The Economic Effects of Alternative Tolls on the St. Lawrence Seaway on The Grain Handling and Transportation System

A Thesis
presented to the University of Manitoba
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by

Alan James Carson

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THE ECONOMIC EFFECTS OF ALTERNATIVE TOLLS ON THE ST. LAWRENCE SEAWAY ON THE GRAIN HANDLING AND TRANSPORTATION SYSTEM

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ABSTRACT

Since the inception of the St. Lawrence Seaway in 1959, the revenues generated from toll charges have not been sufficient to meet all of the costs. The most obvious way to alleviate this problem would be to alter the tolls on the Seaway in such a manner that revenues are sufficient to cover the costs. The major objective of this study is to determine if toll changes on the St. Lawrence Seaway would have any effects on the Grain Handling and Transportation System. The hypothesis of this study is based on the argument that with alternative tolls on the St. Lawrence Seaway the demand for the use of the Canadian ports will vary.

The emphasis of the model is to minimize the impacts to the producers of alternative toll structures by rerouting the export grain delivered to each port. The conceptual argument for this emphasis is that the demand for Canadian export grain is elastic, meaning that the importers of Canadian grain would not be willing to absorb higher tolls, nor would they absorb the benefits of reduced tolls. Therefore, producers will bear the brunt of the impacts of alternative tolls on the Seaway. This study set out to determine if producers could offset (minimize) the impacts of alternative toll structures by rerouting grain to other Canadian ports.

The model selected to study the effects of alternative tolls on the St. Lawrence Seaway on the Grain Handling and Transportation System was a linear programming model. The model had as its objective the minimization of transportation cost, borne by the users, for delivering their grain to export position. This model is consistent with the approach taken by other researchers in this area of study, as well as with the overall objective of the study which was to minimize the impacts of alternative tolls on the St. Lawrence Seaway.

This study found that the distribution of grain to Canadian ports varied as tolls on the Seaway were changed. In particular, for a $0.01 increase in tolls on the Seaway, an additional 47,553 tons of export grain would move through the west coast. The study also found that even with this amount of redistribution of export grain to the ports, the total costs to the users would increase by $79,256.75 for each $0.01 increase in tolls on the Seaway.

The study also determined that once tolls reach $0.95 a ton, no further redistribution of grain can occur with further increases in toll levels. The reason is that at the toll level of $0.95 per ton, the total handling capacity at the west coast is fully utilized, making further movements of export grain westward impossible, unless the handling capacity at the west coast is increased.

From these results, this study was able to derive three significant policy implications with regard to the effects of altering the toll structures on the Seaway. First, higher tolls could lead to a quickening of the rationalization of the rail system, as higher tolls in general will require more grain to be moved westward. This will increase pressure on the railways to ensure that more grain can be moved westward. Second, higher tolls on the Seaway are likely expedite improvements currently being made at the west coast. Third, the opposite situation will develop if tolls on the Seaway were lowered. The pressures on the railways and the west coast would be reduced, thus weakening the pressures for rationalization and improvement of these components of the Grain Handling and Transportation System.

ACKNOWLEDGEMENTS

This study would be incomplete without proper recognition of the people and organizations who helped me over the past twenty months. First, I would like to express my gratitude to the Centre for Transportation Studies at the University of Manitoba for the support I have received while working on this project.

I would like to express my appreciation to the members of my committee for their support and advice both on the project itself and on other non academic matters. First, and foremost, the time and energy put into this project by Dr. Om P. Tangri was of great value to me. I would also like to express thanks to Dr. C.F. Framingham, whose expedient advice and encouragement helped me extensively towards the completion of the project. Dr. Greg Mason's advice and time spent reading the thesis was also greatly appreciated.

I would also like to mention two fellow students; Gary Craven and Bill Wilson for their help. Both were always available for consultation and advice, not only on the project but also on the important question of whether another round was in order.

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CHAPTER I: INTRODUCTION AND BACKGROUND TO THE PROBLEM

Background to the Problem

Since the inception of the St. Lawrence Seaway in 1959, the revenues generated from the toll charges have not been sufficient to meet all of the costs of the Seaway. In 1974 alone, the net loss for the year was $50,360,717.[1]

> Section 17 of the St. Lawrence Seaway Authority Act provides that tolls are to be designed to be sufficient to defray the cost to the Authority of its operations. Such costs are defined as including interest on loans, amounts sufficient to amortize loan principle over a period not exceeding fifty years, and the costs of operating and maintaining the canals and works. Since the inception of the Authority, revenues have been insufficient to meet the full interest or any amortization of loan principle.[2]

In other words, the Seaway was originally intended to be self sufficient; however, it has never been self sufficient in meeting its costs. The existing capital structures (such as locks) on the Seaway have a limited life: time and use will eventually require the replacement of these facilities. The combination of not being self sufficient and a limited life ultimately means that additional financing of the

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[1]St. Lawrence Seaway Authority, 1974 Annual Report, (Ottawa: St. Lawrence Seaway Authority, 1974) p. 16.

[2]Ibid., p. 14.

Seaway will be required. This borrowing will have to take place in addition to existing debts, which have been financed by the Canadian government and which are not being repaid. Unless measures are taken to repay the existing debt, the ultimate result will be that the federal government will have to absorb the debt rather than leave it on the books. The process of absorption or recapitalization of these debts would probably follow a format similar to the one used in the case of the Canadian National Railways, where the debts were absorbed by the federal government.[3] However, the situation surrounding the toll structures and financing of the Seaway is quite different from the debts that faced the C.N.R. As Lesstrang pointed out:

> The Seaway became the only waterway in the United States [or Canada for that matter] which was improved by the federal government, and was then told that it had to pay back the cost of its improvement. The reason, of course, goes back to the old railroad, private utility, East and Gulf Coast port pressures. In the final stretches of Seaway legislation, proponents for the waterway had to promise a pay-back to the government in order to obtain passage for any kind of Seaway Construction bill at all.[4]

In fact, it was these same railway and political pressures which had delayed construction of the Seaway for some

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[3]J. Lukasiewicz, <u>The Railway Game</u>, (Toronto: McCelland and Stewart Limited, 1976) pp. 20-50.

