PANAMA CANAL TRAFFIC AND REVENUE STUDY

1978-2000

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INTRODUCTION

This report is the result of a study which was sponsored jointly by the Panama Canal Company and the U.S. Department of State and which had the following major objectives: (a) to project Panama Canal traffic and revenues for the period 1978-2000; (b) to conduct a sensitivity analysis of future Panama Canal traffic and estimate the effect of toll increases ranging from 15% to 150% on the projected volume of traffic; (c) to make an estimate of the maximum revenue available through tolls; (d) to analyze the long-term effect of inflation on the sensitivity of traffic to toll increases and analyze what effect the toll increases since 1974 had on the sensitivity of Canal traffic to future toll increases.

The structure of this report parallels the above mentioned objectives. The report is divided into five parts. The first part is a brief summary; the second part presents the traffic projections for the 1978-2000 period both in the aggregate and for 23 commodity categories into which total traffic has been divided. The third part is a translation of the above traffic forecasts, which were made in long tons of commodities, into equivalent forecasts of toll revenues, Panama Canal net tons and numbers of ship transits. The fourth part is the sensitivity analysis which estimates the effect of assumed toll increases ranging from 15% to 150% on the projected traffic estimates. Part of this sensitivity study is an estimate of maximum toll revenue. The fifth part is an analysis of toll sensitivity and inflation.

In the course of this study a large number of individuals associated with shipping companies, trading firms, port authorities, federal government agencies, etc., were contacted and most of them gave information that proved valuable for the preparation of this report. However, use of such information should not be construed as assigning any responsibility for the findings of this study to outside contributors. The research team was solely responsible for the selection of data for this report and the conclusions drawn from them.

The research team was led by Ely M. Brandes, President of International Research Associates. Principal contributors were Randall Chun and Ray Olzsewski, a consultant. Cameron and Elizabeth Brister were responsible for much of the statistical work; and Martha Hief, Linda Wolf, and Peggy Brandes typed the report.

The research team wishes to acknowledge the very valuable aid and assistance given to this project by Mr. Donald G. Schmidt of the Panama Canal Company, the contracting officer, and his staff. They provided the research team with a body of traffic and revenue data that was outstanding in every respect.

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PART I

SUMMARY

The scope of the study which prompted this report specified the following six tasks.

a) Project Panama Canal traffic for the period 1978-2000 in long tons of cargo for 23 commodity categories (which comprise the total ocean-going commercial traffic). Also, project the probable impact of North Slope crude petroleum shipments on total traffic.

b) Convert the above tonnage projection into equivalent projections of toll revenues, Panama Canal net tons and number of ship transits.

c) Conduct a sensitivity analysis to determine the effect of toll rate increases ranging from 15% to 150% on 1979, 1980, 1985, and 1990 projections of traffic, revenues, Panama Canal net tons and number of ship transits.

d) Prepare an estimate of maximum toll revenue based on the above projections and sensitivity estimates (including a maximum revenue curve).

e) Analyze the relationship between sensitivity to toll increases and inflation, past and present.

f) Analyze the effect of the 1974 and 1976 toll increases, as well as the 1976 revision of measurement rules on the sensitivity of traffic to future toll increases.

Below is a summary of the principal findings and conclusions with respect to the tasks listed above.

1. Traffic Projections

This report estimates that total Panama Canal traffic will increase from 123 million tons in FY 1977 to 137.4 million tons in 1978, 147.6 million tons in 1979, 149.8 million tons in 1980, 150.8 million tons in 1981, 158.5 million tons in 1985, 169.3 million in 1990, and 201.9 million in 2000.

The relatively sharp increases in traffic projected for 1978 and 1979 are entirely due to the start of North Slope petroleum movements through the Panama Canal. These shipments, which began late in FY 1977, are expected to total 16.5 million tons in 1978 and 25 million tons each in 1979 and 1980. The Alaska oil shipments will then decline to 20 million tons in 1985, 15 million tons in 1990, and 12.5 million tons in 2000. As a result of this decline, total traffic for the 1981-85 period is projected as relatively flat, as increases in other commodity categories will do little more than offset losses in petroleum shipments.

The traffic projections for 1990 and 2000, which are 169 and 202 million tons, respectively, contain an allowance for new movements amounting to 5.5 million tons in 1990 and 23.6 million tons in 2000. The reason for this allowance is that the disaggregated method of traffic projection used here does not provide for the inclusion of any movements which do not exist in some measurable quantity at present. Such allowance is not necessary for projections covering a period of 10 years or less. But beyond 10 years, the assumption must be made, based on past history, that new movements will occur and the total projection must allow for it.

For the entire period from 1977 to 2000, the projected growth rate for traffic is about 2.2% per year. This rate is considerably below the growth rate experienced over the past 20 years.

The detailed findings on this are in Part II.

2. Projection of Revenue, Panama Canal Net Tons and Number of Ship Transits

The report projects that toll revenues will total $182.3 million in 1978, $194 million in 1979, $197.5 million in 1980, $199.2 million in 1981, $209.9 million in 1985, $223.6 million in 1990 and $264.3 million in 2000.

The above projection of toll revenues was derived from the traffic projection on the basis of what are called effective toll rates. Effective toll rates are calculated measures which represent the average amount of toll revenue per ton of cargo for the 23 commodity categories for which traffic projections were made. The average effective toll rates are calculated primarily on the basis of ships carrying single commodities

and allowance is made for ballast movements which are associated with such commodity movements. It is believed that this method of converting cargo projections into revenue projections is the most accurate available.

The projections for PC net tons for the seven selected years are 145.8 million, 155.2 million, 158 million, 159.4 million, 167.9 million, 178.9 million and 211.4 million. These projections of PC tons assume an average ballast to total PC net tonnage of about 14% and an average toll revenue per PC net ton of $1.25. In recent years the ballast to total PC net tonnage ratio has ranged between 11 and 17 percent, with no apparent trend, and 14% appears to be a reasonable average.

The projections for ship transit numbers for the seven selected years are 12,691, 12,968, 12,903, 12,809, 12,743, 13,312 and 14,142. The projected rate of increase in ship transit numbers is much less than the estimated increases in cargo tonnage and revenues. A principal reason for the relatively low growth in ship numbers is the continuing trend toward more dry bulk carriers and container ships within the mix of ships transiting the Canal, and the parallel trend toward fewer general cargo ships. Dry bulk carriers and container ships, on average, are larger than general cargo ships. In addition, there is a continuing trend toward larger ship sizes within each ship type.

The method used in projecting ship transit assumes that both of these trends--the trend toward a change in ship mix and a change toward larger sizes within each ship type--will continue but at reduced rates.

The detailed findings are in Part III.

3. Sensitivity Analysis

The sensitivity analysis established that toll rate increases ranging from 15% to 50% would result in losses of traffic, on a tonnage basis, ranging from 2.4% for a 15% increase to 11.8% for a 50% increase. A 75% increase would result in a 20.6% traffic loss, a 100% increase in a 30% traffic loss, and a 150% rate increase would cause a traffic decrease of more than 50%.

In terms of revenue, however, toll rate increases from 15% to 50% would result in revenue increases ranging from 13% to 33%. Toll rate

increases of 75% or 100% would yield about the same total revenue, an increase of about 40% over the projected total. A 150% increase would yield less revenue than a 50% increase, only about 29% more than the projected total without a toll increase.

The above estimates are made in terms of projected 1985 traffic and it was assumed that a toll increase would be announced on or about 1 April 1978 and put into effect on 1 October 1978. The traffic reducing effect of toll increases tends to increase with time, at least up to seven years. In the shorter run, shippers are often constrained by contracts and are not so free to choose alternatives. As a result, estimates with respect to 1979 and 1980 show smaller traffic losses and relatively higher revenue estimates. While these short-run estimates of the effect of toll increases are useful, their value as guides for setting future toll rates is limited.

Sensitivity analysis, as conducted here, involves an inquiry into the relative cost and availability of alternatives to the Panama Canal for different commodities and different routes. The sensitivity estimates themselves are a reflection of the fact that alternatives are available to many users at a cost that is close to the cost of a Canal transit.

Estimates were also made of the effect of these assumed toll increases on the projection of PC net tons and ship transit numbers.

The detailed findings are in Part IV.

4. Maximum Revenue Estimates

Based upon the data of the sensitivity analysis, a maximum revenue curve was constructed which showed (1) that the maximum attainable revenue was approximately 40% greater than the projected revenue without a toll increase (this is based on the projection for 1990); and (2) the attainment of that revenue would require a toll increase in the range between 75% to 100%.

A number of mathematical revenue functions were derived, based upon the data points developed in the sensitivity analysis, and the two best

functional forms confirmed the estimates. They yielded maximum revenue estimates of $315 million and $323 million, respectively--as opposed to a projected revenue without a toll increase of $224 million--based on toll increases of 106% and 98%.

The shape of the maximum revenue curve developed here was similar to the one developed in Panama Canal Toll Rates: Estimates of Maximum Revenues, International Research Associates, 1975, in the sense that the maximum points are in the range of toll increases from 75% to 100%. However the two curves differ significantly in terms of maximum revenue yield. The 1975 maximum revenue estimate showed that the margin between maximum revenue and projected revenue without increase was about 50%. The present estimate shows that this margin had shrunk to 40%.

The detailed findings are in Part IV.

5. Relationship of Toll Sensitivity to Inflation: Past and Future

Inflation, which affects the cost of all economic processes, also affects the cost of operating the Panama Canal. It must be assumed that the cost of operating the Canal will continue to increase and the question arises whether this increasing cost trend will not soon match or exceed the maximum amount of toll revenue attainable. If this were to happen, the Panama Canal could no longer be operated on a self-sustaining basis.

The inquiry conducted into this subject came to the following conclusions:

a) Over the past 25 years sensitivity of Canal traffic to toll increases rose sharply. This increase in sensitivity was caused primarily by the development of alternatives to the Canal, such as containerization, trend toward larger ships, mini-bridge, etc. Until 1974, inflation played no part in this because the toll rate did not increase .

b) Since 1974, the increases in Panama Canal toll rates, which amounted to about 50% in the aggregate, were matched to some extent by increases in the cost of alternatives. Since some alternatives involve added transportation service, the sharp increases in fuel costs since 1974 were obviously an important factor. Another factor has been the substantial devaluation of the U.S. dollar which had the effect of lowering the cost of Panama Canal transit for many foreign ship operators.

c) An analysis of the trend of wholesale prices since 1958 reveals that between 1958 and 1972 price inflation averaged only 1.6% per year. Since 1972, the average annual price inflation rate has been 10%. This very sharp upturn in the trend-line makes it impossible to produce a credible projection of wholesale prices, either by statistical or analytical means, for the next 22 years.

d) Without reliable long-range forecasts concerning future inflation rates or currency value changes, one cannot make a useful projection about the Canal's ability to raise sufficient revenues to meet its costs some 22 years hence. However, it is possible to make a more positive forecast for the next five to ten years, based primarily on the conclusion that government economic policies seem to be slowing down the rate of inflation, even if only temporarily.

e) Present and future managers of the Panama Canal may be able to exercise some control over the economic life span of the Canal by controlling the size and scope of the future Panama Canal Commission and by the methods used in seeking future toll rate increases.

The discussion of these findings is in Part V.

6. The Effect of Toll Increases Since 1974

The two toll increases and the change in measurement rules, which have been put into effect since 1974, had the combined effect of a toll increase amounting to about 50%. Analysis was conducted to determine (a) the effect of the toll increases on the volume of traffic and (b) the effect of the toll increases on the present toll sensitivity as compared to findings established in 1975. In summary, the findings were as follows:

a) An analysis of Panama Canal traffic since 1974 established that the combined toll increases did cause some traffic losses. There are three traffic segments where losses can at least partly be attributed to the toll increases. These are (1) Europe-Far East container traffic; (2) by-pass coal shipments from the United States, and (3) the large expansion of mini-bridge traffic involving container traffic between the Far East and the United States.

In a complex economic setting it is often impossible to trace events to single causes. This is the case here. The principal cause in shifting most of the Far East-Europe traffic away from the Panama Canal was the re-opening of the Suez Canal and the termination of the special insurance levies with respect to the use of the Suez Canal. Still, the timing of the shift away from the Panama Canal makes it plain that the toll increases played some role in this.

The share of coal exports to Japan from Hampton Roads which by-pass the Canal, as opposed to the shipments which use it, has increased sharply since 1975. Again, other factors, like the current surplus of large bulk carriers also contributed, but the evidence is still strong that the toll increases acted as a spur.

During the last three years, mini-bridge traffic between the Far East and the eastern half of the United States increased very significantly. Time did not permit a thorough analysis of this traffic to determine how much of this gain should be regarded as normal growth and how much represents competitive capture that could be attributed in part at least to the toll increase. But many industry observers feel that a part of the loss was due to the toll increase.

b) As far as the effect of the increases on toll sensitivity is concerned, it was found, as stated earlier, that a part of the toll increase was offset by the effect of inflation on the cost of alternatives as well as by the devaluation of the dollar.

The detailed findings are in Part V.

PART II
PROJECTION OF PANAMA CANAL TRAFFIC
1978 - 2000

Introduction

This part of the comprehensive report on Panama Canal traffic, toll sensitivity and revenues contains a projection of Panama Canal traffic for the years 1978, 1979, 1980, 1981, 1985, 1990 and 2000.

The traffic projection was made in a disaggregated form for twenty-three commodity categories which account for all of the commercial ocean traffic transiting the Canal. This is accomplished by including in one of the commodity categories--general cargo and all others--all of the commodities not specifically covered by the other 22 categories.

The projections were made on the basis of extensive interviews with trade and government sources, covering practically all of the principal commodities included in Panama Canal traffic. While all of the information received was carefully considered, the estimates themselves represent solely the considered judgment of the research team and cannot be attributed to any of the sources.

This part consists of a summary chapter in which the traffic projections for the selected years are totalled. This is followed by a series of commodity chapters in which the traffic projections for the individual commodity categories are discussed. Finally, there is an appendix which deals with the allowance for new movements which is included in the traffic projection for 1990 and 2000.

Summary

The projection of Panama Canal traffic for the period 1978-2000 shows that cargo tonnage for ocean going traffic will reach a total of 137.4 million tons in FY 1978, 147.6 million tons in FY 1979, 149.8 in FY 1980, 150.8 in FY 1981, 158.5 in FY 1985; 169.3 in FY 1990 and 201.9

million tons in 2000. By comparison, the cargo tonnage for ocean going traffic for FY 1977 was 123 million tons.

The projections for the years 1990 and 2000 contain new movement in allowances which amount to 5.5 million tons in 1990 and to 23.6 million tons in 2000. The purpose of these allowances - which are fully explained in Appendix A - is to include new commodity movements which are likely to develop in future Panama Canal traffic but which cannot be forecast specifically 10 years or more before their occurrence.

The relatively sharp increases in traffic volume between 1977, when traffic totalled 123 million tons, and 1978 and 1979, when the traffic totals are projected for 137.4 and 147.6 million tons, respectively, are almost totally accounted for by sharp increases in Alaska and shipments which are scheduled for March or April 1978 (the Alaska oil movements, themselves, began in the summer of 1977). In contrast to this large two year increase, traffic growth during the 1980's, partly because of the Alaska oil shipments, which will reach their high point in 1979, will begin to decline. A full discussion of the projected Alaska oil shipments is contained in the section on "Crude Petroleum and Petroleum Products."

Table I shows the traffic projections for the years 1978 - 2000, broken by 23 commodity groups. In the following sections, the projections for the individual commodity groups are discussed.

TABLE L

PROJECTION OF PANAMA CANAL TRAFFIC
1978 - 2000
('000 LONG TONS)

COMMODITY CATEGORY	1977[1]	1978	1979	1980	1981	1985	1990	2000
Wheat & wheat flour	3,616	4,200	4,000	3,700	3,800	4,000	4,300	4,900
Coarse grains	14,856	15,000	15,500	15,900	16,600	19,100	22,200	27,500
Bananas	1,603	1,650	1,700	1,750	1,800	2,000	2,250	2,500
Sugar	3,636	3,600	3,610	3,610	3,620	3,675	3,700	3,800
Soybeans	4,485	4,800	4,900	5,100	5,200	5,600	6,200	7,500
Lumber	4,966	4,700	4,900	4,900	5,000	5,100	5,100	5,200
Wood pulp, paper & paper products	3,003	3,000	3,000	3,100	3,100	3,200	3,300	3,500
Phosphates	3,887	3,800	3,900	4,100	4,400	4,700	4,900	5,100
Fertilizer, potash & fishmeal	2,374	2,600	2,800	2,900	3,000	3,200	3,400	3,600
Iron ore	2,793	2,400	2,200	2,000	2,000	2,000	2,000	2,000
Miscellaneous ores	3,083	3,200	3,350	3,500	3,600	3,900	4,200	4,900
Scrap metal	1,291	1,300	1,600	2,000	2,200	2,400	2,600	2,600
Alumina & bauxite	1,175	1,235	1,290	1,335	1,380	1,570	1,795	2,200
Miscellaneous metals	1,640	1,600	1,600	1,600	1,600	1,600	1,600	1,600
Coal	12,921	12,300	12,800	13,400	13,900	16,600	17,900	19,500
Crude Petroleum	12,597	27,200	34,900	34,200	32,200	29,200	24,200	21,700
Petroleum Products	10,096	10,200	10,500	11,000	11,000	11,000	11,000	11,000
Chemicals	3,144	3,400	3,450	3,500	3,550	3,750	4,100	4,600
Sulfur	1,240	1,200	1,250	1,250	1,300	1,400	1,500	1,700
Other non-metallic minerals	1,185	1,100	1,100	1,100	1,100	1,200	1,300	1,400
Iron & steel mfrs.	8,720	8,400	8,600	8,800	9,000	10,200	11,600	14,000
Autos & trucks	1,288	1,400	1,445	1,500	1,565	1,730	1,750	1,750
General cargo & all other	19,378	19,100	19,170	19,570	19,900	21,400	22,900	25,750
Allowance for "New Movements"							5,456[2]	23,643
TOTAL	122,977	137,385	147,565	149,815	150,815	158,525	169,251	201,943

[1]Fiscal years ending September 30.

[2]According to the assumptions made concerning new movements, these will begin in 1988 and amount to 1,818,000 long tons and total 3,657,000 tons in 1989. (See Appendix A, Part II)

1. WHEAT AND WHEAT FLOUR

Background

Wheat is the principal food grain of Europe and North America, and, in recent years, wheat consumption has also been increasing in many countries of Asia and Africa. Since the climatic and soil requirements for wheat cultivation are fairly stringent, much of the recent growth in wheat consumption must be supplied through imports.

Total world trade in wheat and wheat flour has exceeded annual totals of 65 million tons with some of the highest totals occurring during the 1972-73 crop failure in the Soviet Union.[1] The United States, Canada, Australia, Argentina and the European Economic Community are principal exporters of wheat, as well as the Soviet Union during normal crop years. Major importing regions are Asia, the Middle East, Latin America and Europe.[2]

Wheat is not a homogeneous commodity; there are, in fact, many types and grades of wheat ranging from hard wheat for bread making to soft wheat for cakes and to specialty wheats such as durum for making noodles. As a result, many countries in Europe are exporters of some grades of wheat and importers of others. Also, because of the many varieties of wheat, most individual wheat shipments tend to be in the 15,000 to 30,000 ton range with ship sizes to match this range. This is unlike coarse grains where larger shipments have become standard.

The Role of the Panama Canal

In relation to world wheat trade, shipments of wheat through the Panama Canal have been relatively small, ranging from 2.1 to 4.8 million tons in recent years. (1974 and 1975 were exceptional years in wheat shipments through the Canal because of large exports from the U. S. and Canada to both the U.S.S.R. and China.)

The principal trade routes for wheat are from the U.S. Gulf to the Far East and from the U.S. Gulf to the west coast of South America and

Central America. Some years ago, there were substantial wheat exports from the west coast of Canada to Europe and sometimes even shipments from the east coast of Canada to the Far East; but in most recent years Canada has been able to route its wheat exports, east and west, in such a way so as to eliminate most shipments through the Panama Canal.

Recent Events and Projections

The present outlook for future wheat traffic via the Canal is for a sharp increase for 1978, declines in 1979 and 1980, followed by a moderate growth rate in the ensuing period. Record wheat production in the U.S. during the past two years has contributed to an enormous wheat surplus. Actions by the U.S. government will probably result in a substantial increase of exports to both Asia and South America during the next two years.[3] U.S. exports will increase also to the U.S.S.R. primarily as a result of a poor crop year in Rusia, but only a fraction of exports to the U.S.S.R. are shipped via the Panama Canal. The volume of wheat shipped under the PL 480 Program may also increase. In total, the volume of wheat and flour shipments will increase to 4.2 million tons in 1978 and then decline to 4.0 million in 1979 and 3.7 million tons in 1980. By 1980 the wheat surplus will have been reduced and exports will return to lower levels.

Over the longer period, both Japan and Korea will increase their wheat imports. However, the emphasis will be to purchase greater amounts of hard spring wheat shipped from the Pacific Northwest rather than the winter wheat shipped out of the Gulf.

There may be some future shipments to the People's Republic of China. However this is no more than a possibility, at present. If the Chinese government adheres to its present policies, it must be expected that any purchases from the United States will again be sporadic.[4] The projection made here assumes no large and regular Chinese purchases of wheat. Should the PRC become a large and regular purchaser of U.S. wheat, such shipments would be included in the special allowance made for "new movements" in the projection for the years 1990 and 2000.

Wheat shipments to Latin America are expected to increase, but the rate of increase will depend on the economic conditions of these countries

since most of the grain is purchased on a cash basis. The rise of oil prices has enabled countries such as Ecuador to increase its imports. For most of these countries, the U.S. will supply some of the growing demand; but increasing competition will come from Argentina and perhaps even Mexico.

Canadian shipments via the Canal will not change radically. Current movements are more accidents of timing, shipping rates, and positioning, since Canada generally attempts to export its grain from both coasts so as to avoid use of the Panama Canal. The internal transportation system and port loading facilities are adequate on both coasts; however various unforeseen or unavoidable events--such as weather and strikes--occasionally make it necessary for Canadian wheat shipments to be routed via the Panama Canal.

Table 2

SUMMARY OF PAST AND PROJECTED SHIPMENTS

WHEAT AND WHEAT FLOUR

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	304	506	2,626	1,980	1,041	1,180
EC US → WC SA	293	375	1,357	1,393	1,203	1,175
EC Can → Asia	-	14	252	812	7	201
WC Can → Europe	482	140	180	81	273	304
Other	1,052	337	375	468	700	756
TOTAL	2,131	1,372	4,790	4,734	3,224	3,616

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	1,600	1,450	1,300	1,350	1,450	1,600	2,000
EC US → WC SA	1,400	1,350	1,200	1,250	1,300	1,400	1,500
EC Can → Asia	200	190	185	180	175	150	100
WC Can → Europe	300	300	300	300	325	350	400
Other	700	710	715	720	750	800	900
TOTAL	4,200	4,000	3,700	3,800	4,000	4,300	4,900

Source: Panama Canal Company, Annual Report and International Research Associates

2. COARSE GRAINS

Background

The classification of coarse grains, as used by the Panama Canal Company, includes primarily feed grains such as corn, sorghum, barley, and oats. Of these four feed grains, corn is by far the most important, sorghum and barley rank second and third, and oat shipments are so small as to be insignificant.

World trade in coarse or feed grain has expanded much more rapidly in recent years than wheat trade, partly because of the very rapid increase in meat consumption in the developed areas, but mainly because most developed countries, other than the United States, do not have the agriculture potential for large scale feed grain production. Furthermore, only the United States has the production capacity for large scale feed grain exports on an assured basis. As a result, the United States has become the principal exporter of feed grains, by a wide margin; and in recent years such exports have totalled more than 50 million tons. Corn exports account for about 80 percent of the total, sorghum for about 12 percent, and barley and oats for the remainder.[5] The principal importers of feed grains are Europe, and particularly the EEC countries, Japan, and the U.S.S.R.

The Role of the Panama Canal

More than 90% of coarse grain shipments through the Panama Canal are from the United States to the Far East, principally Japan. It is very significant that this movement, which in 1977 amounted to more than 12 million tons, did not start in any amount until 1950. Since then, the growth has been both rapid and consistent.

In addition to this large movement, there are smaller movements from the U.S. east coast to the west coasts of South America and Central America, and from the west coast of Canada to Europe, the latter consists primarily of barley.

Coarse grain shipments through the Canal, particularly of corn and sorghum, are generally made in large bulk carriers of 25,000 to 55,000 tons.

Recent Events and Projections

The future outlook for shipments of coarse grains via the Panama Canal is reflected in a projected rise in the total volume of movements from 15 million tons to 27.5 million tons by the year 2000. The basis for this optimistic outlook stems from an analysis of the current consumption pattern of feed grain in Japan and the growing importance of poultry and pork in the daily diet of the Japanese. It also reflects an analysis of the relative consumption levels of meat in Japan and the United States. Finally, the projections take into account the effect of competition and of the alternatives available to shipping via the Canal.

Recent events have indicated that the growing demand for meat in Japan is so well established that the rate of increase in consumption is hardly effected by temporary declines in the economy. (There was a drop in feed grain imports during 1975 and 1976 as a result of the inventory buildup during 1974. But in 1977 imports recovered sharply even though the recession continued.)

It is expected that this shift will continue in the long run since the per capita consumption of meat in Japan is far below that of the United States. In 1976, the Ministry of Agriculture and Forestry in Japan compared the annual per capita consumption of selected food items in Japan and the U.S., for 1960, 1971 and 1975.[6] In 1975 the Japanese consumed about 35 pounds of meat per person as compared to 7 pounds per capita in 1960 and 29 pounds in 1971. In comparison, the consumption pattern in the U.S. went from 168 per capita in 1960 to 194 pounds in 1975 (Table 3.) It should be noted that even when fish is included in the comparison, there is still considerable room for increased meat consumption. Finally, the recent actions by many countries to impose a 200 mile fishing limit on foreign fishing may have the long run effect of reducing the growth in fish consumption in Japan. This will undoubtedly result in additional demand for meat and feed grain.

Table 3

JAPAN: ANNUAL PER CAPITA CONSUMPTION, SELECTED FOOD ITEMS, RETAIL WEIGHT BASIS IN 1960, 1971 AND 1975

	Japan			U.S.		
	1960	1971	1975	1960	1971	1975
	Pounds/Cap					
Beef and Veal	2	5	6	70	86	92
Pork	2	11	14	60	68	51
Lamb and Mutton	1	4	4	4	3	2
Poultry	2	9	11	34	49	49
Total Meat	7	29	35	163	206	194
Fish (edible weight)	61	73	76	13	15	15
Total Meat and Fish	68	102	111	181	221	209
Rice (milled)	253	205	194	6	8	7
Potatoes	67	36	35	109	105	106
Barley	9	2	2	1	1	1
Wheat flour	57	68	69	118	110	107
Fats and oils	21	22	25	49	55	56
Sugar (refined)	33	59	58	97	102	90
Total	440	392	383	380	381	367

Source: See Footnote #6.

The Gulf ports will likely continue to be the major grain export region because of the large and efficient grain export terminals located there as well as the relatively low barge rates available for movements down the Mississippi River.

Most of the grain exported from the Gulf to Japan will be routed via the Canal. Although the freight rates on large bulk carriers, which are routed via the Cape of Good Hope, may be cheaper, there are at present certain economic and institutional barriers which thus far have prevented grain shipments of 100,000 tons or more to Japan. (There have been such large shipments to Europe.) However, there are indications that in the next few years, attempts will be made to ship a portion of the coarse grain exports to Japan via the Cape of Good Hope, and these bypass shipments are likely to grow with time and with increases in tolls.

Table 4

SUMMARY OF PAST AND PROJECTED SHIPMENTS

COARSE GRAINS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	2,478	6,577	12,599	7,806	9,678	12,618
EC US → WC CA	16	9	656	500	290	515
EC US → WC SA	28	212	392	436	334	377
Other	594	476	422	210	910	1,346
TOTAL	3,116	7,274	14,069	8,952	11,212	14,856

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	12,800	13,250	13,600	14,250	16,500	19,200	24,000
EC US → WC CA, WC SA	900	925	950	975	1,100	1,300	1,600
Other	1,300	1,325	1,350	1,375	1,500	1,700	1,900
TOTAL	15,000	15,500	15,900	16,600	19,100	22,200	27,500

Source: Panama Canal Company, Annual Report and International Research Associates

3. BANANAS

Background

Bananas are an important food staple in many tropical countries as well as a significant export commodity. More than 35 million tons of bananas are produced annually, and about 7 million tons are exported. Some large producers of bananas, such as India and Brazil, export only minimal amounts; but for many countries, particularly in Central America, bananas are among the most important export products.

