



**Transportation Study on the Dry Bulk  
Market Segment and the Panama  
Canal**

**Estudio del Transporte del Segmento  
de Mercado de Graneles Secos y el  
Canal de Panamá**

**Nathan Associates, Inc.**

**9 de septiembre de 2003**

**Contrato No. 81851**

**Resumen Ejecutivo**

FINAL REPORT

# Transportation Study on the Dry Bulk Market Segment and the Panama Canal

Volume 1: Main Report

**SUBMITTED TO**  
Autoridad del Canal de Panamá

**SUBMITTED BY**  
Nathan Associates Inc.,  
Arlington Virginia

**IN ASSOCIATION WITH**  
Richardson Lawrie Associates,  
London

**UNDER CONTRACT NO.**  
SAA-81851

September 9, 2003



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# Executive Summary

World trade of dry bulk commodities totals more than 2 billion tons annually. While the Panama Canal captures only 3 percent of this total world trade, dry bulk commodities nonetheless represents a substantial market for the Canal of nearly 70 million tons per year.<sup>1</sup>

## OBJECTIVE AND SCOPE

The Transportation Study on the Dry Bulk Market Segment and the Panama Canal is part of a larger set of studies to examine the feasibility of expanding the capacity of the existing Canal to permit the transit of larger vessels. The dry bulk market segment study will:

- Assess the Canal's potential market for dry bulk trade,
- Determine the economic advantages of using the Canal versus existing and expected alternative transport options,
- Devise a market strategy that attracts the dry bulk business to the extent that the Canal's earnings are maximized under existing and expanded lock conditions, and
- Forecast traffic, transit, and revenue flows through 2025, and associated risks, for the status quo and expanded Canal.

## WORLD TRADE

### Macroeconomic Scenarios

The study has been conducted using three global macroeconomic and trade scenarios to the year 2025 prepared by DRI-WEFA for the Autoridad de Canal de Panamá.<sup>2</sup> The macroeconomic scenarios provide forecasts of GDP, population, per capita income, government and private consumption, investment, and trade of goods and services. The three macroeconomic scenarios—most probable case scenario, best case and worst case—incorporate varying assumptions on world economic performance, geopolitical conditions, international trade policies, and environmental issues.

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<sup>1</sup> This study does not cover the 38 million tons of grains that were shipped through the Panama Canal in 2001. A separate study for the grain market segment has been undertaken. See Nathan Associates Inc., Transportation Study on the Grain Market Segment and the Panama Canal, Final Report Volume 2: Panama Canal's Potential Market, conducted for the Autoridad de Canal de Panamá, September 9, 2003.

<sup>2</sup> DRI-WEFA, Global Macroeconomic and Trade Scenarios to 2025, Volume I: Most Probable Case, prepared for the Panama Canal Authority (Contract No. SAA75897BGP), March 2002.

## **Dry Bulk Production and Consumption**

The analysis of dry bulk commodities is based on the judgment of CRU experts, who are specialists in the economic analysis of specific commodities. The experts have put together the available historical series of data into a standard format and then used their expert judgment to make forecasts.

The first stage in making the forecasts is the generation of demand forecasts. The base case forecasts are based on macroeconomic forecasts generated by for the ACP by WEFA-DRI. The forecasts are driven, however, by expert judgment rather than an econometric model. After demand has been calculated, supply is then forecast based on the experts' view of the future availability of supply from different potential sources.

The demand for raw materials used in downstream products is forecast as a derived demand, utilizing technical and market relationships between upstream and downstream products. Thus, for example, the demand for zinc concentrates is directly related to the supply of refined zinc. Similar relationships are as follows:

- The supply of steel determines the demand for steel scrap, pig iron and DRI/HBI. The supply of pig iron and DRI/HBI, taken together, determines the demand for iron ore. The supply of pig iron alone determines the demand for metallurgical coke. The supply of pig iron and the supply of metallurgical coke together determine the demand for metallurgical coal.
- The supply of primary aluminum determines the demand for calcined petroleum coke and alumina. The supply of alumina in turn determines the demand for bauxite.
- The supply of refined copper helps to determine the demand for copper concentrates.

Supply is variously defined as production or shipments, depending on the judgment of the experts as to which is most suitable. Demand is defined either as apparent or real consumption. Apparent consumption consists of supply plus imports minus exports. Real consumption consists of apparent consumption adjusted for changes in consumers' and traders' stocks.

## **FORECAST OF POTENTIAL CANAL TRADE**

For purposes of the study, the term "potential Canal trade" refers to our estimate of the maximum market share that the Canal could capture of world trade assuming a value of zero for Panama Canal tolls. Table E-1 summarizes potential laden transits in terms of cargo tons, DWT, numbers of transits and PCUMS for both the Existing and Expanded Canals and for all cases. For the Most Probable Cases, ODB cargo transits for the Existing Canal are estimated to increase by 18 percent from 66 million tons in 2000 to almost 77 million tons in 2025 and for the Expanded Canal by 32 percent to over 87 million tons. For the Existing Canal similar percentage increases are projected for transits in terms of DWT and PCUMS. However because of the expected continuing trend towards the utilization of larger vessels, the total number of transits is forecast to increase by just under 8 percent for the Existing Canal, from 2,090 vessels in 2000 to 2,251 vessels in 2025.

For the Expanded Canal the projected growth in transits in terms of DWT and PCUMS remains around 26 percent. This is slightly lower than the rate of growth in cargoes because of the improved utilization that will result from an enlarged Canal. The number of transits would grow by only 6 percent overall as the result of both greater utilization levels and the trend towards larger vessel sizes.