[4]Jacques Lesstrang, <u>Seaway</u>, (Seattle, Washington: Superior Publishing Company, 1976) p. 177.

seventy years.[5]

If the Seaway is required by law to be self supporting, and since changes in this legislation would face considerable opposition, and if the Seaway is not self supporting, then somewhat of a problem is developing. Any capital structure with a limited life, which is not self supporting, and which will have difficulty in finding additional financing, will sooner or later find itself in a situation where its continued operation becomes almost impossible. The most obvious way to alleviate this potential threat, of course, would be is for the Seaway to become self sufficient. The simplest method of increasing revenues would involve restructuring the tolls levied on the Seaway. It is theoretically possible to raise revenues by lowering the tolls and consequently attracting an increased demand for use of the facility. The other alternative for increasing revenue would be to raise tolls. In order to determine which alternative would be effective, the shape of the demand curve for use of the St. Lawrence Seaway as well as the feasibility of either raising or lowering the tolls would have to be considered.

Before the tolls on the St. Lawrence Seaway are restructured, at least one question needs to be answered: Could a

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[5]Ibid., pp. 19-49.

restructuring of tolls on the Seaway result in problems resulting with regard to the allocation of resources? In order to properly answer this question, one must first consider the groups involved and then look at the roles played by each group in turn.

For all practical purposes there are three main groups involved:

i) the producer,

ii) the importing nations and

iii) the Canadian government and taxpayer through their subsidization of grain movements and of the Seaway itself.

Initially, consider the impacts of a restructured toll system involving higher tolls.

It is unlikely that, other things being equal, either the importing nations or the producers would be able or willing to absorb these higher costs. Given the higher elasticity of demand for Canadian export wheat,[6] any increase in price will lead to a more than proportionate decrease in the quantity demanded. This suggests that the importing nations will very likely attempt to purchase their grain elsewhere if the Canadian export price goes more than a few cents above the price at which Canada is currently able to export

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[6]D. R. Campbell, "The Farm Problem," Canadian Economic Problems and Policies, ed. L. H. Officer and L.B. Smith, (Toronto: McGraw-Hill Company of Canada Limited, 1970) p. 198.

its grain. As Canada now relies quite heavily on the export of wheat as a contributer to her total export earnings, the loss of an export market for wheat could affect the standard of living currently enjoyed in Canada.[7] For this reason, the importing nations can not be charged the entire increase in costs which would result from higher tolls.

A similar situation exists with the producers. If due to higher tolls it costs much more than it does today for the producer to get his wheat to market for export, some producers may not be able to stay in the business of producing grain for export. Many producers have indicated that they are concerned with increases in transfer or marketing costs from within the system (transportation) and that continued increases of this type could significantly reduce their economic welfare.[8] This would affect production and since, "the Prairie Region of Canada is basically an exporting region, and hence a major contributer to Canada's balance of payments position,"[9] any reduction in production could affect the standard of living Canadians currently enjoy.

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[7]This point is discussed further in Chapter III.

[8]Government of Canada, Hall Commission, The Report of The Grain Handling and Transportation Commission, Grain and Rail in Western Canada, Volume I, (Ottawa: Printing and Publishing, 1977) p. 72.

[9]Ibid., p. 534.

Since the costs which would result from higher tolls are not readily transferable either forward or backward, the Canadian government will have to pay at least some portion of the higher tolls. From a standpoint of future policy, therefore, it is important that policy makers know the best possible understanding the impact of tolls on the prairie grain producers, the taxpayers, as well as the importing nations.

If lower tolls as an alternative to higher tolls, on the St. Lawrence Seaway are to be effective in raising total income of the St. Lawrence Seaway, then lower tolls would have to result in more grain traffic moving through the Seaway. The impacts of such a development could show themselves in a variety of ways.

First, lower tolls resulting in more grain traffic on the Seaway may be an impractical sclution for two reasons:

i)it would mean additional 'deadheading', (ships returning upstream with no cargo). Currently ships carry grain one way and then are loaded with iron ore or some other commodity to make the return trip. If more grain starts to move through the Seaway, then the balance between shipments upstream and downstream, would be disturbed, resulting in higher costs to the ship owners; that is less revenue would be received as they would only be shipping in one direction. This would make increased grain traffic non profitable unless accompanied by an increase in other types of traffic moving upstream.

ii)if as a result of lower tolls, increases in traffic either up-bound or down-bound or both did occur, bottlenecks on the Seaway could begin to develop. In fact, a recent study done by the the U.S. Army Corps of Engineers revealed that even with expected increases in traffic on the Seaway, "by 1990 traffic in the Seaway system will be so great that a permanent jam-up will occur at the Welland canal."[10] A two-fold problem is developing at the Welland Canal. "Not only will there be too many vessels to handle, but also, if the trend in fleet composition continues, traffic will be further constrained by the fact that many vessels will be too large to pass through the existing canal."[11]

Keeping this in mind, it is possible that attempts to increase the traffic by reducing tolls on the Seaway may have implications with regard to limits on the amount of traffic the Seaway can handle, reducing the benefits which would be derived from reducing tolls.

There is one other factor making a reduction of tolls on the Seaway difficult. That factor deals with the efficiency of the system on a macro level. Although there are

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[10]Lesstrang, op. cit., p. 205.

[11]loc. cit.

currently many problems with the grain transportation system, in the short run an increase in traffic moving eastward through the Seaway might mean a decrease in the amount of traffic which moves through the other Canadian ports, namely Vancouver, Prince Rupert, Churchill and Victoria. A reduction in traffic through these ports would result in excess capacity being created at one or all of these facilities. Although some of the bottlenecks which now develop at the Vancouver terminal could be eliminated, any cost savings or higher revenues resutling from increased traffic due to lower tolls on the Seaway could be offset by increased costs and reduced revenues that would be associated with under utilization of existing facilities in these ports as well as from over utilization of facilities in the Seaway.

Thus the problem of how to restructure tolls on the Seaway is both difficult and complex. It has several dimensions:

i) what type of toll structure would result in an increase in revenue?

ii) what type of toll structure would be politically feasible and economically effecient?

iii) what would be the impacts of different toll structures on the producers, the railways, and the ports?

iv) what impacts would the new toll structures have upon the system as a whole?