The banana export trade is quite complex because of the nature of the fruit and the physical requirements relating to its shipment. Bananas must be harvested when they are green and kept in storage for 4 to 6 weeks to reach maturity. After six weeks, bananas deteriorate rapidly. During the ripening process, bananas must be kept at a temperature of around 50^{o}. Because of this, most bananas are shipped in special refrigerator ships. The vessels used in this trade are generally small because the limited storage life of bananas makes shipment of large quantities impractical. In addition, bananas are easily bruised and require careful handling.

The principal banana exporters are in Central and South America, and include Honduras, Panama, Costa Rica, Guatemala, as well as Ecuador and Colombia in South America.[8] Banana trees are susceptible both to disease and wind damage; and both of these have, from time to time, inflicted considerable damage on banana plantations, particularly in Central America. In recent years, Ecuador has become the largest banana exporter in the world, partly because of a development of a new banana type which is disease resistant and also because Ecuador is not in the hurricane belt and experiences fewer tropical storms than Central America.

The Role of the Panama Canal

The Panama Canal plays a significant role in banana trade as more than 25 percent of all banana exports pass through the Canal. The principal shipments are from the west coasts of South America (Ecuador and Colombia) and from Central America to Europe, and from the same

origin points to the east coast of the United States. The former account for slightly more than 50 percent of total shipment, while the latter amount to about 35 percent. Banana shipments through the Canal have shown a steady increase over the last 10 years which has been primarily due to increases in shipments to Europe.

Recent Developments and Projections

During the last four years, banana shipments have ranged from about 1,450,000 to 1,680,000 tons and there has been some shift in the origin of exports. Specifically, exports from Ecuador to both the United States and Europe have increased, while shipments from Central America have remained unchanged or declined somewhat. Part of this can be attributed to the fact that the Central American countries imposed a special export tax on bananas amounting to 25 cents per 40 pound box.

Banana shipments through the Canal can be expected to grow at a rate of about 2-3% per year which is somewhat less than the growth rate over the past ten years. Most of the growth is likely to occur in shipments to Europe where per capita consumption of bananas still seems to be increasing. (This is particularly true in Eastern Europe.) Per capita consumption in the United States has been relatively stagnant for some time.

Total banana shipments are projected to increase from about 1,600,000 tons in FY 1977 to 1,650,000 tons in FY 1978 and then gradually rise to 2,500,000 tons in the year 2000.

No significant change is projected in the shares of exports as between South America and Central America; but this is done principally because there is no present evidence that any specific future changes are likely to occur. However, there is a past history in the banana industry of significant geographical shifts; and given the fact that the present projection is for 23 years, it is quite possible that there will be additional and significant shifts in the future. (For instance, the Dominican Republic was a significant banana exporter until 1962 when nearly $12 million worth of bananas were shipped. At present, there are no significant banana exports from there.)[9]

Table 5

SUMMARY OF PAST AND PROJECTED SHIPMENTS

BANANAS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC CA → Europe	16	71	260	211	238	215
WC SA → Europe	431	512	626	714	649	670
WC CA → EC US	297	328	246	278	151	191
WC SA → EC US	573	234	308	346	299	354
Other	2	92	47	134	174	173
TOTAL	1,319	1,237	1,487	1,683	1,511	1,603

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC CA, WC SA → Europe	915	940	960	985	1,090	1,195	1,350
WC CA, WC SA → EC US	555	560	580	605	660	775	850
Other	180	200	210	210	250	280	300
TOTAL	1,650	1,700	1,750	1,800	2,000	2,250	2,500

Source: Panama Canal Company, Annual Report and International Research Associates

4. SUGAR

Background

Sugar is an important bulk commodity in world trade as most developed countries import a considerable portion of their total requirements. Since 1970, the sugar market has also been characterized by violent price fluctuations and considerable changes in trading patterns. One factor which precipitated the change in trading patterns has been the expiration of the United States Sugar Act and the start of U.S. sugar imports from many countries in the world. The sharp increases in the price of sugar during 1973-74 prompted a large scale expansion of facilities to produce sugar substitutes such as corn sweeteners. This trend was helped by the fact that in recent years a large portion of sugar consumption has shifted to industrial use--as in the manufacture of soft drinks--where corn sweeteners can be more readily used.

Sugar is shipped both as raw sugar and refined sugar; but in recent years there has been a shift toward larger shipments of raw sugar.

The principal sugar producing and exporting countries in the world are Cuba, Brazil, India, Philippines, Mexico and Australia. Many other Latin American countries including Colombia, Ecuador and Peru are also significant producers and exporters. Historically, producing countries have attempted to maintain some control on the market by imposing sugar export quotas and price stabilization mechanisms, and the long-term outlook is that they will have some success in doing so.

The Role of the Panama Canal

Because of the past prevalence of special trade agreements covering sugar, there has always been a fair amount of cross-hauling of sugar through the Canal. This pattern has persisted to the present. Most of the shipments from the Pacific to the Atlantic involve imports by the United States from Asia, Hawaii, the west coasts of South and Central America and from Australia.

In contrast, shipments from the Atlantic to the Pacific are primarily exports from Cuba and other Carribean origins to the Far East, principally Japan and China.

Sugar shipments through the Canal have averaged about 4 million tons a year in the past decade. Of this amount, about two-thirds involved U.S. imports. A large portion of the remaining amount consisted of sugar from Cuba to Japan and the People's Republic of China.

Recent Developments and Projections

In recent years there have been some rather substantial changes taking place in the world sugar market: sugar prices have fluctuated widely from 5 cents/lb to more than 50 cents/lb; Congress, in 1974, did not extend the Sugar Act and thus allowed, to some extent, free trading among countries supplying sugar to the U.S.; and finally, the world sugar producers, in 1976, allowed the International Sugar Agreement to expire. However, according to latest reports, a new International Sugar Agreement may be completed and ratified by 1978.

Although total traffic increased, these trends were mirrored to some extent in the fluctuations of total shipments which increased from 3.1 million tons in 1965 to 5.1 million tons in 1974 and then declined to 3.6 million tons in 1977.

A significant change in recent years was the sudden rise and decline of Japanese imports of raw sugar from Cuba. The Japanese, apparently unwilling to continue importing high priced Cuban sugar, have begun to search out sources closer to home and at lower prices.

It is expected that sugar traffic via the Canal will not grow substantially in the near or long term. In fact, overall sugar traffic could, in the long run, begin to decline slightly. This conclusion is based on probable assumptions concerning both future sugar consumption and trading relationships.

The level of sugar consumption in the United States has not changed radically over the past few years (ranging between 10 and 11 million tons annually). Sugar consumption on a per capita basis has actually declined from 102 pounds per capita to 95 pounds per capita.[10] The growth in

Table 6

SUMMARY OF PAST AND PROJECTED SHIPMENTS

SUGAR

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
Pacific Basin → EC US	1,877	1,948	2,421	1,863	2,004	2,264
West Indies → Asia	607	1,466	1,722	1,268	565	522
Other	636	793	947	1,122	878	850
TOTAL	3,120	4,207	5,090	4,253	3,447	3,636

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Pacific Basin → EC US	2,200	2,190	2,180	2,170	2,150	2,100	2,000
West Indies → Asia	540	550	550	560	575	600	700
Other	860	870	880	890	950	1,000	1,100
TOTAL	3,600	3,610	3,610	3,620	3,675	3,700	3,800

Source: Panama Canal Company, Annual Report and International Research Associates

population has been responsible for maintaining the overall level of consumption where it is. Also, it is expected that the level of sugar imports will remain roughly between at 40 to 50 percent of total sugar consumed in the United States. Domestic production has remained relatively stable with output ranging from 5.3 to 6.8 million tons. The land on which sugar is grown can also be used to grow corn and other feed grain. Any increase in the level of domestic sugar production would tend to depress the price of sugar and thus result in a shift to other higher income-yielding products.

The emergence of the High Fructose Corn Sweeterner (HFCS) has had considerable impact on the market. The process of deriving sweetener from corn is still a high cost operation and requires sugar prices beyond the current 8-9 cents/lb to become competitive. At the present, HFCS consumption is about one million tons; however, prices for sugar above 15 cents/lb would stimulate additional production of sweetener.[11]

In the next few years, there may be several opportunities to reduce the volume of sugar which is cross-hauled via the Panama Canal. For instance, some importers are seeking to increase sugar imports from the Atlantic basin in lieu of shipments from Asia. Also, a change in U.S.-Cuban relationship may result in some renewal of sugar imports from Cuba. For that reason, the projections made for shipments here are relatively flat, both with respect to U.S. imports and shipments from the West Indies to Asia.

5. SOYBEANS

Background

World trade in soybeans has expanded rapidly in recent years and now totals more than 25 million tons annually. (This amount does not include separate shipments of soybean meal and soybean oil--the two principal soybean products--which amount to several million tons a year also.) Most of this expansion in soybean trade has occurred as a result of the expansion of soybean production in the United States where it is now the second largest agricultural cash crop.

The expansion of soybean exports is related to the rise of protein consumption around the world. Soybean meal is an important protein feed material and has become an indispensable component of poultry and livestock production around the world. The only competitive material to soymeal is fishmeal, the production of which is very irregular and largely dependent on the appearance of anchovies off Peru.

Soybean oil, the other constituent of soybeans, has become the world's most important vegetable oil, replacing and supplementing the more expensive olive oil and cottonseed oil.

Before World War II, Mainland China was the principal source of soybeans. Since World War II, the United States has become the primary producer and exporter of soybeans with an annual production of around 50 million tons and exports amounting to about 40 percent of the crop. During the last ten years, Brazil has also become a significant producer and exporter of soybeans.[12]

Western Europe and Japan are the principal importers of soybeans, but the Soviet Union and some Latin American countries, such as Mexico, have begun to import soybeans in increasing amounts.

The Role of the Panama Canal

Most of the soybeans shipped through the Panama Canal are destined for Japan, with some lesser amounts going to Taiwan and Korea. Japan

is unique among soybean users in that a significant portion of its total soybean consumption is for a direct food use rather than as a raw material for the production of soymeal and oil.

Soybean shipments from the U.S. to the Far East have increased steadily in recent years and currently average more than 4.5 million tons annually. Most shipments of soybeans are made in large bulk carriers of 25,000 to 50,000 tons.

Recent Events and Projections

Growth in the volume of U.S. soybeans exported via the Canal has been steady over the recent years. Tonnage increased from 3 million tons in 1970 to 4 million tons in 1977. Until recently, soybeans were imported by Japan principally for food value and to be crushed for oil. Since soybean meal, a by-product of the crushing process, was found to be a principal source of protein in livestock feed, the use of soybeans has been broadened from a food product to that of a feed ingredient. However, as evidenced by the recent modest rate of growth of soybean imports versus the enormous rise in feed grain imports, soybean meal is used in limited amounts and only for specific applications.

It is expected that over the next 23 years, the volume of soybeans shipped will continue to grow at a moderate rate, increasing from 4.8 million tons in 1978 to 7.5 million tons in 2000. This rate of growth is less than that experienced over the last 12 years. The reduction in the growth rate is justified because since 1973 there has been fluctuation in annual shipments but no consistent growth.

The United States will continue to be the principal supplier although it now faces some competition from Brazil.[13] However, despite the large investment made by the Japanese in Brazilian soybean farms, Brazil is not expected to capture more than 10 percent of the market.[14] In the past, China (PRC) has been a large producer and exporter of soybeans to Japan. However, given China's ever growing problem of feeding its population, it is doubtful that it will continue large scale soybean exports.

Table 7

SUMMARY OF PAST AND PROJECTED SHIPMENTS

SOYBEANS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	1,515	3,029	3,981	3,145	4,167	4,046
Other	154	263	379	339	260	439
TOTAL	1,669	3,292	4,360	3,484	4,427	4,485

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	4,300	4,400	4,550	4,650	5,050	5,600	6,800
Other	500	500	550	550	550	600	700
TOTAL	4,800	4,900	5,100	5,200	5,600	6,200	7,500

Source: Panama Canal Company, Annual Report and International Research Associates

6. LUMBER

Background

The category Lumber contains a number of diverse products all of which are shipped extensively in world trade. The product which accounts for the largest volume in world trade, and in shipments through the Panama Canal, is sawn timber, softwood. North America, the Soviet Union, and northern Europe are three principal softwood timber growing regions of the world and most exports originate from there.

A second product group is wood based panels, including plywood, veneers and particle board, in which production and exports have been growing rapidly in recent years. Finally, the category also includes hardwood logs and lumber. Hardwoods are primarily exported from Southeast Asia and Latin America.

The Role of the Panama Canal

Lumber shipments through the Panama Canal contain the three principal components of this category mentioned above. Softwood lumber is shipped from the west coasts of Canada and the United States to the east coast of the United States and to Europe. Plywood is shipped from the Far East and Western Canada to the United States and Europe; hardwood is shipped from Southeast Asia to Europe.

In terms of volume, the most important shipments are from the west coast of Canada to Europe and to the United States. These account for about 60 percent of all lumber shipments and they consist primarily of softwood lumber and plywood. About 20 percent are shipments from Asia containing both hardwood timber and wood panels, and about 15 percent are shipments from the west coast of the United States to Europe. Twenty years ago and more, there were large intercoastal shipments of lumber from the west to the east coast of the United States. These have almost completely disappeared as most western lumber is shipped by rail or truck. Sawn softwood timber is shipped in bulk carriers but other lumber products are carried in general cargo ships.

Recent Events and Projections

A recent Food and Agriculture Organization report on European Timber Trends and Prospects to 2000 showed a consistent increase in sawn wood consumption from 1965 to 1973.[15] In contrast, the volume of British Columbian (BC) lumber exports to Europe via the Panama Canal since 1965 has fluctuated widely, but on the whole has shown no consistent increase. Scandinavian, U.S.S.R. and Eastern Canadian producers have provided the major competition in this market. The Scandinavians are highly efficient producers and the Russians have enormous reserves and ship huge quantities of lumber at one time, and essentially flood the market. However, the key factor responsible for the level of sales to Europe is Canadian marketing strategy.

The principal market for Western Canadian lumber is the United States. In 1976 nearly 60 percent of the total lumber production in British Columbia was exported to the U.S. as compared to 8 percent for European imports.[16] There is a difference in the lumber dimensions used in the U.S. and Canada versus those of Europe. Therefore, while it is desirable to maintain the European market (and a substantial effort is made to do so), the Canadians have a larger stake in the U.S. market and they can compete more effectively here rather than Europe.

Estimates of future lumber exports from BC to Europe indicate only a modest increase from a low year of 1.3 million tons in 1978 to an average 1.7 million tons by 2000. There is some potential for a further increase in exports but this depends on a series of factors. Because of the growth in population and standard of living in Europe, there will be growth of demand for lumber. According to industry sources, the Scandinavians are producing at capacity with respect to their sustained yield capability. Western Canada has additional untapped reserves, but these reserves are further inland and are more expensive to log.

Canadian exports to the east coast of the U.S. have also fluctuated widely since 1965. In recent years, waterborne shipments from Canada, which represent between 10 to 20 percent of the total lumber exports to the U.S., have been struggling to maintain a share of the market. Western

Canadian lumber must compete with lumber mills in the Pacific Northwest, Southern pine producers and with Eastern Canadian producers. The competition is quite fierce in this market and although waterborne shipments have lower freight costs, the ability of the local producers to provide faster service on special orders has offset this cost disadvantage.

In the long run, therefore, Canadian exports from the coastal region to the United States are likely to decline; and Canadian lumber producers are looking to the Far East, primarily Japan, to replace the lost U.S. market which, on the whole, can apparently be served by Canadian interior mills using land transportation.

In the short run, however, Canadian waterborne lumber shipments to the United States may rise somewhat as a result of a 5 to 10 percent increase in freight rates for rail shipments of lumber from Canada which is widely anticipated by the industry. However, after some adjustment, it is expected that lumber shipments from Canada will decline again.

In summary, Canadian shipments to the United States via the Panama Canal are likely to decline in the long run, primarily as a result of increased competition from a variety of sources, including rail shipments from Canadian mills.

U. S. exports of lumber to Europe consist principally of high quality clearcut lumber, free of knotholes and imperfections, and this product faces little competition from other sources. However, the lumber is from old growth stands, the supply of which is limited. Therefore, it can be expected that the volume of shipments will decrease by 2000 because of the supply limitations.

The final major category of lumber shipments via the Canal consist of hardwood and plywood exports from Asia (Philippines and South Korea) to the east coast U.S. There has been some growth over the past dozen years and it is expected that the growth will continue at a reduced rate.

Table 8

SUMMARY OF PAST AND PROJECTED SHIPMENTS

LUMBER

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC Can → Europe	1,609	1,331	1,725	869	1,034	1,534
WC Can → EC US	1,149	1,299	1,329	786	846	1,223
WC US → Europe	196	392	474	202	609	495
Asia → EC US	319	629	842	668	870	845
Other	1,492	1,087	1,429	1,061	725	869
TOTAL	4,765	4,738	5,799	3,586	4,084	4,966

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC Can — Europe	1,300	1,350	1,350	1,400	1,500	1,600	1,700
WC Can → EC US	1,200	1,400	1,350	1,350	1,250	1,200	1,000
WC US → Europe	500	450	450	450	400	300	300
Asia → EC US	800	800	800	800	850	900	1,000
Other	900	900	950	1,000	1,100	1,100	1,200
TOTAL	4,700	4,900	4,900	5,000	5,100	5,100	5,200

Source: Panama Canal Company, Annual Report and International Research Associates

7. WOOD PULP AND PAPER

Background

Canada and the United States are the leading producers and exporters of wood pulp and paper; and Western Europe and Japan are the leading importers of pulp and paper. It is not surprising, therefore, that wood pulp and paper is a significant commodity in Panama Canal traffic.

In spite of the fact that the paper industry has shown a remarkable growth rate on a worldwide basis--averaging perhaps 6-7 percent per year over the last 20 years--the industry is also characterized by wide cyclical swings of recession and prosperity.

In addition to Canada and the United States, the Scandinavian countries and the U.S.S.R. are significant producers of wood pulp and paper. However, Europe's consumption of paper far exceeds production in that region.

The Role of the Panama Canal

The principal movements for wood pulp are from western Canada and the west coast of the United States to Europe. In 1975 these two movements accounted for nearly 90 percent of all wood pulp shipments through the Canal.

Shipments of paper tend to be more diversified and they include movements of paper--primarily newsprint--from the east coasts of the United States and Canada to the Far East and from Europe to the west coast of the United States. But even here, shipments from the west coast of Canada and the United States to Europe are the most important. (One reason for the cross-hauling of paper is the fact that some newspapers have ownership ties or long-term purchasing contracts with faraway newsprint mills.)

Wood pulp is primarily shipped in bulk carriers; paper is shipped in bulk carriers, general cargo ships and even container ships.

Recent Events and Projections

The growth in the volume of pulpwood, wood pulp and paper products shipped from Canada to Europe via the Panama Canal has been very substantial since 1965. This reflects the pattern of increased demand for all forms of paper products which are used for a variety of purposes ranging from high gloss paper to packaging and cardboard. Paper and paperboard consumption in Europe grew from about 10 million metric tons in 1950 to 40 million metric tons by 1970. Projections made by an FAO group on timber trends in Europe for 2000 indicate an equally strong rate of growth ranging from 100 to 160 million metric tons by 2000.[17]

North American pulpwood is particularly desirable because of the strength derived from the long fibers present in trees found in Western Canada and the U.S. Pacific Northwest. It is expected that due to this premium quality, there will be considerable demand for Canadian lumber and an increase in the volume of pulpwood shipments via the Canal.

However, the following factors should be noted. Although wood pulp and paper products are major industries in their own right, the rate of production is still tied to the lumber industry; and as such, the potential growth is limited by the volume of lumber which is harvested. As indicated in a previous section on lumber products, the Canadian lumber industry is still operating far below its conceptual sustained yield capacity. The problem is the high marginal cost of logging the less accessible timber.

The second limiting factor, and perhaps even more important, is the fact that the United States is still the major export market for Canadian pulp. And given the entry of the Japanese and other Asian countries as major consumers and importers of pulp, it is likely that the Canadians will look towards the closer markets to sell any increased exports. Consequently, the projected estimates of Western Canada pulpwood movement via the Canal are very conservative, increasing only from 1.6 million in 1978 to 2 million in 2000.

Estimates of future movement of pulpwood and paper products of the "other" category are also conservative. Because, as discussed previously, of the institutional and long-term ties established by producers and consumers, the practice of cross-hauling paper products will continue. But it does not appear that there will be any major growth in such movements.

Table 9

SUMMARY OF PAST AND PROJECTED SHIPMENTS

WOOD PULP AND PAPER PRODUCTS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC Can → Europe	371	1,178	1,502	1,770	1,196	1,644
Other	1,098	1,669	1,843	1,682	1,262	1,359
TOTAL	1,469	2,847	3,345	3,452	2,458	3,003

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC Can → Europe	1,600	1,600	1,650	1,650	1,700	1,800	2,000
Other	1,400	1,400	1,450	1,450	1,500	1,500	1,500
TOTAL	3,000	3,000	3,100	3,100	3,200	3,300	3,500

Source: Panama Canal Company, Annual Report and International Research Associates

8. PHOSPHATE ROCK

Background

Phosphate rock is the principal raw material required for the production of phosphatic fertilizers. Since the production of phosphate is highly concentrated--the United States, the U.S.S.R. and Morocco produce more than 75% of it--there is extensive world trade in phosphate rock. The United States is the largest producer and exporter of phosphate rock at the present time; in the future, however, it is expected that Morocco's exports will grow more rapidly because the deposits in the United States which are most convenient for export--they are located in Florida--are rapidly being depleted.[18]

While the use of phosphatic fertilizers has shown a steady increase over the past 25 years, prices for both phosphate rock and fertilizers have shown considerable fluctuations in recent years with unfortunate effects for both producers and users. Phosphate rock mining, which in the United States is strip mining, has also been affected by environmental control legislation.

The Role of the Panama Canal

More than 90 percent of all phosphate rock shipments through the Panama Canal originate on the east coast of the United States (Florida) and are destined either for the Far East (Japan or Korea), west coast of South America or western Canada. The remainder consist primarily of shipments from North Africa to the Far East.

The volume of phosphate rock shipments through the Canal, currently at about 4,000,000 tons a year has grown considerably over the last 25 years. Future growth will depend on the future level of U.S. exports.

Phosphate rock is shipped primarily in 25,000 to 40,000 ton bulk carriers.

Recent Events and Projections

The volume of U.S. exports of phosphate rock to the Pacific Basin via the Panama Canal doubled from 1965. This was partly due to the effect of the Green Revolution and increasing use of chemical fertilizers in agricultural production. Also, U.S. rock producers had established very efficient mining operations and transport systems which contributed to their ability to export large quantities of rock.

While it may be expected that the demand for phosphate fertilizer will continue to increase, there are some rather serious supply problems in the U.S. It is becoming increasingly more expensive to mine phosphate rock. The existing supplies are rapidly being depleted and the additional sources are both deeper in the ground (with higher costs of production) and are farther away from the port (with higher surface transport costs). Finally, the environmental concern surrounding strip mining has added to the cost of production as well as delaying the construciton of new mines. Consequently, the anticipated future growth in exports to the Far East will be modest although it is expected that U.S. producers will continue to maintain a strong market position.

It is also possible that some portion of phosphate rock exports may be carried in large combination carriers around the Cape of Good Hope. The likelihood of such an event would increase if a substantial bypass movement were to develop for grain shipments and if a substantial toll increase were put into effect.

In the aggregrate, phosphate rock shipments are expected to increase at a moderate rate from a current level of about 3.9 million tons to 5.1 million tons in 2000.

Table 10

SUMMARY OF PAST AND PROJECTED SHIPMENTS

PHOSPHATES

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	1,997	2,745	3,223	3,079	2,132	2,744
EC US → WC Can	28	302	935	1,189	811	623
Other	1,321	693	1,038	1,084	373	520
TOTAL	3,346	3,740	5,196	5,352	3,316	3,887

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	2,700	2,900	3,000	3,100	3,200	3,200	3,200
EC US → WC Can	600	500	500	600	700	800	900
Other	500	500	600	700	800	900	1,000
TOTAL	3,800	3,900	4,100	4,400	4,700	4,900	5,100

Source: Panama Canal Company, Annual Report and International Research Associates

9. FERTILIZER, POTASH AND FISHMEAL

Background

This category contains a number of diverse products. Included are manufactured fertilizers, potash and nitrates which are fertilizer ingredients and fishmeal which is a high protein feed for poultry and livestock. As shown below, each of these products has a set of distinct trade routes.

Over the last twenty years, world fertilizer production has increased at a very rapid rate. This rapid rate of growth has, in turn, caused from time to time considerable fluctuations in prices and industry outlook. The United States, Europe and Japan are the principal producers and exporters of fertilizers; but production is also increasing in many lesser developed countries.

Fishmeal is primarily produced by processing anchovies which, at times, are caught in vast quantities off the coast of Peru. Unfortunately, the appearance of anchovies is controlled by ocean currents, and even slight changes in such currents can cause a massive decline in the anchovy catch and fishmeal production. As a result, fishmeal production and exports have flucturated greatly over the past ten years and can be expected to do the same in the future.

The Role of the Panama Canal

Most shipments of manufactured fertilizers are from Europe and the east coast of the United States to Latin America and Asia. These have amounted from about 1,500,000 to 2,200,000 tons per year recently.

Shipments from the west coast of Canada to Europe are primarily potash and these have ranged from 300,000 to 600,000 tons. Nitrates are shipped from Chile to both Europe and the United States in the amount of 300,000 to 400,000 tons a year.

Fishmeal shipments have ranged recently from a low of 300,000 tons to a high of 1,500,000 tons, depending upon the size of the catch.

Recent Events and Projections

Table 11 presents the recent history of fertilizer, potash and fishmeal shipped via the Panama Canal. The ECUS to Pacific Basin and Europe to Central America routes consist principally of fertilizer. Potash is exported from the west coast of Canada to the Atlantic Basin. Finally fishmeal is the primary product shipped from the west coast of South America to Europe.

The bulk of the fertilizer shipped from the U.S. to the Pacific Basin (Asia and Latin America) has a phosphate base--either concentrated super phosphate or ammoniated phosphates.[19] This product is in a rather unique competitive position. The principal competitors are Japanese and South Korean producers who receive the basic phosphate rock from the United States. According to published sources, the existing phosphate fertilizer plants in Asia have sufficient capacity to satisfy nearly all of the area's phosphate fertilizer needs; however, the plants are running far below capacity, probably because of the high input costs for phosphate rock, energy, and sulfuric acid in comparison to the price of imported fertilizers. As a result, there has been a steady growth in the volume of imports of finished fertilizer despite the heavy investment in fertilizer plants.[20]

The outlook for fertilizer shipments is for continued and moderate growth increasing from a present 600,000 tons to 1.2 million by 2000. Because of the current depressed market conditions, there is expected to be a slight drop in shipments in 1978. Estimates for the longer term are based on the following reasoning: The growing food needs of the Pacific will be met by a combination of (a) increased grain imports; (b) increased raw material imports for expanded fertilizer production; and (c) increased fertilizer imports. In all likelihood, increased fertilizer imports will show the lowest growth rate.

Potash, which is exported from Western Canada through the Panama Canal, is shipped primarily to Europe. Potash imports from Canada to the U.S. are by direct rail rather than by rail to the West Coast and by water via the Canal. Europe and South America also import potash from the Mid-East.

Given the presence of strong competition, potash movements via the Canal are not expected to increase much over the next 23 years.

As previously indicated, the volume of fishmeal exports from the west coast of South America to Europe varies greatly depending on the size of the anchovy catch which is controlled by the ocean currents. The average over the recent period is about 700,000 tons. Therefore, it is expected that future export volumes will not divert radically from this average.