**Table E-1. Potential Laden Transits in Cargo Tons, DWT, Number of Transits and PCUMS, Existing and Expanded Canal, No Tolls, All Cases**

Case	Existing Canal						Expanded Canal			
	2000	2005	2010	2015	2020	2025	2010	2015	2020	2025
<b>Cargo (000 long tons)</b>										
Most Probable	65,987.7	68,236.8	72,015.5	73,320.3	75,401.8	76,700.6	78,885.4	80,877.2	86,648.9	87,456.5
Best	66,993.1	73,282.2	83,473.5	91,651.0	102,065.4	113,040.5	91,227.3	100,635.5	115,927.3	127,104.6
Worst	67,072.1	65,611.5	65,607.6	64,155.0	62,387.9	60,268.8	71,763.2	70,711.9	71,888.2	68,948.3
<b>Vessel Size (000 DWT)</b>										
Most Probable	84,570.0	87,440.4	92,460.6	94,115.5	96,984.4	98,634.2	97,318.1	99,602.7	105,725.4	106,790.1
Best	85,780.1	94,016.6	107,491.5	118,123.5	131,927.9	146,260.6	112,578.4	124,052.8	141,749.9	155,558.4
Worst	85,875.1	83,933.4	84,039.7	82,107.2	80,002.3	77,209.5	88,451.2	86,998.4	87,655.8	84,114.4
<b>Transits</b>										
Most Probable	2,089.9	2,127.0	2,173.2	2,200.2	2,218.6	2,251.2	2,157.7	2,180.4	2,206.5	2,221.0
Best	2,130.6	2,265.9	2,444.3	2,648.0	2,872.5	3,136.7	2,418.1	2,609.8	2,832.1	3,056.2
Worst	2,132.9	2,057.3	2,010.9	1,963.7	1,878.1	1,818.5	1,997.8	1,949.0	1,873.5	1,801.9
<b>PCUMS (000)</b>										
Most Probable	43,607.9	45,056.0	47,529.6	48,353.7	49,744.3	50,623.5	49,634.4	50,724.2	53,556.6	54,139.2
Best	44,262.0	48,384.0	55,065.9	60,434.6	67,336.2	74,583.3	57,248.8	62,958.9	71,560.1	78,489.0
Worst	44,312.7	43,288.3	43,288.3	42,300.4	41,167.4	39,782.7	45,200.7	44,417.6	44,515.7	42,774.9

Source: Richardson Lawrie Associates

**Highlights of the findings for the Existing Canal include:**

- A continuing steady shift in market share terms from the smaller size ranges which is most pronounced southbound but also apparent northbound;
- A quite strong increase in both absolute and market share terms in the use of vessels in excess of 70,000 DWT northbound. This reflects in part the already more established presence of these vessels in the northbound business in particular in the coal movements from the West Coast of Vancouver to Europe

For the Expanded Canal, despite the likelihood that larger vessels will transit the Canal in this case, total DWT actually declines southbound and increases only marginally northbound compared to the Existing Canal as utilization levels increase in size ranges up to 80,000 DWT and inefficiencies are removed from the global shipping system. Specifically:

- As Existing Canal bypass trades flow through the Expanded Canal, so northbound DWT in size ranges in excess of 120,000 DWT are introduced. As these are light laden vessels the DWT is significantly in excess of the additional trade shifted through the Canal.
- Cargoes carried in the 70,000–80,000 DWT range northbound increase through 2015 but then, even in an environment of slow overall growth, decline as the use of vessels in the 80,000–100,000 DWT ranges increases.

- Similarly, the use of 60,000–70,000 DWT vessels declines with the introduction of vessels in excess of 80,000 DWT.

Nearly 80 percent of the increase in Canal potential trade for dry bulk commodities during this period is forecasted to occur on Pacific to Atlantic routes that will grow from an estimated 49.1 million tons in 2000 to 95.6 million tons by 2025. Growth of potential Canal trade for dry bulk commodities on Atlantic to Pacific routes will be marginal, increasing from 30.6 million tons in 2000 to 34.0 million tons by 2025.

### **Capture of Canal Bypass Routes**

Canal bypass trades are those undertaken by vessels larger than those that can use the Canal at its current dimensions and which, on the basis of mileage considerations, could use an expanded or restricted Canal. At present, the only bypass trades involve all-water routes.

Iron ore and thermal and metallurgical coal are the two commodities that were identified as Canal bypass trades. In 2001, an estimated 22.2 million tons of iron ore was shipped on Canal bypass routes, 85 percent of which was for the South America East to Far East route. Bypass trade shipments from Brazil-North to the Far East totaled 15.8 million tons in 2001. Note that shipments from southern Brazil to the Far East are not considered as Canal bypass routes as the route through the Panama Canal is not shorter than alternative routes.

More than 75 percent of the 8.4 million tons of thermal and metallurgical coal identified as Canal bypass trade was from North America West to Europe. Another important route for thermal and metallurgical coal is North America West to South America East (1.4 million tons).

Data were obtained on iron ore and coal sailings from a number of export terminals, which are currently the sources of bypass trades, and analyses undertaken to determine vessel size distributions and utilization levels on these routes. As the result of the analyses the conclusions are that only trade on the following routes shown in Table E-2 would switch.

