beam and 12 metre draught.
5. The shipping lines are understandably reluctant to use the route

The general view of those attending was that the route is not yet a feasible option.

Pacific – Atlantic Highway:

An agreement has recently been concluded between El Salvador and the Honduras on the possible benefits of building a highway to complement the Panama Canal, but no date has been set for the start of construction.

Other

There have been proposals for a sea-level canal, and for a trans-isthmus railway. Neither proposal seems to represent feasible competition for the Panama Canal within the next 50 years because of the very high infrastructure costs involved.

6.2.2 Characteristics of the Trades

Table 6.2.2.1 is intended to show the range and complexity of competing objectives which are involved in carrier choice of vessels and routes. Carriers themselves, while they are very keen on monitoring all manner of variables on their trades, do not attempt to use the data so collected to forecast either their own or competitor future vessel deployments.

Cargo routing is often decided by very large US importers such as Wal-Mart and other major US retailers, who are pressuring lines to bypass the West Coast and use the Panama Canal from Asia to the US East Coast. Much of the all-water trade is for mass retailers with East Coast distribution centres, which in the recent past was moved by rail or deconsolidated at local West Coast distribution centres and then moved by domestic road or rail. Customers like Home Depot, Target Corp., Ace Hardware, Ikea, K-Mart and many others have built distribution centres near the ports of New York/New Jersey as they no longer wish to import their cargo via trans-loading facilities on the West Coast. The ports are aggressively courting the retailers and thereby attracting the lines. In addition, some importers have traditionally shipped all-water to the East Coast because of long-standing relationships with brokers and forwarders there, or simply because they do not want their cargo to go by rail.

Table 6.2.2.1

Carrier Objectives, Strategies and Constraints		
Carrier Objectives	**Carrier Strategies**	**Carrier Constraints**
Growth	Vessel policies	Fleet characteristics
Profitability	Fleet deployment	Port characteristics
Survival	Inland distribution policies	Containerline competition
Market share	Customer targeting	Modal competition
	Pricing	Government regulation
	Cost reduction	Customer objectives
	Partnership and competition	Macroeconomic factors
		Trade route factors
		Cargo characteristics

The considerations relevant to the identified constraints are shown on the right.

Partners/competitors	Customer objectives
Strategies	Price
Marketing	Performance quality
Service characteristics	Value-added services
Rate structures	
Cargo characteristics	Port characteristics
Two-way volumes	Safety
Inland locations	Equipment
Commodity values	Quality of maritime links
Equipment	Quality of inland links
	Price
	Service

Much cargo is seasonal particularly for Christmas, but this is often actually shipped throughout the year for stock as it is impossible to produce and ship the necessary amounts in just a few months. Extended transit time via the Canal is therefore not an issue. The other type of cargo is year-round, trading off between time and money. Unless the cargo is high value, the transport savings using the all-water route will more than offset the increased inventory carrying costs and as long as the all-water transit time remains reliably constant, the customer can expect time-definite delivery year-round. In many instances, all-water service is more reliable than the labour disputes, road and congestion problems, and railroad failures of using the West Coast ports. Time sensitive traffic still will move via the faster landbridge, and in fact time sensitive goods such as footwear, clothing and sporting goods declined through the East Coast ports in 1999. If the Canal decides to build larger locks, this will be seen as a direct threat to the West Coast ports.

There are specific advantages to the lines by using this route. Unexpanded, it allows lines to deploy 3,000 TEU vessels cascaded down from other routes as their vessel sizes increased. It also allows lines to offer a low value export service from the East Coast, for commodities such as waste paper, forest products and clay, which cannot support the cost of intermodal movement to the West Coast, but can improve lines' export-import balances. Lines also use the route to allow them to serve the East Coast and offer connections on to Europe and to pick up Caribbean and West Indies traffic as well. The all-water route allows them to hedge their bets against possible congestion on the West Coast and to generate a higher net income, saving at least $1,000 per container in rail costs.

Most major trans-Pacific carriers have at least one all-water service via the Canal and cargo volume on all-water services rose 65% between 1993 and 1999 to 979,000 TEUs. Cosco is developing its schedules connecting Asia, the Mediterranean and the US East Coast via the Panama Canal, rather than via the Suez Canal, which takes longer. Evergreen is looking to increase its utilisation of its Colon transhipment base. The consensus is that all-water traffic will remain viable, particularly as China develops as a major trading partner. Maersk Sealand, however, expects an increase in its East Coast traffic via the Suez Canal, which can accommodate their mega-ships, rather than via the Panama Canal. However, the Suez route will not be viable for traffic originating north of Hong Kong.

Container Cargo Characteristics On Panama Trades - Empty Container Shares And Ton/TEU Relationships

95% of empty containers are classified as 'containerised cargo', and almost all of the remainder are 'all other cargo'. There are a few hundred food, ores, and other metal cargoes. This well compares with the split for all containers - though there it is reefer rather than 'all other'.

Overall, the empty share varies quite widely, but the variations are explicable. The variation in empty share is mirrored in the total tons/all TEU relationship whose average is lowest when the empty share is highest. The same pattern is shown, in a less dramatic way, in the total tons/all TEU ratio (see Table 6.2.2.1 and Figure 6.2.2.2 below).

Table 6.2.2.2

Changes in Key Relationships, 1994/95 – 1999/2000

	94/95	95/96	96/97	97/98	98/99	99/00	Total
Empty share	11.4	12.0	13.1	18.0	16.0	14.4	14.4
Total tons / all TEU	12.0	11.6	11.7	10.9	11.0	11.5	11.4
Total tons / full TEU	13.5	13.2	13.4	13.3	13.1	13.4	13.3

However, whatever container tare weight is assumed, the real tons per loaded TEU ratio is clearly falling over the period. This is an expected result. The ratio is falling by some 0.5% per year (from 10% to 9.95% in one year). 97% of TEU are explained by the routes indicated in Table 6.2.2.3.

These are all realistic numbers. It is not reasonable to suppose that a general decline in weight/TEU applies to all routes, so that key routes have been considered individually in our model.

Figure 6.2.2.1

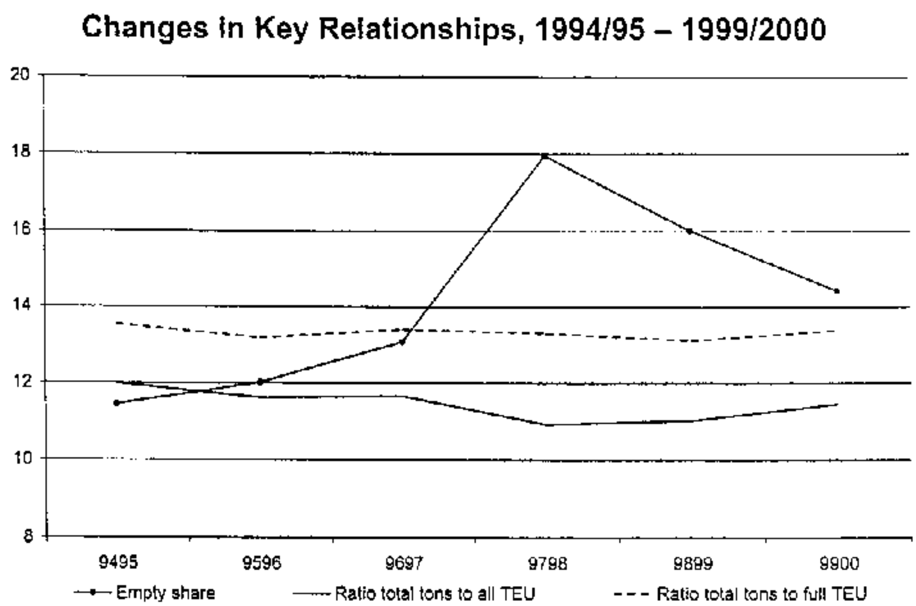


Table 6.2.2.3

Cargo Volumes on Top 15 Transits Routes, 1999/2000

Route	000 Tons	000 TEU	ton/TEU	TEU %
Other South To Other North	22554	2234	10.1	19
Asia To ECUSA	12513	1384	9.0	12
Europe To Asia	16628	1348	12.3	12
ECUSA To Asia	13591	1332	10.2	12
SOUTH (Only Direction Given)	13171	990	13.3	9
NORTH (Only Direction Given)	8317	792	10.5	7
Other North To Other South	7537	659	11.4	6
WC South Am. To ECUSA	7350	601	12.2	5
ECUSA To WCSA	7526	589	12.8	5
Europe To WC South Am.	4893	375	13.1	3
WC South Am. To Europe	5651	368	15.3	3
ECUSA To Oceania	2139	178	12.0	2
Oceania To ECUSA	2619	160	16.4	1
Europe To WCUSA	1417	101	14.0	1
Europe To Oceania	976	71	13.7	1

6.2.3 US Landbridge

From the early 1980's onwards a large part of the world cellular fleet migrated from the US East Coast – Asia route via the Panama Canal, to the US West Coast – Asia rotation. Landbridging was therefore well established in the USA before the first trains but double stack trains were crucial in developing the international landbridge following APL's first trains in 1984. Double stack trains were so efficient that container carriers increased their capacity by 44% immediately. There was therefore a gradual drift to the West Coast of most of the remaining all-water services, although of late this trend has been reversed at the margins.

In 1984, there was one weekly double-stack train between Los Angeles/Long Beach and Chicago. By 1989 there were 114 weekly and by 1996 there were 300 weekly on that route alone. The average stack train currently carries the equivalent of 280 lorries, though railroads are looking to lengthen these trains and they could soon be carrying up to 440 TEU. The double stack train between New York and Chicago, for example, consists of 100 wagons moving 400 boxes, with sizes ranging between 40 and 53 feet.

However, there are growing issues of capacity at both the terminal railheads and on the network itself. There is an acknowledged need to extend the double stack network to accommodate the forecast growth in intermodal traffic. It is worth noting that the use of double stack trains allows the railroads to gain a margin on intermodal traffic that they otherwise would not have. For those railroads which cannot double stack, intermodal is the least profitable of their businesses. Wisconsin Central, for example, moves 9.6% of its volume in intermodal, but it accounts for only 2.9% of its revenue. (Source: RGCF).

The trend in the early 1990s was for the West Coast to become more important in transpacific trade. In 1990, 72% of total trade capacity turned on the West Coast, this increased to 76% in 1992 and in 1995 rose to an estimated 80%. During this period, 92% of all transpacific vessels made at least one West Coast call. Consequently, East Coast trade fell from 28% in 1990 to 20% in 1995. The greatest concentration of capacity was in the PSW, based on Los Angeles/Long Beach and Oakland. Vessel size increased and moved to post-Panamax as standard.

Our latest research, however, reveals that since 1995 the all-water service between Asia and the East Coast of North America has recovered and that traffic volumes are expanding. Since the beginning of 2000, for instance, at least three services have been launched, involving seven separate operators. These new services comprise: Cosco/K Line/Yangming, CMA CGM/China Shipping Container Lines/P&O Nedlloyd, and Evergreen Line

Elsewhere the Grand Alliance's PAX service has been replacing ships of 3,600/4,000TEU with vessels of 4,600/4,800TEU, while several other carriers have plans to phase in larger ships in the next two years.

Over the past 30 years there have been several changes in the way the Asia/US East Coast and Mid-West regions have been served. The growth of containerisation in the transpacific trades, particularly when linked to APL's liner train concept and, ultimately the development of double stack rail services from the late 1970s onwards, led to West Coast ports gaining market share in the trade at the expense of their East Coast rivals. This situation prevailed throughout most of the 1980s and early 1990s. Indeed, several operators that had run all-water services via the Panama Canal suspended them, blaming higher operating costs and only low value cargo as moving on this route. The joint eastabout Asia/USWC/EC service of NOL, OOCL and K Line, for instance, was stopped in 1984/5.

At this time the North American railroads were focusing on attracting deepsea ocean carrier business to their rail networks, as it was considered a business with high growth potential. In addition, the train-operating companies and domestic forwarding companies were evaluating the best method of serving the domestic market. Was the piggyback trailer the best transport mode of the containers? Deals were signed up between ocean carriers, some of which set up specialist intermodal companies, and the railroads. International maritime containers started to be used to carry domestic cargo back for the East Coast and Mid-West to

California and the Pacific North West, where the containers were then reloaded with cargo for the journey back to Asia. Probably the period when the Canal suffered its biggest loss of Asia/USEC/Asia cargo was in the period between 1983 and 1995, since which time interest has been rekindled. The past two years have seen even more interest, as outlined above.

The reasons for this are capacity constraints on the North American rail system (track and railyard) capacity constraints at some USWC ports and continuing concerns over labour issues on the West Coast. Plus, there is now much less movement of domestic cargo moving in maritime containers between the eastern half of the US and the West Coast. This market is now dominated by domestic equipment, principally trailers and 48ft and 53ft domestic containers.

Hence maritime equipment is piling up in the Mid-West and the ports on the East Coast, particularly New York. Rather than paying an expensive rail move tariff back to the West Coast or wait for a suitable domestic load, if one were to be found, and run the risk of having that box tied up in the system for a much longer period of time, carriers are using the all-water connections to reposition equipment back to Asia more quickly.

Shipping lines interviewed confirmed the concerns about the US intermodal system, and the response that either the Canal was used with Panamax vessels or that the Suez routing is used. They also all confirmed that they would use larger vessels through the Canal if it were expanded, and that this would generally dissuade them from expanding their use of the Suez routing.

The information below shows how the US rail system is struggling to keep up with Asian volumes. Even based on the generic growth of the Canal transits, therefore, we expect the Canal to gain share against the landbridge.

The United States Railroad System:

Sources: USDoT US Freight: Economy in Motion 1998, American Association of Railroads, US Maritime Report of the Volpe Center 1999, Journal of Commerce, International Rail Journal, Drewry "Global Container Markets"

1. The Railroads:

The US railroads are geographically distinct, each owning the track over which it operates and in some cases, operating joint services with or operating over the tracks of, another railroads. Usually, these voluntary access agreements are reached through commercial negotiation, but if the railroads involved cannot agree, the Surface Transportation Board can require that carriers grant access over track.

There are 531 freight railroads in the US, but the top 9 carriers by gross revenue are known as Class 1s. Between them, they own 79% of the track miles, generate 94% of the revenue ton-miles and account for 90% of freight revenues. (Source: American Association of Railroads). The Class 1 carriers are Burlington Northern and Santa Fe (BNSF), Union Pacific (UP), CSX, Norfolk Southern (NS), Chicago and North Western, Illinois Central, Kansas City Southern, Grand Trunk Western and CP Rail. The last two are in fact owned by Canadian railroads.

The largest of the Class1 railroads are BNSF, UP, CSX and NS and they operate systems that facilitate traffic on an east/west, west/east basis. BNSF and UP's territories are bounded by the Pacific Ocean and the Mississippi, interchanging freight with connecting carriers in the metropolitan areas of Chicago, Kansas City and St. Louis. CSX and NS are bounded by the Atlantic Ocean and the Mississippi, also interchanging at the same locations. In addition to the major railroads, there are switching and terminal railroads which operate in specific urban areas to facilitate the interchange of rail shipments among the Class1 railroads in their area and they are often owned by the Class1 carriers.

Corridors:

There are two clear corridors in the USA:
- the North/South axis which includes Canadian-Mexico landbridge traffic and
- the West-East axis, which includes 14% share of domestic traffic and the Asia – East Coast landbridge traffic.

Route maps are provided in the section on the individual railroads.

Chicago is the major interchange point, with Kansas City and St. Louis second and third respectively. Switching can actually take place by rail or by road, and this is one of the key issues being addressed in the development of intermodal traffic across the US.

The regions that handle the most intermodal freight are California, Illinois, New York and Texas and the crucial links in the landbridge (defined as the movement of Asian manufactured goods through West Coast ports to North East America), are Chicago and Los Angeles. The constraints and bottlenecks in these areas and those on the East Coast are discussed later in the report. Other key inland intermodal hubs are Atlanta and Memphis.

Mergers:

Deregulation of the US railroads in 1980 (the 'Staggers Act) triggered massive restructuring and re-organisation, increasing competition and innovation, and lowering both rail prices and profits. Over the last few years, there have been many railroad mergers and splits, and facilities have been merged and de-merged and these changes are still occurring, the most recent being the purchase and subsequent splitting of Conrail by CSX and Norfolk Southern.

Prior to the split of Conrail between Norfolk Southern and CSX, Norfolk Southern concentrated on North-South traffic and Conrail on West-East. Conrail had a strong history of intermodal business compared with NS, and once NS bought half of Conrail, the industry anticipated significant growth in NS' container business. Some experts predict that the two competing railroads of CSX and NS could double or triple the volume of intermodal containers moving through the Ports of New York and New Jersey over the next two decades, encouraging Asian traffic to use the Suez Canal all water route. As the mergers continue, some experts within the USDoT forecast that within the next 5 years, only two major railroads could control the majority of US intermodal traffic. Union Pacific admits that it has considered merger with an East coast based railroad to create a transcontinental railroad, but that on examination parallel mergers make more economic sense. "There is very little coast to coast traffic": stated UP. (Source: International Rail Journal).

In addition to mergers and inter-railroad competitive pressures, railroads have also suffered from an increased need for capacity at the same time as they face competitive pressures to cut costs. This has particular repercussions for intermodal traffic, which in general generates lower levels of profit. Over the last two to three years, US railroads have been heavily criticised for rail service disruptions, capacity shortages and "service meltdowns", which have been in part due to merger-related adjustment difficulties and the "bunching" of container traffic during peak periods. Advanced technologies have allowed US railroads to reduce track miles and locomotives in service while carrying more freight, but now track and yard congestion is posing problems for US rail carriers for the first time in their history. In addition, they are having to manage an ageing infrastructure and deteriorating bridges.

2. **Current Intermodal Freight Flows:**

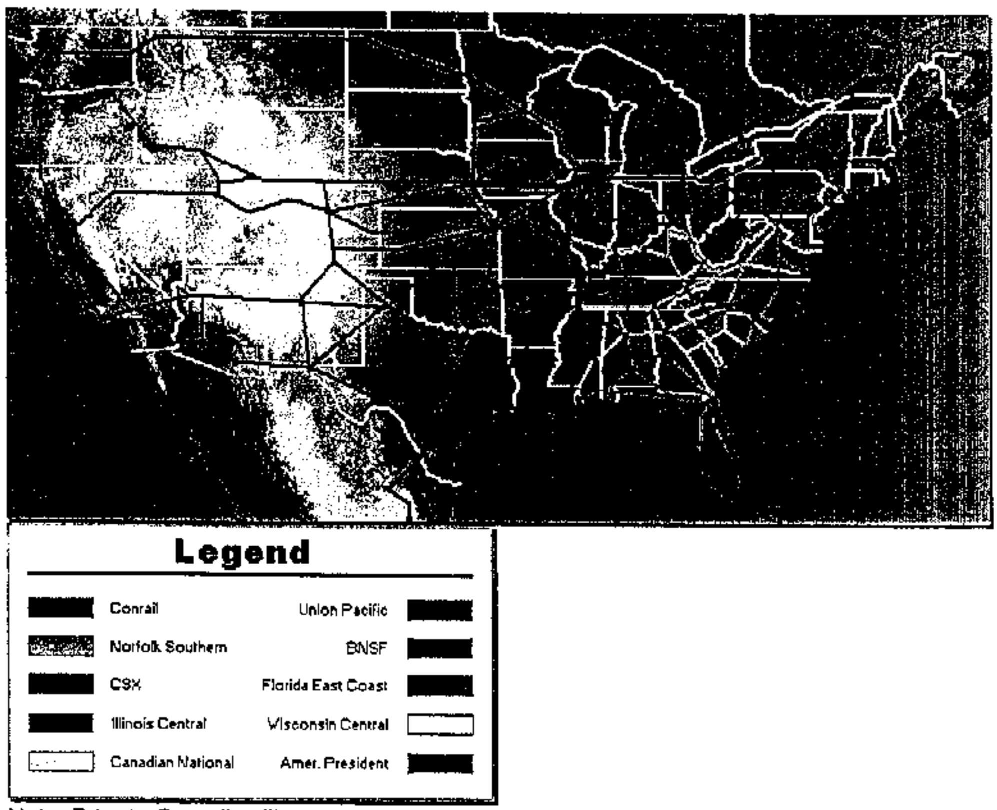
Sources: USDoT, Rail International, Revue Generale des Chemins de Fer

There are 240,000 miles of intermodal routes in the US. The main intermodal axes are from west to east, moving Pacific Rim goods via Los Angeles and Long Beach and via Seattle and Tacoma into the Mid West and East Coast for final delivery or as landbridge onto Europe.

Shipments from east to west come from Europe and Central/South America via New York and New Jersey, Hampton Roads and Charleston destined for the MidWest, the West Coast and some landbridge. Rail economies of scale apply in the US from 1,000 miles onwards.

Figure 6.2.3.1

US Intermodal Landbridge Routes by Railroad Operator

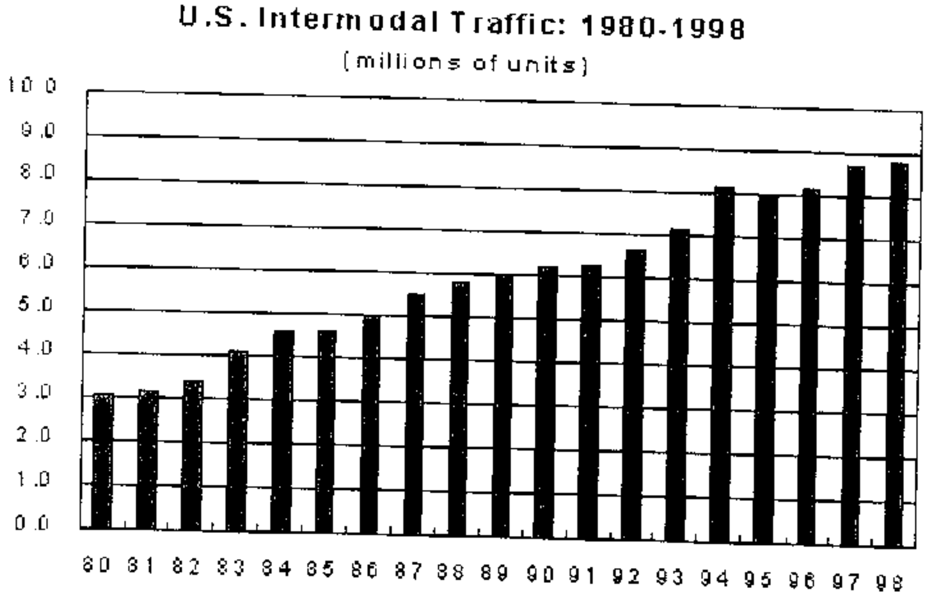


Note: Prior to Conrail split

Volumes:

Rail has 40% of the total container market in the US, and in 1998, total carryings were 5.3 million domestic and maritime boxes, the equivalent of 12 – 13 million TEUs. More than half of this total is maritime, (some sources say up to 70%), which equates to one third of all boxes being moved in and out of ports travelling on the railroads. The US has been singularly successful in developing intermodal business by rail because it consolidates its traffic on very few routes and it has a tendency to go for large investment projects. Each terminal in the US can handle between 4 and 5 times as much traffic as the European equivalent, on tracks three times as long and using engines that are incredibly powerful. The largest terminals have a handling capacity of 1 million units. Interestingly, the trains themselves travel at very low speeds and in the urban areas have major problems with level crossings.

Figure 6.2.3.2



Source: AAR

Table 6.2.3.1

Approximate Number of Containers P.A. (million, domestic and international)													
1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*	2001*	2002*
2.5	3.0	3.0	3.5	4.0	4.1	4.1	5.1	5.1	5.3	6.0	6.0	6.1	6.5

*Forecast
Source: Revue Generale des Chemins de Fer, March 1997

Trailers dominated the intermodal traffic until 1991, but by 1995 54% of the total of intermodal was boxes. Total intermodal traffic has nearly tripled since 1980 from 3 million units to 8.8 million. (Source: AAR) and international traffic has doubled in the past 10 years. Of the total, 30% is tied to international trade but this includes all commodities, e.g. coal for export as well as import containers. Growth stagnated in the mid 1990's as the railroads hit a capacity bottleneck. A sustained programme of gauge enhancements broadened the scope of the double stack network, and this together with the completion of double track programmes and terminal developments has released more capacity into the system. Railroads plan to invest US$160 billion over the next 20 years

Regional distribution of transpacific cargo in the US

An estimated 80% of eastbound transpacific cargo is destined for the Mid West or Eastern and Gulf seaboards, while 55% of west bound cargo comes from these areas. Within the US, there has been little change in origins and destinations for the cargo moving to/from Asia over time.

Table 6.2.3.2

Cargo O/D North America Estimated - % Total Trade

		Eastbound	Westbound
WCNA –	PSW	15	28
	PNW	5	16
Midwest		28	18
US Gulf		12	7
ECNA	Intermodal	24	13
	All water	16	18

Source: Drewry "Global Container Markets", 1996

Note: Availability and Validity of the Statistics:

According to the USDoT and the BTS (Bureau of Transportation Statistics), there are very little rail import and landbridge statistics available. International traffic is excluded from surveys and no information is provided on the ultimate origin or destination of containers. Sampling carried out for the Transportation Statistics Annual Report specifically excludes import traffic either as landbridge or imported on behalf of US manufacturers or wholesalers. In fact, the last data collected on inland movements of international traffic was in 1975. Various conferences have highlighted the need for this information to be available for planning purposes and the BTS has been set the objective of creating a database of this information. The objective of the Transportation Statistics Annual Report is to provide true Origin /Destination information, together with the modes of transport used, the ports used, and the volume by commodity and if containerised.

Any intermodal statistics currently provided, unless specifically stated, include both trailers on flat cars (which are mostly domestic traffic) and containers (which are mostly import/export, although domestic business is growing).

The Intermodal Association of North America provides Rail Intermodal Traffic Reports, at a cost of $600 per report.

3. Forecasts and Trends:

Sources: USDoT, Forum Proceedings, EU-US Forum Towards Improved Intermodal Freight Transport Between Europe and the US, Journal of Commerce, Intermodal Freight Movement Symposium 1996

Traffic and Routes:

By 2010, experts predict that 90% of liner freight will be shipped in containers and US intermodal traffic is expected to increase by more than 50% in the next decade. It is forecast that trips over 1,000 miles will go by rail, although at present only 40% of container traffic on the West Coast and 24% on the East Coast moves by rail. (Source: USDoT). Overall tonnage moving through US ports is expected to triple over the next 30 years, with the explosion of production capacity in southeast Asia and anticipated opening markets in China and Eastern Europe and Central and South America. At present, West Coast ports handle 85% of all inbound cargo from Asia, although volumes are growing to the East Coast with large importers such as Wal-Mart, K-Mart and Home Depot having their distribution centres on the East Coast. Many retailers no longer want to transload on the West Coast, although a large proportion of them still bring in the maritime containers from Asia to transloading facilities near the West Coast ports, then destuff and reload into domestic trailers and boxes to go east. It is likely that much of the future growth will come from East Asia, particularly China, rather than from South East Asia, and the Panama Canal is an obvious route for this traffic.

Port Facilities:

There is a growing realisation that the linking of intermodal freight for US trade corridors needs to be seamless if American ports are to remain competitive and port and terminal handling needs to be more productive. Ports that already consider themselves to be well suited to handling containers want to maximise their container throughput, which means acquiring new land and/or re-developing existing land. One of the problems is that US ports are suffering from a steady decline in the net return on investments even though ports are under considerable duress to invest heavily in new facilities for container terminals. However, the most productive US intermodal ports are not yet as productive as the best international ports by a factor of more than two to one. Ports are becoming more aggressive in seeking transportation improvements. Rail terminals are now being moved on-dock and ports are starting to look at alternatives, such as automated container trains, and moving storage yards far inland.

The impact of the mega ships is also causing concern – few US ports are equipped to handle a doubling of intermodal container traffic or the surges that would be caused by the megaships. Most ports and terminals are located in densely developed urban areas with ageing infrastructure and constrained dimensions leading to over-burdening of land demands and land requirement for containers is a key problem. Additional space for piers, container storage, railroad tracks and roads can and is being purchased and developed, but slowly and usually at a very high cost. There are opportunities to develop new Greenfield rail terminals outside metropolitan areas, but these too are costly and have significant environmental impacts. For the most part, it is anticipated that the growth in intermodal traffic will be handled through existing ports and terminals.

Techniques for increasing throughput at ports and terminals exist; some have been implemented in US ports and many more have been adopted by European and Asian ports. These include:

- Direct transhipment to feeder ships and barges
- On-dock intermodal rail transfer
- Stacking of containers
- Advanced technologies to locate containers
- Round-the-clock operations

However, improvements also need to be made to capacity outside the port gate, particularly as many road hauliers still operate only during normal business hours.

4. Network Capacity Issues:

Sources: USDoT, Forum Proceedings, EU-US Forum Towards Improved Intermodal Freight Transport Between Europe and the US, Journal of Commerce, Maritime Report 1999 and Volpe Center Report, Federal Motor Carrier Safety Administration

At Ports:

Industry and government are becoming increasingly concerned about the capacity of US ports and terminals – and the highways, rail lines and waterways that serve them – to handle steadily increasing volumes of intermodal traffic. They are particularly concerned that landside access to ports and terminals is emerging as the weak link in the intermodal freight system. Congestion on the highways and rail lines serving intermodal ports and terminals is undermining the capacity and reliability of intermodal freight services. A 1997 update of the 1991 AAPA survey showed that over one-third of ports experience major access impediments – one key issue is the lack of near-dock rail terminals that would ease the transfer of containers between rail and vessel. Only 40% of container traffic on the West Coast and 24% on the East Coast moves by rail. A 1993 Transportation Research Board study showed more than one-third of container ports did not have bridge or tunnel clearance for double-stack trains and trains tie up local traffic at half of all ports.

Rail congestion is a serious problem – in metropolitan areas, freight trains compete with passenger trains for space and time and an increase in intermodal traffic can also bring road and rail into conflict. In a number of cities, longer and more frequent trains block the highway at-grade crossings used by the drayage operators to move the containers from ports to rail terminals. Investments in rail facilities take considerable time and expense and some take decades and it is unlikely that the intermodal industry will be able to build its way out of its capacity problems in the near future. One possible short term solution would be to reallocate or redirect some traffic to less congested ports and terminals to reduce the pressure. However this may just shift the problem to other corridors, most of which are already congested, so it is unlikely the industry will be able to move around its problems. The use of more sophisticated IT systems is seen as one solution, particularly by the government.

Inland:

There is significant concern about the inland impacts of rail traffic generated by ports as the industry realises that the midwest yards and cross country mainlines are rapidly approaching capacity. The excess rail capacity that existed has been used up and further expansion is difficult and costly. Following the recent railroad mergers, some ports are not sure that the railroads are likely to have funds available in the near term at least to make large scale investments, but others feel that railroads have to be aggressive in growing their port business.

There is a huge problem in terminal capacity particularly in gateways like Chicago. A recent USDoT Maritime Report has identified the annual rail lift capacities at the major ports and intermodal hubs.

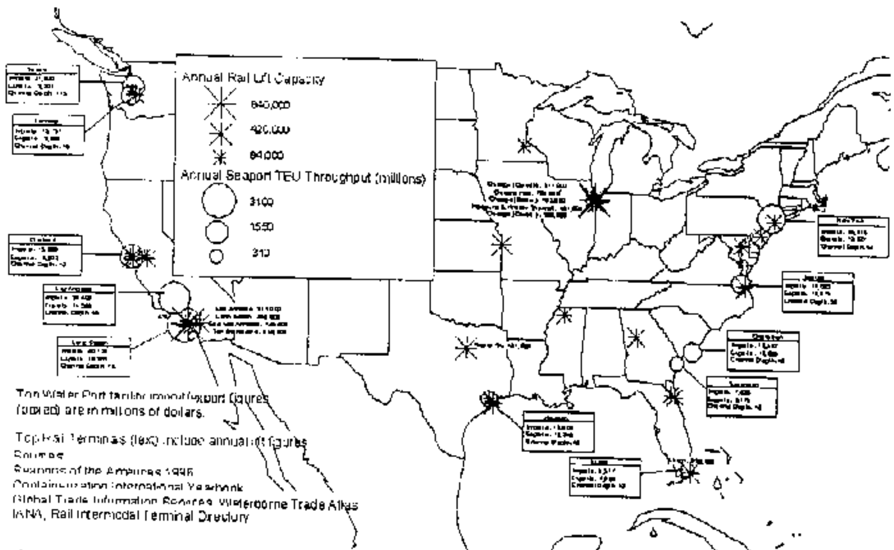
Key Issues Identified:

Following the concerns expressed, the USDoT has held regional symposia at key locations (details are in the Regional Section below), and written many reports identifying key issues to be addressed if intermodal productivity in the US is to be improved and if rail traffic is to increase.

There are operational and non-operational barriers to US intermodal development.

Figure 6.2.3.3

Annual Rail Lift Capacity



Source: US Maritime Report 1999

Non-operational:

- Concerns whether the public sector should have access to private sector traffic data, which is impeding traffic forecasting
- Short term private sector planning time-scales compared with the longer term public sector planning horizons means lack of consensus on the timescales for initiating projects and there is often a conflict with city/regional plans.
- Lack of standardised transportation regulations. There are long lead times for environmental permits, inconsistent State truck sizes and weight limits and increasing State taxes on railroads.
- Inadequate funding, although the ISTEA Act of 1991 (Intermodal Surface Transportation Efficiency Act) now gives a legislative framework for funding of (primarily domestic) intermodal investment.
- Institutional relationships need to be improved as these impede the efficient interconnection between eastern and western railroads.
- There is a lack of publicly-funded projects being able to complement private sector initiatives
- There is a lack of good labour relations when new equipment is introduced.

Operational:

- Lack of adequate infrastructure: there is a need for new large well-located intermodal terminals with new access roads. Successes have occurred when terminals have been built from ground up rather than retro-fitted from existing facilities.
- Shortage of new loading and unloading equipment to manage peak hours.
- Bridge and tunnel improvements for double stack rail clearance.
- Relieving congestion: on access routes, bridges and tunnels serving terminals and ports in large urban areas
- Better located and consolidated rail freight routes and extension of the double stack services.
- Better EDI and IT systems
- Numerous at-grade rail-highway crossings, which need to be bridged.
- Limited land for improvements
- Managing the peak time for the landbridge, which is mid September to mid October when there are often issues of intermodal railcar availability.
- Intermodal equipment is a problem, although rail rolling stock has improved with fixed stanchions and single axles and slack has been eliminated between the wagons.
- The carriers rather than the customers provide the chassis, which means special chassis are required and a large supply is needed. Chassis therefore need to be re-positioned – it would be better if chassis pools were developed around port terminals.
- Connectors between ports and rail present another series of problems.

The industry is looking to develop integrated long term partnerships between rail companies, ocean carriers and ports but future rail use could depend primarily on double stack clearance and grade crossing elimination.

Developments and Proposed Investments:

The growth in intermodal traffic during the 1990's has led to demands for investment, which now appear to be forthcoming. The Class 1 Railroads have all developed investment programmes in locomotives, terminal facilities and track doubling and clearance. The railroads' dilemma is the low profit margin, making the investments relatively high risk. BSNF is considered to be the most dynamic in its thinking. Often the optimal approach to capacity shortages and congestion lies not at the local source of the problem, but at the regional or corridor level, where strategies such as the use of feeder ports and revitalising short-haul railroads could provide the best solution.

The shuttle train principle, moving containers along dedicated rail corridors, is being examined as a possible solution to the issue of the port – rail connection. The Alameda Corridor in Los Angeles is one such: this will shuttle wagons to an inland intermodal distribution. The Alameda Corridor is a very expensive solution however. The resultant costs of $400 per lift will be five times that of a typical lift, e.g. Chicago lift costs are in the range of $60 – 70. The Corridor will in fact be a "trench" to move intermodal traffic with the minimum disturbance to local street level traffic. Ports are beginning to see the value of dedicated freight corridors designed to allow separate uninterrupted flow of vast volumes of containerised cargo to inland destinations. Hub and shuttle rail has also been proposed for cross-harbour tunnel traffic at the Port of New York to join the south Brooklyn terminals with the main rail corridors in New Jersey.

Possible Future Network:

The current pattern of rail network and terminal congestion argues for a revised or rationalised network that will build on existing lines but with radically different terminal functions and locations and a different operating scheme. Loadings from major points, such as Los Angeles, would be to major on-line destinations only, with sufficient volume to permit maximum wagon utilisation and lane density. Existing gateways such as Chicago, St.Louis and Kansas City, would be limited to local traffic only. The former rework functions of the existing gateways would be moved to rural areas with low land costs and minimal environmental impact. These would serve rail-to-rail transfer, not support local businesses, and have run through capability. Enhanced rail-to-rail transfer capability would have to be developed to support the new rework terminals and individual railroads are already moving in this direction.

6. Regional Issues:

Sources: USDoT Report "Mega Ships" 1997, Chicago Area Transportation Study (CATS), Alameda Corridor ACE Project, USDoT Local Symposia, Volpe Center, Southern California Freight Advisory Committee, Journal of Commerce, Transportation Statistics Annual Report 1995

General:

As much as 40% of West Coast international containers are handled by rail; it is lower elsewhere, between 10 and 25%, but appears to be rising. The key regions involved in international intermodal traffic are: Los Angeles and Long Beach, Chicago, New Jersey and New York, and, to a lesser extent, Seattle and Tacoma. Freight industry spokesmen in all these regions have been involved over the last two years in symposia led by the US DoT regarding specific constraints in the development of intermodal traffic in their areas. The prime motivator in these symposia has been the pilot introduction of IT systems, but each one of them has raised other operational issues.

California: Los Angeles and Long Beach Ports:

This region has the nation's largest concentration of intermodal freight container movements, with 20,000 truck trips and 29 train trips per day from the port area to Los Angeles intermodal facilities (25% of all trade entering the US by sea passes through Los Angeles and Long Beach ports and one-third of all international intermodal traffic.

Major issues of capacity constraints in this area have been raised:

- Port terminal capacity is limited and will be exacerbated by the predicted huge increases in container movements. It needs Federal funding to ease congestion.
- Moving the cargo from the marine terminals onto the highways creates major chokepoints.
- The gap between the port area and the rail terminals is 23 miles and if road vehicles are late, the container goes on the train a day late.
- Capacity could be sufficient if the port could maintain a 24 hour operation on collection and delivery of boxes

The proposed intermodal solution to these problems is the "Alameda Corridor" project. This involves consolidating 90 miles of railway track into one 18 mile rail corridor to transport intermodal freight from the Los Angeles and Long Beach ports to distribution centres in Los Angeles. Containers can then be either transhipped to road for some routes, or continue along the Alameda Corridor East for 35 miles to the Intermodal Centre, where the freight will be transhipped to road, air or continue on by rail. Final destinations by rail include: Chicago for New York, Kansas City for the Mid West and Dallas Fort Worth and Houston for the South and Mexico. The estimated cost of the project is $950 million, of which $912 million has been approved and it will take at least 8 years to complete. Upgrading the level crossings and separating the road and rail movements in the area is a priority.

The basis for this project is the forecast that 25% of all US waterborne international trade with the Pacific Rim will enter through the Long Beach and Los Angeles ports and that this trade will double by 2020. This means an estimated increase of 67% in rail movements and of 40% in road movements. (Source: Alameda Corridor Project). Train traffic volume forecast for the route between the first major junction and the Intermodal Terminal indicates maximum weekday volumes of:

Table 6.2.3.3

Forecast Maximum Weekday Volumes on the Los Angeles Intermodal Centre Route		
Year	**No. of trains via the southern route (previously Union Pacific)**	**No. of trains via the northern route (previously Southern Pacific)**
1994	15	33
2010	21	46
2020	23	51

Source: Alameda Corridor Project

There are also options being examined to consolidate three rail freight lines operating between downtown Los Angeles intermodal facilities, where the corridor will terminate, and the eastern end of the Southern Californian Basin (San Bernardino), to enhance the region's ability to manage the flow of international trade goods, but the rail and shipping companies are concerned that this would lead to a potential loss of control over shipping schedules.

Oakland:

BNSF has had no near dock access to the port and must road 11 miles to reach the rail head. It is looking to build on dock ship to rail transfer facilities.

Chicago:

Chicago is the major inland intermodal hub, where eastern and western rail carriers meet. Nearly half the nation's intermodal rail shipments originate, terminate or connect there. There are 23 major intermodal yards plus 3 car transloaders and 5 clusters of freight facilities. The "average" intermodal facility moved 200,000 container p.a. in 1997, the largest moved 670,000. 2.5 million tonnes of freight is moved daily in Chicago. The main problem for Chicago, and the railroad network as a whole, is the significant congestion, both in terms of local road vehicle movements in and out of the yards, and the concentration on a small number of routes between rail yards. Inter-railroad connections are often by road rather than rail, and within a highly urbanised area. In the short term, Chicago has been looking for funds to improve connections between intermodal facilities and highways, but it could be that in the longer term a multi-user intermodal terminal near the city permitting rail-rail connections would be required.

The Symposium listening group for Chicago considered the following as impediments to intermodal growth through Chicago:

- Local and corridor data is weak; up to one third of traffic could be "rubber tyre" exchange, though Union Pacific thinks it is mostly "steel wheel", which can take up to 3 days. A container interchange can often be missed in Chicago, thus missing a sailing window in Baltimore.

- There are operational problems in the terminals, e.g. ramping problems and the need to shuffle boxes and chassis.
- When the decisions are taken to switch service / mode train matching can be a problem.
- There are driver shortages, particularly at night.
- There are 1,946 at-grade crossings creating safety and congestion problems.
- It is still difficult to predict train arrival times and there is a lack of information about container dwell times at terminals.

New York and New Jersey Ports:

Freight volumes through the region are forecast to double by 2040 but the region does not have the space or funds to build extensive new terminals, rail yards and road terminals. In addition, the proposed introduction of mega ships is going to strain the capacity of the port and customs operations. There is also concern that the forecast growth in volume of intermodal traffic post sale of Conrail may strain the capacity of the existing intermodal rail terminals and related facilities. The increased railroad competition could mean in practise increased railroad congestion unless there is additional capital investment. Port Elizabeth and Port Newark are particular bottlenecks. The US ports compete heavily with Montreal and Halifax.

North West Coast and Puget Sound:

Puget Sound is girded by water, making it difficult to accommodate growth through expanded transportation facilities. Within the ports, gates are often congested and port operating hours are limited; the ports need people who work beyond 9 – 5 and who will work when the ship arrives. Labour shortages in the region drive up the cost of off-peak and weekend port operations. Containers are lost in port and rail terminals, and the holding time is too long. BNSF are looking at on-dock rail operations, and the Port of Tacoma has started a mainline rail capacity study, but the Port of Seattle has real problems with local street access to the terminals and port. The freight industry finds it hard to get Seattle politicians to understand how changes in intermodal operations in Chicago affect them in Puget Sound and that they need to spend money.

The main railroad network also has problems: the ability to improve freight rail service at higher speeds has been made problematic by large numbers of at-grade highway rail crossings – grade separation work in Washington State alone was projected to cost $900 million. The crossing issue affects the possibility of moving 8,500 foot trains. Also, the northern tier rail service in the US is less reliable in winter than through Canada, which has better track maintenance. Cargo is moving via Vancouver due to inadequate US rail services and Delta Terminal transports 75% of its intermodal freight by rail. The Canadian rail system parallels that of the USA and runs interrupted from Halifax in the east to Vancouver in the west. Delta Terminal also has rail connections through Minnesota to Chicago. The US rail industry estimates that as many as 350,000 containers p.a. destined for Montreal and Halifax could go to US ports.

6.2.5 Vessel Economics

Voyage costing is important to all shipowners because it determines whether or not a particular voyage will be profitable. It is crucial for tramp shipowners, because it determines routing and is a guide to fixing price offers.

Voyage costing is less relevant to liner operators in either of these respects, as routes and port calls are largely fixed, and because prices are determined in historical markets. Even new entrants on a route would not need to think very hard about what ports to call, or what rates to charge

Unlike most tramp vessels, liners carry very large numbers of consignments, each with different origin/destinations, and having different inland distribution costs. Because liner cargoes have inland origins and destinations, least cost through transport suggests that:

- inland distribution costs (road, rail, inland waterway) must be taken into account
- there is a choice of ports for the same inland markets

As considered elsewhere, customers may be more sensitive to service quality than price, so that the lowest cost shipping alternative may not be preferred.

For liner operators, cargo prices bear no direct relationship with ship costs because:

- some cargo is priced door to door, so that modal cross subsidisation is possible
- container markets can be differentiated by commodity or commodity characteristics
- freights may include the prices of additional 'quality' services
- carriers may choose to direct cargoes along certain routes
- cargo is accepted at less than carrying cost because it makes a marginal contribution

Costing liner services consequently differs from costing tramp voyages in that costs relate to:

- services including several ships, not just one
- services have more rigidly structured vessel deployments
- non revenue earning empty containers must be repositioned on land and at sea

Furthermore, in determining overall service profitability, revenue is not easily attributable, because services are increasingly interlinked into a global web.

The fundamental objective of carriers is to provide at least one fixed day weekly service between ports at either end of a shipping route for their market share of the given volume of trade on the route. This objective largely fixes the number of vessels on the service and their average size.

Vessel speed and port times allow some flexibility, but the same objective also determines the number of ports which can be called overall. Depending on the route, the number of ports can be increased by increasing the fleet size. The route itself can be redefined (by including or excluding countries or port ranges) to change the nature of the service - number of vessels etc.

Ports are chosen because they are well located for the cargo sources or destinations on a through-cost basis. The basic rule of shipping cost is that other things being equal **water transport is always substantially cheaper than land transport.** This appears to be from economies of scale: a ship carries perhaps 4,000 TEU while a railway train carries 70 and a haulier 2. Although this suggests that it is always economic to use water rather than land, this is a misleading conclusion. The relevant comparison is not the ship size but the number of containers which might be exchanged at a particular port. For example, a ship would not extend a European itinerary from Hamburg to Gothenburg for ten containers because the whole cost of the additional voyage, plus the decrease in the annual capacity of the service caused by voyage time, would be borne by them alone.

Extension of a route is clearly more expensive than a small diversion, such as from Hong Kong to Shekou. Even so, the diversion has to be worth it. Usually the container exchange required to divert a vessel will be 10-20% of the overall vessel capacity.

Transhipment

If a port is not worth a diversion it may become a feeder port, but typically only if it cannot be equally well served by road, or sometimes rail. A feeder move requires a container to be hauled by road to a port, then loaded onto a vessel which transports it to the hub port for transhipment onto the mainhaul vessel. There is a road haulage cost and the cost of two extra lifts, all of which generally cost much more than the actual water movement. **It is usually simpler, cheaper, and faster for a container consolidated inland to move to the hub port overland, *if an adequate road system exists.***

Feeder seaports are normally linked to hub ports by a water transfer only when:

- the condition of an adequate road system does not exist, leading to unacceptable road costs or service quality
- the movement is very long; or
- the transhipment is between major seaports.

Ports aim to become hub ports to generate more business, partly because they achieve two lifts per container for transhipped cargoes, and partly because they tie up one or more mainhaul services. Shipping lines prefer to use ports with significant amounts of local cargo as hubs, because the more containers they can exchange at a particular port the more economic that call is.

Hub ports which do not have significant amounts of hinterland cargo are therefore rare, and their success is always due to their geographical location, either at a junction of major routes - North Europe/Far and Mid East, North Europe/West Africa, North Europe/Mediterranean, North America/Mid East, and North America/Mediterranean services all meet at Algeciras (Spain); or surrounded by smaller ports none of which justify a direct call and all of which require a diversion of the mainhaul vessel - Singapore with its links to south Asian ports, and Marsaxlokk (Malta) with its links to eastern Mediterranean ports are examples.

Hub ports without local cargo are seriously at risk from a growth of trade with their feeder hinterlands because at some point carriers find that a direct call at one of the feeder ports is worthwhile. As soon as this happens the hub port will lose not merely that feeder port's cargo, but also some of the rest, as feeder ships are directed to the new, nearer hub port.

They are protected by:

- their range of services. A new hub port cannot compete on service range but can compete on price, so that its success depends entirely on the sensitivity of its customers to this aspect of shipping service; and
- the quality of the port infrastructure. Feeder ports present carriers with a large variety of operational, labour, and physical problems, and possibly concerns about the safety of their ships, so that even when a move is indicated by through cost calculations the carrier stays with a port it can trust.

These are among the considerations carriers take into account when planning services. They are particularly relevant to the issue of future containership size, as carriers are coming to the limits of available port draft even after dredging. They are also relevant to the possibility that trade will be concentrated into new corridors which could particularly benefit the Canal.

In forecasting for all Cases, we have not attempted to model container services. It is sufficient to observe the actual behaviour of carriers around the world when faced with new opportunities resulting either from trade expansion or from the provision of new ports or port facilities, and make qualitative judgements, based on interviews with carriers, on their response to developments of the US landbridge and the expansion of the Panama Canal.

6.2.6 Trade Forecasts for the Expanded and Unrestricted Canals

Enlargement of the Canal would have no impact on cargo volumes on many routes. It would, however, impact on eight of the major routes identified, and these were considered individually. They were:

- Asia to ECUSA
- ECUSA to Asia
- ECUSA to WC South America.
- Europe to WCUSA
- Other North to Other South
- Other South to Other North
- WC South America to ECUSA
- WCUSA to Europe

Some cargo on each of these routes is currently conveyed over the landbridge, either from east to west or vice versa. The increased competitiveness of all-water services following enlargement of the Canal will increase the Canal share of the overall trade.

Landbridge data and JOC data on East and West Coast port shares were considered, together with evaluations of the general ability of the landbridge to compete in the face of increasing volumes of cargo. The shares of US regional container cargoes currently carried both by landbridge and by water were estimated using these data sources together with ACP statistics, and an assessment of the increase in Panama share resulting from enlargement made. The impact of this development on Panama TEU throughput on the target routes was then calculated.

The Containerised Tonnage Forecast.

For the containerised tonnage forecasts, the proportional increases calculated for the TEU forecasts were applied.

The Containerised Cargo Tonnage Forecast By Route And Vessel DWT Category.

The effect of enlargement on individual routes in Case 2 was considered in terms of the existing distribution of vessel sizes, the nature of services on the routes, and the expected strategic response of container carriers to enlargement. The main groups of larger existing and predicted containership TEU size ranges were identified as around 6,500, 8,000, 10,000, and 11,500 TEU, and historic data on TEU/DWT ratios were used to estimate future DWT ranges. New traffic was allocated to post-panamax vessel size groups on the basis of trade volumes on the route - larger vessels were justified by larger annual TEU throughputs. These allocations were entirely qualitative, as there is no historic data available on the probable deployment of as yet unbuilt sizes of ship on routes that were hitherto unavailable.

It has been assumed that the expanded Canal would be opened in 2010, and that all cargo which could use the Canal under the 2050 market share assumption would be immediately available, as would the vessel sizes appropriate to that flow.

Panama Trades, Existing Canal

Table 6.2.6.2 shows how the total tonnage of container cargoes transiting the Panama Canal, carried by all ship types, was allocated by route in 1998/99.

The top 5 outbound origins, East Coast USA, Atlantic: Asia, North Pacific: West Coast South America: Europe: and Other South, accounted for 85% of the total. The top 5 inbound destinations, East Coast USA, Atlantic: Asia, North Pacific: West Coast South America: Europe: and West Coast USA, accounted for 75% of the total.

Sixteen 'routes' of the 324 shown in the table account for over 90% of the total tonnage. However, these routes are one-way. Thus, just two 'routes' which account for 39% of the total are in fact the east and westbound lanes of the same, two-way, route, between Asia North Pacific and East Coast USA. The second most important actual route is between Europe and West Coast USA, with 9%, and the third between Europe and West Coast South America (7%). The fourth, with 6%, is between East Coast USA and West Coast South America.

Non-specified routes account for 12% of the total tonnage. Many of these cargoes are likely to be carried on ships with cargo on the specified routes.

Table 6.2.6.2 shows containership shares of total container tonnages by origin and destination Shares range from 2% to 100%, but as Table 6.2.6.1 shows, the lowest share among the 'major' routes is 63%, on Europe/Oceania. Overall, containerships account for 91% of containerised cargo, and the only significant route which still shows a high (26%) non-containership share is Europe/ West Coast South America.

Table 6.2.6.1

Container Cargo Tonnage 1998/99 by Route (000's tons) and Container Ship Share (%)

Origin	Destination	Tonnage	Share	Container ship share
EC USA, Atlantic	Asia, North Pacific	6628	20	100
Asia, North Pacific	EC USA, Atlantic	6110	19	95
Other South	Other North	2303	7	96
Europe	WC USA	2265	7	94
Other North	Other South	1605	5	91
WC South America	Europe	1549	5	74
WC South America	EC USA, Atlantic	1418	4	92
WC USA	Europe	1265	2	95
Europe	WC South America	1138	2	68
EC USA, Atlantic	WC South America	1019	2	81
Europe	Oceania	705	2	63
WC South America	EC Central America	640	2	89
Oceania	EC USA, Atlantic	582	2	100
EC South America, Caribbean	WC South America	580	2	77
EC USA, Atlantic	Oceania	547	2	83
WC South America	West Indies	500	2	88

Table 6.2.6.2

Containerised Cargo Tonnages by Origin and Destination 1998/99 (000 tons)

ORIGIN	EC USA, Atl	Asia, NPac	WCSA	Europe	WC USA	Other North	Other South	Ocea-nia	West Indies	ECCA	EC USA, Gulf	ECSA, Car	EC CAN	WCCA	Asia, SEA	ECSA, Atl	Asia, IndSub	Africa	WC CAN	Grand Total
ECUSA, Atl		6626	1019		76			547						12	36		3		1	8322
Asia, NPac	6110								404		106		156							6776
WCSA	1418			1549					500	640	332	447				7				4894
Europe		71	1138		2265			705						47	0				11	4238
Other South						2303														2303
Other North							1605													1605
WCUSA	92			1265							6							0		1365
West Indies		248	480		71										1					801
Oceaia	582			6						12	46		6							651
ECSA, Car		6	580		90									1	1		0		6	683
ECUSA, Gulf		108	345		10			162						10	20				1	655
ECCAN		345													0					345
WCCA	11			138							1	35				0				185
Asia, SEA	142								0		28									170
ECSA, Atl			11		1															12
ECCA														7					0	7
Asia, IndSub	4										1		0							5
Africa								0												0
Grand Total	8359	7405	3573	2959	2514	2303	1605	1415	904	652	519	483	162	77	59	7	3	0	19	33017

Table 6.2.6.3

Containership Shares by Origin and Destination %

ORIGIN	EC USA, Atl	Asia, NPac	WCSA	Europe	WC USA	Other North	Other South	Ocea-nia	West Indies	ECCA	EC USA, Gulf	ECSA, Car	EC CAN	WCCA	Asia, SEA	ECSA, Atl	Asia, IndSub	Africa	WC CAN	Grand Total
ECUSA, Atl		100	81		93			83						100	97		100			96
Asia, NPac	95								97		65		99							95
WCSA	92			74					88	89	79	67				90				82
Europe		99	68		94			63						100	92					82
Other South						96														96
Other North							91													91
WC USA	99			95							88							95		95
West Indies		97	96		100										100					97
Oceania	100			2						98	91		100							98
ECSA, Car		100	77		95									100	100		100			79
EC USA, Gulf		86	59		66			87						100	35					70
ECCAN		100													100					100
WCCA	94			96							29	47				100				86
Asia, SEA	42								100		23									39
ECSA, Atl			97		100															98
ECCA														100						98
Asia, IndSub	100										100		100							100
Africa								59												59
Grand Total	94	99	76	84	94	96	91	74	92	89	74	66	99	100	76	90	100	95		91

Trends 1994-2000

Container cargo tonnages transiting Panama increased from 27 to 33 million tons over the five years 9495/9899, and the top five two-way routes marginally increased their share of the total over the period from 75% to 77%. The fastest growing two-way major route was the unspecified North/South, which, as Table 6.2.6.5 shows, increased its share of the total from 7% to 12%.

Table 6.2.6.4

Growth in Container Volumes by Route 1994-99 (000 tons)

Route	9495	9596	9697	9798	9899
EC USA, Atlantic/Asia, North Pacific	10206	10440	11025	11687	12738
Other South/Other North	1907	2456	3012	3728	3908
Europe/WC USA	3103	3009	3221	3319	3531
WC South America/Europe	2391	2640	2625	2098	2687
WC South America/EC USA, Atlantic	2524	2661	2808	2486	2437
Others	6680	6603	6600	7807	7716
Total	**26811**	**27809**	**29292**	**31125**	**33017**

There were significant changes in the balance of trade on all routes. For instance, the northbound share of the Other South/Other North route declined from 73% to 59%.

Table 6.2.6.5

Shares of Container Volumes by Route 1994-99 (%)

Route	9495	9596	9697	9798	9899
EC USA, Atlantic/Asia, North Pacific	38	38	38	38	39
Other South/Other North	7	9	10	12	12
Europe/WC USA	12	11	11	11	11
WC South America/Europe	9	9	9	7	8
WC South America/EC USA, Atlantic	9	10	10	8	7
Others	25	24	23	25	23
Total	**100**	**100**	**100**	**100**	**100**

Even over the relatively short period studied, containerships markedly increased their share of container carryings in tonnage terms, from 80% to 91%. The trend was similar for all five major routes identified, and it is clear that these routes are not unrepresentative.

Table 6.2.6.6

Containership Shares of Container Volumes by Route 1994-99 (%)					
Route	**9495**	**9596**	**9697**	**9798**	**9899**
EC USA, Atlantic/Asia, North Pacific	94	95	98	97	98
Other South/Other North	70	80	86	90	93
Europe/WC USA	92	93	92	94	95
WC South America/Europe	67	69	72	88	78
WC South America/EC USA, Atlantic	82	84	86	93	94
Total	**80**	**82**	**84**	**88**	**91**

6.2.7 Summary

It is expected that there would be no difference in the additional containerised cargoes attracted to the Canal under the Expanded and Unrestricted Cases. The additional quantities are shown in Table 6.2.7.1. Overall, the amount of containerised cargo would increase by almost 15 million tons – an increase of 29.8% versus the generic growth of the trades via the Canal – in 2010 and by 16.8 million tons (+29.0%) and 20.6 million tons (+27.5%) in 2020 and 2050 respectively.

Around 90% of this additional cargo is estimated to come from just the four routes between Asia to ECUSA and between Europe and WCUSA, with 70% on the each way trades between Asia and the ECUSA.

Table 6.2.7.1

Expanded and Unrestricted Canal - Additional Containerised Cargoes						000's tons
	2010	**2015**	**2020**	**2030**	**2040**	**2050**
Asia to ECUSA	4461	4815	5129	5704	6097	6405
Other South to Other North	200	225	249	293	328	359
WC South Am. To ECUSA	459	521	579	687	773	848
WCUSA to Europe	1071	1129	1181	1285	1362	1428
ECUSA to Asia	6216	6487	6734	7233	7589	7898
ECUSA to WC South Am.	459	521	579	687	773	848
Europe to WCUSA	2030	2137	2236	2430	2573	2698
Other North to Other South	93	103	113	131	145	158
Total Northbound	**6191**	**6690**	**7138**	**7970**	**8560**	**9041**
Total Southbound	**8798**	**9249**	**9662**	**10482**	**11081**	**11602**
Grand Total	**14988**	**15939**	**16800**	**18452**	**19641**	**20643**

6.3 Oil and Orimulsion

6.3.1 Introduction

The patterns of oil flows into and out of the W.Hemisphere are such that enlargement of the Canal is unlikely to result in a significant change in the amounts of conventional crude oil and petroleum products being shipped through the Canal compared with the generic growth in the Canal transits. Shipments from the two potential sources of rising crude oil exports from the region – Mexico and Venezuela – are expected either to be concentrated on routes which do not represent by pass trades or will continue to move to short haul destinations in the Americas via the Canal in Panamax vessels. In the latter cases, an enlarged Canal would simply permit the transit of slightly larger tankers without necessarily increasing the volumes of trade versus the generic growth in the trade via the Canal.

6.3.2 Orimulsion

The one potential growth area is Orimulsion from Venezuela. Orimulsion is PDVSA BITOR's patented boiler fuel whose composition is a 70% suspension of bitumen in water. The product is carried in conventional tankers and classified by ACP as a petroleum product. Currently some 1.5 million tons of Orimulsion are exported to Asia and although some quantities are currently still shipped in Panamax vessels via the Canal an increasing proportion of shipments are made in larger tankers up to VLCCs of 280,000 dwt and above. Table 6.3.2.1 provides a breakdown of shipments into Asia. Indications are that cargoes in Panamax tankers will fall even further in the future, possibly to the equivalent of just one transit a year in three or four years' time.

It is estimated that future exports to Asia could reach up to around 15/16 million tons by 2020 but it is likely that these will be moved in either Suezmax (up to around 165,000 dwt) tankers or VLCCs. In any event, if the Canal remains at its existing dimensions it will not capture any of this additional business and will lose most, if not all, of its current Orimulsion trade in Panamax tankers.

Some of the additional quantities of Orimulsion are expected to be moved to countries located in S E Asia, for which the Panama Canal would still not represent the most economic route, even if it were enlarged. For both Singapore and Thailand, the Suez Canal rather than Panama represents the shortest route while the route via the Cape of Good Hope is either shorter or sufficiently close in mileage to make the Panama Canal less economic after taking into account tolls.

With the proposed maximum vessel dimensions for the Expanded Canal at 180 ft beam, 50 ft draft and 1,265 ft loa, VLCCs would not be able to transit the Canal. For Suezmax tankers the main issue would be draft. Typically a modern tanker of around 160,000 dwt would have an loa of 890 ft and a beam of 159 ft. However the draft would be around 56ft. As a result, under the Expanded Canal conditions it is assumed that a slightly smaller vessel of around 140,000 dwt would be employed in order to meet the draft restrictions.

Tables 6.3.2.2 to 6.3.3.6 show the estimated freight costs for Orimulsion shipments to Thailand, the Philippines, Taiwan, S Korea and China. Costs for Japan are not shown simply because they give similar results to those for S Korea and China. Comparisons are made between Panamax, small Suezmax and VLCCs via the Panama Canal versus larger Suezmax tankers and VLCCs via the Cape of Good Hope.

For Thailand, for each vessel size, the alternative routing of the Cape of Good Hope provides the more economic option. The conclusions for the Philippines are similar although for VLCCs the difference is relatively small. For the Expanded Canal the differential for

Suezmax tankers would be larger in favour of the Cape route due the limit on the size of vessel permitted through the Canal. For Taiwan, S Korea and China there are clear incentives to use the Canal except when comparing the freight costs for Panamax tankers versus larger tankers via the Cape.

After making allowances for some future sales to be made in S E Asia, with an unrestricted Canal it is estimated that almost 12.5 million tonnes of Orimulsion could be diverted via the Canal in 2020 as compared with the generic growth in trades via the Canal. However, since most of this would be likely to be moved in VLCCs, expansion of the Canal to accommodate a small Suezmax tanker of around 140,000 dwt would only attract an additional 1.9 million tons from 2010.

Table 6.3.2.1

Orimulsion Exports to Asia, 1991-2000

Year	Total Quantity	Of which Panamax	Panamax as % of Total
		tons	%
1991	382,000	382,000	100%
1992	546,000	546,000	100%
1993	634,000	634,000	100%
1994	531,000	531,000	100%
1995	850,000	589,000	69%
1996	1,003,000	553,000	55%
1997	1,277,000	443,006	35%
1998	605,000	140,042	23%
1999	957,000	283,391	30%
2000	1,507,390	219,445	15%

Table 6.3.2.2

Estimated 2000 Orimulsion Freight Costs

Trade: JOSE - THAILAND (BANGKOK)
Route: DIRECT (VIA CGH)
Freight Basis: 1 YR T/C & Total Operating Costs
Vessel Size: 70,000; 140,000; 160,000 dwt & 280,000 DWT

Year		2000 via Canal	2000 via Canal	2000 via CGH	2000 via Canal	2000 via CGH
Vessel Size (Dwt)		**70,000**	**140,000**	**160,000**	**280,000**	**280,000**
Time Charter Period		**1 Year**	**1 Year**	**1 Year**	**1 Year**	**1 Year**
Stores, Water, etc (Tonnes)						
Bunkers (Tonnes)						
Cargo (Tonnes):		66,500	133,000	152,000	266,000	266,000
Speed (Kts)		13.8	13.5	13.5	13.5	13.5
Fuel Consumption (tpd):						
Fuel Oil:	At Sea	31.0	51.0	52.5	60.0	60.0
	In Port	8.0	14.0	14.0	14.0	14.0
MDO:	At Sea	1.5	3.1	3.1	4.1	4.1
	In Port	1.5	3.1	3.1	4.1	4.1
Single Voyage Miles		11,595	11,595	11,858	11,595	11,858
Days At Sea		70.0	71.6	73.2	71.6	73.2
Port Days:	Jose	1.0	2.0	2.0	2.5	2.5
	Tsingtao	2.5	3.0	3.0	3.5	3.5
	Canal	2.0	2.0		2.0	
	Total	5.5	7.0	5.0	8.0	6.0
Total Voyage Days		75.5	78.6	78.2	79.6	79.2
Charter Rate ($/Day)		17,850	28,100	29,950	37,700	37,700
Bunker Prices ($/Tonne)						
	Fuel Oil	158.7	158.7	158.7	158.7	158.7
	MDO	249.5	249.5	249.5	249.5	249.5
Voyage Costs:						
		$	$	$	$	$
Charter Hire		1,347,998	2,207,931	2,342,016	2,999,943	2,985,747
Bunkers:	Fuel Oil	351,451	594,852	620,973	699,303	710,318
	MDO	28,263	60,773	60,482	81,400	81,015
Port Charges:	Jose	44,500	55,800	55,800	78,900	78,900
	Bangkok	11,130	13,950	15,350	19,750	19,750
Canal Dues		144,892	280,104	0	524,065	0
Total		1,928,234	3,213,410	3,094,620	4,403,360	3,875,730
Freight ($/Tonne)		29.0	24.2	20.4	16.6	14.6

Table 6.3.2.3

Estimated 2000 Orimulsion Freight Costs

Trade: JOSE - PHILIPPINES (SUBIC BAY)
Route: DIRECT (VIA CGH)
Freight Basis: 1 YR T/C & Total Operating Costs
Vessel Size: 70,000; 140,000; 160,000 dwt & 280,000 DWT

Year		2000 via Canal	2000 via Canal	2000 via CGH	2000 via Canal	2000 via CGH
Vessel Size (Dwt)		**70,000**	**140,000**	**160,000**	**280,000**	**280,000**
Time Charter Period		**1 Year**	**1 Year**	**1 Year**	**1 Year**	**1 Year**
Stores, Water, etc (Tonnes)						
Bunkers (Tonnes)						
Cargo (Tonnes):		66,500	133,000	152,000	266,000	266,000
Speed (Kts)		13.8	13.5	13.5	13.5	13.5
Fuel Consumption (tpd):						
Fuel Oil:	At Sea	31.0	51.0	52.5	60.0	60.0
	In Port	8.0	14.0	14.0	14.0	14.0
MDO:	At Sea	1.5	3.1	3.1	4.1	4.1
	In Port	1.5	3.1	3.1	4.1	4.1
Single Voyage Miles		10,281	10,281	12,173	10,281	12,173
Days At Sea		62.1	63.5	75.1	63.5	75.1
Port Days:	Jose	1.0	2.0	2.0	2.5	2.5
	Tsingtao	2.5	3.0	3.0	3.5	3.5
	Canal	2.0	2.0		2.0	
	Total	5.5	7.0	5.0	8.0	6.0
Total Voyage Days		67.6	70.5	80.1	71.5	81.1
Charter Rate ($/Day)		17,850	28,100	29,950	37,700	37,700
Bunker Prices ($/Tonne)						
	Fuel Oil	158.7	158.7	158.7	158.7	158.7
	MDO	249.5	249.5	249.5	249.5	249.5
Voyage Costs:						
		$	$	$	$	$
Charter Hire		1,206,363	1,980,009	2,400,252	2,694,154	3,059,052
Bunkers:	Fuel Oil	312,414	529,203	637,173	622,069	728,833
	MDO	25,293	54,500	61,986	73,103	83,004
Port Charges:	Jose	44,500	55,800	55,800	78,900	78,900
	Subic Bay	29,130	36,520	40,200	51,640	51,640
Canal Dues		144,892	280,104	0	524,065	0
Total		1,762,592	2,936,135	3,195,411	4,043,930	4,001,429
Freight ($/Tonne)		26.5	22.1	21.0	15.2	15.0

Table 6.3.2.4

Estimated 2000 Orimulsion Freight Costs

Trade:	*JOSE - TAIWAN (KAOHSIUNG)*
Route:	*DIRECT (VIA CGH)*
Freight Basis:	*1 YR T/C & Total Operating Costs*
Vessel Size:	*70,000; 140,000; 160,000 dwt & 280,000 DWT*

Year		2000 via Canal	2000 via Canal	2000 via CGH	2000 via Canal	2000 via CGH
Vessel Size (Dwt)		**70,000**	**140,000**	**160,000**	**280,000**	**280,000**
Time Charter Period		**1 Year**	**1 Year**	**1 Year**	**1 Year**	**1 Year**
Stores, Water, etc (Tonnes)						
Bunkers (Tonnes)						
Cargo (Tonnes):		66,500	133,000	152,000	266,000	266,000
Speed (Kts)		13.8	13.5	13.5	13.5	13.5
Fuel Consumption (tpd):						
Fuel Oil:	At Sea	31.0	51.0	52.5	60.0	60.0
	In Port	8.0	14.0	14.0	14.0	14.0
MDO:	At Sea	1.5	3.1	3.1	4.1	4.1
	In Port	1.5	3.1	3.1	4.1	4.1
Single Voyage Miles		9,921	9,921	12,552	9,921	12,552
Days At Sea		59.9	61.2	77.5	61.2	77.5
Port Days:	Jose	1.0	2.0	2.0	2.5	2.5
	Tsingtao	2.5	3.0	3.0	3.5	3.5
	Canal	2.0	2.0		2.0	
	Total	5.5	7.0	5.0	8.0	6.0
Total Voyage Days		65.4	68.2	82.5	69.2	83.5
Charter Rate ($/Day)		17,850	28,100	29,950	37,700	37,700
Bunker Prices ($/Tonne)						
	Fuel Oil	158.7	158.7	158.7	158.7	158.7
	MDO	249.5	249.5	249.5	249.5	249.5
Voyage Costs:						
		$	$	$	$	$
Charter Hire		1,167,558	1,917,565	2,470,320	2,610,376	3,147,252
Bunkers:	Fuel Oil	301,719	511,217	656,665	600,909	751,109
	MDO	24,479	52,781	63,795	70,830	85,397
Port Charges:	Jose	44,500	55,800	55,800	78,900	78,900
	Kaohsiung	32,900	41,240	45,380	58,310	58,310
Canal Dues		144,892	280,104	0	524,065	0
Total		1,716,049	2,858,706	3,291,961	3,943,389	4,120,969
Freight ($/Tonne)		25.8	21.5	21.7	14.8	15.5

Table 6.3.2.5

Estimated 2000 Orimulsion Freight Costs

Trade: JOSE - S KOREA (BUSAN)
Route: DIRECT (VIA CGH)
Freight Basis: 1 YR T/C & Total Operating Costs
Vessel Size: 70,000; 140,000; 160,000 dwt & 280,000 DWT

Year		2000 via Canal	2000 via Canal	2000 via CGH	2000 via Canal	2000 via CGH
Vessel Size (Dwt)		**70,000**	**140,000**	**160,000**	**280,000**	**280,000**
Time Charter Period		**1 Year**	**1 Year**	**1 Year**	**1 Year**	**1 Year**
Stores, Water, etc (Tonnes)						
Bunkers (Tonnes)						
Cargo (Tonnes):		66,500	133,000	152,000	266,000	266,000
Speed (Kts)		13.8	13.5	13.5	13.5	13.5
Fuel Consumption (tpd):						
Fuel Oil:	At Sea	31.0	51.0	52.5	60.0	60.0
	In Port	8.0	14.0	14.0	14.0	14.0
MDO:	At Sea	1.5	3.1	3.1	4.1	4.1
	In Port	1.5	3.1	3.1	4.1	4.1
Single Voyage Miles		9,046	9,046	13,434	9,046	13,434
Days At Sea		54.6	55.8	82.9	55.8	82.9
Port Days:	Jose	1.0	2.0	2.0	2.5	2.5
	Tsingtao	2.5	3.0	3.0	3.5	3.5
	Canal	2.0	2.0		2.0	
	Total	5.5	7.0	5.0	8.0	6.0
Total Voyage Days		60.1	62.8	87.9	63.8	88.9
Charter Rate ($/Day)		17,850	28,100	29,950	37,700	37,700
Bunker Prices ($/Tonne)						
	Fuel Oil	158.7	158.7	158.7	158.7	158.7
	MDO	249.5	249.5	249.5	249.5	249.5
Voyage Costs:						
		$	$	$	$	$
Charter Hire		1,073,242	1,765,790	2,633,381	2,406,749	3,352,507
Bunkers:	Fuel Oil	275,724	467,501	702,027	549,478	802,951
	MDO	22,502	48,603	68,006	65,305	90,967
Port Charges:	Jose	44,500	55,800	55,800	78,900	78,900
	Busan	17,540	27,300	30,030	46,230	46,230
Canal Dues		144,892	280,104	0	524,065	0
Total		1,578,401	2,645,098	3,489,245	3,670,727	4,371,556
Freight ($/Tonne)		23.7	19.9	23.0	13.8	16.4

Table 6.3.2.6

Estimated 2000 Orimulsion Freight Costs

Trade: JOSE - CHINA (TSINGTAO)
Route: DIRECT (VIA CGH)
Freight Basis: 1 YR T/C & Total Operating Costs
Vessel Size: 70,000; 140,000; 160,000 dwt & 280,000 DWT

Year		2000 via Canal	2000 via Canal	2000 Via CGH	2000 via Canal	2000 via CGH
Vessel Size (Dwt)		**70,000**	**140,000**	**160,000**	**280,000**	**280,000**
Time Charter Period		**1 Year**	**1 Year**	**1 Year**	**1 Year**	**1 Year**
Stores, Water, etc (Tonnes)						
Bunkers (Tonnes)						
Cargo (Tonnes):		66,500	133,000	152,000	266,000	266,000
Speed (Kts)		13.8	13.5	13.5	13.5	13.5
Fuel Consumption (tpd):						
Fuel Oil:	At Sea	31.0	51.0	52.5	60.0	60.0
	In Port	8.0	14.0	14.0	14.0	14.0
MDO:	At Sea	1.5	3.1	3.1	4.1	4.1
	In Port	1.5	3.1	3.1	4.1	4.1
Single Voyage Miles		9,548	9,548	13,394	9,548	13,394
Days At Sea		57.7	58.9	82.7	58.9	82.7
Port Days:	Jose	1.0	2.0	2.0	2.5	2.5
	Tsingtao	2.5	3.0	3.0	3.5	3.5
	Canal	2.0	2.0		2.0	
	Total	5.5	7.0	5.0	8.0	6.0
Total Voyage Days		63.2	65.9	87.7	66.9	88.7
Charter Rate ($/Day)		17,850	28,100	29,950	37,700	37,700
Bunker Prices ($/Tonne)						
	Fuel Oil	158.7	158.7	158.7	158.7	158.7
	MDO	249.5	249.5	249.5	249.5	249.5
Voyage Costs:						
		$	$	$	$	$
Charter Hire		1,127,353	1,852,865	2,625,986	2,523,573	3,343,199
Bunkers:	Fuel Oil	290,638	492,581	699,970	578,985	800,600
	MDO	23,637	51,000	67,815	68,475	90,714
Port Charges:	Jose	44,500	55,800	61,400	78,900	78,900
	Tsingtao	80,500	125,300	137,830	212,170	212,170
Canal Dues		144,892	280,104	0	524,065	0
Total		1,711,519	2,857,650	3,593,002	3,986,167	4,525,583
Freight ($/Tonne)		25.7	21.5	23.6	15.0	17.0

7 Commodity Trade Flows by Vessel Type

7.1 Methodology

This section is concerned with the allocation of commodity trade flow to ship types by route for existing Panama Canal trades. As a first step, all commodity trade flows from FY1985/86 through FY1998/99 by route and ship type were analysed. For each commodity, route and year the cargoes moved in each ship type were expressed as percentages of the total amount of cargo shipped on the route. These percentages were scrutinised individually to identify trends. These trends were then used to project future percentage allocations of commodities by ship type and route. In the absence of any clear trends - which was the case in many instances – future distributions of commodities by ship type were set equal to the averages over the past five years or, if considered to be more representative, the figures for the most recent year. The resulting percentages were applied in the transit model to commodity forecasts by route to produce estimates of future commodity trade flows by route and ship type. At this stage, the small quantities of cargoes moved in passenger ships were removed from the analyses as, by implication, they are taken into account in the consideration of passenger ship transits which are dealt with separately in Section 10.