Table 11

SUMMARY OF PAST AND PROJECTED SHIPMENTS

FERTILIZER, FISHMEAL & POTASH

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
(Fertilizer) EC US → Pacific Basin	162	451	605	629	290	675
(Fertilizer) Europe → WC CA	129	115	200	221	195	337
(Potash) WC Can → Atlantic Basin	57	494	523	460	299	201
(Fishmeal) WC SA → Europe	1,222	1,369	332	734	574	413
Other	1,059	800	1,071	598	675	748
TOTAL	2,629	3,229	2,731	2,642	2,033	2,374

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Pacific Basin	600	700	800	850	900	1,000	1,100
Europe → WC CA	300	300	300	300	300	300	300
WC Can → Atlantic Basin	200	300	300	350	400	450	500
WC SA → Europe	700	700	700	700	700	700	700
Other	800	800	800	800	900	950	1,000
TOTAL	2,600	2,800	2,900	3,000	3,200	3,400	3,600

Source: Panama Canal Company, Annual Report and International Research Associates

10. IRON ORE

Background

Iron ore is, in terms of volume, one of the most important dry bulk commodities in world trade. Most of the large steel producers in the world, with the exception of the U.S.S.R., rely on imported iron ore to a greater or lesser extent. This is particularly true of Japan which must import most of its iron ore requirements from abroad.

There are large iron ore deposits in Africa, Latin America, Australia and Asia; and exports from these areas constitute the bulk world shipments in iron ore. The pattern of iron ore shipments is complex and diverse, reflecting such factors as ownership patterns of iron ore mines among steel companies, quality considerations, desire to diversify ore sources, etc.

Total iron ore shipments, in recent years, have exceeded 250,000,000 tons.[21] As shown below, only a small fraction of this transits the Panama Canal.

The Role of the Panama Canal

Between 1958 and 1965, an average of about 6.5 million tons of iron ore was annually shipped via the Panama Canal, principally from Chile and Peru to the United States and Europe. In recent years these movements have dwindled to no more than 2 to 3 million tons.

At present, about three-fourths of total shipments are from Peru and are destined for the United States. The remaining tonnage includes shipments of Peruvian and Chilean iron ore to Europe and movement of some Canadian ore to Japan. In recent years there has even been some shipment of iron ore from Australia to Europe.

Recent Developments and Future Projections

The recent decline in iron ore shipment via the Panama Canal is partly due to the use of larger ore carriers which move some ore from

Peru and particularly Chile, around the Horn to Europe and the United States.

However, the primary reason for the decline in shipments has been a basic realignment of sources and markets, as between Chile and Peru on one side, and the United States and Europe on the other. In essence, both Chile and Peru have shifted most of their sales to Japan while the United States and Europe shifted their purchase to other sources. In the case of the United States imports, an additional factor has been the growing reliance on domestic as opposed to foreign ore. In 1976, for instance, foreign ore (other than Canadian) comprised 14% of total consumption as opposed to 17% in 1967 and 18% in 1973.[22] Another factor was the nationalization of Marcona iron properties in Peru. Given the present depressed state of the steel industry in general and the iron ore market in particular, it is very unlikely that iron ore shipments through the Canal will ever again reach the levels attained during the fifties and sixties.

However, it does appear that exports from Peru to the United States and Europe should hold at a level of 1.0 to 1.5 million tons a year and total Canal shipments should average perhaps 2 million. A basic reason for projecting continued shipments from that area in spite of the current and prospective surplus of iron ore both in Europe and the United States is the fundamental imbalance of bulk material shipments as between the Atlantic and Pacific basins. Most shipments of bulk material--grain, coal, phosphate--are made from the Atlantic to the Pacific with the result that a substantial number of bulk carriers must compete for return cargo to the Atlantic. Many of these returning ships are willing to take on iron ore for shipment to the United States at extremely low rates. If the charter market for bulk carriers were to improve substantially, it is likely that iron ore shipments through the Canal would decline.

In summary, total shipments of iron ore are projected to decline from about 2,400,000 tons in 1978 to a level of about 2,000,000 tons a year with 1,500,000 tons accounted for by shipments from Peru to the United States. The remainder would go to other trade routes.

Table 12

SUMMARY OF PAST AND PROJECTED SHIPMENTS

IRON ORE

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC SA → EC US	3,583	2,808	1,834	2,935	1,028	1,712
WC SA → Europe	2,700	966	428	193	130	820
Other	174	440	666	429	219	261
TOTAL	6,457	4,214	2,928	3,557	1,377	2,793

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC SA → EC US	1,900	1,700	1,500	1,500	1,500	1,500	1,500
Other	500	500	500	500	500	500	500
TOTAL	2,400	2,200	2,000	2,000	2,000	2,000	2,000

Source: Panama Canal Company, Annual Report and International Research Associates

11. MISCELLANEOUS ORES

Background

Miscellaneous ores included here are chrome, copper, lead, manganese, and zinc as well as miscellaneous and mixed ores. (Many ores contain two or more metals.) None of the ores listed here represent large individual movements, but together they constitute a fairly sizeable volume of more than 3 million tons in 1977.

Most copper, lead and zinc ores are partially or totally refined at the mines and only a fraction of such ores are shipped. The mineral content of such ores is often quite low and therefore transportation of the ore is, in most instances, not economical. However, some ores are shipped for a variety of reasons including availability of ships at low rates--this applies particularly for movements from Australia and the west coast of South America to the U.S. and Europe--or the need to transport ores from small mines which have no adjacent refining capacity.

The Role of the Panama Canal

The routing pattern of miscellaneous ore shipments through the Panama Canal is complex and reflects the diversity of the ores themselves. In 1977, zinc ore shipments accounted for 619,000 tons of the 3,083,000 ton total for the category as a whole, and most of the zinc ore shipments originated in Peru and were destined for the United States and Europe. Copper ore shipments were next with 506,000 tons and they came mostly from Chile and Australia and also were shipped primarily to Europe and the United States. 390,000 tons of manganese ore were shipped from Mexico, Brazil and Australia, with most of it going to Japan and a small portion to the United States. Lead ores totalled 250,000 tons and they came mostly from Peru; chrome ore, mostly from the Philippines, totalled 131,000 tons; and miscellaneous totalled 1,120,000 tons, and they came mostly from Australia and Peru.

The total shipments of miscellaneous ores shipped has increased somewhat over the last 10-20 years, but part of this increase was offset

by a relative decline in the shipment of miscellaneous metals.

Recent Developments and Projections

In the last few years shipments of zinc, lead, manganese, copper and miscellaneous ores have increased somewhat, while shipments of chrome ore have generally declined. Year-to-year changes in shipment levels are quite pronounced and they suggest the essential irregularity of the movements involved. Also, total shipments still seem to be declining somewhat in comparison to the very high levels reached in 1974 and 1975. Because of this irregularity, projections of the movements for individual types of ore would tend to be quite unreliable.

In the aggregate, it appears that the total movement of miscellaneous ores might expand at a rate of perhaps 2% per year. It is projected that movement of miscellaneous will increase from 3,200,000 tons in 1978 to about 4,900,000 tons in 2000.

Table 13

SUMMARY OF PAST AND PROJECTED SHIPMENTS

MISCELLANEOUS ORES

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
Pacific Basin → EC US	678	748	1,042	963	912	997
Pacific Basin → Europe	312	954	2,122	1,625	1,818	1,294
Other	302	188	490	938	170	792
TOTAL	1,292	1,890	3,654	3,526	2,900	3,083

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Other							
TOTAL	3,200	3,350	3,500	3,600	3,900	4,200	4,900

Source: Panama Canal Company, Annual Report and International Research Associates

12. METAL SCRAP

Background

Metal Scrap is primarily steel scrap which is used extensively in steel manufacturing. Most steel is produced with a mixture of pig iron and steel scrap. And since in many cases, steel scrap is more readily available than pig iron, trade in scrap expanded tremendously during the post World War II period. The principal purchasers of steel scrap were Japan and Western Europe, while the principal producer and exporter of scrap is the United States.

Steel scrap comes in many types and grades, depending primarily upon the purity and the density of the material. In order to improve the quality of scrap, processing techniques for scrap have been greatly perfected and the scrap industry has changed from a mere collection service to a complex processing industry.

The Role of the Panama Canal

Shipments of scrap through the Panama Canal primarily originate in the United States and are destined for the Far East, primarily Japan, Korea and to a lesser extent Taiwan. (In prior years most exports went to Japan; but recently Korea has become a substantial buyer of scrap.)[23]

Scrap exports have tended to fluctuate considerably between 1.5 and 3.5 million tons a year; but they have shown no consistent growth tendencies. There are, apparently, some good reasons for this behavior. The volume of scrap produced through reprocessing is limited by the capacity of scrap plants, etc. During periods of strong demand for steel--as was experienced in 1973-74--everyone seeks to purchase as much outside scrap as possible. In the past the federal government has responded by temporarily limiting the amount of scrap that can be exported. And this, in turn, limited the increase in scrap exports to the Far East. By contrast, during periods of recession, when steel demand is slow, scrap prices often drop so sharply that steel mills buy scrap on a price basis, even if they have no present need for the material.

Recent Developments and Projections

Since 1974, scrap shipments have dropped sharply from 3,500,000 tons to 1,290,000 tons in 1977, reflecting largely the severe recession which is currently experienced by the steel industry. No further reduction in shipment volume is expected, but it may be some time before total scrap shipments ever again reach the 1974 high.

Over the long run, Japan's need for imported scrap will lessen somewhat as its domestic scrap industry expands. However, there is a growing demand for U.S. steel scrap in Korea and Taiwan where a considerable part of the steel capacity consists of electric furnaces which depend principally on scrap.

While year-to-year shipments will continue to fluctuate widely, a gradual increase in shipments is projected from now to the year 2000 if measured from the current and very low level of shipments. However, the highest annual total projected during that period is still below the amount shipped in 1974.

Table 14

SUMMARY OF PAST AND PROJECTED SHIPMENTS

SCRAP METAL

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	1,910	3,742	3,190	2,090	1,375	1,229
Other	233	203	305	101	143	62
TOTAL	2,143	3,945	3,495	2,191	1,518	1,291

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	1,200	1,500	1,800	2,000	2,200	2,400	2,400
Other	100	100	200	200	200	200	200
TOTAL	1,300	1,600	2,000	2,200	2,400	2,600	2,600

Source: Panama Canal Company, Annual Report and International Research Associates

13. ALUMINA AND BAUXITE

Background

Bauxite is the basic raw material from which aluminum is produced and alumina is an intermediate product between bauxite and aluminum.

Until recently the Caribbean area was a principal producer of bauxite, and most of the bauxite or alumina imported by the United States came from Jamaica, Guyana and Surinam. In the late Sixties discoveries of large bauxite deposits were made in Australia; and at the present time, Australia is the largest exporter of bauxite or alumina.[24]

The bauxite industry is characterized by ownership ties between aluminum companies and bauxite mines, and as a result of this, marketing arrangements in the past tended to be fairly rigid. This has changed to some extent as both Jamaica and Guyana nationalized some foreign owned mining operations. Also, the practice of product exchange has started in the industry.

The Role of the Panama Canal

There are two distinct bauxite/alumina movements which utilize the Canal. The first is a movement of primarily alumina from the Caribbean area to aluminum refineries on the west coast of the United States. (This includes some alumina which is produced on the Gulf Coast from bauxite shipped from the West Indies area.)

The second movement consists of mostly alumina and some bauxite shipped from Australia to the east coast of the United States.

Recent Developments and Projections

Since 1970, alumina/bauxite shipments through the Canal have declined substantially from the more than 1.7 million tons in 1970 to less than 1.2 million tons in 1977. Two factors seem to have been responsible for this decline. First, the proportion of alumina to bauxite has increased significantly to the point where very little bauxite is presently being shipped. The conversion from bauxite to aluminum involves a weight loss

of about one-half. The second factor was the worldwide recession of 1975-76 which affected the aluminum industry very markedly.

The recession in the aluminum industry has ended and aluminum output has increased significantly in recent months. Also, since most shipments are now in the form of alumina, no future volume reduction is likely as a result of conversions from bauxite to alumina.

As a result, it is anticipated that alumina shipments through the Canal will increase in the future, with some of the increase representing a recovery of the present low level of shipments.

The only factor which could make future traffic less than projected is the growing tendency toward product exchanges. However, a major product exchange which would eliminate the shipments to the West Coast is not likely because Reynolds Aluminum--the company primarily responsible for the shipments to the west--has extensive bauxite/alumina interests in the Caribbean area.

Table 15

SUMMARY OF PAST AND PROJECTED SHIPMENTS

ALUMINA & BAUXITE

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
West Indies → WC US	40	499	516	594	461	262
Oceania → EC US	-	-	343	295	404	516
Other	822	1,244	855	678	413	397
TOTAL	862	1,743	1,714	1,567	1,278	1,175

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
West Indies → WC US	310	320	320	320	350	370	400
Oceania → EC US	525	550	575	600	750	925	1,250
Other	400	420	440	460	470	500	550
TOTAL	1,235	1,290	1,335	1,380	1,570	1,795	2,200

Source: Panama Canal Company, Annual Report and International Research Associates

14. MISCELLANEOUS METALS

Background

The principal metals included in this category are copper, lead, zinc, aluminum, tin plate and iron ingots. (The category "Manufactures of Iron and Steel" include primarily the basic shapes produced by steel plants--such as sheets, bars, etc.--as well as foundry products, such as castings. Iron ingots or pig iron is produced in blast furnaces.)

The world shipment pattern of metals is quite diffuse since it includes not only the major movements from producing to consuming countries but very extensive trade movements among consuming countries as well.

Among the metals included here, copper is the most important in terms of quantity, accounting for nearly half of the 1977 total. The remainder is fairly evenly distributed among lead, aluminum, zinc, iron ingots, tin and tin plate and miscellaneous.

The Role of the Panama Canal

The principal trade routes for metal shipments are from the west coast of South America to the United States and to Europe. Chile and Peru are significant producers of copper, lead, and zinc; and of the 1,640,000 tons shipped through the Canal in 1977, shipments from the west coast of South America to the U.S. and to Europe accounted for nearly 900,000 tons. The remainder came from a variety of countries, including the United States, Canada, Japan, Australia and many European countries.

Recent Development and Projections

The total shipments in this category have shown no consistent growth pattern in the past 20 years. In certain years, when demand for metals is very strong--such as occurred in 1974-75--shipments increased, reflecting primarily increased trading and shipping activity. Once the demand subsided, total shipments returned to the previous level of around 1.4 to 1.6 million tons.

Future shipments in this category are projected at a level rate of 1.6 million tons. The major shipments are from a well established mining region where production levels are more likely to decline in the future rather than increase. (Any future production which might come from mines which are based on new discoveries would be accounted for by the allowance made for "new" shipments.) Trade shipments, also, have shown no consistent growth tendencies.

Table 16

SUMMARY OF PAST AND PROJECTED SHIPMENTS

MISCELLANEOUS METALS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC SA → EC US	353	244	140	175	162	215
WC SA → Europe	416	481	296	565	580	673
Other	883	2,223	1,133	1,719	796	752
TOTAL	1,652	2,948	1,569	2,459	1,538	1,640

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Other							
TOTAL	1,600	1,600	1,600	1,600	1,600	1,600	1,600

Source: Panama Canal Company, Annual Report and International Research Associates

15. COAL AND COKE

Background

International coal trade, most of which is seaborne, constitutes one of the larger dry bulk commodity movements with an annual total of more than 100,000,000 tons. The United States and Australia are the principal coal exporting nations in the world, but in recent years Poland, Canada, the U.S.S.R., Great Britain and South Africa have all increased their exports.[25]

Most of the oceanborne coal exports from the United States involve coking coal which is used in steel production. Until the energy crisis and the concurrent increases in oil prices, lower grade coal, used for steam generation, simply could not compete with petroleum as a fuel. Since 1974, coal shipments have increased on a worldwide basis and a growing portion of such shipments involves steam coal.

The Role of the Panama Canal

Until very recently, shipments of coal via the Panama Canal consisted almost entirely of American coking coal being shipped to Japan. This movement has had a spectacular growth during the past twenty years. It began as a very small movement, expanded rapidly during the Fifties and Sixties and reached a total of 25 million tons in 1975. It has since then dropped sharply to 12.5 million tons in 1977.

The basis for this rapid expansion of American coal exports was the phenomenal growth of the Japanese steel industry which started from near zero after World War II and reached an annual output of 100 million tons in the early 1970's. The decline in coal exports to Japan via the Panama Canal since 1975 is partly traceable to the worldwide recession in steel output which began in 1975. Part of the reason, however, is also the growing tendency by exporters and importers to ship U.S. coal in very large bulk carriers--100-150,000 tons--around the Cape of Good Hope rather than through the Canal. At the present time, about 20% of U.S. coal

shipments to Japan bypass the Canal.[26] Finally, Japan has made a strong effort to seek alternate--and less high priced--sources of coking coal to supplement its imports from the United States. As a result of this, Australia has become the largest supplier of coal to Japan, and exports from western Canada to Japan are constantly increasing. In fact, the expansion of coal production in both Australia and Canada has been so rapid in recent years that both countries have begun to ship some coal to other destinations via the Panama Canal in recent years.

Recent Developments and Projections

Since the major share of all coal shipments through the Canal are used by the Japanese steel industry, a discussion of the outlook must begin with a discussion of that steel industry's future. The short term outlook for the Japanese steel industry is not very bright, and below are some of the reasons for this conclusion:

1. Japan's shipbuilding industry is faced with a short and medium term surplus of ships. Furthermore, other countries are beginning to underbid Japanese ship builders for what business is available.
2. The level of steel exports will not materially increase in the near future since world markets for iron and steel products have not recovered from the recession.
3. Despite obvious signs of a serious recession and warnings from Japanese governmental agencies, the Japanese steel industry continued to produce steel in 1976 and early in 1977, and now faces a large surplus.
4. Finally, the Japanese domestic market, which had been the third major consuming sector, has not recovered sufficiently to offset slowdowns in the other areas.

The short term outlook for U.S. coal exports via the Panama Canal is equally bleak.

1. The Japanese have built up a large inventory of raw materials, including three to six month supplies of coal and iron ore. As

Table 17

SUMMARY OF PAST AND PROJECTED SHIPMENTS

COAL AND COKE

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → Asia	6,280	20,407	17,924	24,071	15,397	11,747
WC Can → Europe	-	16	72	649	381	222
Other	416	909	856	1,583	926	952
TOTAL	6,696	21,332	18,852	26,303	16,704	12,921

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → Asia	11,000	11,500	12,000	12,500	15,000	16,000	17,000
WC Can → Europe	300	300	300	300	350	400	500
Other	1,000	1,000	1,100	1,100	1,250	1,500	2,000
TOTAL	12,300	12,800	13,400	13,900	16,600	17,900	19,500

Source: Panama Canal Company, Annual Report and International Research Associates

a result, they have substantially reduced their total imports of coal.

2. The Japanese have improved the process of reforming lower grade coal into briquets which are often equivalent to the higher grade and more expensive coking coal. (Four of the five major steel companies have installed such briqueting plants.)
3. The surplus of large bulk carriers on the world ship market will continue to provide shipping via the Cape of Good Hope at rates lower than shipment through the Canal. The added sailing time, rather than being a negative factor, actually becomes a desirable factor for it postpones the arrival of the coal.
4. The Japanese steel industry will continue to reduce the ratio of use of high priced U.S. coking coal versus other coking coal in their steelmaking process.

As can be seen in Table 17, the volume of coal exports to Japan via the Canal is not expected to rise above 13 million tons by 1981. Although it is likely that the world economy will have recovered by then, the increasing use of lower grade coal, Japan's investment in coal fields in Australia, and the utilization of the bypass route will keep coal tonnage far below the average of the past dozen years.

However, the Japanese will continue to require some high quality coking coal which is only available from West Virginia coal fields.

Beyond 1981, however, it is expected that coal tonnage via the Canal will increase again. Part of it will be due to increased Canadian and Australian exports via the Canal; and part of it will be due to the start of exports of steam coal to Japan. In all likelihood, this will not occur until after 1980.

The Japanese are interested in the use of imported steam coal for generating electric power. Steam coal is generally cheaper (about 30 to 35% less) than high-grade coking coal. The Japanese have sent several trade delegations to the U.S. to evaluate the feasibility of buying steam coal in the United States, including coal mined in Utah, Arizona and Montana, which, of course, would not be shipped via the Canal.

It is expected that as the cost of petroleum rises, Japan will begin to import steam coal. It is also expected that Japan will follow its usual practice and purchase its steam coal from many sources; and in doing so, it most likely will import a fair share from the Appalachian coal mines which, of course, produce steam coal as well as coking coal. Part of these purchases will undoubtedly be shipped through the Canal.

16/17. PETROLEUM AND PETROLEUM PRODUCTS

Background

Petroleum is not only the single largest commodity shipped in world commerce in terms of volume, it exceeds the combined total of all other commodities shipped in world trade. By far the largest portion of the world petroleum trade involves the shipment of crude oil from producing areas to refining and consuming centers. However there is also a large and growing world trade in petroleum products.

The present pattern of crude oil shipments around the world is dominated by the fact that more than three fourths of all exports originate in the Persian Gulf around which the producing fields of Saudi Arabia, Kuwait, Iran, Iraq, Qatar and Abu-Dhabi are located. The only large exporters of crude oil which are not located in the Middle East are Venezuela, Indonesia, Lybia, Algeria and the Soviet Union.

At the present time, most of the crude oil shipments around the world are made in super tankers or VLCC's (very large crude carriers). The shift to the large carriers began in 1967, when the Suez Canal was closed, and it spread rapidly because of the obvious economics involved in the utilization of large ships. In fact, the construction of large tankers has proceeded at such a furious pace that since 1975 there has been a surplus of crude oil tankers which, given the number of laid-up ships, is likely to last several more years.

World trade in petroleum products is relatively smaller in volume and far more diversified than crude oil shipments. And unlike crude oil shipments, the trade in petroleum products is carried in ships of less than 100,000 ton size.

The Role of the Panama Canal

In relation to total world petroleum traffic, the petroleum shipments through the Panama Canal are not very significant. Even so, shipments of crude oil and petroleum products currently exceed 25 million tons a year

and together constitute the single largest commodity category.

Until the early 1970's, crude oil shipments through the Panama Canal involved primarily movements from the Atlantic to the Pacific. Most of the crude oil was shipped from Venezuela and was destined for the west coast of the United States and South America. In 1973, Ecuador became a significant exporter of crude oil and most of its exports went through the Panama Canal to refineries in the United States and Central America. At the same time, shipments from the Atlantic to the Pacific continued as before. (There is a substantial amount of cross-haul traffic in petroleum. This is caused by the fact that (a) crude oil is not a homogeneous commodity and much of the demand is for specific grades of crude oil, and (b) a large portion of petroleum shipments involves interplant transfers from producing to refining centers of individual companies. While there is a tendency toward reducing the amount of cross-haul traffic, much of it is likely to continue.) Most recently, crude oil shipments from Alaska have begun to transit the Canal and, as will be shown below, the significance of these shipments is likely to grow in the future.

Shipments of petroleum products through the Canal are quite substantial and they were, until 1973, much larger than shipments of crude oil. Since then, crude oil shipments have increased sharply and now exceed shipments of products. Most product shipments originate on the Gulf coast, in the Caribbean area or the West Coast of the United States and the destinations include the United States, Latin America, Europe, and in some cases even the Far East. Given the multiplicity of petroleum products and a pattern of seasonal demand changes for the various products, there appears to be a constant need to trade surplus or to acquire additional products; and these needs are being met by product shipments.

Working against the trend of increasing product shipments are the desires of individual petroleum companies to save transport costs and this can often be achieved by arranging product exchanges with other oil companies which saves for each company the need to transport the petroleum products involved.

Recent Developments and Projections in Crude Oil

Total crude oil shipments through the Panama Canal increased from about 5.4 million tons in 1965 to 12.6 million tons in 1977, reaching a recent high of 16.8 million tons in 1974 when the Mideast Oil Embargo prompted large increases in crude oil shipment from other producing areas.

Most of the increase in crude oil shipments during the 1972-77 period came from Ecuador where oil production and exports began in the early Seventies with the completion of a pipeline from the producing fields to the coast. In the last three years, shipments from Ecuador have declined partly because of disputes between Ecuador and the producing companies and partly because of the current surplus of crude oil.

Most of the crude oil shipments from the Atlantic to the Pacific involve shipments from Venezuela, Colombia and the West Indies, both to the United States and to other Latin American countries. In recent years Venezuela, in particular, has made strong efforts to market its crude oil and products within Latin America and many of these shipments proceed through the Canal.

Shipments of crude oil from Venezuela and the West Indies to the refineries on the West Coast of the United States have, in the past, reflected a general shortage of crude oil within the Pacific region as well as the need for the specific types and grades produced in those areas. At present, when the Pacific region has moved into a surplus position, only those shipments which reflect the need for special grades are likely to continue.

Projections of future crude oil shipments of Alaska oil are made in a special chapter below. The following is a discussion and projection of crude oil shipments other than Alaska oil for the period 1978-2000.

a) Projections made here only involve known oil fields. While there are chances or even a high probability that additional oil fields will be discovered over the next 20 years whose development will require shipments via the Canal, there is no way of projecting them. (To some extent, such future developments will be taken account of by a special allowance made for "new movements" in the traffic projection for the years 1990 and 2000.)

b) Shipments of Venezuelan and Colombian crude oil to Latin American countries, which have averaged between 3 and 4 million tons a year in recent years, will continue. The amount is not likely to increase in the future as Ecuador and, perhaps Peru, will attempt to market their excess crude oil in the same market area.

c) Shipments of crude oil from Ecuador to the Atlantic area--primarily to refineries in the Caribbean area--have declined from more than 7 million tons in 1974 to about 3 million tons. They are likely to stabilize at these levels. Any increase in output is likely to be marketed on the west coast of South America.

d) Shipments of crude oil from Venezuela and the West Indies to U.S. refineries on the West Coast, which currently average about 2.5 million tons a year, will decline as the Pacific region becomes a surplus crude area. But a part of this total--perhaps 1 million tons a year or so--will continue to be shipped to meet needs for specialty crude oils.

e) In summary, it appears that crude oil shipments via the Panama Canal--other than shipments from Alaska--will be in the range from 8 to 10 million tons a year during the 1978-2000 period. Again this projection is based on presently known fields and includes no assumptions about new major discoveries.

Prospects for Alaska Oil Shipments via the Panama Canal

Introduction

In the summer of 1977, the first oil shipments were made from the North Slope field in Alaska via the Alaska Pipeline and soon thereafter shipments of Alaska oil began to transit the Panama Canal. At the present time (November, 1977), these shipments amount to about 175,000 barrels per day or 735,000 tons per month.

The question of how large these shipments might become, how long they will last and how much revenue they might produce for the Panama Canal has become important, primarily because the absolute amount of additional traffic and revenue might be very sizeable. However, the entire prospect of future Alaska oil shipments via the Panama Canal is surrounded by many uncertainties. The purpose of this chapter is to identify and analyze these uncertainties and to develop a set of assumptions concerning them which appear most probable under the present circumstances.

The Present and Short Term Future (1978-1980)

At the present time, the Alaska Pipeline delivers more than 700,000 barrels of oil per day to Valdez. This is considerably below the initial rated capacity of the pipeline, and this shortfall in output was caused by an explosion and fire at one of the pumping stations. This damage is being repaired at present and the pipeline should be up to its rated initial capacity of 1,200,000 barrels/day by March or April of 1978.[27] From then until about the end of 1980, production and pipeline delivery is expected to remain constant at 1,200,000 barrels/day.

The shipments of Alaska oil via the Canal, which since October 1, 1977, have averaged about 175,000 barrels/day are prompted by a surplus on the West Coat of domestically produced crude oil. This surplus is likely to grow both as a result of increased Alaska oil production as well as an increase in production from the Elk Hills Naval Reserve field.

As stated above, Alaska oil production will increase by about 500,000 barrels/day in April, 1978. By 1980, production at the Elk Hills Naval Reserve field is also expected to increase from the present level of

100,000 barrels/day to about 250,000 to 300,000 barrels/day in accordance with the recently passed federal legislation.

Until about the end of 1980, when the SOHIO pipeline is likely to start operation, most of the above 650-700,000 barrels/day of added production will be surplus to needs within District V. There are essentially four ways in which this oil can be disposed of. One, it can displace other imported oil; two, it can go toward satisfying the annual increase in petroleum consumption on the West Coast; three, it can somehow be moved to the East; or four, it can be disposed of by means of a product exchange.