**Table E-2. By Pass Trades Switched to the Canal Under Expanded Canal Conditions, Most Probable Case, No Tolls, Selected Years 2010-2025 (000 Tons)**

Origin	Destination	Commodity	2010	2015	2020	2025
East Coast Canada	Korea	Iron Ore	-	-	448	448
East Coast Canada	Japan	Iron Ore	-	-	774	774
Venezuela	Taiwan	Iron Ore	201	225	247	247
Venezuela	China & Hong Kong	Iron Ore	-	-	809	809
Venezuela	Korea	Iron Ore	-	-	771	771
Venezuela	Japan	Iron Ore	-	-	1,047	1,047
West Coast Canada	Europe	Thermal and Metallurgical Coal	2,510	2,449	2,371	2,295
Oceania	North America East	Thermal and Metallurgical Coal	805	1,638	1,661	1,481
Oceania	North America Gulf	Thermal and Metallurgical Coal	2,485	2,344	2,202	1,964
Oceania	Central America East	Thermal and Metallurgical Coal	707	743	764	771
West Coast Canada	North Africa	Thermal and Metallurgical Coal	159	155	150	145
<b>Total</b>			<b>6,867</b>	<b>7,554</b>	<b>11,244</b>	<b>10,753</b>

Source: Richardson Lawrie Associates

### Comparison of ACP Reported Dry Bulk Traffic with Study Estimates

The forecasts of potential Panama Canal dry bulk trade presented in this Volume are not directly comparable to ACP reported dry bulk traffic for several reasons. First, as already mentioned the definition of potential Panama Canal dry bulk trade is based on the assumption of no Panama Canal tolls. Second, the forecast of potential transits is for dry bulk vessels only and does not include dry bulk commodities that may transit the canal on non-dry bulk vessels<sup>3</sup>. Third, there has historically been a modest amount of Canal traffic on routes where the Panama Canal is not the shortest maritime routing and hence would not be included in the forecast that is based on transport economics. Again, this traffic has been identified and may be included in the overall final forecast of Panama Canal traffic.

It is important to recognize that this study was designed not to prepare independent forecasts of potential Panama Canal trade of dry bulk commodities. Accordingly, the study did not use ACP-reported Canal traffic as the basis of the forecast. Rather the study developed the potential trade forecast from other sources of production, consumption and trade of each commodity.

Table E-3 presents a comparison of ACP reported dry bulk traffic with forecasts prepared in this study. The upper portion of the table shows that in 2000 total ACP reported dry bulk commodity traffic was 67.1 million tons. To be comparable to the study's forecast, two items are subtracted: (i) the amount of dry bulk commodities carried on non-dry bulk vessels (11.0 million tons in 2000) and (ii) the amount of dry bulk traffic on routes where the Panama Canal is not the shortest routing (0.9 million tons). The remaining ACP-reported dry bulk traffic on dry bulk vessels totaled 55.2 million tons in 2000.

<sup>3</sup> However, we have prepared and provided the ACP with a forecast of such cargo carried aboard non-dry bulk vessels to be incorporated in other market segment studies.



**Table E-3. Comparison of ACP Reported Dry Bulk Traffic with Study  
Forecasts, 2000 and 2001 (thousands of long tons)**

Item	2000	2001
<b><u>ODB Trade flows from ACP data</u></b>		
ACP reported dry bulk commodities traffic <i>a/</i>	67,103	65,070
Less: Dry bulk commodities on non-dry bulk vessels <i>b/</i>	10,994	11,298
Less: Traffic on routes excluded by mileage <i>c/</i>	889	766
Subtotal dry bulk traffic from RLA	55,220	53,006
<b><u>ODB Trade flows prepared by Study</u></b>		
Trade forecast of dry bulk commodities on routes where Canal routing is shortest	107,782	106,674
Less: Bypass traffic not captured by Canal <i>d/</i>	30,053	30,558
Potential Canal dry bulk trade with zero tolls <i>e/</i>	77,729	76,116
Less: Dry bulk trade in non-dry bulk carriers <i>f/</i>	11,742	11,097
Potential Canal dry bulk trade in dry bulk vessels	65,987	65,019
Less: Traffic diverted with actual ACP tolls <i>g/</i>	7,716	7,966
Forecast of ODB dry bulk traffic on dry bulk vessel <i>g/</i>	58,271	57,053

*a/* From Volume 2, Appendix W Table W-1.

*b/* From Volume 2, Appendix W, Table W1.

*c/* From Volume 2, Appendix W, Table W-2.

*d/* From Table 2-5.

*e/* From Dry Bulk Transit model, Table XB1ODBTRADEFORCAST.XLS

*f/* From Dry Bulk Transit model, Table XB3ODB.xls

*g/* From Volume 5: Marketing Strategy Table 4-2 and 4-3.

Source: As noted.

The lower portion of Table E-3 shows the estimates of dry bulk trade prepared by the study. From the global trade forecasts prepared by the study, we identified the amount of dry bulk commodity trade on trade routes where the Panama Canal is the shortest routing (107.8 million tons in 2000). From this, the amount of trade on bypass routes that cannot be captured by the Existing or Expanded Canal is subtracted (30.1 million tons)<sup>4</sup>. The result is the forecast of potential Panama Canal dry bulk trade with zero tolls of 77.7 million tons as reported in this volume.

However, again this estimate includes dry bulk trade carried on non-dry bulk vessel (11.7 million tons in 2000). Also to be compared with ACP-reported traffic, the amount of potential dry bulk trade that is not captured due to Panama Canal tolls needs to be subtracted (7.7 million tons in 2000). The result is an estimate of 58.3 million tons of dry bulk commodities on dry bulk vessels that would use the Panama Canal. This is 3.1 million tons or 5.5 percent above the figure derived from ACP records. The results are quite close given the entirely independent and separate method used to prepare the forecast.