One of the sectors where there is greater potential for substitution between ship types concerns containerised cargoes. These are discussed separately in Section 7.2. The results from this part of the study are discussed in Section 7.3

7.2 Potential for Substitution Between Ship Types

Any ship which is not a containership but which can carry containers may seek marginal container cargoes as long as they do not impinge on its effectiveness in its main trade. It is not easy to compete with container services on quality, and the business is complicated, so that these marginal cargoes are most likely to be low volume low-value cargoes or empty containers carried for container lessors or shipping lines on ballast voyages.

Some types of vessel have container carriage built into their service structures. Car carriers carry containers on the return leg, and are able to compete because containers are easily carried in the holds of ro-ro vessels and low rates can be charged because otherwise the vessel would be empty. Unlike forest product carriers, which also move containers on the return leg, car carriers also carry parts in containers, which fits into their overall business. The same may be said of reefer ships, which carry reefer containers on deck in addition to reefer cargo in refrigerated holds.

This type of activity, which is marginal to world container trade overall but may be significant on niche routes, will always continue, subject to the origin and destination of the main non-container cargo.

Containerships may expect to continue to increase penetration of the general cargo ship market since containerships are simply modern general cargo ships. This process, which is extremely advanced already, depends on the ability of container lines to build effective services on these routes, which depends on two-way cargo volumes. Once the volume is sufficient to justify a container service and, more important, the terminal facilities required, containers will replace traditional stevedoring. Minor ports will be served by transhipment.

General cargo ships may still be required on routes where:

- there are insufficient regular volumes to sustain container services
- too much cargo is out of gauge, and cannot be containerised
- ports do not have adequate container handling equipment
- container carriers do not trust ports (safety, turnround, theft)

A large report could be written on the potential for containerships to replace reefer vessels, and reefer operators are very fearful that this will happen. The fact is that reefer capacity in containerships now exceeds reefer capacity in reefer ships - but the cargoes are not the same. Reeferships carry seasonal cargoes while containerships generally operate in year-round services. There is no economic sense in a containership serving a seasonal market if the vessel is too large for the cargo flow for nine months in the year, unless of course the trade is justified but unbalanced except in the season. There are several examples of this justification, going back to the beginnings of containerisation and the South African and

Australasian trades to Europe, where container services were built on the back of porthole containers (which are being replaced by reefers), but these services exist already.

There are non-seasonal reefer cargoes like bananas and frozen meat, and containerships and ro-ros have replaced reeferships for part of the US/Central America trade. Here the justification is the inland move, as if this is longer than the sea move it is economic to simplify the whole route by carrying cargo in road-friendly units all the way. If the pattern of distribution changes in Europe to the extent that shippers want their bananas to be delivered inland in container volumes, and the full ripening process is carried out within the container, then this too could change. But:

- on a long sea journey the tare weight of the container costs 20% of the deadweight of the vessel;
- substantial port facilities exist for bananas and other fruit in European and other ports, and banana conveyor handling is extremely efficient;
- the container is an inefficient size for European inland transport compared with the trailer (which is based around the Europallet size).

The margin between container and conventional carriage has been represented by the Australian frozen meat trade to ECNA, where a single contract used to be let to a single supplier. The US is the single biggest market for beef imports. Approximately 1 million tonnes are handled annually with Australia and New Zealand the largest suppliers. In fact US trade accounts for between 55% and 60% of Australian beef exports and 80% of New Zealand's output. Although in the past the trade seesawed between container and conventional, containerships have now made substantial inroads into this trade and now easily surpass the deployment of conventional and pallet reefer vessels, a process which will continue.

The reasons are:

- The movement of smaller shipments on a regular basis has been a clear advantage to containerships and has neatly fitted into liner companies' schedules;
- The break-up of national producer/marketing boards has resulted in more individual shippers dealing direct with shipping lines. In this trading environment, containers have become the main unit of shipment. These shippers do not have the volume to make use of the economies of scale associated with large reeferships and containers offer greater flexibility;
- The centralisation and sale of meat to huge wholesale centres is on the wane, with large customers preferring to deal on a direct basis with producers/farmers. Port-to-port moves are being superseded by door-to-door and value-added logistics options;
- Intermodal options have been growing in importance as a higher portion of integral container units are deployed and reefer transport by rail becomes more efficient and reliable;
- US consignees have found new markets from which to source their imports. The past two years have seen a significant increase in shipments from Argentina, Brazil and Uruguay;
- The movement of deep frozen beef from Australia and New Zealand, which was highly suited to conventional reefer ships, has declined as chilled meat imports have grown.

Overall, Canal transits by all types of ship engaged in the Australia/New Zealand reefer business have come under pressure from cargo being routed intermodally via West Coast ports. Australia-New Zealand Direct Line is focused entirely on this approach, while Columbus is using this option for a larger portion of its meat and other reefer cargo.

This is therefore a particular case of containers successfully competing with conventional reefers, entirely as a result of changes in the organisation of trade and with no particular rationale in competing vessel economics.

The other significant trade in which attempts have been made to convert 'conventional' to container is cars. At present, shipping lines carry cars containerised by specialist forwarders. There are two types of operation.

- high value cars are loaded into containers one or two at a time because containers offer greater security than ro-ro vessels, particularly where transhipment is required;
- lower value cars for developing markets with lower volumes and no ro-ro services are loaded up to six cars into a hi-cube by specialist car forwarders, using various ramp systems. Lines are happy to leave this operation to specialists, just as they are happy to leave the operation of tank containers to specialist forwarders.

Some examples of containerised movements are:

- Rolls Royce, TVR, and Lotus cars are moved across the Atlantic in containers: two Rolls to a 40ft cost $2,500 per box. The determining factors in modal choice on this trade are slightly improved security and, more important, the risk of damage on open-stowed car decks due to rough weather on the Atlantic.
- On the West African trade cars are mostly second hand, and either driven directly onto ro-ro decks or lashed for security atop the container stow on both containerships and ro-ros, if the shipper allows it, as there is risk of salt-spray corrosion.
- Sea-Land has an all ro-ro operation to Puerto Rico and moves 8,000 cars per year on the route inside standard 40ft units. This is traditionally a second-hand car trade, but nowadays a substantial part are unused 'grey' cars, taking advantage of the price differences between new cars on the mainland and nearly new ones in Puerto Rico.
- Crowley has a containerised operation to Venezuela, because no ro-ros operate there.
- Containers are said to have 22% of the 40,000 unit per year (all eastbound) US-Europe secondary market, which consists of dealer to dealer transfers (used cars) and POVs (privately owned vehicles).

However, except in such niche cases, it seems fundamentally silly to move a wheeled cargo into a box so that it can be lifted when it can easily be driven onto a ro-ro ship. Moreover, in interviews major shipping companies (which, incidentally are parts of groups which operate both car carriers and container shipping lines) such as Moller and NYK, no interest was shown in containerised cars. On the major routes "low though container rates are, the revenue obtained from cars is even lower. The only time cars could be considered is for empty positioning." Top container lines are not interested in carrying cars in containers because the car carrier contract prices are so low that breaking into the market is unattractive.

7.3 Results

Generic growth in the Canal trades from 2001 to 2020 and from 2020 to 2050 is greater for southbound routes than northbound routes for all ship types except fully cellular containerships, for which northbound trade has a slightly higher growth rate than southbound for both periods. Overall growth is 1.9% per annum for 2001 to 2020 and 1.1% for 2020 to 2050, with northbound routes contributing 1.5% and 0.9% and southbound routes 2.2% and 1.3% respectively (Table 7.3.1).

Growth rates are greater in the period 2001 to 2020 than for 2020 to 2050 for all ship types except for northbound trade for vehicle carriers and liquid gas ships. Also all growth rates are positive or flat except for reefers and roll-on/roll-off northbound for 2020 to 2050 and for vehicle carriers northbound for 2001 to 2020.

Most ship types follow a general trend of around 2% annual increases from 2001 to 2020 followed by around 1% for 2020 to 2050. The exceptions to this pattern are reefers (0.7% and -0.5%), roll-on/roll-off (1.4% and -0.2%), and vehicle carriers (0.3% and 0.5%) - which had lower growth rates - and full container ships (2.6% and 1.3%) with a higher rate.

For continued use of the Existing Canal with capacity constraints, growth in trade from 2001 to 2020 and from 2020 to 2050 is again greater for southbound routes than northbound routes for all ship types except full containerships. However, overall growth is down to 0.3% per year for 2001 to 2020 and 0.2% for 2020 to 2050, with northbound routes contributing -0.1% and 0% and southbound routes 0.6% and 0.4% respectively (Table 7.3.2).

For this case, seven of the twelve ship types now have lower growth rates in the period 2001 to 2020 than for 2020 to 2050 for northbound trade and for dry bulk carriers and vehicle carriers this is also true for southbound trade. There are now also many negative growth rates with only container/break bulk and full containerships showing positive growth rates for both 2001 to 2020 and 2020 to 2050, northbound and southbound.

Six of the ship types follow the overall trend of small growth from 2001 to 2020 and even smaller growth from 2020 to 2050. Of the remainder, vehicle carriers, roll-on/roll-off vessels and reefers are negative for both periods; tankers and dry/liquid bulk carriers turn negative for the second period and full containerships maintain a growth rate above 1% for the first period.

For the Expanded Canal (Table 7.3.3), growth trends both north and south are the same as for the generic growth trends. The additional growth for dry bulk carriers, tankers and full container ships are fairly steady and southbound biased, and therefore do not alter the underlying trends. The same is true for the Unrestricted Canal case (Table 7.3.4). The main trade increases (southbound dry bulk and tanker trade) do not alter the underlying generic growth trends, although of course – as with the Expanded Case – there would be an initial step increase on enlargement of the Canal.

For the generic growth in containerised cargo trade (expressed in TEUs), growth in demand is greater in the period 2001 to 2020 than 2020 to 2050 for all routes except Other North to Other South. The slowdown in growth between the two periods is more marked for northbound routes than for southbound. The largest growth in demand for both periods involves West Coast of South America routes to and from Europe and the East Coast of the USA. No route exhibits negative growth. Overall growth is 2.3% for 2001 to 2020 and 1.4% for 2020 to 2050 (Table 7.3.5).

For continued use of the Existing Canal with capacity constraints, many routes exhibit a small decline in containerised cargo trade in the period 2001 to 2020 but only one (East Coast USA to Oceania) shows a decline in 2020 to 2050. Overall growth is 0.7% for 2001 to 2020 and 0.5% for 2020 to 2050. Once again the West Coast of South America to and from East Coast USA and Europe have the largest growth rates (Table 7.3.6).

For the Expanded Canal (Table 7.3.7), four routes exhibit a 50% or greater increase in trade when compared with the demand on the Existing Canal. These are Asia to and from East Coast USA and Europe to and from West Coast USA. Some other routes show much smaller increases. These increases would occur as soon as the Expanded Canal was open and growth thereafter would be in line with the demand case. For containerised cargo, an Unrestricted Canal (Table 7.3.8) would not create additional trade over an Expanded Canal.

Table 7.3.1

Scenario 1, Generic Growth in Panama Canal Trades by Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
									000's tons
General Cargo	N	3,365	3,666	4,023	4,271	4,522	5,015	5,466	5,890
General Cargo	S	4,130	4,774	5,437	5,942	6,452	7,426	8,324	9,180
Refrigerated Cargo	N	4,658	4,835	4,950	4,992	4,987	4,800	4,448	3,926
Refrigerated Cargo	S	824	987	1,155	1,254	1,345	1,479	1,559	1,584
Dry Bulk Carrier	N	40,497	44,508	48,365	51,535	55,204	61,911	68,657	75,182
Dry Bulk Carrier	S	67,737	76,189	84,476	92,582	100,831	117,899	135,409	153,594
Tanker	N	12,666	12,087	13,804	13,181	12,595	12,262	12,480	12,583
Tanker	S	25,659	30,067	34,668	38,424	41,562	46,535	51,450	56,135
Dry/Liquid Bulk Carrier	N	177	184	192	196	199	209	217	218
Dry/Liquid Bulk Carrier	S	500	564	645	708	775	850	909	960
Container/Break-Bulk	N	3,055	3,386	3,762	4,036	4,316	4,874	5,398	5,899
Container/Break-Bulk	S	2,850	3,386	3,863	4,234	4,648	5,511	6,407	7,392
Full Container	N	16,883	20,197	24,016	26,526	28,951	33,776	38,067	42,298
Full Container	S	17,628	21,233	24.783	26,970	29,128	33,564	37,720	42,131
Roll-on/Roll-off	N	707	755	840	833	813	745	639	511
Roll-on/Roll-off	S	743	879	998	1,054	1,105	1,196	1,257	1,304
Vehicle Carrier	N	1,303	1,298	1,281	1,264	1,260	1,267	1,287	1,306
Vehicle Carrier	S	386	422	459	493	528	599	671	741
Vehicle/Dry Bulk	N	413	444	480	511	545	616	689	761
Vehicle/Dry Bulk	S	928	1,051	1,182	1,301	1,427	1,680	1,932	2,184
Liquid Gas	N	83	82	87	92	97	107	119	129
Liquid Gas	S	1,638	1,863	2.157	2,394	2,644	2,956	3,214	3,442
Other	N	231	247	265	281	300	333	370	409
Other	S	411	458	510	555	603	682	757	830
Total North		84,039	91,698	102,064	107,718	113,789	125,917	137,837	149,113
Total South		123,434	141,875	160,333	175,911	191,048	220,378	249,810	279,476
Grand Total		207,474	233,573	262,398	283,629	304,837	346,296	387,447	428,589

Table 7.3.2

Scenario 1, Case 1, Existing Canal

Trade by Ship Type

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	3,362	3,317	3,307	3,295	3,286	3,287	3,277	3.254
General Cargo	S	4,126	4,320	4,470	4,584	4,689	4,867	4,990	5.072
Refrigerated Cargo	N	4,853	4,375	4,069	3,851	3,625	3,145	2,666	2,169
Refrigerated Cargo	S	823	893	949	967	977	969	934	875
Dry Bulk Carrier	N	40,458	40,271	39,758	39,754	40,120	40,572	41,154	41,537
Dry Bulk Carrier	S	67,672	68,937	69,443	71,418	73,280	77,264	81,166	84,857
Tanker	N	12,654	10,945	11,347	10,168	9,154	8,036	7,481	6,952
Tanker	S	25,634	27,205	28,499	29,641	30,206	30,496	30,840	31,014
Dry/Liquid Bulk Carrier	N	177	166	158	151	144	137	130	121
Dry/Liquid Bulk Carrier	S	500	510	531	546	563	557	545	530
Container/Break-Bulk	N	3,053	3,063	3,093	3,114	3,137	3,194	3,236	3,259
Container/Break-Bulk	S	2,847	3,063	3,175	3,266	3,378	3,612	3,841	4,084
Full Container	N	16,867	18,274	19,742	20,462	21,041	22,135	22,818	23,369
Full Container	S	17,611	19,212	20,372	20,805	21,169	21,996	22,610	23,276
Roll-on/Roll-off	N	707	683	691	642	591	488	383	282
Roll-on/Roll-off	S	742	796	821	813	803	784	754	720
Vehicle Carrier	N	1,302	1,174	1,053	975	916	831	772	722
Vehicle Carrier	S	386	382	377	380	384	393	402	409
Vehicle/Dry Bulk	N	413	402	394	394	396	404	413	420
Vehicle/Dry Bulk	S	927	951	972	1,004	1,037	1,101	1,158	1,207
Liquid Gas	N	83	74	72	71	71	70	71	72
Liquid Gas	S	1,636	1,686	1,773	1,847	1,922	1,937	1,926	1,901
Other	N	231	223	217	217	218	218	222	226
Other	S	411	414	419	428	438	447	454	459
Total North		83,958	82,970	83,902	83,094	82,698	82,518	82,622	82,382
Total South		123,316	128,370	131,802	135,699	138,847	144,421	149,620	154,405
Grand Total		207,274	211,340	215,703	218,793	221,545	226,939	232,241	236,787

Table 7.3.3

Scenario 1, Case 2, Expanded Canal

Summary Trade By Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's tons 2050
General Cargo	N	4,023	4,271	4,522	5,015	5,466	5,890
General Cargo	S	5,437	5,942	6,452	7,426	8,324	9,180
Refrigerated Cargo	N	4,950	4,992	4,987	4,800	4,448	3,926
Refrigerated Cargo	S	1,155	1,254	1,345	1,479	1,559	1,584
Dry Bulk Carrier	N	51,599	54,763	58,410	65,207	71,933	78,260
Dry Bulk Carrier	S	90,314	98,869	105,189	123,391	142,472	162,872
Tanker	N	13,804	13,181	12,595	12,262	12,480	12,583
Tanker	S	36,603	40,359	43,497	48,470	53,385	58,070
Dry/Liquid Bulk Carrier	N	192	196	199	209	217	218
Dry/Liquid Bulk Carrier	S	645	708	775	850	909	960
Container/Break-Bulk	N	3,762	4,036	4,316	4,874	5,398	5,899
Container/Break-Bulk	S	3,863	4,234	4,648	5,511	6,407	7,392
Full Container	N	30,207	33,216	36,089	41,746	46,627	51,339
Full Container	S	33,580	36,219	38,789	44,046	48,801	53,733
Roll-on/Roll-off	N	840	833	813	745	639	511
Roll-on/Roll-off	S	998	1,054	1,105	1,196	1,257	1,304
Vehicle Carrier	N	1,281	1,264	1,260	1,267	1,287	1,306
Vehicle Carrier	S	459	493	528	599	671	741
Vehicle/Dry Bulk	N	480	511	545	616	689	761
Vehicle/Dry Bulk	S	1,182	1,301	1,427	1,680	1,932	2,184
Liquid Gas	N	87	92	97	107	119	129
Liquid Gas	S	2,157	2,394	2,644	2,956	3,214	3,442
Other	N	265	281	300	333	370	409
Other	S	510	555	603	682	757	830
Total Northbound		**111,490**	**117,637**	**124,134**	**137,183**	**149,673**	**161,232**
Total Southbound		**176,904**	**193,382**	**207,004**	**238,287**	**269,688**	**302,292**
Grand Total		**288,394**	**311,019**	**331,138**	**375,470**	**419,361**	**463,524**

Table 7.3.4

Scenario 1, Case 3, Unrestricted Canal

Summary Trade By Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	2050
							000's tons
General Cargo	N	4,023	4,271	4,522	5,015	5,466	5,890
General Cargo	S	5,437	5,942	6,452	7,426	8,324	9,180
Refrigerated Cargo	N	4,950	4,992	4,987	4,800	4,448	3,926
Refrigerated Cargo	S	1,155	1,254	1,345	1,479	1,559	1,584
Dry Bulk Carrier	N	51,858	55,032	58,686	65,503	72,238	78,555
Dry Bulk Carrier	S	91,382	100,054	108,619	127,350	146,917	167,776
Tanker	N	13,804	13,181	12,595	12,262	12,480	12,583
Tanker	S	41,603	48,359	53,997	58,970	63,885	68,570
Dry/Liquid Bulk Carrier	N	192	196	199	209	217	218
Dry/Liquid Bulk Carrier	S	645	708	775	850	909	960
Container/Break-Bulk	N	3,762	4,036	4,316	4,874	5,398	5,899
Container/Break-Bulk	S	3,863	4,234	4,648	5,511	6,407	7,392
Full Container	N	30,207	33,216	36,089	41,746	46,627	51,339
Full Container	S	33,580	36,219	38,789	44,046	48,801	53,733
Roll-on/Roll-off	N	840	833	813	745	639	511
Roll-on/Roll-off	S	998	1,054	1,105	1,196	1,257	1,304
Vehicle Carrier	N	1,281	1,264	1,260	1,267	1,287	1,306
Vehicle Carrier	S	459	493	528	599	671	741
Vehicle/Dry Bulk	N	480	511	545	616	689	761
Vehicle/Dry Bulk	S	1,182	1,301	1,427	1,680	1,932	2,184
Liquid Gas	N	87	92	97	107	119	129
Liquid Gas	S	2,157	2,394	2,644	2,956	3,214	3,442
Other	N	265	281	300	333	370	409
Other	S	510	555	603	682	757	830
Total Northbound		**111,749**	**117,905**	**124,409**	**137,479**	**149,978**	**161,528**
Total Southbound		**182,972**	**202,568**	**220,933**	**252,746**	**284,634**	**317,695**
Grand Total		**294,721**	**320,473**	**345,342**	**390,225**	**434,612**	**479,223**

Table 7.3.5

Scenario 1, Generic Growth in Panama Canal Containerised Cargoes in Terms of TEU

Route	Direction	2001	2005	2010	2015	2020	2030	2040	2050
								000's TEU	
ASIA TO EC CANADA	N	19	17	20	22	23	27	31	36
ASIA TO W INDIES	N	48	44	51	56	60	70	80	92
ASIA TO ECUSA	N	672	738	858	938	997	1,119	1,219	1,300
OCEANIA EC CENTRAL AM.	N	1	1	1	2	2	2	2	3
OCEANIA TO EC CANADA	N	1	1	1	1	1	1	1	1
OCEANIA TO ECUSA	N	75	68	79	86	93	108	125	143
OCEANIA TO EUROPE	N	1	1	1	1	1	1	1	1
OTHER SOUTH TO OTHER NORTH	N	247	291	362	418	466	568	665	758
WC CENTRAL AM. TO EC SOUTH AM.	N	4	4	4	5	5	6	7	8
WC CENTRAL AM. TO ECUSA	N	1	1	1	2	2	2	2	3
WC CENTRAL AM. TO EUROPE	N	16	15	17	19	20	24	28	31
WC SOUTH AM. TO EC CENTRAL AM.	N	76	69	80	88	94	110	127	146
WC SOUTH AM. TO EC SOUTH AM.	N	54	49	57	62	67	78	90	103
WC SOUTH AM. TO ECUSA	N	131	174	223	263	298	375	452	529
WC SOUTH AM. TO EUROPE	N	109	136	167	191	211	256	299	340
WC SOUTH AM. TO W INDIES	N	59	54	63	69	74	86	99	114
WCUSA TO AFRICA	N	0	0	0	0	0	0	0	0
WCUSA TO ECUSA	N	12	11	12	14	15	17	20	22
WCUSA TO EUROPE	N	107	131	150	163	173	198	223	246
AFRICA TO OCEANIA	S	0	0	0	0	0	0	0	0
AFRICA TO WC CANADA	S	0	0	0	0	0	0	0	0
AFRICA TO WC CENTRAL AM.	S	0	0	0	0	0	0	0	0
EC CENTRAL AM. TO WC CENTRAL AM.	S	1	1	1	1	1	1	1	2
EC SOUTH AM. TO ASIA	S	1	1	1	1	1	1	1	1
EC SOUTH AM. TO WC CENTRAL AM.	S	0	0	0	0	0	0	0	0
EC SOUTH AM. TO WC SOUTH AM.	S	70	64	74	81	87	102	117	134
EC SOUTH AM. TO WCUSA	S	11	10	11	12	13	16	18	21
ECCAN TO ASIA	S	41	37	43	47	51	59	69	78
ECUSA TO WC CENTRAL AM..	S	3	2	3	3	3	4	4	5
ECUSA TO WCUSA	S	10	9	11	12	13	15	17	20
ECUSA TO ASIA	S	733	751	865	942	1,005	1,149	1,291	1,429
ECUSA TO OCEANIA	S	56	65	74	79	82	91	99	106
ECUSA TO WC SOUTH AM.	S	185	261	335	393	445	552	654	751
EUROPE TO ASIA	S	8	8	9	10	11	12	14	16
EUROPE TO OCEANIA	S	71	88	102	112	121	139	156	171
EUROPE TO WC CENTRAL AM.	S	6	5	6	6	7	8	9	11
EUROPE TO WC SOUTH AM.	S	127	167	210	244	274	341	410	480
EUROPE TO WCUSA	S	164	188	215	233	247	281	314	345
OTHER NORTH TO OTHER SOUTH	S	117	119	150	175	199	253	313	380
W INDIES TO ASIA	S	30	27	31	34	37	43	50	57
W INDIES TO WC SOUTH AM.	S	57	52	60	66	71	83	95	109
W INDIES TO WCUSA	S	8	8	9	10	10	12	14	16
Total Northbound		1,633	1,805	2,148	2,396	2,602	3,048	3,473	3,878
Total Southbound		1,698	1,864	2,208	2,462	2,678	3,162	3,647	4,133
Grand Total		3,331	3,670	4,356	4,859	5,279	6,209	7,120	8,010

Table 7.3.6

Scenario 1, Case 1, Existing Canal

All Cargoes in Containers in Terms of TEU

Route	Direction	2001	2005	2010	2015	2020	2030	2040	2050
									000's TEU
ASIA TO EC CANADA	N	19	15	16	17	17	18	19	20
ASIA TO W INDIES	N	48	40	42	43	43	46	48	51
ASIA TO ECUSA	N	671	668	706	723	724	733	731	718
OCEANIA EC CENTRAL AM.	N	1	1	1	1	1	1	1	1
OCEANIA TO EC CANADA	N	1	1	1	1	1	1	1	1
OCEANIA TO ECUSA	N	74	62	65	67	67	71	75	79
OCEANIA TO EUROPE	N	1	1	1	1	1	1	1	1
OTHER SOUTH TO OTHER NORTH	N	247	263	298	322	338	372	399	419
WC CENTRAL AM. TO EC SOUTH AM.	N	4	3	4	4	4	4	4	4
WC CENTRAL AM. TO ECUSA	N	1	1	1	1	1	1	1	1
WC CENTRAL AM. TO EUROPE	N	16	14	14	15	15	16	16	17
WC SOUTH AM. TO EC CENTRAL AM.	N	76	63	66	68	69	72	76	80
WC SOUTH AM. TO EC SOUTH AM.	N	54	45	47	48	49	51	54	57
WC SOUTH AM. TO ECUSA	N	131	157	183	203	217	246	271	292
WC SOUTH AM. TO EUROPE	N	109	123	137	147	154	168	170	188
WC SOUTH AM. TO W INDIES	N	59	49	51	53	54	56	60	63
WCUSA TO AFRICA	N	0	0	0	0	0	0	0	0
WCUSA TO ECUSA	N	12	10	10	10	11	11	12	12
WCUSA TO EUROPE	N	107	118	123	126	126	130	134	137
AFRICA TO OCEANIA	S	0	0	0	0	0	0	0	0
AFRICA TO WC CANADA	S	0	0	0	0	0	0	0	0
AFRICA TO WC CENTRAL AM.	S	0	0	0	0	0	0	0	0
EC CENTRAL AM. TO WC CENTRAL AM.	S	1	1	1	1	1	1	1	1
EC SOUTH AM. TO ASIA	S	1	1	1	1	1	1	1	1
EC SOUTH AM. TO WC CENTRAL AM.	S	0	0	0	0	0	0	0	0
EC SOUTH AM. TO WC SOUTH AM.	S	70	58	61	63	63	67	70	74
EC SOUTH AM. TO WCUSA	S	11	9	9	10	10	10	11	11
ECCAN TO ASIA	S	41	34	35	37	37	39	41	43
ECUSA TO WC CENTRAL AM..	S	3	2	2	2	2	2	3	3
ECUSA TO WCUSA	S	10	8	9	9	9	10	10	11
ECUSA TO ASIA	S	732	680	711	727	730	753	774	790
ECUSA TO OCEANIA	S	56	59	60	61	60	60	59	58
ECUSA TO WC SOUTH AM.	S	185	236	275	304	323	362	392	415
EUROPE TO ASIA	S	6	7	7	8	8	8	8	9
EUROPE TO OCEANIA	S	71	79	84	87	88	91	93	95
EUROPE TO WC CENTRAL AM.	S	6	5	5	5	5	5	6	6
EUROPE TO WC SOUTH AM.	S	127	151	172	188	199	224	246	265
EUROPE TO WCUSA	S	164	170	177	180	180	184	188	191
OTHER NORTH TO OTHER SOUTH	S	117	108	123	135	145	166	188	210
W INDIES TO ASIA	S	30	24	26	26	27	28	30	31
W INDIES TO WC SOUTH AM.	S	57	47	49	51	52	54	57	60
W INDIES TO WCUSA	S	6	7	7	8	8	8	8	9
Total Northbound		1,632	1,634	1,765	1,848	1,891	1,997	2,082	2,142
Total Southbound		1,696	1,687	1,815	1,900	1,946	2,072	2,186	2,283
Grand Total		3,328	3,320	3,581	3,748	3,837	4,069	4,268	4,425

Table 7.3.7

Scenario 1, Case 2, Expanded Canal
All Cargoes in Containers in Terms of TEU

000's TEU

Route	Direction	2010	2015	2020	2030	2040	2050
ASIA TO EC CANADA	N	20	22	23	27	31	36
ASIA TO W INDIES	N	51	56	60	70	80	92
ASIA TO ECUSA	N	1,287	1,406	1,495	1,678	1,829	1,950
OCEANIA EC CENTRAL AM.	N	1	2	2	2	2	3
OCEANIA TO EC CANADA	N	1	1	1	1	1	1
OCEANIA TO ECUSA	N	79	86	93	108	125	143
OCEANIA TO EUROPE	N	1	1	1	1	1	1
OTHER SOUTH TO OTHER NORTH	N	380	439	489	596	698	796
WC CENTRAL AM. TO EC SOUTH AM.	N	4	5	5	6	7	8
WC CENTRAL AM. TO ECUSA	N	1	2	2	2	2	3
WC CENTRAL AM. TO EUROPE	N	17	19	20	24	28	31
WC SOUTH AM. TO EC CENTRAL AM.	N	80	88	94	110	127	146
WC SOUTH AM. TO EC SOUTH AM.	N	57	62	67	78	90	103
WC SOUTH AM. TO ECUSA	N	267	315	358	450	542	634
WC SOUTH AM. TO EUROPE	N	167	191	211	256	299	340
WC SOUTH AM. TO W INDIES	N	63	69	74	86	99	114
WCUSA TO AFRICA	N	0	0	0	0	0	0
WCUSA TO ECUSA	N	12	14	15	17	20	22
WCUSA TO EUROPE	N	225	244	260	297	334	371
AFRICA TO OCEANIA	S	0	0	0	0	0	0
AFRICA TO WC CANADA	S	0	0	0	0	0	0
AFRICA TO WC CENTRAL AM.	S	0	0	0	0	0	0
EC CENTRAL AM. TO WC CENTRAL AM.	S	1	1	1	1	1	2
EC SOUTH AM. TO ASIA	S	1	1	1	1	1	1
EC SOUTH AM. TO WC CENTRAL AM.	S	0	0	0	0	0	0
EC SOUTH AM. TO WC SOUTH AM.	S	74	81	87	102	117	134
EC SOUTH AM. TO WCUSA	S	11	12	13	16	18	21
ECCAN TO ASIA	S	43	47	51	59	69	78
ECUSA TO WC CENTRAL AM.	S	3	3	3	4	4	5
ECUSA TO WCUSA	S	11	12	13	15	17	20
ECUSA TO ASIA	S	1,444	1,573	1,678	1,918	2,156	2,387
ECUSA TO OCEANIA	S	74	79	82	91	99	106
ECUSA TO WC SOUTH AM.	S	384	452	510	634	751	862
EUROPE TO ASIA	S	9	10	11	12	14	16
EUROPE TO OCEANIA	S	102	112	121	139	156	171
EUROPE TO WC CENTRAL AM.	S	6	6	7	8	9	11
EUROPE TO WC SOUTH AM.	S	210	244	274	341	410	480
EUROPE TO WCUSA	S	359	389	413	469	524	577
OTHER NORTH TO OTHER SOUTH	S	157	184	209	266	329	399
W INDIES TO ASIA	S	31	34	37	43	50	57
W INDIES TO WC SOUTH AM.	S	60	66	71	83	95	109
W INDIES TO WCUSA	S	9	10	10	12	14	16
Total Northbound		**2,714**	**3,020**	**3,270**	**3,809**	**4,317**	**4,795**
Total Southbound		**2,989**	**3,317**	**3,592**	**4,214**	**4,834**	**5,451**
Grand Total		**5,703**	**6,336**	**6,862**	**8,023**	**9,152**	**10,246**

Table 7.3.8

Scenario 1, Case 3, Unrestricted Canal
All Cargoes in Containers in Terms of TEU

Route	Direction	2010	2015	2020	2030	000's TEU 2040	2050
ASIA TO EC CANADA	N	20	22	23	27	31	36
ASIA TO W INDIES	N	51	56	60	70	80	92
ASIA TO ECUSA	N	1,287	1,406	1,495	1,678	1,829	1,950
OCEANIA EC CENTRAL AM.	N	1	2	2	2	2	3
OCEANIA TO EC CANADA	N	1	1	1	1	1	1
OCEANIA TO ECUSA	N	79	86	93	108	125	143
OCEANIA TO EUROPE	N	1	1	1	1	1	1
OTHER SOUTH TO OTHER NORTH	N	380	439	489	596	698	796
WC CENTRAL AM. TO EC SOUTH AM.	N	4	5	5	6	7	8
WC CENTRAL AM. TO ECUSA	N	1	2	2	2	2	3
WC CENTRAL AM. TO EUROPE	N	17	19	20	24	28	31
WC SOUTH AM. TO EC CENTRAL AM.	N	80	88	94	110	127	146
WC SOUTH AM. TO EC SOUTH AM.	N	57	62	67	78	90	103
WC SOUTH AM. TO ECUSA	N	267	315	358	450	542	634
WC SOUTH AM. TO EUROPE	N	167	191	211	256	299	340
WC SOUTH AM. TO W INDIES	N	63	69	74	86	99	114
WCUSA TO AFRICA	N	0	0	0	0	0	0
WCUSA TO ECUSA	N	12	14	15	17	20	22
WCUSA TO EUROPE	N	225	244	260	297	334	371
AFRICA TO OCEANIA	S	0	0	0	0	0	0
AFRICA TO WC CANADA	S	0	0	0	0	0	0
AFRICA TO WC CENTRAL AM.	S	0	0	0	0	0	0
EC CENTRAL AM. TO WC CENTRAL AM.	S	1	1	1	1	1	2
EC SOUTH AM. TO ASIA	S	1	1	1	1	1	1
EC SOUTH AM. TO WC CENTRAL AM.	S	0	0	0	0	0	0
EC SOUTH AM. TO WC SOUTH AM.	S	74	81	87	102	117	134
EC SOUTH AM. TO WCUSA	S	11	12	13	16	18	21
ECCAN TO ASIA	S	43	47	51	59	69	78
ECUSA TO WC CENTRAL AM.	S	3	3	3	4	4	5
ECUSA TO WCUSA	S	11	12	13	15	17	20
ECUSA TO ASIA	S	1,444	1,573	1,678	1,918	2,156	2,387
ECUSA TO OCEANIA	S	74	79	82	91	99	106
ECUSA TO WC SOUTH AM.	S	384	452	510	634	751	862
EUROPE TO ASIA	S	9	10	11	12	14	16
EUROPE TO OCEANIA	S	102	112	121	139	156	171
EUROPE TO WC CENTRAL AM.	S	6	6	7	8	9	11
EUROPE TO WC SOUTH AM.	S	210	244	274	341	410	480
EUROPE TO WCUSA	S	359	389	413	469	524	577
OTHER NORTH TO OTHER SOUTH	S	157	184	209	266	329	399
W INDIES TO ASIA	S	31	34	37	43	50	57
W INDIES TO WC SOUTH AM.	S	60	66	71	83	95	109
W INDIES TO WCUSA	S	9	10	10	12	14	16
Total Northbound		**2,714**	**3,020**	**3,270**	**3,809**	**4,317**	**4,795**
Total Southbound		**2,989**	**3,317**	**3,592**	**4,214**	**4,834**	**5,451**
Grand Total		**5,703**	**6,336**	**6,862**	**8,023**	**9,152**	**10,246**

8 Fleet Developments

This section is concerned with trends in the average size of vessels transiting the Canal and changes in the distributions of cargoes between dwt size ranges. Analyses have also been undertaken of trends in the world fleets of dry bulk carriers, full containerships and tankers to determine likely trends in vessel sizes and tankers to determine likely trends in vessel sizes utilising the Canal in the Expanded and Unrestricted Cases. Analyses of vessel beam within dwt size ranges have also been undertaken – both for vessels transiting the Canal and the global fleet. This is discussed further in Section 14.

8.1 Trends in the Dry Bulk Fleet

8.1.1 Panama Trades, Existing Canal

In order to determine the size of vessels transiting the Canal in future the consultants calculated:

- average dwt, within each dwt size range utilised for this study, of dry bulk carriers transiting the Canal historically;
- the allocation of cargo to individual vessel sizes.

These data are provided in Tables 8.1.1.1 and 8.1.1.2, respectively.

From this it became that apparent that there is no measurable trend in the average dwt of dry bulk carrier by size range utilising the Canal but that there are shifts in the allocation of cargo to different size ranges which generally reflects a shift towards the use of larger vessels. RLA developed a series of statistical relationships and adjustment factors which were applied to the forecasts of trade in dry bulk carriers in order to determine future transits by size range.

8.1.2 Global/By Pass Trades

The key issues addressed were:

- the development of average dwts for dry bulk carriers in all sizes in excess of 60,000 dwt;
- the development of individual size ranges in excess of 60,000 dwt as proportions of the global fleet.

Particular consideration was given to vessels in excess of 60,000 dwt as:

- the development of certain size ranges both in terms of average dwts and the proportion of vessels within each size range has been particularly impacted by the current Panama Canal dimensions. With current constraints removed, there is likely to be some change in the capacity and dimensions of vessels in this size range;
- long term changes in the proportions of vessels within each of the larger size ranges will impact on the proportions transiting the Expanded and Unrestricted Canals over the longer term.

In the first instance, the average dwt within each size range in excess of 100,000dwt was forecast was with reference to the (non linear) long term historical rate of change within those sectors. Secondly, average dwts of vessels in the 60,000 – 70,000 dwt and 70,000 – 80,000 dwt size ranges were forecast with reference to the historical rate of change modified to assume that current Panama Canal constraints no longer exist. Results are provided in Table 8.1.2.1.

RLA determined changes in the proportion of vessels of each of the relevant size ranges within the context of the consultants long term total global dry bulk carrier fleet forecasts and the historical rate of change of individual vessel size proportions within this. This was modified as appropriate by shifts in the use of specific sizes in global markets. This results in a global fleet composition which is different to that which would develop if current Panama Canal constraints were to continue. The figures for 2000, which reflect actual mid year data, and the forecasts are provided in Table 8.1.2.1.

The forecasts of average dwts within size range in the global market were used in the forecast of laden transits for dry bulk commodities for the Expanded and Unrestricted Canals.

Adjustment factors were calculated from the forecast of the global fleet by size range which were then applied to the forecasts of the general growth in trade demand as one of the inputs determining the allocation of dry bulk trades to ship sizes. Results are described in Section 9.1.

8.2 Trends in the Full Containership Fleet

Containership size is a critical issue for ACP because it needs to be sure that the expanded Canal will not become obsolete shortly after it is built as a result of increases in vessel size beyond the 'new Panamax' size.

Containership size is determined by the cargo available per minimum frequency of voyage and the physical limits to navigation. It is linked to speed, because the faster a ship is the fewer are required to provide a service, or the smaller they need to be at the same fleet size. Speed is determined by shipbuilding costs, fuel prices and service requirements

The Regina Maersk was the first of the megacarriers, able to load at least 7,000TEU with 1,400TEU reefer slots, and with a 17th row of containers across its deck (14 underdeck). It was the first longer than 300m (APL's post-panamax C10 and C11 designs are 276m), and was the first capable of working by six shore cranes at once.

The design depended on Maersk/Sea-Land's dedicated hub facilities along the key Pacific/Asia/Med/ECNA post-panamax corridor, and their global network of complementary cargo flows.

Otherwise, and apart from its very much more efficient engines, the ship was not so different from the first 22 knot, 1,100TEU gearless full containership of 1968, and the 27 knot, 2,700TEU Panamax ships placed on the Europe/Far East trade in the early 1970s. The same is true of the even larger designs now appearing on drawing boards.

The critical issue for the Canal is future containership size. Will the expanded Canal be sufficient for the next 50 years, or will containerships grow to the Suezmax size of around 18,000 TEU as proposed by Professor Wijnolst, defeating ACP efforts to compete with the landbridge?

powerful enough engine. The present BMW 90HP engines can be optimised to this at a single screw. The propeller would be very large. The largest at present is 8.95 metres diameter, but at 9 metres and up the propeller risks hitting air instead of water when the vessel is part loaded, or increasing the draught. 12,000 TEU at 25 knots with one screw is not possible. The alternative could be two engines, but that would be seriously suboptimal at that size because two engines would cost more, take up more space, and suffer from other disadvantages as well.

Another significant factor is bunker prices. Bunkers are now $150 per ton, whereas 18 months ago they were $60. The vessel would burn 200 tons per day. Of course, future engines will be increasingly efficient.

Other factors include port costs – a larger vessel would face higher port costs and require faster cranes which have further to travel. The Amsterdam inset dock could only be effective when used with a particular sized ship. With a smaller ship only one bank of cranes could be used, the others would be idle. Canal costs must also be taken into account.

There are significant safety aspects. At present most ships have six, occasionally seven, containers high at the side of the ship, where they are partly on the hatch covers and partly on the deck. With eight high there is a significantly increased risk of wire lashings working loose and containers being stripped into the sea in heavy weather. Eight high containers are not permitted in some places such as the US because of fears for safety, and this issue must be addressed. If a solution involves the use of more devices then this will delay the ship.

Of the draft, beam, length variables length is the least problematic, with Maersk vessels already at 347 metres. Draft is something else. Carriers and ports are always arguing which comes first, the depth or the vessels, and it finishes as a compromise.

8.2.6 Conclusion

A fairly simple transhipment model demonstrates that the Beltway concept is untenable in Northern Europe, which wipes out the proposed east-west service structure. The Wijnolst concept is designed only for Europe/Far East trade - there is no Suez limitation on the transpacific - and all larger vessels risk restricting the number of ports which can be served at all, because of draft limitations. Carriers are concerned by the potential power of monopoly ports.

We believe that in the short to medium term the maximum vessel size will stop at around 10,000 TEU but that within 10-20 years the next step, to ships of up to 12,000 TEU will be taken as technical problems are solved. These will be used on Europe/Far East and the transpacific, with the other significant change being that more shuttle services will come into service in preference to transhipment hubs.

Table 8.6.2.1 provides mid year 2000 actual data plus estimates of the future development of the world fleet of fully cellular containerships. This takes into account the expected growth in world containerised trade and the gradual introduction and growth in the supply of increasingly larger vessels in excess of 8,000 TEU. The phase in of these larger ships is dependent on vessel design technology and port developments, plus the growth in trade and the service requirements of operators on the main East-West routes. Estimates take into account also the current composition of the world newbuilding orderbook.

Contrary to normal practice the table is presented in terms of dwt in order to comply with the study terms of reference, which require a common form of size measurement across all ship types. Broadly, current Panamax vessels are up to around 4,400 TEU which means that generally all of the vessels below 60,000 dwt are Panamax or smaller. There are also some appropriate by shifts in the use of specific sizes in global markets. Given that the Panama Canal does not have a significant restrictive impact on the global tanker fleet this did not require adjustment specifically for the Expanded and Unrestricted Canal cases. Results are provided in Table 8.3.2.1 together with mid year 2000 actual figures. Similarly, in the absence of marked trends in the average dwt of tanker, within each of the subject size ranges, no amendments were made to the average dwts in the global fleet over the forecast period. Average dwts were therefore as calculated by RLA as at mid 2000.

8.4 Other Ship Types on Panama Canal Routes

For each of the other vessel types transiting the Canal, the consultants have analysed average dwt and shifts in cargo allocation between size ranges using the same approach as described above for dry bulk carriers, full containerships and tankers. In the absence of significant trends in average dwt by size range, forecasts of transits for these vessels reflect historical averages. Shifts in the allocation of cargo to vessel sizes have been determined statistically and utilised in the forecasts.

None of these vessel types is constrained by Canal dimensions.

Historical time series data on average vessel sizes and cargo distribution by size range are provided in Tables 8.1.1.1 and 8.1.1.2.

Table 8.1.2.1

Dry Bulk Carrier Fleet

Fleet Forecast Assuming Expanded or Unrestricted Canal

000's tons

Size Range	2000	2010	2015	2020	2030	2040	2050
60-70,000	33,113	39,308	41,610	43,751	47,138	50,203	53,007
70-80,000	31,411	37,287	39,471	41,502	44,715	47,623	50,282
80-90,000	2,535	15,796	22,806	30,509	45,320	61,870	80,008
90-100,000	1,299	8,093	11,684	15,631	23,219	31,698	40,991
100-125,000	4,446	5,277	5,586	5,874	6,329	6,740	7,117
125-150,000	20,811	24,704	26,151	27,496	29,625	31,552	33,313
150-175,000	36,645	56,391	66,118	76,320	95,039	115,110	136,482
175-200,000	9,131	14,467	16,963	19,580	24,382	29,531	35,014
200-250,000	7,254	11,493	13,476	15,555	19,371	23,461	27,817
250-300,000	1,561	2,474	2,900	3,348	4,169	5,050	5,987
300,000+	1,323	2,096	2,458	2,837	3,533	4,279	5,074
Total	149,526	217,387	249,223	282,403	342,840	407,117	475,092

Market Share

Size Range	2000	2010	2015	2020	2030	2040	2050
60-70,000	22%	18%	17%	15%	14%	12%	11%
70-80,000	21%	17%	16%	15%	13%	12%	11%
80-90,000	2%	7%	9%	11%	13%	15%	17%
90-100,000	1%	4%	5%	6%	7%	8%	9%
100-125,000	3%	2%	2%	2%	2%	2%	1%
125-150,000	14%	11%	10%	10%	9%	8%	7%
150-175,000	25%	26%	27%	27%	28%	28%	29%
175-200,000	6%	7%	7%	7%	7%	7%	7%
200-250,000	5%	5%	5%	6%	6%	6%	6%
250-300,000	1%	1%	1%	1%	1%	1%	1%
300,000+	1%	1%	1%	1%	1%	1%	1%
Total	100%	100%	100%	100%	100%	100%	100%

Average Dwt

Size Range	2000	2010	2015	2020	2030	2040	2050
60-70,000	65,700	66,741	67,159	67,531	68,168	68,702	69,161
70-80,000	73,218	74,378	74,844	75,258	75,969	76,564	77,076
80-90,000	84,489	85,828	86,366	86,844	87,663	88,350	88,941
90-100,000	92,757	94,227	94,818	95,342	96,242	96,996	97,644
100-125,000	116,990	118,844	119,589	120,251	121,385	122,336	123,154
125-150,000	142,538	144,796	145,705	146,511	147,893	149,051	149,051
150-175,000	162,866	166,108	167,413	168,570	170,555	172,219	173,650
175-200,000	186,337	190,047	191,539	192,863	195,135	197,038	198,676
200-250,000	213,348	217,596	219,304	220,821	223,421	225,600	227,476
250-300,000	260,209	265,390	267,474	269,323	272,495	275,153	277,440
300,000+	330,777	337,363	340,012	342,363	346,395	349,773	352,681

Recent proposals for the enlargement of containerships have ranged downwards from Wijnolst at 18,000 TEU to Ashar at 15,000 TEU to Lloyds Register at 12500 TEU.

8.2.1 Wijnolst

After Rogan McLellan's initial work on a twin screw 15,000 TEU vessel, Germanischer Lloyd also floated the idea of about 15,000 TEUs. Now, Delft University of Technology Professor Niko Wijnolst, has come out with a detailed design for an 18,000 TEU ship, based on the assumption that the Suez Canal will have a draft of 21 metres within 10 years. He says that is likely given the recent pattern of draft increases in the waterway and the apparent intention of the Canal authorities to make it accessible to laden VLCCs (Very Large Crude Carriers).

At 243,611 dwt, the new box ship, designed by Prof Wijnolst and naval architecture student Marco Scholtens, is roughly the size of a VLCC. Like laden VLCCs it will be able to navigate the Malacca and Singapore Straits. So the professor has dubbed his design the Malacca-Max.

Such large vessels would, like VLCCs, only be able to use a few ports and would be unable to serve US ports under current deployments. The intended route for the design is Asia Europe, as the transatlantic and transpacific trades would seem to be inaccessible to the Malacca-Max.

The cost of dredging the Suez Canal to 21 metres is about US$1.65 billion.

The professor sees the new ships operating between just one port in northern Europe, Rotterdam, and a small number in Asia, most notably Singapore. Rotterdam and Singapore would need to see it as being to their advantage to accommodate these big ships. The ports would almost certainly only want to invest in facilities if they could be sure terminals at the other end of the trade would do the same. That would mean some degree of co-operation as would any investment in dredging the Suez Canal.

8.2.2 Ashar

Asaf Ashar, director of the National Ports and Waterways Institute, has proposed an ' Ocean container beltway' in which a round-the-world shipping service using six ships would circle the globe roughly at the equator in 42 days, compared with the more than 70 days common now. The service would skip U.S. and Northern European ports and any other areas off the equator. Those regions would be served by feeder ships the size of today's largest containerships. World trade is expected to double before the beltway concept is likely to take hold two or more decades into the future.

Ashar estimates that up to half of the world's container trade could move via such services. But while considerable operational reordering would be required, today's ports would escape heavy investments in infrastructure.

The Port Authority of New York and New Jersey is on the way to dredging and facilities expansions that are necessary to handle today's megaships, which would become feeders under Ashar's vision.

Ashar's concept allows significantly bigger container ships to be deployed while finding a way around the growing financial and physical barriers to those vessels. The key is the expansion of the Panama Canal to handle ships that can carry some 15,000 TEUs. That is almost double the capacity of today's largest vessels and more than three times the capacity of the biggest container ships the Canal now can accommodate.

The idea is to deploy the new Panamax ships along a relatively straight route around the world, roughly at the equator. The ships would call only at a limited number of what Ashar labels "pure transshipment ports" that would be set up along the route. And new feeder services would haul the containers north and south between traditional seaports and the new transshipment ports.

A variety of factors would promote efficiency: the economies of scale from the vast size of the new ships; the fact that the vessels would not have to deviate from their route to serve traditional ports in the United States and Europe, adding miles and days to their itineraries; and the fact that a round-the-world route maximizes vessel utilisation and avoids the inefficiencies of shuttle and pendulum services, which often have copious unused cargo space at the end points of their runs.

Assuming that the new ships have a speed of 28 knots, which is faster than virtually any containership afloat today, a single weekly service could be fielded using six ships calling at seven pure transshipment ports, Ashar says. A 23,000-mile round-the-world circuit would take 42 days. Daily frequency could be provided in both directions using 84 ships.

The new system would effectively freeze the growing size of the ships now used to serve ports - and the expensive dredging work and new infrastructure needed to accommodate them - because the equatorial service would become the world's primary traffic lane.

Ashar advocates a floating ship-to-ship transfer of containers for his pure transshipment ports. A container would be unloaded from a ship to a barge. A string of barges would be moved by tug to the second ship, and the container would be loaded aboard. The transshipment would require less equipment and fewer moves.

8.2.3 Lloyds Register

The major practical limitation to increases in containership size currently relates to engine number. Naval architects believe that the move to two screws will occur at something under 12,000 TEU. An increase in the number of engines increases the cost per TEU at the same size. Lloyds Register and Ocean Shipping Consultants have settled on a 12,500 TEU ship, at the bottom of the two screw range. Presumably the vessel size adopted also takes into account post constraints.

8.2.4 Current Newbuilding Sizes

Following a P&O Nedlloyd order for vessels of this size, China Shipping Group is to order two container ships of 9,800TEU from Samsung and Hyundai. Previously, the largest ships on order were four 7,200-TEU units at Hyundai for Hapag-Lloyd. The first is due for delivery in October 2001, and current plans are that these will rotate into the Grand Alliance Asia-Europe services. Hapag Lloyd is now considering ordering two more container ships of 7,000 and 9,000 TEU.

Four 6,780 TEU ships are also on order for P&O Nedlloyd, with the first due for delivery in December. All four are destined for Asia-Europe deployment in the Grand Alliance. Maersk Sealand has placed orders for several S-Class ships with stated capacities of 6,600 TEUs though actual capacity could be higher.

Malaysia International Shipping Corp. (MISC, which ranks 18th in world container ship capacity), is currently deliberating over whether to go to Korea or Japan for four new 6,200-TEU ships. Of the world's top 20 lines, all but three have post-Panamax ships on order, and one of those three has Panamax ships of 4,800 TEUs on order.

NYK Line, another Grand Alliance line, has nine 6,200-TEU ships on order, with the first scheduled to enter service in September 2001. Nine ships makes for a complete Asia-Europe string. Another Grand Alliance line, OOCL, took delivery of the last four in a series of 5,500-TEU ships late in 2000. OOCL may place further orders for new ships, the end result being enough to piece together two Asia-Europe strings with their own ships.

In the New World Alliance, Hyundai Merchant Marine has five new 6,500-TEU ships coming out between February and June 2001, and all will go on one trans-Pacific string.

Mitsui O.S.K. Line has five 6,000 TEU ships scheduled for delivery in 2002, and they also are destined for the Pacific. Three new 5,500 TEU ships for the carrier will enter the Asia-Europe trade.

APL will have eight new 5,500 TEU ships in service between May 2001 and mid-2002 on bareboat charter from German and Greek owners for the Asia-Europe trade.

In the Cosco-Yangming-"K" Line alliance, the story is very much the same. "K" Line has 12 ships of 5,500 TEUs on order for delivery in 2001-2002, and eight of these vessels have already been confirmed for entry into the Asia-Europe trade. China Ocean Shipping Corp. has seven 5,250 TEU ships coming out next year, most of which will likely go into the Pacific. Yangming's first two 5,500-TEU ships will be deployed this year in the Asia-Europe trade. Five others look set for the trans-Pacific. Yang Ming is now planning to order five more container ships of 6,000 or 8,000TEU. Mediterranean Shipping have post-Panamax plans of their own.

In late 2000, 108 post-Panamax ships were on order, so that most strings on east-west trades will deploy megaships by the end of 2002. This will spark off the cascading down of capacity.

8.2.5 Carrier Attitudes

Carriers have no doubt that larger ships are more economical and that trade is growing quickly enough to absorb them. Dissatisfaction with the US landbridge is encouraging them to use smaller ships than they would like on services through the Panama Canal or to consider the longer route to ECUSA via Suez. Expansion of the Panama Canal will allow them to serve the ECUSA more economically.

The reason for growth in size is that sea costs per TEU are lower: there is still 40-50 cents per slot to gain which on a typical 56 day round trip Europe/FE gives a $10 saving per slot voyage.

There is disagreement on future vessel sizes, with some believing that 8,000 TEU is the effective limit, and some willing to consider 10,000 TEU in this way, while others refuse to guess. One major carrier interviewed believed that the maximum would be reached at 10-13,000 TEU and would not be more specific, and some were quite happy with ships in the 6-7,000 TEU range. These responses reflect the characteristics of individual trades.

There are significant technical obstacles to larger ships. The key limitation is that the ship must be 25 knots to meet scheduling requirements, and that there must therefore be a

Panamax vessels in the 60,000 – 70,000 dwt size range. Very approximately, the relationships between dwt and TEU sizes may be summarised as follows:

Dwt	TEU
60,000	4,200
70,000	4,900
80,000	5,600
90,000	6,400
100,000	7,100
125,000	8,900
150,000	10,700
175,000	12,500

Table 8.2.6.1

Development of the World Fully Cellular Containership Fleet (mln dwt)

Dwt Size	2000	2001	2002	2003	2004	2005	2010	2015	2020	2030	2040	2050
<10000	4.3	4.3	4.4	4.4	4.5	5.0	5.5	6.0	6.2	6.4	6.5	6.2
10-15000	4.1	4.3	4.5	4.6	4.7	5.1	5.7	6.3	6.7	7.2	7.7	7.9
15-20000	4.0	4.2	4.4	4.5	4.7	5.2	5.7	6.4	6.9	7.5	8.1	8.4
20-25000	8.0	8.2	8.4	8.6	8.9	9.6	10.5	11.2	11.6	11.6	11.3	10.2
25-30000	3.8	3.8	3.9	4.0	4.1	4.5	4.9	5.3	5.6	5.7	5.7	5.4
30-40000	11.1	12.0	12.9	13.9	14.9	15.8	17.3	19.3	20.9	23.0	25.1	26.4
40-50000	12.1	12.5	12.8	13.0	13.3	14.4	15.8	16.9	17.5	17.5	17.0	15.4
50-60000	6.7	7.8	9.0	10.0	11.0	11.7	13.0	15.1	17.1	20.7	24.7	28.4
60-70000	9.5	10.5	11.8	13.0	13.6	14.7	16.5	19.0	21.5	25.6	30.2	34.4
70-80000	0.1	0.8	2.0	3.0	3.8	4.1	5.3	7.6	10.4	16.3	23.4	31.1
80-90000	1.3	1.8	2.0	2.0	2.2	2.7	3.6	4.9	6.4	9.6	13.4	17.5
90-100k	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.7	1.1	1.7	2.4
100-125	1.2	1.5	1.7	2.0	2.2	2.4	2.8	3.5	4.3	5.8	7.6	9.5
125-150	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.5	0.7	1.2	1.8	2.4
150-175	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	2.0	2.7	3.9
	66.2	**71.6**	**77.8**	**83.0**	**87.9**	**95.4**	**107.2**	**122.3**	**136.9**	**161.2**	**186.9**	**209.5**

Over the fifty year forecast period the container fleet is projected to increase by an average of 2.3% per annum. However, growth is expected to be much more robust in the nearer term, averaging 5.0% per annum over the next ten years. While there will be continued growth in the size of the fleet up to Panamax size, most of the increase will be concentrated in the post Panamax sector. As a result the proportion of the world fleet accounted for by vessels below 60,000 dwt – that is, broadly, the fleet of ships up to Panamax size – declines from 82% in 2000 to 73% in 2010 and 52% by 2050.

8.3 Trends in the Tanker Fleet

8.3.1 Panama Trades, Existing Canal

In order to determine trends in the sizes of tankers transiting the Existing Canal, RLA calculated the average dwt within each subject vessel size of tankers transiting the Canal in the historical time series. Additionally, the proportion of cargo allocation to individual sizes was also calculated. These data are presented in Tables 8.1 and 8.2. As with other ship types, there was no discernible trend in average dwts but there were measurable trends in cargo allocations. This particularly centred around a shift towards larger sizes and, in particular from 50,000 – 60,000 dwt vessels to 60,000 – 70,000 dwt vessels.

In order to develop the generic growth in tanker transits over the forecast period, an equation was chosen that represented the future rate of change from which adjustment factors were calculated. The results of this are described in Section 9.3.

8.3.2 Panama Trades, Expanded and Unrestricted Canals

In order to develop transit forecasts for the Expanded and Unrestricted Canals, the consultants utilised their forecasts of the future world fleet and in particular developments in the fleet between 60,000 and 125,000 dwt. As with other ship types being considered here, this was predicated on the notion that trade demand for the Existing Canal would, to an extent, shift upwards in vessel size over time. As the Existing Canal does not represent a constraint on most vessels utilised, this is particularly focused on the 60,000 dwt + fleet.