From a grain handling and distribution system point of view, the problem has two dimensions. First, what will the impacts of a new toll structure be on the system, and second, how will the system be able to offset or at least minimze those impacts by adopting such measures as changing the relative amounts of grain exports through the various ports.

The St. Lawrence: An Overview

Having outlined the problem, a more complete discussion of the economic importance of the St. Lawrence Seaway will now be given in order to emphasize the importance of problems (such as self sufficiency of the Seaway) to Canada, both on a regional and on a national basis.

A description by Lesstrang of the nature and limitations of the Great Lakes of North America is probably one of the better starting points for an overview of the St. Lawrence Seaway. As he observed:

> The geographer, looking at a geodesic globe of the world, would note that the Great Lakes of North America - the largest body of fresh water in the world - connects with the Atlantic Ocean through the St. Lawrence River at the Gulf of St. Lawrence. An economist would note, further, however, that albeit a series of small locks, the Great Lakes might as well be land-locked: In terms of world transportation economics the lakes were virtually non-existant. A shallow draft, plus white-water at the Lachine Rapids, the Soulages and the swift flowing International Rapids - made it impossible for the ocean ships, which carried the commerce of the world to enter or leave the lakes.

And so the maritime commerce that grew up in the Great Lakes was primarily regional - shipping went mostly from small lake port to small lake port, from the United States to Canada.

And so it was during most of the 19th century.[12]

Ports of the Seaway System

The ports had always been there, of course. Some like Duluth, Detroit and Chicago had earned rather respectable reputations for their tonnage even before the Seaway was built. Others were content to accept (or at least put up with) whatever cargoes they could muster from the inter-lake trade, mainly bulk cargoes such as iron ore and grain.

The opening of the Seaway and the definition of the System to include everything between Montreal and the Lakehead, made a potential international superstar out of each port, or so, at least, each port thought.

Today there are close to fifty ports on the Great Lakes each of which is engaged in some aspect of intra-lake or foreign commercial shipping. The International Association of Great Lakes Ports (IAGLP) consists of 22 major ports. The map on the following page indicates the position of those ports and the route that the Seaway takes.

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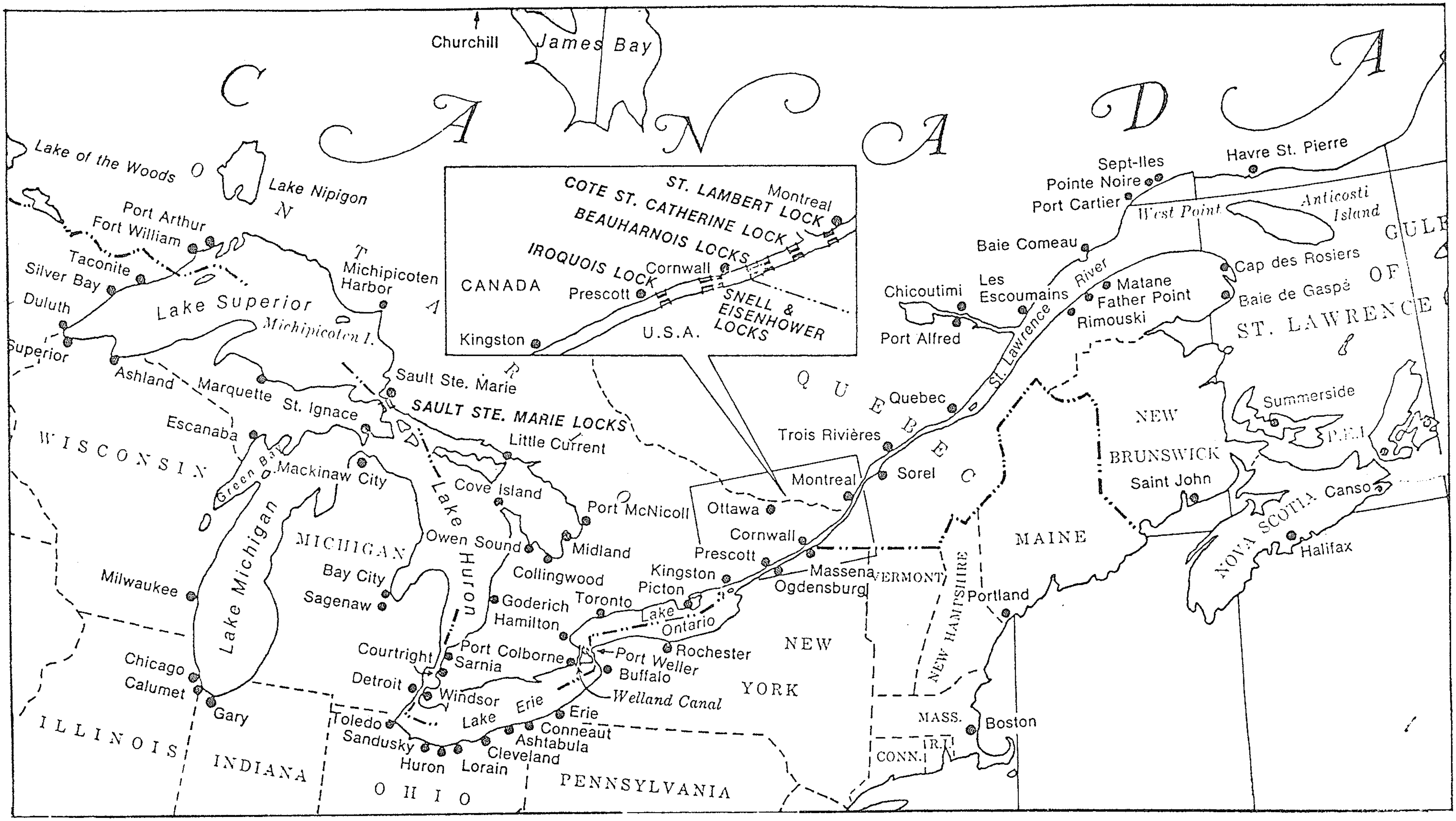
[12] Ibid., p. 9.