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<sup>4</sup> The bypass trade routes are identified in Table 2-5 herein, and the maritime economics is discussed in detail in *Volume 3: Vessel Transit and Fleet Analysis*, Chapter 3.

## WORLD FLEET DEVELOPMENT BY SIZE

The potential growth in the world fleet and the potential impact of an Expanded Canal on its development are important background to the projection of changes in the allocation of cargo to different size ranges of vessel in the Canal transit forecasts. Forecasts of the world fleet by size range for the Existing and Expanded Canals have been developed based on future expectations of world trade growth in dry bulk commodities, changing preferences for ordering particular vessel sizes, the age distribution of the existing fleet and projected scrapping by size range.

The main difference between the Existing and Expanded Canal conditions is that under the latter conditions, the 70,000–80,000 DWT size range would be expected to peak at around 79 million DWT in 2018 before declining to just under 65 million DWT in 2025. This compares with a steady rise to nearly 109 million DWT under Existing Canal conditions. In contrast, with an Expanded Canal, the 80,000–90,000 DWT size range would increase to 54 million DWT instead of about 5 million DWT in the former case. There would also be an approximately 4 million DWT increase in the size of the 90,000–100,000 DWT size range by the end of the forecast period.

## ANALYSIS OF FUTURE SHIP COSTS AND FREIGHT COSTS

For the purpose of this study we define freight costs as the freight paid by the shipper to the ship owner or operator. While these represent the cost to the shipper these are not the same as operating costs (capital, fixed and variable) borne by the owner (see below). Capital costs comprise capital repayments plus interest charges. Fixed operating costs include manning, repairs and maintenance, insurance, stores and supplies and overheads. Variable costs cover bunkers, port charges and Canal dues, where applicable.

Estimates of freight costs—expressed in terms of US\$ per cargo ton—have been developed through voyage estimates by route and deadweight (DWT) size range for:

- All vessels transiting the Canal,
- Bypass routes
- Routes that represent alternatives to the existing Canal, and
- Routes where cargo moves in vessels that could transit the existing Canal but are precluded from so doing by current toll policies.

Decisions to utilize the Canal are based on marginal economics not long run costs so voyage calculations have been used to determine seaborne freight costs. These calculations use charter market rates rather than fully built up operating costs. Future estimates of charter rates have been linked to expected developments in total operating costs within the *Voyage Estimating Model*. The data and estimates used in these calculations include voyage mileages, vessel speeds, port times, Canal transit times, DWT utilization factors, fixed operating costs, bunker prices, port charges and capital costs (vessel prices). The voyage calculations are based on representative ports within each region. The impact of structural change on future operating costs has also been assessed.

## ECONOMIC VALUE OF THE PANAMA CANAL

For purposes of this study, the economic value of the Canal refers to the transportation cost differential for specific commodity route pairs through the Panama Canal as compared to the least cost alternative routing. The determination of the economic value of the Canal has three elements:

- The determination of total seaborne transportation costs by route for projected Canal transits for the Existing Canal and their comparison with total transportation costs on alternative routes, including the incremental interest costs associated with having cargoes at sea for longer durations than would be the case for shorter routes through the Canal;
- The determination of total seaborne transportation costs by route for projected Canal transits for the Expanded Canal and their comparison total transportation costs on alternative routes, including the incremental interest costs associated with having cargoes at sea for longer durations than would be the case for shorter routes through the Canal;
- Calculation of the greater economic value that would be achieved through expansion of the locks versus the Existing Canal.

Table E-4 summarizes the total economic values calculated for both the Existing and Expanded Canal, through to 2025. Under Existing Canal conditions, the economic value of the Canal is estimated to remain within the range of the equivalent of \$4.90 per ton to 6.01 per ton in \$2002 terms. Translated into total economic value, this results in a value of \$396 million in 2001, \$353 million in 2010 and \$388 million in 2025. The higher economic value in 2000 is a result of the peak in maritime freight rates that occurred that year that increased the cost differential for Canal alternative routes.

For the Expanded Canal, the economic value is projected to range from \$5.12 per ton to \$5.35 per ton. Total economic value would rise from \$405 million in 2010 to \$466 million in 2025. The margins between the Expanded Canal and the Existing Canal are estimated to range from \$0.18 per ton to \$0.45 per ton during the period. The margin of the economic value of the Expanded Canal is \$52 million in 2010 increasing to \$78 million by 2025.

**Table E-4. Summary of Economic Value of Existing and Expanded Panama Canal, Most Probable Case, Selected Years 2000-2025**

Year	Existing Canal				Expanded Canal				Margin Expanded vs. Existing Canal	
	Potential Panama Canal Transits	Potential Panama Canal cargo (tons 000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)	Potential Panama Canal Transits	Potential Panama Canal cargo (tons 000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)	Economic Value of Canal (\$/ton)	Economic Value of Canal (\$000s)
2000	2,089.9	65,987.7	6.01	396,618.3	-	-	-	-	-	-
2005	2,127.0	68,236.6	4.97	339,358.9	-	-	-	-	-	-
2010	2,173.2	72,015.0	4.90	352,943.4	2,173.2	75,685.1	5.35	405,288.9	0.45	52,345.5
2015	2,200.2	73,319.6	4.98	364,943.2	2,180.4	81,437.8	5.30	431,822.1	0.33	66,877.5
2020	2,218.6	75,401.0	4.94	372,465.4	2,206.5	86,961.6	5.12	445,260.8	0.18	72,791.2
2025	2,251.1	76,699.5	5.05	387,656.6	2,221.0	87,771.2	5.31	466,100.6	0.26	78,441.0