Table 8.3.2.1

Tanker Fleet Forecast

60,000 - 125,000 dwt

							000's tons
Size Range	**2000**	**2010**	**2015**	**2020**	**2030**	**2040**	**2050**
60-70,000	11,501	12,972	13,375	13,794	13,440	12,721	11,847
70-80,000	2,775	3,424	3,691	3,980	4,238	4,385	4,464
80-90,000	18,195	21,583	23,092	24,612	25,362	25,147	24,357
90-100,000	17,856	20,972	22,439	23,915	24,644	24,435	23,667
100-125,000	18,737	24,520	27,427	30,561	34,423	37,307	39,498
Total	69,064	83,471	90,024	96,862	102,107	103,995	103,833
							Market Share
60-70,000	17%	16%	15%	14%	13%	12%	11%
70-80,000	4%	4%	4%	4%	4%	4%	4%
80-90,000	26%	26%	26%	25%	25%	24%	23%
90-100,000	26%	25%	25%	25%	24%	23%	23%
100-125,000	27%	29%	30%	32%	34%	36%	38%
Total	100%	100%	100%	100%	100%	100%	100%

RLA determined changes, in the proportion of vessels of each of the relevant size ranges within the context of the consultants long term total global tanker fleet forecasts, and the historical rate of change of individual vessel size proportions within this modified as

Table 8.1.1.1

Average Dwt by Vessel Size and Type

Fiscal Years 1985/86 to 1998/99

000's tons

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Container/Break-Bulk														
<10,000	5	5	5	5	7	6	6	7	6	7	5	4	6	6
10-15,000	14	13	13	12	13	14	13	13	14	13	13	14	14	12
15-20,000	17	17	17	17	17	17	17	17	17	17	17	17	17	17
20-25,000	22	22	22	23	23	24	23	22	22	23	22	22	22	22
25-30,000	28	29	29	29	28	28	27	27	27	28	28	28	28	28
30-40,000	34	34	33	34	34	34	35	35	34	35	35	34	33	33
40-50,000	42	42	42	42	42	42	43	43	43	43	43	44	43	44
60-70,000	-	-	63	63	63	-	-	-	-	65	63	63	70	63
Dry Bulk Carrier														
<10,000	6	6	7	6	6	5	5	5	5	5	5	6	5	4
10-15,000	13	12	12	12	12	12	12	12	12	12	12	12	13	13
15-20,000	18	18	18	18	18	18	18	18	18	18	18	18	18	18
20-25,000	23	23	23	23	23	23	23	23	23	23	23	23	23	23
25-30,000	27	27	27	28	27	28	28	27	27	27	27	27	27	27
30-40,000	36	36	36	36	35	36	36	35	35	35	36	36	36	36
40-50,000	44	43	43	43	43	43	43	44	43	44	44	44	44	44
50-60,000	57	55	56	56	56	56	56	55	55	55	55	54	54	53
60-70,000	63	64	64	64	64	64	65	65	65	65	66	66	66	66
70-80,000	73	73	74	73	73	73	74	73	73	73	73	72	72	72
80-90,000	-	81	80	82	81	81	81	81	80	80	80	81	-	80
90-100,0000	-	-	-	-	-	-	-	-	91	91	-	-	91	-
Dry/Liquid Bulk Carrier														
<10,000	-	-	-	9	9	7	-	-	-	-	-	-	-	-
10-15,000	10	10	-	-	-	-	-	-	13	-	-	-	-	-
15-20,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25-30,000	-	-	-	-	-	-	-	-	-	-	-	-	-	26
30-40,000	39	-	37	37	-	-	-	37	-	-	-	-	-	-
40-50,000	47	95	92	90	92	89	89	93	92	92	92	88	87	89
50-60,000	54	54	-	-	54	54	-	54	-	58	58	54	59	-

Average Dwt by Vessel Size and Type

Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Dry/Liquid Bulk Carrier cont..														000's tons
60-70,000	69	70	69	69	66	67	67	69	69	67	64	66	65	64
70-80,000	73	75	74	76	73	73	77	76	75	74	75	77	74	75
80-90,000	84	83	82	-	-	82	-	82	-	83	82	83	-	82
Full Container														
<10,000	8	8	8	7	2	10	6	6	7	8	9	7	5	6
10-15,000	13	12	12	12	12	13	13	13	13	13	13	13	14	14
15-20,000	18	17	17	17	16	16	17	17	18	18	19	18	19	18
20-25,000	23	22	23	23	23	23	23	23	22	22	22	22	22	22
25-30,000	28	28	27	27	27	27	27	28	28	28	28	29	28	28
30-40,000	33	34	35	35	35	35	36	36	37	37	37	37	36	35
40-50,000	43	43	43	43	43	43	43	44	44	45	45	45	45	45
50-60,000	55	53	53	54	55	56	57	58	58	57	58	57	57	58
60-70,000	-	-	-	-	-	-	-	-	62	62	62	62	62	62
General Cargo														
<10,000	6	6	5	5	5	6	5	5	5	5	5	5	5	5
10-15,000	13	14	14	14	14	13	13	13	13	13	14	13	14	13
15-20,000	16	17	17	17	16	17	17	17	17	17	17	17	17	17
20-25,000	22	22	22	22	22	22	22	23	22	22	22	22	22	23
25-30,000	25	25	26	25	25	26	28	26	28	27	27	28	28	28
30-40,000	38	38	38	38	38	36	-	33	34	37	36	35	33	36
40-50,000	-	-	-	-	-	-	-	-	-	43	44	-	43	-
50-60,000	-	-	-	-	-	-	-	-	-	-	-	51	51	51
70-80,000	-	-	-	-	-	-	-	-	-	-	-	-	73	-
Liquid Gas														
<10,000	7	6	6	5	5	6	6	6	7	6	8	5	6	6
10-15,000	12	11	12	12	12	12	12	12	12	12	12	12	12	13
15-20,000	17	17	17	17	17	17	17	17	17	17	17	17	17	17
20-25,000	21	21	22	21	22	22	22	22	23	23	22	23	22	22

Table 8.1.1.1 (continued)

Average Dwt by Vessel Size and Type
Fiscal Years 1985/86 to 1998/99

000's tons

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Liquid Gas cont..														
25-30,000	27	26	-	28	28	28	26	28	28	26	27	27	27	27
30-40,000	38	38	39	38	36	38	37	39	40	39	39	40	-	38
40-50,000	45	45	46	45	45	46	46	46	45	45	46	45	45	45
Other														
<10,000	3	3	3	3	3	3	3	4	3	4	3	3	3	4
10-15,000	13	12	12	12	12	13	13	13	13	12	13	12	13	13
15-20,000	18	17	17	17	16	17	17	17	17	18	17	17	17	17
20-25,000	22	20	23	24	21	21	22	22	22	23	23	21	22	22
25-30,000	28	28	28	-	-	-	30	-	28	29	26	-	-	29
30-40,000	36	37	37	36	36	35	37	37	36	35	38	-	35	39
40-50,000	47	47	42	44	-	46	46	45	45	44	44	45	47	47
Refrigerated Cargo	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<10,000	7	7	7	7	7	8	8	7	7	7	7	7	7	8
10-15,000	11	11	12	11	11	12	12	12	12	12	12	12	12	11
15-20,000	15	15	16	16	16	16	16	17	16	16	15	15	15	15
20-25,000	-	-	-	-	-	-	-	-	-	-	20	-	-	-
Roll-on/Roll-off														
<10,000	6	6	8	9	8	6	4	5	5	4	5	5	5	6
10-15,000	13	13	13	13	13	13	13	13	13	13	13	13	12	12
15-20,000	17	18	17	18	18	17	18	18	17	17	18	18	18	17
20-25,000	22	22	21	22	22	22	22	22	22	22	22	22	22	22
25-30,000	26	26	26	26	27	27	28	27	27	28	27	27	27	27
30-40,000	33	33	33	33	33	33	34	33	33	33	33	33	33	34
40-50,000	43	43	43	43	43	43	43	43	43	43	43	44	44	44
50-60,000	-	51	52	-	-	-	-	-	-	-	53	-	-	-

Table 8.1.1.1 (continued)

Average Dwt by Vessel Size and Type
Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Tanker														000's tons
<10,000	6	6	6	7	6	6	6	7	6	6	6	7	6	7
10-15,000	13	13	12	12	12	12	12	12	12	12	12	12	12	12
15-20,000	18	18	18	18	18	18	18	19	18	18	18	18	17	17
20-25,000	23	23	24	23	23	24	24	23	23	23	23	22	22	22
25-30,000	28	28	28	28	28	28	28	28	28	28	28	28	29	29
30-40,000	35	35	34	35	35	36	36	36	36	36	36	36	36	36
40-50,000	44	43	45	46	45	45	45	45	45	45	44	43	44	44
50-60,000	55	56	55	56	56	56	56	56	58	57	57	58	57	57
60-70,000	63	63	63	63	62	64	64	64	64	65	63	63	63	63
70-80,000	74	71	-	-	-	75	75	70	70	70	70	70	70	72
80-90,000	81	90	-	-	-	82	81	81	82	82	88	81	81	85
90-100,000	91	92	91	91	91	91	91	91	92	91	91	92	-	-
Vehicle Carrier														
<10,000	8	7	8	8	8	8	8	6	4	4	5	7	9	8
10-15,000	13	13	13	13	13	13	13	13	13	13	13	13	13	13
15-20,000	17	17	17	17	17	17	17	17	17	17	17	17	17	17
20-25,000	23	22	23	23	23	22	23	22	22	22	22	22	22	22
25-30,000	28	28	28	28	28	28	28	28	28	28	28	28	28	28
Vehicle/Dry Bulk														
<10,000	-	-	-	-	-	-	-	-	-	-	-	7	-	-
10-15,000	14	14	14	14	14	14	14	14	14	14	-	-	14	-
15-20,000	18	17	19	17	19	0	18	17	17	17	17	17	16	16
20-25,000	22	22	22	22	22	23	22	22	22	23	22	20	21	22
25-30,000	27	27	28	28	28	28	28	28	27	28	27	28	27	29
30-40,000	35	34	35	35	35	35	35	35	34	35	33	33	34	32
40-50,000	41	41	41	41	40	41	41	40	41	-	40	50	41	41
50-60,000	53	53	52	52	52	52	52	53	53	52	51	51	53	53
60-70,000	63	63	63	63	63	62	62	62	62	63	63	62	64	62

Table 8.1.1.2

Distribution of Cargoes to Vessel Size Ranges

Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
													Market Share	
Container/Break-Bulk														
<10,000	0.03	0.03	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02
10-15,000	0.04	0.04	0.06	0.07	0.06	0.06	0.07	0.08	0.03	0.02	0.02	0.02	0.01	0.01
15-20,000	0.23	0.22	0.17	0.16	0.17	0.16	0.20	0.17	0.19	0.16	0.12	0.17	0.10	0.07
20-25,000	0.15	0.16	0.14	0.14	0.08	0.04	0.08	0.07	0.08	0.13	0.12	0.08	0.10	0.09
25-30,000	0.09	0.09	0.10	0.12	0.15	0.16	0.06	0.13	0.14	0.05	0.09	0.08	0.09	0.09
30-40,000	0.09	0.15	0.17	0.17	0.16	0.16	0.16	0.11	0.08	0.10	0.16	0.12	0.12	0.09
40-50,000	0.37	0.33	0.33	0.32	0.37	0.41	0.42	0.42	0.47	0.49	0.47	0.49	0.56	0.61
60-70,000	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.03	0.02	0.02	0.01	0.01
Dry Bulk Carrier														
<10,000	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
10-15,000	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
15-20,000	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.02	0.01
20-25,000	0.05	0.05	0.05	0.06	0.05	0.04	0.04	0.04	0.04	0.05	0.03	0.04	0.04	0.03
25-30,000	0.14	0.15	0.14	0.15	0.14	0.13	0.11	0.12	0.12	0.11	0.11	0.11	0.13	0.12
30-40,000	0.22	0.22	0.22	0.23	0.23	0.21	0.19	0.17	0.16	0.15	0.15	0.14	0.14	0.11
40-50,000	0.16	0.13	0.14	0.13	0.13	0.15	0.17	0.17	0.16	0.18	0.20	0.22	0.25	0.26
50-60,000	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.03
60-70,000	0.29	0.32	0.33	0.32	0.34	0.35	0.36	0.38	0.37	0.39	0.37	0.34	0.28	0.28
70-80,000	0.04	0.03	0.04	0.03	0.04	0.03	0.04	0.03	0.05	0.05	0.07	0.08	0.11	0.14
80-90,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90-100,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dry/Liquid Bulk Carrier														
<10,000	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-15,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
15-20,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-25,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
25-30,000	0.05	0.00	0.04	0.04	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
30-40,000	0.09	0.13	0.24	0.11	0.15	0.29	0.27	0.17	0.25	0.20	0.29	0.45	0.23	0.39

Table 8.1.1.2 (continued)

Distribution of Cargoes to Vessel Size Ranges
Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99 Market Share
Dry/Liquid Bulk Carrier cont..														
40-50,000	0.26	0.18	0.06	0.00	0.20	0.26	0.00	0.10	0.07	0.30	0.29	0.20	0.15	0.05
50-60,000	0.15	0.22	0.36	0.39	0.31	0.15	0.33	0.28	0.44	0.14	0.10	0.19	0.39	0.10
70-80,000	0.41	0.37	0.24	0.45	0.32	0.19	0.41	0.40	0.23	0.23	0.25	0.14	0.23	0.38
80-90,000	0.04	0.09	0.07	0.00	0.00	0.08	0.00	0.02	0.00	0.13	0.07	0.03	0.00	0.06
Full Container														
<10,000	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
10-15,000	0.00	0.01	0.01	0.01	0.01	0.02	0.03	0.05	0.05	0.05	0.03	0.01	0.01	0.01
15-20,000	0.03	0.04	0.05	0.03	0.02	0.01	0.01	0.02	0.02	0.03	0.01	0.01	0.02	0.01
20-25,000	0.13	0.12	0.11	0.11	0.13	0.10	0.08	0.06	0.07	0.12	0.15	0.15	0.14	0.10
25-30,000	0.09	0.08	0.07	0.07	0.08	0.08	0.09	0.07	0.05	0.05	0.04	0.05	0.08	0.10
30-40,000	0.34	0.31	0.32	0.31	0.29	0.29	0.26	0.22	0.17	0.17	0.19	0.17	0.16	0.18
40-50,000	0.19	0.33	0.28	0.24	0.25	0.26	0.29	0.37	0.40	0.33	0.30	0.29	0.32	0.32
50-60,000	0.19	0.11	0.14	0.22	0.22	0.23	0.23	0.20	0.22	0.24	0.22	0.22	0.23	0.22
60-70,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.08	0.05	0.06
General Cargo														
<10,000	0.14	0.13	0.11	0.10	0.10	0.12	0.12	0.14	0.13	0.13	0.12	0.15	0.14	0.21
10-15,000	0.47	0.42	0.39	0.32	0.35	0.35	0.36	0.34	0.34	0.31	0.23	0.17	0.13	0.11
15-20,000	0.27	0.32	0.33	0.37	0.36	0.38	0.39	0.37	0.35	0.32	0.33	0.32	0.32	0.28
20-25,000	0.09	0.12	0.16	0.19	0.18	0.14	0.13	0.13	0.17	0.21	0.28	0.28	0.25	0.23
25-30,000	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.07	0.12	0.13
30-40,000	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.03	0.01
40-50,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00
50-60,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03
70-80,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Liquid Gas														
<10,000	0.05	0.03	0.06	0.04	0.06	0.07	0.08	0.08	0.07	0.06	0.05	0.05	0.09	0.06
10-15,000	0.03	0.04	0.06	0.08	0.13	0.14	0.12	0.08	0.05	0.07	0.08	0.14	0.13	0.14
15-20,000	0.29	0.17	0.21	0.22	0.15	0.20	0.31	0.32	0.30	0.30	0.22	0.25	0.30	0.26

Table 8.1.1.2 (continued)

Distribution of Cargoes to Vessel Size Ranges

Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
													Market Share	
Liquid Gas cont.														
20-25,000	0.10	0.17	0.12	0.11	0.25	0.15	0.06	0.04	0.12	0.15	0.09	0.16	0.17	0.14
25-30,000	0.08	0.01	0.00	0.06	0.05	0.13	0.01	0.06	0.12	0.07	0.04	0.06	0.02	0.06
30-40,000	0.19	0.21	0.23	0.18	0.19	0.22	0.16	0.27	0.13	0.16	0.27	0.21	0.00	0.12
40-50,000	0.26	0.36	0.32	0.30	0.18	0.09	0.27	0.14	0.21	0.20	0.25	0.13	0.29	0.22
Other														
<10,000	0.61	0.56	0.49	0.67	0.54	0.45	0.49	0.57	0.54	0.34	0.46	0.51	0.32	0.24
10-15,000	0.07	0.03	0.07	0.04	0.10	0.16	0.03	0.04	0.02	0.03	0.09	0.16	0.20	0.08
15-20,000	0.03	0.10	0.08	0.04	0.10	0.09	0.10	0.07	0.12	0.09	0.07	0.03	0.06	0.03
20-25,000	0.04	0.02	0.18	0.03	0.14	0.14	0.21	0.10	0.09	0.12	0.04	0.01	0.03	0.03
25-30,000	0.04	0.08	0.03	0.00	0.00	0.00	0.01	0.00	0.03	0.02	0.00	0.00	0.00	0.02
30-40,000	0.17	0.16	0.16	0.17	0.11	0.16	0.08	0.04	0.05	0.14	0.07	0.00	0.06	0.09
40-50,000	0.04	0.05	0.00	0.04	0.00	0.00	0.08	0.18	0.15	0.27	0.26	0.29	0.33	0.50
Refrigerated Cargo														
<10,000	0.61	0.55	0.55	0.56	0.53	0.56	0.53	0.48	0.49	0.51	0.51	0.47	0.48	0.47
10-15,000	0.38	0.43	0.43	0.43	0.45	0.42	0.45	0.51	0.51	0.48	0.47	0.52	0.52	0.53
15-20,000	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.01	0.02	0.01	0.00	0.00
20-25,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Roll-on/Roll-off														
<10,000	0.11	0.11	0.09	0.07	0.14	0.08	0.09	0.11	0.08	0.03	0.01	0.02	0.02	0.06
10-15,000	0.03	0.01	0.02	0.02	0.02	0.02	0.06	0.05	0.08	0.17	0.19	0.17	0.15	0.11
15-20,000	0.06	0.06	0.06	0.06	0.08	0.05	0.04	0.08	0.13	0.16	0.09	0.07	0.04	0.16
20-25,000	0.18	0.16	0.11	0.04	0.06	0.05	0.10	0.11	0.07	0.06	0.07	0.04	0.08	0.09
25-30,000	0.29	0.27	0.30	0.42	0.25	0.16	0.07	0.09	0.09	0.04	0.13	0.08	0.05	0.04
30-40,000	0.22	0.20	0.25	0.25	0.27	0.39	0.39	0.34	0.34	0.33	0.31	0.35	0.34	0.28
40-50,000	0.11	0.17	0.16	0.13	0.18	0.24	0.25	0.22	0.21	0.20	0.18	0.27	0.31	0.26
50-60,000	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00

Table 8.1.1.2 (continued)

Distribution of Cargoes to Vessel Size Ranges
Fiscal Years 1985/86 to 1998/99

Ship Type / Size Range	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
													Market Share	
Tanker														
<10,000	0.03	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
10-15,000	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.03
15-20,000	0.02	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.02
20-25,000	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.01	0.01	0.02	0.02
25-30,000	0.05	0.06	0.06	0.08	0.07	0.06	0.05	0.05	0.06	0.05	0.05	0.07	0.07	0.06
30-40,000	0.31	0.34	0.35	0.35	0.31	0.32	0.31	0.29	0.29	0.30	0.31	0.30	0.26	0.33
40-50,000	0.10	0.09	0.08	0.07	0.07	0.09	0.09	0.10	0.09	0.08	0.11	0.11	0.09	0.16
50-60,000	0.29	0.24	0.26	0.22	0.27	0.25	0.25	0.25	0.24	0.18	0.10	0.13	0.16	0.10
60-70,000	0.14	0.15	0.13	0.17	0.16	0.17	0.17	0.17	0.20	0.24	0.31	0.28	0.29	0.23
70-80,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.02	0.02
80-90,000	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
90-100,000	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.04	0.01	0.00	0.00
Vehicle Carrier														
<10,000	0.06	0.05	0.04	0.04	0.05	0.04	0.03	0.03	0.01	0.01	0.02	0.02	0.03	0.02
10-15,000	0.59	0.55	0.56	0.52	0.55	0.56	0.59	0.53	0.51	0.45	0.49	0.44	0.38	0.42
15-20,000	0.29	0.36	0.34	0.37	0.35	0.36	0.34	0.35	0.39	0.42	0.38	0.40	0.44	0.38
20-25,000	0.01	0.01	0.01	0.03	0.02	0.01	0.02	0.06	0.06	0.07	0.07	0.09	0.11	0.16
25-30,000	0.05	0.03	0.04	0.04	0.03	0.03	0.02	0.04	0.04	0.04	0.05	0.05	0.04	0.03
Vehicle/Dry Bulk														
<10,000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-15,000	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.02	0.01	0.01	0.00	0.00	0.01	0.00
15-20,000	0.02	0.03	0.02	0.02	0.01	0.00	0.02	0.04	0.07	0.06	0.07	0.15	0.10	0.06
20-25,000	0.08	0.05	0.09	0.10	0.09	0.06	0.07	0.03	0.05	0.05	0.02	0.01	0.05	0.17
25-30,000	0.03	0.13	0.16	0.13	0.14	0.10	0.10	0.09	0.12	0.15	0.07	0.08	0.03	0.02
30-40,000	0.51	0.39	0.41	0.33	0.40	0.54	0.49	0.43	0.55	0.41	0.44	0.42	0.56	0.44
40-50,000	0.03	0.01	0.01	0.03	0.04	0.04	0.04	0.03	0.04	0.00	0.01	0.03	0.08	0.03
50-60,000	0.04	0.09	0.12	0.10	0.09	0.13	0.12	0.11	0.07	0.16	0.14	0.16	0.04	0.05
60-70,000	0.28	0.29	0.18	0.27	0.19	0.10	0.15	0.25	0.10	0.16	0.25	0.15	0.13	0.24

9 Forecasts of Commodity Flows by Vessel Type and Size

9.1 Dry Bulk Carriers

9.1.1 Generic Growth

The allocation of dry bulk cargoes to vessel sizes based on the generic growth in trade flows is provided in Table 9.1.1.1. Dry bulk carrier trade in total is forecast to increase by an average of 1.5% per annum with the rate of increase southbound higher than that northbound.

Table 9.1.1.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Dry Bulk Carriers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	150	119	81	41	1	0	0	0
10-15000	N	219	247	278	307	337	394	452	510
15-20000	N	770	818	863	900	942	1,022	1,100	1,174
20-25000	N	1,686	1,795	1,886	1,959	2,051	2,205	2,360	2,510
25-30000	N	5,103	5,525	5,876	6,171	6,536	7,133	7,748	8,351
30-40000	N	6,442	6,680	6,799	6,857	6,994	7,162	7,340	7,492
40-50000	N	8,156	9,380	10,636	11,746	12,969	15,222	17,513	19,793
50-60000	N	1,446	1,507	1,540	1,556	1,593	1,639	1,689	1,733
60-70000	N	13,426	14,798	16,185	17,285	18,540	20,889	23,214	25,416
70-80000	N	3,060	3,595	4,171	4,659	5,183	6,177	7,163	8,114
80-90000	N	39	44	49	54	59	69	79	88
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	218	187	130	68	1	0	0	0
10-15000	S	506	611	716	823	943	1,194	1,471	1,781
15-20000	S	1,034	1,175	1,289	1,398	1,524	1,783	2,057	2,361
20-25000	S	2,320	2,590	2,817	3,044	3,299	3,810	4,344	4,919
25-30000	S	7,044	7,882	8,635	9,388	10,215	11,913	13,704	15,639
30-40000	S	7,644	8,145	8,498	8,837	9,219	9,972	10,712	11,460
40-50000	S	14,816	17,265	19,838	22,346	24,892	30,136	35,546	41,184
50-60000	S	2,260	2,373	2,456	2,539	2,623	2,797	2,969	3,140
60-70000	S	25,660	28,556	31,438	34,259	37,029	42,743	48,542	54,466
70-80000	S	6,022	7,155	8,371	9,553	10,723	13,115	15,553	18,056
80-90000	S	214	250	288	326	362	436	511	588
90-100k	S	0	0	0	0	0	0	0	0
Total North		**40,497**	**44,508**	**48,365**	**51,535**	**55,204**	**61,911**	**68,657**	**75,182**
Total South		**67,737**	**76,189**	**84,476**	**92,582**	**100,831**	**117,899**	**135,409**	**153,594**
Grand Total		**108,233**	**120,697**	**132,841**	**144,116**	**156,035**	**179,811**	**204,067**	**228,776**

Within the constraints of the existing Canal, northbound cargo is expected to be increasingly re-allocated away from vessels below 40,000 dwt. The share of all vessel sizes above 40,000 dwt either increases or is maintained with 65% of cargo being carried in these larger sizes in 2001 and 73% in 2050. A similar trend is forecast southbound but the rate of change is not so fast with 72% of all cargoes being carried in vessels in excess of 40,000 dwt in 2001 and 76% in 2050.

9.1.2 Expanded Canal

In the Expanded Canal conditions, cargo carried in vessels of 60,000+ dwt shifts towards larger sizes. The cargo carrying market share of vessels in the 60,000 – 70,000 dwt size range on northbound routes declines from 33% in 2001 to 22% in 2050. Cargo allocated to vessels in the size ranges between 70,000 dwt and 100,000 dwt increases to 21% compared to 8% in 2001. Additional by pass trade attracted by the Expanded Canal is reflected in the 4% of cargo allocated to vessels in excess of 125,000 dwt.

Southbound, the market share of cargo allocated to vessels in excess of 60,000 dwt remains virtually unchanged over the time period although existing Canal trades shift from 38% in vessels of 60,000 – 70,000 dwt to 22%. Trade is expected to shift up to and around vessels of 100,000 dwt.

By pass trade is 6 %of all cargoes carried and all of this is expected to be in vessels in excess of 100,000 dwt.

Table 9.1.2.1

Commodity Trade Flows for Dry Bulk Carriers, Expanded Canal

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	150	119	80	41	1	0	0	0
10-15000	N	219	247	277	305	335	393	450	508
15-20000	N	770	818	861	898	940	1,019	1,097	1,172
20-25000	N	1,686	1,795	1,881	1,954	2,046	2,200	2,355	2,505
25-30000	N	5,103	5,525	5,866	6,161	6,525	7,121	7,737	8,341
30-40000	N	6,442	6,680	6,792	6,851	6,987	7,156	7,335	7,488
40-50000	N	8,156	9,380	10,625	11,733	12,955	15,207	17,498	19,779
50-60000	N	1,446	1,507	1,539	1,555	1,592	1,638	1,688	1,732
60-70000	N	13,426	14,798	15,341	15,599	15,957	16,509	17,018	17,429
70-80000	N	3,060	3,595	3,773	4,006	4,248	4,637	4,969	5,242
80-90000	N	39	44	888	1,617	2,401	3,998	5,642	7,288
90-100k	N	0	0	385	759	1,156	1,971	2,810	3,648
100-125k	N	0	0	0	0	0	0	0	0
125-150k	N	0	0	1,219	1,140	1,065	992	899	775
150-175k	N	0	0	2,016	2,089	2,142	2,305	2,376	2,302
<10000	S	218	187	130	68	1	0	0	0
10-15000	S	506	611	713	820	940	1,191	1,467	1,778
15-20000	S	1,034	1,175	1,285	1,393	1,520	1,777	2,053	2,356
20-25000	S	2,320	2,590	2,810	3,037	3,291	3,801	4,336	4,912
25-30000	S	7,044	7,882	8,623	9,375	10,201	11,898	13,690	15,627
30-40000	S	7,644	8,145	8,487	8,826	9,208	9,961	10,703	11,453
40-50000	S	14,816	17,265	19,821	22,330	24,874	30,118	35,529	41,171
50-60000	S	2,260	2,373	2,455	2,538	2,621	2,796	2,968	3,139
60-70000	S	25,660	28,556	29,137	29,954	30,608	31,809	32,949	34,048
70-80000	S	6,022	7,155	8,092	8,678	9,200	10,135	10,976	11,757
80-90000	S	214	250	1,980	3,737	5,611	9,553	13,737	18,119
90-100k	S	0	0	885	1,766	2,691	4,793	6,939	9,182
100-125k	S	0	0	2,908	3,097	1,138	1,131	1,110	1,081
125-150k	S	0	0	1,188	1,216	1,158	1,427	1,785	2,264
150-175k	S	0	0	1,743	1,975	2,063	2,933	4,168	5,934
Total North		**40,497**	**44,508**	**51,544**	**54,706**	**58,350**	**65,145**	**71,875**	**78,210**
Total South		**67,737**	**76,189**	**90,255**	**98,808**	**105,124**	**123,324**	**142,411**	**162,821**
Grand Total		**108,233**	**120,697**	**141,799**	**153,514**	**163,474**	**188,469**	**214,286**	**241,031**

9.1.3 Unrestricted Canal

In this case, no further re-allocation of existing Canal cargo to larger vessel sizes is expected. All of the By Pass trade is in vessels in excess of 125,000 dwt and represents 4% of northbound and over 8% of southbound

Table 9.1.3.1

Commodity Trade Flows for Dry Bulk Carriers, Unrestricted Canal

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	150	119	80	41	1	0	0	0
10-15000	N	219	247	277	305	335	393	450	508
15-20000	N	770	818	861	898	940	1,019	1,097	1,172
20-25000	N	1,686	1,795	1,881	1,954	2,046	2,200	2,355	2,505
25-30000	N	5,103	5,525	5,866	6,161	6,525	7,121	7,737	8,341
30-40000	N	6,442	6,680	6,792	6,851	6,987	7,156	7,335	7,488
40-50000	N	8,156	9,380	10,625	11,733	12,955	15,207	17,498	19,779
50-60000	N	1,446	1,507	1,539	1,555	1,592	1,638	1,688	1,732
60-70000	N	13,426	14,798	15,341	15,599	15,957	16,509	17,018	17,429
70-80000	N	3,060	3,595	3,773	4,006	4,248	4,637	4,969	5,242
80-90000	N	39	44	888	1,617	2,401	3,998	5,642	7,288
90-100k	N	0	0	385	759	1,156	1,971	2,810	3,648
100-125k	N	0	0	0	0	0	0	0	0
125-150k	N	0	0	1,219	1,140	1,065	992	899	775
150-175k	N	0	0	2,016	2,089	2,142	2,305	2,376	2,302
175-200k	N	0	0	259	268	275	296	305	165
200-250k	N	0	0	0	0	0	0	0	131
250-300k	N	0	0	0	0	0	0	0	0
<10000	S	218	187	130	68	1	0	0	0
10-15000	S	506	611	713	820	940	1,191	1,467	1,778
15-20000	S	1,034	1,175	1,285	1,393	1,520	1,777	2,053	2,356
20-25000	S	2,320	2,590	2,810	3,037	3,291	3,801	4,336	4,912
25-30000	S	7,044	7,882	8,623	9,375	10,201	11,898	13,690	15,627
30-40000	S	7,644	8,145	8,487	8,826	9,208	9,961	10,703	11,453
40-50000	S	14,816	17,265	19,821	22,330	24,874	30,118	35,529	41,171
50-60000	S	2,260	2,373	2,455	2,538	2,621	2,796	2,968	3,139
60-70000	S	25,660	28,556	29,137	29,954	30,608	31,809	32,949	34,048
70-80000	S	6,022	7,155	8,092	8,678	9,200	10,135	10,976	11,757
80-90000	S	214	250	1,980	3,737	5,611	9,553	13,737	18,119
90-100k	S	0	0	885	1,766	2,691	4,793	6,939	9,182
100-125k	S	0	0	0	0	0	0	0	0
125-150k	S	0	0	4,019	4,231	2,215	2,454	2,759	3,176
150-175k	S	0	0	2,431	2,730	5,028	6,294	7,843	9,264
175-200k	S	0	0	456	511	544	702	905	1,241
200-250k	S	0	0	0	0	0	0	0	500
250-300k	S	0	0	0	0	0	0	0	0
Total North		**51,618**	**44,508**	**51,803**	**54,974**	**58,625**	**65,441**	**72,181**	**78,506**
Total South		**67,737**	**76,189**	**91,323**	**99,993**	**108,554**	**127,283**	**146,856**	**167,724**
Grand Total		**119,354**	**120,697**	**143,126**	**154,968**	**167,179**	**192,724**	**219,037**	**246,230**

9.2 Full Containerships

9.2.1 Generic Growth

The allocation of cargoes to vessel sizes based on the generic growth in trade volumes is provided in Table 9.2.1.1. Full containership trade in total is forecast to increase by an average of 2% per annum.

Within the constraints of the existing Canal, northbound cargo is expected to be increasingly re-allocated away from vessels in the 30,000 - 40,000 dwt to the three higher vessel sizes. The share of cargo being carried in vessel sizes above 40,000 dwt increases from 45% in 2001 to 52% in 2050. The carriage of cargoes in vessel sizes below 30,000 dwt also increases a little. A similar trend is forecast for southbound routes but the rate of change is not so fast.

Table 9.2.1.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Full Containerships

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	29	0	0	0	0	0	0	0
10-15000	N	657	830	1,055	1,236	1,423	1,814	2,207	2,638
15-20000	N	281	263	220	155	83	0	0	0
20-25000	N	2,777	3,391	4,121	4,668	5,224	6,356	7,444	8,594
25-30000	N	2,044	2,422	2,797	3,031	3,264	3,742	4,185	4,653
30-40000	N	3,582	3,960	4,295	4,388	4,461	4,544	4,478	4,323
40-50000	N	4,953	6,030	7,314	8,170	8,986	10,582	11,953	13,284
50-60000	N	1,338	1,699	2,139	2,455	2,760	3,365	3,909	4,450
60-70000	N	1,222	1,603	2,074	2,423	2,750	3,374	3,891	4,356
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	29	0	0	0	0	0	0	0
10-15000	S	712	938	1,183	1,376	1,572	1,979	2,366	2,769
15-20000	S	281	281	235	165	88	0	0	0
20-25000	S	2,308	3,222	4,025	4,643	5,261	6,513	7,657	8,818
25-30000	S	1,978	2,352	2,721	2,941	3,157	3,597	3,982	4,373
30-40000	S	3,782	4,201	4,461	4,469	4,471	4,449	4,301	4,089
40-50000	S	5,394	6,352	7,382	7,993	8,605	9,868	11,111	12,523
50-60000	S	1,316	1,512	1,811	2,006	2,194	2,570	2,912	3,262
60-70000	S	1,829	2,376	2,965	3,377	3,780	4,588	5,392	6,296
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**16,883**	**20,197**	**24,016**	**26,526**	**28,951**	**33,776**	**38,067**	**42,298**
Total South		**17,628**	**21,233**	**24,783**	**26,970**	**29,128**	**33,564**	**37,720**	**42,131**
Grand Total		**34,512**	**41,430**	**48,798**	**53,496**	**58,079**	**67,340**	**75,787**	**84,429**

9.2.2 Expanded Canal

In the Expanded Canal conditions, cargo carried in vessels of 60,000- 70,000 dwt shifts towards larger sizes. Both northbound and southbound, around 50% of the cargoes that were carried in this size range shift towards the 70,000 – 80,000 dwt range.

After the inclusion of by pass trade, between 28% and 30%, varying by year, of southbound cargo is carried in vessels in excess of 70,000 dwt while northbound the proportion varies between 23% and 24% (Table 9.2.2.1).

Table 9.2.2.1

Commodity Trade Flows for Full Containerships, Expanded Canal

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050 (000's tons)
<10000	N	29	0	0	0	0	0	0	0
10-15000	N	657	830	1,055	1,236	1,423	1,814	2,207	2,638
15-20000	N	281	263	220	155	83	0	0	0
20-25000	N	2,777	3,391	4,121	4,668	5,224	6,356	7,444	8,594
25-30000	N	2,044	2,422	2,797	3,031	3,264	3,742	4,185	4,653
30-40000	N	3,582	3,960	4,295	4,388	4,461	4,544	4,478	4,323
40-50000	N	4,953	6,030	7,314	8,170	8,986	10,582	11,953	13,284
50-60000	N	1,338	1,699	2,139	2,455	2,760	3,365	3,909	4,450
60-70000	N	1,222	1,603	1,129	1,243	1,337	1,516	1,597	1,649
70-80000	N	0	0	1,008	1,035	1,041	1,131	1,163	1,164
80-90000	N	0	0	1,274	1,363	1,447	1,745	1,950	2,138
90-100k	N	0	0	332	373	417	492	560	625
100-125k	N	0	0	1,924	2,180	2,449	2,843	3,281	3,718
125-150k	N	0	0	553	535	511	509	489	463
150-175k	N	0	0	2,047	2,383	2,686	3,106	3,411	3,641
<10000	S	29	0	0	0	0	0	0	0
10-15000	S	712	938	1,183	1,376	1,572	1,979	2,366	2,769
15-20000	S	281	281	235	165	88	0	0	0
20-25000	S	2,308	3,222	4,025	4,643	5,261	6,513	7,657	8,818
25-30000	S	1,978	2,352	2,721	2,941	3,157	3,597	3,982	4,373
30-40000	S	3,782	4,201	4,461	4,469	4,471	4,449	4,301	4,089
40-50000	S	5,394	6,352	7,382	7,993	8,605	9,868	11,111	12,523
50-60000	S	1,316	1,512	1,811	2,006	2,194	2,570	2,912	3,262
60-70000	S	1,829	2,376	1,839	2,040	2,220	2,482	2,674	2,775
70-80000	S	0	0	1,123	1,127	1,116	1,193	1,232	1,266
80-90000	S	0	0	1,693	1,716	1,744	2,048	2,285	2,607
90-100k	S	0	0	495	518	546	609	666	723
100-125k	S	0	0	2,738	2,990	3,270	3,740	4,301	4,976
125-150k	S	0	0	825	776	727	704	667	626
150-175k	S	0	0	3,051	3,458	3,818	4,295	4,648	4,925
Total North		**16,883**	**20,197**	**30,207**	**33,216**	**36,089**	**41,746**	**46,627**	**51,339**
Total South		**17,628**	**21,233**	**33,580**	**36,219**	**38,789**	**44,046**	**48,801**	**53,733**
Grand Total		**34,512**	**41,430**	**63,787**	**69,435**	**74,879**	**85,791**	**96,428**	**105,072**

9.2.3. Unrestricted Canal

There is no additional by pass trade in this case compared to the Expanded Canal. Cargo allocations therefore remain unchanged.

Table 9.2.3.1

Commodity Trade Flows for Full Containerships, Unrestricted Canal

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
								000's tons	
<10000	N	29	0	0	0	0	0	0	0
10-15000	N	657	830	1,055	1,236	1,423	1,814	2,207	2,638
15-20000	N	281	263	220	155	83	0	0	0
20-25000	N	2,777	3,391	4,121	4,668	5,224	6,356	7,444	8,594
25-30000	N	2,044	2,422	2,797	3,031	3,264	3,742	4,185	4,653
30-40000	N	3,582	3,960	4,295	4,388	4,461	4,544	4,478	4,323
40-50000	N	4,953	6,030	7,314	8,170	8,986	10,582	11,953	13,284
50-60000	N	1,338	1,699	2,139	2,455	2,760	3,365	3,909	4,450
60-70000	N	1,222	1,603	1,129	1,243	1,337	1,516	1,597	1,649
70-80000	N	0	0	1,008	1,035	1,041	1,131	1,163	1,164
80-90000	N	0	0	1,274	1,363	1,447	1,745	1,950	2,138
90-100k	N	0	0	332	373	417	492	560	625
100-125k	N	0	0	1,924	2,180	2,449	2,843	3,281	3,718
125-150k	N	0	0	553	535	511	509	489	463
150-175k	N	0	0	2,047	2,383	2,686	3,106	3,411	3,641
175-200k	N	0	0	0	0	0	0	0	0
200-250k	N	0	0	0	0	0	0	0	0
250-300k	N	0	0	0	0	0	0	0	0
<10000	S	29	0	0	0	0	0	0	0
10-15000	S	712	938	1,183	1,376	1,572	1,979	2,366	2,769
15-20000	S	281	281	235	165	88	0	0	0
20-25000	S	2,308	3,222	4,025	4,643	5,261	6,513	7,657	8,818
25-30000	S	1,978	2,352	2,721	2,941	3,157	3,597	3,982	4,373
30-40000	S	3,782	4,201	4,461	4,469	4,471	4,449	4,301	4,089
40-50000	S	5,394	6,352	7,382	7,993	8,605	9,868	11,111	12,523
50-60000	S	1,316	1,512	1,811	2,006	2,194	2,570	2,912	3,262
60-70000	S	1,829	2,376	1,839	2,040	2,220	2,482	2,674	2,775
70-80000	S	0	0	1,123	1,127	1,116	1,193	1,232	1,266
80-90000	S	0	0	1,693	1,716	1,744	2,048	2,285	2,607
90-100k	S	0	0	495	518	546	609	666	723
100-125k	S	0	0	2,738	2,990	3,270	3,740	4,301	4,976
125-150k	S	0	0	825	776	727	704	667	626
150-175k	S	0	0	3,051	3,458	3,818	4,295	4,648	4,925
175-200k	S	0	0	0	0	0	0	0	0
200-250k	S	0	0	0	0	0	0	0	0
250-300k	S	0	0	0	0	0	0	0	0
Total North		**16,883**	**20,197**	**30,207**	**33,216**	**36,089**	**41,746**	**46,627**	**51,339**
Total South		**17,628**	**21,233**	**33,580**	**36,219**	**38,789**	**44,046**	**48,801**	**53,733**
Grand Total		**34,512**	**41,430**	**63,787**	**69,435**	**74,879**	**85,791**	**95,428**	**105,072**

9.3 Tankers

9.3.1 Generic Growth

The cargoes reviewed here include liquid chemicals as well as oil and oil products.

Although likely to increase over the shorter term to 2010, northbound tanker cargoes are forecast to decrease marginally over the forecast period from 12.7 to 12.6 million tons. Southbound tanker cargoes are expected to have a relatively robust growth of 1.2% per annum on average through 2050 with the short term to 2010 increasing at an average of 2.4% per annum. For northbound routes, the percentage of cargoes carried in vessels in excess of 40,000 dwt declines from 65% in 2001 to 46% in 2050. Southbound, the proportions remain virtually the same over the forecast time period at around 48% although there are variations within individual size ranges.

Table 9.3.1.1

Scenario 1, Generic Growth in panama Canal Trade Flows for Tankers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	303	298	333	318	302	290	288	285
10-15000	N	328	332	395	430	466	549	653	748
15-20000	N	209	192	202	202	204	215	233	248
20-25000	N	244	213	206	196	188	179	174	167
25-30000	N	515	498	550	551	554	583	629	672
30-40000	N	2,882	2,731	3,024	3,155	3,305	3,683	4,176	4,612
40-50000	N	878	887	1,004	1,054	1,107	1,239	1,396	1,546
50-60000	N	2,781	2,420	2,556	2,115	1,744	1,299	1,026	801
60-70000	N	4,032	4,010	4,932	4,554	4,117	3,596	3,246	2,821
70-80000	N	148	166	190	211	231	271	310	348
80-90000	N	63	68	78	84	90	103	116	129
90-100k	N	281	282	333	310	285	254	231	204
<10000	S	873	987	1,122	1,237	1,346	1,523	1,693	1,851
10-15000	S	740	904	1,088	1,258	1,431	1,748	2,063	2,373
15-20000	S	511	578	641	687	719	765	811	854
20-25000	S	675	721	751	758	747	704	664	621
25-30000	S	1,744	2,032	2,344	2,594	2,796	3,098	3,395	3,674
30-40000	S	8,912	10,521	12,078	13,389	14,658	16,840	18,970	21,049
40-50000	S	3,400	4,063	4,795	5,426	6,050	7,073	8,056	9,010
50-60000	S	2,845	3,012	3,126	3,138	3,026	2,755	2,546	2,347
60-70000	S	5,456	6,617	7,935	9,014	9,727	10,744	11,759	12,663
70-80000	S	346	440	553	655	764	942	1,109	1,271
80-90000	S	106	128	155	178	197	221	242	260
90-100k	S	52	65	79	91	102	122	142	162
Total North		**12,665**	**12,095**	**13,802**	**13,179**	**12,594**	**12,261**	**12,479**	**12,582**
Total South		**25,659**	**30,067**	**34,668**	**38,424**	**41,562**	**46,535**	**51,450**	**56,135**
Grand Total		**38,324**	**42,163**	**48,471**	**51,603**	**54,156**	**58,796**	**63,929**	**68,717**

9.3.2 Expanded Canal

In this case, northbound cargoes carried in tankers remain unchanged while southbound cargoes increase by an average of 1.2% per annum with the addition of by pass trade from Venezuela to Asia. The proportion of cargoes carried in vessels in excess of 40,000 dwt increases marginally.

Table 9.3.2.1

Commodity Trade Flows for Tankers, Expanded Canal

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	303	298	333	318	302	290	288	285
10-15000	N	328	332	395	430	466	549	653	748
15-20000	N	209	192	202	202	204	215	233	248
20-25000	N	244	213	206	196	188	179	174	167
25-30000	N	515	498	550	551	554	583	629	672
30-40000	N	2,882	2,731	3,024	3,155	3,305	3,683	4,176	4,612
40-50000	N	878	887	1,004	1,054	1,107	1,239	1,396	1,546
50-60000	N	2,781	2,420	2,556	2,115	1,744	1,299	1,026	801
60-70000	N	4,032	4,010	4,638	4,248	3,817	3,305	2,973	2,594
70-80000	N	148	166	398	408	414	438	470	494
80-90000	N	63	68	164	193	208	227	230	211
90-100k	N	281	282	333	310	285	254	231	204
<10000	S	873	987	1,122	1,237	1,346	1,523	1,693	1,851
10-15000	S	740	904	1,088	1,258	1,431	1,748	2,063	2,373
15-20000	S	511	578	641	687	719	765	811	854
20-25000	S	675	721	751	758	747	704	664	621
25-30000	S	1,744	2,032	2,344	2,594	2,796	3,098	3,395	3,674
30-40000	S	8,912	10,521	12,078	13,389	14,658	16,840	18,970	21,049
40-50000	S	3,400	4,063	4,795	5,426	6,050	7,073	8,056	9,010
50-60000	S	2,845	3,012	3,126	3,138	3,026	2,755	2,546	2,347
60-70000	S	5,456	6,617	7,409	8,224	8,699	9,272	9,832	10,293
70-80000	S	346	440	792	926	1,054	1,262	1,463	1,658
80-90000	S	106	128	215	310	397	543	678	797
90-100k	S	52	65	167	246	317	444	565	675
100-125k	S	0	0	1,075	1,167	1,258	1,442	1,648	1,869
125-150k	S	0	0	1,000	1,000	1,000	1,000	1,000	1,000
Total North		**12,665**	**12,095**	**13,802**	**13,179**	**12,594**	**12,261**	**12,479**	**12,582**
Total South		**25,659**	**30,067**	**36,603**	**40,359**	**43,497**	**48,470**	**53,385**	**58,070**
Grand Total		**38,324**	**42,163**	**50,406**	**53,538**	**56,091**	**60,731**	**65,864**	**70,652**

9.3.3 Unrestricted Canal

In this case southbound tanker cargoes increase further to 68.6 million tons by 2050. The proportion of cargoes carried in larger size ranges also increases to 56%.

Table 9.3.3.1

Commodity Trade Flows for Tankers, Unrestricted Canal

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	303	298	333	318	302	290	288	285
10-15000	N	328	332	395	430	466	549	653	748
15-20000	N	209	192	202	202	204	215	233	248
20-25000	N	244	213	206	196	188	179	174	167
25-30000	N	515	498	550	551	554	583	629	672
30-40000	N	2,882	2,731	3,024	3,155	3,305	3,683	4,176	4,612
40-50000	N	878	887	1,004	1,054	1,107	1,239	1,396	1,546
50-60000	N	2,781	2,420	2,556	2,115	1,744	1,299	1,026	801
60-70000	N	4,032	4,010	4,638	4,248	3,817	3,305	2,973	2,594
70-80000	N	148	166	398	408	414	438	470	494
80-90000	N	63	68	164	193	208	227	230	211
90-100k	N	281	282	333	310	285	254	231	204
100-125k	N	0	0	0	0	0	0	0	0
125-150k	N	0	0	0	0	0	0	0	0
150-175k	N	0	0	0	0	0	0	0	0
175-200k	N	0	0	0	0	0	0	0	0
200-250k	N	0	0	0	0	0	0	0	0
250-300k	N	0	0	0	0	0	0	0	0
<10000	S	873	987	1,122	1,237	1,346	1,523	1,693	1,851
10-15000	S	740	904	1,088	1,258	1,431	1,748	2,063	2,373
15-20000	S	511	578	641	687	719	765	811	854
20-25000	S	675	721	751	758	747	704	684	621
25-30000	S	1,744	2,032	2,344	2,594	2,796	3,098	3,395	3,674
30-40000	S	8,912	10,521	12,078	13,389	14,658	16,840	18,970	21,049
40-50000	S	3,400	4,063	4,795	5,426	6,050	7,073	8,056	9,010
50-60000	S	2,845	3,012	3,126	3,138	3,026	2,755	2,546	2,347
60-70000	S	5,456	6,617	7,409	8,224	8,699	9,272	9,832	10,293
70-80000	S	346	440	792	926	1,054	1,262	1,463	1,658
80-90000	S	106	128	215	310	397	543	678	797
90-100k	S	52	65	167	246	317	444	565	675
100-125k	S	0	0	1,075	1,167	1,258	1,442	1,648	1,869
125-150k	S	0	0	0	0	0	0	0	0
150-175k	S	0	0	1,000	1,000	1,000	1,000	1,000	1,000
175-200k	S	0	0	0	0	0	0	0	0
200-250k	S	0	0	0	0	0	0	0	0
250-300k	S	0	0	5,000	8,000	10,500	10,500	10,500	10,500
Total North		12,665	12,095	13,802	13,179	12,594	12,261	12,479	12,582
Total South		25,659	30,067	41,603	48,359	53,997	58,970	63,885	68,570
Grand Total		38,324	42,163	55,406	61,538	66,591	71,231	76,364	81,152

9.4 Conventional General Cargo Ships

Generic growth in cargo volumes carried in conventional general cargo ships is expected to average 1.1% per annum northbound and 1.6% per annum southbound between 2001 and 2050.

On northbound routes, there is a significant shift in the use of vessels of less than 15,000 dwt from 33% in 2001 to 17% in 2050. In particular, vessels of 15,000 through 25,000 dwt are substituted. A similar trend is forecast on southbound routes with cargoes in the smaller size ranges falling from 37% to 24% and being substituted by vessels from 15,000 dwt through 25,000 dwt (Table 9.4.1)

As none of these vessels are impacted by current Canal dimensions, there is no difference in the cargo allocations for either the Unrestricted or Expanded Canals.

Table 9.4.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for General Cargo Ships

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
									000's tons
<10000	N	448	492	544	583	621	697	768	836
10-15000	N	673	632	584	526	472	369	266	163
15-20000	N	1,189	1,308	1,450	1,552	1,656	1,860	2,050	2,231
20-25000	N	764	882	1,021	1,128	1,233	1,437	1,625	1,803
25-30000	N	249	303	366	419	470	570	664	754
30-40000	N	43	49	58	64	70	82	94	105
40-50000	N	0	0	0	0	0	0	0	0
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	0	0	0	0	0	0	0	0
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	768	909	1,060	1,181	1,304	1,543	1,768	1,987
10-15000	S	773	778	754	701	648	528	392	245
15-20000	S	1,440	1,675	1,923	2,124	2,330	2,736	3,126	3,511
20-25000	S	907	1,102	1,314	1,485	1,656	1,984	2,287	2,575
25-30000	S	208	267	334	391	447	554	654	748
30-40000	S	34	41	50	57	64	79	94	108
40-50000	S	0	0	0	0	0	0	0	0
50-60000	S	1	1	2	2	3	3	4	4
60-70000	S	0	0	0	0	0	0	0	0
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**3,365**	**3,666**	**4,023**	**4,271**	**4,522**	**5,015**	**5,466**	**5,890**
Total South		**4,130**	**4,774**	**5,437**	**5,942**	**6,452**	**7,426**	**8,324**	**9,180**
Grand Total		**7,495**	**8,440**	**9,460**	**10,213**	**10,974**	**12,442**	**13,791**	**15,070**

9.5 Refrigerated Cargo Ships

Reflecting assumptions concerning the increasing containerisation of some refrigerated cargoes, the generic growth in northbound cargoes in Reefers increases marginally between 2001 and 2020 and then declines over the remainder of the forecast period. Southbound cargoes increase – by an average of 1.3% per annum through the forecast period but the combined trend is downwards. Northbound cargoes carried in vessels less than 10,000 dwt are expected to decline from 47% to 43% with a concomitant shift upwards in the allocation of cargoes to the 10,000 – 15,000 dwt range. A similar pattern is forecast southbound (Table 9.5.1).

As none of these vessels are impacted by current Canal dimensions, there is no difference in the cargo allocations for either the Unrestricted or Expanded Canals.

Table 9.5.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Refrigerated Cargo Carriers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	2,207	2,244	2,252	2,237	2,207	2,086	1,910	1,672
10-15000	N	2,379	2,522	2,633	2,694	2,723	2,664	2,496	2,220
15-20000	N	72	69	65	61	57	50	42	35
20-25000	N	0	0	0	0	0	0	0	0
25-30000	N	0	0	0	0	0	0	0	0
30-40000	N	0	0	0	0	0	0	0	0
40-50000	N	0	0	0	0	0	0	0	0
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	0	0	0	0	0	0	0	0
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	393	448	508	551	594	658	707	732
10-15000	S	426	534	641	697	745	814	844	843
15-20000	S	5	5	5	6	6	7	7	8
20-25000	S	0	0	0	0	0	0	0	0
25-30000	S	0	0	0	0	0	0	0	0
30-40000	S	0	0	0	0	0	0	0	0
40-50000	S	0	0	0	0	0	0	0	0
50-60000	S	0	0	0	0	0	0	0	0
60-70000	S	0	0	0	0	0	0	0	0
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**4,658**	**4,835**	**4,950**	**4,992**	**4,987**	**4,800**	**4,448**	**3,926**
Total South		**824**	**987**	**1,155**	**1,254**	**1,345**	**1,479**	**1,559**	**1,584**
Grand Total		**5,482**	**5,823**	**6,105**	**6,246**	**6,332**	**6,278**	**6,007**	**5,510**

9.6 Container/Breakbulk

Generic growth in northbound cargoes carried in Container/Breakbulk vessels exhibits a markedly slower rate of increase than those moving on southbound routes at an average of 1.3% per annum compared to 1.9% per annum over the forecast time period.

The share of cargo carried in all vessels less than 40,000 dwt is expected to decline although at varying rates both between the individual vessel size ranges and between northbound and southbound routes. The result of the variations made to northbound routes means that the proportion of cargoes carried in vessels of 40,000 – 50,000 dwt increases from 45% to 58% while southbound the shift is from 48% to 52% (Table 9.6.1).

As none of these vessels are impacted by current Canal dimensions, there is no difference in the cargo allocations for either the Unrestricted or Expanded Canals.

Table 9.6.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Container / Break Bulk Carriers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	68	69	71	69	67	61	53	40
10-15000	N	112	116	121	122	122	122	121	118
15-20000	N	433	455	479	487	495	512	524	535
20-25000	N	323	339	356	361	367	378	384	388
25-30000	N	262	293	330	355	381	432	479	524
30-40000	N	481	525	573	609	648	725	799	871
40-50000	N	1,372	1,582	1,825	2,024	2,226	2,632	3,025	3,409
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	5	6	8	9	10	12	13	14
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	45	50	50	47	45	41	35	27
10-15000	S	79	87	94	95	97	97	95	91
15-20000	S	372	414	449	467	486	520	549	576
20-25000	S	342	424	452	464	495	584	705	876
25-30000	S	297	353	412	455	498	579	650	715
30-40000	S	305	377	428	469	524	657	825	1,049
40-50000	S	1,358	1,616	1,901	2,145	2,398	2,899	3,387	3,868
50-60000	S	0	0	0	0	0	0	0	0
60-70000	S	52	65	79	92	105	133	161	190
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**3,055**	**3,386**	**3,762**	**4,036**	**4,316**	**4,874**	**5,398**	**5,899**
Total South		**2,850**	**3,386**	**3,863**	**4,234**	**4,648**	**5,511**	**6,407**	**7,392**
Grand Total		**5,906**	**6,771**	**7,625**	**8,270**	**8,965**	**10,385**	**11,805**	**13,291**

9.7 Roll On/Roll Off

The quantity of cargo carried in RO-RO vessels is already small at less than 1.5 million tons for southbound and northbound combined. Assuming the generic growth in trade flows via the Canal, the result of changes made on northbound routes means that volumes are expected to increase marginally through 2010 but then to start declining by an average of 1.6% per annum over the rest of the forecast period. Southbound, cargoes carried are expected to increase over the time period but are still expected to total only 1.3 million tons by 2050.

Unlike other ship types, northbound cargoes being carried in the larger vessels, in this case vessels of 15,000 dwt through 50,000 dwt, are expected to decline after 2010 with all of the increase seen in the 10,000 – 15,000 dwt size range. Southbound, cargoes in this size range also increase as those below 10,000 dwt decline to zero but cargoes in the 30,000 dwt through 50,000 dwt sizes also increase both absolutely and proportionately (Table 9.7.1).

Table 9.7.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Roll-on / Roll-off Carriers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	39	35	31	26	22	13	0	0
10-15000	N	158	181	214	235	253	284	305	318
15-20000	N	64	71	77	73	69	65	62	0
20-25000	N	72	69	67	53	41	20	6	0
25-30000	N	17	9	0	0	0	0	0	0
30-40000	N	182	198	228	225	215	182	130	64
40-50000	N	174	191	222	220	212	180	128	61
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	0	0	0	0	0	0	0	0
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	49	48	46	41	36	21	0	0
10-15000	S	150	200	252	277	298	336	371	451
15-20000	S	96	115	129	129	128	128	118	0
20-25000	S	34	35	36	31	27	18	9	0
25-30000	S	58	27	0	0	0	0	0	0
30-40000	S	240	303	358	383	406	451	487	517
40-50000	S	116	148	176	193	209	241	267	290
50-60000	S	0	0	0	0	0	0	0	0
60-70000	S	0	0	0	0	0	0	0	0
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**706**	**754**	**839**	**832**	**812**	**744**	**630**	**443**
Total South		**742**	**879**	**998**	**1,054**	**1,105**	**1,195**	**1,251**	**1,258**
Grand Total		**1,449**	**1,632**	**1,837**	**1,885**	**1,917**	**1,939**	**1,882**	**1,700**

9.8 Vehicle and Vehicle/Dry Bulk Carriers

Assuming the generic growth in trade flows via the Canal, cargoes carried on northbound routes in Vehicle Carriers are expected to fluctuate but not increase over the forecast period while on southbound routes the annual average increase is 1.3%. Despite this lack of growth, northbound cargo is expected increasingly to be carried in vessels over 15,000 dwt. Southbound trades, which are much smaller, are expected to exhibit only marginal shifts in the utilisation of different ship sizes over the forecast period (Table 9.8.1).

Northbound trades carried in Vehicle/Dry Bulk Carriers, which are significantly smaller than Vehicle Carrier trades, are forecast to increase by 1.3% per annum through 2050 with increasing proportions carried in vessels of 30,000 – 40,000 dwt. The shift in cargo allocations southbound is towards vessels of 10,000 – 15,000 dwt and 30,000 – 40,000 dwt. Southbound trades are expected to increase by an average of 1.8% over the forecast period.

Table 9.8.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Vehicle and Vehicle/Dry Bulk Carriers

									000's tons
Size Range	**Direction**	**2001**	**2005**	**2010**	**2015**	**2020**	**2030**	**2040**	**2050**
<10000	N	19	15	11	7	5	0	0	0
10-15000	N	663	642	616	593	578	561	553	546
15-20000	N	568	579	585	588	594	611	631	649
20-25000	N	109	119	128	136	145	161	174	185
25-30000	N	81	85	89	94	99	109	119	130
30-40000	N	235	260	288	312	339	394	450	506
40-50000	N	0	0	0	0	0	0	0	0
50-60000	N	5	5	5	5	5	5	4	4
60-70000	N	36	37	39	39	40	42	44	46
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	12	12	10	8	6	1	0	0
10-15000	S	197	213	230	246	262	293	322	349
15-20000	S	202	233	265	298	332	402	471	541
20-25000	S	73	82	91	100	109	127	143	158
25-30000	S	110	119	128	136	145	164	183	203
30-40000	S	360	411	467	518	573	684	795	906
40-50000	S	23	28	33	38	43	53	63	73
50-60000	S	145	170	198	223	249	301	355	409
60-70000	S	192	206	219	227	237	255	272	287
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**1,716**	**1,742**	**1,761**	**1,775**	**1,805**	**1,884**	**1,976**	**2,067**
Total South		**1,314**	**1,474**	**1,641**	**1,794**	**1,956**	**2,279**	**2,603**	**2,925**
Grand Total		**3,030**	**3,216**	**3,402**	**3,569**	**3,760**	**4,163**	**4,578**	**4,992**

9.9 Gas Carriers

Northbound Gas Carrier trades are low and are expected to remain so through the forecast period. As a result, although shifts in vessel size are forecast, there is no material impact on the generic growth in transit demand. For southbound trades, although increases in volumes are expected, shifts in cargo allocations are again marginal.

Table 9.9.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Liquid Gas Carriers

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	10	10	11	12	12	14	15	17
10-15000	N	21	21	24	26	28	32	36	40
15-20000	N	28	27	29	30	32	35	39	43
20-25000	N	9	8	9	9	9	10	11	12
25-30000	N	7	7	7	8	8	9	10	10
30-40000	N	1	1	1	1	1	2	2	2
40-50000	N	7	7	7	7	7	7	7	7
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	0	0	0	0	0	0	0	0
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	163	189	223	252	282	325	362	397
10-15000	S	214	251	303	346	391	449	497	538
15-20000	S	547	622	723	803	888	985	1,060	1,125
20-25000	S	247	278	320	352	387	429	464	495
25-30000	S	90	104	122	138	154	177	197	215
30-40000	S	188	211	238	259	280	312	341	367
40-50000	S	189	207	229	245	262	279	293	304
50-60000	S	0	0	0	0	0	0	0	0
60-70000	S	0	0	0	0	0	0	0	0
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**83**	**82**	**87**	**92**	**97**	**107**	**119**	**129**
Total South		**1,638**	**1,863**	**2,157**	**2,394**	**2,644**	**2,956**	**3,214**	**3,442**
Grand Total		**1,721**	**1,945**	**2,244**	**2,486**	**2,742**	**3,064**	**3,333**	**3,571**

9.10 Other Vessels

Assuming the generic growth in trade flows via the Canal, cargo carried in Other, miscellaneous, vessels is expected to increase by 1.3% per annum through 2050. Northbound, there is a perceptible shift towards smaller sizes while Southbound the converse is true.

Table 9.10.1

Scenario 1, Generic Growth in Panama Canal Trade Flows for Other Vessels

000's tons

Size Range	Direction	2001	2005	2010	2015	2020	2030	2040	2050
<10000	N	154	166	179	192	208	238	275	318
10-15000	N	19	20	21	21	22	23	24	24
15-20000	N	13	13	14	15	16	19	21	23
20-25000	N	8	8	9	10	10	11	13	14
25-30000	N	0	0	0	0	0	0	0	0
30-40000	N	0	0	0	0	0	0	0	0
40-50000	N	37	39	42	43	43	42	38	30
50-60000	N	0	0	0	0	0	0	0	0
60-70000	N	0	0	0	0	0	0	0	0
70-80000	N	0	0	0	0	0	0	0	0
80-90000	N	0	0	0	0	0	0	0	0
90-100k	N	0	0	0	0	0	0	0	0
<10000	S	104	109	114	118	123	130	135	139
10-15000	S	27	31	34	37	41	47	53	59
15-20000	S	28	29	32	34	36	40	45	49
20-25000	S	41	45	49	53	57	65	71	78
25-30000	S	0	0	0	0	0	0	0	0
30-40000	S	26	23	18	14	9	0	0	0
40-50000	S	185	221	263	300	338	401	453	505
50-60000	S	0	0	0	0	0	0	0	0
60-70000	S	0	0	0	0	0	0	0	0
70-80000	S	0	0	0	0	0	0	0	0
80-90000	S	0	0	0	0	0	0	0	0
90-100k	S	0	0	0	0	0	0	0	0
Total North		**231**	**247**	**265**	**281**	**300**	**333**	**370**	**409**
Total South		**411**	**458**	**510**	**555**	**603**	**682**	**757**	**830**
Grand Total		**642**	**705**	**774**	**837**	**903**	**1,016**	**1,127**	**1,239**

10 The Passenger Ship Market

10.1 Introduction

Cruise passenger vessels use the Panama Canal for two main reasons.

10.1.1 Deployment Voyages

Cruise lines deploy vessels on itineraries that include either a full or partial transit via the Canal. These itineraries have grown in popularity in recent years as the Panama Canal and Central America has emerged as an important secondary cruise vessel deployment market i.e. to complement deployment of cruise vessels in the three primary markets (Caribbean, Alaska and Mediterranean).

10.1.2 Repositioning Voyages

Cruise lines use the Canal in order to reposition large capacity, typically 1500 plus lower berth capacity vessels between primary deployment markets – principally between the Caribbean and Alaska immediately prior and immediately after the beginning and the end of the Alaska summer season (May to September).

A third reason for Canal usage by cruise lines is the incorporation of a Canal transit as part of a round the world voyage.

Because Canal usage is inextricably tied into the global deployment of cruise ships it is important to present any forecast of future Canal transits within the context of a broader understanding of how and why the cruise industry is developing. In particular, as explained in section 10.3, it is important to understand how the overall cruise vessel fleet will develop over a short- medium- and long-term time horizon.

Before examining future trends it is useful to identify and examine past and present trends in Canal usage by cruise vessels.

10.2 Historical Trends

Table 10.2.1 presents transit data for cruise vessels in terms of four key indicators:

- Number of transits
- Number of passengers carried
- Total deadweight capacity
- Total lower berth capacity.

Table 10.2.1

Panama Canal Cruise Ship Transits By Key Indicator				
				000's
Year	No. of Transits	No. of Passengers	Dwt Capacity	Total Berths
1985/86	229	124	1045	192
1986/87	203	116	833	161
1987/88	223	134	1066	190
1988/89	180	122	982	173
1989/90	127	82	653	117
1990/91	177	105	902	151
1991/92	150	94	696	125
1992/93	220	154	1160	206
1993/94	305	198	1336	250
1994/95	312	207	1492	288
1995/96	273	208	1208	272
1996/97	292	241	1380	312
1997/98	314	270	1554	353
1998/99	297	265	1483	357

* Lower berth figures exclude deadtow and handline transits

Of the four indicators, particular attention is paid to lower berth capacity as the standard unit of measurement in the cruise industry.

Although the four indicators presented in Table 10.2.1 show an overall growth in cruise ship transits since the mid 1980s, the picture is somewhat erratic. In six of the years, including the last shown, the volume of cruise vessel transit traffic has fallen with the largest year-on-year reduction recorded in 1988/89.

This erratic picture stands in sharp contrast to the consistent demand growth witnessed in the cruise industry over the past 20 years as evidenced by the growth of the primary cruise passenger source market - N.America. As Table 10.2.2 shows, this market has enjoyed consistent year on year demand growth except for a small and short-lived softening of the market in the mid 1990s due to economic recession.

The volatility presented in Table 10.2.1 is explained by the fact that cruise lines change vessel itineraries on a regular basis in response to customer demand or change in vessel ownership.

A further factor, that has grown in significance in recent years, has been the emergence of post-panamax size vessels. These vessels offering lower berth capacities in excess of 2,500 have been brought into service by the big three cruise lines (Carnival, RCI and P&O Princess) in order to realise significant scale economies in cruise ship operation.

Other key trends demonstrated by Table 10.2.1 are discussed below.

Table 10.2.2

US Cruise Passenger Demand, 1980-1999

Year	Pax (m)	% change
1980	1.43	-
1981	1.45	1.4
1982	1.47	1.4
1983	1.69	15.0
1984	1.86	10.1
1985	2.15	15.6
1986	2.62	21.9
1987	2.87	9.5
1988	3.17	10.5
1989	3.28	3.5
1990	3.64	11.0
1991	3.98	9.3
1992	4.14	4.0
1993	4.48	8.2
1994	4.45	-0.7
1995	4.38	-1.6
1996	4.66	6.4
1997	5.05	8.4
1998	5.40	6.9
1999	6.40	18.5

Source: CLIA

10.2.1 Average Vessel Size

The average size of cruise vessel transiting the Canal has grown since the mid 1990s i.e. from a range between 850 to 950 berths to 1200 berths in 1998/99.

10.2.2 Vessel Load Factors

The period since the mid 1980s has seen a gradual increase in the berth occupancy, i.e. from an annual average of 70% during the second half of the 1980s to 75% for the last five years to reflect the growing popularity of itineraries incorporating either full or partial Canal transits.

Table 10.2.2.1 provides a breakdown of total transit by full and partial movements. In the former case, as the name suggests, vessels complete a full movement either northbound or southbound whereas in the latter case, a partial transit involves a vessel completing only a part movement.

Table 10.2.2.1 shows that the majority of Canal transits by cruise vessels are full transits i.e. accounting for between 68% and 78% since the mid 1980s. The split between northbound and southbound movements within full transits is fairly even with the majority in favour of southbound reflecting east-west round-the-world voyages. In the case of partial voyages the vast majority are southbound i.e. movements of ships to and from Balboa or the Gatun Lake.

Table 10.2.2.1

Panama Canal Cruise Ships Full, Partial And Total Transits								
								000's Berths
Year	Partial Transits			Full Transits				Grand
	N/B	S/B	Total	N/B	S/B	Total		Total
1985/86	0.8	42.2	43.0	71.3	77.9	149.2		192.2
1986/87	-	36.8	36.8	58.3	65.6	123.9		160.7
1987/88	-	42.7	42.7	69.5	77.3	146.8		189.6
1988/89	-	48.3	48.3	57.4	67.1	124.4		172.8
1989/90	-	36.5	36.5	33.4	47.1	80.6		117.0
1990/91	1.5	25.6	27.1	55.9	68.0	123.9		151.0
1991/92	-	33.1	33.1	40.6	50.9	91.6		124.6
1992/93	-	61.7	61.7	68.3	76.0	144.3		206.0
1993/94	0.2	72.1	72.3	82.2	95.7	177.9		250.2
1994/95	-	83.1	83.1	93.2	111.1	204.3		287.5
1995/96	-	58.6	58.6	102.5	111.2	213.7		272.3
1996/97	-	98.6	98.6	104.3	118.3	222.6		312.3
1997/98	-	82.8	82.8	124.3	146.1	270.4		353.2
1998/99	-	55.7	55.7	123.3	177.5	300.8		356.5

* Figures exclude deadtows and handline

In terms of the size of cruise vessels using the Canal, Table 10.2.2.2 shows a significant increase in the volume of large size i.e. 2000 lower berth capacity vessels during the past four years. Between 1995 and 1998, 2000+ berth vessels accounted for 18% of transits in capacity terms before increasing to 35% in 1998/99.

Table 10.2.2.2

Panama Canal Cruise Ship Transits By Vessel Size				
				000's Berths
Year	<1000	1000-1499	1500-2000	2000+
1985/86	74.1	114.1	5.6	2.4
1986/87	76.1	84.6	3.4	2.4
1987/88	80.5	103.5	7.2	2.4
1988/89	65.0	84.4	22.1	2.4
1989/90	63.0	32.3	19.4	2.4
1990/91	78.5	58.2	12.3	2.4
1991/92	67.5	37.7	17.0	2.4
1992/93	85.5	82.0	36.4	2.4
1993/94	106.2	93.4	51.4	2.4
1994/95	133.2	82.0	64.2	8.7
1995/96	70.4	70.6	80.6	51.4
1996/97	55.2	119.3	89.5	57.4
1997/98	95.2	41.5	154.8	64.6
1998/99	54.5	56.3	123.4	123.6

* Figures exclude deadtow and handline transits.

10.3 Factors Determining Passenger Ship Traffic

A number of factors influence the volume of Canal transits by cruise ships. These factors are summarised by Table 10.3.1. in terms of whether they primarily exert a positive influence i.e. they enhance usage or a negative influence (limit usage) or both.

Table 10.3.1

Enhancing and Limiting Factors

Factor	Enhancing	Limiting
Fleet Growth	✓	
Ship Size		✓
Vessel Deployment	✓	
Regional Stability	✓	
Regional Development	✓	
Canal Tolls		✓

10.3.1 Fleet Growth

The world cruise fleet has grown consistently since the start of the modern era of cruising in the late 1960s. Accompanying this growth has been a desire by the cruise lines to exploit new areas for vessel deployment i.e. to complement the Caribbean, Alaska and Mediterranean markets.

10.3.2 Ship Size

The movement towards larger capacity cruise ships particularly by the big three cruise lines has exerted both a positive and negative benefit. In the former case, the ability to move more passengers per transit is a benefit particularly at times of Canal congestion. In the latter case, the latest generation vessels are currently unable to utilise the Canal and are, therefore, dedicated to all-year round Caribbean cruising or Caribbean plus USEC, SAEC and/or European deployment.

10.3.3 Vessel Deployment

The Panama Canal and Central American region has emerged as an important secondary market for a number of reasons. Undoubtedly, the region has benefited by its close proximity to the Caribbean as the world's largest cruise vessel deployment area and, in particular, the desire by the cruise lines to seek out new itineraries in the western Caribbean. A further benefit is, of course, the Canal's strategic importance as the Atlantic-Pacific link which has been exploited by the cruise industry in the positioning of ships between the Caribbean and Alaska and by cruise lines offering round-the-world voyages.

10.3.4 Regional Stability

This is an important consideration given that periodic political instability, notably terrorist acts or war, can force the cruise lines to re-deploy ships. Panama and Central America has not suffered political instability in recent years in marked contrast to the Eastern Mediterranean.

10.3.5 Regional Development

Regional development is another important factor. Cruise lines rely on port and airport infrastructure for the safe and efficient movement of passengers to and from their vessels especially during turnaround port calls at the start and finish of itineraries. Infrastructure is an important consideration during itinerary planning given that the appeal and economics of a particular itinerary will to a large extent be determined by the availability of sufficient airlift capacity and attractive destination port calls – the latter being the key selling point and, therefore, point of differentiation when customers choose between different itineraries.

10.3.6 Canal Tolls

Together with port charges, Canal tolls are an important consideration affecting Canal usage. The cruise market is a maturing one which has become price driven as evidenced by widespread discounting. With margins under increasing pressure, the cost of operating itineraries is now under increased scrutiny to the extent that the decision to operate one itinerary as opposed to another may well be determined by savings that can be achieved on fixed and/or variable costs without impairing the marketability to a significant extent.

10.4 Forecasting Future Canal Transits: Methodology

10.4.1 Market Interviews

The various factors identified in Section 10.3 form the basis of vessel deployment and itinerary planning. Typically, the cruise lines plan future vessel deployment and itineraries over a three to five year period or in certain cases – longer time frame. This process initially involves the preparation of block plans i.e. a macro picture of future vessel deployment based on predictions of future passenger desires and vessel availability including anticipated terminal developments. These block plans are then refined by the planning of specific itineraries according to preferred length and the need to re-position ships for example through the Canal or on transatlantic voyages.

In order to forecast future Canal transits, it is important to understand current thinking of the planning departments of the cruise lines. For this reason a series of interviews with senior managers from a cross section of cruise lines were conducted. An interview with one of the new cruise terminals at Colon was also undertaken.

The selected companies were:

Norwegian Cruise Line (NCL)

NCL is a regular provider of trans-canal itineraries between San Juan and Acapulco with all of the line's current fleet able to transit the Canal except the 1966-built, deep drafted *Norway*. NCL has two post-panamax vessels on order for delivery in 2003 and 2004.

Royal Caribbean International (RCI)

RCI is a regular user of the Canal both as a destination market and for re-positioning ships between the Caribbean and Alaska markets. RCI controls two brands – Royal Caribbean and Celebrity. The former employs post-panamax tonnage.

Festival Cruises

Festival is a privately-owned European cruise company currently expanding its activities via a series of new building orders. Currently Festival will continue to focus on short, 7-day cruises within the Mediterranean and Eastern Caribbean market and has no immediate plans to broaden its activities to Panama.

Radisson Seven Seas Cruises (RSSC)

RSSC is a luxury cruise brand that has used vessels for full and partial Canal transits for a number of years. Currently, RSSC is taking delivery of larger capacity ships but will remain focused within the luxury market where the passengers have sufficient leisure time and spending power to be able to take longer cruises, including trans-canal itineraries on a regular basis.

Princess Cruises

Princes is the world's third largest cruise line and currently operates a fleet which includes post-panamax tonnage. Princess is a regular user of the Canal both for full and partial transits and are 'experimenting' with the embarkation and disembarkation of passengers at Colon enabling them to enjoy pre- and post-cruise shore excursions.

Carnival Corp.

Carnival Corp. controls a number of brands that are regular users of the Panama Canal including Holland-America Line and Cunard (see below). Carnival Cruise Line, the core brand, is currently building a series of 2,600 passenger vessels which are still able to transit the Canal.

Costa

Costa is wholly-owned by Carnival. It is an occasional user of the Canal having operated 14-day cruises out of Miami.

Fred Olsen Cruise Line (FOCL)

FOCL is a privately owned Norwegian cruise line that is an occasional user of the Canal as part of an extended South American itinerary.

Cunard Line

Cunard is wholly-owned by Carinal. It is a regular user of the Canal for South American cruises and round-the-world cruises –the latter using the *QE2*.

The notes resulting from these telephone interviews are presented in the Appendix to Section 10.

An analysis of the feedback derived from the interviews with current, past and potential users of the Canal, together with material derived from various published sources, is set out below in terms of a series of assumptions regarding the six factors which determine Canal usage identified in Section 10.3.