FIGURF A

THE GREAT LAKES AND THE ST. LAWRENCE SEAWAY



Canadian Ports Along The Seaway

The Great Lakes and upper St. Lawrence river form the entire southern border of Ontario and provide the province with an exceptional location for economic development. Along this shoreline there lie more than 1000 miles of deep waterways which, as a natural resource, have contributed in many ways to the economic growth of Ontario and Canada.

The impact of the Seaway in Ontario is largely on manufacturing and extractive industries. The largest and most active of the Canadian ports is Toronto. Continued emphasis upon updating and streamlining marine terminals and equipment has enabled Toronto to offer some of the most modern facilities on the Great Lakes. The port services mainly the heavily populated region adjacent to Lake Ontario from the Niagara Frontier in the south to the Detroit-Windsor area in the west and Peterbourough in the east.[13]

The area served by the port is known as its 'hinterland,' which is the geographic region that the port can service for its customers more economically and efficiently than can any other mode of transportation. The Great Lakes-St. Lawrence Seaway has a vast hinterland, extending to Montana, Wyoming and Colorado on the west, Kansas, Missouri and Kentucky on

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[13]Ibid., pp. 128-130.

the south, West Virginia, western Pennslyvania and western New York on the east, and the greater portions of the province of Ontario, Manitoba and eastern Quebec on the north.

Other Canadian ports are not as large as Toronto and consequently do not handle as much traffic. However, each port in the Great Lakes System does have a dual role, namely a regional as well as an international role. Besides serving its immediate hinterland, and thus assisting in the development of the hinterland business, a port also tends to establish through its regional role a rather consistent growth pattern because there are more and more regional activities for the port to deal with. So, over time the port is bound to get increasing traffic provided nothing happens to interfere with the process of growth.

However, the true international role of the Great Lakes and of the Seaway ports is still developing. It is this role which will benefit the agricultural sector of Canada, and which is dealt with in the remaining portion of this study.

Economic Development: Can the St. Lawrence Seaway Contribute?

The answer to this question is hypothetically yes. However, how much the Seaway has actually contributed and will contribute in the future in the growth of the Seaway's surrounding hinterland is a difficult question to answer. Since the question involves numerous difficult and complex dimensions, an attempt to tackle all those dimensions is beyond the scope of this study. This particular review therefore, is intended only to demonstrate how a project such as the St. Lawrence Seaway can aid in the development of a region and consequently lead to the development of the national economy as a whole.

There is now a fairly well accepted body of theory regarding the normal sequence of development stages in a region. This sequence may be outlined as follows:[14]

i) The first stage in the economic history of most regions is one of a self sufficient subsistence economy in which there is little investment or trade. The basic agricultural stratum of population is simply located according to the distribution of natural resources.

ii) With improvements in transport, the region develops some trade and local specialization. A second stratum of population then comes into being, carrying on simple village industries for the farmer.

iii) With the increase of interregional trade, a region

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[14]Douglas C. North, "Location Theory and Regional Economic Growth," ed. David L. Mckee, Robert D. Dean and William H. Leahy, Regional Economics: Theory and Practice, (Toronto: Collier - Macmillan, Canada Limited, 1970) pp. 30f.

tends to move through a succession of agricultural crops from extensive grazing to cereal production to fruit farming etc.

iv) With increased population and diminishing returns in agriculture and other extractive industries, a region is forced to industrialize. Industrialization is the introduction of the so-called secondary industries (mining and manufacturing) on a considerable scale.

v) A final stage of regional growth is reached when a region specializes in tertiary industries producing for domestic as well as export purposes. Such a region exports capital, skilled personnel and special services to less advanced regions.

The role of transport costs is critical in the advancement through these stages of growth. Historically, reduced transport rates have tended to:[15]

i) transform a scattered, and ubiquitous pattern of production into an increasingly concentrated one, and

ii) effect progressive differentiation and selection between regions with superior and inferior resources and trade routes.

Although this stage theory finds a substantial parallel in the European economic development, it bears only limited

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[15]loc. cit.

resemblance to the actual development of regions in North America. These stages also fail to provide any insights into the sources of growth and change. The problem with a comparison of this theory to the development of America is that the development potential of America was exploited mainly as a capitalist venture. Settlements in new regions and their subsequent growth were shaped by the search for and production of goods which were already demanded in world markets. This type of development process is very different from the one implied by the theory of regional development in which regions gradually extended the market from a subsistence economy.

In general the development of North America was not a gradual, linear evolution out of a subsistence economy. Instead, the whole development of the regions within North America was dependent upon their success in producing exportable commodities. "Even the well-worn historical generalization by location theorists that reduced transport rates will transform a scattered, ubiquitous pattern of production into an increasingly concentrated one is not true of America."[16] In fact, many regions in America developed from the beginning around one or two exportable commodities and expanded their export base only after the reduction of

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[16]Ibid., p. 34.

transport costs had occurred.

A slightly more applicable approach to the development of regions as part of the overall development of North America is based upon the importance of the export staple in shaping new economies.[17]

The settlers of a new region often had to experiment with a number of different crops before discovering that one or two were economically feasible. The success of an industry in producing an exportable commodity can be understood in terms of location theory. The development of exportable products reflects a relative advantage in the costs of production including transfer costs.[18]

From the viewpoint of the region, the demand for the exportable commodity was an exogenous factor, but both processing and transfer costs were not. Historically, new regions bent every effort to reduce transfer costs to better the competitive position of it exports.[19]

Concerted efforts have also been made to improve the technology of production. Agricultural experiment stations, universities and other research groups have all participated in efforts to improve the technology of production in the

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[17]Ibid., p. 35.

[18]loc. cit.

[19]Ibid., p. 36.

hopes of improving the comparative advantage of a region.