## ALTERNATIVE PANAMA CANAL MARKETING STRATEGIES

The terms of reference for the study state that the marketing strategy shall pursue the following objectives:

- Maximize Canal's earnings
- Maximize the canal market share for the dry bulk segment, and
- Be non-discriminatory within the dry bulk segment

Based on our review of the Panama Canal Neutrality Treaty and of toll policies at comparable facilities, we believe there is ample scope to differentiate Panama Canal tolls by size of vessel and commodity. Accordingly, we identified alternative toll pricing options for analysis that had tolls varying by size of vessel, and by commodity<sup>5</sup>. Toll options were also analyzed with tolls assessed by PCUMS and by ton of cargo carried. Toll pricing options included ACP tolls in effect prior to October 2002, from October 2002 through June 2003 and ACP tolls to take effect in July 1, 2003. The ACP tolls as of July 1, 2003 were used as the basis for examining a series of toll increases at 25 percent intervals from 25 percent increase through a 150 percent increase.

The detailed review of the Canal toll pricing options revealed the following findings.

- Approximately 15 percent of the potential transits (with no tolls) would be diverted to alternative routes once any non-insignificant Canal tolls were imposed. These involved routes Oceania to North America East and North America Gulf, from Canada West to Brazil South and from North America Gulf to the Far East for vessels greater than 70,000 DWT.
- A sizable number of transits and cargo would be diverted at certain pricing points for particular commodity-route pairs.
- After certain levels of toll increases, Canal revenues decline as the loss of toll revenue due to diverted transits is not offset by toll increases for the remaining Panama Canal transits.

Table E-5 present an examples of summarized results of the 13 Canal toll pricing options for the Existing Canal and Expanded Canal, Most Probable Case for 2011.. The table shows the potential Canal transits and cargo (with no tolls) and the forecast of Canal transits and cargo for each Canal toll pricing option. The tables also present the forecast of Canal toll revenues.

In 2011, estimated Canal toll revenues for dry bulk vessels in the dry bulk market segment under current toll rates total \$109.3 million (Table E-5). The Canal captured 87 percent of potential transits in this market segment and 87 percent of potential dry bulk cargo. However, the Canal toll revenues of \$109.3 million only accounted for 34 percent of the estimated economic value of the Canal of \$323 million.

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<sup>5</sup> As this market segment only deals with dry bulk carriers, Panama Canal toll pricing options by type of vessel were not analyzed.

If Canal toll levels in 2011 were increased by 50 percent, toll revenues in 2011 from this market segment would be \$148.5 million, an increase of 26 percent. Even with tolls at this level, the Canal would still only capture 42 percent of the total economic value of the Canal<sup>6</sup>.

The demand for Canal services is inelastic relative to tolls. That is, a given percentage increase in tolls would result in a smaller percentage decrease in Canal transits and would generate higher Canal toll revenues. A review of Table E-5 provides an indication of the price inelasticity of demand. A 50 percent increase in tolls reduces the forecast of Canal bulk transits from 1,865 vessels to 1,623 vessels, or only 13 percent. A 100 percent increase in tolls reduces the forecast of Canal bulk transits to 1,271 vessels or 32 percent.

For some years and pricing options, the Existing Canal scenario is shown to generate more toll revenues than the Existing Canal for the dry bulk market segment. While these results initially seem counter-intuitive, there are three factors that together fully explain these findings.

First, the total potential Panama Canal dry bulk cargo under the Expanded Canal scenario of 79.3 million tons in 2011 (Table E-5) is only slightly higher than the Existing Canal scenario of 71.8 million tons. Thus, the introduction of the Expanded Canal does not significantly impact the volume of dry bulk trade that could potentially use the Canal in 2011. By 2020, the Expanded Canal has potential traffic of 87.0 million tons compared to the Existing canal potential traffic of 75.4 million tons.<sup>7</sup>

Second, with the Expanded Canal, there is a trend toward using larger vessels and hence the number of dry bulk vessels needed is reduced. The Expanded Canal scenario is shown to have 2,147 potential transits in 2011 while the Existing Canal is forecast at 2,163 potential transits even though the Expanded canal has more cargo traffic. As Canal tolls provide discounted rates for larger vessels, Canal toll revenues for the same annual volume of grain cargo will be less for the Expanded Canal versus the Existing Canal.

Third, the Expanded Canal is shown to have almost the same economic value as the Existing Canal. In 2011, the Expanded Canal has a total economic value of \$360.4 million as compared to \$352.8 million for the Existing Canal. The economic value of the Canal defined for study purposes is the transportation cost savings of the use of the Canal as compared to the least-cost alternative routing. Decisions on whether to use the Canal or an alternative route are made taking into account the shipping characteristics and corresponding costs of each routing. For the Existing Canal scenario,

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<sup>6</sup> For the Canal to capture 100 percent of the economic value of the Canal, it would have to have a toll pricing policy that charged each vessel transiting the full benefit of using the Canal over alternative routings. Such a policy is not administratively practical, nor consistent with the Panama Canal Neutrality Treaty.

<sup>7</sup> This is due to the capture of bypass trade by the Expanded Canal which in 2020 is assumed to be deepened to 50 feet.