10.4.2 Fleet Growth

While the Canal will derive broad benefit from the overall growth in the world cruise fleet, the direct impact will be limited for two main reasons.

Firstly, while the world cruise fleet is expected to continue to grow, the tougher trading environment experienced in the past 12 months, as evidenced by widespread discounting and lower yields, has meant that cruise lines are adopting a more cautious approach to new ordering. In essence, until recently, the major lines have forecast very attractive returns on capital but as expectations diminish the rate of ordering has slowed. Furthermore, while recent years have seen very few ships retired from trading, higher bunker prices and tighter environmental and safety regulations are expected to increase the removal of older, less efficient ships from active trading especially when new SOLAS regulations are enforced towards the end of the current decade.

With these assumptions in mind, the following average compound annual growth rates (CAGR)s for fleet growth are used as the basis for Canal transit forecasts.

	%
2001	12
2002	11
2003	10
2004	9
2005	8
2006-2010	5
2011-2015	3
2016-2020	2
2021-2050	2

The second reason for a limited impact from fleet growth is the fact that as the big three cruise lines continue to seek greater scale economies from ship operation, a greater number of post-panamax ships are being built – ships that will constitute a great percentage of total fleet supply. These vessels are likely to be dedicated more and more to the primary deployment areas rather than switch between different deployment areas via re-positioning voyages.

10.4.3 Vessel Deployment

The following key considerations were discussed in the interviews:

Panama and Central America will continue to develop as an important secondary market for cruise vessel deployment particularly for the larger cruise lines that will wish to market a Canal product offering to their customers within their portfolio of itineraries. Many smaller cruise lines will continue to use the Canal on an occasional basis in order to offer customers an alternative to the core markets such as the Mediterranean and Caribbean. Of these lines, greatest patronage is likely to be by those line offering top end cruises i.e. four and five star plus where higher average per diems and longer cruises can be sold to passengers having more leisure time and greater disposable income.

With the continuing development of the USWC and Asian markets, the need to re-position the larger ships between the Caribbean and the USWC will diminish. Enlargement of the Canal is viewed as a positive trend given that it will afford the operators of the larger capacity ships greater flexibility. However, enlargement is unlikely to stimulate a significant increase in re-positioning voyages.

Round-the-world itineraries will not increase significantly although they are likely to remain an important product offering throughout different segments of the cruise market.

Operational considerations will also have a major impact on the extent to which vessels are utilised on full and partial Canal transits. All cruise lines are extremely sensitive to adverse customer reaction to particular itineraries. Therefore, any significant infrastructure problems resulting in negative customer feedback (for example due to congestion and embarkation/disembarkation delays) could well dissuade cruise lines from increasing their commitment.

Opinions about the future potential growth of partial transits are mixed. Financial incentives offered by the Panamanian government are seen as a major incentive to the cruise lines to disembark and embark passengers at Colon rather than engage in a partial transit which does not benefit from any financial inducement over full transits. For this reason, the future growth of partial as opposed to full transits and, in particular, relative to excursions run from Colon is uncertain. If incentives remain, partial transits will enjoy limited growth and vice versa.

10.4.4 Ship Size

Ship size is not seen to be a particularly important factor. While the average size of cruise ships transiting the Canal is likely to increase and, as a result, have a positive impact on passenger traffic, the growth in post-panamax ships will have a negative impact. Canal enlargement, as previously discussed, will give the big cruise lines greater flexibility but it will not in itself stimulate significantly greater usage. Greater benefits from enlargement will be derived from reduced congestion and delays.

10.4.5 Regional Stability

This factor was not mentioned by any of the interviewees. This is probably due to the fact that the region is not currently seen as a high risk area in terms of terrorism. Neither does it pose a particular threat in terms of security from a shore excursion viewpoint. It should, however, be borne in mind that periodic disruptions due to war and terrorist acts, as have been witnessed in the Eastern Mediterranean in recent years, can severely disrupt cruise vessel deployment and, therefore, undermine any forecasting process.

10.4.6 Regional Development

By contrast, regional development is seen as an important factor given that infrastructural developments can stimulate greater patronage. Efforts to date to encourage greater local and regional tourism are recognised by the cruise lines together with the importance of the various local private and public sector bodies responsible for tourism working harmoniously.

Benefits are likely to be long-term, however, given that cruise itinerary planners must be able to 'sell' the region as a whole i.e. by combining a full or partial cruise ship Canal transit with calls at attractive ports in close proximity. Given that a Canal transit, like an Amazon voyage, is often seen as a once in a lifetime experience, efforts must continue to be made to translate essentially a Canal experience to a regional experience.

10.4.7 Canal Tolls

All respondents view Canal tolls as a cause for concern and as a potentially important disincentive to Canal usage in the future.

Discussions regarding tolls and the related fees for using the waterway focus on the basic economics of operating an itinerary including a full or partial transit. Given that transit fees in excess of $100,000 to $200,000 represent a significant variable cost, cruise line planners have to be comfortable that reasonable net yields are readily achievable, i.e. that the cruise in question will sell without the sales and marketing departments having to resort to heavy discounting. In the case of one of the respondents, Canal tolls are seen as particularly sensitive when deciding to operate shoulder season cruises either side of re-positioning voyages.

10.5 Future Canal Transit Forecasts

10.5.1 Characterisation of Routes

An analysis of Canal transit data 1985/85 to 1998/99 identified cruise ship movements through the Canal between the following nine main source and destination areas:

WEST	EAST
USWC	USEC
WCCA	ECCA
WCSA	CARIB
OTHER	ECSA
	OTHER

In total 40 routes connecting the nine areas are identified comprising 29 active routes i.e. routes where cruise ship movements were recorded in the past three years and 11 inactive.

Of the 29 active routes, an analysis of full transits in the period 1996/97 to 98/99 (the last three years of available transit data) identified the following seven primary routes i.e. routes carrying in excess of 10,000 lower berth capacity of cruise ship transits on an annual basis:

Route	Rank
CARIB – WCCA	1
WCCA – CARIB	2
USEC – WCCA	3
WCCA – USEC	4
USWC – USEC	5
USEC – USWC	6
WCCA – ECSA	7

In the case of partial transits, the analysis of past data identified nine routes of which two are categorised as primary routes based on the volume of cruise ship movements:

Route	Rank
CARIB – BALBOA	1
USEC - BALBOA	2

10.5.2 Base Year

Given that cruise ship transits fluctuate year on year, as cruise lines choose to re-deploy vessels between different primary and secondary markets, it is important to establish a base year (2000) based on average annual transits over a longer-time period. By averaging out transits over the latest three years of available data the following base year transits were established in lower berth capacity units i.e. as the standard unit of measure for the cruise industry.

Full Transits (000s)

1.	CARIB-WCCA	61.3
2.	WCCA-CARIB	44.2
3.	USEC-WCCA	41.6
4.	WCCA-USEC	21.7
5.	USWC-USEC	19.4
6.	USEC-USWC	17.3
7	WCCA-ECSA	11.5
Total Primary routes		217.0
Total Secondary routes		52.8
Total Full transits		269.8

Partial Transits (000s)

1.	CARIB-Balboa	36.7
2.	USEC-Balboa	19.2
Total Primary routes		55.9
Total Secondary routes		8.3
Total Partial transits		64.2
Total Full & Partial		334.0

Having identified the volume of transits for each route in the base year, forecasts were produced by applying average compound annual growth rates (CAGRs) based on:

- the assumptions built up from the study interviews;
- no significant disruptions to the Canal are experienced during the study period;
- a limited increase in throughput is experienced from 2010 onwards due to Canal enlargement.

Tables 10.5.2.1 and 10.5.2.2 show the CAGRs used to prepare the forecasts presented in Table 10.6.1.1.

Table 10.5.2.1

Average CAGRS By Route - Full Transits								
Year	CARIB-WCCA	WCCA-CARIB	USEC-WCCA	WCCA-USEC	USWC-USEC	USEC-USWC	WCCA-ECSA	% Secondary Routes
2001	12.0	12.0	3.0	3.0	2.0	1.8	3.0	3.5
2002	11.0	11.0	2.0	2.0	1.5	1.3	3.0	3.0
2003	10.0	11.0	1.0	2.0	1.0	0.8	3.0	2.8
2004	5.0	5.0	1.0	1.0	0.8	0.5	3.0	3.5
2005	5.0	5.0	1.0	1.0	0.8	0.5	3.0	3.5
2010	2.0	2.0	2.0	2.0	0.8	0.5	5.1	3.0
2015	1.5	1.5	1.5	1.5	0.8	0.5	3.0	2.5
2020	1.3	1.3	1.3	1.3	0.6	0.6	2.3	2.3
2030	1.0	1.0	1.0	1.0	0.5	0.5	1.9	2.0
2040	1.0	1.0	1.0	1.0	0.5	0.5	1.9	2.0
2050	1.0	1.0	1.0	1.0	0.5	0.5	1.9	2.0

Table 10.5.2.2

Average CAGRS By Route - Partial Transits		
Year	Primary Routes	% Secondary Routes
2001	10.0	12.0
2002	10.0	12.0
2003	8.0	12.0
2004	5.0	5.0
2005	5.0	5.0
2010	2.0	2.0
2015	1.5	1.5
2020	1.3	1.3
2030	1.0	1.0
2040	1.0	1.0
2050	1.0	1.0

10.6 Results

10.6.1 Passenger Capacity

The results of the passenger capacity forecasts are shown both at the level of details in which the forecasts have been prepared (Table 10.6.1.1) and aggregated into the ACP route structure (Table 10.6.1.2).

The short-, medium- and long-term forecasts project an overall increase in full and partial cruise passenger ship Canal transits from 358,000 in 2001 lower berths to 799,200 in 2050, an overall increase of 123%.

Within the overall total, full transits are forecast to increase from 287,500 to 639,500, an overall increase of 122%. The primary full transit routes are projected to grow from 232,500 to 475,100 (+104%) and secondary routes from 55,000 to 164,400 (+199%). Partial transits are projected to grow from 70,600 to 159,700 (+126%), with around 85% of these transits on the two primary routes.

Table 10.6.1.1

Passenger Capacity by Passenger Ship Routes

(passenger capacity, 000's)

	2001	2005	2010	2015	2020	2030	2040	2050
FULL TRANSITS								
CARIB - WCCA	68.7	92.4	106.0	110.0	117.0	129.2	141.3	156.1
WCCA - CARIB	49.5	66.6	73.5	79.2	84.2	93.0	102.7	113.4
USEC - WCCA	42.8	45.0	49.7	58.5	56.9	62.9	69.4	76.7
WCCA - USEC	22.4	23.5	25.9	27.9	70.1	32.6	36.0	39.8
USWC - USEC	19.7	20.6	21.4	22.2	22.8	24.0	25.2	26.5
USEC - USWC	17.6	18.2	18.7	19.4	20.0	21.0	22.1	23.2
WCCA - ECSA	11.8	13.3	17.5	20.4	22.9	27.6	33.3	39.4
TOTAL PRIMARY ROUTES	**232.5**	**279.6**	**312.7**	**337.6**	**393.9**	**390.3**	**430.0**	**475.1**
USEC - WCSA	9.6	11.0	12.7	14.3	16.0	19.5	23.7	28.9
CARIB - USWC	8.2	9.3	10.7	12.0	13.4	16.3	19.8	24.1
ECSA - WCCA	7.0	8.0	9.2	10.3	11.5	14.0	17.0	20.7
ECSA - OTHER	6.7	7.6	8.7	9.7	10.8	13.2	16.0	19.5
CARIB - WCSA	2.7	3.1	3.5	3.9	4.4	5.4	6.5	7.9
USEC - OTHER	2.5	2.9	3.4	3.7	4.2	5.1	6.2	7.6
OTHER - WCCA	2.4	2.8	3.2	3.5	3.9	4.8	5.9	7.2
OTHER - OTHER (ATL -PAC)	2.4	2.8	3.2	3.6	4.0	4.9	5.9	7.2
WCCA - ECCA	2.2	2.6	3.3	3.6	4.0	4.9	5.9	7.2
WCSA - ECSA	1.7	2.0	3.0	3.4	3.8	4.6	5.6	6.8
ECCA - WCCA	1.6	1.8	2.3	2.4	2.7	3.3	4.0	4.9
USWC - ECSA	1.8	1.5	1.6	1.8	2.1	2.6	3.2	3.9
WCCA - OTHER	1.1	1.1	1.2	1.2	1.4	1.8	2.0	2.4
WCSA - USEC	1.0	1.1	1.2	1.2	1.4	1.8	2.0	2.4
WCSA - CARIB	0.9	1.0	1.1	1.2	1.4	1.8	2.0	2.4
USWC - CARIB	0.8	0.8	0.9	1.0	1.2	1.5	1.9	2.3
WCSA - ECCA	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.9
OTHER - USEC	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.9
OTHER - WCSA	0.5	0.5	0.6	0.7	0.9	1.1	1.4	1.7
OTHER - OTHER (PAR - ATL)	0.3	0.3	0.4	0.5	0.7	0.9	1.1	1.3
OTHER - ECCA	0.3	0.3	0.3	0.4	0.6	0.8	1.0	1.2
ECSA - WCSA	0.1	0.1	0.1	0.2	0.4	0.6	0.8	1.0
TOTAL SECONDARY ROUTES	**55.0**	**61.8**	**72.0**	**80.2**	**90.8**	**111.3**	**134.9**	**164.4**
TOTAL FULL TRANSITS	**287.5**	**341.4**	**384.7**	**417.8**	**484.7**	**501.6**	**564.9**	**639.5**
PARTIAL TRANSITS								
CARIB - BALBOA	40.3	52.9	58.4	62.7	66.6	73.0	80.7	89.1
USEC - BALBOA	21.1	27.8	30.5	32.8	34.8	38.6	42.7	46.2
TOTAL PRIMARY ROUTES	**61.4**	**80.7**	**88.9**	**95.5**	**101.4**	**111.6**	**123.4**	**135.3**
ECSA - BALBOA	3.8	5.3	5.9	6.4	6.8	7.6	8.5	9.4
ECCA - BALBOA	3.5	4.8	5.3	5.7	6.1	6.8	7.5	8.3
CHRIST - BALBOA	0.7	0.9	1.0	1.1	1.2	1.3	1.4	1.6
BALBOA - ECCA	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.4
WCCA - CHRIST	0.4	0.7	0.8	0.9	1.0	1.2	1.3	1.4
BALBOA - CHRIST	0.3	0.7	0.8	0.9	1.0	1.2	1.3	1.4
CHRIST - WCCA	0.1	0.4	0.5	0.6	0.7	0.8	0.8	0.9
TOTAL SECONDARY ROUTES	**9.2**	**13.5**	**15.1**	**16.5**	**17.8**	**20.1**	**22.1**	**24.4**
TOTAL PARTIAL TRANSITS	**70.6**	**94.2**	**104.0**	**112.0**	**119.2**	**131.7**	**145.5**	**159.7**
TOTAL FULL & PARTIAL TRANSITS	**358.1**	**435.6**	**488.7**	**529.8**	**603.9**	**633.3**	**710.4**	**799.2**

Table 10.6.1.2

Passenger Capacity by ACP Routes

(passenger capacity, 000's)

ACP ROUTE	DIRECTION	2001	2005	2010	2015	2020	2030	2040	2050
FULL TRANSITS									
ECUSA TO WC CENTRAL AM.	S	42.8	45.0	49.7	58.5	56.9	62.9	69.4	76.7
ECUSA TO WCUSA	S	17.6	18.2	18.7	19.4	20.0	21.0	22.1	23.2
OTHER NORTH TO OTHER SOUTH	S	68.7	92.4	106.0	110.0	117.0	129.2	141.3	156.1
OTHER SOUTH TO OTHER NORTH	N	49.5	66.6	73.5	79.2	84.2	93.0	102.7	113.4
WC CENTRAL AM. TO ECUSA	N	22.4	23.5	25.9	27.9	70.1	32.6	36.0	39.8
WCUSA TO ECUSA	N	19.7	20.6	21.4	22.2	22.8	24.0	25.2	26.5
WC CENTRAL AM. TO EC SOUTH AM.	N	11.8	13.3	17.5	20.4	22.9	27.6	33.3	39.4
TOTAL PRIMARY ROUTES		**232.5**	**279.6**	**312.7**	**337.6**	**393.9**	**390.3**	**430.0**	**475.1**
EC CENTRAL AM. TO WC CENTRAL AM.	S	1.6	1.8	2.3	2.4	2.7	3.3	4.0	4.9
EC SOUTH AM. TO WC CENTRAL AM.	S	7.0	8.0	9.2	10.3	11.5	14.0	17.0	20.7
EC SOUTH AM. TO WC SOUTH AM.	S	0.1	0.1	0.1	0.2	0.4	0.6	0.8	1.0
ECUSA TO WC SOUTH AM.	S	9.6	11.0	12.7	14.3	16.0	19.5	23.7	28.9
OTHER NORTH TO OTHER SOUTH	S	14.0	16.1	18.5	20.5	22.9	28.0	34.0	41.5
OTHER SOUTH TO OTHER NORTH	N	7.6	7.7	9.0	10.0	11.9	14.8	18.0	21.9
W INDIES TO WC SOUTH AM.	S	2.7	3.1	3.5	3.9	4.4	5.4	6.5	7.9
W INDIES TO WCUSA	S	8.2	9.3	10.7	12.0	13.4	16.3	19.8	24.1
WC CENTRAL AM. TO EC SOUTH AM.	N	1.7	2.0	3.0	3.4	3.8	4.6	5.6	6.8
WC SOUTH AM. TO W INDIES	N	0.9	1.0	1.1	1.2	1.4	1.8	2.0	2.4
WC SOUTH AM. TO EC CENTRAL AM.	N	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.9
WC SOUTH AM. TO ECUSA	N	1.0	1.1	1.2	1.2	1.4	1.8	2.0	2.4
TOTAL SECONDARY ROUTES		**55.0**	**61.8**	**72.0**	**80.2**	**90.8**	**111.3**	**134.9**	**164.4**
TOTAL FULL TRANSITS		**287.5**	**341.4**	**384.7**	**417.8**	**484.7**	**501.6**	**564.9**	**639.5**
PARTIAL TRANSITS									
OTHER NORTH TO OTHER SOUTH	S	61.4	80.7	88.9	95.5	101.4	111.6	123.4	135.3
TOTAL PRIMARY ROUTES		**61.4**	**80.7**	**88.9**	**95.5**	**101.4**	**111.6**	**123.4**	**135.3**
EC SOUTH AM. TO WC CENTRAL AM.	S	3.8	5.3	5.9	6.4	6.8	7.6	8.5	9.4
EC CENTRAL AM. TO WC CENTAL AM.	S	4.3	6.1	6.8	7.4	8.0	8.9	9.7	10.8
OTHER SOUTH TO OTHER NORTH	N	1.1	2.1	2.4	2.7	3.0	3.6	3.9	4.2
TOTAL SECONDARY ROUTES		**9.2**	**13.5**	**15.1**	**16.5**	**17.8**	**20.1**	**22.1**	**24.4**
TOTAL PARTIAL TRANSITS		**70.6**	**94.2**	**104.0**	**112.0**	**119.2**	**131.7**	**145.5**	**159.7**
TOTAL NORTH		**116.3**	**138.5**	**155.7**	**169.0**	**222.5**	**205.0**	**230.2**	**258.7**
TOTAL SOUTH		**241.8**	**297.1**	**333.0**	**360.8**	**381.4**	**428.3**	**480.2**	**540.5**
GRAND TOTAL		**358.1**	**435.6**	**488.7**	**529.8**	**603.9**	**633.3**	**710.4**	**799.2**

10.6.2 Number of Ships

Forecasts of numbers of transits by route were based on converting passenger capacity forecasts by applying the average passenger ship capacity for FY1998/99. The average passenger ship capacity was worked out as a ratio of total 1998/99 passenger capacity to total 1998/99 number of transits.

The resulting forecasts for both full and partial transits (Table 10.6.2.1) show an increase from 97 and 197 ships in 2001 to 186 and 310 ships in 2020 and 216 and 440 ships in 2050 on northbound and southbound routes, respectively. Full transits increase from 241 in 2001 to 539 in 2050 (+122%), and partial transits rise from 53 in 2001 to 120 in 2050 (+126%).

Table 10.6.2.1

Number of Transits by Route

ACP ROUTE	DIRECTION	2001	2005	2010	2015	2020	2030	(No. of Ships) 2040	2050
FULL TRANSITS									
ECUSA TO WC CENTRAL AM.	S	36	38	42	49	48	53	58	64
ECUSA TO WCUSA	S	15	15	16	16	17	18	19	19
OTHER NORTH TO OTHER SOUTH	S	58	77	89	92	98	108	118	131
OTHER SOUTH TO OTHER NORTH	N	41	56	62	66	71	78	86	95
WC CENTRAL AM. TO ECUSA	N	19	20	22	23	59	27	30	33
WCUSA TO ECUSA	N	17	17	18	19	19	20	21	22
WC CENTRAL AM. TO EC SOUTH AM.	N	10	11	15	17	19	23	28	33
TOTAL PRIMARY ROUTES		**195**	**234**	**262**	**283**	**330**	**327**	**360**	**398**
EC CENTRAL AM. TO WC CENTRAL AM.	S	1	2	2	2	2	3	3	4
EC SOUTH AM. TO WC CENTRAL AM.	S	6	7	8	9	10	12	14	17
EC SOUTH AM. TO WC SOUTH AM.	S	0	0	0	0	0	1	1	1
ECUSA TO WC SOUTH AM.	S	8	9	11	12	13	16	20	24
OTHER NORTH TO OTHER SOUTH	S	12	13	15	17	19	23	28	35
OTHER SOUTH TO OTHER NORTH	N	6	6	8	8	10	12	15	18
W INDIES TO WC SOUTH AM.	S	2	3	3	3	4	5	5	7
W INDIES TO WCUSA	S	7	8	9	10	11	14	17	20
WC CENTRAL AM. TO EC SOUTH AM.	N	1	2	3	3	3	4	5	6
WC SOUTH AM. TO W INDIES	N	1	1	1	1	1	2	2	2
WC SOUTH AM. TO EC CENTRAL AM.	N	1	1	1	1	1	1	1	2
WC SOUTH AM. TO ECUSA	N	1	1	1	1	1	2	2	2
TOTAL SECONDARY ROUTES		**46**	**52**	**60**	**67**	**76**	**93**	**113**	**138**
TOTAL FULL TRANSITS		**241**	**286**	**322**	**350**	**406**	**420**	**473**	**536**
PARTIAL TRANSITS									
OTHER NORTH TO OTHER SOUTH	S	46	61	67	72	76	84	93	102
TOTAL PRIMARY ROUTES		**46**	**61**	**67**	**72**	**76**	**84**	**83**	**102**
EC SOUTH AM. TO WC CENTRAL AM.	S	3	4	4	5	5	6	6	7
EC CENTRAL AM. TO WC CENTAL AM.	S	3	5	5	6	6	7	7	8
OTHER SOUTH TO OTHER NORTH	N	1	2	2	2	2	3	3	3
TOTAL SECONDARY ROUTES		**7**	**10**	**11**	**12**	**13**	**15**	**17**	**18**
TOTAL PARTIAL TRANSITS		**53**	**71**	**78**	**84**	**90**	**99**	**110**	**120**
TOTAL NORTH		**97**	**116**	**130**	**141**	**186**	**171**	**193**	**216**
TOTAL SOUTH		**197**	**241**	**270**	**293**	**310**	**348**	**390**	**440**
GRAND TOTAL		**294**	**357**	**401**	**434**	**496**	**519**	**583**	**656**

10.6.3 Transits by Dwt

Forecasts of dwt by route and dwt size range were based on applying combined factors used to apportion total capacity on a route by dwt size range and convert capacity to dwt, to passenger capacity forecasts by route.

The resulting forecasts (Table 10.6.3.1) for northbound and southbound trades are 514 and 1166 thousand dwt in 2001, rising to 1017 and 1850 thousand dwt in 2020, and 1121 and 2526 thousand dwt in 2050, respectively. Forecasts for full transits rise from 1326 thousand dwt in 2001 to 2946 thousand dwt in 2050 (+122%), and forecasts for partial transits increase from 353 thousand dwt in 2001 to 799 thousand dwt in 2050 (+126%).

Table 10.6.3.1

Dwt Transits by Route and Vessel Size

(000's dwt)

ACP ROUTE	DIRECTION	SIZE RANGE	2001	2005	2010	2015	2020	2030	2040	2050
FULL TRANSITS										
ECUSA TO WC CENTRAL AM.	S	<10000	183	193	213	251	244	269	297	328
ECUSA TO WC CENTRAL AM.	S	10-15000	2	2	2	2	2	3	3	3
ECUSA TO WC CENTRAL AM.	S	15-20000	3	3	3	4	4	4	5	5
ECUSA TO WCUSA	S	<10000	73	75	77	80	83	87	91	96
ECUSA TO WCUSA	S	10-15000	5	5	5	5	6	6	6	6
OTHER NORTH TO OTHER SOUTH	S	<10000	339	456	524	543	578	638	698	771
OTHER SOUTH TO OTHER NORTH	N	<10000	197	265	293	315	335	370	409	452
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	7	9	10	11	12	13	14	16
WC CENTRAL AM TO ECUSA	N	<10000	124	130	144	155	388	181	200	221
WCUSA TO ECUSA	N	<10000	82	86	89	93	95	100	105	110
WÇUSA TO ECUSA	N	10-15000	3	4	4	4	4	4	4	5
WC CENTRAL AM. TO EC SOUTH AM.	N	<10000	45	50	66	77	87	104	126	149
TOTAL PRIMARY ROUTES			**1063**	**1279**	**1430**	**1540**	**1837**	**1780**	**1958**	**2162**
EC CENTRAL AM. TO WC CENTRAL AM.	S	<10000	10	11	14	14	16	20	24	29
EC SOUTH AM. TO WC CENTRAL AM.	S	<10000	34	38	44	49	55	67	82	99
EC SOUTH AM. TO WC CENTRAL AM.	S	10-15000	3	4	4	5	6	7	8	10
EC SOUTH AM. TO WC SOUTH AM.	S	<10000	0	0	0	1	2	3	4	5
ECUSA TO WC SOUTH AM	S	<10000	46	53	61	69	77	94	114	139
OTHER NORTH TO OTHER SOUTH	S	<10000	69	80	91	101	113	138	168	205
OTHER SOUTH TO OTHER NORTH	N	<10000	30	31	36	40	47	59	72	87
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	1	1	1	1	2	2	2	3
W INDIES TO WC SOUTH AM.	S	<10000	14	16	18	20	23	28	34	41
W INDIES TO WCUSA	S	<10000	35	40	46	52	58	70	85	104
WC CENTRAL AM. TO EC SOUTH AM.	N	<10000	6	8	11	13	14	17	21	26
WC SOUTH AM. TO W INDIES	N	<10000	5	5	6	6	7	9	10	12
WC SOUTH AM. TO EC CENTRAL AM.	N	<10000	3	3	4	4	5	7	8	10
WC SOUTH AM. TO ECUSA	N	<10000	6	6	7	7	8	10	11	13
TOTAL SECONDARY ROUTES			**263**	**296**	**344**	**383**	**433**	**531**	**643**	**784**
TOTAL FULL TRANSITS			**1326**	**1575**	**1774**	**1923**	**2270**	**2311**	**2602**	**2946**
PARTIAL TRANSITS										
OTHER NORTH TO OTHER SOUTH	S	<10000	303	399	439	472	501	551	610	668
TOTAL PRIMARY ROUTES			**303**	**399**	**439**	**472**	**501**	**551**	**610**	**668**
EC SOUTH AM. TO WC CENTRAL AM.	S	<10000	18	25	28	31	33	36	41	45
EC SOUTH AM. TO WC CENTRAL AM.	S	10-15000	2	3	3	3	3	4	4	4
EC CENTRAL AM. TO WC CENTAL AM.	S	<10000	26	36	40	44	48	53	58	64
OTHER SOUTH TO OTHER NORTH	N	<10000	4	8	10	11	12	14	16	17
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	0	0	0	0	0	0	1	1
TOTAL SECONDARY ROUTES			**50**	**73**	**81**	**89**	**96**	**108**	**119**	**131**
TOTAL PARTIAL TRANSITS			**353**	**472**	**521**	**561**	**597**	**659**	**728**	**799**
TOTAL NORTH			514	607	680	737	1017	891	999	1121
TOTAL SOUTH			1166	1439	1615	1747	1850	2078	2331	2625
GRAND TOTAL			1680	2046	2295	2484	2867	2970	3330	3746

10.6.4 Transits by PCUMS

Forecasts of dwt transits by route and vessel size were converted into PCUMS for passenger ship transits using a ratio of PCUMS to dwt by size range calculated from the ACP database.

The resulting forecasts (Table 10.6.4.1) for northbound and southbound routes are 3.0 million net tons and 6.8 million net tons in 2001, 5.9 million net tons and 10.7 million net tons in 2020 and 6.4 and 15.2 million net tons, respectively in 2050. Forecasts for full transits rise from 7.7 million net tons in 2001 to 17.0 million net tons in 2050 (+122%), and forecasts for partial transits increase from 2.1 million net tons in 2001 to 4.6 million net tons in 2050 (+126%).

Table 10.6.4.1

PCUMS for Passenger ShipTransits by Route and Vessel Size

(000's PCUMS)

ACP ROUTE	DIRECTION	SIZE RANGE	2001	2005	2010	2015	2020	2030	2040	7050
FULL TRANSITS										
ECUSA TO WC CENTRAL AM.	S	<10000	1067	1122	1239	1459	1419	1568	1730	1912
ECUSA TO WC CENTRAL AM.	S	10-15000	9	9	10	12	12	13	14	16
ECUSA TO WC CENTRAL AM.	S	15-20000	5	5	5	6	6	7	7	8
ECUSA TO WCUSA	S	<10000	424	439	451	467	482	506	532	559
ECUSA TO WCUSA	S	10-15000	24	25	26	27	28	29	31	32
OTHER NORTH TO OTHER SOUTH	S	<10000	1976	2657	3046	3163	3365	3716	4064	4489
OTHER SOUTH TO OTHER NORTH	N	<10000	1147	1544	1704	1836	1952	2156	2381	2629
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	10	14	15	16	18	19	21	24
WC CENTRAL AM TO ECUSA	N	<10000	723	756	836	900	2262	1052	1162	1284
WCUSA TO ECUSA	N	<10000	478	500	519	539	553	582	611	643
WCUSA TO ECUSA	N	10-15000	17	18	19	19	20	21	22	23
WC CENTRAL AM. TO EC SOUTH AM.	N	<10000	260	293	385	449	504	608	733	868
TOTAL PRIMARY ROUTES			**6140**	**7384**	**8258**	**8895**	**10620**	**10277**	**11310**	**12487**
EC CENTRAL AM. TO WC CENTRAL A	S	<10000	55	62	80	83	94	114	139	170
EC SOUTH AM. TO WC CENTRAL AM	S	<10000	195	223	257	287	321	391	474	578
EC SOUTH AM TO WC CENTRAL AM.	S	10-15000	17	19	22	25	28	34	41	50
EC SOUTH AM. TO WC SOUTH AM	S	<10000	3	3	3	5	11	16	22	27
ECUSA TO WC SOUTH AM.	S	<10000	269	308	356	400	448	546	664	809
OTHER NORTH TO OTHER SOUTH	S	<10000	403	463	532	590	659	805	978	1193
OTHER SOUTH TO OTHER NORTH	N	<10000	176	178	209	232	276	343	417	508
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	2	2	2	2	2	3	4	5
W INDIES TO WC SOUTH AM.	S	<10000	82	94	106	118	134	164	197	240
W INDIES TO WCUSA	S	<10000	205	233	268	301	336	408	496	604
WC CENTRAL AM. TO EC SOUTH AM.	N	<10000	37	44	66	75	84	101	123	150
WC SOUTH AM. TO W INDIES	N	<10000	27	30	33	36	42	54	60	72
WC SOUTH AM. TO EC CENTRAL AM.	N	<10000	19	18	22	25	32	38	47	60
WC SOUTH AM TO ECUSA	N	<10000	32	35	39	39	45	58	65	77
TOTAL SECONDARY ROUTES			**1523**	**1715**	**1994**	**2219**	**2510**	**3076**	**3727**	**4543**
TOTAL FULL TRANSITS			**7663**	**9098**	**10252**	**11114**	**13130**	**13354**	**15037**	**17030**
PARTIAL TRANSITS										
OTHER NORTH TO OTHER SOUTH	S	<10000	1766	2321	2557	2746	2916	3209	3549	3891
TOTAL PRIMARY ROUTES			**1766**	**2321**	**2557**	**2746**	**2916**	**3209**	**3549**	**3891**
EC SOUTH AM. TO WC CENTRAL AM.	S	<10000	106	148	165	179	190	212	237	262
EC SOUTH AM. TO WC CENTRAL AM.	S	10-15000	9	13	14	15	16	18	20	23
EC CENTRAL AM. TO WC CENTAL AM	S	<10000	149	211	236	256	277	308	336	374
OTHER SOUTH TO OTHER NORTH	N	<10000	25	49	56	63	70	83	90	97
OTHER SOUTH TO OTHER NORTH	N	10-15000	0	0	0	0	0	0	0	0
OTHER SOUTH TO OTHER NORTH	N	15-20000	0	0	0	1	1	1	1	1
TOTAL SECONDARY ROUTES			**290**	**421**	**471**	**513**	**553**	**623**	**685**	**757**
TOTAL PARTIAL TRANSITS			**2056**	**2742**	**3027**	**3260**	**3470**	**3832**	**4234**	**4648**
TOTAL NORTH			**2955**	**3485**	**3905**	**4232**	**5860**	**5120**	**5738**	**6441**
TOTAL SOUTH			**6764**	**8356**	**9374**	**10141**	**10739**	**12066**	**13532**	**15238**
GRAND TOTAL			**9719**	**11840**	**13279**	**14374**	**16599**	**17186**	**19270**	**21678**

10.6.5 Tolls

Revenue forecasts were based on an assumption of US$ 2.57 per PCUMS, which was applied to the PCUMS forecasts for passenger ship transits.

The forecasts show that northbound and southbound toll revenues increase from US$7.6 million and US$16.4 million in 2001 to US$15.1 million and US$27.6 million in 2020 and US$16.6 million and US$39.2 million in 2050, respectively. The total revenue for all the trades increases by 123% by 2050 from US$25.0 million in 2001 to US$55.7 million in 2050. Revenues from full transits rise from US$19.7 million in 2001 to US$43.8 million in 2050 (+122%), and tolls for partial transits increase from US$5.3 million in 2001 to US$11.9 million in 2050 (+126%).

Results of Cruise Industry Survey

1. Company A

This company carries 0.5 million pax/year of which 90% are North Americans.

Fleet growth is seen as an important factor enhancing usage of the Panama Canal (4 on a scale of 1-5). Panama is regarded as a secondary market and as Miami becomes full they (and others) are looking for other business to complement existing routes. The company had a ship running between San Juan and Acapulco during the winter/fall seasons. They see a future in shorter duration cruises – referred to as 'mini series' - involving Panama transits. One problem in the Caribbean is availability of air space. As examples, San Juan and Aruba are becoming tight.

Ship Size. This is considered to be relatively unimportant and a neutral view is taken as to whether this is a factor that would either limit or enhance usage of the Canal (1 on a scale of 1 to 5). All but one of the company's vessels can currently transit the Canal. They have two new post-Panamax vessels due for delivery in 2003/2004 but their views on usage would not change with a larger Canal. These ships will be used close to population centres and an enlarged Canal would not help except for positioning for Los Angeles and Alaska. However there are no 'monster' ships in this market.

Vessel Deployment. No change envisaged. The company will continue to operate in the Caribbean in the winter out of San Juan/Miami with 1 to 2 transits each year in April/October to/from Alaska.

Regional Tourism. This is expected to have a minor positive impact (2 on a scale of 1 to 5). There is little market there. For the company, their international business is small and the magnitude of Panama is just 2%. The heavy advertising bill that would be required is just not warranted. This is ranked alongside places such as Mexico and Venezuela as an area in which to 'dabble'.

Fees. At deployment meetings, Canal tolls are always an issue (5 out of 5). It costs approximately $125,000 for a 2000 pax vessel which works out at around $5-10 per diem. This is difficult to get back. Interest is gaining in 10 day round trip cruises to Colon/Cristobal, taking people off here to avoid tolls.

Other considerations – costs. There are not a lot of quality ports around Panama. Tourism needs a lot of ports. Costa Rica is good ('wonderful') and the company is trying Honduras and Belize. Nevertheless although the Canal is a great centre piece more quality ports are needed. This seems to be a fairly important limitation (3/4).

Positioning Voyages. These are seen to continue as they are – static. The exception is that the introduction of post Panamax vessels might have a slight negative impact for the Canal in its current form. Positioning voyages to Alaska could fluctuate up/down by 1 or 2%.

Partial transits. One of the company's competitors has started with a full winter season of cruises to the Canal Zone and back. The respondent thinks they have been successful. There could be double digit growth in this market if someone else comes in.

Round the World Cruises. These are few and far between and the numbers are small. Future numbers likely to change up/down by, say, 1%.

Mini Series – where vessels spend a whole season going back and forth through the Canal, such as between San Juan and Acapulco. This is seen as a growth area, rising by between 3% and 4%.

2. Company B

Fleet Growth. We will not see the current/recent rate of growth in the industry continue indefinitely. 12% growth will not be sustained and growth will be slower. Nevertheless the cruise sector will continue to increase its share of the market for tourism, that is, growth will be greater than for the tourist industry overall. Impact on Canal usage will be positive, 3 on scale of 1 to 5.

Vessel Size/Deployment. The company has post Panamax vessels with 157 ft beams which are too large to transit. If the Canal were to be enlarged, these would be sent through but we would not see enormous increases in volumes – this would be more of an advantage for positioning. There might be one transit a year each way to the US West Coast. A competitor is planning to leave a post Panamax on the West Coast. It would be too expensive to re-position around Cape Horn. Market rumours suggest the ship will be moved from the ship yard via the Far East. We will not see regular through trips of current post Panamax vessels. While the impact on Canal usage would be positive it would be relatively low (1/2)

Regional Tourism. Development will be a slow process. Panama is geographically disadvantaged. It costs a lot more to fly from the southern Caribbean. There has been some experimenting from Aruba to Colon. (Positive impact, say 2/3)

Fees. These are important (5). These can cost up to $200,000 for a 2000 pax vessel – even for a partial transit. There is not a strong market for through sailings.

Positioning Voyages. The respondent would expect growth to be in line with or slightly behind the rate of growth of the industry. The West Coast market – including the Mexican Riviera - is weak, Alaska is constrained by berthing capacity.

Partial Transits. A competitor is currently doing Fort Lauderdale, Caribbean, Colon, Gatun Lake and are doing reasonably well. Another competitor is about to start up and will call at Colon. This will open up the hinterland to tourists and trips along the Canal will be offered. It is expensive to market in the US. Therefore the hope will be to attract interest by word of mouth. This means encouraging tourists to get off at Colon and explore the country from there. The other issue is Canal tolls. Do you pay $200,000 or call at Colon. Full fees are paid even for a partial transit. Alternatively if you call at Colon you pay port fees, but the Panamanian government has offered cash back incentives to use Colon which makes it virtually free. This also gives the cruise line the opportunity to sell excursions from Colon, including trips along the Canal. It will be interesting to see how this develops. The respondent would expect to see overall growth of around 12%, that is, in line with industry growth although it is likely to be 'lumpy'.

Through Cruises. Typically S Florida/San Juan + Caribbean ports + Canal + Acapulco, terminating at different locations – Costa Rica, Acapulco (problems with air lifts) – but typically ending in Southern California. The problem is the duration of such cruises. With short holidays typical in the US there is strong market preference for 2 week trips. Only retirees can consider longer cruises. Would expect growth to be relatively low. If industry growth is 12%, would expect 4%.

3. Company C

This company does not operate cruises involving Panama yet. They have considered this but in the near future have ruled it out as a possibility. The reason is that they usually operate 7 day cruises. This is dictated by the European market which they serve. Passengers are restricted by both time and money. For Europeans they must operate out of the E Caribbean – in this case Guadaloupe - to minimise flight times. To incorporate Panama into the itinerary would require a longer cruise of 10-12 days. Nevertheless they are always looking to expand and will consider Panama if they decide to go for longer cruises. In summary, while the Panama Canal is seem as a highlight, the marketing department are not looking at this at the moment and they have no real views about future usage of the Canal.

4. Company D

Fleet Growth. A slowdown in growth is expected over the next ten years with older smaller ships being phased out and more new, larger vessels being introduced. The respondent was unwilling to commit to a figure and unwilling to say whether usage of the Panama Canal would grow in line with the overall trend or above/below. The main reason for the reluctance to commit on future usage levels of the Canal was the over-riding importance of fees and associated costs (see below).

Ship Size. The company specialises in up-market smaller vessels. Changes in ship size are not an issue for them in terms of Canal usage and will not be when/if the Canal is enlarged. Enlargement of the Canal would not change this although it would have other benefits. The company is 'selling' the Canal as an experience. As part of this, for example, they aim to give their passengers the experience of passing through the locks at dawn, dusk and the afternoon. When the Gaillard Cut is widened so that ships will be able to run in both directions simultaneously, this will eliminate the occasions currently when ships have to sit for four hours because traffic is one way.

Vessel Deployment. The company were one of the first to use the Canal. The Canal is a feature of a range of 7-18 day through cruises offered with passengers disembarking at San Francisco, Los Angeles, Costa Rica, Panama and Lima. They operate full transits plus stops with full disembarkation at Colon and Balboa. Some cruises turn around at Balboa. Unlike a competitor, this company sees equal opportunities in the short and longer cruise markets and offer a whole variety to meet all. Also they do not see the problem of a lack of other quality ports. This may be in part because they have set out to make Panama an experience. However facilities in Panama are not always up to standard and not designed to accommodate more than one ship at a time. Landing fees are levied to pay for tourism upgrades but these and other costs are encouraging operators to use Colon to disembark guests and move them to the Canal Zone by bus. This also saves Canal tolls.

Regional Tourism. The whole industry is looking for new ideas and the company are looking at making Panama as successful as Costa Rica. They are the only company which feature a full day's Panama Canal experience which incorporates flights over the Canal, excursions, etc. However costs continue to grow and this is not consistent with aims to build up the area. It might be different when more people have joined the trend but in the meantime the authorities ought to be more willing to be less concerned with current profit and go for market growth. The company feels they are not being given sufficient encouragement. They are trying to promote tourism in the area but are suffering the penalty of high fees while others avoid these by operating out of Colon. (Based on RLA's analysis of partial transits, there were reductions of 18% and 27% in passenger numbers in 97/98 and 98/99 respectively and

this is put down to the increasing use of Colon.) In summary it is felt that the Canal Authority do a pretty good job but need to do more (this includes night time fees).
Fees. These are seen to be overwhelmingly important and critical to future growth. Fees are typically in the region of $150,000 to $200,000. There are also landing fees within the Canal and pilot dues. Fees are paid for a full transit even if the vessel turns around at the Gatun Lake. Whereas rebates are offered for passengers and operators at Colon and special tour boats for clients wishing to go through the Canal. Panama is a great destination but fees really are an issue. For example, it is difficult to sell cruises in November/December so they have to look at discounting. The first question is – 'will I put on a cruise which I will have to discount if I know I have got to pay $150,000-200,000 in Canal fees?'. At this level the respondent probably will not even look at a cruise that has to be discounted.

Because of the perceived impact of fees, the respondent was unwilling to give opinions on future trends in types of Canal usage in the future.

5. Company E

This company is one of the main cruise industry users of the Canal.

Fleet Growth. They feel there is potential for growth in the Panama Canal. As new vessels are brought in and placed in prime locations such as the Caribbean and Europe, vessels are displaced to other markets. The Panama Canal is considered to be in the 1st tier of markets in which to place such vessels. However, yields on Canal cruises have suffered recently. As a destination it has lost its lustre. The current trend in through transits is down. Partial transits have seen less of a drop. (This is this company's particular experience and as such it appears to contradict general trends in the Canal). At the moment they are using a 1600 pax vessel for partial transits and 2000 pax vessel on through transits. They are going to swap these vessels around. Cruises are longer and connections more complex on through transits. Air connections and air costs are a negative factor on full transits. This plus the lesser appeal of the destination. Low water levels in the Canal in recent times have not had an impact/caused operational problems. The company had planned to introduce a new ship in Panama but as a result of these considerations, decided not to. Air costs are a major issue. Typically through transits are 10/12 day cruises out of Fort Lauderdale or San Juan (more convenient location but high air costs). They would like to see another Pacific Coast destination on the way to Puerto Caldero. Panama itself is not a good land based port. Costa Rica would be better. Ideally they need something 200 miles to the North of Panama. The Mexican Riviera is weak. On the Atlantic side, destinations are poor. The itinerary is good but not beach/sun. Panama ends up as a destination oriented cruise – that is Panama is the centre piece and the cruise works if Panama works. Another factor is the older demographics on through transits. These are the generations for whom US achievements matter quite a bit. Now that the Canal has passed back into Panamanian hands this is seen as less a piece of the USA. The outlook for Panama usage has gone from very good to not so good. In summary fleet growth is seen to be a less important although positive influence on future Canal usage (1 or 2 out of 5).

Ship Size/Vessel Deployment. This will affect future usage absolutely. With greater numbers of post Panamax vessels being introduced, the Canal could lose some positioning voyages. The company is deploying a 3000 pax post Panamax vessel on the US West Coast via the Pacific (you can absorb 3000 passengers in a city like Osaka very easily). The Los Angeles/Alaska market is important. This reduces the need to position vessels between the Caribbean and USWC. If the Canal is expanded it will provide for greater flexibility, more positioning voyages. A 'new' Canal could also bring renewed interest. Importance as a factor is probably 3 out of 5, either way.

Regional Tourism. Developments in Panamanian tourism are seen as a positive development. There has been some improvement but there is a need for a little bit of promotion, a need to create greater awareness. They would like to see the destination promote itself more, perhaps allying itself with Costa Rica and the Caribbean. There is certainly the potential. One factor affecting Panama transits may be Colon 2000. Currently the company disembarks passengers at Colon and picks them up again at Colon. They consider that if you sell Panama you have to have a Canal transit. However they are keen to see what happens with their 10 day Caribbean cruise program by comparison with Panama (see below). Regional tourism is seen as a plus but the potential impact on Canal usage is obscured by potential competition from the increasing use of Colon as single Panama cruise stop.

Fees. Fees are a big deal (4 or 5 out of 5). They are too high for a 10 day Caribbean programme. The company will soon have one vessel on partial transits and a sister ship on Caribbean cruises. Their returns should be the same. If the yields turn out the same this will be an indictment on the appeal of Panama where fees of $150,000-200,000 have to be absorbed. In which case they will move to calling at Colon instead of partial transits.

In summary, the most important element is the appeal factor of the destination. Another important factor determining Panama usage is the yield on cruises/obtaining a reasonable return. Fees of course have an impact.

For the company, positioning voyages will decrease slightly with their vessel based on the US West Coast. Growth in through transits will be less than the industry sector as a whole. For the company, 1999 was an historical high. 2000 was 3% down, 2001 will be 8% down, 2002 will see a slight uptick, 2003 onwards is flat. Partial transits are seen as stable, subject to yield/making sure they are getting premiums to offset Canal fees.

6. Company F

Fleet Growth. Growth in the industry will not directly impact on usage of the Panama Canal – for three reasons. Firstly, growth is concentrated in post Panamax vessels. Measured in terms of passenger berths some 60/70% of the growth will be in post Panamax ships. Secondly, part of the Panama business is in partial transits which are charged as full transits. This segment is dead with the inauguration of Pier 6 (Hutchison Whampoa) and Colon 2000 at Colon. Therefore overall we will see less than industry growth in the Canal. 2000 will be the peak for a while, maybe with a slight increase 2000/2001 but not much beyond – that is for the next several years. The third reason for this static picture is the hostile atmosphere in Alaska. Alaska used to be the major reason for increases in Panama transits. In summary the respondent would say that growth in Panama will not be dramatic. Numbers of vessels may stay the same although with trend towards larger ships would see greater numbers of passengers.

Vessel Size/Deployment. As soon as an itinerary works for larger vessels we will see greater usage. Changes will come about through vessel upgrades and increases in available berths – through vessel size rather than numbers of vessels. The company is introducing new Panamax 'max' vessels that are 10,000 GRT larger than previous vessels. These have been adopted not through Panama Canal considerations but because they offer greater flexibility than post Panamaxes. You lose something on size but gain on flexibility.

Regional Tourism. Tourism will grow. It is growing rapidly in the Caribbean Basin – Costa Rica/Colombia. From the Panama Canal perspective this is not necessarily an upside – but could lead to an increase in the use of Colon.

All the above factors were rated about 2 out of 5 in terms of their potential positive impact on the Canal.

Fees. It goes without saying that fees are critical. With a 'no choice' vessel, such as the need to re-position a ship, the operator in stuck. However it is the company's practice to make one or two trips back and forth through the Canal prior to re-positioning. These are 'choice' trips which they can take or leave and represent about 30% to 40% of their Canal crossings.

One final issue is waiting time. So far the Canal have been 'kind' and despite hints of delays the company has continued to enjoy priority. If this is taken away they will go away. Widening the Gaillard Cut is not seen as a particular benefit because cruises already have priority but with the Canal operating close to capacity a time is envisaged that with further growth in all vessel transits the cruise operators could face delays. This would not be workable as, for example, clients have planes to catch. The prevention of delays is an important reason for developing the Canal; otherwise the company would again consider cutting its 'choice' voyages between Fort Lauderdale and Caldero.

7. Company G

The company does not operate very much in the Panama market. In the past 5 years they have used the Canal 6-7 times in total. They did not call November/December 2000 and have no plans to call in 2001. When they did call they used the Cristobal entrance with a partial transit to the Gatun Lake where passengers disembarked for visits.

They used one vessel based in Miami geared to the US cruise market. The cruises took 14 days and this is a bit too long for the US market which is geared to 7 days and possibly 10 days. Having said this there was a high degree of customer satisfaction on the cruises they did undertake.

His general comments on Panama which derive from the comments of his cruise industry colleagues and what he reads are that it has a big potential for cruises because people are seeking new destinations. Cristobal is developing a good program for maritime 'stations'. He would guess at a 100% increase in the next 5 years for cruises using Cristobal.

Globally, he sees a 50-60% growth in the next 5 years because the vessels that are being built are improving significantly. For example, and according to the respondent, only 1.5 million people go on cruises or 1% of the vacation market.

He does not think that the advent of bigger vessels will make any difference to Panama transits. There are still many panamax vessels available. The company has 6 vessels on order (the first one just delivered) which are 85,000 tons, 2,600 pax and still panamax.

8. Company H, Agents in Panama

The respondents' particular focus is costs, illustrated by transit costs that relatively recently were around $100,000 having now risen to $160,000. Booking fees for priority sailings are about 10% of the cost.

The respondent believes that there will be a small decline in the number of partial transits through the Canal. This is because of a combination of Panama Canal fees and the development of Pier 6 and Colon 2000. Vessels can dock in Panama and passengers then get a bus to the Gatun Lake instead of going through the Canal. Alternatively, passengers can be taken through the Canal to Gatun on small ferry boats. The cost of this is around $20,000 instead of $60,000 for a small cruise ship and around $160,000 for a larger vessel.

It is also in line with the short duration cruise market which is a budget market advertised in terms of the number of ports that passengers will visit.

He believes that total transits will be approximately the same in the short term with some increase in the longer haul cruises geared to the more affluent market. The state of the cruise market currently is that more passengers could go through the Canal without any increase in vessel capacity/transits.

The Canal will always be a popular area for cruise ships. The limitation is that once a relatively affluent passenger has transited the Canal it not necessarily a feature that they want to repeat. Against this, longer haul cruises to South America are being developed for the South American market and this involves a one way transit of the Canal. Companies such as Cunard, Seaborn and NCL - that is the people with the more affluent passengers - are looking for more unusual places bearing in mind that the Caribbean is saturated. However, these cruises are not a year round market. They are a feature of the summer season.

The current Canal dimensions are unlikely to be a limiting factor. The respondent believes that the Canal is a good market for the 600, 800-1200 pax vessels. The large vessels currently being built are for the budget eg Caribbean markets.

Positioning voyages: the Alaskans are restricting the number of vessels that will be allowed so there is a definite limit on the number of vessels positioning.

9. Company I

This company only go through the Canal once every two years when they have a 69 day round South America trip. However, the respondent was willing to discuss the Canal generally.

Fleet growth. Around 55 ships are on order for delivery over the next 5 years. One can see this continuing with 10-12 ships per annum. In other words, 12% pa is probably about right. This level of growth is likely to be reflected in positioning voyages through the Canal.

Current Canal dimensions are not a limiting factor for cruise ships. One makes a decision to build to Panama dimensions at up to 2,500 pax and 80,000 tons or go much bigger to 3,500 pax and 130,000 tons such as Royal Caribbean Cruises. The large vessels being built now are for the short duration market eg around the Caribbean but are not budget vessels being of 4 star and upwards quality and costing the passenger around $150/day.

The longer duration cruise serving the more affluent/older market is growing and likely to double over the next 5 years. However, this tends to mean an emphasis on new places eg China rather than existing markets. The Canal is a bit on the fringe of this and, as it is not a big market, then even significant growth would not make a big difference to Panama Canal transits.

Partial transits would increase if costs were lower. 1 Panama Canal transit = the cost of 10 ports of call. The company do 14 day cruises in the Caribbean which could easily incorporate a partial transit but they cannot afford it. £10,000-£15,000 would be a more appropriate fee. Both Suez and Panama pricing structure are based on the notion that the vessel has to go through the Canal but for cruise ships this is not the case. Upmarket operators can absorb a larger fee than middle range operators. This is particularly the case now with the Cristobal developments. The company has just positioned a vessel in Cuba and would like to incorporate a Canal partial transit but the economics do not work.

The respondent believes that partial transits will increase over the next few (10) years because the West Caribbean market is underdeveloped. However, the rate of increase will be much lower than if something were done about fees.

10. Company J

They use the Canal as part of their world cruises and South American cruises. This means one ship 1-2 times a year and other vessels 4 times a year. They are shying away from using the Canal for smaller vessels as they are no longer guaranteed daylight transits. For vessels operated by a subsidiary, they used to have 6 Canal cruises that is Fort Lauderdale to Punta Arenas or Caldera and back 3 times a year. This has now stopped. The subsidiary now has 2 transits of Fort Lauderdale to LA and back and 1 around S. America. Vessels end up with a daylight passage over 50% of the time but this is not guaranteed.

The increase in cruise ship capacity generally means that operators are looking at their per diem and their cost base.

He does not think that a large number of post panamaxes will be developed although he has been proved wrong in the past. Most large vessels are being built for the 7 day market which is not their market. However, he could envisage that there could be more air lift passengers in the Caribbean market using Curacao or Aruba which would encourage partial transits of the Canal in the short cruise sector.

Canal fees are becoming more important but you can make money from the Canal market or not. The fees are not so important in the upscale sector as in the mass market.

The upscale sector is growing steadily but how this will affect the Canal is not easy to see. Cruises such as Fort Lauderdale to Los Angeles and back are winter time only. If such a cruise is offered one year it may be a function of the fact that an Amazon cruise was offered the year before. Also, the Caribbean is a good winter destination but it is congested in the summer and may not be so appealing even if the Panama Canal is a strong attraction. But in winter there are not so many destinations for luxury cruises. On balance he thinks there will be limited growth in the affluent/round the world cruise transits of the Panama Canal but is unable to put a number to this. There is a new upscale port development on the Pacific side at Armador – an island connected to the causeway. Upscale cruises turn around on the USWC or in Costa Rica. This is the first upscale development between the Canal itself and Acapulco. More upscale ports are needed on the western side of the Caribbean but there are none. A Panama Canal transit is used as a feature they can market.

Partial transits – he believes that there will be a small percentage increase despite the advent of Colon and Hutchison because there will be more ships delivered. However, they use the Canal sparingly anyway so an increase will not make that much of a difference. Pier 6 and Colon 2000 probably have a bright future with excursions from the terminals.

Positioning voyages – probably not much of an increase. This has a lot to do with Alaska which is congested. Ships for this market may become larger to ease congestion but obviously will still be able to transit the Canal.

11. Company K, One of the Cruise Terminals at Colon

The terminal has two markets. Vessels transiting the Canal northbound will stop at Colon and shop in the free zone, go to shows, restaurants etc. This will be good for the cruise industry and good for Panama. The ships transiting northbound are generally at the beginning of the daylight convoy. The shops in Colon will be open until 8.00 pm in order for the passengers to be able to use the facility to its fullest.

Additionally, the Caribbean market is the largest in the world. They aim to attract vessels to stop off at Colon and use the facilities. This is vessels which would not be transiting the Canal anyway. They can also then take excursions through the Canal if they want. For a vessel of 1700 – 2000 pax approximately, there could be a ferry of around 500 pax capacity to take people to the Gatun Lake. This would take approx. 4 hours in total with a very short time at the Lake as the major attraction is to go through the locks. This compares to a large vessel taking 3 hours to Gatun and then discharging passengers to go on different tours. (The ferries would be provided by the tour operators who have tours to the islands). This is scheduled to start in summer 2001. The extent to which the ferry traffic to Gatun will happen will depend on the cruise lines. They will make their own contracts with the ferry operators. The Panamanian Government is providing incentives to use Colon in order for people to spend money landside.

11 Forecasts of Laden Transits by Route , Vessel Type and Size

This section describes the conversion of trade forecasts by route into transits by route, ship type and size expressed in terms of deadweight, numbers of vessels and PCUMS. As discussed in Section 2, the ACP databases have been used to develop factors for converting cargo tons to deadweight, deadweight to numbers of ships (via average vessel size by route and dwt size range) and deadweight to PCUMS. The results are discussed in the following sections. The figures in this section exclude passenger ships which are covered separately in Section 10.

Since completion of the study, some differences have become apparent between the actual number of full container ship transits as extracted from the ACP databases and the estimate to 2000 developed by RLA in its traffic demand study completed in January. This is despite the fact that forecasts, for example, of PCUMS are close.

As described in Section 2, the calculation of transit numbers is based on:

- Forecasts of cargo tonnage for each trade route;
- The breakdown of commodity trade flows within route by vessel type;
- Analysis of historical deadweight size distributions by trade route;
- Forecast changes in deadweight size distributions
- Loading factors (cargo:dwt ratios)
- The development of average dwt sizes within each dwt size range

Each of the above items have been audited to ascertain the possible causes of the higher than expected number of transits for full container ships. It has been concluded that the historical analysis of deadweight size distributions by trade route is the most likely source of the problem. These distributions were derived from the transit records and vessel data contained in the databases SDB 85-97 and SDB 94-00, which enabled a vessel deadweight size range and trade route to be assigned to each transit. Our audit has called into question the integrity and completeness of this data in the databases and has concluded that these could have led to a bias towards smaller ships on the main trade routes and hence a larger number of transits. The main area of concern in the transit data is the designation of trade route.

It is accepted that full container ships have multiple origins and destinations and it is therefore not straightforward to assign a trade route, but it appears that in many cases there are either non-systemic errors or inappropriate rules used to assign routes in the transit database. Two examples of this are:

- Where there are multiple load/discharge areas associated with a single vessel transit, examples in the transit database have been found where the transit has been assigned to a trade route which is responsible for a much smaller proportion of the cargo than another trade route involved in the transit.

- Assigning a cargo to a trade route which is not involved in the transit.

As an example of the first problem, further investigation revealed that many of the Europe - West Coast USA cargo records had been given a Europe- West Coast Canada route in the transit data. A comparison of cargo versus transit records for these two routes was therefore undertaken for the fiscal year 1998/1999. The results were as follows:

Europe - WCUSA	Europe-WCCAN

Cargo Data		
Cargo (tons)	3335472	70547
No. of Transits Involved	566	47
Transit Data		
Cargo (tons)	398359	514121
No of Transits	22	31

It can be seen that for the cargo data, Europe - WCUSA completely dominates with nearly 50 times more trade and more than 10 times as many transits involved. However, for the transit data, Europe - WCCAN has significantly more transits and trade. Consequently, in this particular example, the estimation of deadweight size distributions for Europe-WCUSA would be based on a small non-representative number of transits and any errors (sampling or statistical) would be magnified many times over when the true trades were applied.

With regard to the problem of wrong routes, on comparing sequence numbers for cargo and transit data for Europe-WCUSA trades, it was noticed that 3 of the 22 transits from the transit data above were not amongst the cargo data transits. These 3 transit records (70960, 78482, 80065) were looked up in the cargo database and were found to contain no Europe-WCUSA cargo, the main route for each of them being Europe-WCSA. Consequently, not only was the deadweight size distribution for Europe-WCUSA based on an unrepresentatively small number of transits, some of these transits were also non-representative.

Finally, as was to be expected, a significant number of transits were given North-South or South-North routes in the transit data due to the number of origins and destinations involved. This in itself is likely to introduce some small errors in the overall deadweight size distribution process but such errors will have been magnified by the problems described above.

The problems with the data were not readily apparent, particularly since the ACP data was used to calculate % cargo distributions by route and dwt size range directly from the raw data. Further a check on the data was not possible (nor required) given that in a period of five years alone there were about 7,600 individual transit records for full containerships, associated with almost 43,000 cargo records.

RLA has discussed with ACP a number of options for overcoming this problem. However, all would require significant further work. It is understood that if ACP wishes to use the forecasts for numbers of vessels in its other work, it will need to adjust these figures in the light of the latest data.

11.1 Generic Growth

Total laden transits are projected to increase from 312 million dwt in 2001 to 460 million dwt in 2020 and 639 million dwt in 2050, an increase of 105% over the forecast period (Table 11.1.1). Greatest gains are expected in southbound transits which are estimated to increase by 126%. Northbound transits are forecast to grow by just 78%. Transits of full container ships in particular are seen to increase the most. Projections in terms of numbers of ships are seen to increase to a lesser extent – by 88% overall - due to gradual increases in the average size of vessels (Table 11.1.2). Demand for the existing Canal is projected to grow from 11,398 transits in 2001 to 21,463 transits in 2050, of which 30% are estimated to be dry bulk carriers and 26% full container ships. Overall rates of growth in terms of PCUMS are similar to those for dwt. Total transits are projected to increase from 199 million PCUMS net tons in 2001 to 289 million net tons in 2020 and 395 million net tons in 2050 (Table 11.1.3).

Table 11.1.1

Scenario 1, Generic Growth in Dwt Laden Transits by Route and Ship Type

000's dwt

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	6,090	6,634	7,279	7,724	8,173	9,051	9,850	10,598
General Cargo	S	7,841	9,096	10,385	11,341	12,296	14,099	15,726	17,247
Refrigerated Cargo	N	11,871	12,340	12,659	12,797	12,821	12,424	11,617	10,377
Refrigerated Cargo	S	4,622	5,617	6,614	7,132	7,585	8,250	8,593	8,671
Dry Bulk Carrier	N	53,182	58,600	63,676	67,876	72,792	81,546	90,396	98,976
Dry Bulk Carrier	S	81,368	91,575	101,592	111,387	121,354	141,973	163,119	185,073
Tanker	N	16,906	16,172	18,439	17,743	17,091	16,847	17,328	17,631
Tanker	S	31,667	37,034	42,677	47,269	51,056	56,993	62,864	68,442
Dry/Liquid Bulk Carrier	N	236	245	256	261	265	279	289	291
Dry/Liquid Bulk Carrier	S	628	709	811	890	974	1,072	1,150	1,217
Container/Break-Bulk	N	4,818	5,320	5,900	6,310	6,727	7,559	8,337	9,088
Container/Break-Bulk	S	4,603	5,493	6,258	6,815	7,438	8,728	10,045	11,486
Full Container	N	34,913	41,656	49,479	54,566	59,463	69,161	77,686	86,025
Full Container	S	36,506	43,883	51,246	55,808	60,315	69,608	78,335	87,605
Roll-on/Roll-off	N	1,610	1,694	1,861	1,823	1,763	1,593	1,258	841
Roll-on/Roll-off	S	1,791	2,139	2,460	2,578	2,683	2,864	2,971	2,990
Vehicle Carrier	N	4,771	4,857	4,920	4,954	5,025	5,205	5,410	5,608
Vehicle Carrier	S	2,877	3,153	3,433	3,687	3,957	4,495	5,042	5,580
Vehicle/Dry Bulk	N	555	595	639	679	722	815	908	1,002
Vehicle/Dry Bulk	S	1,117	1,265	1,421	1,563	1,713	2,013	2,314	2,615
Liquid Gas	N	170	167	178	188	198	219	242	263
Liquid Gas	S	2,419	2,755	3,192	3,546	3,919	4,395	4,794	5,150
Other	N	478	503	541	574	608	676	746	812
Other	S	563	625	693	753	816	923	1,023	1,118
Total North		135,601	148,783	165,828	175,494	185,648	205,373	224,067	241,511
Total South		176,002	203,343	230,784	252,769	274,105	315,413	355,976	397,195
Grand Total		311,603	352,126	396,611	428,263	459,753	520,786	580,043	638,706

Table 11.1.2

Scenario 1, Generic Growth in the Number of Laden Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	465	503	548	578	609	669	723	773
General Cargo	S	643	744	847	924	1,001	1,148	1,283	1,411
Refrigerated Cargo	N	1,335	1,382	1,413	1,424	1,423	1,374	1,280	1,139
Refrigerated Cargo	S	485	582	680	732	778	847	884	893
Dry Bulk Carrier	N	1,296	1,407	1,506	1,587	1,684	1,870	2,059	2,243
Dry Bulk Carrier	S	1,878	2,101	2,308	2,510	2,720	3,181	3,657	4,158
Tanker	N	452	434	490	481	473	482	511	534
Tanker	S	957	1,114	1,280	1,417	1,536	1,728	1,917	2,097
Dry/Liquid Bulk Carrier	N	4	4	4	4	5	5	5	5
Dry/Liquid Bulk Carrier	S	11	12	14	16	17	19	21	23
Container/Break-Bulk	N	200	215	234	244	255	277	295	313
Container/Break-Bulk	S	180	213	236	251	269	307	345	388
Full Container	N	1,077	1,268	1,502	1,657	1,808	2,113	2,394	2,676
Full Container	S	1,138	1,371	1,612	1,767	1,921	2,241	2,544	2,861
Roll-on/Roll-off	N	98	99	106	104	101	93	71	55
Roll-on/Roll-off	S	114	131	147	150	152	153	146	148
Vehicle Carrier	N	306	307	307	306	308	314	324	334
Vehicle Carrier	S	199	215	232	246	261	286	319	352
Vehicle/Dry Bulk	N	19	20	22	23	25	28	31	34
Vehicle/Dry Bulk	S	33	38	42	47	52	61	71	81
Liquid Gas	N	12	12	13	14	14	16	18	19
Liquid Gas	S	155	178	208	233	259	293	322	348
Other	N	242	253	267	282	299	334	376	425
Other	S	102	107	112	117	123	133	143	153
Total North		5,503	5,905	6,412	6,704	7,003	7,574	8,086	8,551
Total South		5,895	6,806	7,719	8,410	9,089	10,398	11,652	12,912
Grand Total		11,398	12,711	14,131	15,114	16,092	17,972	19,738	21,463

Table 11.1.3

Scenario 1, Generic Growth in PCUMS for Laden Transits by Route and Ship Type

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	3,700	4,027	4,414	4,681	4,949	5.476	5,954	6,402
General Cargo	S	4,777	5,539	6,320	6,899	7,477	8,570	9,555	10,477
Refrigerated Cargo	N	9,573	9,953	10,212	10,325	10,346	10,028	9,379	8,378
Refrigerated Cargo	S	3,734	4,538	5,345	5,764	6,130	6,669	6,946	7,010
Dry Bulk Carrier	N	26,535	29,233	31,755	33,846	36,296	40,653	45,064	49,346
Dry Bulk Carrier	S	40,339	45,416	50,394	55,261	60,225	70,499	81,043	92,001
Tanker	N	7,960	7,599	8,640	8,335	8,056	7,988	8,264	8,457
Tanker	S	15,491	18,100	20,840	23,068	24,915	27,813	30,678	33,402
Dry/Liquid Bulk Carrier	N	115	120	125	127	129	136	141	142
Dry/Liquid Bulk Carrier	S	307	347	397	435	476	523	560	592
Container/Break-Bulk	N	2,778	3,063	3,393	3,624	3,858	4,326	4,763	5,183
Container/Break-Bulk	S	2,656	3,167	3,602	3,915	4,267	4,997	5,742	6,558
Full Container	N	25,990	30,927	36,641	40,316	43,844	50,822	56,922	62,858
Full Container	S	27,156	32,488	37,796	41,027	44,217	50,801	56,978	63,543
Roll-on/Roll-off	N	1,741	1,818	1,988	1,947	1,882	1,699	1,335	931
Roll-on/Roll-off	S	1,941	2,292	2,621	2,748	2,861	3,054	3,173	3,260
Vehicle Carrier	N	12,786	12,931	13,009	13,037	13,174	13,563	14,037	14,498
Vehicle Carrier	S	7,633	8,364	9,112	9,794	10,513	11,945	13,385	14,791
Vehicle/Dry Bulk	N	302	324	348	370	394	444	496	547
Vehicle/Dry Bulk	S	605	685	770	847	928	1,090	1,253	1,416
Liquid Gas	N	110	108	115	122	128	141	156	170
Liquid Gas	S	1,576	1,796	2,080	2,311	2,553	2,864	3,125	3,358
Other	N	365	384	412	437	463	516	572	626
Other	S	374	408	447	481	516	577	633	685
Total North		91,955	100,487	111,052	117,166	123,520	135,793	147,082	157,538
Total South		106,589	123,140	139.722	152,550	165,079	189,402	213,072	237,092
Grand Total		198,544	223,627	250,773	269,715	288,600	325,195	360,154	394,630

11.2 Existing Canal with Capacity Constraints

So far in this report discussion of the Case for the Existing Canal has been limited to the demand for trade flows through the Canal, without taking into account capacity constraints. This has been referred to the generic growth in transits demand and the results are described in Section 11.1. The projections of laden transits in this section (Case 1) are the figures which result when a limit of 42 transits per day is imposed.

Projections of Case 1 transits have been derived from the generic growth estimates as follows:

- Estimates of the generic growth in the total numbers of laden and ballast transits for commercial cargo carrying vessels developed were added to forecasts of passenger ship transits plus ballast transits for Other ship types (see Section 12.5);
- It has been assumed that passenger vessels will continue to receive priority and if necessary the numbers of other vessel transits in each year have been reduced proportionately in order to bring the total number of transits back to a daily figure of 42;
- The same overall percentage reductions were applied to all cargoes and vessel types and were equivalent to 9.5% in 2005, 17.8% in 2010, 27.3% in 2020 and 44.8% in 2050.

In reality, it is likely that more sophisticated scheduling and toll pricing policies would be introduced to manage a situation in which potential demand was persistently in excess of capacity. Also it is likely that other priorities would be established and different booking arrangements introduced. However all of these considerations fall outside of the remit of this study. For this reason, any reductions have been made pro rata across all ship types except passenger vessels.