As to the first alternative, displacement of other imports, much of this has already occurred. Prior to the start of Alaska oil shipments, imports into District V, which includes the West Coast plus Nevada and Arizona, averaged about 1.1 million barrels/day. Since then, imports have declined to about 650,000 barrels/day, reflecting the current consumption of about 500,000 barrels/day of Alaska crude oil in the district. There may be additional cutbacks in foreign oil imports into District V, but it is doubtful that total imports will decline to less than 500,000 barrels/day because of the special needs for sweet crude oil which is imported from Indonesia.

Petroleum consumption is increasing in District V, but the rate of increase is projected at only about 3% per year or an increase of about 60,000 barrels/day each year.

Because of the restrictions under the Jones Act, foreign flag vessels cannot be used to transport Alaska oil to the East Coast. However, some small quantities of such oil are being shipped in foreign flag VLCC's around the Horn to the Virgin Islands which are outside the customs territory of the United States. Because of the current oversupply of large crude carriers, such movements are considerably cheaper, at present, than shipment in U.S. flag vessels via the Panama Canal. While such a movement has been found to be technically legal in a recent court decision, there is a general opinion at the Department of Energy that large scale shipments of Alaska oil in foreign flag vessels would probably lead to

legislative action because such shipments constitute a violation of the intent of the Jones Act.[28]

The last alternative involves a crude oil exchange which according to present law could only be arranged with Canada or Mexico. Mexico is building a refinery on its west coast to be supplied with crude oil via a pipeline from its east coast. This would present an excellent opportunity for arranging crude oil exchanges, except that the potential quantities that could be exchanged there are not likely to be large.

Since all of the above alternatives for disposing of the crude oil exist as possibilities rather than as firm commitments, any estimate made as to the distribution of the oil among the alternatives can be no more than educated guesses. And as will be shown later, the consensus among trade experts is that of the 650,000 to 700,000 barrels/day of additional domestic crude oil that will become available, somewhere between 300,000 and 400,000 barrels/day will be shipped east via the Canal. The rest may be distributed among the other four alternatives. Specifically, it is estimated that oil imports might be reduced by another 150,000 barrels/day. Increase in consumption might account for an additional 50,000 barrels/day each year, while product exchanges and shipment of oil to the Virgin Islands might account at most for 100,000 barrels/day. This would leave the above mentioned 300,000 to 400,000 barrels/day available for shipment through the Canal, in addition to the 175,000 barrels/day currently being shipped.

The Medium Term Future (1981-1985)

The end of the near term future is set near the end of 1980 or the beginning of 1981, which currently appears as the most probable completion date for the SOHIO (Standard Oil Company of Ohio) pipeline from Long Beach, California, to West Texas. This pipeline, when completed or rather converted from its present status, will provide a capacity for moving 500,000 barrels/day of crude oil from the Pacific to West Texas, which is the western terminus of an extensive crude pipeline network that stretches all the way to the Northeast.

The status of the SOHIO Pipeline Project can best be described as highly probable, but not yet certain. It appears that after considerable negotiation, an agreement in principle was reached between the State of California and SOHIO to the effect that in order to compensate for the additional air pollution which the pipeline will cause, SOHIO will donate some major air pollution equipment for one of the large power plants in the area. Negotiations are currently being conducted between the power company and SOHIO. Assuming the successful conclusion of the negotiations during 1978, the pipeline conversion should be completed toward the end of 1980.

With the completion of the SOHIO pipeline, it would appear that the volume of oil shipments via the Panama Canal might be drastically reduced, but this is not likely to occur. First, it is possible that the Navy may defer the final boost in production at Elk Hills until this pipeline is in operation, and then seek to obtain some capacity in the line for movement of its oil to the East. (The Navy officially maintains that it has many options available with respect to the disposition of Elk Hills oil. Yet these choices--whether to seek pipeline capacity and build its own connection to that pipeline or build a pipeline to permit tanker shipments--are still open only in the sense that no specific decision has been made on any individual choice. However, if the Navy is to produce from its reserve at the level prescribed by law, it must provide for some facility to get the oil to markets beyond the west coast.)[29]

Second, there is a strong probability that as soon as the SOHIO pipeline opens, the consortium which controls North Slope production will seek an increase in field production from 1,200,000 barrels/day to

1,600,000 barrels/day which is considered the maximum economic rate for that field.

The combined effect of all these changes would appear to result in only a slight reduction of tonnage available for shipment through the Canal in 1981.

The course of probable development beyond 1981 becomes more uncertain since there exist a number of possibilities which could provide for (1) additional new oil on the West Coast and (2) additional pipeline capacity from west to east. Additional new oil could come from Alaska or off-shore areas, while the most likely pipeline project that could come into services by 1985 is a line from Kitimat, B.C., through Alberta and from there to the Midwest.

Either event, a new big oil find or a new pipeline, can, by itself, be only regarded as a possibility. However, should a big new oil find occur in the West, the probability of a pipeline following it would increase very sharply. Conversely, without a new big oil find, the probability of building an additional crude pipeline from the West Coast will shrink rapidly. Because of this obvious interrelationship of new big oil and a new pipeline, the effect of either event on future shipments through the Canal may be less than originally thought.

The Long Term Future (1985 and Beyond)

Beyond 1985, the uncertainties concerning oil production in the west and shipment from there multiply. However some future events or trends can still be regarded as probable in spite of the many contingencies that seem to surround this subject.

For instance, it is highly probable that over the next 7 years or so there will be some significant new, though not necessarily very big, oil discoveries on the West Coast, including Alaska. It is also likely that with such discoveries the West Coast region will continue as a crude oil surplus area throughout the 1980's and beyond. Another trend which is likely to continue is the need to import special grades of crude oil into the West Coast region and these imports, in turn, will tend to increase

the amount of petroleum which must be moved to the Midwest and East.

Beyond this point the probabilities grow scarce. As stated earlier, the greater the size of the oil surplus that must be transferred by tanker, the greater the chances that new pipeline schemes will be planned and built. But this still leaves a fairly large area of uncertainty covering a possible surplus--beyond the installed pipeline capacity--of anywhere from nothing to 400,000 barrels/day, where a new pipeline scheme would not be economically justified.

But even if no good pin-point estimates can be made of the volume of shipments via the Canal, it is likely that these shipments will be declining as a reflection of increasing oil consumption within District V. And this feature of declining shipments should be included in any realistic long term projection of Alaska oil shipments via the Canal.

Alternatives for Projecting Alaska Oil Shipments via the Panama Canal

A simple method for formulating alternative projections of shipments of Alaska oil via the Canal involves joining, on one side, assumptions and projections which all would have a negative impact on the amount of Alaska oil shipped through the Canal; on the other side one can group the assumptions and projections which would all have a positive effect.

a) The negative projection. The principal elements of a negative projection are:

1. Prompt completion of the SOHIO pipeline (by mid-1980 or before).
2. No significant future oil discoveries in the West.
3. Rapid growth in petroleum consumption in the West.
4. Maximum replacement of imported oil in District V with Alaska oil.

A projection of Alaska oil shipments which incorporate these assumptions would be as follows:

FY 1978	350,000 b/d or 16.5 million tons
FY 1979	500,000 b/d or 25 million tons
FY 1980	450,000 b/d or 22.5 million tons (SOHIO pipeline opened in last quarter)
FY 1981	300,000 b/d or 15 million tons

FY 1985	125,000 b/d or 6.25 million tons
FY 1990	Nothing
FY 2000	Nothing

b) The positive projection. The positive projection obviously involves opposite assumptions to those stated above. However, the assumptions chosen here are regarded as normal and not extreme. For instance, it is assumed that the SOHIO pipeline will experience normal delays, but nothing like those encountered by the Alaska pipeline. An average amount of new oil discoveries are assumed, consistent with current drilling activity. A moderate increase in consumption is assumed, reflecting both the effect of conservation measures as well as of increasing prices for petroleum. Finally, it is assumed that at least 500,000 barrels/day of imported oil will not be replaced by Alaska oil because of quality and grade consideration. The following projections appear consistent with these assumptions:

FY 1978	350,000 b/d or 16.5 million tons
FY 1979	500,000 b/d or 25 million tons
FY 1980	500,000 b/d or 25 million tons
FY 1981	460,000 b/d or 23 million tons
FY 1985	400,000 b/d or 20 million tons
FY 1990	300,000 b/d or 15 million tons
FY 2000	250,000 b/d or 12.5 million tons

It is the opinion of the research team that the positive alternative is more realistic and the above amounts are included in the traffic projections. This choice is made in spite of all uncertainties which seem to surround this issue. However, there is one key assumption which is crucial to this or any other forecast of Alaska oil shipments through the Panama Canal: the assumption that the U.S. government will continue to prohibit the sale of Alaska oil to Japan or the disposition of the oil through an exchange with Japan. Should the federal government change its policy on this point, it is likely that all Alaska oil shipments through the Canal would be terminated. The reason for this reservation is simple.

A crude oil exchange with Japan would be by far the most economic alternative for the petroleum companies.

Incremental Revenues from Alaska Oil Shipments

Assuming an effective toll rate for Alaska oil shipments of $1.20 per long ton (which corresponds to the present experience), the following are estimates of incremental toll revenues attributable to Alaska oil shipments (based on positive projection).

FY 1978	$19,800,000
FY 1979	$30,000,000
FY 1980	$30,000,000
FY 1981	$27,600,000
FY 1985	$24,000,000
FY 1990	$18,000,000
FY 2000	$15,000,000

Projection of Total Crude Petroleum Movements

In the aggregate, it is projected that total crude petroleum movements will increase sharply from 12.6 million tons in 1977 to 27.2 million tons in 1978 and 34.9 million tons in 1979. From there shipments will decline to 32.2 million tons in 1981, 29.2 million tons in 1985, 24.2 million tons in 1990 and 21.7 million tons in 2000.

Recent Developments and Projections: Petroleum Products

In contrast to crude oil shipments, shipments of petroleum products through the Canal have shown no appreciable growth in recent years. In the early Seventies, the annual shipment volume average was 10 to 12 million tons a year. During the energy crisis years of 1973 and 1974, shipment volume rose to more than 15 million tons as many consumers sought to purchase supplies wherever available, which in the aggregate, increased the total volume of petroleum shipments. Since then, shipments have declined to about 10 million tons a year.

Most of the petroleum products shipped through the Canal originate on the Gulf Coast, the West Indies, the east coast of South America

Table 18

SUMMARY OF PAST AND PROJECTED SHIPMENTS

CRUDE OIL, Page 1

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC SA → WC US	2257	1032	1434	1859	1133	601
EC SA → WC CA	789	695	1499	1584	1732	1979
EC SA → WC SA	951	1594	1715	1528	1229	1864
West Indies → WC US	73	17	333	405	759	1888
WC US → EC US includes Alaskan Oil	82	31	-	-	28	432
TOTAL						

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC US → EC US includes Alaskan Oil	16,500	25,000	25,000	23,000	20,000	15,000	12,500
EC SA & West Indies → WC US	1500	1200	1000	1000	1000	1000	1000
EC SA → WC CA & WC SA	4000	3500	3500	3500	3500	3500	3500
WC SA → EC SA, EC CA and West Indies	3200	3200	3200	3200	3200	3200	3200
Other	2000	2000	1500	1500	1500	1500	1500
TOTAL	27,200	34,900	34,200	32,200	29,200	24,200	21,700

Source: Panama Canal Company, Annual Report and International Research Associates

Table 18

SUMMARY OF PAST AND PROJECTED SHIPMENTS

CRUDE OIL, Page 2

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC SA → EC US	-	1295	1177	20	857	751
WC SA → EC CA	-	-	1912	794	2017	1348
WC SA → EC SA	-	-	1789	2109	1828	1701
WC SA → West Indies	-	130	3595	1010	1067	470
Other	592	1022	3393	1543	1288	1563
TOTAL	4741	5816	16,847	10,852	11,938	12,597

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Other							
TOTAL							

Source: Panama Canal Company, Annual Report and International Research Associates

(Venezuela), and the west coast of the United States. The shipment patterns from each of these origin points are quite diverse, and there are only a few shipments which are large and which seem to continue over time.

The level of future shipments is likely to be influenced by two major factors. The first is the continued growth of petroleum consumption which should lead to a concurrent expansion of petroleum product shipments. This is likely to be of particular importance with respect to Panama Canal traffic because the growing supply of Alaska crude oil on the West Coast has led to an expansion of refinery capacity in the area; and such expansion, in turn, will lead to an increase in shipments.

The other factor, which will have a negative effect on petroleum product shipments, is the growing desire of oil companies to minimize transportation costs by arranging product exchanges in lieu of cross-hauling through the Canal. In the past, most of the petroleum shipments were made from the Atlantic to the Pacific; in the future, however, the prospective surplus of Alaska oil on the west coast will promote increased refinery output on the Pacific Coast which, in turn, will displace a portion of present product shipments from the Atlantic.

It is anticipated that these opposite factors will offset each other and future petroleum product shipments will remain at a relatively stable level ranging from 10 to 12 million tons a year. The actual projections are for 10,200,000 tons in FY 1978, for 10,500,000 tons in FY 1979 and for 11,000,000 tons per year for the entire period beyond that.

Table 19

SUMMARY OF PAST AND PROJECTED SHIPMENTS

PETROLEUM PRODUCTS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
West Indies → All Destinations	3,894	4,060	2,788	3,385	3,140	2,623
EC US → All Destinations	2,206	1,514	1,685	1,344	1,717	1,369
WC US → All Destinations	948	1,458	2,145	2,784	2,412	2,342
EC SA → All Destinations	2,965	3,311	4,545	2,573	1,242	1,383
Other	545	1,506	3,955	2,967	1,476	2,379
TOTAL	10,558	11,849	15,118	13,053	9,987	10,096

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
West Indies → All Destinations	2,500	2,500	2,500	2,500	2,500	2,500	2,500
EC US → All Destinations	1,500	1,500	1,500	1,500	1,500	1,500	1,500
WC US → All Destinations	2,000	2,000	2,500	2,500	2,500	2,500	2,500
EC SA → All Destinations	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other	2,200	2,500	2,500	2,500	2,500	2,500	2,500
TOTAL	10,200	10,500	11,000	11,000	11,000	11,000	11,000

Source: Panama Canal Company, Annual Report and International Research Associates

18. CHEMICALS

Background

This is a large and heterogeneous commodity category containing a variety of specific products such as ammonium compounds and caustic soda as well as miscellaneous chemicals and petrochemicals.

The world chemical industry grew rapidly during the 1950's and 1960's, but in recent years, the growth rate of the industry has abated somewhat. This is largely due to the fact that the chemical industry has become increasingly dependent upon the petroleum industry for fuel and feed stock, and with the increasing cost and the declining availability of natural gas and petroleum, industry expansion has slowed down.

World trade in chemicals is dominated by shipments among the developed countries. The United States, Western Europe and Japan are all large scale importers and exporters of chemicals. More recently, many large petroleum producers, including Saudi Arabia, Iran, Venezuela and Mexico, have begun to develop substantial petrochemical industries of their own which in time may become substantial exporters of petroleum.

The Role of the Panama Canal

The principal movements of chemical products through the Panama Canal are shipments from the east coast of the United States to the Far East, to the west coast of the United States and to Oceania which together accounted for nearly half of 3,144,000 tons of chemicals shipped through the Canal during 1977.

Other shipment routes include movements from the Far East to the United States, from Europe to Oceania and to the west coast of the United States and from the west coast to Europe.

Prior to 1977, there were also substantial shipments of chemicals between Europe and the Far East via the Panama Canal. But these movements, like general cargo shipments between the two regions, have apparently been rerouted via the Suez Canal.

Recent Developments and Projections

Chemical shipments declined sharply after 1974, when they reached a total of more than 4 million tons, and they have held at around 3 million tons during the last three years.

It is estimated that future shipments of chemical products will increase slowly over the period projected here. Factors which contribute to this projection are:

1. The reduced rate of chemical industry expansion around the world;
2. The building of chemical plants in petroleum producing countries which may lead to new export patterns not utilizing the Panama Canal; and
3. The rerouting of shipments between Asia and Europe, which, prior 1977, represented a very important route for chemical shipments.

The actual projections range from 3.4 million tons in 1978 to 4.6 million tons in 2000.

Table 20

SUMMARY OF PAST AND PROJECTED SHIPMENTS

CHEMICALS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US → WC US	312	466	628	475	522	537
EC US → Oceania	81	205	358	391	367	393
EC US → Asia	467	529	803	403	531	563
Asia → EC US	24	114	172	362	190	160
Other	828	1,292	2,050	1,540	1,388	1,491
TOTAL	1,712	2,606	4,011	3,171	2,998	3,144

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US → WC US, Oceania, Asia	1,600	1,650	1,650	1,650	1,750	1,900	2,100
Asia → EC US	200	200	200	250	250	300	400
Other	1,600	1,600	1,650	1,650	1,750	1,900	2,100
TOTAL	3,400	3,450	3,500	3,550	3,750	4,100	4,600

Source: Panama Canal Company, Annual Report and International Research Associates

19. SULFUR

Background

Sulfur shipments through the Panama Canal have changed substantially in the last fifteen years with respect to both origin and destination. At the present time, more than 85% of all shipments originate in Western Canada where the sulfur is recovered as a by-product at gas processing plants. (Natural gas produced in Alberta has a high sulfur content and the sulfur must be removed before the gas is shipped through the pipeline.) Recovered sulfur has recently become a very important part of world sulfur production.[30]

Prior to this, most sulfur shipped through the Canal came from the U.S. Gulf area where sulfur is mined directly.

Recent Developments and Projections

Sulfur shipments from Canada are made partly from stockpile and partly from current production. The stockpile was created by environmental problems as the Port of Vancouver refused to permit the loading of sulfur in its natural form, which is a powder. At present, sulfur is converted into slate form prior to shipment.

Canadian exports via the Canal seem to have leveled off at around one million tons a year. Since there is little prospect for increased natural gas production in the area, both production and shipment of sulfur should remain level for some time. On the other hand, it is expected that sulfur will become available as a by-product in other areas. It is therefore likely that sulfur shipments from other sources may increase somewhat in the future. The projections made here show an increase from 1.2 million tons in 1978 to 1.7 million tons in 2000.

Table 21

SUMMARY OF PAST AND PROJECTED SHIPMENTS

SULFUR

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC Can → Atlantic Basin	324	301	924	1,130	910	1,072
Other	472	210	494	223	119	168
TOTAL	796	511	1,418	1,353	1,029	1,240

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC Can → Atlantic Basin	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Other	200	250	250	300	400	500	700
TOTAL	1,200	1,250	1,250	1,300	1,400	1,500	1,700

Source: Panama Canal Company, Annual Report and International Research Associates

20. NON-METALLIC MINERALS

Background

This category contains primarily salt and clay (China or Kaolin), as well as asbestos. Salt shipments represent primarily imports by the United States. In 1977, the United States imported about 600,000 tons of salt from Mexico and the West Indies. In total, some 840,000 tons of salt were shipped through the Canal.

Clay or Kaolin shipments are made primarily from the United States to the Far East.[31] A principal use of clay is as a glaze for paper, and demand for clay is increasing. Shipments during 1977 amounted to 290,000 tons.

Recent Developments and Projections

Shipments of salt have been very irregular in amount and timing. As a result, little increase is projected here. Clay shipments, on the other hand, are expected to grow somewhat in the future. In total, projections for this category range from 1.1 million tons in 1978 to 1.4 million tons in 2000.

Table 22

SUMMARY OF PAST AND PROJECTED SHIPMENTS

OTHER NON-METALLIC MINERALS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
(Clay-Kaolin) EC US → Pacific Basin	93	247	289	194	215	289
Other	169	822	362	427	621	896
TOTAL	262	1,069	651	621	836	1,185

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
(Clay-Kaolin) EC US → Pacific Basin	300	300	350	350	400	450	500
Other	800	800	750	750	800	850	900
TOTAL	1,100	1,100	1,100	1,100	1,200	1,300	1,400

Source: Panama Canal Company, Annual Report and International Research Associates

21. MANUFACTURES OF IRON AND STEEL

Background

Manufactures of iron and steel are the basic iron and steel shapes produced by steel plants. These include primarily steel sheet and strip, such as used in automobile manufacturing, steel bars, pipes, steel plates and structural shapes, as used in buildings.

Steel has for a long time been one of the important commodity categories in Panama Canal traffic. However, prior to 1960, most of the traffic consisted of south bound shipments from the United States to South America and the U.S. west coast. Since the 1960's, however, the pattern has changed drastically. Japan emerged as the major exporter of steel products, and, at the present time, the preponderant share of all shipments are from Japan.[32]

The Role of the Panama Canal

In 1975, a total of 11.3 million tons of steel products were shipped through the Panama Canal; and of this amount, nearly 8.5 million tons came from Japan; in contrast U.S. shipments accounted for no more than 500,000 tons. Of Japan's exports via the Panama Canal, 4.8 million tons were destined for the United States, 2.8 million tons went to Europe and about 1 million tons to South America. Since 1975, a major change in this pattern has been the virtual elimination of shipments from Japan to Europe via the Panama Canal. As was the case in the container cargo, most such shipments have apparently been rerouted via the Suez Canal.

Steel product shipments are usually carried in bulk carriers ranging in size from 20,000 to 40,000 tons. Many bulk carriers which are involved in grain or coal shipments to Japan carry steel products as a backhaul.

Recent Developments and Projections

Total shipments of iron and steel manufactures declined from 11.2 million tons in 1975 to 8.7 million in 1977, but much of this decline was

due to the virtual elimination of Japan-Europe traffic from the Panama Canal. In fact, Japanese exports to the United States actually increased from 4.8 million tons in 1975 to 5.4 million in 1977.

The explanation for this paradox is that Japanese steel is very price competitive in spite of the fact that Japan must import practically all of the raw materials required for steel production.

The American steel industry is currently experiencing a severe economic crisis, in which the recession is only one aspect. One basic problem appears to be the fact that a large portion of the industry's total plant is quite old and inefficient. For many years the industry had sought a way of acquiring sufficient capital to modernize or rebuild its aging plant; but this is no longer a realistic expectation. The problems involved in building new large steel plants in the United States in terms of money requirements, environmental considerations, etc., are so enormous that the steel industry cannot hope to solve its problems by a massive dose of capital expansion.

Instead, the industry seems to have chosen another and simpler path toward modernization which is by way of closing down inefficient facilities. While this has generated considerable labor and community opposition, the industry is likely to continue with this strategy because it represents the best hope for an eventual solution of its problem.

However, the strategy chosen by the steel industry means that for the next 20 years, the United States will become increasingly dependent on imported steel; this in turn means larger imports from Japan. The increases in U.S. imports projected here are still fairly modest, because any increase in steel imports is likely to generate strong political opposition.

The strong competitive position of Japan's steel industry is likely to lead to increased exports to other regions, including the east coast of South America.[33] (Steel exports from Japan to Europe are also likely to increase, but most of these shipments will be routed via the Suez Canal.)

In the long run aggregate shipments of iron and steel manufactures will increase to 14 million tons by 2000. In the short run, the picture is somewhat confusing. On the one hand, there are large and unsold inventories of imported steel in the United States which would argue for

lower imports during 1978 and 1979. At the same time, users of imported steel had been apprehensive about possible restrictions on the steel imports and as a result, have chosen to add to inventories. Now that the U.S. government has decided on a method of controlling steel imports--through target prices--it is believed that imports will now begin to decline.

The specific projections made here envisage a slight decline in total shipments for 1978 and 1979--to 8.4 million tons and 8.6 million tons respectively--and then resumption of the long term growth.

Table 23

SUMMARY OF PAST AND PROJECTED SHIPMENTS

IRON & STEEL MANUFACTURES

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
Asia → EC US	1,858	3,511	3,186	4,774	4,572	5,398
Asia → EC SA	209	499	736	939	666	1,332
Asia → Europe	10	1,355	2,227	2,826	2,179	454
Other	1,766	2,747	2,640	2,698	1,454	1,536
TOTAL	3,843	8,112	8,789	11,237	8,871	8,720

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Asia → EC US	5,200	5,200	5,200	5,300	5,700	6,200	7,600
Asia → EC SA	1,300	1,400	1,500	1,600	2,000	2,500	3,000
Asia → Europe	400	400	400	300	300	200	200
Other	1,500	1,600	1,700	1,800	2,200	2,700	3,200
TOTAL	8,400	8,600	8,800	9,000	10,200	11,600	14,000

Source: Panama Canal Company, Annual Report and International Research Associates

22. AUTOMOBILES AND ACCESSORIES

Background

The shipments of automobiles and accessories around the world has become a significant part of ocean transportation only during the last ten years; and the Panama Canal has participated fully in this development.

Automobiles, of course, have been carried on ships for many years; however, only during the last decade have automobile shipments grown to such volume that it has become economical to build a new family of ships--vehicle carriers--to transport automobiles. As an indication of how recent this development is, it might be pointed out that in 1965, U.S. automobile imports totalled about 600,000 cars; and they accounted for about 6% of total sales. By 1975, imports had increased to 2.4 million cars and they accounted for 25% of all sales.

Two factors were primarily responsible for this growth in the ocean transporting of automobiles. The first was the emergence of the United States as the world's largest market for imported cars and the second, the emergence of Japan as a major car exporter. Europe has had considerable foreign trade in automobiles for many years, but the proximity of the countries involved did not require the development of a massive transportation industry to serve that trade.

At the present time, the major automobile trade routes are from Japan to the United States, from Europe to the United States, and from Japan to Europe. (In theory, these trade routes and the ships serving them, permit shipments of vehicles in both directions. In actuality, automobile shipments on these major trade routes are quite one-sided.)

The Role of the Panama Canal

There are two principal automobile movements through the Panama Canal. The first and largest involves automobiles from Japan and their shipment to the United States. This movement accounts for about 75% of the total. The second movement is from Europe to the west coast of the United States and involves European cars.

Over the last few years, shipments have ranged from 1.3 to 1.5 million tons; but because of the stowage characteristics of automobiles, shipments of motor vehicles are very important to the Panama Canal from a revenue point of view. For instance, it is estimated that at the present toll level, the effective toll rate is about $13.20 per ton; and 1.5 million tons of automobiles per year account for about $20 million of toll revenue. To obtain the same amount of revenue through the shipment of bulk material via the Canal would require the movement of more than 23 million tons of coal.

Recent Developments and Projections

During the 1974-76 period, automobile shipments through the Canal stayed level at around 1.5 million tons. In 1977 shipments declined to about 1.3 million primarily as a result of the rerouting of most of the Far East-Europe shipments, presumably via the Suez Canal. This rerouting resulted in a loss of shipments amounting to 200,000 tons which matches the decline experienced in total shipments.

The future level of automobile shipment is chiefly dependent upon the export capability of the Japanese automobile industry, and continued willingness of the U.S. market to absorb a growing volume of cars. On the first point, the competitive standing of the Japanese automobile industry, there is little doubt that its present standing will at least be maintained. Japanese automobiles have acquired a reputation for quality, good workmanship and in some cases, even technical excellence. This should permit the industry to maintain, at least, its position in the American market.

There is a question of whether it is realistic to project a further expansion of the market share that will be held by imported cars. The present momentum suggests that there might be some further slight increase in this share--up to 30% perhaps. It appears unlikely, however, that the imported market share will exceed this figure within the foreseeable future. Continued concern about the deteriorating balance of payment situation in the United States may soon lead to a variety of measures limiting imports. The automobile industry would be an early target for such measures.

Automobile shipments--or more specifically, toll revenues from such shipments--would be severely affected if the major Japanese producers (Toyota and Nissan) decided to establish assembly plants in the United States. There is obviously a possibility that one or the other producer will make such a decision, but most industry observers seem to feel that Japanese automobile manufacturers still enjoy a significant cost and perhaps even a quality advantage by assembling cars in Japan. For this reason, there is little likelihood of an early decision on their part to establish large assembly plants here.[34] (A recent decision by Honda to establish a small plant in the United States is viewed as an exception which was prompted by Honda's inability to expand its main plant in Japan.)

Based on the above considerations, it is projected that total automobile shipments will increase gradually from 1.3 to 1.7 million tons by 1985. Thereafter, it is expected that total shipments will stabilize at that level, reflecting both a concern about limiting imports as well as preventing a continued expansion of the American automobile fleet.