Briefly then, there are two theories of regional development. The first applies to the development of European countries and the second applies to the development of North America. In the first approach, one component contributing to development of a region is a reduction in transport costs. In the second approach, there are two factors which aid in improving the comparative advantage of the region and consequently in widening the export base of the region. By improving the comparative advantage of a region, growth and development in the region are thus accelerated or augmented. These two factors are:

i) reduction of transfer costs, and

ii) improvements in the technology of production

For purposes of development, a reduction in transfer costs may be more important to a particular region than an improvement in the technology of production in the region. The reason for this is that an improvement in the transportation system is likely to give a 'distinctive' advantage in the sense that other areas or regions may not have the opportunity to develop transportation systems such as inland waterways. Technology on the other hand tends to be relatively mobile from region to region. Developments which lead to the introduction of new seed varieties or new farming practices within a particular region will, sooner or later, likely find their way to other regions.

The building of the St. Lawrence Seaway was definitely an improvement in the transportation system for goods and commodities produced in North America. In particular, the northern region which has proximity to the Great Lakes has benefitted from the Seaway. Although a canal system connecting the Great Lakes with the Atlantic Ocean existed prior to the development of the Seaway, it did not have the capacity that the Seaway now has. More importantly, it did not give ocean going vessels direct access beyond the port of Montreal. The Seaway system, on the other hand, gives ocean going vessels direct access to inland ports such as Thunder Bay and Duluth. Thus a combination of increased accessability and lower transportation costs for export goods and intraregional traffic has greatly increased the 'hinterland' of the Great Lakes and the interconnecting waterways. The Seaway also enables these new hinterland areas to broaden their export base and/or increase their total exports, which were often previously restricted by high transportation costs and a lack of capacity.

Thus it at least appears that the Seaway can and has contributed to the development of the hinterland areas. However, this does not necessarily mean that these regions would not have developed without the Seaway. In fact, Fogel's axiom of inevitability may have been a factor in the development of the hinterland areas. Although, once the Seaway was in place, development occurred around it, unless a great deal of the components for development had not been in place prior to the Seaway, this development might not have occurred.

Economic Effects of The St. Lawrence Seaway

From a theoretical perspective the St. Lawrence Seaway should have made a contribution to the economic growth and development of the regions within its hinterland. In order to demonstrate whether the Seaway has in fact contributed to growth within its hinterland three indicators will be examined, both prior to and since the completion of the Seaway. These are:

i) private and public investment trends on a regional basis

ii) employment trends by region

iii) changes in the movement of the major commodities the Seaway handles.

Table 1 shows the rates of change in private and public investment on a regional basis in the pre and post Seaway development periods. The data give no indication that the regions in Canada most affected by the Seaway, that is Manitoba and Ontario, have faired any better than any other region in Canada. In fact, for the post Seaway period 1960-1977 Ontario and Manitoba rank only ahead of Saskatchewan and the Atlantic Region. This indicates that the St. Lawrence Seaway has not resulted in growth in investment in its hinterland at any greater rate than occurred outside its hinterland. Had the Seaway not existed the growth in investment in the hinterland may have been even less than it was.

Table 1

Rates of Change of Public and Private Investment per Year by Region With 1952 as the Base Year[20]

Region	1952-1960	1960-1977	1952-1977
Manitoba	101.2	293.4	691.7
Ontario	50.4	409.3	666.0
Atlantic Region	75.6	397.0	772.6
Quebec	56.4	438.8	742.9
British Columbia	48.2	583.0	912.1
Alberta	57.1	731.7	1207.0
Saskatchewan	51.4	377.8	623.6

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[20]Department of Finance of Canada, Economic Review, April 1978, (Ottawa: Minister of Supply and Services Canada, 1978) p. 141.

The employment data are presented in Tables 2 and 3. From Table 2 it can be seen that Ontario and the Prairie Region consistently rank second and third respectively in both pre and post Seaway development periods in rates of changes of total employment by region. Table 3 shows that in terms of the regional employment as percentage of total employment in Canada, only British Columbia and Quebec have shown a change of more than 2 percentage points, and B.C. is certainly not within the hinterland of the St. Lawrence Seaway. Both Quebec and the Atlantic Region have lost vis a vis other regions, indicating that the benefits of having key ports and facilities may have moved westward and in particular to Ontario due to the development of the Seaway. The prairie region experienced no significant change vis a vis the rest of Canada for the period 1954-1977.

From the data presented, it is reasonable to conclude that the St. Lawrence Seaway has been only partially effective, if effective at all in stimulating changes in the rate of growth of its hinterland, as the hinterland has shown little change vis a vis the rest of Canada. It should be noted that the evidence for this conclusion is based on limited information. Therefore, this conclusion should be considered only as indicative, and that further research be done in this particular area.

Table 2

Percentage Change in Total Employment by Region
With 1954 as the Base Year[21]

Region	1954-1960	1960-1977	1954-1977
Prairie Region	15.6	57.9	82.5
Ontario	15.6	67.3	93.4
Atlantic Region	5.1	49.6	57.3
Quebec	11.5	52.8	70.3
British Columbia	18.1	106.4	143.7

[21] Ibid., p. 158, and; Department of Finance of Canada, Economic Review, April 1976, (Ottawa: Minister of Supply and Services, 1976) p. 146.

Table 3

Relative Employment by Region, as a Percentage of Total Employment in Canada With 1954 as the Base Year[22]

Region	1954	1960	1977
Prairie Region	17.6	17.9	17.3
Ontario	37.1	37.7	38.6
Atlantic Region	8.9	8.2	7.5
Quebec	28.0	27.5	25.7
British Columbia	8.3	8.7	10.9

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[22]loc. cit.

From Figures 1 and 2 it can be seen how the changes in movements of the major commodities of the Seaway have occurred from 1955 to 1977.[23] In 1977, the movement of the five product classes grain, iron ore, coal, petroleum products and manufactured iron and steel accounted for 86.4 percent[24] of the total tonnage moved through the Welland Canal Section with grain and other agricultural products accounting for 35.3 percent of the total. In the Montreal Lake Ontario Section of the Seaway, these product classes acccounted for 85.8 percent[25] with grain and agricultural products accounting for 38 percent of the total. The iron ore movement in the two sections respectively accounts for 30.6 percent and 35.2 percent of the total movement.

Thus grain and agricultural products in combination with iron ore account for roughly two-thirds of the total traffic which moves through the Seaway. Lesstrang argues, therefore, that the discovery of iron ore in Labrador played a major role in the development of the Seaway.[26]

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[23]The Seaway was officially opened in 1959.