With estimates for 2001 close to the operating capacity for the existing Canal, overall growth to 2050 in dwt terms is projected at just 13%. Total transits are forecast to increase to just 334 million dwt in 2020 and 353 million dwt in 2050 (Table 11.2.1). Northbound transits are estimated to decline marginally over the period with southbound transits increasing by 25%. The figure for 2020 represents a reduction of 126 million dwt (27%) from the projected demand for the Canal. By 2050, the cut would be 286 million dwt (45%). Under this case, the number of laden transits would increase by just 4% over the entire forecast period, with virtually no growth from 2010 (Table 11.2.2). Transits in terms of PCUMS are forecast to rise to 210 million net tons in 2020 and 218 million net tons in 2050, representing reductions from the demand for the Canal of 79 million net tons (-27%) and 177 million net tons (-45%) respectively (Table 11.2.3).

Table 11.2.1

Scenario 1, Case 1, Existing Canal Demand
Dwt Laden Transits by Route and Ship Type

000's dwt

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	6,084	6,003	5,984	5,959	5,940	5,931	5,904	5,855
General Cargo	S	7,833	8,230	8,537	8,748	8,936	9,240	9,427	9,529
Refrigerated Cargo	N	11,860	11,166	10,406	9,871	9,318	8,142	6,964	5,733
Refrigerated Cargo	S	4,618	5,082	5,437	5,502	5,512	5,406	5,151	4,791
Dry Bulk Carrier	N	53,131	53,022	52,345	52,360	52,903	53,439	54,185	54,682
Dry Bulk Carrier	S	81,290	82,858	83,514	85,924	88,196	93,040	97,776	102,249
Tanker	N	16,890	14,632	15,157	13,687	12,421	11,040	10,386	9,741
Tanker	S	31,637	33,509	35,083	36,464	37,106	37,350	37,682	37,813
Dry/Liquid Bulk Carrier	N	236	222	211	201	192	183	173	161
Dry/Liquid Bulk Carrier	S	627	641	667	686	708	702	689	673
Container/Break-Bulk	N	4,814	4,814	4,850	4,867	4,889	4,954	4,997	5,021
Container/Break-Bulk	S	4,598	4,970	5,145	5,257	5,406	5,720	6,021	6,346
Full Container	N	34,879	37,691	40,674	42,093	43,216	45,323	46,566	47,527
Full Container	S	36,471	39,706	42,127	43,051	43,835	45,616	46,955	48,400
Roll-on/Roll-off	N	1,608	1,532	1,530	1,406	1,281	1,044	754	465
Roll-on/Roll-off	S	1,790	1,935	2,022	1,989	1,950	1,877	1,781	1,652
Vehicle Carrier	N	4,766	4,394	4,044	3,821	3,652	3,411	3,243	3,098
Vehicle Carrier	S	2,875	2,853	2,822	2,844	2,876	2,946	3,022	3,083
Vehicle/Dry Bulk	N	554	538	526	524	525	534	544	554
Vehicle/Dry Bulk	S	1,116	1,145	1,168	1,206	1,245	1,319	1,387	1,445
Liquid Gas	N	170	152	147	145	144	143	145	145
Liquid Gas	S	2,416	2,493	2,624	2,736	2,848	2,880	2,874	2,845
Other	N	478	455	445	442	442	443	447	448
Other	S	563	565	570	581	593	605	613	617
Total North		135,471	134,621	136,318	135,378	134,923	134,588	134,309	133,430
Total South		175,833	183,988	189,715	194,988	199,210	206,701	213,377	219,442
Grand Total		311,304	318,609	326,033	330,365	334,133	341,289	347,686	352,872

Table 11.2.2

Scenario 1, Case 1, Existing Canal
Number of Laden Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	464	455	451	446	443	438	433	427
General Cargo	S	642	673	696	713	728	753	769	779
Refrigerated Cargo	N	1,334	1,251	1,161	1,098	1,034	900	767	629
Refrigerated Cargo	S	484	526	559	565	566	555	530	493
Dry Bulk Carrier	N	1,295	1,274	1,238	1,224	1,224	1,225	1,234	1,239
Dry Bulk Carrier	S	1,877	1,901	1,897	1,936	1,977	2,085	2,192	2,297
Tanker	N	452	392	403	371	344	316	306	295
Tanker	S	956	1,008	1,052	1,093	1,116	1,133	1,149	1,158
Dry/Liquid Bulk Carrier	N	4	4	4	3	3	3	3	3
Dry/Liquid Bulk Carrier	S	11	11	12	12	13	13	13	12
Container/Break-Bulk	N	199	195	192	188	185	181	177	173
Container/Break-Bulk	S	180	192	194	194	195	201	207	215
Full Container	N	1,076	1,147	1,235	1,278	1,314	1,385	1,435	1,479
Full Container	S	1,137	1,241	1,325	1,363	1,396	1,469	1,525	1,581
Roll-on/Roll-off	N	96	90	87	80	73	61	42	30
Roll-on/Roll-off	S	114	119	120	116	110	100	87	82
Vehicle Carrier	N	306	278	252	236	224	206	194	184
Vehicle Carrier	S	199	195	191	190	190	187	191	194
Vehicle/Dry Bulk	N	19	18	18	18	18	18	19	19
Vehicle/Dry Bulk	S	33	34	35	36	38	40	42	45
Liquid Gas	N	12	11	10	10	10	11	11	11
Liquid Gas	S	155	161	171	180	188	192	193	192
Other	N	242	229	220	217	217	219	225	235
Other	S	102	97	92	90	89	87	86	85
Total North		5,498	5,343	5,271	5,171	5,089	4,964	4,847	4,724
Total South		5,890	6,158	6,345	6,488	6,606	6,814	6,984	7,134
Grand Total		11,387	11,501	11,616	11,659	11,695	11,778	11,831	11,858

Table 11.2.3

Scenario 1, Case 1, Existing Canal
PCUMS for Laden Transits by Route and Ship Type

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	3,696	3,643	3,629	3,611	3,597	3,589	3,569	3,537
General Cargo	S	4,772	5,012	5,195	5,322	5,434	5,616	5,728	5,788
Refrigerated Cargo	N	9,563	9,006	8,395	7,965	7,519	6,572	5,622	4,629
Refrigerated Cargo	S	3,731	4,106	4,394	4,446	4,455	4,370	4,164	3,873
Dry Bulk Carrier	N	26,510	26,451	26,104	26,109	26,379	26,641	27,012	27,263
Dry Bulk Carrier	S	40,300	41,093	41,426	42,629	43,770	46,200	48,578	50,829
Tanker	N	7,953	6,876	7,102	6,430	5,855	5,235	4,954	4,672
Tanker	S	15,476	16,377	17,131	17,795	18,107	18,227	18,389	18,454
Dry/Liquid Bulk Carrier	N	115	108	103	98	94	89	84	78
Dry/Liquid Bulk Carrier	S	307	314	326	335	346	343	336	327
Container/Break-Bulk	N	2,775	2,771	2,789	2,795	2,804	2,835	2,855	2,863
Container/Break-Bulk	S	2,653	2,866	2,961	3,020	3,101	3,275	3,442	3,623
Full Container	N	25,965	27,983	30,120	31,100	31,864	33,305	34,120	34,728
Full Container	S	27,130	29,395	31,070	31,649	32,136	33,291	34,153	35,106
Roll-on/Roll-off	N	1,739	1,645	1,634	1,502	1,368	1,113	800	514
Roll-on/Roll-off	S	1,939	2,074	2,155	2,120	2,079	2,002	1,902	1,801
Vehicle Carrier	N	12,773	11,700	10,694	10,057	9,574	8,889	8,414	8,010
Vehicle Carrier	S	7,626	7,568	7,490	7,555	7,640	7,828	8,023	8,172
Vehicle/Dry Bulk	N	302	293	286	286	286	291	297	302
Vehicle/Dry Bulk	S	605	620	633	653	674	714	751	782
Liquid Gas	N	110	98	95	94	93	92	94	94
Liquid Gas	S	1,575	1,625	1,710	1,783	1,856	1,877	1,873	1,855
Other	N	365	347	339	337	337	338	343	346
Other	S	373	369	367	371	375	378	380	378
Total North		91,866	90,922	91,290	90,382	89,770	88,990	88,163	87,036
Total South		106,487	111,419	114,858	117,678	119,974	124,121	127,718	130,989
Grand Total		198,353	202,341	206,147	208,061	209,744	213,111	215,881	218,025

11.3 Expanded Canal

For the Expanded Canal, the laden transits expressed in dwt are estimated at 500 million in 2020 (Table 11.3.1) - an increase of 51% versus the case for the Existing Canal – and 691 million in 2050, almost double the figure for the Existing Canal (Case 1). In terms of numbers of ships, laden transits for the expanded Canal are projected to reach 16,268 in 2020 and 21,493 in 2050 (Table 11.3.2), increases of 4,573 (39%) and 9,908 (84%) respectively versus the estimates for 2020 and 2050 in the Existing Case. The increases in percentage terms are less than for the figures expressed in dwt due to increasing vessel sizes employed in existing Panama Canal trades and also the larger ships which would switch from by pass trades. In terms of PCUMS, total transits would reach 316 million net tons in 2020 and 429 million tons in 2050, representing similar increases versus the Existing Canal as those for dwt transits.

Table 11.3.1

Scenario 1, Case 2, Expanded Canal

Dwt Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's dwt 2050
General Cargo	N	7,279	7,724	8,173	9,051	9,850	10,598
General Cargo	S	10,385	11,341	12,296	14,099	15,726	17,247
Refrigerated Cargo	N	12,659	12,797	12,821	12,424	11,617	10,377
Refrigerated Cargo	S	6,614	7,132	7,585	8,250	8,593	8,671
Dry Bulk Carrier	N	67,511	71,737	76,656	85,595	94,499	102,908
Dry Bulk Carrier	S	107,829	118,062	125,654	147,469	170,365	194,874
Tanker	N	18,234	17,529	16,869	16,604	17,064	17,347
Tanker	S	44,473	48,940	52,606	58,303	63,907	69,202
Dry/Liquid Bulk Carrier	N	256	261	265	279	289	291
Dry/Liquid Bulk Carrier	S	811	890	974	1,072	1,150	1,217
Container/Break-Bulk	N	5,900	6,310	6,727	7,559	8,337	9,088
Container/Break-Bulk	S	6,258	6,815	7,438	8,728	10,045	11,486
Full Container	N	60,761	66,763	72,475	83,664	93,220	102,374
Full Container	S	67,787	73,122	78,335	89,042	98,789	108,945
Roll-on/Roll-off	N	1,861	1,823	1,763	1,593	1,258	841
Roll-on/Roll-off	S	2,460	2,578	2,683	2,864	2,971	2,990
Vehicle Carrier	N	4,920	4,954	5,025	5,205	5,410	5,608
Vehicle Carrier	S	3,433	3,687	3,957	4,495	5,042	5,580
Vehicle/Dry Bulk	N	639	679	722	815	908	1,002
Vehicle/Dry Bulk	S	1,421	1,563	1,713	2,013	2,314	2,615
Liquid Gas	N	178	188	198	219	242	263
Liquid Gas	S	3,192	3,546	3,919	4,395	4,794	5,150
Other	N	541	574	608	676	746	812
Other	S	693	753	816	923	1,023	1,118
Total North		**180,740**	**191,338**	**202,302**	**223,683**	**243,439**	**261,509**
Total South		**255,356**	**278,429**	**297,974**	**341,653**	**384,718**	**429,097**
Grand Total		**436,096**	**469,767**	**500,276**	**565,336**	**628,158**	**690,606**

Table 11.3.2

Scenario 1, Case 2, Expanded Canal
Number of Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	548	578	609	669	723	773
General Cargo	S	847	924	1,001	1,148	1,283	1,411
Refrigerated Cargo	N	1,413	1,424	1,423	1,374	1,280	1,139
Refrigerated Cargo	S	680	732	778	847	884	893
Dry Bulk Carrier	N	1,516	1,588	1,677	1,847	2,019	2,184
Dry Bulk Carrier	S	2,323	2,510	2,682	3,111	3,558	4,031
Tanker	N	483	474	467	476	504	527
Tanker	S	1,286	1,420	1,536	1,722	1,905	2,079
Dry/Liquid Bulk Carrier	N	4	4	5	5	5	5
Dry/Liquid Bulk Carrier	S	14	16	17	19	21	23
Container/Break-Bulk	N	234	244	255	277	295	313
Container/Break-Bulk	S	236	251	269	307	345	388
Full Container	N	1,589	1,747	1,900	2,212	2,495	2,778
Full Container	S	1,744	1,901	2,056	2,381	2,685	3,000
Roll-on/Roll-off	N	106	104	101	93	71	55
Roll-on/Roll-off	S	147	150	152	153	146	148
Vehicle Carrier	N	307	306	308	314	324	334
Vehicle Carrier	S	232	246	261	286	319	352
Vehicle/Dry Bulk	N	22	23	25	28	31	34
Vehicle/Dry Bulk	S	42	47	52	61	71	81
Liquid Gas	N	13	14	14	16	18	19
Liquid Gas	S	208	233	259	293	322	348
Other	N	267	282	299	334	376	425
Other	S	112	117	123	133	143	153
Total North		6,502	6,788	7,082	7,643	8,140	8,587
Total South		7,871	8,547	9,186	10,462	11,681	12,906
Grand Total		14,373	15,336	16,268	18,105	19,821	21,493

Table 11.3.3

Scenario 1, Case 2, Expanded Canal
PCUMS for Laden Transits by Route and Ship Type

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	4,414	4,681	4,949	5,476	5,954	6,402
General Cargo	S	6,320	6,899	7,477	8,570	9,555	10,477
Refrigerated Cargo	N	10,212	10,325	10,346	10,028	9,379	8,378
Refrigerated Cargo	S	5,345	5,764	6,130	6,669	6,946	7,010
Dry Bulk Carrier	N	33,406	35,501	37,945	42,368	46,787	50,982
Dry Bulk Carrier	S	53,081	58,122	62,023	72,774	84,037	96,063
Tanker	N	8,747	8,424	8,126	8,031	8,283	8,453
Tanker	S	21,661	23,834	25,628	28,420	31,167	33,767
Dry/Liquid Bulk Carrier	N	125	127	129	136	141	142
Dry/Liquid Bulk Carrier	S	397	435	476	523	560	592
Container/Break-Bulk	N	3,393	3,624	3,858	4,326	4,763	5,183
Container/Break-Bulk	S	3,602	3,915	4,267	4,997	5,742	6,558
Full Container	N	45,031	49,398	53,544	61,653	68,543	75,111
Full Container	S	50,063	53,877	57,600	65,258	72,222	79,487
Roll-on/Roll-off	N	1,988	1,947	1,882	1,699	1,335	931
Roll-on/Roll-off	S	2,621	2,748	2,861	3,054	3,173	3,260
Vehicle Carrier	N	13,009	13,037	13,174	13,563	14,037	14,498
Vehicle Carrier	S	9,112	9,794	10,513	11,945	13,385	14,791
Vehicle/Dry Bulk	N	348	370	394	444	496	547
Vehicle/Dry Bulk	S	770	847	928	1,090	1,253	1,416
Liquid Gas	N	115	122	128	141	156	170
Liquid Gas	S	2,080	2,311	2,553	2,864	3,125	3,358
Other	N	412	437	463	516	572	626
Other	S	447	481	516	577	633	685
Total North		121,201	127,992	134,939	148,381	160,446	171,422
Total South		155,498	169,026	180,973	206,741	231,800	257,463
Grand Total		276,699	297,019	315,912	355,122	392,246	428,886

11.4 Unrestricted Canal

The increase in laden transits versus the Expanded Case is relatively small. Total transits in terms of dwt are estimated at 514 million in 2020 and 705 million in 2050 (Table 11.4.1), just 3% and 2% respectively above the figures for the Expanded Case. Total numbers of laden transits would be up by just 52 in 2020 and 54 in 2050 (Table 11.4.2). Transit figures in terms of PCUMS would reach 321 million net tons in 2020 and 435 million tons in 2050 (Table 11.4.3).

Table 11.4.1

Scenario 1, Case 3, Unrestricted Canal

Dwt Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's dwt 2050
General Cargo	N	7,279	7,724	8,173	9,051	9,850	10,598
General Cargo	S	10,385	11,341	12,296	14,099	15,726	17,247
Refrigerated Cargo	N	12,659	12,797	12,821	12,424	11,617	10,377
Refrigerated Cargo	S	6,614	7,132	7,585	8,250	8,593	8,671
Dry Bulk Carrier	N	67,366	71,600	76,527	85,473	94,387	102,811
Dry Bulk Carrier	S	108,256	118,554	128,756	150,937	174,065	198,648
Tanker	N	18,234	17,529	16,869	16,604	17,064	17,347
Tanker	S	49,736	57,361	63,659	69,356	74,960	80,254
Dry/Liquid Bulk Carrier	N	256	261	265	279	289	291
Dry/Liquid Bulk Carrier	S	811	890	974	1,072	1,150	1,217
Container/Break-Bulk	N	5,900	6,310	6,727	7,559	8,337	9,088
Container/Break-Bulk	S	6,258	6,815	7,438	8,728	10,045	11,486
Full Container	N	60,761	66,763	72,475	83,664	93,220	102,374
Full Container	S	67,787	73,122	78,335	89,042	98,789	108,945
Roll-on/Roll-off	N	1,861	1,823	1,763	1,593	1,258	841
Roll-on/Roll-off	S	2,460	2,578	2,683	2,864	2,971	2,990
Vehicle Carrier	N	4,920	4,954	5,025	5,205	5,410	5,608
Vehicle Carrier	S	3,433	3,687	3,957	4,495	5,042	5,580
Vehicle/Dry Bulk	N	639	679	722	815	908	1,002
Vehicle/Dry Bulk	S	1,421	1,563	1,713	2,013	2,314	2,615
Liquid Gas	N	178	188	198	219	242	263
Liquid Gas	S	3,192	3,546	3,919	4,395	4,794	5,150
Other	N	541	574	608	676	746	812
Other	S	693	753	816	923	1,023	1,118
Total North		**180,594**	**191,201**	**202,172**	**223,561**	**243,328**	**261,411**
Notal South		**261,046**	**287,341**	**312,130**	**356,174**	**399,471**	**443,923**
Grand Total		**441,640**	**478,542**	**514,302**	**579,735**	**642,799**	**705,334**

Table 11.4.2

Scenario 1, Case 3, Unrestricted Canal
Number of Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	548	578	609	669	723	773
General Cargo	S	847	924	1,001	1,148	1,283	1,411
Refrigerated Cargo	N	1,413	1,424	1,423	1,374	1,280	1,139
Refrigerated Cargo	S	680	732	778	847	884	893
Dry Bulk Carrier	N	1,515	1,587	1,676	1,846	2,018	2,183
Dry Bulk Carrier	S	2,320	2,507	2,697	3,128	3,576	4,049
Tanker	N	483	474	467	476	504	527
Tanker	S	1,303	1,448	1,573	1,760	1,942	2,116
Dry/Liquid Bulk Carrier	N	4	4	5	5	5	5
Dry/Liquid Bulk Carrier	S	14	16	17	19	21	23
Container/Break-Bulk	N	234	244	255	277	295	313
Container/Break-Bulk	S	236	251	269	307	345	388
Full Container	N	1,589	1,747	1,900	2,212	2,495	2,778
Full Container	S	1,744	1,901	2,056	2,381	2,685	3,000
Roll-on/Roll-off	N	106	104	101	93	71	55
Roll-on/Roll-off	S	147	150	152	153	146	148
Vehicle Carrier	N	307	306	308	314	324	334
Vehicle Carrier	S	232	246	261	286	319	352
Vehicle/Dry Bulk	N	22	23	25	28	31	34
Vehicle/Dry Bulk	S	42	47	52	61	71	81
Liquid Gas	N	13	14	14	16	18	19
Liquid Gas	S	208	233	259	293	322	348
Other	N	267	282	299	334	376	425
Other	S	112	117	123	133	143	153
Total North		6,501	6,787	7,081	7,642	8,139	8,586
Total South		7,885	8,572	9,239	10,516	11,736	12,961
Grand Total		14,386	15,359	16,320	18,158	19,875	21,547

Table 11.4.3

Scenario 1, Case 3, Unrestricted Canal

PCUMS for Laden Transits by Route and Ship Type

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	4,414	4,681	4,949	5,476	5,954	6,402
General Cargo	S	6,320	6,899	7,477	8,570	9,555	10,477
Refrigerated Cargo	N	10,212	10,325	10,346	10,028	9,379	8,378
Refrigerated Cargo	S	5,345	5,764	6,130	6,669	6,946	7,010
Dry Bulk Carrier	N	33,342	35,441	37,888	42,314	46,738	50,938
Dry Bulk Carrier	S	53,250	58,318	63,359	74,269	85,632	97,687
Tanker	N	8,747	8,424	8,126	8,031	8,283	8,453
Tanker	S	23,787	27,240	30,099	32,892	35,639	38,238
Dry/Liquid Bulk Carrier	N	125	127	129	136	141	142
Dry/Liquid Bulk Carrier	S	397	435	476	523	560	592
Container/Break-Bulk	N	3,393	3,624	3,858	4,326	4,763	5,183
Container/Break-Bulk	S	3,602	3,915	4,267	4,997	5,742	6,558
Full Container	N	45,031	49,398	53,544	61,653	68,543	75,111
Full Container	S	50,063	53,877	57,600	65,258	72,222	79,487
Roll-on/Roll-off	N	1,988	1,947	1,882	1,699	1,335	931
Roll-on/Roll-off	S	2,621	2,748	2,861	3,054	3,173	3,260
Vehicle Carrier	N	13,009	13,037	13,174	13,563	14,037	14,498
Vehicle Carrier	S	9,112	9,794	10,513	11,945	13,385	14,791
Vehicle/Dry Bulk	N	348	370	394	444	496	547
Vehicle/Dry Bulk	S	770	847	928	1,090	1,253	1,416
Liquid Gas	N	115	122	128	141	156	170
Liquid Gas	S	2,080	2,311	2,553	2,864	3,125	3,358
Other	N	412	437	463	516	572	626
Other	S	447	481	516	577	633	685
Total North		**121,137**	**127,932**	**134,882**	**148,327**	**160,397**	**171,379**
Total South		**157,793**	**172,628**	**186,781**	**212,707**	**237,866**	**263,558**
Grand Total		**278,931**	**300,560**	**321,663**	**361,035**	**398,263**	**434,937**

12 Forecasts of Ballast Transits

As discussed in Section 2, future ballast transits for commercial ship types have been determined by relating them to laden transits at the stage where transits are expressed in dwt. In the absence of any long term trends linking laden and ballast transits, the last five years' actual data from the ACP database have been used. Factors have been calculated by ship type, route and size. The factor for each ballast route relates to the laden transits in terms of dwt on the reverse route – for example, ballast transits from Asia to the US East Coast are related to laden transits from the US East Coast to Asia. Laden/ballast ratios for larger vessel sizes have been based on the ratios for the largest sizes currently utilising the Canal.

For commercial vessels, ballast transits in terms of numbers of ships and PCUMS have been determined by applying the same average dwts and dwt/PCUMS ratios as determined for laden transits. The results for each case are discussed in Sections 12.1 to 12.4. There are only very occasional ballast transits for passenger ships. A different methodology has, of necessity, been adopted for Other Ship types since a large proportion of these do not have reported dwts in the database and in any event there is little justification in linking movements of these vessels with those of commercial tonnage.

For other ship types, trend analyses have been undertaken for north- and southbound numbers of transits and these have been used to develop future projections. Based on observations from the PCUMS data, it has been assumed that all of the vessels without dwts are in the dwt size range below 10,000 dwt. Using the ACP database it has therefore been possible to calculate average PCUMS net tons per vessel for each dwt size range. These relationships have been used to make projections of ballast transits for these vessel types in terms of PCUMS. The results are summarised in Section 12.5.

12.1 Generic Growth

Total ballast transits for commercial cargo carrying vessels are estimated to increase from 43.7 million dwt in 2001 to 62.5 million dwt in 2020 and nearly 85 million dwt in 2050 (Table 12.1.1). This represents an annual average growth rate of 1.3% over the period. Between 74% and 80% of ballast transits are accounted for by dry bulk carriers and tankers, in particular on northbound routes. As a result, most of the growth in ballast transits is projected to occur on northbound routes. In total, ballast transits are between 13% and 14% of laden transits throughout the forecast.

The total number of ballast transits is estimated to reach 2,918 in 2050 - an increase of 66% from 2001 - with northbound transits rising by 113% and those southbound by just 4% (Table 12.1.2). Transits in terms of PCUMS are projected to increase from 27.2 million net tons in 2001 to 37.6 million tons in 2020 and 49.9 million tons in 2050 (Table 12.1.3).

12.2 Existing Canal with Capacity Constraints

Total ballast transits are estimated to increase by just 8% over the forecast period, from 43.6 million dwt to 47.0 million dwt (Table 12.2.1). The figure for 2050 represents a reduction of some 38.0 million dwt from the estimated demand for the Canal. Northbound transits are shown to rise by 22% with southbound transits declining by almost one third. Because of increasing vessel sizes transiting the Canal the total number of ballast transits is projected to decline by 8% overall to just 1,612 ships in 2050, from 1,755 in 2001 (Table 12.2.2). Because of the predominance of dry bulk carriers and tankers among ballast ships, the growth in transits in terms of PCUMS net tons – at just 2% between 2001 and 2050 – is even lower than for dwt (Table 12.2.3). These vessel types generally have lower PCUMS/dwt ratios than most other ships.

12.3 Expanded Canal

In this case, total transits in 2010 are estimated at 55.9 million dwt, almost 26% above the figure for the Existing Canal of 42.7 million dwt (Table 12.3.1). By 2020, ballast transits are projected to reach 65.8 million dwt (45% above Case 1) and by 2050, 95.9 million dwt – that is, just over twice the Case 1 figure. The total number of ballast transits are projected to rise from 2,114 in 2010 to 3,029 in 2050, an overall increase of 43% (Table 12.3.2). Ballast transits in terms of PCUMS are forecast at 33.8 million net tons in 2010, rising to 39.1 million net tons in 2020 and 54.8 million net tons in 2050, approximately double the figure under Case 1 (Table 12.3.3).

12.4 Unrestricted Canal

As in the case of laden transits, the Unrestricted Case represents very little increase over the Expanded Case. In 2020, they are estimated at 66.0 million dwt in total (Table 12.4.1), just 0.3% above the Case 2 figure and in 2050 when transits are projected to reach 96.0 million dwt, the difference is just 0.1%. Total numbers of transits are estimated to be broadly the same as in Case 2 (Table 12.4.2). Transits in terms of PCUMS are estimated in 2020 and 2050 at 39.2 million net tons and 54.9 million net tons respectively (Table 12.4.3).

12.5 Other Ship Types

As discussed above, projections of ballast transits for other, non-specific vessel types have been handled outside of the model since a large proportion of these on the ACP database have no deadweights and trends in transits – as might be expected - bear no relation to laden transits. The results are shown in Table 12.5. For the Existing Canal (Case 1), total transits are forecast to decline from 1,905 in 2001 to 1,460 in 2020 and 1,155 in 2050. In contrast, under the other three cases, transits are projected to reach 2,009 in 2020 and 2,090 in 2050. Expressed in terms of PCUMS, transits under Case 1 are shown to decline from 858,000 net tons in 2001 to 523,000 net tons by 2050. In the other three cases transits are forecast to rise.

Table 12.1.1

Scenario 1, Generic Growth in Dwt Ballast Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's dwt 2050
General Cargo	N	1,425	1,633	1,846	2,005	2,167	2,475	2,757	3,025
General Cargo	S	572	611	657	686	715	772	823	870
Refrigerated Cargo	N	319	382	445	477	504	539	548	532
Refrigerated Cargo	S	3,917	4,070	4,176	4,221	4,226	4,097	3,829	3,416
Dry Bulk Carrier	N	16,613	18,690	20,684	22,655	24,682	28,921	33,315	37,944
Dry Bulk Carrier	S	2,347	2,565	2,776	2,946	3,142	3,523	3,904	4,269
Tanker	N	10,436	12,230	14,143	15,699	17,000	19,003	20,955	22,801
Tanker	S	2,911	2,802	3,186	3,004	2,828	2,674	2,635	2,579
Dry/Liquid Bulk Carrier	N	125	143	165	183	202	230	255	278
Dry/Liquid Bulk Carrier	S	52	54	56	57	57	60	61	61
Container/Break-Bulk	N	461	532	603	653	703	799	885	966
Container/Break-Bulk	S	348	382	420	447	474	529	580	629
Full Container	N	669	753	858	916	973	1,095	1,208	1,320
Full Container	S	453	527	625	694	763	912	1,064	1.225
Roll-on/Roll-off	N	104	121	138	137	134	125	112	92
Roll-on/Roll-off	S	118	113	111	103	94	80	51	24
Vehicle Carrier	N	498	543	589	632	677	761	851	938
Vehicle Carrier	S	1,062	1,089	1,116	1,139	1,168	1,234	1,306	1,377
Vehicle/Dry Bulk	N	289	326	365	400	438	514	589	665
Vehicle/Dry Bulk	S	48	52	58	60	65	73	82	92
Liquid Gas	N	891	1,013	1,170	1,296	1,428	1,595	1,734	1,857
Liquid Gas	S	15	15	15	16	17	19	20	22
Total North		**31,828**	**36,367**	**41,007**	**45,054**	**48,908**	**56,057**	**63,208**	**70,418**
Total South		**11,841**	**12,279**	**13,196**	**13,373**	**13,552**	**13,973**	**14,355**	**14,563**
Grand Total		**43,669**	**48,645**	**54,203**	**58,427**	**62,459**	**70,030**	**77,563**	**84,981**

* Excludes ballast transits for 'Other' Ship Types

Table 12.1.2

Scenario 1, Generic Growth in the Number of Ballast Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	145	167	191	208	226	261	293	324
General Cargo	S	53	57	62	65	68	73	79	84
Refrigerated Cargo	N	35	42	49	52	55	58	59	57
Refrigerated Cargo	S	463	480	491	495	495	480	449	402
Dry Bulk Carrier	N	418	465	505	545	587	689	795	910
Dry Bulk Carrier	S	63	67	70	72	75	84	92	100
Tanker	N	284	332	382	424	462	520	577	630
Tanker	S	70	67	75	72	70	68	69	70
Dry/Liquid Bulk Carrier	N	2	2	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1	1	1
Container/Break-Bulk	N	21	24	26	27	28	30	32	33
Container/Break-Bulk	S	16	17	18	19	20	21	22	23
Full Container	N	30	30	35	38	41	48	54	60
Full Container	S	21	22	27	30	34	41	49	57
Roll-on/Roll-off	N	11	12	12	11	10	8	6	5
Roll-on/Roll-off	S	19	18	18	18	17	15	2	2
Vehicle Carrier	N	24	26	28	30	32	34	38	41
Vehicle Carrier	S	48	47	47	46	45	45	45	46
Vehicle/Dry Bulk	N	8	9	10	11	12	15	17	19
Vehicle/Dry Bulk	S	2	2	2	2	2	2	3	3
Liquid Gas	N	23	26	31	34	38	42	45	48
Liquid Gas	S	1	1	1	1	1	1	1	1
Total Northbound		1,001	1,134	1,271	1,384	1,494	1,708	1,919	2,131
Total Southbound		756	779	811	821	828	831	812	788
Grand Total		1,757	1,913	2,082	2,205	2,322	2,540	2,732	2,919

* Excludes ballast transits for 'Other' ship types

Table 12.1.3

Scenario 1, Generic Growth in PCUMS for Ballast Transits by Route and Ship Type

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	877	1,005	1,136	1,235	1,335	1,524	1,698	1,864
General Cargo	S	351	375	403	421	439	474	505	534
Refrigerated Cargo	N	258	308	360	385	407	435	443	430
Refrigerated Cargo	S	3,157	3,281	3,367	3,404	3,410	3,305	3,089	2,757
Dry Bulk Carrier	N	8,313	9,357	10,358	11,348	12,368	14,504	16,720	19,059
Dry Bulk Carrier	S	1,186	1,296	1,403	1,489	1,588	1,782	1,975	2,160
Tanker	N	5,149	6,028	6,963	7,724	8,362	9,343	10,297	11,200
Tanker	S	1,308	1,254	1,419	1,341	1,266	1,206	1,197	1,182
Dry/Liquid Bulk Carrier	N	60	69	79	88	97	110	122	133
Dry/Liquid Bulk Carrier	S	25	26	27	28	28	29	30	30
Container/Break-Bulk	N	268	309	350	378	406	459	507	552
Container/Break-Bulk	S	204	224	246	261	276	307	336	363
Full Container	N	498	555	627	664	701	781	854	927
Full Container	S	328	378	446	492	538	637	739	847
Roll-on/Roll-off	N	110	128	146	144	141	132	117	102
Roll-on/Roll-off	S	133	125	121	111	101	83	50	27
Vehicle Carrier	N	1,345	1,465	1,592	1,709	1,828	2,058	2,298	2,528
Vehicle Carrier	S	2,814	2,869	2,924	2,972	3,039	3,195	3,370	3,545
Vehicle/Dry Bulk	N	155	175	196	216	236	277	317	358
Vehicle/Dry Bulk	S	26	28	30	33	35	40	45	50
Liquid Gas	N	586	667	770	853	940	1,050	1,141	1,223
Liquid Gas	S	10	10	10	11	11	12	13	14
Total Northbound		17,620	20,066	22,577	24,742	26,819	30,671	34,515	38,375
Total Southbound		9,541	9,867	10,397	10,561	10,732	11,070	11,350	11,508
Grand Total		27,161	29,933	32,974	35,303	37,551	41,741	45,865	49,882

* Excludes ballast transits for 'Other' ship types

Table 12.2.1

Scenario 1, Case 1, Existing Canal
Dwt Ballast Transits by Route and Ship Type

000's dwt

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	1,424	1,477	1,517	1,547	1,575	1,622	1,653	1,671
General Cargo	S	571	553	540	529	520	506	493	480
Refrigerated Cargo	N	319	345	366	368	366	353	328	294
Refrigerated Cargo	S	3,913	3,683	3,432	3,256	3,073	2,685	2,295	1,887
Dry Bulk Carrier	N	16,597	16,911	17,004	17,477	17,938	18,953	19,970	20,963
Dry Bulk Carrier	S	2,345	2,320	2,282	2,273	2,284	2,309	2,340	2,359
Tanker	N	10,426	11,066	11,626	12,110	12,355	12,454	12,561	12,597
Tanker	S	2,908	2,535	2,619	2,317	2,055	1,752	1,579	1,425
Dry/Liquid Bulk Carrier	N	125	130	136	141	147	150	153	154
Dry/Liquid Bulk Carrier	S	52	49	46	44	41	39	37	34
Container/Break-Bulk	N	460	482	496	504	511	523	530	534
Container/Break-Bulk	S	348	346	346	345	345	347	347	347
Full Container	N	668	681	705	706	707	717	724	729
Full Container	S	452	476	514	535	555	598	638	677
Roll-on/Roll-off	N	104	110	114	105	97	82	67	51
Roll-on/Roll-off	S	118	102	92	79	69	52	30	13
Vehicle Carrier	N	498	491	485	488	492	499	510	518
Vehicle Carrier	S	1,061	985	918	879	849	809	783	761
Vehicle/Dry Bulk	N	288	295	300	309	318	337	353	367
Vehicle/Dry Bulk	S	48	47	46	47	47	48	49	51
Liquid Gas	N	890	917	962	1,000	1,038	1,045	1,039	1,026
Liquid Gas	S	15	13	13	13	12	12	12	12
Total North		31,797	32,905	33,710	34,755	35,544	36,736	37,888	38,904
Total South		11,830	11,110	10,848	10,316	9,849	9,157	8,605	8,046
Grand Total		43,627	44,015	44,557	45,071	45,393	45,893	46,492	46,950

Table 12.2.2

Scenario 1, Case 1, Existing Canal Demand
Number of Ballast Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	145	151	157	161	164	171	176	179
General Cargo	S	53	52	51	50	49	48	47	46
Refrigerated Cargo	N	35	38	40	40	40	38	35	31
Refrigerated Cargo	S	462	434	403	382	360	314	269	222
Dry Bulk Carrier	N	418	420	415	420	426	451	477	502
Dry Bulk Carrier	S	63	61	58	56	55	55	56	55
Tanker	N	284	300	314	327	335	341	346	348
Tanker	S	70	61	62	56	51	45	42	39
Dry/Liquid Bulk Carrier	N	2	2	2	2	2	2	2	2
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	0	0	0
Container/Break-Bulk	N	21	21	21	21	21	20	19	18
Container/Break-Bulk	S	16	16	15	15	14	14	13	12
Full Container	N	30	27	29	29	30	31	32	33
Full Container	S	21	20	22	23	24	27	29	31
Roll-on/Roll-off	N	11	11	10	9	8	5	4	3
Roll-on/Roll-off	S	19	16	15	14	13	10	1	1
Vehicle Carrier	N	24	24	23	23	23	22	23	23
Vehicle Carrier	S	48	43	38	35	33	29	27	25
Vehicle/Dry Bulk	N	8	8	8	9	9	10	10	11
Vehicle/Dry Bulk	S	2	2	2	2	2	2	2	2
Liquid Gas	N	23	24	25	26	28	28	27	27
Liquid Gas	S	1	1	1	1	1	1	1	1
Total Northbound		1,000	1,026	1,045	1,067	1,086	1,119	1,150	1,177
Total Southbound		755	705	667	633	601	545	487	436
Grand Total		1,755	1,731	1,712	1,701	1,687	1,664	1,637	1,613

Table 12.2.3

Scenario 1, Case 1, Existing Canal
PCUMS for Ballast Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's tons 2050
General Cargo	N	876	909	934	953	970	999	1,018	1,030
General Cargo	S	350	339	332	325	319	311	303	295
Refrigerated Cargo	N	257	279	296	297	296	285	265	238
Refrigerated Cargo	S	3,154	2,969	2,768	2,626	2,479	2,166	1,852	1,523
Dry Bulk Carrier	N	8,305	8,466	8,515	8,754	8,988	9,505	10,022	10,530
Dry Bulk Carrier	S	1,185	1,173	1,153	1,149	1,154	1,168	1,184	1,194
Tanker	N	5,144	5,454	5,724	5,958	6,077	6,123	6,172	6,188
Tanker	S	1,307	1,135	1,167	1,034	920	790	718	653
Dry/Liquid Bulk Carrier	N	60	62	65	68	70	72	73	74
Dry/Liquid Bulk Carrier	S	25	24	22	21	20	19	18	16
Container/Break-Bulk	N	268	280	288	291	295	301	304	305
Container/Break-Bulk	S	204	202	202	201	201	201	201	201
Full Container	N	498	502	515	513	509	512	512	512
Full Container	S	328	342	366	379	391	418	443	468
Roll-on/Roll-off	N	110	116	120	111	102	86	70	56
Roll-on/Roll-off	S	133	114	100	86	74	55	30	15
Vehicle Carrier	N	1,344	1,325	1,309	1,318	1,329	1,349	1,377	1,396
Vehicle Carrier	S	2,811	2,596	2,404	2,293	2,209	2,094	2,020	1,958
Vehicle/Dry Bulk	N	155	159	161	166	171	181	190	198
Vehicle/Dry Bulk	S	26	25	25	25	25	26	27	27
Liquid Gas	N	586	603	633	658	683	688	684	675
Liquid Gas	S	10	9	8	8	8	8	8	8
Total Northbound		17,603	18,156	18,559	19,086	19,491	20,100	20,689	21,201
Total Southbound		9,532	8,928	8,547	8,147	7,800	7,254	6,803	6,358
Grand Total		27,135	27,084	27,106	27,233	27,291	27,354	27,492	27,559

* Excludes ballast transits for 'Other' ship types

Table 12.3.1

Scenario 1, Case 2, Expanded Canal

Dwt Ballast Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's dwt 2050
General Cargo	N	1,846	2,005	2,167	2,475	2,757	3,025
General Cargo	S	657	686	715	772	823	870
Refrigerated Cargo	N	445	477	504	539	548	532
Refrigerated Cargo	S	4,175	4,221	4,228	4,097	3,829	3,416
Dry Bulk Carrier	N	22,362	25,321	28,055	34,673	41,621	49,043
Dry Bulk Carrier	S	2,962	3,131	3,325	3,710	4,089	4,441
Tanker	N	14,089	15,614	16,887	18,832	20,719	22,498
Tanker	S	3,123	2,944	2,771	2,620	2,580	2,522
Dry/Liquid Bulk Carrier	N	165	183	202	230	255	278
Dry/Liquid Bulk Carrier	S	56	57	57	60	61	61
Container/Break-Bulk	N	603	653	703	799	885	966
Container/Break-Bulk	S	420	447	474	529	580	629
Full Container	N	858	916	973	1,095	1,208	1,320
Full Container	S	625	694	763	912	1,064	1,225
Roll-on/Roll-off	N	138	137	134	125	112	92
Roll-on/Roll-off	S	111	103	94	80	51	24
Vehicle Carrier	N	589	632	677	761	851	938
Vehicle Carrier	S	1,116	1,139	1,168	1,234	1,306	1,377
Vehicle/Dry Bulk	N	365	400	438	514	589	665
Vehicle/Dry Bulk	S	56	60	65	73	82	92
Liquid Gas	N	1,170	1,296	1,428	1,595	1,734	1,857
Liquid Gas	S	15	16	17	19	20	22
Total North		**42,630**	**47,635**	**52,167**	**61,637**	**71,278**	**81,215**
Total South		**13,318**	**13,499**	**13,679**	**14,106**	**14,485**	**14,678**
Grand Total		**55,949**	**61,134**	**65,845**	**75,742**	**85,763**	**95,892**

* Excludes ballast transits for Other ship types

Table 12.3.2

Scenario 1, Case 2, Expanded Canal

Number of Ballast Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	191	208	226	261	293	324
General Cargo	S	62	65	68	73	79	84
Refrigerated Cargo	N	49	52	55	58	59	57
Refrigerated Cargo	S	491	495	495	480	449	402
Dry Bulk Carrier	N	522	570	618	739	867	1,004
Dry Bulk Carrier	S	74	76	78	87	95	103
Tanker	N	393	436	474	532	589	642
Tanker	S	76	73	70	69	70	71
Dry/Liquid Bulk Carrier	N	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1
Container/Break-Bulk	N	26	27	28	30	32	33
Container/Break-Bulk	S	18	19	20	21	22	23
Full Container	N	35	38	41	48	54	60
Full Container	S	27	30	34	41	49	57
Roll-on/Roll-off	N	12	11	10	8	6	5
Roll-on/Roll-off	S	18	18	17	15	2	2
Vehicle Carrier	N	28	30	32	34	38	41
Vehicle Carrier	S	47	46	45	45	45	46
Vehicle/Dry Bulk	N	10	11	12	15	17	19
Vehicle/Dry Bulk	S	2	2	2	2	3	3
Liquid Gas	N	31	34	38	42	45	48
Liquid Gas	S	1	1	1	1	1	1
Total North		1,298	1,421	1,537	1,771	2,003	2,237
Total South		815	825	831	835	816	792
Grand Total		2,114	2,245	2,369	2,606	2,819	3,029

* Excludes ballast transits for Other ship types

Table 12.3.3

Scenario 1, Case 2, Expanded Canal
PCUMS for Ballast Transits by Route and Ship Type

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	1,136	1,235	1,335	1,524	1,698	1,864
General Cargo	S	403	421	439	474	505	534
Refrigerated Cargo	N	360	385	407	435	443	430
Refrigerated Cargo	S	3,367	3,404	3,410	3,305	3,089	2,757
Dry Bulk Carrier	N	11,096	12,529	13,868	17,067	20,425	24,011
Dry Bulk Carrier	S	1,483	1,569	1,667	1,861	2,052	2,232
Tanker	N	6,947	7,693	8,319	9,274	10,201	11,074
Tanker	S	1,482	1,399	1,319	1,252	1,237	1,215
Dry/Liquid Bulk Carrier	N	79	88	97	110	122	133
Dry/Liquid Bulk Carrier	S	27	28	28	29	30	30
Container/Break-Bulk	N	350	378	406	459	507	552
Container/Break-Bulk	S	246	261	276	307	336	363
Full Container	N	627	664	701	781	854	927
Full Container	S	446	492	538	637	739	847
Roll-on/Roll-off	N	146	144	141	132	117	102
Roll-on/Roll-off	S	121	111	101	83	50	27
Vehicle Carrier	N	1,592	1,709	1,828	2,058	2,298	2,528
Vehicle Carrier	S	2,924	2,972	3,039	3,195	3,370	3,545
Vehicle/Dry Bulk	N	196	216	236	277	317	358
Vehicle/Dry Bulk	S	30	33	35	40	45	50
Liquid Gas	N	770	853	940	1,050	1,141	1,223
Liquid Gas	S	10	11	11	12	13	14
Total North		**23,298**	**25,893**	**28,277**	**33,166**	**38,124**	**43,201**
Total South		**10,540**	**10,699**	**10,863**	**11,195**	**11,467**	**11,612**
Grand Total		**33,839**	**36,592**	**39,140**	**44,362**	**49,591**	**54,813**

* Excludes ballast transits for 'Other' ship types

Table 12.4.1

Scenario 1, Case 3, Unrestricted Canal

Dwt Ballast Transits by Route and Ship Type

000's dwt

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	1,846	2,005	2,167	2,476	2,757	3,025
General Cargo	S	657	686	715	772	823	870
Refrigerated Cargo	N	445	477	504	539	548	532
Refrigerated Cargo	S	4,175	4,221	4,228	4,097	3,829	3,416
Dry Bulk Carrier	N	22,254	25,204	28,231	34,855	41,790	49,175
Dry Bulk Carrier	S	2,955	3,125	3,319	3,705	4,063	4,436
Tanker	N	14,089	15,614	16,887	18,832	20,719	22,498
Tanker	S	3,123	2,944	2,771	2,620	2,580	2,522
Dry/Liquid Bulk Carrier	N	165	183	202	230	255	278
Dry/Liquid Bulk Carrier	S	56	57	57	60	61	61
Container/Break-Bulk	N	603	653	703	799	885	966
Container/Break-Bulk	S	420	447	474	529	580	629
Full Container	N	858	916	973	1,095	1,208	1,320
Full Container	S	625	694	763	912	1,064	1,225
Roll-on/Roll-off	N	138	137	134	125	112	92
Roll-on/Roll-off	S	111	103	94	80	51	24
Vehicle Carrier	N	589	632	677	761	851	938
Vehicle Carrier	S	1,116	1,139	1,168	1,234	1,306	1,377
Vehicle/Dry Bulk	N	365	400	438	514	589	665
Vehicle/Dry Bulk	S	56	60	65	73	82	92
Liquid Gas	N	1,170	1,296	1,428	1,595	1,734	1,857
Liquid Gas	S	15	16	17	19	20	22
Total North		**42,522**	**47,517**	**52,343**	**61,819**	**71,448**	**81,346**
Total South		**13,312**	**13,492**	**13,673**	**14,100**	**14,479**	**14,673**
Grand Total		**55,834**	**61,009**	**66,016**	**75,919**	**85,927**	**96,019**

* Excludes ballast transits for 'Other'ship types

Table 12.4.2

Scenario 1, Case 3, Unrestricted Canal
Number of Ballast Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	191	208	226	261	293	324
General Cargo	S	62	65	68	73	79	84
Refrigerated Cargo	N	49	52	55	58	59	57
Refrigerated Cargo	S	491	495	495	480	449	402
Dry Bulk Carrier	N	520	568	619	740	868	1,004
Dry Bulk Carrier	S	74	76	78	87	95	103
Tanker	N	393	436	474	532	589	642
Tanker	S	76	73	70	69	70	71
Dry/Liquid Bulk Carrier	N	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1
Container/Break-Bulk	N	26	27	28	30	32	33
Container/Break-Bulk	S	18	19	20	21	22	23
Full Container	N	35	38	41	48	54	60
Full Container	S	27	30	34	41	49	57
Roll-on/Roll-off	N	12	11	10	8	6	5
Roll-on/Roll-off	S	18	18	17	15	2	2
Vehicle Carrier	N	28	30	32	34	38	41
Vehicle Carrier	S	47	46	45	45	45	46
Vehicle/Dry Bulk	N	10	11	12	15	17	19
Vehicle/Dry Bulk	S	2	2	2	2	3	3
Liquid Gas	N	31	34	38	42	45	48
Liquid Gas	S	1	1	1	1	1	1
Total North		**1,297**	**1,419**	**1,538**	**1,772**	**2,004**	**2,238**
Total South		**815**	**825**	**831**	**835**	**816**	**792**
Grand Total		**2,112**	**2,244**	**2,369**	**2,607**	**2,820**	**3,030**

* Excludes ballast transits for 'Other' ship types

Table 12.4.3

Scenario 1, Case 3, Unrestricted Canal
PCUMS for Ballast Transits by Route and Ship Type

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	1,136	1,235	1,335	1,524	1,698	1,864
General Cargo	S	403	421	439	474	505	534
Refrigerated Cargo	N	360	385	407	435	443	430
Refrigerated Cargo	S	3,367	3,404	3,410	3,305	3,089	2,757
Dry Bulk Carrier	N	11,048	12,476	13,944	17,146	20,498	24,067
Dry Bulk Carrier	S	1,480	1,566	1,664	1,858	2,050	2,230
Tanker	N	6,947	7,693	8,319	9,274	10,201	11,074
Tanker	S	1,482	1,399	1,319	1,252	1,237	1,215
Dry/Liquid Bulk Carrier	N	79	88	97	110	122	133
Dry/Liquid Bulk Carrier	S	27	28	28	29	30	30
Container/Break-Bulk	N	350	378	406	459	507	552
Container/Break-Bulk	S	246	261	276	307	336	363
Full Container	N	627	664	701	781	854	927
Full Container	S	446	492	538	637	739	847
Roll-on/Roll-off	N	146	144	141	132	117	102
Roll-on/Roll-off	S	121	111	101	83	50	27
Vehicle Carrier	N	1,592	1,709	1,828	2,058	2,298	2,528
Vehicle Carrier	S	2,924	2,972	3,039	3,195	3,370	3,545
Vehicle/Dry Bulk	N	196	216	236	277	317	358
Vehicle/Dry Bulk	S	30	33	35	40	45	50
Liquid Gas	N	770	853	940	1,050	1,141	1,223
Liquid Gas	S	10	11	11	12	13	14
Total North		**23,250**	**25,840**	**28,353**	**33,245**	**38,196**	**43,257**
Total South		**10,537**	**10,696**	**10,860**	**11,193**	**11,465**	**11,610**
Grand Total		**33,787**	**36,536**	**39,213**	**44,437**	**49,661**	**54,867**

* Excludes ballast transits for 'Other' ship types

Table 12.5.1

Number and PCUMS for Ballast Transits for Other Ship Types								
	2001	2005	2010	2015	2020	2030	2040	2050
Case 1								000's (No.)
Northbound	774	715	663	632	603	556	517	483
Southbound	1,131	1,036	952	902	857	782	723	672
Total	1,905	1,751	1,615	1,534	1,460	1,338	1,240	1,155
Case 2 and 3								
Northbound	775	791	806	819	830	848	862	874
Southbound	1,132	1,145	1,158	1,169	1,179	1,194	1,206	1,216
Total	1,906	1,936	1,965	1,989	2,009	2,042	2,068	2,090
Case 1								000's PCUMS
Northbound	439	406	376	358	342	315	293	274
Southbound	420	384	353	335	318	290	268	249
Total	858	790	729	693	660	605	561	523
Case 2 and 3								
Northbound	439	448	457	465	471	481	489	496
Southbound	420	425	430	434	437	443	447	451
Total	859	873	887	899	908	924	936	947

13 Forecasts of Tolls for Laden and Ballast Transits

It is important that this study be placed in its proper context. The study terms of reference call for projections of potential toll revenue based on the existing toll structure. It should be recognised that this approach does not take into account potential future changes in toll pricing policies whose objectives may not be limited solely to economic considerations. In any event there will be some trades where the economics are such that higher toll levels could be sustained. Equally, there are some routes for which a marginal pricing policy would enable the Canal to capture more trade.

13.1 Generic Growth

Estimates of future tolls revenue for laden and ballast transits for commercial cargo vessels have been derived by multiplying transit forecasts expressed in terms of PCUMS by the tolls of US$2.57/PCUMS and US$2.04/PCUMS respectively. Estimates exclude other ancillary charges which together add approximately 20% to the tolls. The results are shown in Tables 13.1.1 to 13.1.2. Laden toll revenue is estimated to increase from $510 million in 2001 to $742 million in 2020 and $1,014 in 2050, representing an average growth rate of 1.4% per annum. Over the same period revenue from ballast transits is forecast to rise from $56 million to $102 million, equivalent to approximately 10/11% of the laden revenue. Total revenue therefore would increase from $566 million in 2001 to $818 million in 2020 and $1,115 million in 2050.

Table 13.1.1

Scenario 1, Tolls Based on Generic Growth In Laden Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	9,508	10,349	11,344	12,030	12,720	14,073	15,303	16,454
General Cargo	S	12,277	14,235	16,243	17,730	19,217	22,024	24,557	26,925
Refrigerated Cargo	N	24,602	25,579	26,245	26,536	26,590	25,772	24,103	21,533
Refrigerated Cargo	S	9,597	11,663	13,736	14,813	15,754	17,138	17,852	18,017
Dry Bulk Carrier	N	68,195	75,130	81,610	86,984	93,280	104,479	115,815	126,819
Dry Bulk Carrier	S	103,671	116,719	129,513	142,022	154,779	181,181	208,280	236,443
Tanker	N	20,458	19,530	22,204	21,421	20,705	20,530	21,239	21,733
Tanker	S	39,811	46,516	53,558	59,284	64,030	71,480	78,842	85,842
Dry/Liquid Bulk Carrier	N	297	308	322	327	332	349	361	364
Dry/Liquid Bulk Carrier	S	790	891	1,019	1,118	1,223	1,344	1,440	1,522
Container/Break-Bulk	N	7,139	7,872	8,720	9,313	9,916	11,118	12,240	13,320
Container/Break-Bulk	S	6,825	8,139	9,256	10,061	10,967	12,842	14,756	16,853
Full Container	N	66,795	79,482	94,167	103,611	112,680	130,611	146,289	161,546
Full Container	S	69,792	83,493	97,135	105,440	113,638	130,558	146,434	163,305
Roll-on/Roll-off	N	4,473	4,673	5,108	5,003	4,837	4,365	3,431	2,392
Roll-on/Roll-off	S	4,987	5,891	6,736	7,063	7,353	7,850	8,156	8,378
Vehicle Carrier	N	32,859	33,232	33,433	33,505	33,857	34,858	36,074	37,260
Vehicle Carrier	S	19,617	21,495	23,417	25,171	27,018	30,700	34,399	38,013
Vehicle/Dry Bulk	N	776	832	895	952	1,012	1,142	1,274	1,406
Vehicle/Dry Bulk	S	1,556	1,762	1,979	2,176	2,385	2,801	3,220	3,639
Liquid Gas	N	282	278	296	312	329	363	402	436
Liquid Gas	S	4,052	4,616	5,346	5,939	6,562	7,362	8,032	8,630
Other	N	939	987	1,058	1,122	1,190	1,327	1,470	1,610
Other	S	960	1,049	1,148	1,235	1,327	1,482	1,628	1,760
Total North		236,323	258,251	285,403	301,115	317,448	348,988	378,001	404,873
Total South		273,935	316,470	359,085	392,053	424,254	486,762	547,595	609,327
Grand Total		510,258	574,721	644,487	693,169	741,701	835,750	925,596	1,014,200

Table 13.1.2

Scenario 1, Tolls Based on Generic Growth in Ballast Transits by Route and Ship Type

000's US$

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	1,789	2,050	2,318	2,519	2,723	3,110	3,464	3,802
General Cargo	S	716	765	823	859	895	967	1,031	1,089
Refrigerated Cargo	N	526	629	734	786	830	888	903	878
Refrigerated Cargo	S	6,439	6,693	6,868	6,944	6,957	6,743	6,303	5,623
Dry Bulk Carrier	N	16,958	19,088	21,130	23,149	25,230	29,587	34,109	38,880
Dry Bulk Carrier	S	2,420	2,645	2,862	3,038	3,240	3,635	4,028	4,407
Tanker	N	10,504	12,297	14,205	15,756	17,058	19,059	21,006	22,847
Tanker	S	2,668	2,558	2,895	2,735	2,583	2,459	2,442	2,412
Dry/Liquid Bulk Carrier	N	122	140	162	179	197	224	249	272
Dry/Liquid Bulk Carrier	S	52	54	56	56	57	59	61	60
Container/Break-Bulk	N	547	631	713	770	828	937	1,034	1,126
Container/Break-Bulk	S	417	456	502	532	564	627	685	741
Full Container	N	1,016	1,132	1,279	1,355	1,430	1,593	1,743	1,891
Full Container	S	669	771	909	1,003	1,097	1,300	1,508	1,727
Roll-on/Roll-off	N	224	261	298	293	287	269	239	208
Roll-on/Roll-off	S	271	256	247	227	207	170	102	55
Vehicle Carrier	N	2,745	2,988	3,247	3,486	3,730	4,198	4,687	5,156
Vehicle Carrier	S	5,740	5,853	5,966	6,063	6,199	6,517	6,875	7,231
Vehicle/Dry Bulk	N	317	358	401	440	481	564	647	730
Vehicle/Dry Bulk	S	53	57	62	66	71	81	91	101
Liquid Gas	N	1,196	1,360	1,570	1,740	1,917	2,141	2,329	2,494
Liquid Gas	S	20	20	21	22	23	25	27	29
Total Northbound		35,945	40,935	46,057	50,474	54,712	62,569	70,411	78,284
Total Southbound		19,464	20,129	21,211	21,545	21,893	22,582	23,153	23,476
Grand Total		55,409	61,063	67,267	72,018	76,604	85,151	93,564	101,760

* Excludes ballast transits for 'Other' ship types

13.2 Existing Canal with Capacity Constraints

Taking into account capacity constraints under the Existing Canal, laden toll revenue would increase to only $539 million in 2020 and $560 million in 2050 (Table 13.2.1), representing 'lost revenue' versus demand for the Canal of $203 million and $454 million respectively. Estimates of ballast toll revenue are around $56 million in both 2020 and 2050 (Table 13.2.2). These figures are $21 million and $46 million below toll figures based on generic growth in transits via the Canal. Total revenue under this case would be $595 million in 2020 and $617 million in 2050.

Table 13.2.1

Scenario 1, Case 1, Existing Canal

Tolls for Laden Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	9,499	9,363	9,326	9,280	9,245	9,222	9,173	9,090
General Cargo	S	12,265	12,880	13,352	13,677	13,966	14,433	14,720	14,876
Refrigerated Cargo	N	24,578	23,144	21,575	20,470	19,325	16,889	14,448	11,896
Refrigerated Cargo	S	9,588	10,553	11,292	11,427	11,449	11,231	10,701	9,954
Dry Bulk Carrier	N	68,130	67,978	67,087	67,100	67,793	68,468	69,421	70,065
Dry Bulk Carrier	S	103,572	105,609	106,465	109,557	112,488	118,734	124,846	130,630
Tanker	N	20,438	17,671	18,253	16,524	15,047	13,454	12,731	12,007
Tanker	S	39,773	42,089	44,027	45,732	46,535	46,843	47,259	47,426
Dry/Liquid Bulk Carrier	N	296	279	264	252	241	229	217	201
Dry/Liquid Bulk Carrier	S	789	806	838	862	889	881	863	841
Container/Break-Bulk	N	7,133	7,123	7,168	7,184	7,206	7,286	7,337	7,359
Container/Break-Bulk	S	6,819	7,364	7,609	7,761	7,971	8,416	8,845	9,311
Full Container	N	66,731	71,916	77,410	79,927	81,892	86,594	87,688	89,251
Full Container	S	69,725	75,546	79,849	81,337	82,588	85,559	87,774	90,223
Roll-on/Roll-off	N	4,469	4,228	4,199	3,859	3,515	2,861	2,057	1,321
Roll-on/Roll-off	S	4,983	5,331	5,537	5,448	5,344	5,144	4,889	4,628
Vehicle Carrier	N	32,827	30,069	27,484	25,846	24,606	22,844	21,623	20,585
Vehicle Carrier	S	19,598	19,449	19,250	19,417	19,636	20,119	20,620	21,001
Vehicle/Dry Bulk	N	775	753	736	734	735	748	763	777
Vehicle/Dry Bulk	S	1,554	1,594	1,627	1,679	1,733	1,836	1,930	2,010
Liquid Gas	N	282	252	243	241	239	238	241	241
Liquid Gas	S	4,048	4,176	4,395	4,581	4,769	4,824	4,814	4,768
Other	N	938	893	870	865	865	870	881	889
Other	S	959	950	944	953	964	971	976	973
Total North		236,096	233,669	234,614	232,283	230,710	228,704	226,579	223,684
Total South		273,672	286,346	295,185	302,433	308,333	318,992	328,236	336,641
Grand Total		509,768	520,016	529,799	534,716	539,043	547,695	554,815	560,325

Table 13.2.2

Scenario 1, Case 1, Existing Canal
Tolls for Ballast Transits by Route and Ship Type

000's US$

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	1,788	1,855	1,906	1,943	1,979	2,038	2,077	2,101
General Cargo	S	715	692	676	662	651	634	618	602
Refrigerated Cargo	N	525	569	603	606	603	582	541	485
Refrigerated Cargo	S	6,433	6,056	5,646	5,357	5,056	4,419	3,778	3,107
Dry Bulk Carrier	N	16,941	17,271	17,370	17,857	18,336	19,390	20,445	21,480
Dry Bulk Carrier	S	2,418	2,393	2,353	2,344	2,355	2,362	2,415	2,435
Tanker	N	10,494	11,126	11,678	12,154	12,397	12,490	12,591	12,623
Tanker	S	2,665	2,315	2,380	2,110	1,877	1,612	1,464	1,333
Dry/Liquid Bulk Carrier	N	122	127	133	138	143	147	149	150
Dry/Liquid Bulk Carrier	S	52	48	46	43	41	39	36	33
Container/Break-Bulk	N	547	571	587	594	602	614	620	622
Container/Break-Bulk	S	417	413	412	411	410	411	410	409
Full Container	N	1,015	1,024	1,051	1,046	1,039	1,044	1,045	1,045
Full Container	S	668	698	747	774	797	852	904	954
Roll-on/Roll-off	N	224	236	245	226	209	176	143	115
Roll-on/Roll-off	S	271	232	203	175	150	112	61	30
Vehicle Carrier	N	2,742	2,704	2,669	2,689	2,711	2,751	2,810	2,849
Vehicle Carrier	S	5,734	5,296	4,904	4,677	4,506	4,271	4,121	3,995
Vehicle/Dry Bulk	N	317	324	329	339	350	370	388	404
Vehicle/Dry Bulk	S	53	52	51	51	52	53	55	56
Liquid Gas	N	1,194	1,231	1,291	1,342	1,393	1,403	1,396	1,378
Liquid Gas	S	20	18	17	17	17	16	16	16
Total Northbound		35,910	37,038	37,861	38,936	39,762	41,004	42,205	43,250
Total Southbound		19,446	18,213	17,436	16,620	15,911	14,799	13,878	12,970
Grand Total		55,356	55,251	55,297	55,555	55,673	55,803	56,084	56,220

* Excludes ballast transits for 'Other' ship types

13.3 Expanded Canal

Laden toll revenue is estimated at $812 million in 2020 and $1,102 million in 2050 (Table 13.3.1). These figures are $273 million and $542 million above those for the Existing Canal and about 9% above the toll estimates based on the generic growth in transits via the Canal. Revenue from ballast transits is projected to reach $80 million in 2020 and $112 million in 2050 (Table 3.3.2). These estimates are $24 million and $56 million above those for the Existing Canal and between 4% and 10% above the figures for the generic growth in transits demand. Total revenue under this case would equal $892 million in 2020 and $1,214 million in 2050.

Table 13.3.1

Scenario 1, Case 2, Expanded Canal

Tolls for Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	11,344	12,030	12,720	14,073	15,303	16,454
General Cargo	S	16,243	17,730	19,217	22,024	24,557	26,925
Refrigerated Cargo	N	26,245	26,536	26,590	25,772	24,103	21,533
Refrigerated Cargo	S	13,736	14,813	15,754	17,138	17,852	18,017
Dry Bulk Carrier	N	85,854	91,239	97,517	108,885	120,244	131,023
Dry Bulk Carrier	S	136,418	149,373	159,398	187,029	215,976	246,883
Tanker	N	22,481	21,650	20,885	20,639	21,288	21,724
Tanker	S	55,668	61,254	65,863	73,040	80,100	86,780
Dry/Liquid Bulk Carrier	N	322	327	332	349	361	364
Dry/Liquid Bulk Carrier	S	1,019	1,118	1,223	1,344	1,440	1,522
Container/Break-Bulk	N	8,720	9,313	9,916	11,118	12,240	13,320
Container/Break-Bulk	S	9,256	10,061	10,967	12,842	14,756	16,853
Full Container	N	115,730	126,953	137,608	158,447	176,157	193,035
Full Container	S	128,663	138,465	148,033	167,713	185,611	204,281
Roll-on/Roll-off	N	5,108	5,003	4,837	4,365	3,431	2,392
Roll-on/Roll-off	S	6,736	7,063	7,353	7,850	8,156	8,378
Vehicle Carrier	N	33,433	33,505	33,857	34,858	36,074	37,260
Vehicle Carrier	S	23,417	25,171	27,018	30,700	34,399	38,013
Vehicle/Dry Bulk	N	895	952	1,012	1,142	1,274	1,406
Vehicle/Dry Bulk	S	1,979	2,176	2,385	2,801	3,220	3,639
Liquid Gas	N	296	312	329	363	402	436
Liquid Gas	S	5,346	5,939	6,562	7,362	8,032	8,630
Other	N	1,058	1,122	1,190	1,327	1,470	1,610
Other	S	1,148	1,235	1,327	1,482	1,628	1,760
Total North		311,488	328,941	346,793	381,339	412,347	440,555
Total South		399,629	434,398	465,100	531,325	595,726	661,681
Grand Total		711,117	763,339	811,893	912,664	1,008,073	1,102,236

Table 13.3.2

Scenario 1, Case 2, Expanded Canal

Tolls for Ballast Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	2,318	2,519	2,723	3,110	3,464	3,802
General Cargo	S	823	859	895	967	1,031	1,089
Refrigerated Cargo	N	734	786	830	888	903	878
Refrigerated Cargo	S	6,868	6,944	6,957	6,743	6,303	5,623
Dry Bulk Carrier	N	22,637	25,558	28,291	34,817	41,668	48,983
Dry Bulk Carrier	S	3,026	3,200	3,400	3,796	4,187	4,553
Tanker	N	14,171	15,695	16,971	18,919	20,809	22,590
Tanker	S	3,023	2,854	2,691	2,553	2,524	2,479
Dry/Liquid Bulk Carrier	N	162	179	197	224	249	272
Dry/Liquid Bulk Carrier	S	56	56	57	59	61	60
Container/Break-Bulk	N	713	770	828	937	1,034	1,126
Container/Break-Bulk	S	502	532	564	627	685	741
Full Container	N	1,279	1,355	1,430	1,593	1,743	1,891
Full Container	S	909	1,003	1,097	1,300	1,508	1,727
Roll-on/Roll-off	N	298	293	287	269	239	208
Roll-on/Roll-off	S	247	227	207	170	102	55
Vehicle Carrier	N	3,247	3,486	3,730	4,198	4,687	5,156
Vehicle Carrier	S	5,966	6,063	6,199	6,517	6,875	7,231
Vehicle/Dry Bulk	N	401	440	481	564	647	730
Vehicle/Dry Bulk	S	62	66	71	81	91	101
Liquid Gas	N	1,570	1,740	1,917	2,141	2,329	2,494
Liquid Gas	S	21	22	23	25	27	29
Total North		**47,529**	**52,821**	**57,685**	**67,660**	**77,773**	**88,130**
Total South		**21,502**	**21,826**	**22,161**	**22,838**	**23,393**	**23,688**
Grand Total		**69,031**	**74,647**	**79,846**	**90,498**	**101,166**	**111,818**

* Excludes ballast transits for 'Other' ship types

13.4 Unrestricted Canal

Projected revenue under the Unrestricted Case is only marginally higher than in the Expanded Case. Total laden revenue is estimated at $827 million in 2020 and $1,118 million in 2050 (Table 13.4.1) while tolls from ballast transits are projected to reach $80 million in 2020 and $112 million in 2050 (Table 13.4.2). Total revenue therefore would equal $907 million in 2020 and $1,230 million in 2050, increases of 1.6% and 1.3% respectively versus the case for the Expanded Canal.

Table 13.4.1

Scenario 1, Case 3, Unrestricted Canal

Tolls for Laden Transits by Route and Ship Type

ShipType	Direction	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	11,344	12,030	12,720	14,073	15,303	16,454
General Cargo	S	16,243	17,730	19,217	22,024	24,557	26,925
Refrigerated Cargo	N	26,245	26,536	26,590	25,772	24,103	21,533
Refrigerated Cargo	S	13,736	14,813	15,754	17,136	17,852	18,017
Dry Bulk Carrier	N	85,690	91,083	97,371	108,747	120,117	130,911
Dry Bulk Carrier	S	136,853	149,877	162,834	190,870	220,073	251,054
Tanker	N	22,481	21,650	20,885	20,639	21,288	21,724
Tanker	S	61,133	70,006	77,354	84,531	91,591	98,271
Dry/Liquid Bulk Carrier	N	322	327	332	349	361	364
Dry/Liquid Bulk Carrier	S	1,019	1,118	1,223	1,344	1,440	1,522
Container/Break-Bulk	N	8,720	9,313	9,916	11,118	12,240	13,320
Container/Break-Bulk	S	9,256	10,061	10,967	12,842	14,756	16,853
Full Container	N	115,730	126,953	137,608	158,447	176,157	193,035
Full Container	S	128,663	138,465	148,033	167,713	185,611	204,281
Roll-on/Roll-off	N	5,108	5,003	4,837	4,365	3,431	2,392
Roll-on/Roll-off	S	6,736	7,063	7,353	7,850	8,156	8,378
Vehicle Carrier	N	33,433	33,505	33,857	34,858	36,074	37,260
Vehicle Carrier	S	23,417	25,171	27,018	30,700	34,399	38,013
Vehicle/Dry Bulk	N	895	952	1,012	1,142	1,274	1,406
Vehicle/Dry Bulk	S	1,979	2,176	2,385	2,801	3,220	3,639
Liquid Gas	N	296	312	329	363	402	436
Liquid Gas	S	5,346	5,939	6,562	7,362	8,032	8,630
Other	N	1,058	1,122	1,190	1,327	1,470	1,610
Other	S	1,148	1,235	1,327	1,482	1,628	1,760
Total North		**311,323**	**328,785**	**346,647**	**381,201**	**412,220**	**440,444**
Total South		**405,529**	**443,655**	**480,027**	**546,658**	**611,316**	**677,344**
Grand Total		**716,852**	**772,440**	**826,674**	**927,859**	**1,023,535**	**1,117,788**

Table 13.4.2

Scenario 1, Case 3, Unrestricted Canal
Tolls for Ballast Transits by Route and Ship Type

000's US$

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	2,318	2,519	2,723	3,110	3,464	3,802
General Cargo	S	823	859	895	967	1,031	1,089
Refrigerated Cargo	N	734	786	830	888	903	878
Refrigerated Cargo	S	6,868	6,944	6,957	6,743	6,303	5,623
Dry Bulk Carrier	N	22,538	25,451	28,446	34,977	41,816	49,096
Dry Bulk Carrier	S	3,019	3,194	3,394	3,791	4,182	4,549
Tanker	N	14,171	15,695	16,971	18,919	20,809	22,590
Tanker	S	3,023	2,854	2,691	2,553	2,524	2,479
Dry/Liquid Bulk Carrier	N	162	179	197	224	249	272
Dry/Liquid Bulk Carrier	S	56	56	57	59	61	60
Container/Break-Bulk	N	713	770	828	937	1,034	1,126
Container/Break-Bulk	S	502	532	564	627	685	741
Full Container	N	1,279	1,355	1,430	1,593	1,743	1,891
Full Container	S	909	1,003	1,097	1,300	1,508	1,727
Roll-on/Roll-off	N	298	293	287	269	239	208
Roll-on/Roll-off	S	247	227	207	170	102	55
Vehicle Carrier	N	3,247	3,486	3,730	4,198	4,687	5,156
Vehicle Carrier	S	5,966	6,063	6,199	6,517	6,875	7,231
Vehicle/Dry Bulk	N	401	440	481	564	647	730
Vehicle/Dry Bulk	S	62	66	71	81	91	101
Liquid Gas	N	1,570	1,740	1,917	2,141	2,329	2,494
Liquid Gas	S	21	22	23	25	27	29
Total North		47,430	52,714	57,840	67,819	77,921	88,244
Total South		21,496	21,820	22,155	22,833	23,388	23,684
Grand Total		68,926	74,534	79,995	90,652	101,309	111,928

* Excludes ballast transits for 'Other' ship types

13.5 Other Ship Types

Under the Existing Canal case, total ballast revenue would decline from $1.8 million in 2001 to $1.3 million in 2020 and $1.1 million in 2050. For all other cases, revenue would follow a slight rising trend, reaching $1.9 million in 2020 and 2050 (Table 13.5).