Table 24

SUMMARY OF PAST AND PROJECTED SHIPMENTS

AUTOS AND TRUCKS

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
Asia → EC US	12	189	540	481	699	722
Asia → Europe	1	95	295	401	212	34
Europe → WC US	119	230	256	194	182	174
Other	286	509	419	453	424	358
TOTAL	418	1,023	1,510	1,529	1,517	1,288

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
Asia → EC US	750	775	800	840	900	850	800
Asia → Europe			Included in "Other"				
Europe → WC US	200	210	220	225	250	250	250
Other	450	460	480	500	580	650	700
TOTAL	1,400	1,445	1,500	1,565	1,730	1,750	1,750

Source: Panama Canal Company, Annual Report and International Research Associates

23. GENERAL CARGO AND ALL OTHERS

Background

The basic approach in making the present traffic projection for the Panama Canal--which in fact is very similar to the approach used in previous studies--is to regard this category as essentially a residual category. This means, in effect, that the category contains general cargo, as such, as well as minor bulk commodities, both liquid and dry. However, this inclusion in the general cargo category is quite logical because the shipments involved are generally carried in general cargo or container ships.

In fact, one facet of the many changes which the so-called container revolution has brought about is the fact that the nature of the cargo, whether a manufactured product or a bulk commodity, is hidden once it is inside a container. As a result of the rapid growth in container cargo, the quantity of many individual commodities shipped through the Canal, such as canned food, textiles, cotton, etc., seem to have declined in recent years. Actually, much of this cargo is now part of the "container cargo" category. For example, in 1977, the entire General Cargo category amounted to 19,378,000 tons. Of this, 9,688,000 tons were accounted for by container cargo and miscellaneous cargo.

In the aggregate, general cargo movements through the Canal have increased considerably over the last 15 years. However, this generalization tends to conceal a number of diverse trends which affected the many trade routes that pass through. Below is a brief analysis of the nine major general cargo trade routes which pass through the Canal and which account for about 75% of the general cargo traffic.

a. East Coast United States - Far East Asia

This is by far the largest general cargo trade route using the Panama Canal. In 1977, it accounted for about 30 percent of the total general cargo traffic, measuring the volume in both directions. Included in the nearly 5.4 million tons of general cargo shipped on this trade route is manufactured equipment of all types, food products, textiles, cotton, vegetable oil, etc., etc.

The volume of shipments has about doubled since 1965 from 2 million tons to the present level of 5,400,000 tons.

b. East Coast United States - Oceania

This is another trade route where trade has expanded quite rapidly in recent years. In 1977, it accounted for 1 million tons of cargo or about 8 percent. In 1965 the total was a mere 430,000 tons. The principal commodities are meat and dairy products shipped from Australia and New Zealand and manufactured products shipped from the United States.

c. East Coast United States - West Coast South America

This is a trade route on which the volume of trade has actually declined somewhat since 1965. In 1977, the combined volume was 800,000 against 832,000 in 1965. Principal commodities include food products, cotton and manufactured products.

A basic reason for the decline of trade has been a growing tendency on the part of Latin Americans to strengthen their trade ties with other Latin Americans at the expense of all other trading partners.

d. East Coast United States - West Coast United States

Intercoastal trade in general cargo amounted to 907,000 in 1977. This represents an increase from 1965 when the total was 475,000 but the volume has been virtually unchanged since 1974. Most of the cargo involved is simply listed as container cargo or miscellaneous.

e. West Coast United States - Europe

The total volume on this trade was quite large in 1977, amounting to 1,950,000 tons, as compared to about 1,500,000 tons in 1965.

The general cargo total is somewhat inflated here because it includes a bulk commodity--borax--which is shipped from the West Coast to Europe. This is the only significant shipment of this commodity via the Panama Canal and it averages about 500,000 tons a year.

Other commodities included on this route are refrigerated food products and manufactured goods.

f. Oceania - Europe

This is a substantial route where traffic volume amounted to 1,613,000 tons in 1977. However, there has been little traffic growth in

Table 25

SUMMARY OF PAST AND PROJECTED SHIPMENTS

GENERAL CARGO, Page 1

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
EC US ↔ WC US	525	173	871	969	1,070	939
EC US ↔ WC SA	837	485	826	783	811	884
EC US ↔ Oceania	689	881	1,436	1,336	1,523	1,522
EC US ↔ Asia	2,705	4,326	6,146	4,528	4,845	5,366
EC Can ↔ Asia	222	347	681	614	547	760
TOTAL						

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
EC US ↔ WC US	900	900	900	900	900	900	900
EC US ↔ WC SA	800	800	800	800	800	800	800
EC US ↔ Oceania	1,600	1,650	1,750	1,850	2,200	2,600	3,200
EC US ↔ Asia	5,500	5,700	5,900	6,000	6,600	7,200	8,100
EC Can ↔ Asia	760	780	800	810	880	960	1,080
TOTAL							

Source: Panama Canal Company, Annual Report and International Research Associates

Table 25

SUMMARY OF PAST AND PROJECTED SHIPMENTS

GENERAL CARGO, Page 2

(thousand long tons)

PAST SHIPMENTS	1965	1970	1974	1975	1976	1977
WC US ↔ Europe	1,280	1,479	1,582	1,792	1,833	1,437
WC SA ↔ Europe	1,246	1,206	887	936	999	1,096
Oceania ↔ Europe	1,345	1,664	1,679	1,770	1,518	1,844
Asia ↔ Europe	110	1,199	2,910	3,012	2,450	909
Other	1,913	4,303	3,421	3,810	3,211	4,621
TOTAL	10,872	16,063	20,439	19,550	18,807	19,378

PROJECTED SHIPMENTS	1978	1979	1980	1981	1985	1990	2000
WC US ↔ Europe	1,980	2,010	2,040	2,075	2,250	2,450	2,700
WC SA ↔ Europe	800	800	800	800	800	800	800
Oceania ↔ Europe	1,700	1,700	1,700	1,750	1,750	1,800	1,800
Asia ↔ Europe	500	1/	1/	1/	1/	1/	1/
Other	4,560	4,830	4,880	4,915	5,220	5,390	6,370
TOTAL	19,100	19,170	19,570	19,900	21,400	22,900	25,750

Source: Panama Canal Company, Annual Report and International Research Associates

1/ Included in "Other"

recent years as the 1965 total was 1,435,000 tons.

There are several reasons for this lack of growth. One, Great Britain's joining with the Common Market led to a definite decline in British trade with Australia and New Zealand. Second, movement through the Panama Canal is just one of the routes by which trade between the two regions is carried on. It is suspected that in the last year or so, some portion of this trade was shifted to the Suez Canal.

The principal commodities carried on this trade route are food products and wool from Australia and New Zealand and manufactured products from Europe.

g. Europe - Far East

The total volume of cargo moved on this trade route during 1977 was 946,000 tons, and most of this was shipped during the early part of the year. At the present time, there are no substantial movements made between the two regions via the Panama Canal.

This is a drastic change from the situation which existed in 1975 when 3,365,000 tons of general cargo was shipped via the Canal between the two regions. Large scale shipments on this trade route began in the early Seventies when a fleet of very large container ships began service between the two regions. And since the Suez Canal was closed at the time, service was begun via the Panama Canal.

Purely on the basis of mileage, the Suez route is about 1200 miles shorter than the Panama route; but according to traffic data, many of the ships changed their routing only after the 1976 toll increase. It must be assumed that the latter played some part in causing the change.

h. Europe - West Coast South America

The total volume of general cargo traffic carried on this route was 785,000 tons in 1977 which is actually lower than the 831,000 tons shipped in 1965.

As in the case in trade with the United States, the countries on the west coast of South America have shifted their sales and purchasing activities to trades with other Latin American Countries and with Japan.

The composition of trade between Europe and the Latin American countries is very much like that between the United States and these

countries. Primarily manufactured products are shipped to South American countries while shipments from there include tropical products like cocoa, coffee as well as cotton and fruit.

i. East Coast Canada - Far East

The total volume of general cargo traffic amounted to 750,000 tons in 1977 as against 213,000 tons in 1954. The growth of trade between these two regions is really an extension of trade between the east coast of the United States and the Far East. In most cases the very same container ships call on ports in Eastern Canada as well as at ports on the east coast of the United States.

Outlook and Projections

In general, the future growth of general cargo traffic through the Panama Canal will be much less than in the past 10 years, because the mere introduction of container ships brought with it an expansion of the general cargo category which shows itself in the statistics as growth. Now that most of the major trade routes have already become routes for container ships, this one-time gain in traffic is unlikely to be repeated. Second, some of the major routes also are threatened by substantial competition via alternate routes which may limit future growth. This threat is particularly strong in the case of the East Coast United States - Far East trade, but it is also affecting East Coast United States - Oceania, East Coast Canada - Far East and the U.S. intercoastal trade. (With respect to the latter, Sealand recently announced the termination of its East Coast - West Coast container ship service.) On all of these routes, the competition offered by mini-bridge service is extremely strong and effective.

Third, for a number of trade routes, including U.S. intercoastal, East Coast U.S. - West Coast South America and Europe - Oceania, there has been no growth in general cargo trade via the Panama Canal and there is no basis for projecting any future growth. Below are estimates of future traffic growth, if any, for the nine trade routes.

a. East Coast U.S. - Far East Asia: Projected to grow at the rate of about 2% per year to 8,100,000 tons by 2000.

b. East Coast U.S. - Oceania: Projected to grow at the rate of about 3% per year to 2,900,000 tons by 2000.

c. East Coast U.S. - West Coast South America: No growth projected. Traffic in 2000 estimated at 800,000.

d. East Coast U.S. - West Coast U.S.: No growth projected. Traffic in 2000 estimated at 900,000.

e. West Coast U.S. - Europe: Projected to grow at the rate of 1½% per year. Estimated total for 2000 is 2,700,000 tons.

f. Oceania - Europe: No growth projected. Estimated total for 2000 is 1,600,000 tons.

g. Europe - Far East: No significant trade between the two regions via the Panama Canal is projected for the period. Any remaining trade is included under "Other".

h. Europe - West Coast South America: No growth projected. Estimated total for 2000 is 800,000 tons.

i. East Coast Canada - Far East: Projected growth rate of 2%. Estimated total for 2000 is 1,150,000 tons.

j. All Other: Projected growth rate for the entire period to 2000 is 1½%.

In summary, it was projected that general cargo shipments will increase from 19,100,000 tons in 1978 to 25,750,000 tons by 2000.

Appendix A

ALLOWANCE FOR NEW MOVEMENTS

The projection of Panama Canal traffic made here--which follows a pattern established many years ago--is based on a disaggregated analysis. This means, in effect, that the total projection is built up from a series of individual commodity and trade movement projections. The analysis tries to determine, for each commodity movement, whether its probable future course is up, down or level.

This method is very adequate, provided the list of commodity movements analyzed covers the universe of all possible movements. In the case of short or medium projections, which are up to 10 years, one can make a valid assumption that the major movements that will comprise the Panama Canal traffic ten years hence either exist now or are visible on the horizon. (As an example, the first indications that there might be an Alaska oil movement through the Canal appeared about a decade ago when the magnitude of the North Slope find became apparent.)

However, if the time period covered by the projection is substantially longer than 10 years, there is no specific and direct way of including new movements in the projection, since by definition, they cannot be known in advance. If no allowance is made for new movements, the total projection will inevitably have a downward bias since it will include all movements that can be projected as declining and disappearing, but it cannot include the new movements which have not yet begun and whose identity is not known.

How can one make an allowance for such new movements and, even more important, how should such an allowance be quantitatively determined? The method used here was to make a historical backward glance and measure the portion of 1977 Panama Canal traffic which would not have been projected in 1955 because the movements involved did not then exist to any significant extent, and there were no visible signs on the horizon that such movements might appear. For instance, in 1955 there was no evidence that Japan would

be capable of developing a first-rate automobile industry and would become the world's largest exporter of automobiles. Therefore, no one could have projected automobile shipments from Japan in 1955.

Using this method, it was determined that 21.3% of the 1977 Panama Canal traffic was accounted for by "new" movements. These movements included, among others, feed grain shipments (corn, sorghum) from the United States to Japan; steel exports from Japan; bauxite shipments from Australia to the United States; crude oil exports from Ecuador to the United States and to the West Indies; and sugar exports from Australia to Europe and to the United States.

A large portion of the "new movements" which developed and grew during the 1955-1977 period are related to the extraordinary economic development and growth which occurred in Japan during this period. If it were assumed that in the next 22 years the rate of emergence of new movements would remain the same, one would almost have to assume that the next 22 years will see the emergence of another "Japan" elsewhere, and that this new emergence would have a similar effect on Panama Canal traffic.

Since the above assumptions are not regarded as probable, it was decided arbitrarily to reduce by 50% the calculated volume of new movements and assume that the traffic projection for the year 2000 contain only 11.6% of new traffic. It was also assumed these "new" movements would begin in 1987 and grow at a constant rate until they reached the projected total for 2000. This procedure resulted in adding 5,456,000 tons of new movements to the 1990 projections and 23,643,000 tons to the projection for the year 2000.

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PART III

PROJECTION OF REVENUES, PC NET TONS AND NUMBER OF SHIP TRANSITS

Introduction

This part covers two tasks: (1) a conversion of projected traffic into revenues and PC net tons, and (2) a conversion of projected traffic into ship transits. The approach taken in this part is based on the notion that commodity movements, measured in cargo tons, are the only economic quantities that can be directly projected. The other quantities--PC net tons, revenues and transits--result from cargo movement and must be derived from tonnage projections. Chapter 1 and 2 describe in detail the methods of conversion and then give estimates of projected PC net tons, revenues and number of ship transits.

CHAPTER 1

Projection of Revenues and PC Net Tons

a) Method of Conversion

First, definitions of terms used throughout this part: Cargo tons refer to the quantity of specific commodities passing through the Canal, as measured in long tons. PC Net Tons is the measured cargo carrying capacity of ships passing through the Canal. A PC net ton is equivalent to 100 cubic feet of cargo carrying space, as determined by the measurement rules of the Panama Canal Company. Revenues are the toll revenues paid by ships on the basis of the current toll rates of $1.29 per PC net ton for each laden transit and $1.03 per PC net ton for each ballast transit. The effective toll rate is a calculated measure and represents an estimate of the average amount of toll paid per cargo ton on each of the 23 commodity categories for which projections are made.

The method described is used both for conversion to PC net tons and revenues. There is only one factor which could cause a divergence of trends

as between revenues and PC net tons and that is a change in ratio of ballast to total PC net tonnage. (A change in load factor has parallel effects on revenues and PC net tons.) There are year-to-year fluctuations in the ballast ratio, but over the past 20 years, the ratio has averaged about 14% and there has been no observable trend in this ratio. (This ballast ratio is based on tonnage rather than transit numbers.) For this reason, the discussion in the remaining part of this chapter will focus on the conversion from cargo tons to revenues. By implication, the further conversion to PC net tons is automatic.

To determine a proper method for converting tonnage into toll revenues an analysis was made to determine: (1) what factors have influenced the relation of cargo tonnage and revenues over the past 20 years; (2) which of these are most important; and (3) are future changes involving these factors predictable? (In making this analysis, the effect of the past toll increases and changes in measurement rules was neutralized.)

In the course of the analysis it was determined that there are two significant variables which determine the relationship of cargo tons to revenue. The first of these is the load factor or the degree to which ships are laden. This load factor may be influenced by a number of environmental conditions, such as water supply which controls the draft restriction placed on ships, by economic conditions which have a significant effect on the load factor of general cargo and container ships, and, to some extent, by the distribution of ships by ship type.

The second factor influencing the relationship of cargo tons to revenues is the mix of commodities. Proof of the importance of this factor is furnished by the effective toll rates. Depending upon the commodity category involved, a ton of cargo can produce revenues ranging from 82 cents per ton to more than $13.00 per ton. Obviously, a change in commodity mix can produce a significant change in the aggregate revenue to cargo ton ratio.

In examining the factors which are primarily responsible for changes in revenue in cargo ton ratio, it was found that the first of these, the load factor, tends to vary from year to year with no discernible short or long term trend. In contrast, ratio changes produced by

the changes in the commodity mix can be projected. The future change in commodity mix is represented by the traffic projections made in cargo tons for 23 commodity categories.

Based on these findings, a method was chosen for converting projected cargo tons into projected revenues by means of the effective toll rates for the 23 commodity categories for which traffic projections were made. The following are the individual steps involved in this method.

1. Effective toll rates were established for the 23 commodity groups initially from the 1977 data concerning single commodity laden transits.
2. The above data were adjusted upward to include an allowance for associated ballast movement based upon the ship types involved and their average ballast ratio.
3. The adjusted toll rates were checked against 1977 by multiplying the 1977 cargo tonnage totals with the adjusted effective toll rates for each of the commodity categories. The sum of this calculation yielded the 1977 toll revenues. (Allowance was made for the change in toll rates in 1976.)
4. The adjusted effective toll rates were used to make revenue projections which match the traffic projections made in Part II of this study. The revenue projections are made by multiplying the projected tonnages for each commodity category with the effective toll rates. The effective toll rates were those determined under step (2) above, with one exception. The effective toll rate for crude petroleum was adjusted upward to reflect the fact that most Alaska oil shipped through will involve a higher than average ballast movement and thus a higher effective toll rate than heretofore experienced.

The above method, in effect, accepts the load factor experienced in 1977 as "normal" and makes no adjustment for this. It is likely that 1977 was not a normal year as far as the average load factor is concerned. But knowing this provides no clue for the kind of adjustment that needs to be made with respect to the effective toll rates to have

them reflect a "normal" load factor.

Irrespective of whether the specific effective toll rates chosen here are correct for a long-term projection, we believe that the basic method chosen here for converting cargo ton projections into projections of revenue is the simplest and best available.

b) The Revenue and PC Net Ton Estimates

Table 26 shows the adjusted effective toll rates which were used to calculate the projected revenues and PC net ton totals for the years 1978-2000. As mentioned earlier, the toll rates are based on 1977 data and were tested against 1977 traffic and revenue results, with the exception of crude oil where an upward adjustment to $1.12 was made to allow for the higher effective tolls associated with Alaska oil movements.

Based on the traffic projections presented in Part II and the above effective toll rates, the revenue estimates are as follows:

1978	$182,279,000	1985	$209,933,000
1979	$194,043,000	1990	$223,631,000
1980	$197,485,000	2000	$264,253,000
1981	$199,227,000		

The projections of PC net tons are calculated by dividing the above revenue estimates by the projected average toll revenue/PC net ton which is $1.25. This average revenue figure assumes a .14 ballast to total PC net tonnage ratio which has been the average for the last 10 years. The PC net ton estimates are as follows:

	('000 PC Net Tons)		('000 PC Net Tons)
1978	145,823	1985	167,946
1979	155,234	1990	178,905
1980	157,988	2000	211,402
1981	159,382		

Table 26

ADJUSTED EFFECTIVE TOLL RATES

Commodity	Dollars per Long Ton
Wheat	$ .85
Coarse Grain	.84
Bananas	3.58
Sugar	.86
Soybeans	.84
Lumber	1.10
Wood pulp, paper and paper products	2.75
Phosphates	.84
Fertilizer, Potash and Fishmeal	1.08
Iron Ore	.82
Miscellaneous Ores	.88
Scrap Metal	.86
Alumina and Bauxite	.82
Miscellaneous Metals	1.10
Coal	.85
Crude Petroleum	1.12
Petroleum Products	1.15
Chemicals	1.10
Sulfur	.85
Other non-metallic metals	1.00
Iron and Steel Mfrs.	1.12
Autos and Trucks	13.20
General Cargo and All Others	2.02

CHAPTER 2

Projection of Number of Ship Transits

a) Analysis of Past Data

Over the past 20 years, the growth in traffic has not been matched by an equivalent growth in the number of ships transiting the Panama Canal. In fact, the number of ships transiting the Canal at present is little changed from the number during the early 1960's, even though the volume of cargo has about doubled.

An obvious explanation of this phenomenon is that the average ship size has increased. But this "cause" is largely the effect of deeper causes which have been identified after a careful analysis.

In brief, it was found that the reduction in the number of ships as compared to cargo tons was traceable to three separate trends. The first of these was a change in the mix of ships which carry cargo through the Canal, which, in turn, was largely dictated by a change in the commodity mix. The basic ship types include dry bulk carriers, tankers, refrigeration ships, general cargo ships and container ships; and, over the past ten years, the number of dry bulk carriers and container ships has increased, the number of tankers and refrigeration ships has remained about level, while the number of general cargo ships has declined. Since dry bulk and container ships are larger, on average, than general cargo ships, the combined effect of this change in ship mix was to produce a larger average ship size.

The second factor concerns the shift from general cargo ships to container ships. This is somewhat different from the trend mentioned above in that the change was not required by a change in commodity mix. Both general cargo ships and container ships carry "general cargo" but since container ships are bigger on average, the effect of this shift, too, was to reduce the number of ships required.

The third factor was an increase in the average size of ships within each category. The increases in average size were particularly pronounced

with respect to dry bulk carriers and tankers. Table 27 shows the number of ships of the five major categories transiting the Canal during the 1968-77 period, and Table 28 shows the average size ship for each of the categories in each of these years.

A sensitivity study which evaluated these factors found that roughly two-thirds of the trend was caused by a change in the ship type mix, both as a result of a change in commodity mix and as a result of conversion from general cargo ships to container ships. One-third of the effect was caused by the increasing ship size within each category.

b) Method of Projecting Transit Numbers

The above findings served as a basis for developing a methodology of converting cargo projections into projections of transit numbers. In essence, the method allows for changes in commodity mix and the continued conversion from general cargo to container ships to determine the mix of ships that will be required to carry the future cargo. The actual ship numbers are then determined by making specific assumptions about future growth in ship size within each category.

The following are the specific steps involved:

1. The cargo projections made for 1978-2000 imply distribution among bulk carriers, tankers, refrigerator, container and general cargo ships. Changes from the present are dictated by changes in future commodity mix (each commodity is allocated to a ship type). At this step, certain commodity categories are allocated to container and general cargo ships together, and the separation between them will be made later.
2. Total cargo tons allocated to each ship type are converted into PC net tons by applying the load factor ratio which is appropriate for that commodity category.
3. The number of laden transits is arrived at by dividing the PC net tons allocated to each ship type by the average size projected for that ship type.
4. With respect to cargo allocated to general cargo and cargo ships, the allocation also provides for a continued shift from general cargo to container ships.

Table 27

NUMBER OF PANAMA CANAL TRANSITS
BY BASIC SHIP TYPES
(1968 - 1977)

	Bulk Carrier	% of[1] Total	Tanker	% of[1] Total	Refrig.	% of[1] Total	General Cargo	% of[1] Total	Container	% of[1] Total
1968	1784	14.1	2030	16.1	1826	14.4	6847	54.1	169	1.3
1969	2125	16.8	2081	16.5	1905	15.1	6348	50.3	170	1.3
1970	2431	18.7	1954	15.0	1827	14.0	6534	50.2	268	2.1
1971	2589	19.1	1963	14.5	1888	14.0	6789	50.2	301	2.2
1972	2879	21.6	1882	14.1	2088	15.7	6047	45.4	419	3.2
1973	3059	22.8	1769	13.2	2301	17.2	5488	41.0	775	5.8
1974	3480	26.3	2300	17.4	1981	15.0	4458	33.7	1009	7.6
1975	3752	29.4	1909	15.0	2076	16.3	3945	31.0	1064	8.3
1976	3433	30.3	1693	14.9	1825	16.1	3218	28.4	1166	10.3
1977	3551	31.8	1682	15.1	1740	15.6	2955	26.5	1231	11.0

Source: Annual Reports of the Panama Canal Company

[1]For the purpose of this Table, the "total number of ships" includes only the above ship types.

Table 28

PANAMA CANAL TRANSITS 1968 - 1977

AVERAGE SHIP SIZES

OF LADEN VESSELS

('000's PC Net Tons)

	Bulk	Tanker	Refrigerator	General Cargo	Container
1968	12.61	8.91	3.61	6.20	15.02
1969	13.10	8.87	4.08	6.17	16.23
1970	13.40	8.78	4.65	6.20	16.64
1971	13.59	8.68	4.26	6.39	14.80
1972	13.91	9.31	3.90	6.42	15.52
1973	14.28	11.24	4.09	6.62	18.78
1974	14.82	11.80	4.64	6.47	17.72
1975	15.30	11.53	4.77	6.54	17.61
1976	15.71	12.51	4.97	6.65	17.43
1977	16.46	13.59	5.42	6.86	16.49

Source: Annual Reports of the Panama Canal Company

5. Total transits for the five ship types are then determined by adding an appropriate number of ballast transits to each of the five ship types. (The ballast ratios are assumed to remain constant for the ship types.)

6. The five major ship types account for about 93-94% of all commercial ocean-going transits. The remaining 800 or so vessels consist of passenger ships, fishing vessels and miscellaneous ships. To allow for these, 800 ships are added to each year's projection of transits.

The algorithm for this operation appears below:

Cargo Tons shipped (For each ship category)
X Load Factor (PC net tons/tons shipped)
= PC Net Tons
÷ Average Ship Size
= Laden Transits
X (1 + ballast ratio) Ballast Ratio = ballast transits/laden transits
= Transits for each ship category
Σ Transits for each ship category
= Commercial transits
+ 800 Miscellaneous transits
= Total Commercial transits.

c) Assumptions About Future Ship Size

In order to make the projection of ship numbers as outlined above, assumptions must be made about (a) the future rate of conversion from general cargo to container ships, and (b) the future rate of size growth for each category. The basic reason why assumptions must be made in these areas is that applying the growth factors experienced over the last few years would yield results that are unrealistic, if not impossible. For instance, with respect to ship size, the limitations of the Canal itself impose a limit. But long before that, the average size for each category is likely to approach a limiting value dictated by the fact that the mix of ships will always involve a distribution over a considerable size range.

The same problem exists with respect to conversion from general cargo to container or later roll-on-roll-off ships, which are regarded by many as the ultimate successor to the general cargo ships. Assuming the continuation of the present trend--which shows a very sharp decline in the number of general cargo ships in recent years--would again yield unrealistic estimates for 1990 and 2000.

The assumptions made below about future growth in ship size per type and future conversion to container ships generally involve a substantial slowdown in the growth rates. We believe the growth rates, themselves, will continue because the economics of ship operation exert strong pressure in that direction. The slowdown in the growth rate will be dictated primarily by the physical limitation of the Canal. In some instances, special circumstances seem to reinforce this assumption. For instance, the start of the Alaska oil movement will lead to a very sharp increase in the average size of tankers for the 1978-80 period. After that, the growth rate will also flatten out.

Below are the specific assumptions made and conversions from general cargo to container ships.

a. Bulk carriers. Assumed rate of annual size increase 1977-2000: 1.2%. Actual average size in 1977 - 16,460 PC net tons. Projected average size for 2000 - 21,760 PC net tons.

b. Tankers. Assumed rate of annual size increase 1977-2000: 1.7%. Actual average size in 1977 - 13,590 PC net tons. Projected average size for 2000 - 20,200 PC net tons.

c. Refrigerator ships. Assumed rate of annual size increase 1977-2000: 1%. Actual average size in 1977 - 5,420 PC net tons. Projected average size for 2000 - 6,800 PC net tons.

d. General Cargo Ships. Assumed rate of annual size increase 1977-2000: 0.3%. Actual average size in 1977 - 6,860 PC net tons. Projected average size for 2000 - 7,450 PC net tons.

e. Container ships. Assumed rate of annual size increase 1977-2000: 0.5%. Actual average size in 1977 - 16,490 PC net tons. Projected average size for 2000 - 18,500 PC net tons.

f. General Cargo to Container Ship Conversion. It is assumed that by 2000 there will only be 1500 general cargo ships in the mix of ships transiting the Canal. In 1977, there were 2955.

In order to provide for a smooth transition from the past to the future, the average ship sizes assumed for intermediate years--between 1978 and 2000--were determined on a curve. Table 29 shows the projected average sizes for the various ship types for the 1978-2000 period.