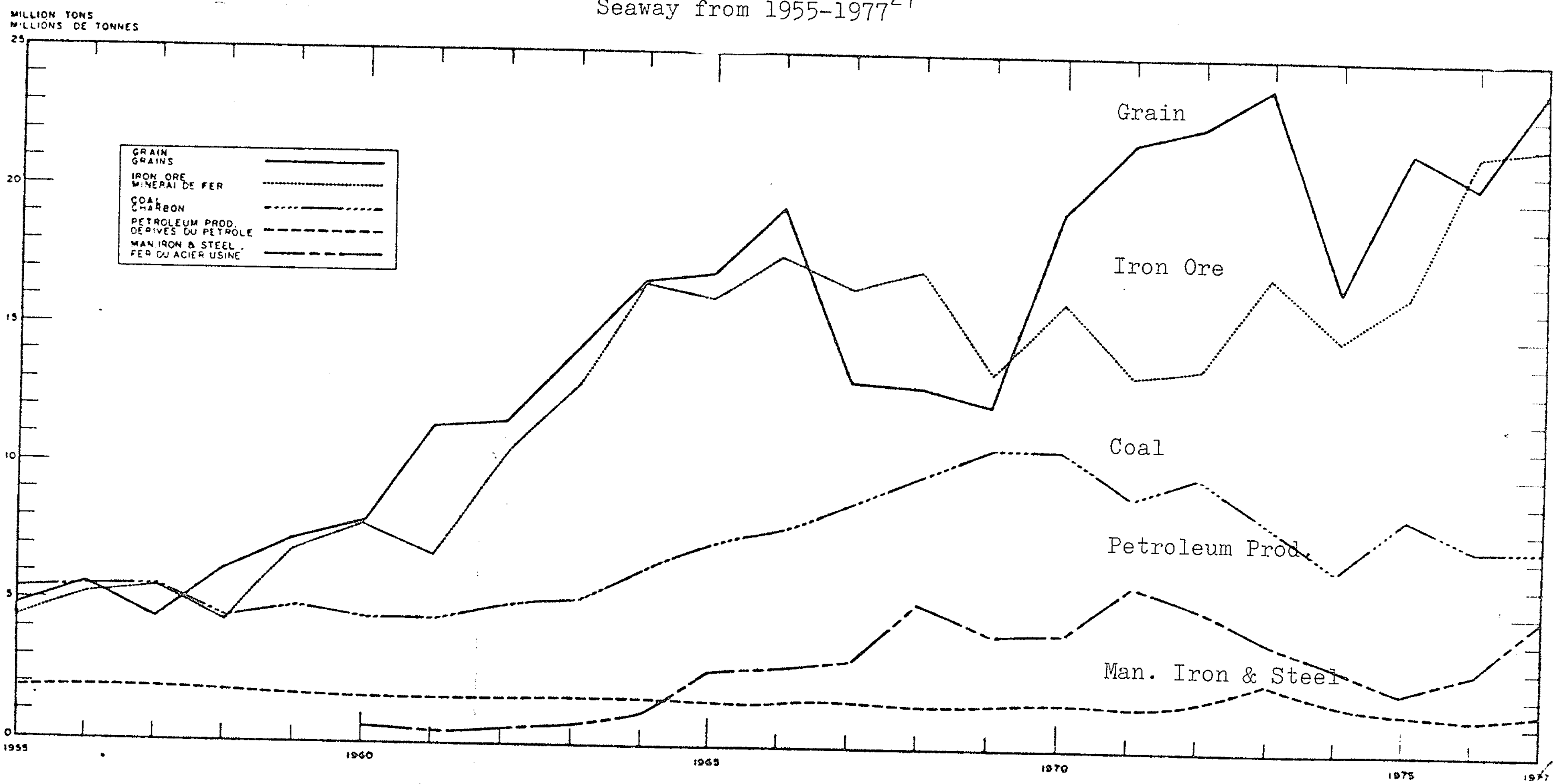
[24]St. Lawrence Seaway Authority, The Seaway: Operations, Outlook, Statistics, 1977, (Ottawa: St. Lawrence Seaway Authority, 1977) p. 30.

[25]Ibid., p. 23.

[26]Ibid., p. 33.