**Table E-5. Dry Bulk Market Segment: Summary of Panama Canal Toll Pricing Options, Existing and Expanded Canal, Most Probable Case 2011**

Canal Scenario and Item	Panama Canal Toll Pricing Option											
	ACP tolls		PCUMS		PCUMS		PCUMS		PCUMS		Commodity	
	to Oct 2002	June 2003	ACP tolls from July 2003	Option 1 (25% increase)	Option 2 (50% increase)	Option 3 (75% increase)	Option 4 (100% increase)	Option 5 (125% increase)	Option 6 (140% increase)	Option 7 (150% increase)	Option 1 & Option 2 & Option 3 & Option 7 (75% increase)	Option 1 & Option 2 & Option 3 & Option 7 (75% increase)
<b>Existing Canal</b>												
Potential Panama Canal Transits (no.)	2,163	2,163	2,163	2,163	2,163	2,163	2,163	2,163	2,163	2,163	2,163	2,163
Potential Panama Canal Cargo (ton 000s)	71,775	71,775	71,775	71,775	71,775	71,775	71,775	71,775	71,775	71,775	71,775	71,775
Forecast Panama Canal Transits (no.)	1,894	1,873	1,865	1,803	1,623	1,480	1,271	1,112	1,051	977	1,578	1,543
Percent of Potential Transits	87.6%	86.6%	86.2%	83.3%	75.0%	68.4%	58.8%	51.4%	48.6%	45.2%	72.9%	71.3%
Forecast Panama Canal Cargo (ton 000s)(ton 000s)	62,433	61,818	61,602	58,681	51,624	45,481	38,249	32,458	30,687	27,414	50,016	48,670
Percent of Potential Cargo	87.0%	86.1%	85.8%	81.8%	71.9%	63.4%	53.3%	45.2%	42.8%	38.2%	69.7%	67.8%
Economic Value of Canal for Potential Transits (\$000s)	352,793	352,793	352,793	352,793	352,793	352,793	352,793	352,793	352,793	352,793	352,793	352,793
Economic Value of Traffic Diverted Due to Tolls (\$000s)	4,491	5,608	6,030	12,132	30,535	48,916	74,540	97,693	105,973	120,436	35,633	39,984
Forecast Panama Canal Toll Revenues (\$000s)	105,115	112,667	117,659	140,436	148,593	153,828	148,460	142,299	143,251	134,436	163,852	160,771
Average Toll Revenue per Forecasted Transit (\$000)	55	60	63	78	92	104	117	128	136	138	104	104
Average Toll Revenue per Ton of Forecasted Cargo (\$/ton)	1.68	1.82	1.91	2.39	2.88	3.38	3.88	4.38	4.67	4.90	3.28	3.30
<b>Expanded Canal</b>												
Potential Panama Canal Transits (no.)	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147	2,147
Potential Panama Canal Cargo (ton 000s)	79,297	79,297	79,297	79,297	79,297	79,297	79,297	79,297	79,297	79,297	79,297	79,297
Forecast Panama Canal Transits (no.)	1,884	1,859	1,839	1,783	1,618	1,471	1,244	1,093	1,019	955	1,547	1,524
Percent of Potential Transits	87.7%	86.6%	85.7%	83.0%	75.4%	68.5%	58.0%	50.9%	47.5%	44.5%	72.1%	71.0%
Forecast Panama Canal Cargo (ton 000s)	69,577	68,774	67,795	64,728	57,698	48,814	39,094	32,959	30,495	27,391	52,603	51,790
Percent of Potential Cargo	87.7%	86.7%	85.5%	81.6%	72.8%	61.6%	49.3%	41.6%	38.5%	34.5%	66.3%	65.3%
Economic Value of Canal for Potential Transits (\$000s)	360,415	360,415	360,415	360,415	360,415	360,415	360,415	360,415	360,415	360,415	360,415	360,415
Economic Value of Traffic Diverted Due to Tolls (\$000s)	4,706	6,108	7,665	13,426	29,280	45,235	77,347	100,526	111,329	123,671	34,937	34,976
Forecast Panama Canal Toll Revenues (\$000s)	110,124	117,731	121,713	145,929	156,034	157,125	145,406	138,705	136,808	129,956	164,101	162,711
Average Toll Revenue per Forecasted Transit (\$000)	58	63	66	82	96	107	117	127	134	136	106	107
Average Toll Revenue per Ton of Forecasted Cargo (\$/ton)	1.58	1.71	1.80	2.25	2.70	3.22	3.72	4.21	4.49	4.74	3.12	3.14

Source: Prepared by Nathan Associates Inc.

Preferred Canal toll pricing option

Alternative Canal toll pricing option

the decision is based on the shipping characteristics and costs associated with that scenario. These were described fully in *Volume 3: Vessel Transit and Fleet Analysis*. With the Expanded Canal scenario, again decisions to use the Canal are determined by the shipping characteristics and costs for the Canal and alternative routings associated with that scenario.

The reason that the economic value of the Canal is not higher for the Expanded Canal scenario is that the cost differentials between the Expanded Canal and its least-cost alternative routings are lower than those estimated for the Existing Canal. With the Expanded Canal, there will be a trend toward use of larger vessels and some originating and receiving ports will develop facilities to accommodate the larger vessels. However, the use of larger vessel will reduce the transport cost of both Canal and least-cost alternative routings. As the mileages for the least-cost alternative routings are greater than for Canal routes, the cost saving of using larger vessels is greater in absolute terms. Thus the Expanded Canal has a smaller transportation cost differential or economic value between the Canal and the least-cost alternative routing<sup>8</sup>.