Using the above assumption and formula, the projected transit numbers (commercial ocean-going vessels types 1-17) are as follows:

	Transits
FY 1978	12,691
FY 1979	12,968
FY 1980	12,903
FY 1981	12,809
FY 1985	12,743
FY 1990	13,312
FY 2000	14,142

Table 29

PROJECTED AVERAGE SHIP SIZES

FOR PANAMA CANAL TRANSITS
('000's PC net tons)

Fiscal Years	Bulk Carrier	Tankers	Refrigera-tor	General Cargo	Container	Average for all Ships
1977	16.46	13.59	5.42	6.86	16.49	11.20[1]
1978	17.24	14.76	5.65	6.92	16.65	11.49
1979	17.61	15.56	5.78	7.00	16.78	11.97
1980	17.90	16.05	5.89	7.05	16.90	12.24
1981	18.10	16.45	5.97	7.08	17.00	12.44
1985	18.90	17.55	6.32	7.25	17.42	13.18
1990	19.50	18.65	6.59	7.38	17.88	13.44
2000	21.76	20.20	6.80	7.45	18.50	14.95

Source: International Research Associates

[1]Actual

PART IV

SENSITIVITY OF PANAMA CANAL TRAFFIC TO TOLL INCREASES

A. INTRODUCTION

Present and future Panama Canal traffic is sensitive to increases in Panama Canal tolls because many Canal users have alternatives available which make it unnecessary for them to pay toll increases beyond certain amounts. If Canal tolls are increased beyond these amounts, the Canal users can be expected to make decisions to divert their cargo from the Panama Canal.

The nature of these alternatives and their costs as compared to the cost of transiting the Canal vary greatly depending upon the nature of the commodity and the trade route involved. Furthermore, the decisions made by Canal users to divert the cargo from the Canal may either be instantly effective, or it may involve a delayed response where the actual diversions would not take place for some months or even years. But all of these many and varied decisions can be linked logically to a set of Panama Canal toll increases which would change the cost of using the Canal without immediately affecting the cost of the alternatives to the Canal.

The principal objective of the sensitivity analysis is to measure the aggregate effect of toll increases on Panama Canal traffic volume. Given the fact that the cost of alternatives varies by commodity and trade route, this analysis must be conducted on a disaggregated basis. Furthermore, it must allow for the differential impacts based upon the intervals between the assumed toll increases and the time the measurements are made.

This part of the report has, in addition to the short introduction, five chapters. The second chapter deals with the methodology of the sensitivity analysis; the third is a discussion of present and prospective alternatives to the use of the Panama Canal; the fourth chapter contains the sensitivity estimates in terms of cargo tonnage and revenue; the fifth contains sensitivity estimates in terms of PC net tonnage and transit numbers and the sixth chapter consists of an estimate of maximum revenue available.

B. METHODOLOGY

The analysis and measurement of the sensitivity of Panama Canal traffic presents a number of theoretical and practical problems that need to be understood in order to assess the validity of the findings presented here. Furthermore, these theoretical and practical problems exerted an important influence on the development of the methodology employed in the sensitivity analysis. Below are the most important of these problems.

a. There are literally thousands of decision makers who, in fact, will determine whether specific commodity movements will continue through the Canal or not. While it may be convenient to combine these decision makers into groups, based on different routes and commodities, one must recognize that there is no uniformity of interest or opinion within these groups.

b. In a marginal analysis, it is important to establish not just what the majority opinion is, but how strong the minority view is. For instance, it is not sufficient to conclude that in response to a given toll increase the "average" cost of shipping grain from the U.S. to the Far East via the Panama Canal will still be less than the "average" cost of the next best alternative. The important question is to determine what fraction of the total amount would, in response to a toll increase, regard the alternative as preferable to shipment via the Panama Canal.

c. The most knowledgeable sources of information for this study are the decision makers themselves. Unfortunately, because they have an economic stake in this matter, their stated opinions may not be entirely objective.

d. Toll increases directly affect the cost of ship operation. When, or even whether, these cost increases are translated into price increases in the form of higher rates depends upon many factors, including competition.

e. Decisions relating to foreign trade patterns, routings, methods of transportation are made and changed constantly in response to

many changes in conditions. The task here is to isolate the changes which are attributable solely to a change in toll rates.

A basic principle of the methodology adopted here is to recognize the full complexity of this diverse and intricate pattern of decision making which represents the collective response to a toll increase. Admittedly, the measurement of the response resulting from such a complex pattern involves the use of judgment and estimates. But it is our strongly felt conviction that simplification of the measurement process--which is the making of estimates by judgment--is far preferable to simplification of problem definition which is usually achieved by making a "simplifying" assumption that often assumes away the problem. (An example of such a "simplifying assumption" is one that has been made in numerous studies concerning the economic value of the Panama Canal and the cost of alternatives. It is to assume that all shipments from the origins to the destinations of the sea-voyages via the Panama Canal are necessary, and that the alternatives to be considered must involve the same origins and destinations. Such an assumption, of course, ignores the fact that many alternatives do not preserve the original origin-destination pair.)

The first step in making a sensitivity analysis of the type required here is to assume a fixed date for the toll increase. For the purpose of the analysis, the assumed toll increases would be put in effect on October 1, 1978, but the exact size of the toll increase would be announced on or about April 1, 1978. For the purpose of timing the start of the response to a toll increase, the announcement date is more significant than the effective date.

The next step in the methodology is to identify and discuss present and future alternatives to the Panama Canal and indicate which of the commodity categories or routes might be affected by them. Since the assumed toll increases extend only to a maximum of 150%, only those alternatives will be considered which are likely to produce measurable effects at the assumed toll increase.

The next chapter contains the actual sensitivity estimates for the various commodities. The estimates are developed on the basis of the

following guidelines.

a. For each commodity category the relevant alternatives are selected which take account not only of the commodity characteristics but of the principal routes.

b. Based on evidence collected, a determination is made whether or not any diversion is taking place within the commodity category at present toll rates.

c. If no diversion is presently occurring, an estimate is made about the minimum toll increase necessary to prompt any move toward the use of alternatives. This might be called the threshold determination.

d. The principal sensitivity estimate for any commodity category is made on the basis of a substantial toll increase, generally no less than 50%. These base estimates are made after an assessment of the future economic choices likely to be available to the decision makers. These choices may or may not coincide with the present opinions of individual decision makers, but represent what may be called an "informed consensus."

e. Sensitivity estimates for lesser or greater increases are interpolated on a straight line basis. The interpolation, however, takes into account the threshold determined earlier, in the sense that no effect on Canal traffic is registered in response to increases below the threshold value. Sensitivity estimates for greater increases are extrapolated by determining to what extent the larger increase will (a) speed the process of shifting to alternatives and/or (b) make the choice of alternatives attractive for additional market segments.

f. Sensitivity estimates for future years are adjusted to reflect the anticipated spread of use of alternatives. (The basic notion here is that any economic process, with time, tends to become more efficient.)

The final chapter of this part contains the estimate of maximum revenue. This estimate is made with respect to the 1985 traffic projection and the sensitivity estimates for 1985. The procedure for making the

estimate is relatively simple. The revenue estimates for 1985, based on toll increases ranging from 15% to 150% are the data points for a mathematical formulation of a revenue curve. The maximum value of this curve represents the maximum feasible toll increase.

C. ALTERNATIVES TO THE PANAMA CANAL --PRESENT AND FUTURE

Most alternatives to the Panama Canal are very route and commodity specific. In fact, the value of many alternatives is not at all apparent unless they are examined in relation to a specific commodity trade movement. Still, it is important to be aware of these alternatives as such in order to judge their possible use in commodity trades where they are not currently used. Also, the various alternatives to the Panama Canal should not be viewed primarily as specific responses to Panama Canal tolls or increases in such tolls. Instead, they should be looked upon as general competitive responses which are present in any market which involves ocean transportation. Technology, economic and trade development have combined in different ways to produce alternate routes, alternate methods and alternate trade patterns.

But this in no way minimizes the role which toll increases play in motivating users to choose alternatives. They often trigger the shift to alternatives and they definitely control the speed with which the use of alternatives will spread.

This view of alternatives as natural phenomena, already in existence, is appropriate when marginal changes as between the use of the Panama Canal and its alternatives are being considered. In such a setting it is appropriate to assume that these shifts can be accomplished without assuming special and new investments in alternate facilities.

a. Simple rerouting -- No change of ship size or mode of transport. This is the most obvious alternative to the use of the Panama Canal; but given the range of assumed toll increases, there are only a few trade routes where simple rerouting is a probable alternative. The most likely candidates for rerouting are movements between east coast United States and the Philippines or Indonesia. The distances via the Panama Canal and via the Suez Canal are very close and often depend upon the specific origin and destination ports. For instance, the distance between New York and Manila is 11,365 miles via Panama and 11,467 miles via Suez. Also, the relative levels of Suez and Panama Canal rates are important and at present the former are considerably higher.

Another trade route where simple rerouting is a possibility is between Australia and Europe, particularly if the origin or destination port is in western Australia.

However, in assessing the probability of simple rerouting of scheduled liners, it is important to note that decisions to reroute are only likely if all ports of call can be served better via alternate routing and not simply some of them. For instance, with respect to the Europe-Australia route, the shortest distance between Perth and Naples is via the Suez Canal. But a scheduled liner serving these two cities would be rerouted via the Suez Canal only if the entire route can be served better via the Suez Canal.

B. Rerouting -- Larger ship size. This is a very important alternative to the Panama Canal, particularly with respect to dry bulk cargo. During FY 1977, about 3.5 million tons of coal were shipped from Hampton Roads, Virginia, to Japan in 100,000 to 130,000 DWT bulk carriers via the Cape of Good Hope. There may be additional coal shipments, from Baltimore or the Gulf Coast, perhaps, which are routed to the Far East via the Cape, based on a comparison of U.S. foreign trade and Panama Canal data. However, the time lag involved between export declarations and transits through the Canal prevents a precise comparision of the two data sources.

In the future, other bulk commodities moving between the U.S. and the Far East, such as grain, phosphate rock, and possibly steel scrap, may be shipped in large bulk carriers via the Cape of Good Hope; and the rate of such shipments will undoubtedly depend on the level of toll charges. At present, there are some barriers preventing the wide-spread use of larger dry bulk carriers. But these also existed when the larger ships were first used to carry coal.

There is also a potential for the use of very large tankers as an alternative to shipment of petroleum via the Canal. The best opportunity for such use involves the movement of crude oil from Ecuador to refineries in the Caribbean area. However, with respect to Alaska crude oil, the use of very large crude carriers is not likely.

The Jones Act requires that ocean shipments between any two United States ports be carried in United States flag vessels. There is at

present, a large surplus of foreign flag VLCC's (very large crude carriers), and the current charter rates for these ships are extremely low. There is no similar surplus--current or prospective--of U.S. flag VLCC's; and therefore the movement of Alaska oil in such vessels around the Horn would not be economical, even if one assumes a 150% toll increase.

c. Rerouting by alternate mode. There are many variations of this alternative, but they all involve a complete or partial substitute of one mode of transport--usually rail transportation--for another mode of transport, usually ocean transportation.

In its purest form, this alternative is exemplified by the substitution of rail movements between the east and west coasts of the United States for intercoastal shipment via the Canal. Even before the first recent Panama toll increase in 1974, most of the lumber movement from the U.S. Northwest was rerouted to rail or truck shipment. This also involved, in most cases, a shift to timber lands which are further inland.

The greatest future opportunities for this alternative exist with respect to container and other general cargo traffic moving between the Far East and the eastern half of the United States and between Europe and the western half of the United States. Mini-bridge traffic, as it is called, is very competitive with movements through the Canal, particularly if the true origin or destination of the shipment in the United States is some distance from either coast. In terms of rates to shippers, there is generally no difference between mini-bridge rates and rates via the Panama Canal.

While most of the opportunities for this type of rerouting involve the use of land transportation within the United States, there are some movements where foreign land transportation might be the replacing element. For instance, with respect to Canadian lumber exports to the United States, rail shipment from Canada is an alternative already in current use. There is also a possibility that banana shipments from Panama might be trucked to the east coast of Panama to avoid payment of tolls.

d. Product exchange. This alternative is primarily used in the petroleum industry and involves the exchange of products at different geographic locations with the view of reducing total transportation costs and, in some cases, avoiding the need of two separate and opposite movements via the Panama Canal. (In fact, one petroleum company uses Panama Canal Company statistics to uncover opportunities for future product exchanges.) Similar opportunities exist with respect to crude oil, but current federal policy precludes the use of this alternative with respect to Alaska crude oil.

While product exchange is a procedure that is particularly suitable for petroleum companies because of the prevalence of interplant transfers and the standardization of products, it is possible that other industries might adopt similar procedures.

e. Alternate Markets and Sources. One common and erroneous assumption which is often made concerning shipments via the Panama Canal is that the shipment must be completed between points A and B. This is obviously true in the very short run; but in the longer run, the only true economic necessities relate to complementary economic desires at points A and B which can conceivably be satisfied without any shipments between the two. The seller at point A is primarily concerned in disposing of his output at maximum profit and the buyer at point B seeks to acquire a specific commodity at minimum cost. If a small increase in the transportation cost between A and B results in severing a trade relationship, the obvious implication is that both A and B had alternatives available which were so close in terms of economic satisfaction that even a fractional change with respect to one of the options--trade between A and B--is likely to cause a discontinuation of that trade.

Alternate markets and sources have become a significant alternative to the Panama Canal in the last two decades because of the emergence of Japan as a primary economic power within the Pacific area. Prior to that event, raw material producers in the Pacific basin had to have access to markets within the Atlantic basin to market their products and the Panama

Canal provides that access. Now there are significant markets for all types of raw materials within the Pacific basin--for iron ore, coal, bauxite, phosphate rock, etc. In fact, there have been many significant mineral development projects in Australia, Western Canada and South America which, from the very beginning, were pointed to markets in the Far East.

The commodity categories in which this alternative plays a significant role include iron ore, scrap, bananas, lumber, coal, citrus and sugar.

f. Alternate development. Alternate development is a long-run version of alternate markets and sources, and it involves an economic development in agriculture, mining, forestry, which was specifically designed to lessen the transport cost between source and market, and incidentally, avoid shipment via the Panama Canal. In retrospect, the coal mine developments in Australia and Canada, whose principal objective was to substitute Australian and/or Canadian coal for U.S. coal in Japanese imports, were such alternate developments.

At the present time, another such development seems to be occurring in the banana industry. Ecuador, which has a significant transport cost disadvantage in banana exports vis-a-vis Central America, as well as the added burden of Canal tolls, is attempting to shift its agricultural production to cocoa and other tropical products; and the strength of these efforts will definitely be related to future toll increases and their size. The chances are that any reduction in exports on the part of Ecuador is likely to be made up by new development on the Caribbean side of Central America.

D. SENSITIVITY ESTIMATES: CARGO TONNAGE AND REVENUES

The sensitivity estimates for Panama Canal traffic were made separately for the 23 commodity categories for which traffic estimates had been made. Also, the estimates are expressed both in terms of cargo tonnage as well as the associated toll revenue.

As previously stated, it was assumed for the purpose of these estimates that increases in toll rates amounting to 15, 25, 30, 40, 50, 75, 100 and 150 percent would be announced April 1, 1978, and put into effect on October 1, 1978. The effect of these assumed toll increases was measured against the traffic projections made for the fiscal years 1979, 1980, 1985 and 1990.

The actual estimates are contained in 8 summary tables, showing both tonnages and the associated revenues for the four specified years. Eight tables follow the discussion concerning the individual commodity categories.

Below is a brief discussion of the sensitivity estimates for the individual commodity categories.

Wheat

In the aggregate, wheat traffic via the Panama Canal does not appear to be very sensitive to toll increases of 100% of less; but it is felt that toll increases greater than 100% will result in a substantial loss in traffic volume. This loss in traffic will probably be due to consumers buying wheat from other sources, such as Canada, Australia, and the West Coast of the United States, as well as shifting of some wheat shipments to alternative routes.

Canadian exports which are sometimes cross-hauled via the Canal are likely to be affected by any substantial toll increases. As indicated earlier, this cross-hauling occurs by accident and is not predetermined. However, the raising of tolls will result in a greater degree of planning by the Canadian Wheat Board to avoid cross shipments.

Most of the U.S. East Coast exports to Asia via the Canal are not

sensitive to smaller toll increases largely because individual wheat shipments are generally small in size. However, sharply higher toll increases will certainly cause importers to evaluate the economics of using larger ships (not only for by-pass opportunities, but also for ships from Pacific Basin port areas--Vancouver, Australia and West Coast United States).

It is also believed that the imposition of a substantial toll increase--50% or better--will lead, in a few years, to such a substantial by-pass movement of coarse grain from the Gulf Coast to the Far East that some wheat shipments might become part of it. (See discussion under Coarse Grain below.)

Coarse Grain

The imposition of higher Canal tolls will result in a substantial decline in coarse grain traffic via the Panama Canal. While a small part of the loss in traffic may be due to a shift to other markets, it is expected that the toll increase will provide an incentive to buyers and sellers to reroute a substantial volume of grain via the Cape of Good Hope.

As indicated previously, the principal route of coarse grain shipments via the Canal consists of grain from the East Coast U.S. (Gulf and Atlantic ports) to Asia (Japan and South Korea), and it is expected that this movement will continue to grow at a substantial rate. This increased volume of export will begin to tax the capacity of existing delivery systems causing added congestion at both loading and discharge port areas.

One obvious method for dealing with port congestion caused by the growing volume of shipments is to increase the size of individual shipments. It is apparent that in spite of the many current objections to the use of 70,000 to 100,000 DWT ton vessels in movements around the Cape, the growing volume of feed grain shipments will exert strong pressure toward increasing the size of the average shipment. As a result, there is a strong probability that in the near future some trial shipments of feed grain will be made in large bulk carriers around the Cape.

As was the case with coal shipments, the charter rate for these early shipments will undoubtedly be much less than the rates then current for shipments via the Panama Canal. Given the volatility of charter rates even during quiet times, it is difficult to project specific rates with any degree of probability. At present, for instance, charter rates for grain from the Gulf to Japan range from $10 to $12.50 per ton. Rates for larger vessels going around the Cape would, at first, have to be about $1.50-$2.50 per ton less to attract interest. These early shipments would serve to pave the way for the handling of larger ships. In time, there will undoubtedly be a substantial volume of by-pass traffic between the United States and the Far East; and given the growing number of large bulk carriers in use, other commodities shipped in lesser volume will be attracted to it.

A substantial toll increase would serve to encourage or speed up the shift toward a by-pass route. Once such larger shipments have become established at a few ports, competitive forces will tend to narrow the difference in charter rates between the two types of ships. At that time, a toll increase of 50% or more will have a significant effect on deciding whether individual shipments are routed via the Canal or via the Cape.

It is expected that substantial toll increases will also result in a shift of a small amount of coarse grain to be exported via the West Coast ports instead of the Gulf ports. Because of the nature of transport economics, grain which is exported generally comes from the areas closest to the Mississippi River, its tributaries and to some extent the Atlantic Coast ports. However, increased foreign demand is requiring now that grain from areas less accessible to the inland waterways be routed into export channels.

In summary, it is estimated that a toll increase of 50% would reduce feed grain shipments by about 10% in 1985. Beyond that traffic losses would mount sharply, reaching 30% in response to 100 percent increase and more than 40% in response to a 150 percent increase.

Most of the losses will occur as a result of by-pass shipments via the Cape of Good Hope. Diversions to the West Coast would amount to no more than 2-3% of the total.

Bananas

Bananas are quite sensitive to toll increases. Because of the very high effective toll rates for bananas, the industry has been aware of the impact of Panama Canal toll rates and has taken steps to minimize the effects. For instance, the industry is exploring the shipment of Panama bananas by truck to the east coast, and thus avoid passage through the Canal.

A more effective alternative appears to be the intention of the banana industry to restructure its distribution within the United States and to supply a larger portion of the country with shipments via the West Coast. At present, only the West Coast and the Rocky Mountain region are supplied with shipments via Los Angeles. A toll increase of 50% or greater would result in such a distribution shift by some, if not all, banana importers.

The cost considerations involved here are complex. Ocean transport costs amount to as much as 20% to 30% of the delivered wholesale price of bananas and the industry is exploring many ways to reduce this cost. A substantial toll increase, it is believed, will act as a spur and prompt the industry to restructure its supply systems, involving a considerable reduction in the number of transits.

In the longer run, the industry is definitely seeking to encourage new banana planting in the Caribbean area; and the speed of this development can be tied directly to the level of future toll increases. In summary, it is estimated that a 50% toll increase would cause a traffic loss of nearly one-third by 1985.

Sugar

Sugar traffic is quite sensitive to toll increases. It is expected that in the short run, toll increases of 100% or more will result in a substantial loss of traffic; in the long run, even toll increases of 15% are likely to result in some loss in traffic.

The loss in traffic will be produced most likely by changes of existing markets and sources. As indicated in the previous parts of traffic projections, several U.S. companies are engaged in attempts to secure

additional supplies of nearby sugar perhaps through a product exchange with Japan, which is trying to buy more sugar in the Pacific basin. A toll increase will in all likelihood encourage these and similar endeavors by sugar importers.

Soybeans

Soybean traffic via the Panama Canal appears to be sensitive to toll increases at levels beyond 75 percent. Sensitivity of soybean shipments will increase during the Eighties particularly if a large volume of by-pass grain traffic develops between the U.S. Gulf and the Far East.

As discussed in a previous section on Coarse Grain, the increased volume of grain shipments to the Far East will result in attempts by traders to initiate such by-pass shipments regardless of a toll increase. Once this traffic exists, some soybean shipments may be directed to it.

Soybean traffic is less sensitive to toll increases than coarse grain because they are exported in smaller shipment sizes and there are also substantial grade differences. But some shipments could be large enough to justify rerouting via the Cape in 70,000 - 100,000 DWT ton bulk carriers.

Lumber

The imposition of higher Canal tolls will result in a substantial reduction of lumber traffic via the Canal. This loss will be caused primarily by a reduction of exports of Canadian merchant grade lumber to both the East Coast U.S. and to Europe. Competition from U.S. Southern pine and East Coast Canada lumber producers has resulted in a steady erosion of the position held by western Canadian lumber on the East Coast United States. Toll increases will only serve further to weaken this competitive position. Canadian exports to Europe will be similarly affected by toll increases since competitive Russian and Scandanavian lumber have smaller transport costs. However, Canadian producers will seek to maintain some export of lumber that comes from coastal sources and mills and which would be difficult to reroute by rail to domestic U.S. markets. In terms of transport costs, it is generally accepted that cost parity currently exists between ocean shipments and rail shipments from British Columbia at destinations which are 100 to 300 miles from the U.S. east coast.

Pulpwood and Paper Products

Pulpwood and paper product traffic will be affected by higher Canal tolls but, in all likelihood, not to the extent that lumber and lumber products are affected.

The loss in traffic caused by toll increases will generally result from a shifting of markets rather than a rerouting of trade routes. As indicated, North American pulpwood is desirable because of the long fibers present in the hemlock and firs. There is a growing demand for this product both in the traditional European markets and in the Far East. Higher toll rates will help to redirect the focus of Canadian producers from Europe to Japan.

Substantially higher tolls might generate some other realignments of markets; but on the whole, because of the diversification of the market and because of the strong institutional ties, it is not expected that tolls will cause a major shift in the traffic pattern or buying pattern.

Phosphates

Phosphate shipments are regarded as moderately sensitive to toll increases, and even minimum toll increases are likely to produce some diversion of traffic from the Panama Canal.

The principal trade route involved is from the Gulf Coast to the Far East; and as was stated in the section on coarse grains, it is anticipated that in the next few years, a by-pass traffic in bulk materials, other than coal, will develop. Once this traffic exists, some phosphate will be diverted to it. A toll increase will obviously accelerate the shift to larger vessels and the use of the by-pass route.

However, since only one of the phosphate loading docks at Tampa can handle bulk carriers with no limitation on length and a maximum draft of 40 feet, the number of shipments diverted is likely to be small; as a result, phosphate shipments are regarded as less sensitive than coarse grain shipments.

Fertilizer, Potash, and Fishmeal

The three commodities in this category are only moderately sensitive to toll increases up to 75 percent. They are far more sensitive to toll increases of 100 and 150 percent.

The most sensitive of the three are fertilizer shipments which are largely from the Gulf Coast to the Far East, South America and Australia. There are also large fertilizer shipments from Europe to South America and Oceania. The principal alternative would be alternate markets and sources, since world fertilizer production has not only greatly increased in volume in recent years, but it has spread geographically, thereby increasing the opportunities for substitute sources and markets. The same is true for potash shipments from the west coast of Canada to Europe. Fishmeal shipments from the west coast of South America to Europe are regarded as least sensitive to toll increases.

Iron Ore

Iron ore is the most sensitive commodity category. It is estimated that a toll increase of 50% will reduce iron ore shipments to one-half of the projected levels by 1985 and to one-quarter in response to a 100% toll increase.

Practically all of the iron shipments through the Canal are from Peru and Chile and are destined to the east coast of the United States and Europe. The principal alternatives will be rerouting by larger ships via Cape Horn and alternate markets and sources with the United States and Europe further curtailing their purchases of iron ore from the west coast of South America. And Chile and Peru, in turn, would sell more of their ore to Japan.

The reason for the extreme sensitivity of iron ore shipments is the fact that even under present toll rates, the competitive position of these iron shipments is very marginal, both in Europe and the United States. The shipments themselves are made possible by very low charter rates; and further toll increases would eliminate most of them.

Miscellaneous Ores

Miscellaneous ores, like miscellaneous metals, involve primarily the movement of cargoes which are less than shiploads. As a result, shipments would only be moderately sensitive to toll increases, and most of the diversions here will be related to routing changes by general cargo and/or container ships. For instance, it is assumed that if, as a result of a substantial toll increase, there occurs a substantial diversion of United States-Far East traffic to U.S. West Coast ports, shipments of this category would be equally affected.

Scrap Metal

Steel scrap shipments are not considered sensitive except in case of toll increases in excess of 50 percent, and particularly in excess of 100 percent. The principal movement is from the east coast of the United States to the Far East. Since most scrap exports involve quantities of 20,000 tons or less, there are only limited opportunities for utilizing large bulk carriers in movements via the Cape of Good Hope.

However, in the case of a toll increase of 100% or more, it is estimated that the nature of bulk cargo movements between the U.S. and the Far East would change so significantly that even the smaller bulk commodity categories would be affected. At that time, large combination bulk carriers would enter the trade and these could handle the smaller scrap shipments in conjunction with other commodities.

Alumina and Bauxite

The two principal movements in this category are shipments of alumina from Australia to the Gulf Coast and from the West Indies to the Pacific Northwest. These two movements, which are roughly equivalent in size, constitute a classic case of cross-hauling.

As stated earlier, there are numerous corporate ties between bauxite/alumina production and aluminum refining and as a result, the complete elimination of such cross-hauling is not imminent. However, product exchange is a growing practice in the aluminum industry. It is therefore

likely that with toll increases of more than 50 percent, a fair volume of product exchanges will be arranged.

Miscellaneous Metals

This category is only moderately sensitive to toll increases. There are very few single commodity movements involving this category. As a result, most of the diversions involved here will be related to changes in routing by general cargo and container ships. Example: shipments from the Far East via west coast ports.

Coal

Coal shipments from the east coast of the United States to the Far East are very sensitive to toll increases, even though it must be expected that the major effect of such toll increases will be delayed for 3 to 5 years. The reason for this delay is that the principal alternative available to coal buyers is the use of large bulk carriers (100,000-150,000 tons) via the Cape of Good Hope, and the number of such vessels currently available at attractive rates is limited. Also, there is some opposition on the part of some users to receiving coal in such large quantities which is based on practical difficulties which might be overcome with time.

Even though at present charter rates for large carriers are sometimes $1.50 or $2.00 a ton lower than equivalent rates for smaller ships going through the Canal, a further toll rate increase of 100%--which is the equivalent of an additional 85 cents per ton cost for voyages via the Canal--would reduce the volume of coal shipments by no more than 42 percent. The reason for this is that a toll increase of such magnitude would be partly offset by changes in charter rates as between smaller and larger vessels, reflecting relative demand for each. (For instance, there are a number of automobile carriers who take coal cargoes as backhaul to Japan. Should Panama Canal tolls be raised, such ships would, if necessary, lower their backhaul rates in order to assure the continued contribution to their total operating costs.)

Crude Petroleum

Crude petroleum shipments are moderately sensitive to toll increases up to 50 percent, but very sensitive to increases of 75 to 150 percent. This division is based on the conclusion that for toll increases up to 50 percent, there will be diversions only of non-Alaska crude oil. Crude oil shipments from Ecuador are likely to be diverted in large crude carriers via the Horn, and there may also be some diversion of Venezuelan crude oil.