Figure 1

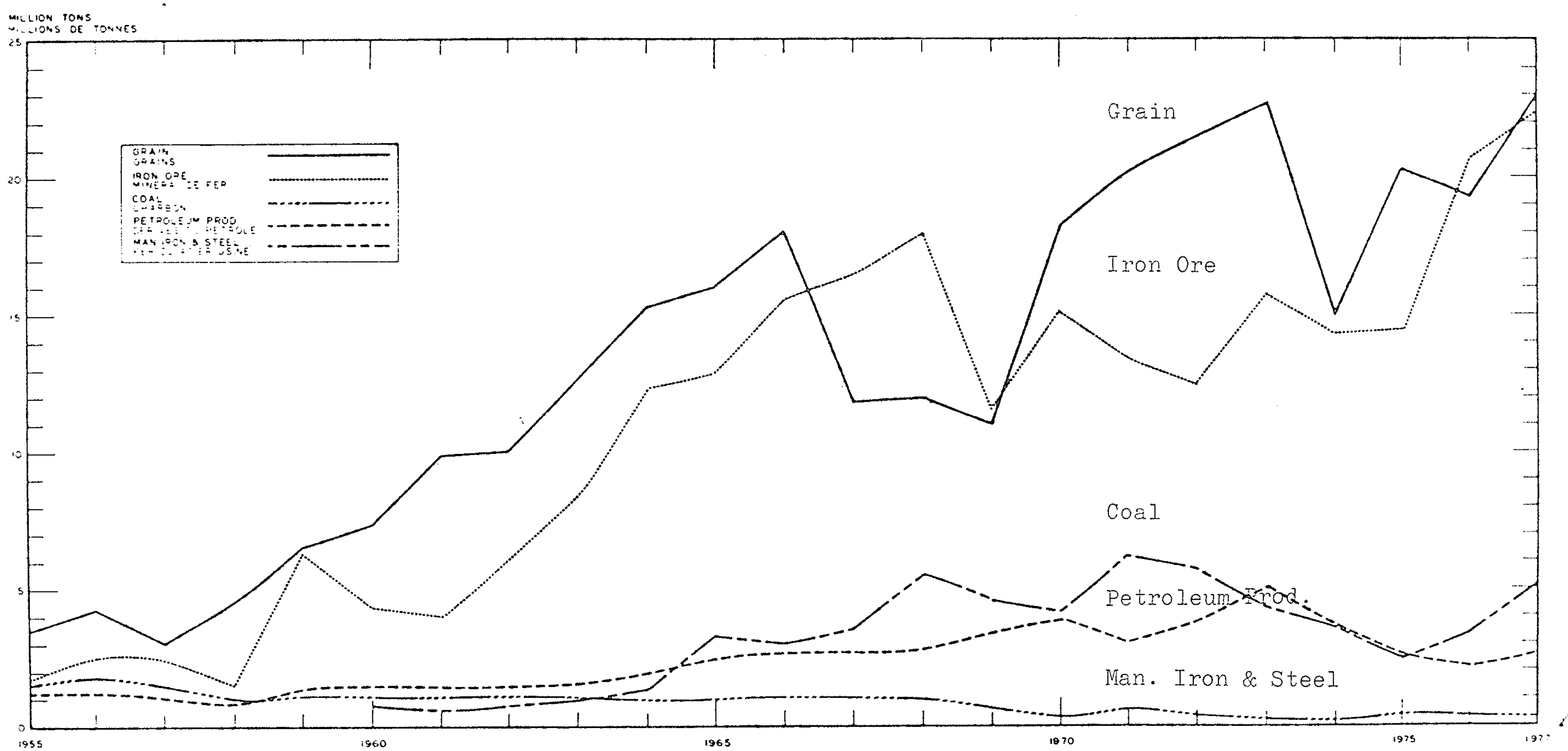
Movement of Selcted Commodities Through the Welland Canal Section of the St. Lawrence Seaway from 1955-1977[27]



[27]Ibid., p. 40.

Figure 2

Movement of Selected Commodities Through the Montreal-Lake Ontario Section of the St. Lawrence Seaway from 1955-1977[28]



[28]Ibid., p. 39.

Thus, it would seem that the Seaway was not a causal factor in the growth of the iron and steel industry; in fact, it is the iron and steel industry that would seem to have been responsible for the development of the Seaway.

Taking this argument into consideration, and once again referring to Figures 1 and 2, this time with no consideration of the iron ore movements, the only commodity that has enjoyed real growth in movement through the Seaway has been grain. In fact, the increase in movement from 1959 to the present is nearly fivefold.

The argument that this increase in movement of grain has been a result of improved and increased production due to gains in technology over the years certainly can not be discounted. This argument is in fact keeping with the development process outlined for North America above, as one of the components which aids in the broadened and expanded export base of a region is technology. However, improvements in transportation, with the inherent potential of moving larger quantities at possibly lower prices must also be considered as an important factor in this growth of grain movement through the Seaway.[29] Had the Seaway not had the higher capacity and had the costs of transportation not been

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[29]Total exports of U.S. and Canadian grain have more than doubled since the introduction of the St. Lawrence Seaway in 1959.

as low as they were it is quite reasonable that at least some of the growth in movements of grain through the Great Lakes system would not have occurred. This is especially true in the Canadian case, where in recent years the handling capacity of the west coast ports has come under criticism while the handling capacity of the port of Thunder Bay and the St. Lawrence Seaway has been deemed sufficient.[30]

In light of the above, it can be concluded that the St. Lawrence Seaway has at least in part contributed to an increase in the exports of grain and agricultural commodities, and has, therefore, played an important role in the economic growth of western Canada and the north eastern region of the United States.

Thus not only has grain been a significant element in traffic moving through the Seaway, but the Seaway has also, at least in part, contributed to the development of agriculture in North America.

In conclusion then, there is only limited empirical evidence to indicate that the St. Lawrence Seaway has been effective in contributing to the economic growth of its hinterland as the hinterland has shown only minor gains in

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[30]Canadian Grain Handling and Transportation Committee, Report of the Thunder Bay Sub-Committee, (Winnipeg: Canada Grains Council, 1977) p. 11.

economic status vis a vis the rest of Canada.

There is evidence to suggest, however, that the St. Lawrence Seaway has contributed to the growth in the exports of grain from Canada, and as grain is one of Canada's major export commodities, the Seaway has, in part contributed to the economic well being of Canada by being a factor contributing to increases in exports. If the Seaway is to continue to play a role in the economic well being of Canada then several steps and considerations are necessary. These are of particular importance to western Canada and grain producing regions of the north eastern United States. Any problems such as self sufficiency, bottlenecks, strikes or poor handling methods which restrict the capability of the Seaway, should be of great concern to these regions and efforts to prevent and minimize these types of problems should be encouraged to the maximum possible extent.

The reason for this is that the development of these types of problems can have an effect on the export base which the Seaway has given these regions and thus will ultimately affect the econcmy of these regions.

The Seaway, then, is an important part of the North American transportation system. It helps in the growth of agricultural regions even though they have only indirect access to the Seaway. Thus, it must be determined not only whether further investments in the Seaway which would alleviate problems at the Seaway are warranted but also whether or not investments in alternative modes of transport would be beneficial.

A Historical Perspective on The St. Lawrence Seaway

In light of the theoretical arguments which indicate that the Seaway would be able to contribute to the regional and natonal economic growth of Canada, it would seem that the construction of the Seaway would have closely followed the engineering developments which created the capability for construction. However, the political struggle prior to the creation of the St. Lawrence Seaway was long and arduous. The power of big business and unions was able to delay the construction of the Seaway for a long period of time. That control certainly has not lessened since the completion of the Seaway in 1959,[31] and is still an influential component when considering solutions to the problems such as self sufficiency or considering forces that influence decisions made by the policy maker. In order to demonstrate how the power of big business and unions can influence decisions on Seaway tolls, a more complete description of the political struggle prior to the building of the St. Lawrence Seaway follows.

As early as 1892, legislation originating in the United

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[31]Lesstrang, op. cit., p. 179.