### IDENTIFICATION OF PREFERRED PANAMA CANAL TOLL PRICING

The preferred Panama Canal toll pricing option was selected for the Existing and Expanded Canal scenarios separately by applying the following criteria:

- Maximization of Canal's earnings
- Maximization of the Canal market share for the grain bulk segment, and
- Non-discriminatory within the grain bulk segment
- Administrative simplicity (easy to measure and apply without cumbersome verification)
- Ease of understanding and transparency to shipping community
- Stability from one year to next with gradual variations

All of the tolls pricing options analyzed were considered to be non-discriminatory within the dry bulk segment. Precedents set at comparable facilities allow for differentiation of tolls by size of vessel and by commodity as long as they are applied to all such vessels on a consistent basis. First priority was given to maximization of toll revenues, closely followed by maximization of Canal market share. A preferred Canal toll pricing option was identified for each year and each Canal scenario (Table E-6).

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<sup>8</sup> Please note that the treatment of economic used herein for the toll pricing analysis differs from that presented in *Volume: Economic Value of Panama Canal*. In Volume 4, the terms of reference called for a direct comparison of the economic value of the Existing Canal and Expanded Canal. Thus for that analysis, transportation costs of routes through the Existing and Expanded Canals were both compared to the transportation costs of the alternative routes under the Existing Canal scenario.

**Table E-6. Preferred and Alternative Canal Toll Pricing Options, 2000-2025**

Year	Existing Canal		Expanded Canal	
	Preferred Toll Pricing Option	Alternative Toll Pricing Option	Preferred Toll Pricing Option	Alternative Toll Pricing Option
2000-2009	Commodity Option1 (75% increase with 10% discounts for phosphates, cement, met coke and copper concentrates)	PCUMS Option 1 (25% increase)	n.a.	n.a.
2010	Commodity Option1 (75% increase with 10% discounts for phosphates, cement, met coke and copper concentrates)	PCUMS Option 1 (25% increase)	Commodity Option1 (75% increase with 10% discounts for phosphates, cement, met coke and copper concentrates)	PCUMS Option 1 (25% increase)
2011–2024	Commodity Option 2 (75% increase with 10% discounts for phosphates, cement, and 5% discount for met coke and copper concentrates)	PCUMS Option 1 (25% increase)	Commodity Option 2 (75% increase with 10% discounts for phosphates, cement, and 5% discount for met coke and copper concentrates)	PCUMS Option 1 (25% increase)
2025	Commodity Option 3 (75% increase with 10% discounts for phosphates and cement)	PCUMS Option 1 (25% increase)	Commodity Option 3 (75% increase with 10% discounts for phosphates and cement)	PCUMS Option 1 (25% increase)

Source: Volume 5, Table 4-2 through Table 4-27.

### Existing Canal

For the Existing Canal, the preferred option for 2000 through 2010 is Commodity Option 1 which corresponds to Panama Canal tolls increased by 75 percent from July 1, 2003 levels with 10 percent discounts for vessels carrying phosphates, cement, metallurgical coke and copper concentrates. These discounts allow the Canal to increase toll revenue by 8 percent as compared to a uniform 75 percent increase. This pricing option allows the Canal to retain approximately 72 percent of total potential transits as compared to 87 percent under current tolls. Panama Canal toll revenues, however, increase by 36 to 40 percent under Commodity Option 1 as compared to current tolls.

From 2011 through 2024, the preferred Canal toll pricing option is Commodity Option 2 which corresponds to Panama Canal tolls increased by 75 percent with 10 percent discounts for vessels carrying phosphates, cement, and a 5 percent discount for vessels carrying metallurgical coke and copper concentrates. Again toll revenues from the preferred pricing option are about 40 percent higher than those forecast under current toll levels.

For 2025, the preferred Canal toll pricing option is Commodity Option 3 corresponds to a 75 percent increase in Canal tolls from the July 1, 2003 levels combined with a 10 percent discount for phosphate and cement (discounts for metallurgical coke and copper concentrates are eliminated). None of the other Canal pricing options analyzed yield more revenue than the preferred Canal toll pricing options. In general, Canal toll revenue declines once tolls exceed levels 75 percent above the July 1, 2003 rates.

An interesting alternative to the preferred Canal pricing option is to look at Panama Canal tolls with only an increase of 25 percent increase over July 1, 2003 rates. This generates approximately 13 percent to 15 percent less toll revenue but also results in significantly less diversions of potential cargo.



## Expanded Canal

The preferred Canal toll pricing options for the Expanded Canal are the same as those for the Existing Canal. From 2011 through 2024, the preferred Canal toll pricing option is Commodity Option 2 which corresponds to Panama Canal tolls increased by 75 percent with 10 percent discounts for vessels carrying phosphates, cement, and a 5 percent discount for vessels carrying metallurgical coke and copper concentrates. Again toll revenues from the preferred pricing option are about 40 percent higher than those forecast under current toll levels.

For 2025, the preferred Canal toll pricing option is Commodity Option 3 corresponds to a 75 percent increase in Canal tolls from the July 1, 2003 levels combined with a 10 percent discount for phosphate and cement (discounts for metallurgical coke and copper concentrates are eliminated).

Using the combined objectives of maximizing Canal earnings and Canal market share, a preferred Canal toll pricing option was identified for each year and each Canal scenario. The preferred option through 2010 is Commodity Option 1 which corresponds to Panama Canal tolls increased by 75 percent from July 1, 2003 levels combined with 10 percent discounts for transits carrying phosphate, cement, metallurgical coke and copper concentrates. This pricing option allows the Canal to retain approximately 73 percent of total potential transits (with no tolls) and in fact has additional diversions of around 15 percent of the forecasted transits under July 1, 2003 tolls. Panama Canal revenues, however, increase by 36 percent under the preferred Canal toll pricing option.