With respect to Alaska oil, toll increases of up to 75% will produce few diversions from the Panama Canal. The projections made here for shipments of North Slope oil through the Canal already assume that the SOHIO pipeline will be completed and utilized to the maximum extent and that, additionally, there may be some crude oil exchanges with Mexico and some shipments in foreign flag super-tankers to the Virgin Islands. These latter alternatives might be utilized to a somewhat greater extent in case of toll rate increases up to 75%, but the margin of change will be small.

With a 100% toll increase, this situation would change. A 100% toll increase might make a pipeline through Honduras a viable proposition or it might be sufficient to swing the balance in favor of building the Kitimat pipeline from British Columbia to the Midwest. The addition of either of these pipelines would sharply reduce the volume of crude oil shipments via the Canal.

In the aggregate, it is estimated that a 50% toll increase would decrease crude petroleum shipments by about 15%; but a 100% increase would raise the traffic loss to 35% and a 150% toll increase would raise the loss to about 70%.

Petroleum Products

Shipments of petroleum products are moderately sensitive to toll increases. Because of the general uniformity of product prices, the

standardization of products and the availability of competing products in many locations, diversions from the Panama Canal are occurring at present toll rates.

The principal alternatives are alternate markets and sources, and product exchanges. (The latter is really a special case of alternate markets and sources.) The practice of product exchanges is rapidly growing; and since large petroleum companies utilize computer programs for their distribution of crude oil and products, even small cost changes may dictate alternate shipping and distribution patterns.

Chemicals

Shipments of chemicals are regarded as only moderately sensitive to assumed toll increases of 50% or less. The sensitivity increases sharply in response to toll increases of 50% or more.

Chemicals are a broad category in terms of products, routes and even types of vessels used. More than half of the chemical shipments originate on the east coast of the United States and are destined primarily for the Far East, Oceania and the U.S. West Coast. The rest of the shipments are spread over a number of different routes.

The diversity of products and routes involved in this category suggest that the sensitivity of shipments in this category is very much like the sensitivity of general cargo, particularly since a significant portion of chemical product shipments is carried in general cargo or container ships.

Sulfur

Sulfur shipments, which are primarily from British Columbia to Europe and the United States, are not sensitive to toll increases of 50% or less. Toll increases greater than 50%, and particularly toll increases of 100% or above, will result in a reduction of traffic through the Panama Canal.

The principal alternatives are rerouting by rail for shipments to the United States and alternate markets, which in this instance would mean larger sales to the Far East. As with other, smaller bulk commodity categories, it is estimated that a toll increase in excess of 100% is

likely to produce a substantial reduction in traffic because a toll increase of such magnitude will undoubtedly lead to a significant change in the routing patterns of bulk carriers presently engaged in Panama Canal shipments. These changes in routing patterns will, by themselves, affect the sensitivity of other bulk commodity shipments.

Other Non-Metallic Minerals

The principal commodities in this category, which are salt and China clay, are not regarded as sensitive to toll rate increases up to 50 percent. Toll increases greater than 50 percent, and particularly toll increases over 100 percent, are likely to result in significant traffic reductions (most often reduction would come in salt).

The primary shipments of salt are from Central America and the Caribbean area to both the east and west coasts of the United States. The principal alternative is a product exchange which is likely to be initiated as a consequence of a substantial toll increase. (It might occur sooner, but one effect of a substantial toll increase will be to act as an alarm clock as far as Canal users are concerned.)

The principal route for clay is from the southeastern part of the United States to Japan. Since clay is often shipped in containers, mini-bridge rail-movement to the west coast would be the principal alternative. Again, a substantial toll increase is likely to act as a spur.

Manufactures of Iron and Steel

Shipments of steel products are only moderately sensitive to toll increases up to 100 percent, partly because steel products are among the few bulk commodities available for shipment to the United States from the Far East, as opposed to the large volume of bulk commodities shipped to the Far East. As a result, charter rates for steel products are very attractive and would be competitive with shipments in larger vessels.

In response to toll rate increases of up to 75%, the most likely alternative would involve shipment to the west coast of the U.S. and rail or truck shipment from there. However, such diversions are only likely if the destination of shipment is some distance inland from the East Coast.

Toll rate increases of 100% or more will result in substantial decreases in traffic because toll rate increases of such magnitude are likely to bring about a radical change in the composition of the bulk carrier fleet operating between the United States and the Far East; and this change alone will affect all other dry bulk commodities moving on this route.

Automobiles and Trucks

Automobile shipments, particularly from Japan, will be sensitive to toll increases of 50% or more. The sensitivity is traceable to the expansion of Japanese car sales in the United States and to the fact that the distribution network of the major Japanese car manufacturers covers the entire country. The sensitive portion of automobile traffic relates to shipment destined for the Midwest and the Rocky Mountain regions which can be served via the east or the west coast. Should some automobile carriers be shifted to west coast destinations, the growing volume of Japanese lumber imports from Canada could provide backhauls for these carriers. Other backhaul commodities available on the west coast include grain, both from the U.S. and Canada, and coal from Canada. (Backhaul commodities are essential for competitive rerouting of automobile carriers.)

General Cargo

The sensitivity of general cargo movements, including containers, to toll increases varies considerably, depending upon the route involved. However, it appears that the largest and fastest growing general cargo routes using the Panama Canal are also the most sensitive. These include the United States-Far East and the United States-Oceania routes which are particularly sensitive with respect to U.S. imports. Also sensitive are shipments on the Oceania-Europe and Europe-West Coast United States routes.

We believe that substantial toll increases--in excess of 50%--will have a significant effect on the expansion plans of various shipping companies. Once a toll increase of such magnitude is put into effect,

it is likely that it will encourage fleet expansion by companies whose routes by-pass the Canal. These additions to capacity will lead to sharp price competition--which occurs even among members of freight conferences--which would put Canal users at an even greater disadvantage.

With respect to most general cargo shipments in which alternate routing via mini-bridge is available, the rates charged to shippers are the same for either route. As a result, decisions are often made on the basis of schedule frequency, service quality, and the shippers' acquaintance or lack of acquaintance with specific shipping companies. Many of these intangible factors tend to go with the route that has the most companies and the most ships. As a result, once an alternate route has gained the upper hand in this competition, further and greater losses of Panama Canal traffic must be expected in the future.

It is obviously difficult to quantify the assumptions made here; but this difficulty makes them no less probable. The estimates made here are that a toll increase of 50% will result in a traffic loss of 8% by 1985. However, a 100% increase would raise the traffic loss figure sharply to about 25%.

Table 30

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1979

(000's of Long Tons)

CARGO	Tonnage with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	147,565	147,350	146,610	145,108	143,853	142,046	135,222	126,914	112,621
Wheat	4,000	4,000	4,000	4,000	3,960	3,920	3,920	3,700	3,280
Coarse grains	15,500	15,500	15,500	15,423	15,229	15,074	14,783	14,337	13,309
Bananas	1,700	1,683	1,641	1,607	1,564	1,488	1,386	1,241	969
Sugar	3,610	3,610	3,610	3,610	3,610	3,556	3,303	3,105	2,744
Soybeans	4,900	4,900	4,900	4,900	4,827	4,728	4,704	4,606	4,288
Lumber	4,900	4,900	4,900	4,900	4,900	4,900	4,606	4,435	4,092
Wood pulp, paper & paper products	3,000	3,000	3,000	3,000	3,000	3,000	2,940	2,820	2,595
Phosphates	3,900	3,900	3,900	3,881	3,861	3,822	3,783	3,705	3,510
Fertilizer, potash & fishmeal	2,800	2,800	2,800	2,800	2,800	2,800	2,702	2,520	2,226
Iron Ore	2,200	2,002	1,826	1,749	1,639	1,540	1,276	1,034	759
Miscellaneous ores	3,350	3,350	3,350	3,333	3,300	3,233	3,166	2,931	2,680
Scrap metal	1,600	1,600	1,600	1,600	1,600	1,600	1,544	1,464	1,272
Alumina & bauxite	1,290	1,290	1,290	1,290	1,284	1,258	1,200	1,155	1,084
Miscellaneous metals	1,600	1,600	1,600	1,592	1,576	1,544	1,512	1,400	1,280
Coal	12,800	12,800	12,736	12,608	12,288	12,032	11,328	10,264	9,280
Crude petroleum	34,900	34,900	34,726	34,028	34,028	33,504	31,236	28,793	24,256
Petroleum products	10,500	10,500	10,343	10,238	10,080	9,975	9,660	8,925	7,560
Chemicals	3,450	3,450	3,433	3,381	3,364	3,347	3,157	3,002	2,726
Sulfur	1,250	1,250	1,250	1,250	1,250	1,250	1,231	1,169	1,019
Other non-metallic metals	1,100	1,100	1,100	1,100	1,100	1,100	1,084	1,029	897
Iron & steel mfrs.	8,600	8,600	8,600	8,600	8,471	8,299	7,998	7,654	6,708
Autos and trucks	1,445	1,445	1,431	1,431	1,431	1,431	1,358	1,235	1,134
General cargo	19,170	19,170	19,074	18,787	18,691	18,595	17,445	16,390	14,953

NOTE: Slight discrepancies due to rounding.

Table 31

SUMMARY OF SENSITIVITY ESTIMATES· EFFECTS OF TOLL INCREASE FY 1980

(000's of Long Tons)

CARGO	Tonnage with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	149,815	149,551	147,973	146,213	144,377	142,307	133,939	124,185	106,297
Wheat	3,700	3,000	3,700	3,682	3,645	3,608	3,515	3,386	2,942
Coarse grains	15,900	15,900	15,900	15,741	15,500	15,361	14,844	14,226	12,992
Bananas	1,750	1,706	1,645	1,593	1,523	1,444	1,321	1,216	823
Sugar	3,610	3,610	3,610	3,610	3,556	3,448	3,195	2,960	2,581
Soybeans	5,100	5,100	5,100	5,100	4,998	4,922	4,794	4,667	4,233
Lumber	4,900	4,900	4,900	4,900	4,900	4,900	4,508	4,239	3,920
Wood pulp, paper & paper products	3,100	3,100	3,100	3,100	3,100	3,100	2,976	2,837	2,573
Phosphates	4,100	4,100	4,059	4,018	4,018	3,957	3,854	3,752	3,403
Fertilizer, potash & fishmeal	2,900	2,900	2,900	2,900	2,900	2,900	2,726	2,509	2,204
Iron Ore	2,000	1,780	1,630	1,550	1,430	1,330	1,070	870	630
Miscellaneous ores	3,500	3,500	3,483	3,465	3,430	3,343	3,255	2,958	2,660
Scrap metal	2,000	2,000	2,000	2,000	2,000	2,000	1,910	1,770	1,480
Alumina & bauxite	1,335	1,335	1,335	1,335	1,315	1,288	1,222	1,161	1,068
Miscellaneous metals	1,600	1,600	1,592	1,584	1,568	1,528	1,488	1,352	1,216
Coal	13,400	13,400	13,199	12,998	12,663	12,328	11,457	10,586	8,978
Crude petroleum	34,200	34,200	33,687	33,003	32,832	32,148	29,412	26,505	20,691
Petroleum products	11,000	11,000	10,725	10,615	10,395	10,230	9,845	9,020	7,260
Chemicals	3,500	3,500	3,465	3,413	3,378	3,378	3,168	2,993	2,625
Sulfur	1,250	1,250	1,250	1,250	1,250	1,250	1,213	1,138	975
Other non-metallic metals	1,100	1,100	1,100	1,100	1,100	1,100	1,067	1,001	858
Iron & steel mfrs.	8,800	8,800	8,756	8,712	8,536	8,404	8,008	7,656	6,600
Autos and trucks	1,500	1,500	1,463	1,463	1,455	1,455	1,380	1,238	1,103
General cargo	19,570	19,570	19,374	19,081	18,885	18,885	17,711	16,145	14,482

NOTE: Slight discrepancies due to rounding.

Table 32

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1985

(000's of Long Tons)

CARGO	Tonnage with Toll Rate Increases of. None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	158,525	154,818	151,429	148,473	144,437	139,806	125,981	109,982	78,598
Wheat	4,000	4,000	3,960	3,920	3,880	3,800	3,600	3,400	2,640
Coarse grains	19,100	18,768	18,339	18,151	17,531	17,102	15,430	13,329	10,082
Bananas	2,000	1,840	1,660	1,600	1,500	1,360	1,140	800	400
Sugar	3,675	3,491	3,344	3,271	3,161	3,019	2,720	2,426	1,911
Soybeans	5,600	5,544	5,488	5,432	5,320	5,208	4,872	4,536	3,528
Lumber	5,100	5,100	5,100	5,049	4,896	4,692	4,284	3,927	3,162
Wood pulp, paper & paper products	3,200	3,200	3,200	3,200	3,200	3,104	2,848	2,656	2,304
Phosphates	4,700	4,653	4,606	4,559	4,465	4,371	4,089	3,854	3,196
Fertilizer, potash & fishmeal	3,200	3,200	3,200	3,200	3,168	3,040	2,784	2,528	1,984
Iron Ore	2,000	1,660	1,520	1,400	1,180	1,000	700	500	360
Miscellaneous ores	3,900	3,900	3,822	3,783	3,666	3,510	3,315	2,925	2,340
Scrap metal	2,400	2,400	2,400	2,400	2,400	2,328	2,208	1,920	1,248
Alumina & bauxite	1,570	1,570	1,570	1,570	1,497	1,444	1,350	1,240	1,036
Miscellaneous metals	1,600	1,600	1,568	1,552	1,504	1,440	1,360	1,200	960
Coal	16,600	15,604	14,940	14,442	13,778	13,114	11,454	9,628	6,142
Crude petroleum	29,200	28,032	27,740	26,864	26,280	25,404	21,608	17,520	8,760
Petroleum products	11,000	10,780	10,120	9,900	9,680	9,350	8,580	7,370	4,950
Chemicals	3,750	3,750	3,675	3,600	3,525	3,450	3,150	2,813	2,250
Sulfur	1,400	1,400	1,400	1,400	1,400	1,372	1,232	1,134	882
Other non-metallic metals	1,200	1,200	1,200	1,200	1,200	1,176	1,056	972	756
Iron & steel mfrs.	10,200	9,996	9,894	9,792	9,486	9,282	8,772	7,956	6,222
Autos and trucks	1,730	1,730	1,661	1,644	1,609	1,557	1,453	1,298	1,073
General cargo	21,400	21,400	20,972	20,544	20,116	19,688	17,976	16,050	12,412

NOTE: Slight discrepancies due to rounding.

Table 33

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1990

(000's of Long Tons)

CARGO	Tonnage with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	169,251	165,449	161,810	158,759	154,402	149,460	135,060	118,253	85,497
Wheat	4,300	4,300	4,257	4,214	4,171	4,085	3,870	3,665	2,838
Coarse grains	22,200	21,831	21,413	21,142	20,427	19,934	17,985	15,543	11,769
Bananas	2,250	2,070	1,868	1,800	1,688	1,530	1,283	900	450
Sugar	3,700	3,515	3,367	3,293	3,182	3,034	2,738	2,442	1,924
Soybeans	6,200	6,138	6,076	6,014	5,890	5,766	5,394	5,022	3,906
Lumber	5,100	5,100	5,100	5,049	4,896	4,692	4,284	3,927	3,162
Wood pulp, paper & paper products	3,300	3,300	3,300	3,300	3,300	3,201	2,937	2,739	2,376
Phosphates	4,900	4,851	4,802	4,753	4,655	4,577	4,263	4,018	3,332
Fertilizer, potash & fishmeal	3,400	3,400	3,400	3,400	3,366	3,230	2,958	2,686	2,108
Iron Ore	2,000	1,660	1,520	1,400	1,180	960	700	500	360
Miscellaneous ores	4,200	4,200	4,116	4,074	3,948	3,780	3,570	3,150	2,520
Scrap metal	2,600	2,600	2,600	2,600	2,600	2,522	2,392	2,080	1,352
Alumina & bauxite	1,795	1,795	1,795	1,795	1,705	1,651	1,544	1,418	1,184
Miscellaneous metals	1,600	1,600	1,568	1,552	1,504	1,440	1,360	1,200	960
Coal	17,900	16,826	16,110	15,573	14,857	14,141	12,351	10,382	6,623
Crude petroleum	24,200	23,232	22,990	22,264	21,780	21,054	17,908	14,520	7,260
Petroleum products	11,000	10,780	10,120	9,900	9,680	9,350	8,580	7,370	4,950
Chemicals	4,100	4,100	4,018	3,936	3,854	3,772	3,444	3,075	2,460
Sulfur	1,500	1,500	1,500	1,500	1,500	1,470	1,320	1,215	945
Other non-metallic metals	1,300	1,300	1,300	1,300	1,300	1,274	1,144	1,053	819
Iron & steel mfrs.	11,600	11,368	11,252	11,136	10,788	10,556	9,976	9,048	7,076
Autos and trucks	1,750	1,750	1,680	1,663	1,628	1,575	1,470	1,313	1,085
General cargo	22,900	22,900	22,442	21,984	21,526	21,068	19,236	17,175	13,282
New movements	5,456	5,333	5,216	5,117	4,977	4,818	4,353	3,812	2,756

NOTE: Slight discrepancies due to rounding.

Table 34

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1979

(000's of Dollars)

CARGO	Revenues with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	194,044	222,532	240,873	247,939	265,132	280,943	311,363	332,709	369,895
Wheat	3,400	3,910	4,250	4,420	4,712	4,998	5,682	6,290	6,970
Coarse grains	13,020	14,973	16,275	16,842	17,909	18,993	21,731	24,086	27,949
Bananas	6,086	6,929	7,343	7,479	7,839	7,991	8,683	8,886	8,673
Sugar	3,105	3,570	3,881	4,036	4,346	4,587	4,971	5,341	5,900
Soybeans	4,116	4,733	5,145	5,351	5,677	6,020	6,915	7,738	9,005
Lumber	5,390	6,199	6,738	7,007	7,546	8,085	8,867	9,757	11,253
Wood pulp, paper & paper products	8,250	9,488	10,313	10,725	11,550	12,375	14,149	15,510	17,841
Phosphates	3,276	3,767	4,095	4,238	4,541	4,816	5,561	6,224	7,371
Fertilizer, potash & fishmeal	3,024	3,478	3,780	3,931	4,234	4,536	5,107	5,443	6,010
Iron Ore	1,804	1,888	1,872	1,864	1,882	1,894	1,831	1,696	1,556
Miscellaneous ores	2,948	3,390	3,685	3,813	4,066	4,268	4,876	5,159	5,896
Scrap metal	1,376	1,582	1,720	1,789	1,926	2,064	2,324	2,518	2,735
Alumina & bauxite	1,058	1,217	1,323	1,375	1,474	1,547	1,722	1,894	2,222
Miscellaneous metals	1,760	2,024	2,200	2,277	2,427	2,548	2,911	3,080	3,520
Coal	10,880	12,512	13,532	13,932	14,623	15,341	16,850	17,449	19,720
Crude petroleum	39,088	44,591	48,616	49,545	53,356	56,287	61,223	64,496	67,917
Petroleum products	12,075	13,886	14,868	15,306	16,229	17,207	19,441	20,528	21,735
Chemicals	3,795	4,364	4,720	4,835	5,181	5,523	6,077	6,604	7,497
Sulfur	1,063	1,222	1,328	1,381	1,488	1,594	1,831	1,987	2,165
Other non-metallic metals	1,100	1,265	1,375	1,430	1,540	1,650	1,897	2,058	2,243
Iron & steel mfrs.	9,632	11,077	12,040	12,522	13,283	13,942	15,676	17,145	18,782
Autos and trucks	19,074	21,935	23,612	24,556	26,445	28,334	31,370	32,604	37,422
General cargo	38,723	44,532	48,162	49,335	52,858	56,343	61,668	66,216	75,513

NOTE: Slight discrepancies due to rounding.

Table 35

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1980

(000's of Dollars)

CARGO	Revenues with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	197,485	226,723	243,392	250,242	266,345	281,993	309,494	326,195	350,100
Wheat	3,145	3,617	3,931	4,069	4,338	4,600	5,229	5,756	6,252
Coarse grains	13,356	15,359	16,695	17,189	18,228	19,355	21,821	23,900	27,284
Bananas	6,265	7,024	7,361	7,414	7,633	7,754	8,276	8,707	7,366
Sugar	3,105	3,571	3,881	4,036	4,281	4,448	4,808	5,091	5,549
Soybeans	4,284	4,927	5,355	5,569	5,878	6,202	7,047	7,841	8,889
Lumber	5,390	6,199	6,738	7,007	7,546	8,085	8,678	9,326	10,780
Wood pulp, paper & paper products	8,525	9,804	10,656	11,083	11,935	12,788	14,322	15,604	17,689
Phosphates	3,444	3,961	4,262	4,388	4,725	4,986	5,665	6,303	7,146
Fertilizer, potash & fishmeal	3,132	3,602	3,915	4,072	4,385	4,698	5,152	5,419	5,951
Iron Ore	1,640	1,679	1,671	1,652	1,642	1,636	1,536	1,427	1,292
Miscellaneous ores	3,080	3,542	3,831	3,964	4,226	4,413	5,013	5,206	5,852
Scrap metal	1,720	1,978	2,150	2,236	2,408	2,580	2,875	3,044	3,182
Alumina & bauxite	1,095	1,259	1,369	1,424	1,510	1,584	1,754	1,904	2,189
Miscellaneous metals	1,760	2,024	2,189	2,265	2,415	2,521	2,864	2,974	3,344
Coal	11,390	13,099	14,024	14,363	15,069	15,718	17,042	17,996	19,078
Crude petroleum	38,304	44,050	47,162	48,052	51,481	54,009	57,648	59,371	57,935
Petroleum products	12,650	14,548	15,417	15,869	16,736	17,647	19,813	20,746	20,873
Chemicals	3,850	4,428	4,764	4,881	5,202	5,574	6,098	6,585	7,219
Sulfur	1,063	1,222	1,329	1,382	1,488	1,595	1,804	1,935	2,072
Other non-metallic metals	1,100	1,265	1,375	1,430	1,540	1,650	1,867	2,002	2,145
Iron & steel mfrs.	9,856	11,334	12,258	12,685	13,384	14,119	15,696	17,149	18,480
Autos and trucks	19,800	22,770	24,140	25,105	26,888	28,809	31,878	32,683	36,399
General cargo	39,531	45,461	48,919	50,107	53,407	57,222	62,608	65,226	73,134

NOTE: Slight discrepancies due to rounding.

Table 36

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1985

(000's of Dollars)

CARGO	Revenues with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	209,933	236,812	251,090	256,259	268,963	278,954	294,368	294,294	269,092
Wheat	3,400	3,910	4,208	4,332	4,617	4,845	5,355	5,700	5,610
Coarse grains	16,044	18,130	19,308	19,821	20,616	21,549	22,682	22,392	21,171
Bananas	7,160	7,575	7,429	7,446	7,518	7,303	7,142	5,728	3,580
Sugar	3,161	3,453	3,595	3,656	3,806	3,888	4,094	4,172	4,109
Soybeans	4,704	5,356	5,762	5,932	6,256	6,562	7,162	7,621	7,409
Lumber	5,610	6,452	7,013	7,220	7,540	7,742	8,247	8,639	8,696
Wood pulp, paper & paper products	8,800	10,120	11,000	11,440	12,320	12,804	13,706	14,608	15,840
Phosphates	3,948	4,495	4,837	4,978	5,251	5,507	6,011	6,475	6,712
Fertilizer, potash & fishmeal	3,456	3,974	4,320	4,493	4,790	4,925	5,262	5,460	5,357
Iron Ore	1,640	1,565	1,558	1,492	1,355	1,230	1,005	820	738
Miscellaneous ores	3,432	3,947	4,204	4,328	4,517	4,633	5,105	5,148	5,148
Scrap metal	2,064	2,374	2,580	2,683	2,890	3,003	3,323	3,302	2,683
Alumina & bauxite	1,287	1,481	1,609	1,674	1,713	1,776	1,952	2,034	2,124
Miscellaneous metals	1,760	2,024	2,156	2,219	2,316	2,376	2,618	2,640	2,640
Coal	14,110	15,253	15,874	15,958	16,396	16,720	17,038	16,368	13,052
Crude petroleum	32,704	36,105	38,836	39,114	41,207	42,679	42,352	39,245	24,528
Petroleum products	12,650	14,257	14,548	14,801	15,585	16,129	17,267	16,951	14,231
Chemicals	4,125	4,744	5,053	5,148	5,428	5,692	6,064	6,189	6,188
Sulfur	1,190	1,369	1,487	1,547	1,666	1,749	1,833	1,928	1,874
Other non-metallic metals	1,200	1,380	1,500	1,560	1,680	1,764	1,848	1,944	1,890
Iron & steel mfrs.	11,424	12,875	13,852	14,257	14,874	15,594	17,193	17,821	17,422
Autos and trucks	22,836	26,261	27,407	28,211	29,734	30,829	33,564	34,267	35,409
General cargo	43,228	49,712	52,954	53,949	56,888	59,655	63,595	64,842	62,681

NOTE: Slight discrepancies due to rounding.

Table 37

SUMMARY OF SENSITIVITY ESTIMATES: EFFECTS OF TOLL INCREASE FY 1990

(000's of Dollars)

CARGO	Revenues with Toll Rate Increases of: None	15%	25%	30%	40%	50%	75%	100%	150%
Estimated Total	223,631	252,125	267,572	273,206	286,664	297,304	314,356	315,031	290,331
Wheat	3,655	4,203	4,523	4,656	4,964	5,208	5,757	6,231	6,031
Coarse grains	18,648	21,089	22,484	23,087	24,022	25,117	26,437	26,112	24,715
Bananas	8,055	8,522	8,359	8,377	8,460	8,216	8,038	6,444	4,028
Sugar	3,182	3,476	3,620	3,682	3,831	3,913	4,120	4,200	4,137
Soybeans	5,208	5,929	6,380	6,567	6,927	7,265	7,929	8,437	8,203
Lumber	5,610	6,464	7,013	7,220	7,540	7,742	8,247	8,639	8,696
Wood pulp, paper & paper products	9,075	10,436	11,344	11,798	12,705	13,204	14,134	15,065	16,335
Phosphates	4,116	4,686	5,042	5,190	5,474	5,741	6,267	6,750	6,997
Fertilizer, potash & fishmeal	3,672	4,223	4,590	4,774	5,089	5,233	5,591	5,802	5,692
Iron Ore	1,640	1,565	1,558	1,492	1,355	1,181	1,005	820	738
Miscellaneous ores	3,696	4,250	4,528	4,661	4,864	4,990	5,498	5,544	5,544
Scrap metal	2,236	2,571	2,795	2,907	3,130	3,253	3,600	3,578	2,907
Alumina & bauxite	1,472	1,693	1,840	1,913	1,957	2,031	2,216	2,326	2,427
Miscellaneous metals	1,760	2,024	2,156	2,219	2,816	2,376	2,618	2,640	2,640
Coal	15,215	16,447	17,117	17,208	17,680	18,030	18,372	17,649	14,074
Crude petroleum	27,104	29,923	32,186	32,416	34,151	35,371	35,100	35,524	20,328
Petroleum products	12,650	14,257	14,548	14,801	15,585	16,129	17,267	16,951	14,231
Chemicals	4,510	5,187	5,525	5,628	5,935	6,224	6,630	6,765	6,765
Sulfur	1,275	1,466	1,594	1,658	1,785	1,874	1,964	2,066	2,008
Other non-metallic metals	1,300	1,495	1,625	1,690	1,820	1,911	2,002	2,106	2,048
Iron & steel mfrs.	12,992	14,642	15,753	16,214	16,916	17,734	19,553	20,268	19,813
Autos and trucks	23,100	26,565	27,720	28,537	30,085	31,185	33,957	34,663	33,805
General cargo	46,258	53,917	56,666	57,730	60,876	63,836	67,999	69,387	67,074
New movements	7,202	8,095	8,606	8,781	9,197	9,540	10,055	10,064	9,095

NOTE: Slight discrepancies due to rounding.

E. SENSITIVITY ESTIMATES: PC NET TONS AND SHIP TRANSIT NUMBERS

Panama Canal Net Tons

As indicated in Part III above, the projections of Panama Canal net tonnage were derived from the revenue projections by dividing the latter by 1.25. This, in effect, assumes that the average toll revenue per PC net ton will be $1.25 and that the average ballast rate--based on PC net tonnage--will be about 14 percent.