Table 13.5.1

Tolls for Ballast Transits for Other Ship Types

	2001	2005	2010	2015	2020	2030	2040	2050
Case 1								000's US$
Northbound	895	828	767	731	698	643	598	559
Southbound	856	784	721	683	648	592	547	508
Total	1,751	1,612	1,488	1,414	1,346	1,235	1,145	1,067
Case 2 and 3								
Northbound	896	915	933	948	961	981	998	1,011
Southbound	857	867	877	885	892	904	913	920
Total	1,753	1,781	1,810	1,833	1,853	1,885	1,910	1,931

13.6 Summary

Combining the above figures with those for passenger ships (see Section 10), the toll revenue that would accrue from the projected generic growth of transits) would be $589 million in 2001, rising to $863 million in 2020 and $1,174 million in 2050. Taking into account capacity constraints for the Existing Canal, toll revenue would rise modestly from $588 million in 2001 to $639 million in 2020 and $673 million in 2050. These figures represent 'lost' revenue of $224 million and $501 million respectively compared with the generic growth figures. Toll revenue under the Expanded Case would reach $936 million in 2020 and $1,272 million in 2050, while total toll revenues of $951 million and $1,287 million are projected for 2020 and 2050 respectively under the Unrestricted Case.

14 Beam Analysis

14.1 Generic Growth

Table 14.1.1 shows the generic growth in the number of laden transits by beam ranges. In order to calculate these data, the consultants created a frequency analysis of beam within vessel type and size range for all vessel types transiting the Canal. For the Existing Canal, the frequency analysis was based on data from the ACP database.

For northbound routes, the increasing incidence of transits by larger vessels is apparent. Vessels with a beam of less than 80' decline from 47% of all northbound transits in 2001 to 39% in 2050. The share of all of the other sizes increases, particularly vessels in the 100'-106' range which increase from 28% in 2001 to 33% in 2050. For southbound routes, the proportions in each beam range vary only marginally over the time period.

14.2 The Existing Canal

Table 14.2.1 summarises the number of forecast laden transits by beam range after reduction of the vessel transit forecasts in order to capture the impact of Existing Canal capacity constraints.

14.3 The Expanded Canal

In order to determine transits by beam for the Expanded Canal, the consultants developed a second frequency analysis of beam within vessel type and size range. This frequency analysis differs from the first in that the larger vessel sizes reflect global fleet data rather than Canal data. Table 14.3.1 below shows the revised results for dry bulk carriers, full containerships and tankers. Transits for the remaining vessels are unchanged from the generic growth figures in the Expanded Canal case. In this case, 7%, rising to 8% of transits for these three ship types are undertaken by vessels in excess of the current Panamax beam.

14.4 The Unrestricted Canal

Table 14.4.1 below shows the revised results for dry bulk carriers and tankers – the only two ship types where number of transits and sizes of vessel utilised change compared to the Expanded Canal case. In this case, 5% rising to 9.5% of transits are undertaken by vessels exceeding the current Panamax beam.

Table 14.1.1

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo									
<80	N	403	431	465	486	507	549	587	622
80-84.9	N	24	27	32	35	38	44	50	55
85-90.9	N	37	43	51	57	63	74	85	95
91-94.9	N	0	0	0	0	0	1	1	1
95-99.9	N	0	0	1	1	1	1	1	1
100-106	N	0	0	0	0	0	0	0	0
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	566	650	734	795	857	975	1,084	1,186
80-84.9	S	32	39	46	52	58	69	79	88
85-90.9	S	44	54	66	75	84	102	118	133
91-94.9	S	0	0	0	0	0	0	0	0
95-99.9	S	1	1	1	1	1	2	2	2
100-106	S	0	0	1	1	1	1	1	1
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		465	503	548	578	609	669	723	773
Total Southbound		643	744	847	924	1,001	1,148	1,283	1,411
Grand Total		1,108	1,247	1,395	1,502	1,610	1,817	2,006	2,184
Refrigerated Cargo Ships									
<80	N	1,252	1,296	1,324	1,334	1,333	1,286	1,198	1,066
80-84.9	N	83	86	89	90	90	87	82	73
85-90.9	N	0	0	0	0	0	0	0	0
91-94.9	N	0	0	0	0	0	0	0	0
95-99.9	N	0	0	0	0	0	0	0	0
100-106	N	0	0	0	0	0	0	0	0
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	444	532	620	668	710	772	806	815
80-84.9	S	41	50	60	64	68	74	77	78
85-90.9	S	0	0	0	0	0	0	0	0
91-94.9	S	0	0	0	0	0	0	0	0
95-99.9	S	0	0	0	0	0	0	0	0
100-106	S	0	0	0	0	0	0	0	0
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		1,335	1,382	1,413	1,424	1,423	1,374	1,280	1,139
Total Southbound		485	582	680	732	778	847	884	893
Grand Total		1,819	1,964	2,093	2,156	2,202	2,221	2,164	2,032

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
Dry Bulk Carriers									
<80	N	292	303	309	313	319	347	376	403
80-84.9	N	76	82	86	89	94	101	109	116
85-90.9	N	187	200	209	217	227	243	260	276
91-94.9	N	85	88	91	92	95	98	101	105
95-99.9	N	100	110	119	127	136	152	169	185
100-106	N	556	624	691	747	811	927	1,043	1,156
106-159.9	N	1	1	1	1	1	2	2	2
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	384	421	447	471	499	568	682	786
80-84.9	S	94	104	113	122	132	152	174	197
85-90.9	S	236	260	282	303	326	372	421	473
91-94.9	S	92	98	104	109	115	126	137	148
95-99.9	S	128	144	161	177	194	228	263	299
100-106	S	944	1,071	1,201	1,327	1,453	1,713	1,979	2,252
106-159.9	S	1	1	1	1	1	2	2	2
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		1,296	1,407	1,506	1,587	1,684	1,870	2,059	2,243
Total Southbound		1,878	2,101	2,308	2,510	2,720	3,181	3,657	4,158
Grand Total		3,175	3,508	3,814	4,097	4,403	5,051	5,717	6,401
Tankers									
<80	N	129	127	143	143	144	151	164	176
80-84.9	N	25	23	25	25	25	26	28	29
85-90.9	N	38	36	40	42	43	47	53	58
91-94.9	N	13	12	13	14	15	16	19	20
95-99.9	N	28	27	30	31	33	36	41	46
100-106	N	218	208	239	226	214	205	206	205
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	308	354	407	451	493	561	628	692
80-84.9	S	70	80	89	96	102	109	117	125
85-90.9	S	97	114	131	145	158	180	200	220
91-94.9	S	32	38	44	48	53	60	68	75
95-99.9	S	73	86	100	111	122	140	157	174
100-106	S	376	441	509	565	609	678	746	810
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		452	434	490	481	473	482	511	534
Total Southbound		957	1,114	1,280	1,417	1,536	1,728	1,917	2,097
Grand Total		1,409	1,547	1,770	1,898	2,009	2,211	2,428	2,631

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
Dry/Liquid Bulk Carriers									
<80	N	0	0	0	0	0	0	0	0
80-84.9	N	0	0	0	0	0	0	0	0
85-90.9	N	0	0	0	0	0	0	0	0
91-94.9	N	0	0	0	0	0	0	0	0
95-99.9	N	1	1	1	1	1	1	1	1
100-106	N	3	4	4	4	4	4	4	4
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	0	0	0	0	0	0	0	0
80-84.9	S	0	0	0	0	0	0	0	0
85-90.9	S	0	0	0	0	0	0	0	0
91-94.9	S	0	0	0	0	0	0	0	0
95-99.9	S	1	2	2	2	3	3	3	4
100-106	S	10	11	12	14	15	16	18	19
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		4	4	4	4	5	5	5	5
Total Southbound		11	12	14	16	17	19	21	23
Grand Total		15	17	19	20	22	24	26	28
Container/Break-Bulk Carriers									
<80	N	98	102	107	107	108	109	108	106
80-84.9	N	11	12	13	13	14	15	15	16
85-90.9	N	32	35	38	40	42	47	51	55
91-94.9	N	9	10	11	12	13	14	16	17
95-99.9	N	14	16	18	20	22	25	29	32
100-106	N	35	41	47	52	57	67	77	86
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	77	87	92	93	96	100	104	108
80-84.9	S	15	18	20	21	22	25	30	36
85-90.9	S	35	42	48	51	55	65	76	90
91-94.9	S	5	7	7	8	9	11	14	17
95-99.9	S	10	12	14	15	17	20	24	28
100-106	S	39	47	56	63	70	84	98	111
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		200	215	234	244	255	277	295	313
Total Southbound		180	213	236	251	269	307	345	388
Grand Total		380	428	470	495	524	583	641	701

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1									
ShipType / Beam	**Direction**	**2001**	**2005**	**2010**	**2015**	**2020**	**2030**	**2040**	**2050**
Full Container Ships									
<80	N	125	137	168	192	215	267	322	381
80-84.9	N	113	133	156	172	187	221	257	295
85-90.9	N	138	167	200	224	248	298	345	395
91-94.9	N	97	117	138	153	168	199	228	258
95-99.9	N	87	103	120	130	141	162	181	201
100-106	N	515	610	719	785	847	965	1,058	1,144
106-159.9	N	1	1	1	1	2	2	2	3
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	165	186	227	257	286	351	416	485
80-84.9	S	105	139	167	186	205	248	290	334
85-90.9	S	137	180	220	249	278	337	393	450
91-94.9	S	97	125	150	168	185	222	254	288
95-99.9	S	95	116	135	147	159	184	206	229
100-106	S	536	624	711	758	803	896	980	1,071
106-159.9	S	2	2	3	3	4	4	5	5
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		1,077	1,268	1,502	1,657	1,808	2,113	2,394	2,676
Total Southbound		1,138	1,371	1,612	1,767	1,921	2,241	2,544	2,861
Grand Total		2,215	2,639	3,114	3,424	3,728	4,355	4,938	5,538
Roll-on/Roll-off Vessels									
<80	N	46	46	46	44	42	37	20	14
80-84.9	N	7	8	9	10	10	10	10	10
85-90.9	N	15	16	19	21	22	24	24	25
91-94.9	N	2	2	2	1	1	1	1	0
95-99.9	N	2	1	1	1	1	1	0	0
100-106	N	25	26	28	27	25	20	14	7
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	56	61	63	61	58	50	35	27
80-84.9	S	8	10	12	14	14	16	17	20
85-90.9	S	19	25	31	34	37	41	45	52
91-94.9	S	1	2	2	2	2	2	2	1
95-99.9	S	1	1	1	1	1	1	0	0
100-106	S	29	33	36	38	40	43	46	48
106-159.9	S	0	0	0	0	0	0	1	1
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		96	99	106	104	101	93	71	55
Total Southbound		114	131	147	150	152	153	146	148
Grand Total		210	230	252	253	253	247	216	203

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
Vehicle Carriers									
<80	N	3	3	2	2	1	1	0	0
80-84.9	N	0	0	0	0	0	0	0	0
85-90.9	N	36	34	33	31	30	29	29	29
91-94.9	N	23	23	22	21	21	20	20	21
95-99.9	N	38	38	38	38	38	39	40	41
100-106	N	206	210	213	214	218	226	234	243
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	7	7	6	6	5	1	1	1
80-84.9	S	1	1	1	1	1	0	0	0
85-90.9	S	30	32	33	34	35	34	37	40
91-94.9	S	20	21	22	23	23	23	25	27
95-99.9	S	17	19	21	22	24	28	31	34
100-106	S	123	136	149	161	174	200	224	248
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		306	307	307	306	308	314	324	334
Total Southbound		199	215	232	246	261	286	319	352
Grand Total		505	523	539	552	568	600	643	685
Vehicle/Dry Bulk Carriers									
<80	N	6	6	7	7	7	8	9	10
80-84.9	N	2	2	3	3	3	3	4	4
85-90.9	N	4	4	5	5	5	6	7	8
91-94.9	N	5	6	7	7	8	9	10	11
95-99.9	N	0	0	0	0	0	0	0	0
100-106	N	1	1	1	1	1	1	1	1
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>-180	N	0	0	0	0	0	0	0	0
<80	S	10	12	14	15	17	20	24	28
80-84.9	S	2	2	3	3	3	4	4	5
85-90.9	S	5	6	7	7	8	10	11	13
91-94.9	S	8	9	11	12	13	16	18	21
95-99.9	S	0	0	0	0	0	0	0	0
100-106	S	7	8	9	9	10	12	13	15
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		19	20	22	23	25	28	31	34
Total Southbound		33	38	42	47	52	61	71	81
Grand Total		52	58	64	70	76	89	102	115

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
Liquid Gas Carriers									
<80	N	9	9	10	10	11	12	14	15
80-84.9	N	2	2	2	2	2	2	3	3
85-90.9	N	1	1	1	1	1	1	1	1
91-94.9	N	0	0	0	0	0	0	0	0
95-99.9	N	0	0	0	0	0	0	0	0
100-106	N	0	0	0	0	0	0	0	0
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	102	118	139	156	175	199	220	239
80-84.9	S	34	38	44	49	54	60	65	70
85-90.9	S	6	7	8	9	10	11	12	14
91-94.9	S	1	1	1	1	1	1	1	1
95-99.9	S	2	2	3	3	3	4	4	4
100-106	S	12	13	14	15	17	18	20	21
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		12	12	13	14	14	16	18	19
Total Southbound		155	178	208	233	259	293	322	348
Grand Total		167	190	221	247	273	309	340	367
Other									
<80	N	208	217	229	241	256	286	322	365
80-84.9	N	6	6	6	7	7	8	10	11
85-90.9	N	8	8	9	9	10	11	12	13
91-94.9	N	14	14	15	16	17	19	21	24
95-99.9	N	4	4	4	4	5	5	6	6
100-106	N	4	4	4	4	4	5	5	6
106-159.9	N	0	0	0	0	0	0	0	0
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	79	82	85	88	92	98	104	111
80-84.9	S	3	3	3	4	4	4	5	5
85-90.9	S	5	5	6	6	7	7	8	9
91-94.9	S	6	6	7	7	7	8	8	9
95-99.9	S	5	6	7	7	8	9	11	12
100-106	S	4	5	5	5	6	6	7	8
106-159.9	S	0	0	0	0	0	0	0	0
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		242	253	267	282	299	334	376	425
Total Southbound		102	107	112	117	123	133	143	153
Grand Total		344	360	379	399	422	466	519	578

Table 14.1.1 (continued)

Generic Growth in the Number of Vessel Transits by Beam, Scenario 1

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
All Ships									
<80	N	2,572	2,677	2,809	2,879	2,943	3,054	3,120	3,157
80-84.9	N	350	382	421	445	470	519	567	613
85-90.9	N	494	544	604	646	691	779	867	954
91-94.9	N	248	272	299	317	337	377	417	457
95-99.9	N	273	300	331	353	376	422	468	513
100-106	N	1,565	1,728	1,945	2,061	2,182	2,420	2,644	2,853
106-159.9	N	2	2	2	3	3	4	4	4
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	2,198	2,509	2,834	3,061	3,286	3,716	4,105	4,478
80-84.9	S	404	484	557	611	663	762	859	957
85-90.9	S	614	726	830	913	997	1,159	1,321	1,492
91-94.9	S	263	307	347	377	408	468	527	587
95-99.9	S	332	388	443	487	532	618	702	786
100-106	S	2,080	2,387	2,703	2,956	3,198	3,668	4,131	4,604
106-159.9	S	3	4	4	5	5	6	7	8
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		5,503	5,905	6,412	6,704	7,003	7,574	8,086	8,551
Total Southbound		5,895	6,806	7,719	8,410	9,089	10,398	11,652	12,912
Grand Total		11,398	12,711	14,131	15,114	16,092	17,972	19,738	21,463

Table 14.2.1

Number of Vessel Transits by Beam, Scenario 1,Case 1, Existing Canal

ShipType / Beam	Direction	2001	2005	2010	2015	2020	2030	2040	2050
All Ships									
<80	N	2,569	2,422	2,309	2,221	2,139	2,001	1,870	1,744
80-84.9	N	349	346	346	343	342	340	340	339
85-90.9	N	493	492	496	498	502	511	519	527
91-94.9	N	248	246	246	245	245	247	250	253
95-99.9	N	273	271	272	272	274	277	280	283
100-106	N	1,563	1,563	1,599	1,590	1,585	1,586	1,585	1,576
106-159.9	N	2	2	2	2	2	2	2	2
160-164.9	N	0	0	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0	0	0
<80	S	2,196	2,270	2,330	2,362	2,388	2,435	2,460	2,474
80-84.9	S	403	438	458	471	482	500	515	529
85-90.9	S	614	657	683	704	724	760	792	825
91-94.9	S	263	278	285	291	297	307	316	324
95-99.9	S	332	351	364	376	387	405	420	434
100-106	S	2,078	2,160	2,222	2,280	2,324	2,404	2,476	2,544
106-159.9	S	3	3	4	4	4	4	4	4
160-164.9	S	0	0	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0	0	0
Total Northbound		5,498	5,343	5,271	5,171	5,089	4,964	4,847	4,724
Total Southbound		5,890	6,158	6,345	6,488	6,606	6,814	6,984	7,134
Grand Total		11,387	11,501	11,616	11,659	11,695	11,778	11,831	11,858

Table 14.3.1

Number of Vessel Transits by Beam, Scenario 1, Case 2, Expanded Canal

ShipType / Beam	Direction	2010	2015	2020	2030	2040	2050
Dry Bulk Carriers							
<80	N	309	312	318	346	375	403
80-84.9	N	86	89	94	101	109	116
85-90.9	N	209	217	227	243	259	275
91-94.9	N	91	92	94	98	101	105
95-99.9	N	119	127	136	152	169	185
100-106	N	652	687	729	800	871	940
106-159.9	N	51	64	78	106	135	161
160-164.9	N	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	446	470	498	586	681	785
80-84.9	S	113	122	132	152	173	196
85-90.9	S	281	302	325	372	421	473
91-94.9	S	104	109	114	126	137	148
95-99.9	S	161	177	194	228	262	299
100-106	S	1,118	1,199	1,278	1,437	1,598	1,763
106-159.9	S	101	132	141	211	285	366
160-164.9	S	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0
Total Northbound		1,516	1,588	1,677	1,847	2,019	2,184
Total Southbound		2,323	2,510	2,682	3,111	3,558	4,031
Grand Total		3,839	4,099	4,358	4,958	5,576	6,215
Full Containers							
<80	N	168	192	215	267	322	381
80-84.9	N	156	172	187	221	257	295
85-90.9	N	200	224	248	298	345	395
91-94.9	N	136	153	168	199	228	258
95-99.9	N	118	129	139	160	179	199
100-106	N	647	700	750	844	917	983
106-159.9	N	161	178	193	223	247	267
160-164.9	N	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	227	257	286	351	416	485
80-84.9	S	167	186	205	248	290	334
85-90.9	S	220	249	278	337	393	450
91-94.9	S	150	168	185	222	254	288
95-99.9	S	134	146	158	183	205	227
100-106	S	635	671	705	774	834	897
106-159.9	S	212	225	238	267	292	319
160-164.9	S	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0
Total Northbound		1,589	1,747	1,900	2,212	2,495	2,778
Total Southbound		1,744	1,901	2,056	2,381	2,685	3,000
Grand Total		3,333	3,647	3,956	4,593	5,179	5,777

Table 14.3.1 (continued)

Number of Vessel Transits by Beam, Scenario 1, Case 2, Expanded Canal

ShipType / Beam	Direction	2010	2015	2020	2030	2040	2050
Tankers							
<80	N	143	143	144	151	164	176
80-84.9	N	25	25	25	26	28	29
85-90.9	N	40	42	43	47	53	58
91-94.9	N	13	14	15	16	19	20
95-99.9	N	30	31	33	36	41	46
100-106	N	196	186	176	171	173	174
106-159.9	N	36	34	31	28	26	24
160-164.9	N	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	407	451	493	561	628	692
80-84.9	S	89	96	102	109	117	125
85-90.9	S	131	145	158	180	200	220
91-94.9	S	44	48	53	60	68	75
95-99.9	S	100	111	122	140	157	174
100-106	S	447	492	529	584	640	692
106-159.9	S	69	75	80	87	95	101
160-164.9	S	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0
Total Northbound		483	474	467	476	504	527
Total Southbound		1,286	1,420	1,536	1,722	1,905	2,079
Grand Total		1,769	1,894	2,003	2,198	2,409	2,607
Summary							
<80	N	620	647	677	765	861	959
80-84.9	N	267	285	305	348	393	440
85-90.9	N	449	482	518	588	658	729
91-94.9	N	242	259	278	313	348	383
95-99.9	N	267	287	308	348	389	429
100-106	N	1,494	1,573	1,655	1,814	1,961	2,097
106-159.9	N	249	276	302	358	408	452
160-164.9	N	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	1,080	1,178	1,276	1,498	1,726	1,962
80-84.9	S	369	404	439	509	581	655
85-90.9	S	632	696	761	889	1,014	1,143
91-94.9	S	297	325	353	408	459	512
95-99.9	S	395	434	474	550	624	700
100-106	S	2,200	2,362	2,512	2,795	3,072	3,352
106-159.9	S	381	432	459	565	672	787
160-164.9	S	0	0	0	0	0	0
165-169.9	S	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0
Total Northbound		3,588	3,809	4,043	4,534	5,017	5,489
Total Southbound		5,353	5,831	6,274	7,215	8,148	9,110
Grand Total		8,941	9,640	10,317	11,749	13,165	14,599

Table 14.4.1

Number of Vessel Transits by Beam, Scenario 1, Case 3, Unrestricted Canal

ShipType / Beam	Direction	2010	2015	2020	2030	2040	2050
Dry Bulk Carrier							
<80	N	309	312	318	346	375	403
80-84.9	N	86	89	94	101	109	116
85-90.9	N	209	217	227	243	259	275
91-94.9	N	91	92	94	98	101	105
95-99.9	N	119	127	136	152	169	185
100-106	N	652	687	729	800	871	940
106-159.9	N	50	63	77	105	133	159
160-164.9	N	0	0	0	0	0	1
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	446	470	498	586	681	785
80-84.9	S	113	122	132	152	173	196
85-90.9	S	281	302	325	372	421	473
91-94.9	S	104	109	114	126	137	148
95-99.9	S	161	177	194	228	262	299
100-106	S	1,118	1,199	1,278	1,437	1,598	1,763
106-159.9	S	97	128	156	227	302	380
160-164.9	S	1	1	1	1	1	3
165-169.9	S	0	0	0	0	0	0
170-174.9	S	0	0	0	0	0	0
175-179.9	S	0	0	0	0	0	0
>=180	S	0	0	0	0	0	0
Total Northbound		1,515	1,587	1,676	1,846	2,018	2,183
Total Southbound		2,320	2,507	2,697	3,128	3,576	4,049
Grand Total		3,835	4,094	4,373	4,974	5,594	6,232
Tankers							
<80	N	143	143	144	151	164	176
80-84.9	N	25	25	25	26	28	29
85-90.9	N	40	42	43	47	53	58
91-94.9	N	13	14	15	16	19	20
95-99.9	N	30	31	33	36	41	46
100-106	N	196	186	176	171	173	174
106-159.9	N	36	34	31	28	26	24
160-164.9	N	0	0	0	0	0	0
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	407	451	493	561	628	692
80-84.9	S	89	96	102	109	117	125
85-90.9	S	131	145	158	180	200	220
91-94.9	S	44	48	53	60	68	75
95-99.9	S	100	111	122	140	157	174
100-106	S	447	492	529	584	640	692
106-159.9	S	66	73	78	85	92	98
160-164.9	S	1	1	1	1	1	1
165-169.9	S	1	1	1	1	1	1
170-174.9	S	1	2	3	3	3	3
175-179.9	S	4	7	9	9	9	9
>=180	S	13	21	27	27	27	27
Total Northbound		483	474	467	476	504	527
Total Southbound		1,303	1,448	1,573	1,760	1,942	2,116
Grand Total		1,787	1,922	2,040	2,235	2,446	2,644

Table 14.4.1 (continued)

Number of Vessel Transits by Beam,
Scenario 1, Case 3, Unrestricted Canal

ShipType / Beam	Direction	2010	2015	2020	2030	2040	2050
Summary							
<80	N	451	455	462	497	539	578
80-84.9	N	110	114	119	127	137	145
85-90.9	N	249	258	270	290	312	333
91-94.9	N	104	106	109	114	120	125
95-99.9	N	149	158	169	189	210	231
100-106	N	848	873	905	971	1,044	1,114
106-159.9	N	86	97	108	133	159	183
160-164.9	N	0	0	0	0	0	1
165-169.9	N	0	0	0	0	0	0
170-174.9	N	0	0	0	0	0	0
175-179.9	N	0	0	0	0	0	0
>=180	N	0	0	0	0	0	0
<80	S	852	921	990	1,148	1,310	1,477
80-84.9	S	202	218	233	262	291	321
85-90.9	S	412	447	483	551	621	693
91-94.9	S	147	157	167	186	205	223
95-99.9	S	260	288	315	367	420	473
100-106	S	1,565	1,691	1,806	2,021	2,237	2,455
106-159.9	S	163	201	234	312	394	478
160-164.9	S	1	1	1	2	2	4
165-169.9	S	1	1	1	1	1	1
170-174.9	S	1	2	3	3	3	3
175-179.9	S	4	7	9	9	9	9
>=180	S	13	21	27	27	27	27
Total Northbound		1,998	2,061	2,142	2,321	2,522	2,711
Total Southbound		3,623	3,955	4,271	4,888	5,518	6,165
Grand Total		5,621	6,016	6,413	7,209	8,040	8,876

15 Risk Analysis

15.1 Introduction

The risk analysis undertaken considers the potential for both upward and downward revisions from the base case forecasts. As a major sensitivity to the base case a second scenario has been developed which takes into account a number of potential global structural changes that may take place and assesses their potential impact on trade, both internationally and through the Panama Canal.

A global equilibrium model has been used to adjust the forecasts developed under Scenario 1. This model assesses the possible consequences for trades affecting Panama Canal traffic, which could arise from the following potential structural changes in the world economy:

- Trade liberalisation and economic integration
    - The scenario is for generally reduced non-tariff barriers to world trade
- Environmental policies
    - The scenario is a dramatic global tax on the use of fossil fuels
- The "new economy"
    - The scenario is higher productivity growth in parts of the world due to efficient use of information and communication technology
- Globalisation and fragmentation of world trade
    - The scenarios is high growth in foreign direct investments, particularly in Asia, and a continuation of the trend that more of world trade will be internal shipments in transnational corporations

The underlying economic model used for this is described in some detail in R. Forslid, J.I. Haaland, K.H.M. Knarvik and O. Mæstad: "Integration and transition: Scenarios for location of production and trade in Europe", *Working Paper 13/99*, SNF, Bergen, Norway. This paper describes a different set of scenarios, not applicable to this study, but contains a concise description of the model. Refinements have been made to model inputs and outputs to handle the greater level of detail required on trade in Latin America and on Panama Canal routes. The model is very rich in economic relations, capturing changes in comparative advantage as well as agglomeration effects and changes in levels of competition in industries with imperfect competition. In the field of economic research this is a very sophisticated global, economic model.

15.2 Trade Liberalisation and Economic Integration

It is assumed that the World Trade Organisation (WTO) will continue, and eventually succeed in its effort of bringing the non-tariff barriers to international trade substantially down. It is assumed that China will become a full member of the WTO and that world trade in agricultural products will be liberalised to a greater extent than trade in manufactures as this is the most protected part of world trade today.

The timing of this is that we will see the general effect of trade in manufactures from about 2010 onwards, and in agriculture from 2020 onwards. In a model context, the effects has been implemented as a 30% general reduction in non-tariff barriers after 2010, and reduced barriers to trade in agricultural products to 40% of current levels from 2020 so that countries with the highest barriers are reducing their barriers the most. This particularly effects Japan and the EU, but also other countries, leading to a high level of exports of agricultural products from third world countries to the industrial countries.

This has mainly two effects. Firstly there is a generally strong increase in intercontinental trade in manufactures, particularly between Asia and Europe, but also US-Asia and US-Europe. This affects mainly the container trades and has much less impact on raw materials trades. The second effect is a generally strong increase in south-north trades in agricultural products.

Within the next twenty years it is estimated that there a 70% chance of a general reduction in non tariff barriers in manufactures and a 40 to 45% of substantial cuts in non tariff barriers in agriculture. In 50 years these percentages rise to 80%.

15.3 Environmental Policy

It is assumed that the global greenhouse effect will be more obvious in the years to come and eventually it will lead to some rather drastic means to reduce CO2 emissions. It is assumed this may take the form of a general, global tax on all uses of fossil fuel. This will lead to fairly dramatic reductions in the demand for fossil fuels, and a substitution away from coal and oil. What is really problematic to predict is the possibility of the introduction of some form of back-stop technology that will completely change the energy picture. One such technology would be fuel-cells based on hydrogen for use in motors of all kinds. This will soon be a technological possibility, but energy prices must increase a lot more before this technology becomes economically viable on a global scale. We will assume that no new technology has been introduced on a global scale within the next 50 years, but instead assume that higher energy taxes lead to a speedy technological development making the world generally more energy efficient. This will again reduce the demand for energy in all uses, but it will also lead to productivity gains because of lower costs.

The timing of this is difficult to predict, but we assume it will take effect from about 2030. In model context, this is implemented as a 50% tax on oil and coal and a 20% tax on other fuels and a 20% increase in the efficiency of energy use in all types of economic activity.

This is no doubt the scenario with the strongest effects on shipping trade volumes, with strong reductions in all oil and coal trades. The most prominent result from this scenario is the strong reduction in intermediate uses of energy. This reduces energy consumption by some 20-25% world-wide. At the same time the energy taxes induce improvements in energy saving technologies, further enhancing the reductions in the use of fossil fuels. This is the scenario with the strongest influences on the "correction factors" used to make adjustments from the Scenario 1 forecast, as many of the trades important to the Panama Canal are directly affected by this scenario.

The chances of such developments having an impact over the next 10 to 15 years is put at 40%, rising to 80% twenty to thirty years out.

15.4 The New Economy

We have seen the US economy grow record for a record length of time over the last 5 years, at productivity levels far above the average for the last 25-30 years. Many economists believe this is due to the fact that information technology finally has reached a level of development and uses of it are now so widespread, that one finally can see the impact on productivity across industries. It is assumed this will spread to other regions as well. This is implemented as a 2% increase in productivity in the USA from 2005, 1.5% in Europe from 2010 and in Japan from 2015 and a 1% increase in Asia from 2030.

This comes in addition to the growth generated by traditional mechanisms such as investments, increases in labour stock and changes in the industrial distribution of the work force.

The main effect is to lift GDP growth rates in the main developing countries. This has a positive effect on most manufacturing trades, and leads to a shift in the composition of Asian manufacturing production, with office machinery and transport equipment as the most obvious winning sectors there. The scenario has moderate effects on raw material trades. It is estimated that there is a 60 to 70% chance that this will have a lasting impact.

15.5 Globalisation and Fragmentation of World Trade

The activity of transnational companies will affect world trade. We will see more production taking place in ideal locations in low-cost areas, spurred by high levels of direct foreign investments, and more international transportation of intermediary goods. This is very difficult to translate into detailed effects on world trade flows, but we believe that countries like India and China will be the target for large amounts of foreign direct investments and consequently these countries will produce and export more of products using semi-skilled labour.

The timing of this we believe will come gradually – the process is already well under way.

This fairly complex relationship has been implemented as a shift in the capital base in Asia, combined with technology shifts in sectors using semi-skilled and skilled labour intensively to produce, for example, machinery, transportation equipment and office machinery in some Asian countries. This is to simulate what we believe will be a pattern in the future, that some Asian countries will be highly competitive in some areas where the transnational companies are predominantly present.

This is just an amplification of the former scenario, where Asia is gaining competitive advantage in skilled and semi-skilled manufactured products. As a result the likelihood of seeing the impact of this effect over the next twenty years is put as high as 80 to 90%. Again this will mostly affect container trades, and the general result will be less intercontinental transport flows in finished products and more intercontinental transport of intermediate products, typically containerised cargoes.

15.6 Implementation of Structural Changes in the Forecasts

The way we take these structural changes into consideration when making our detailed forecasts are as follows:

- Model output has been converted to adjustment factors by using detailed statistics from the COMTAP database, with production and trade figures for each commodity according to the International Classification of Industrial Production;
- employing the analytical data from the UN Seaborne Trade Statistics database have enabled the construction of a more detailed geographical breakdown of trade flows.

The dominating effects which influence trade flows through the Panama Canal are:

- The higher US productivity from 2005 leads to high export performance and somewhat reduced imports between 2005 and 2020 due to higher domestic production. The import reductions are found particularly for trade with Europe and Asia.

- This trend is turned around from 2030 as the Asian economies achieve higher productivity, leading to higher exports and somewhat lower imports, particularly in trades with the US.

- The energy tax and increased energy efficiency reduced trades in energy dramatically. It also affects the steel industry, which reduces both the use of iron ore and coal. The increased energy efficiency increases economic growth, however, and creates more trade in manufactures, affecting particularly containerised goods and the residual group "all other cargoes". The model has an underlying input-output structure, so any direct effect on particular sectors (like the steel industry) will have secondary effects through reductions in sectors delivering to the steel industry.

- The lower non-tariff barriers have a general positive effect on trade flows, and particularly after 2030, world trade in agricultural products increases substantially. This is mostly exports from third world countries to Europe, but also a notable increase in Asian imports due to the high barriers existing in some countries, particularly Japan.

The model output has been converted to adjustment factors for the forecasts without structural changes of the nature detailed above. The main effects for the various trades and commodities are summarised as follows:

All other cargoes – North	Slight reductions in US imports 2010-2020 generally higher imports 2030-2050, particularly from Asia due to higher growth there
All other cargoes – South	Slight reductions in US exports 2010-2030 reductions in European exports 2030-2050 due to increased relative competitiveness in Asia and South America
Alumina/Bauxite – North	Increased north American imports 2010-2020 general reduction in trades 2030-2050 due to higher energy costs.
Alumina/Bauxite - South	Increased South American exports and reduced European exports 2030-2050
Automobiles – North	Some reduction in US imports 2010-2020, strong growth in Asian and South American exports 2030-2050
Automobiles - South	Increased US exports to Asia and Europe 2010-2020, reduction 2030-2050

Bananas – North	Slight reduction in European imports 2010-2015, strong increase in European imports 2030-2050
Bananas – South	No adjustments made
Chemicals – North	Reduced US imports 2010-2020 from Asia and South America, increased exports from US to Europe 2010-2015, strong increase in US imports 2030-2050 from Asia
Chemicals – South	Increased US exports 2010-2020, reduction 2030-2050, fairly strong European export increases 2030-2050 (mainly due to Eastern European integration)
Coal & Coke – North	Generally reduced US imports; 2010-2020 due to strong domestic production, 2030-2050 due to energy taxes, all main trades with general reductions 2030-2050
Coal & Coke - South	Increased US exports 2010-2020, strong reductions in all trades 2030-2050 due to the energy taxes
Containerised cargo – North	Slight reductions in US imports 2010-2020, high increases in US imports from Asia and South America 2030-2050, also high increases in European imports from all regions
Containerised cargo – South	Some increase in US exports 2010-2020, slight reduction in US and European exports 2030-2050, due to Asia dominance
Corn – North	General increase in trade 2030-2050 due to trade liberalisation
Corn – South	General increase in US exports, particularly after 2030
Crude oil – North	Some increase in US imports 2010-2020, but mainly strong reductions after 2030 due to energy taxes
Crude oil - South	Some increase in US imports 2010-2020, but mainly strong reductions after 2030 due to energy taxes
Fertilisers – North	Some increases in US imports 2010-2020, mainly driven by higher domestic production of agricultural products, and a similar reduction 2030-2050
Fertilisers – South	Increased US exports 2030-2050, driven by high agricultural production in Central and South America and Asia
Food and agricultural products - North	Increased US imports 2010-2020, increased European imports 2030-2050
Food and agricultural products – South	Increased US exports to Asia, reduced European exports 2030-2050, high South American exports 2030-2050
Iron & Steel – North	Reduced US imports 2010.-2020, general strong reductions in trade 2030-2050 due to energy tax
Iron & Steel – South	Mostly a strong reduction after 2030
Lumber products – North	Slight reduction in US imports 2010-2020, general increase in trade 2030-2050
Lumber products – South	Reduction in US and European exports 2030-2050, increase in South American exports 2030-2050
Miscellaneous Minerals – North	Reduction in US imports 2010-2020 – general increase in US imports 2030-2050
Miscellaneous Minerals – South	Increase in US exports 2010-2020, decrease thereafter, reduction in European exports to US
Ores – North	Reduction in US imports 2010-2020, general strong decrease 2030-2050, as a consequence of reduction in Iron and Steel output.

Ores – South	Slight reduction in South American exports to Asia 2010-2020, general reduction in trades 2030-2050
Other grains – North	Reduction in European imports, general increase in trades 2030-2050
Other grains – South	Increased US exports 2020-2020, reduction thereafter, reduced European exports, general increase in exports from South America
Other metals – North	Reduction in US imports 2010-2020, increased exports from South American 2030-2050
Other metals – South	Increased US and South American exports, reduction in European exports 2030-2050
Paper – North	Reduction in US imports 2010-2020, increased South American exports 2030-2050
Paper – South	Reduction in US and European exports 2030-2050, increased South American exports
Petroleum Chemicals - North	Reduction in US imports from Asia 2010-2020, increase thereafter, fairly strong reduction in European imports 2030-2050
Petroleum Chemicals – South	Increased US exports 2010-2020, reduction thereafter, increase in European exports 2030-2050
Petroleum Coke - North	General reduction 2030-2050 for all trades
Petroleum Coke – South	Slight increase US exports 2010-2020, reduction thereafter
Petroleum Products – North	Reduced US imports from Asia 2010-2020, general reduction in all trades 2030-2050 due to the energy tax
Petroleum Products – South	Reduced US imports, and increased US exports 2010-2020, general reduction in all trades 2030-2050
Phosphates – North	Reduced European imports 2030-2050
Phosphates – South	Increased US exports 2010-2020, reduction thereafter, Reduced European exports, particularly after 2030, increased African exports 2030-2050
Pulpwood – North	Increased exports in most trades 2030-2050
Pulpwood - South	Reduction in US imports, increase in US exports 2010-2020, slight increase in other exports 2030-2050
Reefer Products – North	Increased South and Central American exports, particularly after 2030
Reefer Products – South	Increase in US exports to Asia, general reduction in European exports after 2030
Residual Petroleum – North	General reduction in trades after 2030
Residual Petroleum – South	Increase in US exports 2010-2020., general decrease in all trades after 2030
Scrap metal – North	General and fairly strong increase in all trades after 2030 (as a replacement for iron ore)
Scrap metal – South	Strong reduction in US and European exports after 2030, strong increases in exports for most other trades after 2030
Soybeans - North	General increase in trades after 2030
Soybeans – South	Reduction in US and European exports after 2030, general increase in

	other trades
Sugar – North	General increase in Exports after 2030
Sugar – South	Elimination of European exports after 2030, increase in exports from West Indies
Wheat – North	Reduction in US exports to Africa after 2030, increase in other trades
Wheat – South	Reduction in US and European exports after 2030, increase in other trades

15.7 Results

The revised commodity trade flows which result from this scenario have been input to RLA's transit model in order to produce estimates of future transits under Scenario 2 for:

- A revised generic growth in transits via the Panama Canal without taking into account potential capacity constraints;
- A revised Expanded Canal Case;
- A revised Unrestricted Canal Case.

15.7.1 Generic Growth

Through 2030, the number of laden transits is increased slightly from the generic growth figures. These increases are seen particularly in southbound transits for tankers, dry bulk carriers and full containerships although most vessel types are changed. Thereafter, the number of transits decreases both northbound and southbound in comparison to Scenario 1. By 2050 total transits are 2% below the Scenario 1 numbers but this encompasses some substantial changes for individual ship types and also by direction. In this Case, northbound laden transits in 2050 increase by 4% compared to Scenario 1, while southbound the number of laden transits declines by 5%. The most notable differences for individual ship types are:

- Northbound and southbound increases for full containerships;
- Southbound reductions for both tankers and dry bulk carriers;
- Northbound increases for reefers.

The result of these changes means that toll revenues from laden transits are changed only marginally from the Scenario 1 case. In 2010, toll revenue is nearly 1% above the Scenario 1 case and in 2020 toll revenues are more than 1% above Scenario 1. By 2050, revenues are reduced by 1% in total which encompasses a 2% increase northbound and a 2% reduction southbound.

A similar trend is seen in ballast toll revenues. Through 2030, revenue is marginally up on the Scenario 1 case; by 2050 revenue is 1% below it.

15.7.2 Existing Canal

As would be expected, the results of Scenario 2 for the Existing Canal with capacity constraints show very little change from estimates under Scenario 1. The minor differences that do exist result from a slightly different mix of vessels transiting the Canal but the overall constraints are the same in both cases. For the sake of good order the results are included here as Tables 15.7.2.1 to 7.

15.7.3 Expanded Canal

The pattern of laden transits follows that seen in demand for the Existing Canal. On the bottom line, transits are marginally in excess of the Scenario 1, Expanded Canal case (that is varying through 0.3% to 1.3% annually) through 2030 but by 2050 transits are down by nearly 2%. On this basis, tolls revenue from laden transits is nearly 2% above the corresponding Scenario 1 case in 2020 and 2030 and by 2050 is 1% below it. Toll revenue from ballast transits remains below the Scenario 1 Case through the forecast period.

15.7.4 Unrestricted Canal

As with the other two cases, the number of laden transits is marginally increased through 2030 and then declines by a total of 1.5% in 2050. Tolls revenue from laden transits increases such that by 2030 it is nearly 2% above the Scenario 1 case and in 2050, while still increasing, it is nearly 1% below the Scenario 1 case. The tolls revenue from ballast remains below the Scenario 1 case throughout the forecast period.

Table 15.7.1.1

Scenario 2, Generic Growth in Panama Canal Cargo Flows in Existing Trades

Commodity	Direction	2001	2005	2010	2015	2020	2030	2040	2050
							tons/% per annum growth		
All Other Cargoes	N	835726	809046	737265	743489	770724	749865	729264	716833
			-0.8%	-1.8%	0.2%	0.7%	-0.5%	-0.6%	-0.3%
All Other Cargoes	S	1449651	1427845	1476357	1475473	1411482	1343224	1277105	1229617
			-0.4%	0.7%	0.0%	-0.9%	-1.0%	-1.0%	-0.8%
Alumina/Bauxite	N	533383	593396	697632	754395	783646	847765	910004	978276
			2 7%	3.3%	1.6%	0.8%	1.6%	1.4%	1.5%
Alumina/Bauxite	S	242702	285682	326779	371759	423506	515538	610158	704071
			4.2%	2.7%	2.6%	2.6%	4.0%	3.4%	2.9%
Automobiles	N	1241780	1244980	1048617	1065545	1137405	1336989	1406496	1499915
			0.1%	-3.4%	0.3%	1.3%	3.3%	1.0%	1 3%
Automobiles	S	425703	471273	524254	570888	619295	705598	841895	950666
			2.6%	2.2%	1 7%	1.6%	2.7%	3.5%	2.5%
Bananas	N	2326690	2372597	2379148	2434246	2521082	3032291	3275645	3927014
			0.5%	0.1%	0.5%	0.7%	3.8%	1.6%	3.7%
Bananas	S	17318	17318	17318	17318	17318	17318	17318	17318
			0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0 0%
Chemicals	N	2877685	2728891	3140662	3834876	4206888	5858993	7545394	9162134
			-1.3%	2.9%	3.0%	3.0%	6.8%	5.2%	4.0%
Chemicals	S	6560156	8274198	10232028	12024379	13361415	15513810	18105553	20739045
			6.0%	4.3%	3.3%	2.1%	3.0%	3.1%	2.8%
Coal & Coke	N	8759609	9943170	10184926	10652853	11336520	11102920	9301172	8214160
			3.2%	0.5%	0.9%	1.3%	-0.4%	-3.5%	-2 5%
Coal & Coke	S	2171846	2818588	2823428	2955151	3196300	3700661	3156702	3156087
			6.7%	0.0%	0.9%	1.6%	3.0%	-3.1%	0.0%
Containerised Cargo	N	17029433	20258747	23665274	28188135	28320145	32112420	34998257	37476301
			4.4%	3.3%	1.9%	1.6%	2.5%	1.7%	1.4%
Containerised Cargo	S	18547437	22465197	26734656	29049385	30752784	34087367	38616499	38947802
			4.9%	3.5%	1.7%	1.1%	2.1%	1.4%	1.2%
Corn	N	185156	204975	231314	239787	257927	318876	405763	485869
			2.6%	2.4%	0.7%	1.5%	4.3%	4.9%	3.7%
Corn	S	21333958	23326233	26653329	28827303	31345853	37269379	48132644	58083230
			2.3%	2.7%	1.6%	1.7%	3.5%	5.2%	3 1%
Crude Oil	N	5598171	5215380	6531660	5274309	3983653	2305061	1121152	240629
			-1.8%	4.6%	-4.2%	-5.5%	-10.4%	-13.4%	-26.5%
Crude Oil	S	4897288	5948507	6947675	7566281	7383517	6641912	5275374	4315310
			5 0%	3.2%	1.7%	-0.5%	-2.1%	-4 5%	-3.9%
Fertilisers	N	1178723	1311345	1483586	1631886	1743276	1905571	2031429	2055054
			2.7%	2.5%	1.9%	1.3%	1.8%	1.3%	0.2%
Fertilisers	S	5822839	6778376	7882663	8778140	9716239	11829832	14247571	16855819
			3.9%	3.0%	2.2%	2.1%	4.0%	3.8%	3.2%
Food & Agricultural Products	N	1943066	1871957	1811610	1736903	1673503	1748242	1863039	2045365
			-0.9%	-0.7%	-0.8%	-0.7%	0.9%	1.3%	1.9%
Food & Agricultural Products	S	905392	902121	915878	904009	892703	897948	899749	896693
			-0.1%	0.3%	-0.3%	-0.3%	0.1%	0.0%	-0.1%
Iron & Steel	N	6885677	7396747	7731310	8149374	8122932	9770682	8879507	8071099
			1.8%	0.9%	1.1%	2.3%	1.4%	-1.9%	-1.9%
Iron & Steel	S	4119845	4849422	5572231	6278643	7109800	8106730	7884998	7215644
			4.2%	2.8%	2.4%	2.5%	2.7%	-0.6%	-1.8%
Lumber Products	N	1707596	1899723	2088040	2261680	2477349	2976552	3681304	4422480
			2.7%	1.9%	1.6%	1.8%	3.7%	4.3%	3.7%
Lumber Products	S	3896033	4585975	5500962	6308805	6826477	8011595	8604402	9505776
			4 2%	3.7%	2.8%	1.6%	3.3%	1.4%	2.0%
Miscellaneous Minerals	N	7232238	8045960	8600086	8725266	10431474	12061533	14840345	17050591
			2.7%	1.3%	0.3%	3.6%	4.0%	3.2%	2.8%
Miscellaneous Minerals	S	1624281	1911922	2245910	2561191	2809163	3326434	3772956	4314289
			4.2%	3.3%	2.7%	1.9%	3.4%	2.6%	2.7%
Ores	N	5998169	6873065	7274291	8001917	8872876	9937216	9753133	9785470
			2.7%	1.7%	1.9%	2.1%	2.3%	-0.4%	0.1%
Ores	S	738028	868724	1000170	1123895	1266704	1507051	1570103	1734734
			4.2%	2.9%	2.4%	2.4%	3.5%	0.8%	2.0%

Table 15.7.1.1 (continued)

Scenario 2, Generic Growth in Panama Canal Cargo Flows in Existing Trades

tons/% per annum growth

Commodity	Direction	2000	2005	2010	2015	2020	2030	2040	2050
Other Grains	N	745885	796863	873224	940421	1014715	1168752	1408138	1645085
			1.7%	1.8%	1 5%	1.5%	2.9%	3.8%	3.2%
Other Grains	S	2642811	2800671	2981860	3410558	3565426	3944007	4055875	4309215
			1.5%	1.3%	2.7%	0.9%	2.0%	0.6%	1.2%
Other Metals	N	1988651	2190150	2413169	2651019	2934434	3421804	3998239	4596461
			2.7%	2.0%	1.9%	2.1%	3.1%	3.2%	2 8%
Other Metals	S	806992	949901	1100938	1243192	1407219	1731066	2070501	2413235
			4.2%	3 0%	2.5%	2.5%	4.2%	3.6%	3.1%
Paper	N	665711	740612	818494	892144	970676	1156599	1375836	1614474
			2.7%	2.0%	1.7%	1.7%	3.6%	3.5%	3.3%
Paper	S	933823	1099192	1273233	1435115	1607629	1950038	2293869	2676035
			4.2%	3.0%	2.4%	2.3%	3.9%	3.3%	3 1%
Petroleum Chemicals	N	474471	449357	520024	600220	694521	890070	1109281	1310265
			-1.4%	3.0%	2.9%	3.0%	5 1%	4.5%	3.4%
Petroleum Chemicals	S	1890833	2437426	2994649	3470606	3875285	4735631	5640595	6583436
			6.6%	4.2%	3 0%	2.2%	4.1%	3.6%	3.1%
Petroleum Coke	N	2675392	2887920	3153816	3421104	3539320	3909082	3390879	3392415
			1 8%	1.9%	1.6%	0.7%	2.0%	-2.8%	0.0%
Petroleum Coke	S	732642	764346	813903	844544	863675	883927	776373	747204
			1.1%	1.3%	0.7%	0.4%	0.5%	-2.6%	-0.8%
Petroleum Products	N	1756087	1794264	1818165	1857048	1895036	1877031	1652152	1463408
			0.5%	0.3%	0.4%	0.4%	-0.2%	-2.5%	-2.4%
Petroleum Products	S	11721946	13119775	15115624	16658868	16215202	18792045	16750059	15246405
			2.9%	2.9%	2.0%	1.8%	0.6%	-2.3%	-1.9%
Phosphates	N	49049	54568	60376	65778	71536	82377	90443	98625
			2.7%	2.0%	1.7%	1.7%	2.9%	1.9%	1.7%
Phosphates	S	9365963	10902933	12897407	14666730	15976483	18736137	22089900	24942607
			3.8%	3.4%	2.6%	1.7%	3.2%	3.3%	2.5%
Pulpwood	N	2565225	2853848	3157605	3440141	3741233	4505617	5460632	6475223
			2.7%	2.0%	1.7%	1.7%	3.8%	3.9%	3.5%
Pulpwood	S	1269600	1517656	1793161	2037361	2250640	2750711	3300679	3845385
			4.2%	3.4%	2.6%	2.0%	4.1%	3.7%	3.1%
Reefer Products	N	3622913	4043990	4531329	4989291	5509917	6456879	7691944	9297517
			2.8%	2.3%	1.9%	2.0%	3.2%	3.6%	3.9%
Reefer Products	S	1240227	1482782	1868636	2260478	2677234	3579826	4811168	6470727
			4.6%	4.7%	3.9%	3.4%	6.0%	6.1%	6.1%
Residual Petroleum	N	804829	804829	804829	804829	804829	788733	708250	603622
			0.0%	0.0%	0.0%	0 0%	-0 4%	-2.1%	-3.1%
Residual Petroleum	S	1815148	1781320	1734553	1712181	1684348	1593068	1399725	1164540
			-0.5%	-0.5%	-0.3%	-0.3%	-1.1%	-2.6%	-3.6%
Scrap Metal	N	62340	69354	76736	83602	90919	137398	213262	296011
			2.7%	2.0%	1.7%	1.7%	8.6%	9.2%	6.8%
Scrap Metal	S	1641506	1932197	2318960	2637253	2878494	3150851	2816157	2333350
			4.2%	3.7%	2.6%	1.8%	1.8%	-2.2%	-3 7%
Soybeans	N	11998	12546	13036	14988	16122	19152	22731	26566
			1.1%	0.8%	2.8%	1.5%	3.5%	3 5%	3 2%
Soybeans	S	13513588	14840658	16618110	17849405	18709641	21797671	25146354	29043256
			2.4%	2.3%	1 4%	0.9%	3.1%	2.9%	2.9%
Sugar	N	2049473	2026644	2001823	1980154	1960924	1943037	1931061	1927289
			-0.3%	-0.2%	-0.2%	-0.2%	-0.2%	-0.1%	0.0%
Sugar	S	480480	434601	394377	363928	339493	313324	289970	286705
			-2.5%	-1.9%	-1.6%	-1.4%	-1.8%	-1.5%	-0.2%
Wheat	N	2688487	2906401	3247713	3444680	3705267	4311283	5039759	5678770
			2.0%	2.2%	1.2%	1.5%	3.1%	3.2%	3.1%
Wheat	S	3055030	3407315	3789953	4087492	4440456	4961619	5641092	6558659
			2.8%	2.2%	1.5%	1.7%	2.2%	2.6%	3.1%
Total Northbound		**84473630**	**92181323**	**101295719**	**106680079**	**114588848**	**127332989**	**134830509**	**144756941**
Total Southbound		**123882968**	**142402548**	**164529000**	**181490331**	**195623780**	**222397119**	**248095345**	**273066854**
Grand Total		**208356598**	**234583871**	**265824719**	**288170410**	**310212628**	**349730107**	**382925854**	**417823795**
Annual % Change									
Total Northbound			**2.2%**	**1.9%**	**1.0%**	**1.4%**	**2.1%**	**1.2%**	**1.4%**
Total Southbound			**3.8%**	**2.9%**	**2.0%**	**1.5%**	**2.6%**	**2.2%**	**1.9%**
Grand Total			**3.0%**	**2.5%**	**1.6%**	**1.5%**	**2.4%**	**1.8%**	**1.8%**

Table 15.7.1.2

Scenario 2, Generic Growth in Number of Laden Transits

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	465	503	545	578	613	674	725	776
General Cargo	S	643	744	855	935	1007	1134	1204	1250
Refrigerated Cargo	N	1335	1382	1408	1427	1461	1543	1524	1559
Refrigerated Cargo	S	485	582	683	736	781	840	868	862
Dry Bulk Carrier	N	1296	1407	1472	1558	1679	1838	1864	1936
Dry Bulk Carrier	S	1878	2101	2367	2584	2780	3242	3746	4211
Tanker	N	452	434	488	476	468	502	547	600
Tanker	S	957	1114	1298	1448	1556	1664	1671	1714
Dry/Liquid Bulk Carrier	N	4	4	4	4	5	5	4	4
Dry/Liquid Bulk Carrier	S	11	12	14	16	18	19	20	21
Container/Break-Bulk	N	200	215	233	245	257	280	301	323
Container/Break-Bulk	S	180	213	238	254	271	300	302	309
Full Container	N	1077	1268	1496	1663	1829	2148	2456	2788
Full Container	S	1138	1371	1637	1807	1954	2264	2558	2874
Roll-on/Roll-off	N	96	99	104	103	104	98	73	58
Roll-on/Roll-off	S	114	131	149	153	153	152	139	135
Vehicle Carrier	N	306	307	274	281	299	346	368	395
Vehicle Carrier	S	199	215	231	246	261	282	330	366
Vehicle/Dry Bulk	N	19	20	22	23	25	28	30	33
Vehicle/Dry Bulk	S	33	38	43	48	52	61	68	75
Liquid Gas	N	12	12	12	13	14	16	17	18
Liquid Gas	S	155	178	212	239	263	284	281	278
Other	N	242	253	269	284	301	331	365	399
Other	S	102	107	113	118	123	134	145	158
Total North		5503	5905	6327	6657	7043	7810	8274	8888
Total South		5895	6806	7840	8583	9219	10377	11332	12251
Grand Total		11398	12711	14167	15240	16262	18186	19606	21138

Table 15.7.1.3

Scenario 2, Generic Growth in Number of Ballast Transits

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	145	167	192	211	228	258	277	290
General Cargo	S	53	57	61	65	68	74	79	84
Refrigerated Cargo	N	35	42	49	52	55	58	58	56
Refrigerated Cargo	S	463	480	488	495	505	540	536	553
Dry Bulk Carrier	N	418	465	519	563	600	701	807	908
Dry Bulk Carrier	S	63	67	69	72	75	83	85	89
Tanker	N	284	332	388	434	468	501	503	517
Tanker	S	70	67	76	72	69	70	73	77
Dry/Liquid Bulk Carrier	N	2	2	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1	1	1
Container/Break-Bulk	N	21	24	26	28	29	30	30	30
Container/Break-Bulk	S	16	17	18	19	20	21	22	23
Full Container	N	30	30	35	38	41	48	54	60
Full Container	S	21	22	27	30	34	41	50	60
Roll-on/Roll-off	N	11	12	13	12	11	8	6	5
Roll-on/Roll-off	S	19	18	18	18	19	17	2	2
Vehicle Carrier	N	24	26	29	31	33	34	37	39
Vehicle Carrier	S	48	47	41	42	44	49	51	54
Vehicle/Dry Bulk	N	8	9	10	11	12	15	16	18
Vehicle/Dry Bulk	S	2	2	2	2	2	2	3	3
Liquid Gas	N	23	26	31	35	39	41	40	38
Liquid Gas	S	1	1	1	1	1	1	1	1
Total North		1001	1134	1296	1418	1518	1697	1832	1963
Total South		756	779	802	816	837	900	903	947
Grand Total		1757	1913	2097	2234	2354	2597	2735	2909

Table 15.7.1.4

Scenario 2, Generic Growth in PCUMS of Laden Transits

000' tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	3700	4027	4392	4684	4987	5526	5951	6387
General Cargo	S	4777	5539	6397	6998	7534	8469	8944	9236
Refrigerated Cargo	N	9573	9953	10180	10353	10561	11308	11232	11596
Refrigerated Cargo	S	3734	4538	5365	5790	6146	6608	6804	6734
Dry Bulk Carrier	N	26535	29233	31020	33215	36182	39905	40640	42414
Dry Bulk Carrier	S	40339	45416	51775	56967	61639	72088	84155	95072
Tanker	N	7960	7599	8641	8272	7952	8193	8613	9189
Tanker	S	15491	18100	21114	23533	25185	26691	26572	27069
Dry/Liquid Bulk Carrier	N	115	120	125	127	129	130	112	104
Dry/Liquid Bulk Carrier	S	307	347	398	437	478	513	523	539
Container/Break-Bulk	N	2778	3063	3387	3628	3881	4378	4863	5370
Container/Break-Bulk	S	2656	3167	3624	3953	4291	4910	5127	5407
Full Container	N	25990	30927	36421	40488	44454	51854	58629	65661
Full Container	S	27156	32488	38630	42383	45360	51602	57489	64033
Roll-on/Roll-off	N	1741	1818	1946	1944	1927	1767	1392	990
Roll-on/Roll-off	S	1941	2292	2670	2810	2885	3029	3057	3035
Vehicle Carrier	N	12786	12931	11610	11973	12804	14935	15912	17096
Vehicle Carrier	S	7633	8364	9053	9750	10492	11794	13929	15500
Vehicle/Dry Bulk	N	302	324	344	369	393	445	479	525
Vehicle/Dry Bulk	S	605	685	782	863	936	1085	1201	1318
Liquid Gas	N	110	108	110	117	126	142	150	157
Liquid Gas	S	1576	1796	2118	2371	2593	2780	2756	2730
Other	N	365	384	416	445	473	512	541	550
Other	S	374	408	454	489	521	578	626	666
Total North		91955	100487	108593	115615	123868	139095	148515	160038
Total South		106589	123140	142381	156343	168059	190145	211182	231338
Grand Total		198544	223627	250973	271958	291928	329240	359697	391376

Table 15.7.1.5

Scenario 2, Generic Growth in PCUMS for Ballast Transits

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	877	1005	1149	1252	1344	1507	1599	1660
General Cargo	S	351	375	403	422	442	478	506	535
Refrigerated Cargo	N	258	308	362	388	409	433	437	420
Refrigerated Cargo	S	3157	3281	3351	3408	3483	3751	3733	3680
Dry Bulk Carrier	N	8313	9357	10664	11730	12667	14830	17252	19496
Dry Bulk Carrier	S	1186	1296	1378	1470	1586	1756	1820	1926
Tanker	N	5149	6028	7051	7874	8454	8988	8901	9040
Tanker	S	1308	1254	1428	1337	1250	1210	1202	1226
Dry/Liquid Bulk Carrier	N	60	69	80	89	98	109	116	124
Dry/Liquid Bulk Carrier	S	25	26	27	28	28	28	24	22
Container/Break-Bulk	N	268	309	353	383	409	455	476	493
Container/Break-Bulk	S	204	224	246	262	278	311	345	380
Full Container	N	498	555	635	675	708	784	854	926
Full Container	S	328	378	445	493	543	646	758	887
Roll-on/Roll-off	N	110	128	150	149	143	130	110	91
Roll-on/Roll-off	S	133	125	119	111	104	88	52	28
Vehicle Carrier	N	1345	1465	1604	1721	1837	2036	2349	2577
Vehicle Carrier	S	2814	2869	2682	2793	2986	3465	3746	4061
Vehicle/Dry Bulk	N	155	175	200	221	238	276	304	332
Vehicle/Dry Bulk	S	26	28	30	33	35	39	42	46
Liquid Gas	N	586	667	780	869	951	1018	990	974
Liquid Gas	S	10	10	10	10	11	12	13	13
Total North		17620	20066	23029	25351	27257	30564	33388	36133
Total South		9541	9867	10119	10367	10746	11785	12241	13004
Grand Total		27161	29933	33148	35718	38004	42349	45629	49137

Table 15.7.1.6

Scenario 2, Tolls Based on Generic Growth in Laden Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	9,508	10,349	11,288	12,037	12,817	14,202	15,295	16,415
General Cargo	S	12,277	14,235	16,441	17,984	19,363	21,765	22,986	23,737
Refrigerated Cargo	N	24,602	25,579	26,163	26,607	27,143	29,061	28,866	29,801
Refrigerated Cargo	S	9,597	11,663	13,788	14,880	15,794	16,982	17,486	17,306
Dry Bulk Carrier	N	68,195	75,130	79,720	85,361	92,989	102,556	104,446	109,003
Dry Bulk Carrier	S	103,671	116,719	133,062	146,406	158,412	185,267	216,277	244,334
Tanker	N	20,458	19,530	22,208	21,258	20,438	21,056	22,135	23,616
Tanker	S	39,811	46,516	54,262	60,480	64,725	68,595	68,290	69,567
Dry/Liquid Bulk Carrier	N	297	308	320	327	330	333	288	266
Dry/Liquid Bulk Carrier	S	790	891	1,024	1,124	1,228	1,319	1,345	1,384
Container/Break-Bulk	N	7,139	7,872	8,705	9,323	9,974	11,252	12,497	13,801
Container/Break-Bulk	S	6,825	8,139	9,313	10,160	11,029	12,617	13,175	13,896
Full Container	N	66,795	79,482	93,602	104,055	114,246	133,265	150,676	168,748
Full Container	S	69,792	83,493	99,279	108,925	116,574	132,616	147,747	164,564
Roll-on/Roll-off	N	4,473	4,673	5,002	4,997	4,952	4,542	3,578	2,544
Roll-on/Roll-off	S	4,987	5,891	6,863	7,221	7,414	7,784	7,856	7,800
Vehicle Carrier	N	32,859	33,232	29,836	30,772	32,906	38,382	40,895	43,937
Vehicle Carrier	S	19,617	21,495	23,266	25,057	26,965	30,310	35,796	39,836
Vehicle/Dry Bulk	N	776	832	885	948	1,009	1,145	1,232	1,349
Vehicle/Dry Bulk	S	1,556	1,762	2,010	2,218	2,405	2,788	3,086	3,387
Liquid Gas	N	282	278	283	301	323	365	385	404
Liquid Gas	S	4,052	4,616	5,443	6,092	6,664	7,145	7,083	7,016
Other	N	939	987	1,070	1,143	1,215	1,315	1,391	1,413
Other	S	960	1,049	1,166	1,256	1,340	1,485	1,609	1,711
Total North		236,323	258,251	279,083	297,130	318,341	357,474	381,684	411,297
Total South		273,935	316,470	365,919	401,802	431,913	488,673	542,737	594,539
Grand Total		510,258	574,721	645,002	698,931	750,254	846,147	924,421	1,005,836

Table 15.7.1.7

Scenario 2, Tolls Based on Generic Growth in Ballast Transits by Route and Ship Type

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	1,788	2,050	2,345	2,553	2,741	3,074	3,262	3,387
General Cargo	S	715	765	822	862	902	975	1,032	1,091
Refrigerated Cargo	N	525	629	738	791	833	863	890	857
Refrigerated Cargo	S	6,433	6,693	6,836	6,952	7,105	7,652	7,616	7,916
Dry Bulk Carrier	N	16,941	19,088	21,755	23,929	25,841	30,254	35,194	39,772
Dry Bulk Carrier	S	2,418	2,645	2,810	2,999	3,236	3,583	3,713	3,929
Tanker	N	10,494	12,297	14,383	16,064	17,245	18,336	18,159	18,442
Tanker	S	2,665	2,558	2,914	2,727	2,549	2,468	2,451	2,501
Dry/Liquid Bulk Carrier	N	122	140	163	181	199	222	236	253
Dry/Liquid Bulk Carrier	S	52	54	56	56	57	56	48	44
Container/Break-Bulk	N	547	631	721	782	835	928	971	1,006
Container/Break-Bulk	S	417	456	502	534	567	635	704	776
Full Container	N	1,015	1,132	1,295	1,378	1,445	1,599	1,743	1,888
Full Container	S	668	771	908	1,007	1,108	1,317	1,546	1,810
Roll-on/Roll-off	N	224	261	307	304	292	265	224	187
Roll-on/Roll-off	S	271	256	242	226	213	180	106	57
Vehicle Carrier	N	2,742	2,988	3,272	3,511	3,747	4,153	4,792	5,256
Vehicle Carrier	S	5,734	5,853	5,472	5,697	6,092	7,070	7,642	8,284
Vehicle/Dry Bulk	N	317	358	409	450	486	562	620	678
Vehicle/Dry Bulk	S	53	57	62	67	71	81	87	94
Liquid Gas	N	1,194	1,360	1,591	1,773	1,940	2,076	2,020	1,987
Liquid Gas	S	20	20	20	21	22	25	26	27
Total North		35,910	40,935	46,978	51,717	55,605	62,351	68,111	73,712
Total South		19,446	20,129	20,643	21,148	21,923	24,041	24,972	26,529
Grand Total		55,356	61,063	67,621	72,865	77,528	86,392	93,083	100,240

* Excludes ballast transits for 'Other' ship types

Table 15.7.2.1

Scenario 2, Demand for Cargo Flows Through the Existing Canal with Capacity Constraints

Commodity	Direction	2001	2005	2010	2015	2020	2030	2040	2050
							tons/% per annum growth		
All Other Cargoes	N	835726	732036	604370	568959	554635	485553	439429	401102
			-3.3%	-3.8%	-1.2%	-0.5%	-2.6%	-2.0%	-1 8%
All Other Cargoes	S	1449651	1291935	1210238	1129115	1015742	869765	769539	688029
			-2.8%	-1.3%	-1.4%	-2.1%	-3.1%	-2.4%	-2.2%
Alumina/Bauxite	N	533383	536913	571881	577305	563934	548946	548336	547392
			0.2%	1.3%	0.2%	-0.5%	-0.5%	0.0%	0.0%
Alumina/Bauxite	S	242702	258489	267676	284491	304767	333821	367660	393961
			1.6%	0.7%	1.2%	1.4%	1.8%	1.9%	1.4%
Automobiles	N	1241780	1126475	858600	815415	818509	865728	847505	839274
			-2.4%	-5.3%	-1.0%	0.1%	1.1%	-0.4%	-0.2%
Automobiles	S	425703	426414	429755	436876	445662	458832	507297	531943
			0.0%	0.2%	0.3%	0.4%	0.6%	2.0%	1.0%
Bananas	N	2326690	2146760	1950298	1862822	1814242	1963471	1973789	2197350
			-2.0%	-1.9%	-0.9%	-0.5%	1.6%	0.1%	2.2%
Bananas	S	17318	15669	14198	13253	12462	11214	10435	9690
			-2.5%	-2.0%	-1.4%	-1.2%	-2.1%	-1.4%	-1.5%
Chemicals	N	2877685	2469140	2574546	2781611	3027396	3793820	4546590	5126648
			-3.8%	0.8%	1.6%	1.7%	4.6%	3.7%	2.4%
Chemicals	S	6560156	7486611	8387665	9201730	9615253	10045514	10909773	11604478
			3.4%	2.3%	1.9%	0.9%	0.9%	1.7%	1.2%
Coal & Coke	N	6759609	6996721	8349054	8152162	8158081	7189372	5604561	4596211
			0.7%	-1.5%	-0.5%	0.0%	-2 5%	-4.9%	-3.9%
Coal & Coke	S	2171846	2550298	2314494	2261448	2300148	2396255	1902118	1765980
			4.1%	-1.9%	-0.5%	0.3%	0.8%	-4.5%	-1.5%
Containerised Cargo	N	17029433	18330402	19563468	20040633	20379978	20793459	21087519	20969765
			1.9%	1.3%	0.5%	0.3%	0.4%	0.3%	-0.1%
Containerised Cargo	S	18547437	20326829	21915633	22230222	22130575	22072279	22063820	21793139
			2.3%	1.5%	0 3%	-0.1%	-0.1%	0.0%	-0.2%
Corn	N	185156	185464	189619	183498	185611	206479	244498	271678
			0.0%	0.4%	-0.7%	0.2%	2.2%	3.4%	2.1%
Corn	S	21333958	21105907	21848965	22080273	22557364	24132697	29003046	31370032
			-0.3%	0.7%	0.2%	0.4%	1 4%	3.7%	1.6%
Crude Oil	N	5598171	4718950	5354303	4036198	2866749	1492575	675567	134643
			-4.2%	2.6%	-5.5%	-6.6%	-12.2%	-14.7%	-27.6%
Crude Oil	S	4897288	5382293	5695331	5791674	5313388	4300776	3178756	2414620
			2.4%	1.1%	0.3%	-1 7%	-4.1%	-5.9%	-5.4%
Fertilisers	N	1178723	1186524	1216147	1248811	1254511	1233897	1224068	1149900
			0.2%	0.5%	0.5%	0.1%	-0.3%	-0.2%	-1.2%
Fertilisers	S	5822839	6133171	6445386	6717527	6992081	7659933	8585087	9319720
			1.3%	1.0%	0.8%	0.8%	1.8%	2.3%	1.7%
Food & Agricultural Products	N	1943066	1693773	1485060	1329176	1204300	1132023	1122602	1144479
			-3.4%	-2.6%	-2.2%	-2.0%	-1.2%	-0.2%	0.4%
Food & Agricultural Products	S	905392	818251	750788	691798	642414	581440	542157	501742
			-2.6%	-1.7%	-1.6%	-1.5%	-2.0%	-1.4%	-1.5%
Iron & Steel	N	6885677	6692682	6337712	6236360	6565120	6326720	5350480	4516162
			-0.7%	-1.1%	-0.3%	1.0%	-0.7%	-3.3%	-3.3%
Iron & Steel	S	4119845	4387825	4567815	4804770	5116414	5249276	4751224	4037495
			1.6%	0.8%	1.0%	1.3%	0.5%	-2 0%	-3.2%
Lumber Products	N	1707596	1718896	1711663	1730764	1782770	1927379	2218225	2474587
			0.2%	-0.1%	0.2%	0 6%	1.6%	2.9%	2.2%
Lumber Products	S	3898033	4149455	4509393	4826322	4912526	5187674	5184712	5318932
			1.6%	1.7%	1.4%	0.4%	1.1%	0.0%	0.5%
Miscellaneous Minerals	N	7232238	7280099	7049871	6677064	7506784	8198606	8942272	9540613
			0.2%	-0.6%	-1.1%	2.4%	1.8%	1.6%	1.3%
Miscellaneous Minerals	S	1624261	1729934	1841076	1959967	2021553	2153935	2273451	2414049
			1.6%	1.3%	1.3%	0.6%	1.3%	1.1%	1.2%
Ores	N	5998169	6037883	5963073	6123517	6385173	6434554	5876896	5475434
			0.2%	-0.2%	0.5%	0.8%	0.2%	-1.8%	-1.4%
Ores	S	738028	786034	819886	860068	911556	976647	946089	970666
			1.6%	0.8%	1.0%	1.2%	1.4%	-0.6%	0.5%