From 2011 through 2024, the preferred Canal toll pricing option is Commodity Option 2 which corresponds to a 75 percent increase in Canal tolls from the July 1, 2003 levels combined with a 10 percent discount for phosphate and cement and a 5 percent discount for metallurgical coke and copper concentrates. For 2025, the preferred Canal toll pricing option is Commodity Option 3 corresponds to a 75 percent increase in Canal tolls from the July 1, 2003 levels combined with a 10 percent discount for phosphate and cement (discounts for metallurgical coke and copper concentrates are eliminated).

None of the other Canal pricing options analyzed yield more revenue than the preferred Canal toll pricing options. In general, Canal toll revenue declines once tolls exceed 75 percent of the July 1, 2003 rates.

Tables E-7 and E-8 present Panama Canal transits, cargo and revenues under the preferred toll pricing option of a 75 percent increase combined with commodity discounts specified above for the Existing Canal and Expanded Canal scenarios. For the Existing Canal, forecasted Canal transits increase slightly from 1,529 vessels in 2004 to 1,562 vessels in 2010 and to 1,592 vessels by 2025. Forecasted canal revenues increase from \$149 million in 2004 to \$161 million in 2010 and \$174 million by 2025. Average revenue per transit ranges from \$100,000 in 2004 to \$109,000 as average vessel sizes increase.

The forecast for the Expanded Canal shows slightly lower transits and revenues than the Existing Canal scenario due to a larger average vessel size despite the slight increase in cargo volumes.

**Table E-7. Panama Canal Transits, Cargo, and Revenue under Preferred Toll Option, Existing Canal, Most Probable Case, 2000–2025**

Year	Forecast with Preferred Tolls			Forecast with Current Tolls		
	Transits (no.)	Cargo (ton 000s)	Toll Revenue ('000)	Transits (no.)	Cargo (ton 000s)	Toll Revenue ('000)
2000	1,643	49,631	163,266	1,850	57,914	110,975
2001	1,534	46,075	151,591	1,796	56,442	108,008
2002	1,475	44,713	147,069	1,771	56,179	107,338
2003	1,487	44,988	147,735	1,774	56,425	107,752
2004	1,498	45,385	148,922	1,795	57,238	109,287
2005	1,547	47,081	154,540	1,859	59,491	113,674
2006	1,522	46,637	152,957	1,834	59,037	112,761
2007	1,526	47,009	154,216	1,839	59,507	113,662
2008	1,532	47,487	155,833	1,846	60,111	114,818
2009	1,540	48,171	158,115	1,854	60,861	116,261
2010	1,562	49,074	161,221	1,877	61,927	118,312
2011	1,578	50,016	164,558	1,865	61,602	117,659
2012	1,584	50,269	165,409	1,862	61,546	117,539
2013	1,600	51,011	167,832	1,861	61,596	117,623
2014	1,603	51,194	168,496	1,864	61,749	117,905
2015	1,629	52,054	171,605	1,884	62,387	119,180
2016	1,581	51,050	168,303	1,841	61,572	117,640
2017	1,575	51,034	168,290	1,839	61,773	118,033
2018	1,573	51,161	168,774	1,853	62,397	119,280
2019	1,574	51,348	169,475	1,862	62,904	120,286
2020	1,579	51,721	170,796	1,877	63,636	121,725
2021	1,580	51,721	170,803	1,881	63,771	121,969
2022	1,578	51,773	170,976	1,883	63,947	122,298
2023	1,586	52,135	172,251	1,892	64,292	122,985
2024	1,590	52,318	172,871	1,899	64,620	123,612
2025	1,592	52,513	174,167	1,905	64,959	124,258

Source: Volume 5, Table 4-2 through Table 4-27.

**Table E-8. Panama Canal Transits, Cargo, and Revenue under Preferred Toll Option, Expanded Canal, Most Probable Case, 2010–2025**

Year	Forecast with Preferred Tolls			Forecast with Current Canal Tolls		
	Transits (no.)	Cargo (ton 000s)	Toll Revenue (\$'000)	Transits (no.)	Cargo (ton 000s)	Toll Revenue (\$'000)
2010	1,570	51,805	162,466	1,858	63,933	116,621
2011	1,547	52,588	164,749	1,839	67,795	121,713
2012	1,551	52,756	165,380	1,835	67,804	121,696
2013	1,563	53,341	167,193	1,833	67,938	121,907
2014	1,563	53,401	167,520	1,835	68,198	122,344
2015	1,589	54,377	170,907	1,853	68,972	123,780
2016	1,539	53,281	167,366	1,805	67,766	121,657
2017	1,529	53,169	167,084	1,798	67,628	121,523
2018	1,524	53,197	167,281	1,806	67,953	122,297
2019	1,521	53,266	167,651	1,812	68,359	123,148
2020	1,510	51,610	163,707	1,822	68,800	124,137
2021	1,507	51,512	163,524	1,822	68,813	124,232
2022	1,502	51,439	163,471	1,820	68,867	124,437
2023	1,507	51,671	164,508	1,826	69,089	125,002
2024	1,506	51,716	164,872	1,829	69,296	125,508
2025	1,504	51,753	165,826	1,843	70,276	127,221

Source: Volume 5, Table 4-12 through Table 4-27.