Table 38 shows the effect of the assumed toll rate increases, ranging from 15 to 150% on the total traffic projected for 1979, 1980, 1985 and 1990, as expressed in PC net tons. Under the assumed toll increase, the average toll revenue per PC net ton would also be increased by 15%, 25%, 30%, etc.

Table 38

EFFECTS OF TOLL INCREASES
ON PC NET TONS
('000's PC Net Tons)

	NONE	15%	25%	30%	40%	50%	75%	100%	150%
1979	155235	154805	154159	152578	151505	149386	142337	133084	118366
1980	157988	157520	155771	153995	152197	150396	141483	130478	112032
1985	167946	164739	160698	157698	153693	148775	134568	117718	86109
1990	178904	175391	171246	168127	163808	158562	143706	126012	92906

Source: International Research Associates

Ship Transit Numbers

As indicated in Part III, the projection of ship transit numbers was developed by assuming (a) that the projected cargo mix will largely determine the composition of the fleet that will transit the Canal, (b) that the conversion trend from general cargo ships to container ships will continue but at a slower rate; and (c) that the trend toward larger ships within each category will continue, but also at a slower rate.

The effect of the assumed toll increases on the projected numbers of ship transits was determined by assuming (a) the reduction in ship numbers among the five basic ship types--bulk carriers, tankers, refrigerator ships, general cargo and container--will be proportional to the reductions in cargo tonnage; and (b) the 800 "other vessels" (passenger ships, fishing vessels) would not be sensitive to toll increases. In each case, therefore, the 800 vessels were added to the totals determined for each year and for each assumed toll increase.

Table 39 shows the effect of the assumed toll increases on the projected number of ship transits.

Table 39

EFFECTS OF TOLL INCREASES

ON COMMERCIAL OCEAN-GOING TRANSITS

	NONE	15%	25%	30%	40%	50%	75%	100%	150%
1979	12968	12950	12889	12765	12662	12513	11950	11265	10089
1980	12903	12882	12754	12612	12464	12296	11620	10832	9387
1985	12743	12464	12208	11986	11682	11332	10291	9086	6721
1990	13312	13031	12762	12536	12214	11849	10784	9542	7120

Source: International Research Associates

F. MAXIMUM REVENUE ESTIMATES

a. Maximum Revenue Curve

Table 37 shows toll revenue estimates for 1990 bases on traffic projections made earlier, and assuming toll rate increases of 15, 25, 30, 40, 50, 75, 100 and 150 percent. As can be seen from the table, a 75% increase yields the largest revenue total, a 100% toll rate increase yields the second largest total, and 50% the third largest. However, the revenue totals for 75 and 100 percent increase are so close that they can be regarded as equivalent; and the total for the 50% increase is only about 5% less.

In making a maximum revenue estimate, it is appropriate to measure the effect of toll increases on a long term rather than a short term basis. Since it has been established that the short term effect of a toll increase is considerably less than the long term impact, it would obviously not be advisable to base toll rate decisions on the short term effect of a toll increase.

The data from Table 37 were used to construct a revenue curve shown in Figure 1. The toll rates are shown on the X axis with the present toll rate equal to 1.00. The assumed toll rate increases are shown as ranging from 1.15 to 2.50. On the Y axis are shown the revenue ratios, with the projected revenue estimate for 1990, assuming no toll rate increase equal to 1.00. A value of 1.50 on the Y axis indicates a revenue total for 1990 which is 50% greater than the estimated revenue for that year with no toll increase.

The revenue curve rises sharply in response to toll rate increases of up to 50 percent. Thereafter, the revenue curve flattens out and apparently reaches a maximum somewhere between 75 and 100 percent. After 100%, the curve turns downward quite sharply.

The maximum revenue estimates were determined mathematically as shown below.

b. Maximum Revenue Values -- Mathematical Formulation

Based on the nine point estimates for Panama Canal revenues at toll rate increases from 15 to 150 percent, we devised a number of possible forms for the revenue function. Revenue was treated as the product of price (toll rate) and quantity (PC net tons). Quantity point estimates were derived from our revenue estimates and various functional forms were fitted to the price quantity points.

The best two functional forms are:

(1) $q = 3055.61 - 7.41p$ $\quad (R^2 = .9940)$

$R = 3055.61p - 7.41p^2$

Maximum revenue = 315,004

at p = 206.18

(2) $q = 2458.08 - 0.021p^2$ $\quad (R^2 = .9985)$

$R = 2458.08p - 0.021p^3$

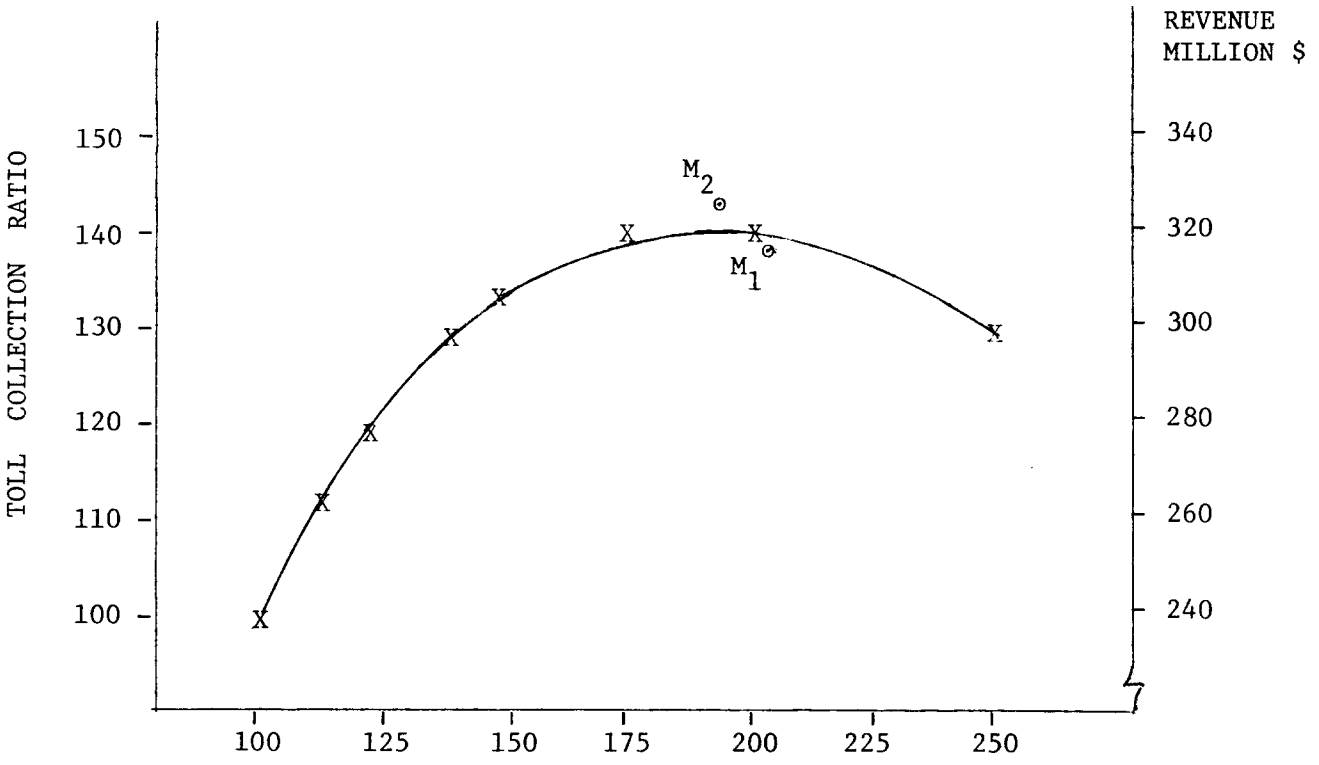
Maximum revenue = 323,693

at p = 197.53

Form two yields a slightly better fit than form one, however, the data do not permit a clear choice between the two forms. Both are clearly superior to other standard functional forms we tried. In Figure 1, the maximum revenue values are shown as M_1 and M_2.

Figure 1

REVENUE CURVE FOR PANAMA CANAL



c. Comparison with 1975 Maximum Revenue Estimate

The present maximum revenue estimate is similar to the 1975 estimate, but there are some differences. First, the maximum attainable revenue appears to be less in relation to the base revenue than in the 1975 study. (Panama Canal Toll Rates: Estimates of Maximum Revenue, January, 1975, International Research Associates.) The present revenue maximum is about 40% greater than the estimated revenue without toll increase as opposed to about 50% in the earlier study.

Second, the present maximum revenue curve seems to flatten out somewhat earlier than the 1975 curve, with the flat portion beginning shortly after the 50% increase.

Finally, there is a much more decided fall in revenues in response to a 150% toll increase.

These differences suggest that the toll increases since 1974 have apparently been offset, to a large extent, by increases in the cost of alternatives. While the margin between projected revenues and maximum attainable revenues has shrunk somewhat in percentage terms from 50% in the 1975 study to 40% in the present study, there is little difference between the two studies in terms of additional revenue that can be obtained through maximizing toll rates. In the 1975 study the amount of additional revenue that could be obtained in 1985 from a 75% toll increase was estimated at $81.8 million, while in the present study, which assumes a larger base revenue for 1985, a 75% toll increase would yield an additional $84.4 million.

This assessment, also, corresponds with the majority view which we encountered in our field survey. Most of the individuals interviewed seemed to believe that the competitive position of the Canal vis-a-vis its competitive alternatives has not changed materially from the situation found three years ago.

We did find, however, that the awareness about competitive alternatives to the Panama Canal has increased significantly since our last survey. As a result, we concluded that for most commodity movements the threshold level for reacting to toll increases has been reduced significantly; and,

in particular, there appears to be a far greater readiness to take action in response to relatively large toll increases. This change in attitude shows itself in the projected downturn in revenue following a toll increase of more than 100 percent.

PART V

TOLL SENSITIVITY and INFLATION PAST and FUTURE

1. Statement of the Problem

The Panama Canal Company, like all commercial enterprises, is affected by inflation. But unlike most other enterprises, the Canal Company has only limited economic freedom to pass through any cost increases which it experiences to its customers in the form of higher prices. The Company's ability to raise toll rates is constrained by the cost of alternatives available to Canal users; and while the cost of these alternatives is often affected by inflation, there is no certainty that any future cost increases experienced by the Canal will be matched, dollar for dollar, by increases in the cost of alternatives to the Panama Canal. In fact, there is evidence that in the past the cost of alternatives has often gone down while the cost of operating the Canal has increased.

The relationship of toll sensitivity to inflation would not be an important issue if the aggregate consumer surplus--the difference between current toll revenues and the cost of alternatives to users--were large in the sense that it amounted to 200 or 300% of toll revenues. According to the sensitivity analysis conducted as part of the study, the maximum attainable toll revenue, which is equivalent to the cost of alternatives, is only 40% greater than the revenue projected under current toll rates. And since, furthermore, another toll increase is currently being considered, the eventual elimination of this user surplus must be viewed as a distinct possibility. The practical consequence of such an event would be the termination of the economic life of the Panama Canal on a toll revenue supporting basis.

In view of this, the issue arising from the future effect of inflation on toll sensitivity can be defined in the following manner:

> Can the course of the future relationship between inflation and toll sensitivity be predicted in the sense that one could say that by the year X the cost of operating the Canal will be equal to the maximum revenues attainable?

2. Toll Sensitivity - An Examination of the Past

In the popular mind, the principal, if not the only alternative to the Panama Canal has always presented itself as a geographical image of a voyage around the Horn.

At the time the Panama Canal was built, and for some decades thereafter, this geographical image was correct, even in an economic sense. Passage from the Pacific to the Atlantic basin was vital for producers of raw materials, for instance, because the industrial world of the first half of the 20th Century was on the rim of the Atlantic basin. The emergence of Japan as a significant industrial nation and as a consumer of vast amounts of imported raw materials has provided raw material producers located in the Pacific Basin with alternate markets and has made them less dependent on the Panama Canal. Measured by its impact on the economic value of the Panama Canal, Japan's economic growth was definitely an event which led to a significant reduction of the difference in cost between going through the Canal and its closest alternative. (It is indeed ironic that Japan's economic growth, in which the Panama Canal played such a significant role, should in turn lead to a decline of the economic value of the Panama Canal.)

The emergence of Japan as an alternate market for raw materials was just one of several significant developments which, during the last three decades, contributed to making the cost difference between going through the Canal and doing the next best thing much smaller than it was. There is containerization, for instance, which has greatly facilitated the transfer of cargo from one mode to another and which has therefore made the mini-bridge movement across the United States a very cost effective alternative. Construction of large tankers and dry bulk carriers was another technological development of the last two decades which led to a significant alternative to the Canal, and the growing trade practice of product exchange is providing an alternative without even requiring any technological aids.

The combined effect of all these developments was to reduce the cost of alternatives to the use of the Canal. And since this occurred during a time when the cost of Canal operation increased, the combined

effect was to produce a considerable reduction in the net economic value of the Canal. This conclusion is in no way contradicted by the fact that the very same time period witnessed a remarkable expansion of Panama Canal traffic. Canal traffic is a measure of the volume of demand for transportation services and not a measure of the relative value of a Panama Canal transit versus any alternative.

3. Maximum Revenue Estimates for the Panama Canal, 1975 and 1978

Until 1975 no estimate had been made of the maximum attainable revenues at the Panama Canal which took into account all of the alternatives available to shippers. An accurate estimate of maximum revenue attainable is the best method for determining the amount of consumer surplus that exists with respect to the Panama Canal. And the economic survival of the Canal on the basis of user-paid tolls, of course, requires that a margin of consumer surplus remains.

The 1975 maximum revenue estimate established that the maximum attainable was about 50% greater than the revenue projected without a toll increase, and that to attain this maximum revenue level would require a toll increase of somewhere between 75 and 100 percent.

Since the completion of the 1975 maximum revenue study--which was actually begun in 1974--there have been two Panama Canal toll rate increases and a change in measurement rules which in the aggregate amounted to a 50% toll increase.

The maximum revenue estimate which is contained in this report and which took into account the above toll rate increases, establishes that the maximum toll revenue currently attainable is some 40% greater than the revenue projected without a toll increase. Again, attainment of the maximum revenue requires a toll rate increase of somewhere between 75 and 100 percent.

On the basis of these two maximum revenue estimates, one can draw the following conclusions about the relationship of toll sensitivity and inflation since the beginning of 1975.

a) The toll rate increases since 1974 appear to have been matched, to a large extent, by increases in the cost of alternatives.

b) External evidence suggests that the sharp increases in fuel prices since 1974 and the devaluation of the dollar both contributed to increasing the cost of alternatives vs the cost of transiting the Canal.

4. The Effect of Past Toll Increases on Traffic Volume

The attribution of events which occur in a complex economic setting to single causes is a hazardous undertaking. Often the very nature of the decision-making process which leads to the event argues against such simple linkages. (For instance, most managers demand a complete array of factors and arguments to be considered before making a decision.)

The task of estimating the effect on present Panama Canal traffic of the two toll increases and the change in measurment rules which occurred since 1974 represents such a problem. After a thorough analysis of traffic data and discussions with trade sources, three instances of traffic losses were identified where toll increases probably contributed to traffic losses. These were (a) the increase in by-pass coal shipments from the United States to Japan; (b) loss of most Europe-Asia shipments to Suez; and (c) the expansion of mini-bridge movements between the U.S. and the Far East.

a) In FY 1974 and FY 1975 each, the coal by-pass movement around the Cape amounted to about 10% of the U.S. coal shipments to the Far East via the Canal. In 1976 this percentage increased to 22.5% and in 1977 it reached 29.2%. There were contributing factors, such as the large surplus of bulk carriers; but the toll increase undoubtedly played a part in increasing the by-pass movements.

b) The losses in general cargo (container) movements between the Far East and Europe occurred primarily during FY 1976 and 1977; and while the principal cause was probably due to the reopening of the Suez Canal and the termination of the various insurance surcharges levied on its use, the toll increases played some part in the timing of the shifts.

c) Since 1974, mini-bridge shipments between the Far East and the eastern half of the United States have increased substantially. It was not possible to quantify this growth. However partial proof of it can

be found in the fact that general cargo movement between the East Coast U.S. and the Far East have not increased since 1974 despite the continued trade expansion. The conclusion is that the toll increases played some part in this growth of the mini-bridge movement.

5. The Analysis of Wholesale Price Indexes, 1958-1977

The proposed Panama Canal Treaty provides that one portion of the annuity payable to Panama be adjusted in line with the wholesale price index for manufactured goods, as published by the Bureau of Labor Statistics.

The wholesale price index for manufactured goods is one of a large series of wholesale price indexes published by BLS. The principal series cover (1) commodity groups and commodities; (2) selected groupings, such as manufactured goods, consumer finished goods, producer finished goods; and (3) wholesale prices by stages of production, such as crude materials, intermediate materials and finished goods.

All of the BLS wholesale price indexes are based on 1967 prices. Table 40 compares the manufactured goods index with three other large indexes, namely the all commodity index, the finished goods index, and the index for all industrial commodities. First, a comparison of the relative levels at the present time. At the end of 1976 the wholesale price indexes for manufactures for all commodities and for industrial commodities were roughly at the same level between 179.0 and 183.0. The wholesale price index for finished goods was somewhat lower at 170.3, primarily because of the weight given in that series to consumer durable goods which at the end of 1976 had a price index of 144.4. (This heavy weight given to consumer durables tends to make this index less representative of the total economy.)

More significant than the differences among the various wholesale price indexes is the broad trend of wholesale prices since 1958. There have been, in effect, two separate growth rates. The first covered the time period from 1958 to 1972, during which the wholesale price index for manufactured goods moved from 93.8 to 117.1, or an average increase of 1.6% per year. Since then, the index has moved to about

Table 40

WHOLESALE PRICE INDEXES

(1967 = 100)

YEAR	TOTAL MANUFACTURES	ALL COMMODIITES	FINISHED GOODS	INDUSTRIAL COMMODITIES
1976	179.0	183.0	170.3	182.4
1975	171.1	174.9	163.4	171.5
1974	154.1	160.1	147.5	153.8
1973	129.2	134.7	127.9	125.9
1972	117.1	119.1	117.2	117.9
1971	113.8	113.9	113.5	114.0
1970	110.2	110.4	110.3	110.0
1969	106.2	106.5	106.6	106.0
1968	102.5	102.5	103.3	102.5
1967	100.0	100.0	100.0	100.0
1966	99.1	99.8	98.8	98.5
1965	96.3	96.6	95.7	96.4
1964	94.8	94.7	94.0	95.2
1963	94.3	94.5	93.7	94.7
1962	94.5	94.8	94.0	94.8
1961	94.4	94.5	93.7	94.8
1960	94.8	94.9	93.7	95.3
1959	94.6	94.4	93.0	95.2
1958	93.8	94.2	93.2	93.6

Source: Wholesale Prices and Price Indexes monthly report; Bureau of Labor Statistics, U.S. Department of Labor

Statistical Abstract of the United States, Bureau of Census, U.S. Department of Commerce

190 for 1977 (the exact average for the entire year has not yet been computed), and the average yearly increase for the last five years has been approximately 10 percent.

This sharp change in the underlying trend means, in effect, that there have been two separate trends in wholesale prices over the past twenty years. This very pronounced trend change, which occurred in 1972, makes a statistical extrapolation of the data very difficult. Given the data points from 1958 on, one can imagine an extrapolation which assumes that the basic long term inflation trend resembles an S curve, with the 1958-72 segment forming the first flat part of the S, the sharply ascending curve since 1972 forming the middle portion, to be succeeded soon by another flat portion.

In complete contrast to the above, one may assume that the 1958-1977 wholesale price trend represents the beginning of a parabolic function which would imply that the sharp growth rate of the past few years will continue and even intensify. Needless to say, the range of potential future inflation rates indicated by these two extreme, yet possible, assumptions is enormous.

This wide range of future statistical possibilities is almost matched by the range of analytical possibilities that one can develop with respect to future inflation rates. On the one hand, one can assume that federal economic policy will eventually succeed in halting excessive inflation rates and produce an S-shaped inflation trend between 1958 and 2000. On the other hand, recent economic history, particularly with respect to Great Britain, has shown that currency devaluation and inflation tend to fuel each other with the result that both proceed much farther and deeper than was originally suspected.

In summary, the choice of the specific wholesale price index selected for the purpose of adjusting the annuity payments does not appear to be significant if compared to other indexes such as the all commodity index and the industrial commodity wholesale price indexes. (Even the Gross National Product deflator, which is an inflation index maintained by the U.S. Department of Commerce, did not yield significantly different results over the 1958-77 period.)

As far as projecting future inflation rates based on behavior of the wholesale indexes over the last 20 years, the change in inflation rates since 1972 has made such an undertaking hazardous and unreliable.

6. Toll Sensitivity and Inflation -- A Future Assessment

The toll sensitivity estimates contained in Part IV of this study show the effect of various assumed toll increases put into effect during 1978 on projected traffic out to 1990. Does this mean one can make definitive estimates at present about the future sensitivity of Canal traffic to toll increases throughout the 1980's?

Unfortunately this is not the case. The sensitivity estimates contained in this report attempt to project the future effect of a single present event--an assumed toll increase--on Canal traffic. But these estimates can say nothing about the future effects of future events on Panama Canal traffic and its sensitivity to tolls. And as time passes, the effects of new and yet unforeseeable events will loom larger in comparison to a past toll increase.

One practical application of this notion is that the sensitivity estimates presented in this study can only be used as a guide for a single toll increase and provided, further, that the toll increase is put into effect within a reasonably short time, say within two years. After two years, and particularly after a new toll increase of perhaps 25 to 40 percent has been put into effect, new and unpredictable events will affect toll sensitivity to an unknowable extent.

The future sensitivity of traffic to toll increase will be determined largely by the relationship of future cost of Panama Canal transits to future cost alternatives. And that relationship will be influenced primarily by two factors: (a) the force and direction of future inflation rates; and (b) the future value of the U.S. Dollar vs other currencies.

As the previous chapter indicates, statistical analysis of inflation rates over the last 20 years provides no clue as to probable course of inflation over the next 20 years. This essential uncertainty remains even if one attempts an inflation projection by analytical means which is by

examining the probable causes of inflation and their present and prospective strength. To justify an optimistic long-range forecast of inflation on an analytical basis would require that one could see how the United States could eventually reverse its massive trade deficit, or halt the continuing slide in the value of the U.S. Dollar or achieve a balanced federal budget. Since, at present, the means for attaining these goals cannot even be clearly defined, the future course of world inflation over the next 20 years must be considered as too uncertain to warrant a credible estimate. As far as inflation within the United States is concerned, the uncertainty may even be greater, because currency weakness often adds to internal inflation, far beyond the inflation rates prevailing in other industrialized countries.

The uncertainty over the future course of inflation is minimized if one restricts the forecast to a lesser period such as five to ten years. For a shorter range analysis, one can give more weight to what appear to be temporary improvements. For instance, the rate of inflation in the United States has abated, the U.S. budget deficit is beginning to shrink and there is hope for some improvement in the United States foreign trade balance. Even if these developments will not lead to lasting solutions, they may be sufficient to prevent, in the near and medium future, a recurrence of the inflationary spurt experienced during 1973-1975 period.

The second factor which will influence the future relationship of the cost of Panama Canal transits to the cost alternatives is the future value of the U.S. Dollar in relation to other currencies.

Until about seven years ago, the value relationships among the world's major currencies were relatively stable. Since then, value changes have become far more numerous and much larger. In particular, the U.S. Dollar has undergone, in recent years, a very substantial devaluation vis-a-vis other major currencies, such as the Japanese Yen, the German Mark, the Swiss Franc; and during the last year, even against the British Pound Sterling. As an indication of the magnitude of this decline, it is worth noting that during the last 12 months alone, the value of the Yen, as measured in dollars, increased by 22%, the German Mark by 12%, and the British Pound by 13 percent.

One aggregate effect of this massive devaluation of the dollar has been to make the cost of a Panama Canal transit relatively cheaper for foreign ships than the present dollar level suggests. And since the process of dollar devaluation does not yet seem to have run its course, a further lowering of the real price of Panama Canal transits for foreign ship operators can be expected as a result of future declines in the value of the dollar.

However, a common and less advantageous by-product of currency devaluation is that it tends to increase the rate of internal inflation. Therefore the gain in economic value which the devaluation of the dollar may bring to Panama Canal users may be offset, to some extent, by additional cost increases experienced in the operation of the Canal.

From the above analysis it is obvious that a high rate of inflation even if combined with continued devaluation of the U.S. Dollar would, on balance, constitute a greater danger to the Canal's ability to raise sufficient tolls than low or moderate inflation. Under high rates of inflation, the cost of Canal operation and toll rates would definitely increase. But there is no certainty that the cost of all alternatives will show parallel increases, because there is a distinct possibility that future inflation rates may be far higher in the United States than in the rest of the world.

In contrast, a low to moderate rate of inflation of around 3% per year should permit stabilization of the cost of Canal operation, which in turn would cause relatively stable toll rates. Under such circumstances, the prospects for maintaining the Canal operation on a financially self-supporting basis would undoubtedly be better.

In summary:

(1) There is no basis for making a credible forecast, covering the next 22 years, concerning the future course of inflation or the future value of the U.S. Dollar.

(2) Without reliable projections in these areas, it is impossible to say whether with any degree of reliability what the relationship between the cost of operating the Canal and the cost of alternatives might be 22 years hence.

(3) It is possible to make a more positive assessment for the next five to ten years to the effect that the aggregate cost of alternatives to the Canal should continue to exceed the cost of Canal operations or toll revenues by some margin. The basis for this assessment is (a) the recent reduction in the inflation rate is likely to continue for the next few years; (b) the lower inflation rate should permit the maintenance of stable toll rates for at least four to seven years, after an initial increase in rates to pay for the treaty costs.

7. A Management Strategy to Minimize the Effect of Inflation on Toll Sensitivity

If economic analysis cannot be used to predict the future relationship of toll sensitivity and inflation, can it be used to control or in any other way ameliorate the deleterious effects of inflation on toll sensitivity? The answer here is a possible yes, even though the margin of control left to management in this matter may be less than decisive.

It can be assumed that federal policy will require that tolls be set at a level sufficient to meet all costs. However, such an assumption need not imply that the future level of tolls will be independent of management policies. There are at least two areas where management decisions may have a significant effect on future toll levels. The first and foremost concerns the development of an organization which is tailored to the new and perhaps smaller task which the new Panama Canal Commission will have in comparison to the present Panama Canal Company. The second area concerns the manner in which future toll increases are sought.

The scope and organization of the future Panama Canal Commission are clearly beyond the range of the present research. Yet the size and structure of this future organization will have an impact on its revenue needs as long as cost recovery through toll revenues is a policy requirement.

As pointed out in Part IV, the traffic reducing effect of a toll increase tends to increase in severity for at least ten years. This means that a principal impact of a toll increase is its dampening effect

on future traffic growth. A lower rate of traffic growth, in turn, presents fewer opportunities for achieving productivity gains which can offset the effect of cost increases. In summary, then, the act of increasing tolls involves an exchange of foregone future growth for the sake of an immediate revenue gain. Needless to say, if public policy demands that the economic lifetime of the Canal be extended, any increase in tolls beyond the level absolutely necessary would run counter to that public interest.

The impact of a toll increase is also affected by the manner and timing of the request for an increase. For instance, it was noted during various interview with trade representatives that businessmen often have a tendency to ignore small price changes and continue with the established practices, even if the cost of the alternative is close. The change to any alternate practice generally involves some added cost, direct or indirect, and there is a tendency to seek justification for such a change. And the justification most often sought is a substantial cost increase.

This tendency of businessmen to ignore small cost increase argues strongly for a strategy of seeking smaller but more numerous toll increases rather than fewer and larger increases. There is only one exception to this principle, and that involves increasing toll rates on a regular and automatic basis by means of an index escalation formula. It is our opinion that if such an automatic toll increasing system were put into effect, many Canal users would develop transportation plans that are based not upon Canal toll rates prevailing at the time, but upon projected future rate levels which appear justified on the basis of the escalation formula. Needless to say, such actions would tend to increase the sensitivity of Canal traffic and promote the shift to alternatives.