Table 15.7.2.1 (continued)

Scenario 2, Demand for Cargo Flows Through the Existing Canal with Capacity Constraints

Commodity	Direction	2001	2005	2010	2015	2020	2030	2040	2050
								tons/% per annum growth	
Other Grains	N	745885	721013	715822	719663	730218	756791	848495	920503
			-0.8%	-0.1%	0.1%	0.3%	0.7%	2.3%	1.6%
Other Grains	S	2642811	2534088	2444369	2609951	2565782	2553826	2443928	2411210
			-1.0%	-0.7%	1.3%	-0.3%	-0.1%	-0.9%	-0.3%
Other Metals	N	1968651	1981679	1978166	2028709	2111702	2215689	2407994	2571938
			0.2%	0.0%	0.5%	0 8%	1.0%	1.7%	1.3%
Other Metals	S	806992	859484	902490	951361	1012675	1120901	1247611	1350319
			1.6%	1.0%	1.1%	1.3%	2.1%	2.2%	1 6%
Paper	N	665711	670116	670958	682719	698526	748922	829031	903375
			0.2%	0.0%	0.3%	0.5%	1.4%	2.1%	1 7%
Paper	S	933823	994564	1043728	1098231	1156896	1262690	1382205	1497368
			1.6%	1.0%	1.0%	1.0%	1.8%	1.8%	1.6%
Petroleum Chemicals	N	474471	406564	426288	459322	499797	578339	668414	733155
			-3.8%	1.0%	1.5%	1.7%	2.9%	3.0%	1.9%
Petroleum Chemicals	S	1890833	2205417	2454863	2655903	2788765	3068419	3398825	3683744
			3.9%	2 2%	1.6%	1.0%	1 9%	2.1%	1.6%
Petroleum Coke	N	2675392	2594935	2585329	2618021	2546995	2531212	2043225	1898217
			-0.8%	-0.1%	0.3%	-0.5%	-0.1%	-4.2%	-1.5%
Petroleum Coke	S	732642	691591	667194	646292	621525	572361	467815	418096
			-1.4%	-0.7%	-0.6%	-0.8%	-1.6%	-4.0%	-2.2%
Petroleum Products	N	1756087	1623475	1490434	1421117	1363721	1215417	995529	818846
			-1.9%	-1.7%	-0.9%	-0.8%	-2.3%	-3.9%	-3.8%
Petroleum Products	S	11721946	11870958	12390976	12748302	13108175	12168240	10092999	8531085
			0.3%	0.9%	0.6%	0.6%	-1.5%	-3 7%	-3.3%
Phosphates	N	49049	49374	49493	50337	51479	53341	54498	55186
			0.2%	0.0%	0.3%	0.4%	0.7%	0.4%	0.3%
Phosphates	S	9365963	9865128	10572600	11223806	11497130	12132038	13310600	13956567
			1.3%	1.4%	1.2%	0.5%	1.1%	1.9%	1.0%
Pulpwood	N	2565225	2582201	2588435	2632589	2692297	2917610	3290385	3623194
			0.2%	0.0%	0.3%	0.4%	1.6%	2.4%	1.9%
Pulpwood	S	1289500	1373377	1469937	1559103	1619625	1761143	1988873	2151675
			1.6%	1.4%	1.2%	0.8%	1.9%	2.2%	1 6%
Reefer Products	N	3622913	3659060	3714540	3818088	3965092	4180963	4634896	5202401
			0.2%	0.3%	0.6%	0.8%	1.1%	2.1%	2.3%
Reefer Products	S	1240227	1341642	1531807	1729845	1926613	2318012	2899041	3620678
			2.0%	2.7%	2.5%	2 2%	3.8%	4.6%	4 5%
Residual Petroleum	N	804829	728221	659756	615901	579178	510721	426768	337755
			-2.5%	-2.0%	-1.4%	-1.2%	-2.5%	-3.5%	-4 6%
Residual Petroleum	S	1615148	1611763	1421894	1310257	1212105	1031545	843425	651615
			-2.9%	-2.5%	-1.6%	-1.5%	-3.2%	-3.9%	-5.0%
Scrap Metal	N	62340	62752	62904	63977	65428	88968	128504	165632
			0.2%	0.0%	0.3%	0.4%	6.3%	7 6%	5.2%
Scrap Metal	S	1641506	1748279	1900959	2018174	2071446	2040242	1696917	1305620
			1.6%	1.7%	1.2%	0.5%	-0.3%	-3.6%	-5.1%
Soybeans	N	11998	11352	10686	11470	11602	12401	13697	14865
			-1.4%	-1.2%	1.4%	0.2%	1.3%	2.0%	1.7%
Soybeans	S	13513588	13428036	13622633	13659368	13463987	14114445	15152313	16251077
			-0.2%	0.3%	0.1%	-0.3%	0.9%	1.4%	1.4%
Sugar	N	2049473	1833736	1640987	1515325	1411137	1258157	1163589	1078409
			-2 7%	-2.2%	-1.6%	-1.4%	-2.3%	-1.6%	-1 5%
Sugar	S	480480	393414	323289	278498	244308	202884	174726	160425
			-4.9%	-3.9%	-2.9%	-2.6%	-3.6%	-2.9%	-1 7%
Wheat	N	2688487	2629753	2662300	2836062	2666415	2791645	3038782	3289450
			-0.6%	0.2%	-0.2%	0.2%	0.9%	1.7%	1.6%
Wheat	S	3055030	3082987	3106799	3127979	3195478	3212752	3309124	3669880
			0.2%	0.2%	0.1%	0.4%	0.1%	1.1%	1.5%
Total Northbound		84473630	83406969	83036783	81637594	82461381	82450756	81244143	80998364
Total Southbound		123882968	128847846	134872027	138886605	140776414	144006756	149493568	152793836
Grand Total		208356598	212254814	217908810	220524199	223237795	226457513	230737711	233792200
Annual % Change									
Total Northbound			-0.3%	-0.1%	-0.3%	0.2%	0.0%	-0.3%	-0.1%
Total Southbound			1.0%	0.9%	0.6%	0.3%	0.5%	0.8%	0.4%
Grand Total			0.5%	0.5%	0.2%	0.2%	0.3%	0.4%	0.3%

Table 15.7.2.2

Scenario 2, Case 1, Existing Canal
Number of Laden Transits

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	465	455	447	443	441	437	437	434
General Cargo	S	643	673	701	715	725	734	725	699
Refrigerated Cargo	N	1335	1251	1154	1092	1045	999	918	872
Refrigerated Cargo	S	485	526	560	563	562	544	523	482
Dry Bulk Carrier	N	1296	1274	1206	1192	1208	1190	1123	1083
Dry Bulk Carrier	S	1878	1901	1940	1977	2001	2099	2257	2356
Tanker	N	452	392	400	364	337	325	330	336
Tanker	S	957	1008	1064	1108	1119	1077	1007	959
Dry/Liquid Bulk Carrier	N	4	4	4	3	3	3	2	2
Dry/Liquid Bulk Carrier	S	11	11	12	12	13	12	12	12
Container/Break-Bulk	N	200	195	191	187	185	181	181	181
Container/Break-Bulk	S	180	192	195	194	195	194	182	173
Full Container	N	1077	1147	1226	1273	1316	1391	1480	1560
Full Container	S	1138	1241	1342	1362	1406	1466	1541	1608
Roll-on/Roll-off	N	96	90	85	79	75	63	44	32
Roll-on/Roll-off	S	114	119	122	117	110	98	84	76
Vehicle Carrier	N	306	278	224	215	215	224	222	221
Vehicle Carrier	S	199	195	190	188	188	183	199	205
Vehicle/Dry Bulk	N	19	18	18	18	18	18	18	18
Vehicle/Dry Bulk	S	33	34	35	37	38	39	41	42
Liquid Gas	N	12	11	10	10	10	10	10	10
Liquid Gas	S	155	161	174	183	189	184	169	155
Other	N	242	229	220	218	217	214	220	223
Other	S	102	97	93	91	89	87	87	88
Total North		5503	5343	5186	5094	5069	5057	4986	4973
Total South		5895	6158	6427	6569	6634	6719	6828	6855
Grand Total		11398	11501	11613	11662	11703	11776	11814	11828

Table 15.7.2.3

Scenario 2, Case 1, Existing Canal
Number of Ballast Transits

ShipType	Direction	2001	2005	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	145	151	158	161	164	167	167	163
General Cargo	S	53	52	50	49	49	48	48	47
Refrigerated Cargo	N	35	38	40	40	40	38	35	31
Refrigerated Cargo	S	463	434	400	379	364	350	323	309
Dry Bulk Carrier	N	418	420	426	431	432	454	487	508
Dry Bulk Carrier	S	63	61	57	55	54	53	51	50
Tanker	N	284	300	318	332	337	325	303	289
Tanker	S	70	61	62	55	50	45	44	43
Dry/Liquid Bulk Carrier	N	2	2	2	2	2	2	2	2
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	0	0	0
Container/Break-Bulk	N	21	21	21	21	21	20	18	17
Container/Break-Bulk	S	16	16	15	15	14	14	13	13
Full Container	N	30	27	29	29	30	31	32	34
Full Container	S	21	20	22	23	24	27	30	33
Roll-on/Roll-off	N	11	11	10	9	8	5	3	3
Roll-on/Roll-off	S	19	16	15	14	13	11	1	1
Vehicle Carrier	N	24	24	24	24	23	22	22	22
Vehicle Carrier	S	48	43	34	32	31	32	31	30
Vehicle/Dry Bulk	N	8	8	8	9	9	9	10	10
Vehicle/Dry Bulk	S	2	2	2	2	2	2	2	2
Liquid Gas	N	23	24	26	27	28	26	24	21
Liquid Gas	S	1	1	1	1	1	1	1	1
Total North		1001	1026	1062	1085	1092	1099	1104	1098
Total South		756	705	657	624	602	583	544	530
Grand Total		1757	1731	1719	1710	1694	1682	1648	1628

Table 15.7.2.4

Scenario 2, Case 1, Existing Canal Demand
PCUMS of Laden Transits

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	3700	3643	3600	3584	3589	3578	3586	3574
General Cargo	S	4777	5012	5244	5355	5422	5484	5389	5168
Refrigerated Cargo	N	9573	9006	8345	7923	7600	7322	6768	6488
Refrigerated Cargo	S	3734	4106	4398	4431	4423	4279	4100	3768
Dry Bulk Carrier	N	26535	26451	25428	25418	26038	25839	24488	23733
Dry Bulk Carrier	S	40339	41093	42443	43595	44357	46679	50709	53197
Tanker	N	7960	6876	7084	6330	5723	5305	5190	5142
Tanker	S	15491	16377	17308	18009	18124	17283	16011	15146
Dry/Liquid Bulk Carrier	N	115	108	102	97	93	84	68	58
Dry/Liquid Bulk Carrier	S	307	314	327	335	344	332	315	301
Container/Break-Bulk	N	2778	2771	2777	2776	2793	2835	2930	3005
Container/Break-Bulk	S	2656	2866	2971	3025	3088	3179	3089	3025
Full Container	N	25990	27983	29856	30984	31990	33577	35328	36740
Full Container	S	27156	29395	31667	32434	32642	33413	34641	35829
Roll-on/Roll-off	N	1741	1645	1595	1488	1386	1144	839	554
Roll-on/Roll-off	S	1941	2074	2189	2150	2076	1961	1842	1698
Vehicle Carrier	N	12786	11700	9517	9163	9214	9670	9588	9566
Vehicle Carrier	S	7633	7568	7421	7461	7550	7637	8393	8673
Vehicle/Dry Bulk	N	302	293	282	282	283	288	289	294
Vehicle/Dry Bulk	S	605	620	641	660	674	702	724	737
Liquid Gas	N	110	98	90	90	80	92	90	88
Liquid Gas	S	1576	1625	1736	1814	1866	1800	1661	1528
Other	N	365	347	341	340	340	331	326	308
Other	S	374	369	372	374	375	374	377	373
Total North		91955	90922	89018	88475	89139	90067	89490	89549
Total South		106589	111419	116716	119643	120940	123123	127251	129445
Grand Total		198544	202341	205735	208117	210079	213190	216741	218993

Table 15.7.2.5

Scenario 2, Case 1, Existing Canal
PCUMS for Ballast Transits

000's tons

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	877	909	942	958	967	976	964	929
General Cargo	S	351	339	330	323	318	309	305	299
Refrigerated Cargo	N	258	279	296	297	294	280	263	235
Refrigerated Cargo	S	3157	2969	2747	2608	2506	2429	2250	2171
Dry Bulk Carrier	N	8313	8466	8742	8976	9116	9603	10395	10909
Dry Bulk Carrier	S	1186	1173	1129	1125	1142	1137	1097	1076
Tanker	N	5149	5454	5780	6026	6083	5820	5364	5058
Tanker	S	1308	1135	1171	1023	899	783	724	686
Dry/Liquid Bulk Carrier	N	60	62	66	68	70	70	70	70
Dry/Liquid Bulk Carrier	S	25	24	22	21	20	18	14	12
Container/Break-Bulk	N	268	280	290	293	295	295	287	276
Container/Break-Bulk	S	204	202	202	200	200	202	208	213
Full Container	N	498	502	520	517	510	508	515	518
Full Container	S	328	342	365	378	391	418	457	497
Roll-on/Roll-off	N	110	116	123	114	103	84	66	51
Roll-on/Roll-off	S	133	114	97	85	75	57	31	16
Vehicle Carrier	N	1345	1325	1315	1317	1322	1318	1416	1442
Vehicle Carrier	S	2814	2596	2199	2137	2149	2244	2257	2272
Vehicle/Dry Bulk	N	155	159	164	169	171	179	183	186
Vehicle/Dry Bulk	S	26	25	25	25	25	26	26	26
Liquid Gas	N	586	603	639	665	684	659	597	545
Liquid Gas	S	10	9	8	8	8	8	8	7
Total North		**17620**	**18156**	**18878**	**19400**	**19615**	**19791**	**20118**	**20218**
Total South		**9541**	**8928**	**8295**	**7933**	**7733**	**7631**	**7376**	**7277**
Grand Total		**27161**	**27084**	**27173**	**27334**	**27349**	**27422**	**27494**	**27495**

Table 15.7.2.6

Scenario 2, Case 1, Existing Canal

Tolls for Laden Transits by Route and Ship Type

000's US$

ShipType	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	9,508	9,363	9,253	9,212	9,223	9,196	9,216	9,185
General Cargo	S	12,277	12,880	13,478	13,763	13,934	14,093	13,850	13,282
Refrigerated Cargo	N	24,602	23,144	21,447	20,361	19,533	18,818	17,394	16,675
Refrigerated Cargo	S	9,597	10,553	11,303	11,387	11,366	10,996	10,536	9,684
Dry Bulk Carrier	N	68,195	67,978	65,351	65,323	66,918	66,407	62,935	60,993
Dry Bulk Carrier	S	103,671	105,609	109,077	112,038	113,998	119,964	130,321	136,716
Tanker	N	20,458	17,671	18,205	16,268	14,708	13,634	13,338	13,214
Tanker	S	39,811	42,089	44,481	46,282	46,578	44,417	41,149	38,926
Dry/Liquid Bulk Carrier	N	297	279	263	250	238	216	174	149
Dry/Liquid Bulk Carrier	S	790	806	839	860	883	854	811	775
Container/Break-Bulk	N	7,139	7,123	7,136	7,134	7,176	7,286	7,530	7,722
Container/Break-Bulk	S	6,825	7,364	7,634	7,775	7,936	8,170	7,939	7,775
Full Container	N	66,795	71,916	76,730	79,628	82,215	86,292	90,792	94,423
Full Container	S	69,792	75,546	81,384	83,355	83,890	85,872	89,027	92,081
Roll-on/Roll-off	N	4,473	4,228	4,100	3,824	3,563	2,941	2,156	1,423
Roll-on/Roll-off	S	4,987	5,331	5,626	5,526	5,335	5,040	4,734	4,365
Vehicle Carrier	N	32,859	30,069	24,458	23,548	23,680	24,853	24,642	24,585
Vehicle Carrier	S	19,617	19,449	19,072	19,175	19,404	19,626	21,570	22,290
Vehicle/Dry Bulk	N	776	753	725	725	726	741	742	755
Vehicle/Dry Bulk	S	1,556	1,594	1,648	1,697	1,731	1,805	1,860	1,895
Liquid Gas	N	282	252	232	230	232	237	232	226
Liquid Gas	S	4,052	4,176	4,462	4,662	4.795	4,627	4,268	3,926
Other	N	939	893	877	874	874	852	838	790
Other	S	960	950	956	961	964	962	970	958
Total North		236323	233669	228777	227380	229087	231472	229989	230140
Total South		273935	286348	299960	307481	310816	316426	327034	332673
Grand Total		510258	520016	528738	534861	539904	547898	557024	562813

Table 15.7.2.7

Scenario 2, Case 1, Existing Canal

Tolls for Ballast Transits by Route and Ship Type

000's US$

Ship Type	Direction	2001	2005	2010	2015	2020	2030	2040	2050
General Cargo	N	1,788	1,855	1,922	1,954	1,973	1,991	1,966	1,895
General Cargo	S	715	692	674	660	649	631	622	610
Refrigerated Cargo	N	525	569	605	605	600	572	537	479
Refrigerated Cargo	S	6,433	6,056	5,604	5,320	5,113	4,955	4,589	4,429
Dry Bulk Carrier	N	16,941	17,271	17,834	18,312	18,596	19,590	21,206	22,254
Dry Bulk Carrier	S	2,418	2,393	2,304	2,295	2,329	2,320	2,237	2,199
Tanker	N	10,494	11,126	11,791	12,293	12,410	11,873	10,942	10,319
Tanker	S	2,665	2,315	2,389	2,087	1,834	1,598	1,477	1,399
Dry/Liquid Bulk Carrier	N	122	127	134	139	143	144	142	142
Dry/Liquid Bulk Carrier	S	52	48	46	43	41	36	29	25
Container/Break-Bulk	N	547	571	591	598	601	601	585	563
Container/Break-Bulk	S	417	413	411	409	408	411	424	434
Full Container	N	1,015	1,024	1,061	1,054	1,040	1,035	1,050	1,056
Full Container	S	668	698	744	770	797	853	932	1,013
Roll-on/Roll-off	N	224	236	251	233	210	171	135	104
Roll-on/Roll-off	S	271	232	199	173	153	117	64	32
Vehicle Carrier	N	2,742	2,704	2,682	2,687	2,697	2,689	2,888	2,941
Vehicle Carrier	S	5,734	5,296	4,485	4,360	4,384	4,578	4,605	4,635
Vehicle/Dry Bulk	N	317	324	335	345	350	364	373	379
Vehicle/Dry Bulk	S	53	52	51	51	51	52	52	53
Liquid Gas	N	1,194	1,231	1,304	1,357	1,396	1,344	1,217	1,112
Liquid Gas	S	20	18	16	16	16	16	16	15
Total North		**35910**	**37038**	**38510**	**39577**	**40015**	**40374**	**41041**	**41245**
Total South		**19446**	**18213**	**16922**	**16184**	**15776**	**15567**	**15047**	**14844**
Grand Total		**55356**	**55251**	**55432**	**55761**	**55791**	**55941**	**56088**	**56089**

* Excludes ballast transits for 'Other' ship types

Table 15.7.3.1

Scenario 2, Demand for Cargo Flows Through the Expanded Canal

Commodity	Direction	2010	2015	2020	2030	2040	2050
					tons/% per annum growth		
All Other Cargoes	N	737265	743489	770724	749865	729264	716833
			0.2%	0.7%	-0.5%	-0.6%	-0.3%
All Other Cargoes	S	1476357	1475473	1411482	1343224	1277105	1229617
			0.0%	-0.9%	-1.0%	-1.0%	-0.8%
Alumina/Bauxite	N	697632	754395	783646	847765	910004	978276
			1.6%	0.8%	1.6%	1.4%	1.5%
Alumina/Bauxite	S	326779	371759	423506	515538	610158	704071
			2.6%	2.6%	4.0%	3.4%	2.9%
Automobiles	N	1048617	1065545	1137405	1336989	1406496	1499915
			0.3%	1.3%	3.3%	1.0%	1.3%
Automobiles	S	524254	570888	619295	708598	841895	950666
			1.7%	1.6%	2.7%	3.5%	2.5%
Bananas	N	2379148	2434246	2521082	3032291	3275645	3927014
			0.5%	0.7%	3.8%	1.6%	3.7%
Bananas	S	17318	17318	17318	17318	17318	17318
			0.0%	0.0%	0.0%	0.0%	0.0%
Chemicals	N	3140662	3634876	4206888	5858993	7545394	9162134
			3.0%	3.0%	6.8%	5.2%	4.0%
Chemicals	S	10232026	12024379	13361415	15513810	18105553	20739045
			3.3%	2.1%	3.0%	3.1%	2.8%
Coal & Coke	N	13419527	13881601	14542998	14069491	11266443	9599013
			0.7%	0.9%	-0.7%	-4.3%	-3.2%
Coal & Coke	S	5882103	6257260	6473727	7380784	6080461	5847309
			1.2%	0.7%	2.7%	-3.8%	-0.8%
Containerised Cargo	N	29725318	32835003	36286459	41487733	45379037	48865364
			2.0%	2.0%	2.7%	1.8%	1.5%
Containerised Cargo	S	36179316	39142224	40859800	44699859	47324655	49902111
			1.6%	0.9%	1.8%	1.1%	1.1%
Corn	N	231314	239787	257927	318876	405763	485889
			0.7%	1.5%	4.3%	4.9%	3.7%
Corn	S	26653329	28827303	31345853	37269379	48132644	56063230
			1.6%	1.7%	3.5%	5.2%	3.1%
Crude Oil	N	6531660	5274309	3983653	2305061	1121152	240629
			-4.2%	-5.5%	-10.4%	-13.4%	-26.5%
Crude Oil	S	6947675	7568281	7383517	6641912	5275374	4315310
			1.7%	-0.5%	-2.1%	-4.5%	-3.9%
Fertilisers	N	1483566	1631886	1743276	1905571	2031429	2055054
			1.9%	1.3%	1.8%	1.3%	0.2%
Fertilisers	S	7862663	8778140	9716239	11829632	14247571	16655819
			2.2%	2.1%	4.0%	3.8%	3.2%
Food & Agricultural Products	N	1811610	1736903	1673503	1748242	1863039	2045365
			-0.8%	-0.7%	0.9%	1.3%	1.9%
Food & Agricultural Products	S	915878	904009	892703	897948	899749	896693
			-0.3%	-0.3%	0.1%	0.0%	-0.1%
Iron & Steel	N	7731310	8149374	9122932	9770682	8879507	8071099
			1.1%	2.3%	1.4%	-1.9%	-1.9%
Iron & Steel	S	5572231	6278643	7109800	8106730	7884998	7215644
			2.4%	2.5%	2.7%	-0.6%	-1.8%
Lumber Products	N	2088040	2261680	2477349	2976552	3681304	4422480
			1.6%	1.8%	3.7%	4.3%	3.7%
Lumber Products	S	5500962	6306805	6826477	8011595	8604402	9505776
			2.8%	1.6%	3.3%	1.4%	2.0%
Miscellaneous Minerals	N	8600065	8725266	10431474	12661533	14840345	17050591
			0.3%	3.6%	4.0%	3.2%	2.8%
Miscellaneous Minerals	S	2245910	2561191	2809163	3326434	3772956	4314289
			2.7%	1.9%	3.4%	2.6%	2.7%
Ores	N	7274291	8001917	8872876	9937216	9753133	9785470
			1.9%	2.1%	2.3%	-0.4%	0.1%
Ores	S	3908130	4220899	2404332	2604590	2480377	2577698
			1.6%	-10.6%	1.6%	-1.0%	0.8%

Table 15.7.3.1 (continued)

Scenario 2, Demand for Cargo Flows Through the Expanded Canal

tons/% per annum growth

Commodity	Direction	2010	2015	2020	2030	2040	2050
Other Grains	N	873224	940421	1014715	1168752	1408138	1645085
			1.5%	1.5%	2.9%	3.8%	3.2%
Other Grains	S	2981860	3410558	3565426	3944007	4055875	4309215
			2.7%	0.9%	2.0%	0.6%	1.2%
Other Metals	N	2413169	2651019	2934434	3421804	3996239	4596461
			1.9%	2.1%	3.1%	3.2%	2.8%
Other Metals	S	1100939	1243192	1407219	1731066	2070501	2413235
			2.5%	2.5%	4.2%	3.6%	3.1%
Paper	N	818494	892144	970676	1156599	1375836	1614474
			1.7%	1.7%	3.6%	3.5%	3.3%
Paper	S	1273233	1435115	1607629	1950038	2293869	2676035
			2 4%	2.3%	3.9%	3.3%	3.1%
Petroleum Chemicals	N	520024	600220	694521	890070	1109281	1310265
			2.9%	3.0%	5.1%	4.5%	3.4%
Petroleum Chemicals	S	2994649	3470606	3875285	4735631	5640595	6583436
			3.0%	2.2%	4.1%	3.6%	3.1%
Petroleum Coke	N	3153816	3421104	3539320	3909082	3390879	3392415
			1.6%	0.7%	2.0%	-2.8%	0.0%
Petroleum Coke	S	813903	844544	863675	883927	776373	747204
			0.7%	0.4%	0.5%	-2.6%	-0.8%
Petroleum Products	N	1818165	1857048	1895036	1877031	1652152	1463408
			0.4%	0.4%	-0.2%	-2.5%	-2.4%
Petroleum Products	S	17050624	18593868	20150202	20727045	18685059	17181405
			1.7%	1.6%	0.6%	-2.1%	-1.7%
Phosphates	N	60376	65778	71536	82377	90443	98625
			1.7%	1.7%	2.9%	1.9%	1.7%
Phosphates	S	12897407	14666730	15976483	18736137	22089900	24942602
			2.6%	1.7%	3.2%	3.3%	2.5%
Pulpwood	N	3157605	3440141	3741233	4505817	5460632	6475223
			1.7%	1.7%	3.8%	3.9%	3.5%
Pulpwood	S	1793161	2037361	2250640	2750711	3300679	3845385
			2.6%	2.0%	4.1%	3.7%	3.1%
Reefer Products	N	4531329	4989291	5509917	6456879	7691944	9297517
			1.9%	2.0%	3.2%	3.6%	3.9%
Reefer Products	S	1868636	2260478	2677234	3579826	4811168	6470727
			3.9%	3.4%	6.0%	6.1%	6.1%
Residual Petroleum	N	804829	804829	804829	788733	708250	603622
			0.0%	0.0%	-0.4%	-2.1%	-3.1%
Residual Petroleum	S	1734553	1712181	1684348	1593068	1399725	1164640
			-0.3%	-0.3%	-1.1%	-2.6%	-3.6%
Scrap Metal	N	76736	83602	90919	137398	213262	296011
			1.7%	1.7%	8.6%	9.2%	6.8%
Scrap Metal	S	2318960	2637253	2878494	3150851	2816157	2333350
			2.6%	1.8%	1.8%	-2.2%	-3.7%
Soybeans	N	13036	14988	16122	19152	22731	26566
			2.8%	1.5%	3.5%	3.5%	3.2%
Soybeans	S	16618110	17849405	18709641	21797671	25146354	29043256
			1.4%	0.9%	3.1%	2.9%	2.9%
Sugar	N	2001823	1980154	1960924	1943037	1931061	1927289
			-0.2%	-0.2%	-0.2%	-0.1%	0.0%
Sugar	S	394377	363928	339493	313324	289970	286705
			-1.6%	-1.4%	-1.6%	-1.5%	-0.2%
Wheat	N	3247713	3444680	3705267	4311283	5039759	5878770
			1.2%	1.5%	3.1%	3.2%	3.1%
Wheat	S	3789953	4087492	4440456	4961619	5641092	6558659
			1.5%	1.7%	2.2%	2.6%	3.1%
Total Northbound		**110390364**	**116555695**	**125761640**	**139674872**	**147178560**	**157530858**
Total Southbound		**181875294**	**199917283**	**212080851**	**239722273**	**264572534**	**289490349**
Grand Total		**292265658**	**316472979**	**337842491**	**379397144**	**411751094**	**447021207**
Annual % Change							
Total Northbound			**1.1%**	**1.5%**	**2.1%**	**1.1%**	**1.4%**
Total Southbound			**1.9%**	**1.2%**	**2.5%**	**2.0%**	**1.8%**
Grand Total			**1.6%**	**1.3%**	**2.3%**	**1.7%**	**1.7%**

Table 15.7.3.2

Scenario 2, Case 2, Expanded Canal
Number of Laden Transits

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	545	578	613	674	725	776
General Cargo	S	855	935	1007	1134	1204	1250
Refrigerated Cargo	N	1408	1427	1451	1543	1524	1559
Refrigerated Cargo	S	683	736	781	840	868	862
Dry Bulk Carrier	N	1484	1562	1674	1816	1822	1877
Dry Bulk Carrier	S	2384	2586	2744	3166	3614	4028
Tanker	N	481	469	461	496	541	595
Tanker	S	1306	1454	1559	1664	1671	1713
Dry/Liquid Bulk Carrier	N	4	4	5	5	4	4
Dry/Liquid Bulk Carrier	S	14	16	18	19	20	21
Container/Break-Bulk	N	233	245	257	280	301	323
Container/Break-Bulk	S	238	254	271	300	302	309
Full Container	N	1575	1751	1937	2272	2587	2926
Full Container	S	1778	1953	2094	2405	2691	2999
Roll-on/Roll-off	N	104	103	104	98	73	58
Roll-on/Roll-off	S	149	153	153	152	139	135
Vehicle Carrier	N	274	281	299	346	368	395
Vehicle Carrier	S	231	246	261	282	330	366
Vehicle/Dry Bulk	N	22	23	25	28	30	33
Vehicle/Dry Bulk	S	43	48	52	61	68	75
Liquid Gas	N	12	13	14	16	17	18
Liquid Gas	S	212	239	263	284	281	278
Other	N	269	284	301	331	365	399
Other	S	113	118	123	134	145	158
Total North		6411	6742	7140	7904	8357	8962
Total South		8007	8737	9326	10442	11332	12193
Grand Total		14418	15478	16466	18346	19689	21155

Table 15.7.3.3

Scenario 2, Case 2, Expanded Canal
Number of Ballast Transits

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	192	211	228	258	277	290
General Cargo	S	61	65	68	74	79	84
Refrigerated Cargo	N	49	52	55	58	58	56
Refrigerated Cargo	S	488	495	505	540	536	553
Dry Bulk Carrier	N	525	571	612	719	832	939
Dry Bulk Carrier	S	71	73	75	81	83	86
Tanker	N	399	446	480	513	512	524
Tanker	S	76	73	69	71	73	78
Dry/Liquid Bulk Carrier	N	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1
Container/Break-Bulk	N	26	28	29	30	30	30
Container/Break-Bulk	S	18	19	20	21	22	23
Full Container	N	35	38	41	48	54	60
Full Container	S	27	30	34	41	50	60
Roll-on/Roll-off	N	13	12	11	8	6	5
Roll-on/Roll-off	S	18	18	19	17	2	2
Vehicle Carrier	N	29	31	33	34	37	39
Vehicle Carrier	S	41	42	44	49	51	54
Vehicle/Dry Bulk	N	10	11	12	15	16	18
Vehicle/Dry Bulk	S	2	2	2	2	3	3
Liquid Gas	N	31	35	39	41	40	38
Liquid Gas	S	1	1	1	1	1	1
Total North		**1312**	**1438**	**1541**	**1726**	**1865**	**2001**
Total South		**804**	**818**	**838**	**900**	**902**	**944**
Grand Total		**2116**	**2256**	**2379**	**2626**	**2767**	**2946**

Table 15.7.3.4

Scenario 2, Case 2, Expanded Canal
PCUMS for Laden Transits

ShipType	Direction	2010	2015	2020	2030	2040	2050
							000's tons
General Cargo	N	4392	4684	4987	5526	5951	6387
General Cargo	S	6397	6998	7534	8469	8944	9236
Refrigerated Cargo	N	10180	10353	10561	11308	11232	11596
Refrigerated Cargo	S	5365	5790	6146	6608	6804	6734
Dry Bulk Carrier	N	32709	34910	37871	41481	41700	43184
Dry Bulk Carrier	S	54562	59916	63499	74009	85406	96013
Tanker	N	8752	8362	8020	8232	8630	9189
Tanker	S	22012	24427	26075	27572	27454	27952
Dry/Liquid Bulk Carrier	N	125	127	129	130	112	104
Dry/Liquid Bulk Carrier	S	398	437	478	513	523	539
Container/Break-Bulk	N	3387	3628	3881	4378	4863	5370
Container/Break-Bulk	S	3624	3953	4291	4910	5127	5407
Full Container	N	44169	49398	55539	64945	72997	81377
Full Container	S	51801	56395	59329	66201	72155	78999
Roll-on/Roll-off	N	1946	1944	1927	1767	1392	990
Roll-on/Roll-off	S	2670	2810	2885	3029	3057	3035
Vehicle Carrier	N	11610	11973	12804	14935	15912	17096
Vehicle Carrier	S	9053	9750	10492	11794	13929	15500
Vehicle/Dry Bulk	N	344	369	393	445	479	525
Vehicle/Dry Bulk	S	782	863	936	1085	1201	1318
Liquid Gas	N	110	117	126	142	150	157
Liquid Gas	S	2118	2371	2593	2780	2756	2730
Other	N	416	445	473	512	541	550
Other	S	454	489	521	578	626	666
Total North		**118141**	**126310**	**136709**	**153801**	**163960**	**176526**
Total South		**159236**	**174198**	**184779**	**207547**	**227981**	**248129**
Grand Total		**277378**	**300508**	**321487**	**361348**	**391941**	**424655**

Table 15.7.3.5

Scenario 2, Case 2, Expanded Canal
PCUMS for Ballast Transits

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	1149	1252	1344	1507	1599	1660
General Cargo	S	403	422	442	478	506	535
Refrigerated Cargo	N	362	388	409	433	437	420
Refrigerated Cargo	S	3351	3408	3483	3751	3733	3880
Dry Bulk Carrier	N	10798	12063	13211	15801	18749	21523
Dry Bulk Carrier	S	1349	1418	1507	1626	1647	1707
Tanker	N	7034	7845	8411	8922	8824	8953
Tanker	S	1492	1395	1302	1254	1237	1255
Dry/Liquid Bulk Carrier	N	80	89	98	109	116	124
Dry/Liquid Bulk Carrier	S	27	28	28	28	24	22
Container/Break-Bulk	N	353	383	409	455	476	493
Container/Break-Bulk	S	246	262	278	311	345	380
Full Container	N	635	675	708	784	854	926
Full Container	S	445	493	543	646	758	887
Roll-on/Roll-off	N	150	149	143	130	110	91
Roll-on/Roll-off	S	119	111	104	88	52	28
Vehicle Carrier	N	1604	1721	1837	2036	2349	2577
Vehicle Carrier	S	2682	2793	2986	3465	3746	4061
Vehicle/Dry Bulk	N	200	221	238	276	304	332
Vehicle/Dry Bulk	S	30	33	35	39	42	46
Liquid Gas	N	780	869	951	1018	990	974
Liquid Gas	S	10	10	11	12	13	13
Total North		**23146**	**25655**	**27759**	**31470**	**34808**	**38073**
Total South		**10155**	**10373**	**10720**	**11699**	**12104**	**12814**
Grand Total		**33300**	**36028**	**38478**	**43169**	**46912**	**50887**

Table 15.7.3.6

Scenario 2, Case 2, Expanded Canal
Tolls for Laden Transits

ShipType	Direction	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	11,288	12,037	12,817	14,202	15,295	16,415
General Cargo	S	16,441	17,984	19,363	21,765	22,986	23,737
Refrigerated Cargo	N	26,163	26,607	27,143	29,061	28,866	29,801
Refrigerated Cargo	S	13,788	14,880	15,794	16,982	17,486	17,306
Dry Bulk Carrier	N	84,063	89,718	97,328	106,606	107,168	110,984
Dry Bulk Carrier	S	140,223	153,985	163,192	190,202	219,495	246,754
Tanker	N	22,494	21,490	20,611	21,157	22,180	23,617
Tanker	S	56,571	62,779	67,012	70,861	70,556	71,836
Dry/Liquid Bulk Carrier	N	320	327	330	333	288	266
Dry/Liquid Bulk Carrier	S	1,024	1,124	1,228	1,319	1,345	1,384
Container/Break-Bulk	N	8,705	9,323	9,974	11,252	12,497	13,801
Container/Break-Bulk	S	9,313	10,160	11,029	12,617	13,175	13,896
Full Container	N	113,514	126,953	142,734	166,909	187,603	209,140
Full Container	S	133,128	144,934	152,476	170,137	185,438	203,028
Roll-on/Roll-off	N	5,002	4,997	4,952	4,542	3,578	2,544
Roll-on/Roll-off	S	6,863	7,221	7,414	7,784	7,856	7,800
Vehicle Carrier	N	29,836	30,772	32,906	38,382	40,895	43,937
Vehicle Carrier	S	23,266	25,057	26,965	30,310	35,796	39,836
Vehicle/Dry Bulk	N	885	948	1,009	1,145	1,232	1,349
Vehicle/Dry Bulk	S	2,010	2,218	2,405	2,788	3,086	3,387
Liquid Gas	N	283	301	323	365	385	404
Liquid Gas	S	5,443	6,092	6,664	7,145	7,083	7,016
Other	N	1,070	1,143	1,215	1,315	1,391	1,413
Other	S	1,166	1,256	1,340	1,485	1,609	1,711
Total North		**303,623**	**324,616**	**351,342**	**395,269**	**421,376**	**453,671**
Total South		**409,237**	**447,690**	**474,881**	**533,395**	**585,912**	**637,693**
Grand Total		**712,860**	**772,305**	**826,222**	**928,664**	**1,007,288**	**1,091,364**

Table 15.7.3.7

Scenario 2, Case 2, Expanded Canal

Tolls for Ballast Transits

ShipType	Direction	2010	2015	2020	2030	2040	000's US$ 2050
General Cargo	N	2,345	2,553	2,741	3,074	3,282	3,387
General Cargo	S	822	862	902	975	1,032	1,091
Refrigerated Cargo	N	738	791	833	883	890	857
Refrigerated Cargo	S	6,836	6,952	7,105	7,652	7,616	7,916
Dry Bulk Carrier	N	22,028	24,608	26,951	32,235	38,248	43,907
Dry Bulk Carrier	S	2,753	2,893	3,075	3,317	3,360	3,483
Tanker	N	14,349	16,003	17,158	18,202	18,002	18,263
Tanker	S	3,044	2,846	2,655	2,558	2,524	2,560
Dry/Liquid Bulk Carrier	N	163	181	199	222	236	253
Dry/Liquid Bulk Carrier	S	56	56	57	56	48	44
Container/Break-Bulk	N	721	782	835	928	971	1,006
Container/Break-Bulk	S	502	534	567	635	704	776
Full Container	N	1,295	1,378	1,445	1,599	1,743	1,888
Full Container	S	908	1,007	1,108	1,317	1,546	1,810
Roll-on/Roll-off	N	307	304	292	265	224	187
Roll-on/Roll-off	S	242	226	213	180	106	57
Vehicle Carrier	N	3,272	3,511	3,747	4,153	4,792	5,256
Vehicle Carrier	S	5,472	5,697	6,092	7,070	7,642	8,284
Vehicle/Dry Bulk	N	409	450	486	562	620	678
Vehicle/Dry Bulk	S	62	67	71	81	87	94
Liquid Gas	N	1,591	1,773	1,940	2,076	2,020	1,987
Liquid Gas	S	20	21	22	25	26	27
Total North		**47,217**	**52,335**	**56,628**	**64,198**	**71,009**	**77,668**
Total South		**20,716**	**21,161**	**21,868**	**23,865**	**24,691**	**26,141**
Grand Total		**67,933**	**73,496**	**78,496**	**88,064**	**95,700**	**103,810**

* Excludes ballast transits for 'Other' ship types

Table 15.7.4.1

Scenario 2, Demand for Cargo Flows Through the Unrestricted Canal

Commodity	Direction	2010	2015	2020	2030	2040	2050
					tons/% per annum growth		
All Other Cargoes	N	737265	743489	770724	749865	729264	716833
			0.2%	0.7%	-0.5%	-0.6%	-0.3%
All Other Cargoes	S	1476357	1475473	1411482	1343224	1277105	1229617
			0.0%	-0.9%	-1.0%	-1.0%	-0.8%
Alumina/Bauxite	N	697632	754395	783646	847765	910004	978276
			1.6%	0.8%	1.6%	1.4%	1.5%
Alumina/Bauxite	S	326779	371759	423506	515538	610158	704071
			2.6%	2.6%	4.0%	3.4%	2.9%
Automobiles	N	1048617	1065545	1137405	1336989	1406496	1499915
			0.3%	1.3%	3.3%	1.0%	1.3%
Automobiles	S	524254	570888	619295	708598	841895	950666
			1.7%	1.6%	2.7%	3.5%	2.5%
Bananas	N	2379148	2434246	2521082	3032291	3275645	3927014
			0.5%	0.7%	3.8%	1.6%	3.7%
Bananas	S	17318	17318	17318	17318	17318	17318
			0.0%	0.0%	0.0%	0.0%	0.0%
Chemicals	N	3140662	3634876	4206888	5858993	7545394	9162134
			3.0%	3.0%	6.8%	5.2%	4.0%
Chemicals	S	10232026	12024379	13361415	15513810	18105553	20739045
			3.3%	2.1%	3.0%	3.1%	2.8%
Coal & Coke	N	13678503	14149935	14818136	14335972	11449628	9732097
			0.7%	0.9%	-0.7%	-4.4%	-3.2%
Coal & Coke	S	5817517	6217100	6491140	7270141	6204086	6473130
			1.3%	0.9%	2.3%	-3.1%	0.9%
Containerised Cargo	N	29725318	32835003	36286459	41487733	45379037	48865364
			2.0%	2.0%	2.7%	1.8%	1.5%
Containerised Cargo	S	36179316	39142224	40859800	44699859	47324655	49902111
			1.6%	0.9%	1.8%	1.1%	1.1%
Corn	N	231314	239787	257927	318876	405763	485889
			0.7%	1.5%	4.3%	4.9%	3.7%
Corn	S	26653329	28827303	31345853	37269379	48132644	56063230
			1.6%	1.7%	3.5%	5.2%	3.1%
Crude Oil	N	6531660	5274309	3983653	2305061	1121152	240629
			-4.2%	-5.5%	-10.4%	-13.4%	-26.5%
Crude Oil	S	6947675	7568281	7383517	6641912	5275374	4315310
			1.7%	-0.5%	-2.1%	-4.5%	-3.9%
Fertilisers	N	1483566	1631886	1743276	1905571	2031429	2055054
			1.9%	1.3%	1.8%	1.3%	0.2%
Fertilisers	S	7862663	8778140	9716239	11829632	14247571	16655819
			2.2%	2.1%	4.0%	3.8%	3.2%
Food & Agricultural Products	N	1811610	1736903	1673503	1748242	1863039	2045365
			-0.8%	-0.7%	0.9%	1.3%	1.9%
Food & Agricultural Products	S	915878	904009	892703	897948	899749	896693
			-0.3%	-0.3%	0.1%	0.0%	-0.1%
Iron & Steel	N	7731310	8149374	9122932	9770682	8879507	8071099
			1.1%	2.3%	1.4%	-1.9%	-1.9%
Iron & Steel	S	5572231	6278643	7109800	8106730	7884998	7215644
			2.4%	2.5%	2.7%	-0.6%	-1.8%
Lumber Products	N	2088040	2261680	2477349	2976552	3681304	4422480
			1.6%	1.8%	3.7%	4.3%	3.7%
Lumber Products	S	5500962	6306805	6826477	8011595	8604402	9505776
			2.8%	1.6%	3.3%	1.4%	2.0%
Miscellaneous Minerals	N	8600065	8725266	10431474	12661533	14840345	17050591
			0.3%	3.6%	4.0%	3.2%	2.8%
Miscellaneous Minerals	S	2245910	2561191	2809163	3326434	3772956	4314289
			2.7%	1.9%	3.4%	2.6%	2.7%
Ores	N	7274291	8001917	8872876	9937216	9753133	9785470
			1.9%	2.1%	2.3%	-0.4%	0.1%
Ores	S	4912180	5334382	5759639	6345797	6008909	6246994
			1.7%	1.5%	2.0%	-1.1%	0.8%

Table 15.7.4.1 (continued)

Scenario 2, Demand for Cargo Flows Through the Unrestricted Canal

tons/% per annum growth

Commodity	Direction	2010	2015	2020	2030	2040	2050
Other Grains	N	873224	940421	1014715	1168752	1408138	1645085
			1.5%	1.5%	2.9%	3.8%	3.2%
Other Grains	S	2981860	3410558	3565426	3944007	4055875	4309215
			2.7%	0.9%	2.0%	0.6%	1.2%
Other Metals	N	2413169	2651019	2934434	3421804	3996239	4596461
			1.9%	2.1%	3.1%	3.2%	2.8%
Other Metals	S	1100939	1243182	1407219	1731066	2070501	2413235
			2.5%	2.5%	4.2%	3.6%	3.1%
Paper	N	818494	892144	970676	1156599	1375836	1614474
			1.7%	1.7%	3.6%	3.5%	3.3%
Paper	S	1273233	1435115	1607629	1950038	2293869	2676035
			2.4%	2.3%	3.9%	3.3%	3.1%
Petroleum Chemicals	N	520024	600220	694521	890070	1109281	1310265
			2.9%	3.0%	5.1%	4.5%	3.4%
Petroleum Chemicals	S	2994649	3470606	3875285	4735631	5640595	6583436
			3.0%	2.2%	4.1%	3.6%	3.1%
Petroleum Coke	N	3153816	3421104	3539320	3909082	3390879	3392415
			1.6%	0.7%	2.0%	-2.8%	0.0%
Petroleum Coke	S	813903	844544	863675	883927	776373	747204
			0.7%	0.4%	0.5%	-2.6%	-0.8%
Petroleum Products	N	1818165	1857048	1895036	1877031	1652152	1463408
			0.4%	0.4%	-0.2%	-2.5%	-2.4%
Petroleum Products	S	22050624	26593868	30650202	31227045	29185059	27681405
			3.8%	2.9%	0.4%	-1.3%	-1.1%
Phosphates	N	60376	65778	71536	82377	90443	98625
			1.7%	1.7%	2.9%	1.9%	1.7%
Phosphates	S	12897407	14666730	15976483	18736137	22089900	24942602
			2.6%	1.7%	3.2%	3.3%	2.5%
Pulpwood	N	3157605	3440141	3741233	4505817	5460632	6475223
			1.7%	1.7%	3.8%	3.9%	3.5%
Pulpwood	S	1793161	2037361	2250640	2750711	3300679	3845385
			2.6%	2.0%	4.1%	3.7%	3.1%
Reefer Products	N	4531329	4989291	5509917	6456879	7691944	9297517
			1.9%	2.0%	3.2%	3.6%	3.9%
Reefer Products	S	1868636	2260478	2677234	3579826	4811168	6470727
			3.9%	3.4%	6.0%	6.1%	6.1%
Residual Petroleum	N	804829	804829	804829	788733	708250	603622
			0.0%	0.0%	-0.4%	-2.1%	-3.1%
Residual Petroleum	S	1734553	1712181	1684348	1593068	1399725	1164540
			-0.3%	-0.3%	-1.1%	-2.6%	-3.6%
Scrap Metal	N	76736	83602	90919	137398	213262	296011
			1.7%	1.7%	8.6%	9.2%	6.8%
Scrap Metal	S	2318960	2637253	2878494	3150851	2816157	2333350
			2.6%	1.8%	1.8%	-2.2%	-3.7%
Soybeans	N	13036	14988	16122	19152	22731	26566
			2.8%	1.5%	3.5%	3.5%	3.2%
Soybeans	S	16618110	17849405	18709641	21797671	25146354	29043256
			1.4%	0.9%	3.1%	2.9%	2.9%
Sugar	N	2001823	1980154	1960924	1943037	1931061	1927289
			-0.2%	-0.2%	-0.2%	-0.1%	0.0%
Sugar	S	394377	363928	339493	313324	289970	286705
			-1.6%	-1.4%	-1.6%	-1.5%	-0.2%
Wheat	N	3247713	3444680	3705267	4311283	5039759	5878770
			1.2%	1.5%	3.1%	3.2%	3.1%
Wheat	S	3789953	4087492	4440456	4961619	5641092	6558659
			1.5%	1.7%	2.2%	2.6%	3.1%
Total Northbound		110649340	116824029	126036778	139941354	147361745	157663942
Total Southbound		187814759	208990606	225953571	253852837	278724691	304285466
Grand Total		298464099	325814635	351990349	393794190	426086436	461949408
Annual % Change							
Total Northbound			1.1%	1.5%	2.1%	1.0%	1.4%
Total Southbound			2.2%	1.6%	2.4%	1.9%	1.8%
Grand Total			1.8%	1.6%	2.3%	1.6%	1.6%

Table 15.7.4.2

Scenario 2, Case 3, Unrestricted Canal
Number of Laden Transits

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	545	578	613	674	725	776
General Cargo	S	855	935	1007	1134	1204	1250
Refrigerated Cargo	N	1408	1427	1451	1543	1524	1559
Refrigerated Cargo	S	683	736	781	840	868	862
Dry Bulk Carrier	N	1482	1561	1673	1815	1821	1877
Dry Bulk Carrier	S	2380	2582	2759	3182	3631	4049
Tanker	N	481	469	461	496	541	595
Tanker	S	1326	1486	1602	1711	1719	1763
Dry/Liquid Bulk Carrier	N	4	4	5	5	4	4
Dry/Liquid Bulk Carrier	S	14	16	18	19	20	21
Container/Break-Bulk	N	233	245	257	280	301	323
Container/Break-Bulk	S	238	254	271	300	302	309
Full Container	N	1575	1751	1937	2272	2587	2926
Full Container	S	1778	1953	2094	2405	2691	2999
Roll-on/Roll-off	N	104	103	104	98	73	58
Roll-on/Roll-off	S	149	153	153	152	139	135
Vehicle Carrier	N	274	281	299	346	368	395
Vehicle Carrier	S	231	246	261	282	330	366
Vehicle/Dry Bulk	N	22	23	25	28	30	33
Vehicle/Dry Bulk	S	43	48	52	61	68	75
Liquid Gas	N	12	13	14	16	17	18
Liquid Gas	S	212	239	263	284	281	278
Other	N	269	284	301	331	365	399
Other	S	113	118	123	134	145	158
Total North		6410	6740	7139	7903	8356	8961
Total South		8023	8765	9385	10504	11398	12264
Grand Total		14433	15506	16523	18408	19754	21225

Table 15.7.4.3

Scenario 2, Case 3, Unrestricted Canal
Number of Ballast Transits

ShipType	Direction	2010	2015	2020	2030	No. of Ships 2040	2050
General Cargo	N	192	211	228	258	277	290
General Cargo	S	61	65	68	74	79	84
Refrigerated Cargo	N	49	52	55	58	58	56
Refrigerated Cargo	S	488	495	505	540	536	553
Dry Bulk Carrier	N	525	571	612	719	832	939
Dry Bulk Carrier	S	71	73	75	81	83	86
Tanker	N	400	448	483	517	517	529
Tanker	S	76	73	69	71	73	78
Dry/Liquid Bulk Carrier	N	2	2	3	3	3	3
Dry/Liquid Bulk Carrier	S	1	1	1	1	1	1
Container/Break-Bulk	N	26	28	29	30	30	30
Container/Break-Bulk	S	18	19	20	21	22	23
Full Container	N	35	38	41	48	54	60
Full Container	S	27	30	34	41	50	60
Roll-on/Roll-off	N	13	12	11	8	6	5
Roll-on/Roll-off	S	18	18	19	17	2	2
Vehicle Carrier	N	29	31	33	34	37	39
Vehicle Carrier	S	41	42	44	49	51	54
Vehicle/Dry Bulk	N	10	11	12	15	16	18
Vehicle/Dry Bulk	S	2	2	2	2	3	3
Liquid Gas	N	31	35	39	41	40	38
Liquid Gas	S	1	1	1	1	1	1
Total North		**1313**	**1440**	**1544**	**1730**	**1869**	**2006**
Total South		**804**	**818**	**838**	**900**	**902**	**944**
Grand Total		**2117**	**2258**	**2382**	**2630**	**2771**	**2951**

Table 15.7.4.4

Scenario 2, Case 3, Unrestricted Canal
PCUMS for Laden Transits

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	4392	4684	4987	5526	5951	6387
General Cargo	S	6397	6998	7534	8469	8944	9236
Refrigerated Cargo	N	10180	10353	10561	11308	11232	11596
Refrigerated Cargo	S	5365	5790	6146	6608	6804	6734
Dry Bulk Carrier	N	32645	34849	37814	41433	41670	43165
Dry Bulk Carrier	S	54661	60052	64805	75407	86878	97803
Tanker	N	8752	8362	8020	8232	8630	9189
Tanker	S	24146	27845	30563	32069	31954	32456
Dry/Liquid Bulk Carrier	N	125	127	129	130	112	104
Dry/Liquid Bulk Carrier	S	398	437	478	513	523	539
Container/Break-Bulk	N	3387	3628	3881	4378	4863	5370
Container/Break-Bulk	S	3624	3953	4291	4910	5127	5407
Full Container	N	44169	49398	55539	64945	72997	81377
Full Container	S	51801	56395	59329	66201	72155	78999
Roll-on/Roll-off	N	1946	1944	1927	1767	1392	990
Roll-on/Roll-off	S	2670	2810	2885	3029	3057	3035
Vehicle Carrier	N	11610	11973	12804	14935	15912	17096
Vehicle Carrier	S	9053	9750	10492	11794	13929	15500
Vehicle/Dry Bulk	N	344	369	393	445	479	525
Vehicle/Dry Bulk	S	782	863	936	1085	1201	1318
Liquid Gas	N	110	117	126	142	150	157
Liquid Gas	S	2118	2371	2593	2780	2756	2730
Other	N	416	445	473	512	541	560
Other	S	454	489	521	578	626	666
Total North		**118077**	**126249**	**136652**	**153753**	**163930**	**176506**
Total South		**161470**	**177752**	**190573**	**213442**	**233954**	**254423**
Grand Total		**279547**	**304001**	**327225**	**367195**	**397884**	**430930**

Table 15.7.4.5

Scenario 2, Case 3, Unrestricted Canal
PCUMS for Ballast Transits

000's tons

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	1149	1252	1344	1507	1599	1660
General Cargo	S	403	422	442	478	506	535
Refrigerated Cargo	N	362	388	409	433	437	420
Refrigerated Cargo	S	3351	3408	3483	3751	3733	3880
Dry Bulk Carrier	N	10798	12063	13211	15801	18749	21523
Dry Bulk Carrier	S	1349	1418	1507	1626	1647	1707
Tanker	N	7053	7877	8455	8989	8903	9043
Tanker	S	1492	1395	1302	1254	1237	1255
Dry/Liquid Bulk Carrier	N	80	89	98	109	116	124
Dry/Liquid Bulk Carrier	S	27	28	28	28	24	22
Container/Break-Bulk	N	353	383	409	455	476	493
Container/Break-Bulk	S	246	262	278	311	345	380
Full Container	N	635	675	708	784	854	926
Full Container	S	445	493	543	646	758	887
Roll-on/Roll-off	N	150	149	143	130	110	91
Roll-on/Roll-off	S	119	111	104	88	52	28
Vehicle Carrier	N	1604	1721	1837	2036	2349	2577
Vehicle Carrier	S	2682	2793	2986	3465	3746	4061
Vehicle/Dry Bulk	N	200	221	238	276	304	332
Vehicle/Dry Bulk	S	30	33	35	39	42	46
Liquid Gas	N	780	869	951	1018	990	974
Liquid Gas	S	10	10	11	12	13	13
Total North		**23165**	**25686**	**27803**	**31537**	**34887**	**38163**
Total South		**10155**	**10373**	**10720**	**11699**	**12104**	**12814**
Grand Total		**33319**	**36059**	**38523**	**43235**	**46990**	**50977**

Table 15.7.4.6

Scenario 2, Case 3, Unrestricted Canal
Tolls for Laden Transits

000's US$

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	11,288	12,037	12,817	14,202	15,295	16,415
General Cargo	S	16,441	17,984	19,363	21,765	22,986	23,737
Refrigerated Cargo	N	26,163	26,607	27,143	29,061	28,866	29,801
Refrigerated Cargo	S	13,788	14,880	15,794	16,982	17,486	17,306
Dry Bulk Carrier	N	83,898	89,563	97,182	106,482	107,092	110,934
Dry Bulk Carrier	S	140,480	154,334	166,549	193,797	223,277	251,353
Tanker	N	22,494	21,490	20,611	21,157	22,180	23,617
Tanker	S	62,055	71,562	78,547	82,417	82,123	83,413
Dry/Liquid Bulk Carrier	N	320	327	330	333	288	266
Dry/Liquid Bulk Carrier	S	1,024	1,124	1,228	1,319	1,345	1,384
Container/Break-Bulk	N	8,705	9,323	9,974	11,252	12,497	13,801
Container/Break-Bulk	S	9,313	10,160	11,029	12,617	13,175	13,896
Full Container	N	113,514	126,953	142,734	166,909	187,603	209,140
Full Container	S	133,128	144,934	152,476	170,137	185,438	203,028
Roll-on/Roll-off	N	5,002	4,997	4,952	4,542	3,578	2,544
Roll-on/Roll-off	S	6,863	7,221	7,414	7,784	7,856	7,800
Vehicle Carrier	N	29,836	30,772	32,906	38,382	40,895	43,937
Vehicle Carrier	S	23,266	25,057	26,965	30,310	35,796	39,836
Vehicle/Dry Bulk	N	885	948	1,009	1,145	1,232	1,349
Vehicle/Dry Bulk	S	2,010	2,218	2,405	2,788	3,086	3,387
Liquid Gas	N	283	301	323	365	385	404
Liquid Gas	S	5,443	6,092	6,664	7,145	7,083	7,016
Other	N	1,070	1,143	1,215	1,315	1,391	1,413
Other	S	1,166	1,256	1,340	1,485	1,609	1,711
Total North		**303,459**	**324,461**	**351,196**	**395,145**	**421,300**	**453,621**
Total South		**414,978**	**456,823**	**489,773**	**548,545**	**601,262**	**653,868**
Grand Total		**718,436**	**781,283**	**840,968**	**943,690**	**1,022,562**	**1,107,489**

Table 15.7.4.7

Scenario 2, Case 3, Unrestricted Canal
Tolls for Ballast Transits by Route and Ship Type

000's US$

ShipType	Direction	2010	2015	2020	2030	2040	2050
General Cargo	N	2,345	2,553	2,741	3,074	3,262	3,387
General Cargo	S	822	862	902	975	1,032	1,091
Refrigerated Cargo	N	738	791	833	883	890	857
Refrigerated Cargo	S	6,836	6,952	7,105	7,652	7,616	7,916
Dry Bulk Carrier	N	22,028	24,608	26,951	32,235	38,248	43,907
Dry Bulk Carrier	S	2,753	2,893	3,075	3,317	3,360	3,483
Tanker	N	14,388	16,068	17,248	18,338	18,162	18,447
Tanker	S	3,044	2,846	2,655	2,558	2,524	2,560
Dry/Liquid Bulk Carrier	N	163	181	199	222	236	253
Dry/Liquid Bulk Carrier	S	56	56	57	56	48	44
Container/Break-Bulk	N	721	782	835	928	971	1,006
Container/Break-Bulk	S	502	534	567	635	704	776
Full Container	N	1,295	1,378	1,445	1,599	1,743	1,888
Full Container	S	908	1,007	1,108	1,317	1,546	1,810
Roll-on/Roll-off	N	307	304	292	265	224	187
Roll-on/Roll-off	S	242	226	213	180	106	57
Vehicle Carrier	N	3,272	3,511	3,747	4,153	4,792	5,256
Vehicle Carrier	S	5,472	5,697	6,092	7,070	7,642	8,284
Vehicle/Dry Bulk	N	409	450	486	562	620	678
Vehicle/Dry Bulk	S	62	67	71	81	87	94
Liquid Gas	N	1,591	1,773	1,940	2,076	2,020	1,987
Liquid Gas	S	20	21	22	25	26	27
Total North		**47,256**	**52,400**	**56,718**	**64,335**	**71,169**	**77,852**
Total South		**20,716**	**21,161**	**21,868**	**23,865**	**24,691**	**26,141**
Grand Total		**67,971**	**73,561**	**78,586**	**88,200**	**95,860**	**103,994**

* Excludes ballast transits for 'Other' ship types

Appendix I

Container Shipping Schedules

General:
Containerisation International identifies more than 150 principal trade routes for Pacific Coast ports. Typical itineraries fall into the following categories:
Single call at Seattle/Tacoma
Call at Seattle/Tacoma with second call at Vancouver or Portland
Single call at Los Angeles/Long Beach only
Call at Los Angeles/ Long Beach with second call at Oakland
Calls at both Northern and Southern ports

Examples:

APL:
Source: Web Site

- Transpacific for East Coast using landbridge:
- SAX: Singapore via Los Angeles and Oakland
- PS1, PS2, PS3: HK and Singapore via Seattle and Los Angeles
- PSW: as above plus Tacoma
- PNW: via Vancouver, Tacoma and Portland, but no New York traffic routed this way
- PNX: Tokyo, HK via Seattle and Vancouver
- GCX: Japan and Korea to Los Angeles and Oakland

The all water route calls at Colon then Charleston and New York from Hong Kong and Japan, the ECS.
Asia – Europe traffic is routed via the Suez Canal.

CCN:
Source: Web Site
Offers a 1,700 TEU service using 6 vessels between New York, Baltimore, Gulf Ports via the Canal to Chile and the Western Coast of South America.
Also offers a West Mediterranean and West Coast of South America service via the Canal, of 4 x 1,150 TEU vessels.
The Condor service is between the UK and Northern Europe ports and West South America via the Canal: 6 x 1,830 TEU.

Cho Yang:
Source: Web Site
Five Transpacific:

- PNX 1 and 2: Singapore, HK, Japan to PNW
- PS-PDM 1 and 2: Pendulum between Europe, Asia and USWC (PSW)
- CAX: China – Oakland and Long Beach

Two using the Panama Canal:

6. AWE – PDM: All Water Express Pendulum: HK to Oakland, Long Beach, USEC to Europe and return
7. AWE: All Water Express: HK, Korea, Japan to USEC only

Asia – Europe via Suez
USEC – Mediterranean – Asia via Suez

Cosco:
Source: Web Site
Three Transpacific using landbridge:

- KL – PNW: Japan – PNW

- KL – PSW: Singapore, HK, Japan – Los Angeles/Long Beach and Oakland (x 2)

One via Panama Canal:

- AEX: Shanghai, HK – New York

Evergreen:

Source: Web Site

Four Transpacific:

- TPS: HK – Los Angeles and Oakland
- TPN: HK and Japan – Vancouver and Tacoma
- HTW: HK and Japan – Los Angeles and Portland
- KJW: Tokyo and Korea – Los Angeles and Tacoma

Two Round The World via the Panama and Suez Canals, calling Los Angeles and New York:

- RWE - Eastbound
- RWW – Westbound

Hanjin:

Source: Web Site

Hanjin markets the USEC ports, e.g. Boston, via the West Coast and landbridge.

Transpacific services:

- CAX: China – Long Beach and Oakland
- PDA: Pendulum Express Singapore, HK, Japan – Long Beach and Oakland
- PDB: As above
- PNA: Singapore – PNW ports
- PNB: As above

Using the Panama Canal:

- AWP: Europe – USEC and USWC
- AWE: HK, Korea, Japan – New York
- AWP: Asia – USEC: HK, Korea – Oakland, New York, Europe

Four Asia –Europe services via Suez

Hyundai Merchant Marine:

Source: Web Site

Eight Transpacific services:

- PNW: HK, Korea, Japan – Vancouver, Tacoma, Portland
- PS1: Singapore, HK, Japan – Seattle and Los Angeles
- PS2: Via Oakland
- PS3: As above
- China Express
- PSW: HK, Korea – Long Beach, Oakland, Tacoma
- PNX: Via Vancouver and Seattle
- SAX: Singapore, HK – Los Angeles, Oakland

One service via Panama Canal:

- ECS: HK, Korea, Japan – USEC

Three Asia – Europe via Suez Canal

NYK:

Source: Web Site

NYK has six services across the Pacific, one of which goes via the Canal to the North East Coast:

- AEX: All Water Express

The other five services use the landbridge:

- PAX: Pacific Atlantic Express to New York via Seattle and BVNSF to Chicago, then "Conrail" (now CSX or NS)
- JCX: Japan China Express via Los Angeles and BNSF to Chicago
- PNX: Express via Seattle and BNSF and CSX
- FEX: Far East Express via Los Angeles and BNSF via Chicago
- SSX: Super Shuttle via Long Beach and BNSF

OOCL:
Source: Web Site
Three Transpacific:

- FEX: HK, Japan – Los Angeles and Oakland
- PNX: Singapore, HK – Seattle, Vancouver and Oakland
- SSX: Singapore, HK – Long Beach

Via Panama Canal:

- PAX: HK, Japan – Seattle, Oakland, Los Angeles – Canal – USEC and return

Via Suez Canal:

- Asia – USEC Express

Yang Ming:
Source: Web Site
Yang Ming has nine TransPacific services and three services from Asia to Europe.
The three services from Asia to Europe and all via the Suez Canal and are:

- Asia general
- Japan – Europe
- China – Europe

The nine Pacific services include two all water through the Panama Canal to the North East Coast of America:

- AWE
- AEX

The other seven services offer landbridge options and use primarily K Line and Cosco vessels:

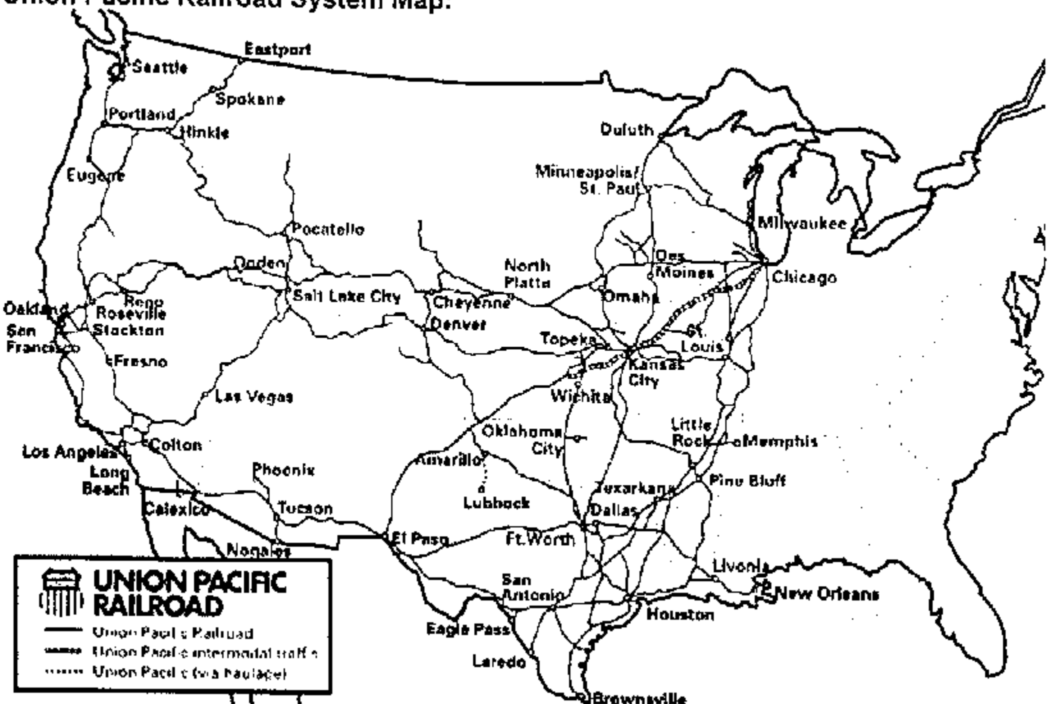
- PSW (Yang-Ming's own): to Los Angeles and Oakland and return
- ASX (K Line): to Long Beach and Oakland and return
- PSW (K Line): as above
- CES (Cosco): as above
- PNW (K Line): to Vancouver and return
- SEA (Cosco): to Long Beach, Seattle and Vancouver and return
- CEN (Cosco): to Tacoma, Vancouver, Long Beach and return

The Major Class1 Railroads:

Sources: Company Web Sites, Jane's World Railways 1998 – 9, Journal of Commerce

Union Pacific:
The Union Pacific serves all of the West Coast and the Gulf Coast ports, with double stack services to New York and the Mid West as well as to Houston and New Orleans. UP has invested heavily to ensure that railroad transits can match road; the fastest Chicago – Los Angeles double stack train now takes 50 hours, matching the road time. In 1997 UP's intermodal traffic increased by 26% and the railroad is considering the development of a third intermodal terminal in Western Chicago. The two they already have there are primarily for international traffic. UP has also invested in doubling the track between El Paso and Los Angeles and upgrading the route between El Paso and Kansas City to take intermodal traffic. UP now has double stack clearance to Oakland and there are new intermodal terminals in Kansas, Memphis and Los Angeles. In addition, UP has invested in new 6,000 hp locomotives.
An average of 75 trains per week serve the new Intermodal Container Terminal Facility at Long Beach. The ICTF has 11 km of track and can load and unload 5 double stack trains simultaneously. The investment put in by UP will be enhanced by the development of the Alameda Corridor (see Los Angeles section). APL is UP's single largest customer.

Union Pacific Railroad System Map:



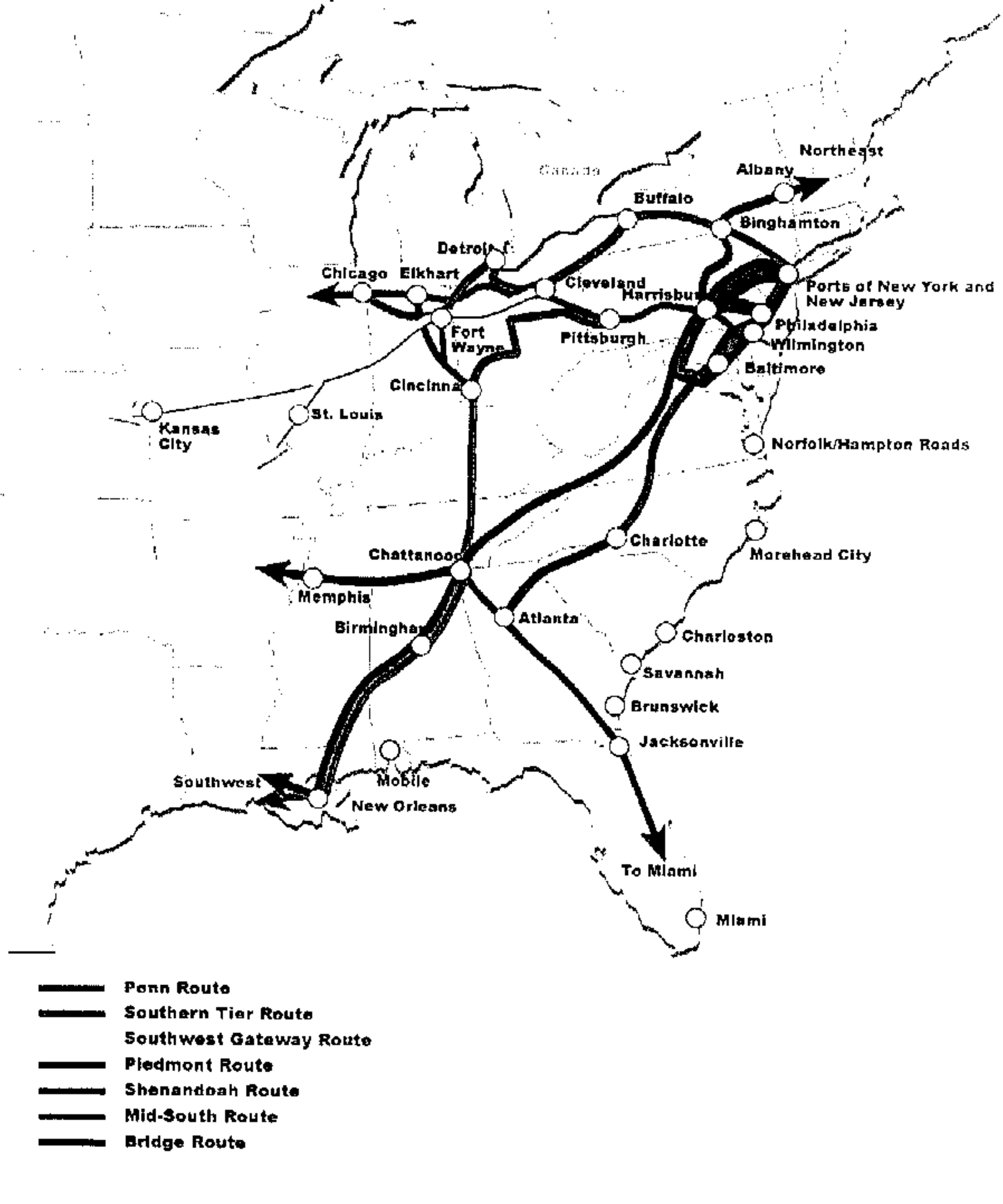
Source: Union Pacific Web Site

Burlington Northern Santa Fe:
BNSF is the main rival to the Union Pacific system. Intermodal freight is its main revenue earner, and it works in partnership with the road haulage company J B Hunt. BNSF offers a double stack service now for international refrigerated boxes as well as providing dedicated intermodal services between New Orleans and California, Texas and the Pacific North West and Vancouver, and significant capacity in Chicago. BNSF is intending to double stack its Chicago – Los Angeles trunk route in New Mexico in the near future. BNSF's strategy is to develop Kansas City, as an alternative to congested Chicago, as its main Los Angeles route runs through Kansas City en route to Chicago. Currently, BNSF runs 26 east and west bound intermodal trains daily between the Midwest and Northern California.

CSX:
CSXI was created as the integrated door to door intermodal carrier of Sealand, having 33 intermodal terminals and 300 intermodal trains per week, including 13 transcontinental double stack trains. CSXI's main flows are from the Pacific North West to Florida and from California to New England, the North East and Mid Atlantic states. Now CSX itself has bought Conrail (with NS), CSX is also hoping to bypass the congestion in Chicago, which would allow CSX to reduce its transit times to BNSF and UP destinations by 1 day.

Norfolk Southern:
NS is based in Virginia. Following the split of Conrail between NS and CSX, Norfolk Southern has targeted its growth in intermodal traffic. It is looking to invest in double tracking and upgrading the signalling on the so-called Penn Route, between New Jersey, Philadelphia and Chicago, investing more than $300 million in the first three years for clearance and capacity improvements. Conrail had already started this process, gaining traffic for the port of Philadelphia destined for Pittsburgh, which had previously entered the US through the West Coast ports. Improvements of $9 million are also to be made to the Chicago intermodal terminal and the creation of a new connection with Union Pacific. New Jersey is looking to double its freight train services from New York to Western US using NS. In 1997, intermodal traffic increased by 11%, and within this, container traffic increased by 12%.

NS system routes and ports



Appendix III

USDOT Report On The Impact Of Mega Containerships On US Ports

The report was written in 1997 and is a summary of the input received by the USDoT at four regional meetings held to address the potential impact of the mega ships on US ports. A lot of the information is obvious, but it represented the views of the US ports at the time as they all took part in the meetings. There is some information on terminal design and it also includes information on current and proposed US port drafts, possible regional port hub developments, the effect of cargo peaking on terminal operations, characteristics of the mega-ship terminal, forecast US mega berth requirements, labour and Customs issues for US ports. The full report is available on the Bureau of Transportation site: http://www.bts.gov.

Summary of Issues Raised:

US port officials stated that carriers do not pay their full share of port infrastructure improvements and ship owners do not typically consult with ports on long range planning for port infrastructure.

Trade growth projections forecast containerised growth for US ports at 6.0% p.a. and at 1.5% p.a. for Canadian ports. By 2010, experts predict that 90% of all liner freight will be shipped in containers. Every major container port is projected to triple its cargo by 2020. The US ports need to focus not only on technological developments to handle more traffic and larger ships, but also on improved labour agreements, operating procedures and administrative policies.

Portside infrastructure changes have been identified:

Each channel, berth, and turning basin must be at least 50 feet in depth

Large cranes are needed

Stronger wharves are needed to support more and heavier cranes, to accommodate the drafts as existing pilings could be undermined, to support more yard equipment and to support rail wagons.

In addition, peak container traffic will increase and the modal split that is used to transport this peak will have a profound effect on the design of the terminals.

Pacific Region:

By 2010, the West Coast could see as many as 46 megaships operating in the trans-Pacific service to Long Beach/Los Angeles, Seattle/Tacoma and possibly to Oakland and Portland if they can be dredged. These port representatives were mainly concerned with developing the ,most appropriate transport facilities. Cargo peaking, strategic trade corridors and integrated movements were key for them.

The 17 million people in Los Angeles determines that the San Pedro Bay ports of Los Angeles and Long Beach are the likely candidates for calls by the megaships. Growth in carrier business has had problems keeping up with demand for this region. Oakland's view is that it wants to keep up in terms of projected growth by attracting business as a transhipment port if it cannot handle the megaships.

Seattle has already proposed new container facilities and dredging, but many felt that the ports of Seattle, Tacoma and the entire Puget Sound need to be viewed as a single entity serving the northwest corridor. The ability to improve rail services in the area is a cause for concern and traffic often goes via Vancouver, as the Delta Terminal has rail connections across Canada to Chicago.

Water Depth and Throughput – Pacific Ports 1997

Port	Channel Depth	Berth Depth	1996 Throughput TEU
Anchorage	30 - 70	35	337,770
Vancouver	50	40 - 50	616,692
Seattle	175	40 - 50	1,473,561
Tacoma	40 - 50	40 - 50	1,073,471
Portland	40	40	302,171
Oakland	42	35 - 42	1,498,202
Los Angeles	45*	45	2,682,802
Long Beach	76	35 - 50	3,067,334
Honolulu	45	40	453,044

*50' project

Source: AAPA and Containerisation International

Gulf Region:

This has the smallest intermodal market base, but forecasts are for the strongest growth in containerised trade. The key market is the north/south corridor from the Gulf to Chicago to develop Central and South American plus Caribbean trade. If megaships do call in this region, there is not enough data on landside access, infrastructure or transhipment scenarios to gauge potential impact, but most felt that any megaships operating in this region would not target Houston, as a hub port or transhipment point but as a feeder port for inland access.

Water Depth and Throughput – Gulf Ports 1997

Port	Channel Depth	Berth Depth	1996 Throughput TEU
Houston	40*	38 - 40	794,481
Gulfport	36	36	153,470
New Orleans	36 - 45	35	261,007

*45' project

Source: AAPA and Containerisation International

North Atlantic Region:

For Baltimore and north, market analysts have forecast development of 7 or 8 megaship berths to serve the North Atlantic shipping lanes and the largest customer base in the country. Although the impact of the megaships on the East Coast is projected to be significantly less than on the West Coast, East Coast port capacity would be hard pressed to meet the traffic surges created by these ships. Even if the ships themselves don't call on the US ports on the North Atlantic coast, the view of the ports was that they would have to handle larger volumes anyway through transhipments because the region is such a large consumer market. Dredging is the paramount issue except for Baltimore. Not only is 50' the minimum, but several people felt that waves and water passing under the ship's keel creating wave damage to the channel would also be issues.

Water Depth and Throughput – North Atlantic Ports 1997

Port	Channel Depth	Berth Depth	1996 Throughput TEU
Montreal	36	35	852,530
Halifax	60	45 – 47	392,273
Boston	40	40	127,087
NY/NJ	40*	35 – 45	2,269,500
Philadelphia	40	40	95,086
Wilmington	38	38	162,884
Baltimore	50	36 – 42	474,816
Hampton Roads	50	32 - 45	1,141,357

*50' project

Source: AAPA and Containerisation International

South Atlantic Region:

Market projections forecast that growth in maritime trade could support 5 to 6 megaship berths to serve South Atlantic shipping lanes. Ports in this region noted that as markets move further west to India and China, gateways for intermodal freight traffic could move from the West Coast to the East Coast in response to rising costs at the Panama Canal, the current inability of post-Panamax vessels to transit the Canal and overland transit times to the East Coast. The Far East centre of manufacture has shifted from Japan and Korea to Singapore and could move to India or China in the future so an increased amount of traffic could move via the Suez Canal in the future. NOL have saved between 2 and 4 days using this route. In 1993 only 1.5% of US bound traffic went via the Suez Canal, by 1997 that had increased to 6%. However, there is insufficient back haul cargo for this route to overtake the West Coast route. Large scale transhipment ports that could handle megaships are being considered, such as Freeport, Kingston and Puerto Rico and the Panama ports. Freeport could be a good choice for a hub because it has sufficient harbour depth and labour costs are lower. Puerto Rico's San Juan has higher harbour costs and only 35' depth but could become a transhipment hub for US Gulf and Mexico.

Water Depth and Throughput – South Atlantic Ports 1997

Port	Channel Depth	Berth Depth	1996 Throughput TEU
Wilmington, NC	40	40	103,579
Charleston	42*	40	1,078,590
Savannah	42	42	650,253
Jacksonville	38	38	613,448
Palm Beach	33	33	174,870
Everglades	47	37 – 44	701,281
Miami	42	42	656,798
Freeport	47	47	New terminal
San Juan, Puerto Rico	35	35	1,640,624

*45' project

Source: AAPA and Containerisation International

Some of the port respondents questioned whether the trend would increase, saying that not all carriers are persuaded by the economies of scale and there are diseconomies for loading, unloading and accommodating the diverse range of cargoes to be carried by the ships. They saw three possible market scenarios:

Megaships with large concentrations of cargo

Fastship markets with smaller concentrations of time-sensitive cargoes

Major residual markets where service by medium to small ships would predominate.

There were also discussions about port capacity planning, highlighting that for US ports in general, reducing container dwell time by one half will increase terminal capacity two-fold. Container dwell time averages 6 to 8 days (in some places in the US it is 30 days) and in rail intermodal terminals it is 1.5 – 2 days. Virtually all participants agreed there is reserve capacity in US ports but it can not be tapped under existing operating practices nor is it necessarily compatible with the capacity of supporting landside networks. Ports that rely on road transport tend to have higher dwell times, and on dock rail facilities are important – a recent study found that simultaneous interchange between container ships and trains could achieve 30% cost savings.

There is a graph showing how the peak arrival of the mega ship then transfers to the rail peak and the road peak if wanted.

There are discussions in the report on the effect on the ports of:

Lack of public awareness of the importance of financing port projects

Container information systems

Data needs – difficulties for the ports in making projections for future trade flows

Labour and union issues and high overtime pay

Regulations, particularly for dredging and the taxes, which could be instrumental in diverting traffic to Canadian ports and an incentive for developing a Caribbean megaport to feed US ports

At the meetings, port representatives acknowledged the danger in thinking that if megaships are to be constructed they must automatically add infrastructure capacity to their port – they urged caution in investment, particularly for those ports which are likely to be feeder ports. Carriers were seen as being likely to narrow their choices to only two or three ports on each US coast.

Appendix IV

Cranes

The 186 container cranes on order at June 2000 set a world record for any period since the beginnings of containerisation. World Cargo News, the source of this data, believes that 2001 will also be a record year because of the number of cranes known to be in the pipeline. Most deliveries are planned for 2000-2001.

There are 46 super post-panamax and 64 large post-panamax cranes on order, which are analysed by port, number on order, waterside outreach, and rows of containers on board ships in the table below. The number of rows of containers is not perfectly related to the crane waterside outreach because of the situation at individual ports.

The 46 super post-panamax cranes should be added to the 17 already in place, located as follows:

Rotterdam	5
Yokohama	5
Algeciras	3
Oman	2
Halterm	2

Another 50-60 are expected to be ordered within the year to June 2001, including 12-15 for Maersk Sealand in Los Angeles, 12 for the new Hanjin terminal at Long Beach, 12-16 for CT9 in Hong Kong, and two for Felixstowe.

The largest cranes in existence or on order are the Noell cranes in Rotterdam, but these do not have the 23-wide capability of the ZPMC cranes planned for Oakland or the IHI cranes at Yokohama because they are set further from the quay – the standard ECT service road creates the requirement for an extra 10 m outreach.

The trolley speeds of the largest cranes are high, as would be expected, with most at 240 metres per minute. This compares with a typical 180 mpm for an 18 row crane.

The size of cranes ordered by ports is significant, particularly when they are ordered by shipping lines for their own dedicated terminals, because they reflect a consensus about containership row number for some time in the future. Cranes, which like ships are expected to have lives of 25 years or more, can be sold and moved to other ports, but this is not easy: cranes are significantly less mobile than ships and cannot be cascaded down to lesser trades with quite the same ease.

Nevertheless, although 22 rows is quite sufficient for some designs of 12,000 TEU vessel it is insufficient for the Malaccamax vessel, which demands 24 rows on deck. There is a design for a Malaccamax crane, from Huisman-Itrec, providing 64 moves per hour and therefore 360 moves per hour for a vessel serviced by six cranes. This is very fast. Ceres at Amsterdam has a target of 300 moves per hour with nine cranes.

At these speeds, there will be a problem for the yard in keeping up. Landside productivity is an issue. The US based company Robotics International has designed a $400 million machine which with computer control of all moving elements can support 60 crane moves per hour in a 50 acre yard – stacking terminals manage 25-30 moves per hour and require between 300 and 600p acres. Each machine can handle trucks per hour and trucks would be in the terminal for 23 minutes.

There are other solutions. But it is generally understood that disgorging ships of this size will be a major problem because of the land requirement and the constraints imposed by land transport modes.

Large and super post-panamax cranes on order

Super post-panamax			
Port	Number	Waterside outreach (m)	Rows
Oakland	6	65	23
Amsterdam	9	61	22
Bremerhaven	8	62	22
Hamburg	7	61	22
Ningbo	6	60	22
Port Said East	5	60	22
PA Jamaica	4	60	22
Hong Kong	1	60	22
Large post- panamax			
Port	Number	Waterside outreach (m)	Rows
Antwerp	10	56	21
Yantai	3	55	21
Jeddah	2	55	21
Southampton	2	53	20
Dalian	2	55	20
Qingdao	2	55	20
Sharjah	2	55	20
Kaifeng	2	56	20
Valencia	1	50	20
Vancouver	1	59	20
Newark	4	51	19
SAGT Sri Lanka	6	51	18
Damietta	4	50	18
Martinique	3	47	18
Le Havre	3	48	18
Busan	3	56	18
Aarhus	2	50	18
Bao Shan	2	50	18
Sepetiba	2	50	18
Tokyo	2	50	18
Tanjung Pelapas	2	53	18
Marseille	1	47	18
Jungonglu	1	48	18
Tacoma	1	50	18
Port Klang	1	51	18

Integration and Transition:
Scenarios for Location of Production and Trade in Europe*

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ABSTRACT
Applying a newly developed CGE-model, we present scenarios for the future economic geography of Europe. The model divides the world into ten regions, of which five are European, and there are 14 industries, of which 12 are imperfectly competitive. With a complete input-output structure, the model captures comparative advantage mechanisms as well as intra-industry trade and "new economic geography" agglomeration forces. The simulations focus on successful transformation in Eastern Europe, and on further European or global integration. The results indicate that both transformation and European integration are of great importance for Eastern Europe, while the effects for other European regions are moderate.

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1. Introduction

The purpose of this paper is – through model simulations – to assess the long-term production and trade effects of some of the most important current structural and trade policy changes in Europe. We focus on two sets of scenarios: Eastern European transformation, and further European or global integration. For each of the scenarios we look at several possible ways of specifying the "policy experiments". The purpose is to gain insights about how each one of these possible specifications may affect the pattern of production and trade in various regions in Europe.

While both economic integration and Eastern European transformation have been studied before[1], we believe our analysis has something to add. We apply a newly developed model that incorporates several features that have not been implemented in CGE-models before, and with a regional structure that allows us to identify effects for various parts of Europe. In particular, we include region-specific, complete input-output matrices. By modelling all intra- and inter-industry linkages in a setting with imperfect competition and trade costs, we are able to capture important agglomeration forces. Furthermore, the way we specify the scenarios differs from previous studies. In particular, for Eastern European transformation we include productivity and employment growth as well as closer market integration. The economic integration scenarios allow us to compare the effects of European and global liberalisation, and also to compare the effects of different types of policy changes.

The model is based on both traditional trade theory and more recent theory of international trade and economic geography. In this way it captures comparative advantage effects as well as agglomeration and clustering effects of structural changes or policy events. Five of the ten regions in the model are European ones. Hence, the model should be suitable for analysing regional development in Europe – where things like agglomeration effects and the centre-periphery dimension have been emphasised in the theoretical and applied literature, but so far not been implemented in a full-scale, data based general equilibrium model. Given the focus on European regional analysis, the model is called EURORA (European Regional Analysis).

[1] European integration has been studied in many model-based analyses, e.g. Gasiorek, Smith and Venables (1991, 1992), Haaland and Norman (1992, 1995), Baldwin, Forslid and Haaland (1996), Allen, Gasiorek and Smith (1998), Keuschnigg and Kohler (1996). For studies of Eastern European transformation and eastern enlargement of the EU, see e.g. Baldwin, Francois and Portes (1997) or Keuschnigg and Kohler (1998).

When studying the future economic geography in Europe, the development in Eastern Europe must be a central topic. Eastern Europe has experienced a number of very significant changes since 1989, both on the political and on the economic arena. However, we have not yet seen the longer-term effects of the economic reforms. What we have observed so far in most of the countries is more of the short-term adjustment problems than of the long-term possibilities. If the countries manage to come through the transition phase, the opportunities are there. They may experience productivity growth, and investment and employment booms. Should that happen, the economic conditions in these countries might change dramatically, with potentially significant implications for the transforming countries as well as for other countries or regions in Europe.

Another driving force for the development we have seen lately is the trend towards more integrated markets, both on a regional basis – like in the EU or NAFTA – and on the global arena. While regional policies and regionalisation were in the headlines in the beginning of the 1990s, globalisation has been more focussed on towards the end on the decade. In both cases, however, we have to do with movement towards freer trade in goods and factors – either within a region or globally. In this paper we study further European and global liberalisation, and we compare the importance of the two for different regions. In the European case we combine a deepening of integration in Western Europe and a widening of integration towards Eastern Europe. In the globalisation case we look at changes in both import barriers, export policies and transport costs. While further integration is not the only possible scenario when it comes to trade policies – the world has seen such processes being reversed before – it is clearly an interesting case to look at.

For both scenarios we study stylised characteristics rather than trying to assess the exact nature or magnitude of the exogenous changes. Hence, the results should be read as "what – if" type of experiments; not as complete scenarios for the future economic geography of Europe[2].

In the next section the model is sketched, while section 3 reviews some important aspects of the benchmark data. Section 4 contains the simulation results, while conclusions are given in the final section.

[2] In Forslid et al (1999) the approach is discussed in more detail. Alternative scenarios are also presented in that report – in particular there is a set of scenarios capturing important aspects of successful European or global environment policies.

2. The model

The model we apply has been developed to capture long-term changes in the economic geography, with a special emphasis on European issues. It is a general-equilibrium model of the world economy; there are ten regions in the model, of which five (or six, depending on how we count former Soviet Union) are European regions. The model is designed such that it builds on all parts of modern trade theory. Comparative advantages appear through differences in relative factor endowments and relative productivity between regions. Intra-industry trade follows from product differentiation, scale economies and imperfect competition, and agglomeration and "new economic geography" effects are captured through a combination of a complete input-output structure and imperfectly competitive industries with positive trade costs. Hence, it is a model with focus on fairly long-term structural changes, and it is unique in including all these theoretical channels. The basic model equations are given in Appendix A; in the present section we will only sketch some of the main features of the model. A complete description of the model is given in Forslid et al (1999).[3]

In each region in the model there are 14 production sectors; the regions and sectors are listed in the table below. There are three primary factors of production – capital, skilled labour and unskilled labour; these are mobile between industries within a region, but immobile between regions. The supply of the two types of labour is exogenously given; for capital the supply is endogenously determined from a steady state condition. The factor demand comes from the 14 producing sectors. In addition to the three mobile factors, two of the sectors – energy and agriculture –use sector-specific natural resources. Hence, these two sectors show decreasing returns to scale with respect to the mobile factors. These sectors (energy and agriculture) are modelled as perfectly competitive and with free trade[4].

[3] The model builds on Haaland and Norman (1992), but with significant differences. The regional set-up differs, and so does the input-output structure. Hence the present model is more suitable for economic geography issues. The model has similarities with a few other models, like e.g. the one applied in Baldwin et al (1997) but, again, the regional as well as the input-output structure is richer in the present model. The model sketched in Gasiorek and Venables (1998) captures economic geography effects in a similar way to the present model; however, their model is constructed for a different purpose; hence it is not comparable to what we are doing.

[4] The assumptions of perfect competition and free trade for these two sectors are not realistic ones; however, since the emphasis of the model is on manufacturing, we have kept the resource-based sectors as simple as possible. With perfect competition and homogenous products, the model will only determine the net trade position of a region, and that is why we do not include trade policies for these goods.

Regions and sectors in the model
(model name in parenthesis where necessary)

Regions	*Traded manufactures (imperf. comp., IRS, diff.prod.)*
Europe West (EuropeW)	Textiles
BeNeLux, France, Ireland, UK	Leather
Europe Central (EuropeC)	Wood and pulp products (Woodsprod)
Austria, Denmark, Germany, Switzerland	Metals
Europe South (EuropeS)	Minerals
Greece, Italy, Portugal, Spain	Chemicals
Europe North (EuropeN)	Food products (Foodprod)
Finland, Iceland, Norway,Sweden	Transport equipment (Transeq)
Europe East (EuropeE)	Machiny and equipment (Machines)
Bulgaria, Hungary, Czeck Rep., Poland,	Other manufacturing (Otherman)
Romania, Slovakia, Slovenia	*Non-traded services (imperf. comp., IRS, diff.prod.)*
Former Soviet Union (FormSov)	Public services (PubServ)
China and South Asia (CSAsia)	Private services (PrivServ)
South East Asia (SEAsia)	*Traded resources (perfect comp., free trade)*
USA and Canada (USACAN)	Agriculture (Agricult)
Rest of the World (RestofW)	Energy goods (Energy)

The remaining 12 sectors are all modelled with increasing returns to scale, imperfect competition and product differentiation. For the ten manufacturing sectors in the model, there are trade flows between all regions, but various types of trade costs hamper trade. The model includes both transport costs, import barriers and export taxes or subsidies, and all of these affect trade flows. The two imperfectly competitive services sectors in the model are assumed to be non-traded. Although trade in services is not negligible in reality, it is clear from the benchmark data that a very large share of the output from these sectors is sold in domestic markets.

One important feature of the model is the input-output linkages between sectors. There is a complete input-output system, and with trade costs and imperfect competition we know that this could cause agglomeration through backward and forward linkages (see e.g. Venables, 1996). The data reveals a clear pattern of these linkages: for most industries inputs from own industry dominate, with inputs from the services industries as number two. Hence, the non-traded nature of the services industries as well as the trade costs for manufactures are potential sources of agglomeration in this model.

In each of the differentiated goods industries there is assumed to be Chamberlinean monopolistic competition with free entry and exit of firms. Hence, prices will be a mark-up over marginal costs; the mark-up depending on the elasticity of substitution between varieties. There are increasing returns to scale, and the

The model includes production subsidies in agriculture and energy; however, in the scenarios presented number of firms in an industry in a region is determined from a zero-profit condition. For the differentiated manufactures, there is demand for each variety in every region; the demand parameters are calibrated based on the benchmark data. Demand for every variety in a region depends on the overall general equilibrium conditions in that region and on the prices and trade costs between regions. Sales within a region are considered as domestic sales with no trade costs; for sales across regional borders, trade and transport costs apply, as mentioned above. The real transport costs are modelled as iceberg costs, while the tariff equivalents of import barriers appear as transfers (to the representative consumer) in the importing country. Export taxes (or subsidies) are transfers in the exporting country.

3. The benchmark situation

In this section we briefly review some key characteristics of production and trade for the regions we focus on. Forslid et al (1999) present the data base and data sources for the model in more detail – in the present section we only focus on characteristics that are important when it comes to understanding the scenarios we analyse later on.

Table 1. Key characteristics - base case

	The region's share (percent) of				
	World GDP	*World manufaturing*		*World production of*	
		exports	*imports*	*energy*	*agriculture*
EuropeW	12.09	17.65	17.70	12.52	8.71
EuropeC	11.75	18.50	17.88	7.09	3.54
EuropeS	8.27	8.84	8.80	7.34	6.05
EuropeN	1.96	3.51	3.45	2.16	1.69
EuropeE	0.89	2.06	2.78	1.53	2.57
FormSOV	2.21	0.78	0.78	3.79	2.11
CSAsia	3.17	4.39	4.37	3.12	17.07
SEAsia	20.27	20.80	20.80	12.94	18.31
USACAN	27.71	15.74	15.75	20.46	16.07
RestofW	11.67	7.73	7.69	29.05	23.87

Table 1 shows some key characteristics. First, it is important to notice the significant differences in size between the regions[5]. In particular when we analyse the effects of successful transformation in Eastern Europe and Former Soviet Union, it should be

in this paper, these policies are kept unaltered.

[5] The benchmark data set is constructed using the GTAP database (versions 3 and 4), EUROSTAT (input-output tables and REGIO) and NBER World Trade Database. With 1992 as the benchmark year, GTAP ver.3 is used for the non-EU regions, while the other sources are used to construct the database for the four Western European regions in the model. GTAP ver.4 is used for some of the share data (e.g. the split in skilled and unskilled labour) and for transport costs. The data we present in

remembered that in economic terms these regions are very small. Secondly, trade is more important for the European regions than for the other ones[6]; in part this reflects the close integration within Europe, but it should be observed that trade flows are relatively important for Europe East as well. Finally, the table shows that the regions differ significantly when it comes to relative importance of the resource-based industries. In particular, for Europe East, former Soviet Union, China and South Asia, and the rest of the world, the shares of energy and/or agriculture production are higher than these regions' overall shares of global GDP. When looking at simulation results, these differences are important to keep in mind.

Next we focus on manufacturing. Table 2 shows the pattern of specialisation as measured by the Hoover localisation quotient; for each industry in a region, the number shows the region's share of global production (measured by value added) in this industry relative to the region's overall share of manufacturing value added. Hence, a number greater than one indicates that this industry is of more than average importance for the region.

Table 2. The pattern of manufacturing specialisation
(Share of the industry's value added relative to share of total manufacturing value added)

	EuropeW	EuropeC	EuropeS	EuropeN	EuropeE	FormSOV	CSAsia	SEAsia	USACAN	RestofW
Textiles	0.78	0.58	1.61	0.53	1.59	0.73	2.51	0.86	0.78	1.71
Leather	0.88	0.56	3.15	0.72	2.75	0.22	2.17	0.86	0.34	1.68
WoodProd	1.06	0.91	0.67	1.63	1.03	1.12	0.48	0.84	1.25	0.91
Metals	0.96	1.05	1.15	1.19	1.16	1.04	0.82	1.07	0.90	0.95
Minerals	0.92	0.70	1.17	1.06	1.57	1.52	1.87	0.92	0.74	1.67
Chemical	1.06	0.98	0.92	0.83	0.89	0.88	0.84	0.97	1.06	1.05
FoodProd	1.08	0.81	1.13	0.89	1.31	1.13	0.92	0.94	0.84	1.57
TransEq	1.15	1.32	0.84	0.84	0.47	1.09	0.38	0.87	1.23	0.61
Machines	0.95	1.18	0.74	1.01	0.60	0.90	0.70	1.22	1.10	0.44
OtherMan	0.96	1.48	0.54	0.64	0.91	0.73	3.74	0.95	0.66	1.01

The pattern of specialisation is, to a large extent, as we should expect. The big, advanced regions like Europe Central and West, USA and Canada and South East Asia have more than average production of what we could call skill-intensive products (transport equipment, machines). Labour intensive products (textiles and leather) are more important in the smaller, poorer regions like Europe East and China and South Asia, but also in Europe South. Europe East is also fairly specialised in energy- and natural resource-intensive industries, like metals, minerals and food

this section are from the constructed benchmark; hence, the actual observations and characteristics may differ somewhat from similar numbers from other data sources.

[6] The table only reports trade between the regions; in addition there may be significant trade flows between the countries within each region.

products. A similar pattern appears for Europe North, with a specialisation in wood products and metals.

Finally, the geographical pattern of trade will be reviewed. Table 3 shows the geographical distribution of manufacturing sales from each region. A couple of observations are due. First, the home market dominance is very clear in all regions, but less so in Europe than in the other regions. The explanation for this is, however, obvious; Europe is split into five regions with close ties between them. Second, geographical closeness seems to matter; Europe Central has strong trade links to the other European regions. In Asia, South East Asia is the most important trading partner for China and South Asia. Thirdly, the strong trade links between Europe East and Europe Central should be noticed; Europe Central is by far the most important market for exports from Europe East, and it is also the most important supplier of imports to Europe East[7]. This pattern is of great importance when it comes to understanding some of the simulation results.

Table 3. Distribution (percent) of total sales of manufactures from the region

Sales to / *From*	EuropeW	EuropeC	EuropeS	EuropeN	EuropeE	FormSOV	CSAsia	SEAsia	USACAN	RestofW
EuropeW	69.3	11.2	6.9	1.4	0.5	0.3	0.5	2.5	3.6	3.7
EuropeC	11.9	71.3	5.5	1.9	1.4	0.6	0.4	2.4	2.5	1.9
EuropeS	8.1	7.0	78.0	0.6	0.6	0.4	0.2	1.3	1.8	2.1
EuropeN	8.6	7.9	2.7	73.5	0.5	0.5	0.4	1.8	2.6	1.4
EuropeE	3.6	10.5	3.6	1.0	74.8	1.2	0.6	0.9	0.8	3.1
FormSOV	0.7	0.9	0.5	0.4	0.5	94.3	1.3	0.7	0.3	0.5
CSAsia	1.1	0.9	0.5	0.1	0.1	0.6	82.0	7.2	4.7	2.9
SEAsia	1.3	1.2	0.5	0.2	0.1	0.1	1.6	87.5	5.3	2.3
USACAN	1.8	0.9	0.5	0.2	0.1	0.1	0.4	3.1	89.4	3.5
RestofW	1.4	0.9	0.8	0.1	0.2	0.1	0.5	2.2	4.1	89.8

Forslid et al (1999) give a more detailed description of the benchmark data, including a discussion of the initial trade and transportation costs, which are based on GTAP data. There are significant differences in trade barriers and export subsidies between sectors, with agriculture and food products at the top. As our model is not constructed to analyse agricultural issues, we do not treat trade policies in agriculture in detail. The trade costs in food products, on the other hand, might have a significant influence on the model simulations. There are also important differences between the regions when it comes to trade barriers; as expected, barriers between Western European countries (the EU and EEA countries) are low, while trade barriers and export subsidies between east and west in Europe are more important. Import barriers are significant for most products in the Asia regions and also in the rest of the world.

And for a few products, export subsidies may be of some importance; in particular, there are export subsidies on several important export goods from Europe North, according to the GTAP data.

4. Model simulations

We will look at two main scenarios: i) Eastern European transformation, and ii) European and global integration. Within each of these, a number of different cases will be presented, representing various possible assumptions linked to the broad topic of the scenario in question. It should be emphasised at the outset that these scenarios are not meant to be predictions or forecasts of the actual development; they should be looked at as illustrations of possible consequences of a set of assumptions making up the complete scenario. The assumptions we make in each case are not even meant to be best guesses of the actual, future development; they are just illustrative, to show what the consequences of certain exogenous changes may be. The types of changes we look at are, however, meant to capture some important features of the cases we study.

4. 1 Eastern European Transformation

In this section we focus on Eastern Europe and Former Soviet Union. The aim is to get an impression of what the consequences for trade and development in Europe may be, should the regions manage to transform into well-functioning market economies.

A "successful transformation" of the Eastern European economies includes many things. It is a change from the old command economy to a market system, and it is a change towards freer trade relations and maybe new trade partners. It includes a restructuring of industry and changes in the pattern of production and consumption. It implies an improvement in resource allocation and better investment and employment opportunities, and, ultimately, increased income and welfare. In a general equilibrium model some of these implications appear as endogenous equilibrium effects, while others must be specified as exogenous changes. The model cannot capture the transformation from non-market to market economy endogenously, nor can it tell us how unemployment will develop. But it can help us understand what the consequences for production, trade and welfare may be of various possible scenarios.

[7] See Forslid et al (1999) for a similar distribution from the demand side.

We will look at three "stylised stages" of successful transformation in this section, first for Europe East alone, and then for the former Soviet Union in addition.

The first case is one in which we look at the consequences of improved productivity in all sectors in the relevant region. There are a number of reasons why we should expect such productivity improvements: transformation to market economies implies more efficient organisation of production, more cost-efficient production and more competition in goods and factor markets, both within each country and between the countries in the model regions. All of these changes within an industry will appear as more efficient production for the industry as a whole. In our stylised case we analyse the general equilibrium consequences of an exogenously given five percent Hick-neutral productivity improvement in all industries in the region in question. In reality, there will, of course, be differences between industries; some may experience huge improvements, while for others the scope for improvements is less. Such differences would reinforce the structural changes we get, but lack of information about individual industries prevents us from modelling the sector-specific variation.

Our second case focuses on investments. It is widely assumed that successful transformation would imply a better investment climate in Eastern Europe. While the combination of low production costs and closeness to the big European markets may already give high expected rates of returns to investments in Eastern Europe, uncertainties regarding the general development have so far dampened the actual willingness to invest. In this scenario we lower the required risk premium for investments in Europe East (and Former Soviet Union in the subsequent cases), to reflect the improved confidence following a successful transformation. In the model aggregate investments in a region are determined from a steady state condition such that investments will grow until the marginal rate of return is equal to the steady state required rate. Improved profitability in an industry, e.g. due to changing market conditions or better productivity, implies more investments, and vice versa. Similarly, reduced uncertainties and hence lower required rate of return imply more aggregate investments. It is, however, more difficult to know in which industries the investments will appear. That depends on the relative profitability of various industries, which is one of the endogenously determined results in our simulations. Hence, one interesting feature is where investments will take place, given that the overall investment climate improves.

Thirdly, it is not unlikely that successful transformation also implies reduced unemployment by generating new employment opportunities. We do not attempt to determine endogenously how important such new employment will be; we simply assume aggregate employment to grow by five percent, and focus on the consequences.

Previous analyses, in particular Baldwin et al (1997) and Keuschnigg and Kohler (1998), have focused on market access and EU enlargement; hence, trade liberalisation has been the key aspect. However, they include reduced risk premium as part of the enlargement process. We will look at trade policies in the next section, but before we do that, we believe it is important to get a grasp on to which extent the transformation process itself may affect European markets. Our specification of efficiency gains in terms of productivity improvements, as well as the employment growth, should capture some of the potential growth effects of successful transformation in Eastern Europe. By feeding these into the CGE-model we get an assessment of how strong the "multiplier" effects may be in the transforming regions and of how such successful transformation may affect the economic situation in the rest of Europe and the world. Liberalisation and European integration may be a prerequisite for the transformation to be successful; we will, however, come back to the explicit effects of liberalisation in the next section.

Results

Table 4 shows the real income effects for all the regions for the cases sketched above. The specific model experiments are: i) five percent Hick-neutral productivity improvement in all sectors in the region; ii) the above plus five percent reduced risk premium, and iii) the above two plus five percent increase in the employment of both skilled and unskilled labour. Six cases are presented: in the first three cases exogenous changes only take place in Europe East, in the following three cases, changes take place in former Soviet Union as well, with the assumptions for Europe East remaining as in case 3.

The table reveals that the changes are of great importance for the regions themselves, while the consequences for other regions are small. When a five percent productivity improvement results in 15 percent real GDP growth for Eastern Europe, there are three important mechanisms: first, the direct production effects of higher productivity; secondly, the implied improvements in competitiveness, and thirdly, induced investment growth. Similar effects appear in the other cases. In the case of Europe East, investments grow by approximately 15 percent in the productivity case, and by another 10 percent (relative to the benchmark data) when the risk premium is reduced. Hence, the induced investment effects through the steady-state condition play an important role for the results. The fact that the model includes pecuniary externalities through forward and backward linkages is also important; these agglomeration forces will typically reinforce the welfare effects of the initial shifts towards growth in manufacturing production. Although it is difficult to compare with previous studies, since the model experiments differ, the results tend to indicate that we get relatively strong welfare gains. To take only one example, the reduced risk premium case is similar to a case studied in Baldwin et al (1997), and when comparing the results, the welfare gains we get are approximately twice as high as in their results.

Table 4. Real income effects of changes in Eastern Europe and former Soviet Union
(Percent change in real GDP from base case)

	Europe East			Europe East & Former Soviet Union		
	Productivity improvement +	*Lower risk premium* +	*Increased employment*	*Productivity improvement* +	*Lower risk premium* +	*Increased employment*
EuropeW	0.03	0.04	0.06	0.04	0.04	0.03
EuropeC	-0.12	-0.15	-0.22	-0.22	-0.22	-0.22
EuropeS	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05
EuropeN	-0.05	-0.07	-0.11	-0.12	-0.13	-0.13
EuropeE	15.88	21.16	33.26	33.05	32.97	32.83
FormSOV	-0.01	-0.01	-0.02	12.50	16.83	25.84
CSAsia	-0.13	-0.17	-0.25	-0.40	-0.45	-0.56
SEAsia	0.01	0.01	0.01	-0.01	-0.03	-0.03
USACAN	0.00	0.00	0.00	0.00	0.00	0.00
RestofW	-0.04	-0.07	-0.10	-0.14	-0.18	-0.19

For the trading partners, there are two opposing forces affecting production; they lose in competitiveness relative to Eastern Europe, but on the other hand, increased demand in Eastern Europe could lead to more exports. In addition consumers are affected through lower import prices. The most important trading partner for Europe East is Europe Central, and the table shows that the negative effects through competitiveness dominate. Among the remaining regions, it is worth noticing that China and South Asia lose both from changes in Eastern Europe and in the former Soviet Union. The reason in this case is not the direct trade relations between the regions; it must be a terms-of-trade loss for CSAsia because the transforming regions expand production in industries that are export sectors for CSAsia.

In table 5 the aggregate trade effects are shown. As indicated above, Europe Central – as the most important trading partner for Europe East – is most severely hit on the export side, but there are also significant effects for Europe North. For the other regions the trade effects are more moderate. It is worth noticing that imports to Europe East actually decline in these cases; hence the competition effect dominates over the income effect. As the trade balance for each region is kept unaltered in all scenarios, the counterpart of this pattern of changes in manufactures must be opposite changes in net exports from the perfectly competitive sectors (agriculture and energy). For Europe East that means increased demand for imports of both agricultural and energy products in these scenarios. It should also be noticed that changes in the former Soviet Union have only minor effects on the other regions; this is a consequence of the initial trade pattern (see table 3) where the trade flows between Former Soviet Union and other regions are insignificant. The export growth from Former Soviet Union is also much more moderate than for Europe East.

Table 5. Changes in the value of manufacturing trade

Table 5a. Total value of manufacturing exports (percent change from base case)

	Europe East			Europe East & Former Soviet Union		
	Productivity improvement +	*Lower risk premium +*	*Increased employment*	*Productivity improvement +*	*Lower risk premium +*	*Increased employment*
EuropeW	0.3	0.4	0.6	0.6	0.6	0.6
EuropeC	-3.3	-4.2	-6.3	-6.2	-6.1	-6.1
EuropeS	-0.4	-0.5	-0.8	-0.7	-0.7	-0.7
EuropeN	-1.6	-2.1	-3.2	-3.2	-3.2	-3.2
EuropeE	34.9	45.8	73.6	72.3	72.0	71.0
FormSOV	-0.5	-0.6	-1.0	9.5	13.1	20.4
CSAsia	-0.4	-0.6	-0.8	-1.2	-1.3	-1.6
SEAsia	0.1	0.1	0.1	0.2	0.2	0.2
USACAN	0.1	0.1	0.1	0.2	0.3	0.3
RestofW	-0.4	-0.5	-0.8	-0.8	-0.7	-0.7

Table 5b. Total value of manufacturing imports (percent change from base case)

	Europe East			Europe East & Former Soviet Union		
	Productivity improvement +	*Lower risk premium +*	*Increased employment*	*Productivity improvement +*	*Lower risk premium +*	*Increased employment*
EuropeW	-1.0	-1.2	-1.7	-1.6	-1.6	-1.6
EuropeC	1.8	2.4	3.9	3.9	3.9	4.0
EuropeS	-0.2	-0.2	-0.1	-0.1	0.0	0.0
EuropeN	0.0	0.1	0.3	0.4	0.5	0.6
EuropeE	-1.9	-2.4	-3.6	-3.1	-3.0	-2.7
FormSOV	1.7	2.2	3.8	3.6	3.7	3.5
CSAsia	0.2	0.3	0.6	1.0	1.1	1.4
SEAsia	-0.3	-0.4	-0.6	-0.5	-0.5	-0.5
USACAN	-0.3	-0.3	-0.5	-0.5	-0.5	-0.5
RestofW	0.3	0.4	0.7	0.8	0.8	0.8

Finally, we will focus on the sectoral effects of successful transformation. While production of all goods in all regions is affected by the changes, it should be clear from the above that the effects are very moderate in most regions. Table 6 shows the production effects in Europe East and Former Soviet Union, respectively, following the region's own transformation, while table 7 gives the production effects in the other regions in one of the cases – the one with all changes taking place in Europe East. It is clear from the results that the former Soviet Union reforms hardly have any effects at all on production and trade for the other regions.

When studying the production effects in table 6, we should distinguish between three groups of industries. Public and private services are non-traded. Hence, these develop in accordance with domestic demand; however, since we have a full input-output structure in the model, and since private services is an important input in most other industries, the strong growth in production of private services reflects to some extent such linkages. Secondly, energy and agriculture are treated as perfectly competitive sectors in the model; hence, these are fairly flexible, and will to a large extent serve as residuals. Should other sectors be profitable enough to expand beyond the possibilities made available by increased productivity and new investments and labour, the resources will have to be taken from the perfectly competitive sectors. It is interesting to note that for Europe East, the growth impetus to other sectors is very strong, since significant resources are drawn out of agriculture and energy production in that region, while in former Soviet Union that is not the case. The difference must be due to different trade and competition relations with other countries. Fairly open economies can use international markets and specialise; fairly closed economies cannot specialise in a similar way. Our results indicate that Europe East is in the former category while Former Soviet Union is not. This is also in accordance with the benchmark data presented in table 3.

Thirdly, there are ten traded, manufacturing goods. This is where the large changes take place, and given that the initial "shocks" in terms of productivity improvements and additional resources are neutral between the sectors, it is interesting to see the significant differences in production effects. Labour-intensive sectors like textiles and leather grow significantly both in Europe East and in the former Soviet Union, but the most surprising effect in the table is the strong growth in production of transport equipment and machines in Europe East. These results indicate that with a successful transformation the region may become very competitive in such sectors – both productivity, investment climate and increased employment contribute to these effects. For former Soviet Union there is not a similar indication of potential competitiveness in such skill-intensive sectors.

Table 6. Production effects in EuropeE and FormSov from the region's own changes
(Percent change from base case)

	Europe East			Former Soviet Union		
	Productivity improvement +	*Lower risk premium +*	*Increased employment*	*Productivity improvement +*	*Lower risk premium +*	*Increased employment*
PubServ	9	12	19	8	11	17
PrivServ	12	17	25	10	14	21
Textiles	29	38	59	13	18	28
Leather	22	29	45	31	42	64
WoodProd	16	22	33	10	13	20
Metals	25	33	49	10	13	20
Minerals	18	24	37	9	13	20
Chemical	19	25	38	9	13	19
FoodProd	15	20	33	12	16	24
TransEq	75	97	148	10	14	23
Machines	37	49	74	11	15	23
OtherMan	20	26	40	12	16	25
Agriculture	-11	-16	-23	2	-1	2
Energy	-9	-9	-20	14	21	28

Table 7 shows that among the other regions the production effects are strongest for Europe Central, which is also the most important trading partner for Europe East. In terms of industries, the labour-intensive ones are most severely hit in Europe Central, while the skill-intensive ones also see significant negative effects. For Europe North the strong negative effects in the production of transport equipment should be noticed. The same also applies for China and South Asia. In addition to motor vehicles, things like shipbuilding may play an important role here. Apart from these examples, the table reveals that the production effects in most sectors in most regions are insignificant.

To summarise, we can conclude that successful reforms and transformation in Eastern Europe and former Soviet Union are of huge importance for the economic development in these regions, and that we may see significant changes in the pattern of specialisation and trade in these regions. However, in economic terms both regions are too small to matter very much for the overall production and welfare elsewhere. Even for Europe Central, where some sectors may see successful transformation in Eastern Europe as a threat, the overall effects, in terms of real GDP, are modest, as shown in table 4 above.

Table 7. Production effects in other regions of successful transformation in Eastern Europe
(Percent change from base case)

	EuropeW	EuropeC	EuropeS	EuropeN	CSAsia	SEAsia	USACAN	RestofW
PubServ	0.0	0.1	0.0	0.0	-0.2	0.0	0.0	0.0
PrivServ	0.0	0.0	0.0	-0.1	-0.3	0.0	0.0	-0.1
Textiles	3.8	-17.1	0.0	1.5	-0.5	0.1	0.0	-0.4
Leather	1.0	-10.9	-1.7	0.4	-1.9	0.4	1.2	-0.2
WoodProd	0.1	-1.1	-0.6	-0.7	-0.4	0.0	0.0	-0.4
Metals	0.3	-2.7	-0.8	-1.5	-1.1	0.0	0.1	-1.1
Minerals	-0.1	-0.8	-0.5	-0.3	-0.4	0.0	0.0	-0.5
Chemical	0.1	-1.2	-0.5	-0.3	-0.5	0.0	0.0	-0.4
FoodProd	-0.1	0.0	-0.1	-0.1	-0.2	0.0	0.0	-0.2
TransEq	-0.3	-3.1	-0.8	-11.6	-4.1	0.2	0.2	-1.4
Machines	0.6	-2.0	-0.5	-0.7	-1.0	0.1	0.1	-1.2
OtherMan	0.1	-0.2	-0.9	-0.4	-0.5	0.0	0.1	-0.4
Agriculture	-1.6	27.8	1.7	5.6	0.3	-0.1	-0.3	0.6
Energy	-0.6	9.1	1.2	2.5	0.0	-0.4	-0.2	0.2

4.2 European and global integration

In this section we will focus on trade policies. While a number of trade policy scenarios could be interesting to study, we stick to some "stylised" and fairly neutral cases in this paper. We concentrate on further liberalisation both within Europe and globally, and we do not attempt to distinguish between the manufacturing sectors when it comes to the strength of the policy experiments. Hence, what we study in this section are the effects of general liberalisation and integration, first in Europe and then world-wide.

In the model trade and transaction costs for manufacturing goods appear through three parameters: import barriers (tariffs and tariff equivalents of non-tariff barriers), export subsidies (or taxes), and transport costs. In the scenarios in this section we study fairly moderate reductions in all of these; first for trade within Europe only, and then globally. In all cases we look at a five percent reduction in the relevant trade cost; in the European integration cases, there is thus a five percent reduction in tariffs and NTBs, export subsidies and transport costs between Europe West, Central, South, North and East. In the global cases, similar reductions are assumed for trade between all regions. Although we have no particular reason to believe that future liberalisation will be of this magnitude or implemented in such a neutral way, the results should help us understand what type of effects we should expect from further integration. It should, however, be noticed that the exact specification of the liberalisation may be of importance for the results. A proportional reduction in all trade costs implies that the absolute changes in trade costs vary between sectors and regions, depending on the initial pattern of the trade costs.

Hence, the effects of proportional reduction of the type we study, may differ from the effects one would get from other liberalisation schemes – e.g. similar absolute reductions in trade costs in all sectors and regions.

It is also worth noticing that we allow for reductions in all elements of the trade costs. Hence, not only trade policies are altered; we also assume real transport costs to go down. This could either be due to more efficient supply of transport services, or it could stem from closer market integration, with e.g. lower technical barriers to trade. The analysis allows us to distinguish the relative importance of each one of the three elements of trade cost reductions.

Results

Table 8 shows the overall impact of the various stages of integration for each region, as measured by the percentage change in real GDP. The table reveals that the impact of further European integration as specified here, is fairly moderate on average; for Eastern Europe, however, freer trade and closer integration is very important. This is in line with what one should expect; we have already seen substantial steps towards integrated markets in the EU and EEA regions, while eastern enlargement is still to come. Hence the remaining trade barriers within Western Europe are moderate. Between east and west, on the other hand, there are significant remaining trade costs, so that the absolute effects of the five percent reductions are more pronounced with accompanying strong real income effects for Europe East[8]. From the discussion above we know that differences in size and economic importance are such that even strong growth in trade between east and west in Europe will only have a minor impact on the overall situation in the west. It is, however, interesting to notice that global liberalisation will also add significantly to the gains for Eastern Europe.

Global liberalisation turns out to have a significant, positive effect for the two Asian regions, though for China and South Asia the positive impact depends on the type of policy changes. Removing import barriers alone does not yield gains for that region. It is further interesting to notice that for Europe West global integration seems to be more important than further European integration. The reason may be found in the initial trade barriers and the trade pattern. Table 3 shows that trade flows

[8] In fact, the welfare gains from liberalisation for Eastern Europe may well be stronger than these results indicate. Baldwin (1994) emphasises the importance of liberalising east-east trade as well as

with non-European regions are more important for Europe West than for the rest of Europe. And since trade with other Western European countries is already free in the benchmark data, global liberalisation matters more. World-wide, the gains from global liberalisation of approximately half a percent may seem modest; however, it should be remembered that we look at fairly small policy changes here, with only five percent reductions in trade and transportation costs. Historically, we have seen much stronger reductions in transaction costs.

Table 8. Real income effects of European and global integration
(Percent change in real GDP from base case)

	European integration			Global integration		
	imp.barr.	*+exp.subs.*	*+trans.cost*	*imp. barr.*	*+exp.subs.*	*+trans.cost*
EuropeW	0.03	0.07	0.17	0.59	0.53	0.58
EuropeC	-0.02	-0.08	-0.10	-0.24	-0.27	-0.29
EuropeS	0.01	0.01	0.06	0.08	0.09	0.09
EuropeN	0.08	0.07	0.11	0.15	0.17	0.18
EuropeE	1.15	2.56	3.33	4.61	5.09	5.30
FormSov	0.00	0.00	0.00	0.06	0.08	0.08
CSAsia	-0.04	-0.05	-0.14	-0.62	0.72	1.61
SEAsia	0.00	0.01	-0.01	1.10	1.39	1.53
USACAN	0.00	0.00	0.00	0.07	0.09	0.13
RestofW	0.00	0.01	-0.01	-0.36	-0.22	-0.18
All regions	*0.01*	*0.02*	*0.04*	*0.27*	*0.39*	*0.47*

The aggregate trade implications of integration are shown in table 9. The following should be observed: First, export growth is strong for the regions that according to table 8 are to gain most from integration, i.e. for Europe East and the Asian regions. Secondly, Europe Central – a region that actually loses from integration – experiences reductions in exports and growth in imports of manufacturing. This strong correlation between welfare gains and exports of manufactures calls for an explanation, as such a result would not appear in traditional trade models. However, our model differs from traditional comparative advantage models in many ways; in particular, there are pecuniary externalities in manufacturing production. Hence, there are self-reinforcing growth effects in manufacturing production, which could give rise to cost advantages and the type of correlation we observe between manufacturing exports and welfare in the simulations. Put differently, we get "externality shifting" effects of trade policies – regions that get more of the industries with pecuniary externalities gain, while other regions may lose.

east-west trade. In our simulation, east-east trade is already free, since this is trade within a region in the model.

Although our simulations do not cover agricultural policies, the implications for agricultural markets in Europe may be of interest. The strong growth impetus to manufacturing sectors in Europe East in these scenarios actually implies increased demand for imports of agricultural products to the region. In a more complete scenario the overall effects for agriculture will, of course, depend on the direct effects of changing agricultural policies and on the implied effects of liberalising other sectors. Our analysis only includes the latter effect. However, the results indicate that the "conventional wisdom" of an expected strong growth of exports of farm products from east to west following European integration, is not necessarily true.

Table 9. Changes in the value of manufacturing trade

Table 9a. Total value of manufacturing exports (percent change from base case)

	European integration			Global integration		
	imp.barr.	*+exp.subs.*	*+trans.cost*	*imp. barr.*	*+exp.subs.*	*+trans.cost*
EuropeW	1.0	1.0	2.5	8.4	6.3	7.1
EuropeC	-0.5	-2.6	-3.0	-7.2	-9.2	-10.0
EuropeS	0.3	0.1	1.6	1.2	0.7	0.9
EuropeN	1.1	-3.7	-2.6	-2.7	-3.4	-3.2
EuropeE	10.0	22.1	28.7	38.8	42.9	44.8
FormSov	-0.2	-0.2	-0.4	2.0	3.4	4.8
CSAsia	-0.3	-0.3	-0.9	7.7	15.2	22.3
SEAsia	0.0	0.0	-0.2	10.1	13.7	15.9
USACAN	0.0	0.0	-0.1	0.4	-1.0	-0.1
RestofW	-0.2	-0.2	-0.4	-1.6	0.7	2.3

Table 9b. Total value of manufacturing imports (percent change from base case)

	European integration			Global integration		
	imp.barr.	*+exp.subs.*	*+trans.cost*	*imp. barr.*	*+exp.subs.*	*+trans.cost*
EuropeW	0.1	-1.0	-0.7	-2.6	-2.4	-2.4
EuropeC	1.3	1.7	3.4	6.4	7.0	7.8
EuropeS	1.0	0.1	1.0	1.7	1.2	1.5
EuropeN	0.5	-0.1	0.6	0.8	0.2	0.4
EuropeE	0.5	-1.7	-1.7	-3.3	-4.5	-4.6
FormSov	0.1	0.1	0.0	1.4	-1.1	1.2
CSAsia	0.0	0.0	0.0	13.0	13.4	15.1
SEAsia	-0.1	-0.3	-0.3	1.0	0.5	2.5
USACAN	-0.1	-0.2	-0.2	5.5	8.1	10.0
RestofW	0.0	0.0	0.1	6.8	6.1	7.8

Finally, the different effects of global integration for Europe Central and West may be surprising. For Europe West exports increase while imports go down as a consequence of global integration, which is the opposite of the effects for Europe Central. The reasons for this could – as mentioned above –have to do with the trade pattern, and the initial pattern of trade barriers and trade costs. Finally, it should be noted that for China and South Asia, reduction of import barriers implies more growth in imports than in exports of manufactures. This reflects the fact that this region has a fairly strong degree of import protection at the outset.

Table 10. Changes in exports

(Percent changes in exported quantities from base case)

Table 10a. European integration (reduced import barriers, export subsidies and transport costs)

	Textiles	Leather	Woodpr.	Metals	Minerals	Chemicals	Foodpr.	Transeq	Machines	Otherman
EuropeW	9.6	1.1	2.4	1.1	2.5	1.4	5.7	0.2	0.8	1.5
EuropeC	-28.6	-8.4	2.3	0.5	2.6	-0.7	5.6	0.0	0.6	1.5
EuropeS	4.3	4.0	1.8	0.6	3.1	0.3	3.7	-0.1	0.1	2.2
EuropeN	5.7	0.7	-11.0	2.1	2.5	2.0	10.7	-0.4	0.3	0.8
EuropeE	93.0	21.6	6.9	7.6	9.4	10.0	18.5	19.1	3.4	8.0
FormSov	-2.3	0.0	0.6	-0.3	-0.5	-0.3	-0.5	-0.5	-0.2	-0.8
CSAsia	-0.8	-3.3	-0.2	-0.3	-0.2	-0.3	-0.3	-0.7	-0.3	-0.4
SEAsia	-0.3	-0.1	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.3
USACAN	-0.2	2.1	0.0	-0.1	-0.1	-0.1	-0.2	-0.1	-0.1	-0.2
RestofW	-1.2	-0.5	-0.1	-0.2	-0.1	-0.2	-0.4	-0.3	-0.2	-0.6

Table 10b. Global integration (reduced import barriers, export subsidies and transport costs)

	Textiles	Leather	Woodpr.	Metals	Minerals	Chemicals	Foodpr.	Transeq	Machines	Otherman
EuropeW	11.1	3.7	4.4	5.7	5.0	3.0	4.6	7.7	4.3	16.1
EuropeC	-61.1	-22.6	2.6	-0.3	4.5	-1.3	5.6	-3.8	-0.8	-1.4
EuropeS	6.2	3.2	2.8	1.0	5.7	0.5	2.3	-2.9	-0.4	-1.0
EuropeN	4.7	0.0	-11.8	2.4	3.5	2.5	13.6	-1.6	0.4	-1.0
EuropeE	130.6	25.3	11.4	13.6	14.5	14.9	30.3	32.3	9.3	11.1
FormSov	17.4	-69.2	7.8	3.2	27.6	3.0	21.1	2.8	2.5	-1.0
CSAsia	13.2	150.4	2.2	0.3	5.3	3.5	16.6	-4.2	-3.8	-2.1
SEAsia	54.1	-6.5	7.9	7.0	9.2	5.8	14.9	6.8	9.1	14.7
USACAN	-5.0	-100.0	3.3	2.6	7.0	2.0	20.1	1.1	0.2	-0.9
RestofW	13.7	-9.3	2.7	-0.6	3.5	1.3	19.2	-7.1	-5.7	-6.8

While table 9 shows the overall pattern of changes in manufacturing trade for all cases, table 10 contains more detailed information about the industrial composition of the export changes for two of the cases – European integration (third case in tables 8 and 9) and global integration (sixth case in tables 8 and 9). The table shows that there is significant variation between regions for specific goods and between industries for each region. One clear feature is the growth in exports of food products from most regions, in particular in the global integration cases. This should not come as a surprise, given the initial pattern of protection. Secondly, there is strong growth in exports of labour-intensive products (textiles and leather) from Eastern Europe and the Asian regions; again, this has to do with the pattern of protection and comparative advantages. The counterpart is a reduction in labour-intensive sectors in Europe Central and in USACAN. While the table shows exports, there will be a similar, but dampened, effect on production. In general, the pattern of manufacturing production does not show strong changes in these cases; the most significant change is a five percentage points increase in Europe East's share of European production of textiles, from 8 to 13 percent, with an accompanying reduction in Europe Central's share.

5. Conclusions

In this paper we have presented model simulations for two sets of scenarios. Although the scenarios have been specified in a stylised way, with no attempt at predicting or forecasting real world phenomena, they are intended to capture potentially important structural changes. However, on each one, there is great uncertainty, even about the sign of the changes. We study successful transformation in Eastern Europe, and continued integration in Europe and globally – it could be argued that the opposite development is not an unlikely outcome.

If we look at the results, there are some striking features. Eastern European transformation matters a lot for the transforming regions (Europe East and former Soviet Union), but the consequences for the rest of Europe are limited. Although trade with Eastern Europe increases significantly for most regions in percentage terms, the economic effects of this are very small. And the reason is simply that in economic terms, Eastern Europe and former Soviet Union are small regions, and even if they experience strong growth, the effects for other regions are moderate.

There are, however, regional differences; the neighbouring countries in Europe Central are more severely hit than other European regions, and one feature that was not obvious ex ante, is that the overall effect for Europe Central is negative. Eastern European success could on the one hand imply increased production and exports through improved competitiveness for Eastern European producers; but on the other hand, it would also imply increased income and demand in Eastern Europe, with accompanying growth in import demand in the region. The simulation results clearly indicate that the former effect dominates; the most important trading partners experience strong growth in their imports from Eastern Europe, but not any significant changes in exports to the region. When it comes to production effects, although the overall impression is that successful Eastern European transformation only has limited effects on production in other regions, there are a few exceptions. In particular, the neighbouring region, Europe Central, may expect significant production cuts in labour-intensive sectors, should Eastern Europe succeed as in our scenario. A final observation worth noticing in this scenario, is the negative welfare effect in China and South Asia following Eastern European success. This seems to be a clear terms-of-trade effect; increased competition from Eastern Europe gives downward price pressure on export goods from China and south Asia, and hence a welfare loss in this region.

Secondly, we look at trade policies. We focus on liberalisation and integration, either in Europe or globally. The scenario distinguishes between reductions in import barriers, export taxes or subsidies, and transportation costs. For some regions there are qualitative differences between the three types of changes (e.g. for China and South Asia, where import liberalisation implies a loss, while the region gains significantly from the other two changes), while for most of the regions the changes in various policies reinforce each other.

The simulation results of European integration show that for the EEA-area the effects are very moderate – that simply reflects the fact that these countries are already closely integrated, with few remaining barriers. For Europe East, on the other hand, integration with the rest of Europe is very important. The are large welfare gains as a consequence of significant growth in exports from the region. The bulk of the export growth comes in labour-intensive industries, but there are also substantial effects in some of the other industries. In addition it should be remembered that, although we treat Eastern European transformation and economic integration in two separate sets of scenarios, integration and improved market access might actually be an important prerequisite for successful transformation. This may well turn out to be the most important effect of integration, as a comparison of the two scenarios in this paper could indicate.

The global integration cases reveal three interesting results: first, the Asian regions may gain significantly from further liberalisation, while for other regions the overall effects are moderate. Secondly, for at least one of the European regions – Europe West – global liberalisation seems to matter more than further European integration. Both of these results can be explained from the initial trade patterns for the regions. The Asian regions do rely heavily on trade, but initial trade barriers limit the possibilities; hence, further liberalisation yields gains. And Europe West has relatively more trade than other European regions have with countries outside Europe. The final observation is that trade in food products shows significant growth as a consequence of global liberalisation. Again, the reason must be the initial patterns of protection; food and food products are heavily protected in most regions, and that implies strong effects of liberalisation. In the model we do not capture the effects for agriculture, but we do pick up the importance for food products.

A striking feature of the results is the correlation we find between growth in manufacturing exports and welfare gains. This is a feature we would not expect in traditional models of trade based on comparative advantage. In our model, however, where the combination of input-output linkages, imperfect competition and trade costs gives rise to pecuniary externalities, such effects may well appear. From theory we know that it may be beneficial to have more of the industries in which externalities are important, since that gives a cost advantage to the country. In our context, pecuniary externalities are linked to manufacturing, while the perfectly competitive sectors do not show such effects. Hence, if policy changes imply shifts in the pattern of manufacturing production and exports between regions, that may well give rise to self-reinforcing agglomeration effects, with accompanying gains for those who get more of the manufacturing industries, and losses for other regions. The similarity to the "profit shifting" effects of strategic trade policies is obvious. There are, however, no pure profits in our model, so we may call this an "externality shifting" effect of trade policies. In reality – and also in our model – the strength of such agglomeration forces differs between industries. A subject for future research would be to look deeper into the sectoral differences in order to identify the more precise relationship between changes in the industry pattern and welfare gains or losses for the regions.

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Appendix A.

Basic model equations

This appendix shows some of the basic model equations to illustrate how specific features of the model work; a complete description is found in Forslid et al (1999).

Consumers have Cobb-Douglas preferences over a set of all goods (AG), implying that they will spend a fixed share of their income on each good:

$$C_{im} = \alpha_{im} \frac{Y_{im}}{P_{im}} \qquad i \in AG \qquad (1.)$$

For perfectly competitive goods prices are world market prices given by world market clearing conditions for the respective goods. One of these goods is chosen as numeraire. As for imperfectly competitive, differentiated goods (the set I), the price level for good i is an index of the prices of each variety of the good sold in market m. The calibrated demand parameter for each of the N_{ij} varieties of good i from country j sold in market m, is a_{ijm}.

$$P_{im} = \left(\sum_{j=1}^{R} N_{ij} a_{ijm} PI_{ijm}^{(1-\sigma_i)} \right)^{\frac{1}{1-\sigma_i}} \qquad i \in I, \qquad (2.)$$

For non-traded, differentiated goods $a_{ijm}=0$ for all $m \neq j$, since by assumption only domestically produced varieties are consumed. σ_i is the elasticity of substitution between various varieties of good i.

The imperfectly competitive sectors are characterised by monopolistic competition *à la* Dixit and Stiglitz (1977). Producer prices (PPI) of individual varieties are given as a mark-up over firms' marginal costs (MC):

$$PPI_{ij} = \frac{\sigma_i}{\sigma_i - 1} MC_{ij} \qquad i \in I \qquad (3.)$$

while consumer prices (PI_{ijm}) for the traded goods are subject to trade costs of three types: export taxes (EXTAX), transport costs (TRANS), and tariff equivalents of import barriers (TAREQ). The transport costs are of the iceberg type, while export taxes and import tariffs are transfers (to the representative consumer).

$$PI_{ijm} = PPI_{ij} \times (1 + EXTAX_{ijm}) \times (1 + TRANS_{ijm}) \times (1 + TAREQ_{ijm}) \qquad i \in ITG \qquad (4.)$$

Demand for each variety of good i in market m may now be derived as:

$$X_{ijm} = a_{ijm} \left(\frac{P_{im}}{PI_{ijm}} \right)^{\sigma_i} C_{im} \qquad i \in ITG \qquad (5.)$$

Prices and demand for non traded differentiated goods are derived in the same way as for traded goods, but with no need to distinguish between producer and consumer prices since there is only domestic consumption of these goods.

The price index for differentiated intermediate goods (Q_{hm}) is industry specific by purchasing industry (h) and region (m). The industry uses all goods as inputs, weighting the aggregate price of each good by the parameter g_{ihm}. The parameter is calibrated from the use of good i as intermediate input in the production of industry h in country m.

$$Q_{hm} = \left(\sum_{\forall i \in I} g_{ihm} P_{im}^{(1-sq)} \right)^{\frac{1}{1-sq}} \qquad \forall h \in AG \qquad (6.)$$

where sq is the elasticity of substitution among imperfectly competitive goods used as intermediates. Observe that we use the same price index (P_{im}) for industry i here as for consumer demand; hence, we assume that intermediate demand and final demand use different varieties of good i in the same proportions. The price indices for perfectly competitive goods (the set PC) as intermediates are constructed in the same way.

$$QPC_{hm} = \left(\sum_{\forall i \in PC} g_{ihm} PPC_i^{(1-sq)} \right)^{\frac{1}{1-sq}} \qquad \forall h \in AG \qquad (7.)$$

PV_{ij} is a price aggregate for all primary factors used in the production in sector i in region j. The use of each individual factor is industry and country specific and given by the parameter β.

$$PV_{ij} = \left(\sum_{k=1}^{K} \beta_{ijk} W_{jk}^{1-s_i} \right)^{\frac{1}{1-s_i}} \qquad i \in AG \qquad (8.)$$

Finally, the marginal cost for industry i in country j is specified as a nested CES-function, with primary inputs, differentiated intermediates, and homogenous intermediates in one second-level nest each, and with S_{top} as the elasticity of substitution between the nests at the top level. Using the price indices above, the marginal cost function can we written

$$MC_{ij} = \left[BV_{ij} \left(PV_{ij} \right)^{1-S_{top,i}} + BZ_{ij} \left(Q_{ij} \right)^{1-S_{top,i}} + BZPC_{ij} \left(QPC_{ij} \right)^{1-S_{top,i}} \right]^{\frac{1}{1-S_{top,i}}} \qquad (9.)$$

From (9), using (6) – (8) and market clearing conditions for each good, we find the demand for primary factors and intermediate goods from each sector. Together with supply conditions, these form the general equilibrium system.

The use of intermediates from own as well as other industries implies the existence of inter- and intra-industry cost linkages. The presence of these linkages, together with trade costs, means that the number of firms producing in the region affects each firm's costs, i.e. they generate pecuniary externalities. Firms located in a region with a large number of suppliers of important intermediates, will be relatively more competitive.

Agglomeration forces do not directly affect the perfectly competitive sectors. These sectors, however, expand or contract as a consequence of competition for factors with the other sectors. The decreasing returns in these sectors (due to a specific factor) act to dampen the expansion of the ITG sectors.