States, called for the construction of a water route from the head of Lake Superior to the sea. In 1894 a Canadian group formed what they called a Deep Waterways Association and voted support for the U.S. legislation. Even at the time of these developments, opposition to the development of the Seaway was emerging from the eastern railroads, and, strangely enough, from the owners of the lake ships - water transportation interests who feared the potential competition of larger ships which would be brought into the Great Lakes through an access to the sea.

The success of the U.S. proposal in 1892, and the subsequent establishment by President Cleveland of a joint U.S.-Canadian international commission to study alternatives for deep-draft ocean ships to enter the lakes was to be the last major victory for the proponents of the Seaway for nearly fifty years.

Following World War I, The Great Lakes-St.-Lawrence Tidewater Association emerged, and for sixteen years the association pushed relentlessly, if unsuccessfully, for the construction of a Seaway. From 1920-1930 a series of battles between public and private power interests became prominent. The New York Governor, Franklin Roosevelt, while not opposed to the use of the St. Lawrence Seaway for navigation purposes, was much more in favour of the development of the river for hydro electric power. Under Roosevelt, the Power Authority of the State of New York (PASNY) was created and authorized to develop St. Lawrence power and to cooperate with the federal (U.S.) government in improving navigation on the river.

It seemed, however, that while the United States was eager to plan construction of the St. Lawrence Seaway, Canada was unwilling to proceed. Prime Minister McKenzie King was able to create delay after delay in discussions relating to the physical construction of the Seaway until 1930 when he lost the election with one of the major election issues being the unresolved Seaway discussions.

By 1932 the new Prime Minister, R.B. Bennett and President Hoover signed a treaty to build a Seaway to a draft of 27 feet, making the U.S. responsible for completing work from Lake Superior to Lake Erie, with Canada to be in charge of work in its national section, with both nations to share in the work and cost for the International Rapids section of the river. Under the treaty, costs for work which were already completed were to be shared equally. However, the treaty soon ran into serious opposition from many organized interest groups. As Lesstrang observed:

> Opposition to the Hoover-Bennett Treaty was strong, immediate and vocal: The railroads again, fearing the Seaway as a competitor, denounced the treaty. The strong railroad unions - the Brotherhoods - had joined their employers in opposing the Seaway and as well, privately owned utilities, coal, Eastern and Gulf port interests, regional waterways and lake carrier organizations had joined forces to

oppose the Seaway. The monstrous physical size and the combined financial strength of these self-interest factions, coupled with their unrelentless attacks upon the treaty, began at once to badly hurt its chances for survival.

> The Great Lakes port of Chicago joined forces with New Orleans against the Seaway in a Mississippi Waterway Association. The Lake carriers and the railroad center of Cleveland, Ohio, another Great Lakes port, struck out against the Seaway. And there were others in the Lakes who did not want a route to the sea - like Toledo and Buffalo.[32]

With the coming of the mid 1930's, the effects of the great depression once again postponed any plans for the development of the Seaway, although Keynesian developments in economic theory after the depression recommended that the implementation by government of a project such as the Seaway would have helped in getting the economies of Canada and the United States out of the depression.

After the 1930's had passed, interest in the Seaway arose again. In 1940 Franklin D. Roosevelt, now President of the United States in a statement to a Great Lakes Seaway and Power Conference said that a Seaway up the St. Lawrence River "along with its benefits to national defense, will contribute to the peacetime welfare of a multitude of labourers, ... The fear that the Seaway will result in injury on the lower Mississippi or to our Atlantic ports is

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[32]Ibid., pp. 24-25.

groundless."[33]

His major interest as stated previously, was in the development of the Seaway for the hydro-electric power which the development of the St. Lawrence project would provide.

It was now The Chamber of Commerce of the United States which objected to the Seaway, contending that, "It is obvious that the St. Lawrence power project cannot be justified, either in Canada or the United States, for electric power for defense industries."[34]

Other organizations were also opposed to the development of the Seaway at this time. Donald D. Conn, Executive Vice President of the Transportation Association of America, objected to the Seaway and the Hoover-Bennett Treaty, citing that:

> No matter how vile the odor of the Illinois Waterway might become at Joliet, or what epidemics might break out, Congress could not authorize an increased diversion of water without it being subject to veto by the international tribunal.[35]

H.L. Bodman, representing the New York Produce Exchange before a Congressional committee on July 14, 1941, noted that ".... we must not forget that now we have an excess of

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[33]Ibid., p. 25.

[34]as quoted by Lesstrang, op. cit., p. 26.

[35]loc. cit.

transportation."[36] Other dissenters also spoke up. The Niagara Frontier Planning Board in Buffalo probably expressed the greatest all round argument against the Seaway, finding virtually everything wrong with it. According to the board:[37]

i) the minimum total cost of the whole St. Lawrence project for both the United States and Canada would be $1,120,588,000.

ii) at least 85 percent of the United States share of the project's cost would be borne by American Taxpayers who would be victims of unfair discrimination: These taxpayers live in the region which could not be benefitted by the St. Lawrence Seaway even if claims of proponents were valid.

iii) American labour, transportation and industry, on the government's estimates of possible Seaway traffic, would lose $109,647,000 a year. Diversion of business from the American transportation system to foreign carriers, diversion of Canadian export grain movements from the United States and loss to American coal producers account for this figure.

iv) the American farmer would not gain from the St. Lawrence Seaway; export grain would be the chief American

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[36] loc. cit.

[37] Ibid., p. 28.

agricultural product to be shipped through the waterway. Even if a possible maximum saving of 3 cents a bushel were realized, this would be absorbed by the foreign purchasers and vessel owners.

There were more negative voices against the development of the Seaway. The New Orleans City Wide Committee and the Mississippi Valley Association testified with great apparent wisdom that there was no need to develop the Seaway for electric power as there are many other sources which were available at the time.

It was not until 1943 that the U.S. Senate actually turned its active attention to the Hoover-Bennett Treaty. The vote was 46 in favour and 42 against, failing the two-thirds majority required by law to approve a treaty.

Although every Canadian Prime Minister since 1913 and all Presidents since 1911 had been in favour of the construction of the Seaway, the self-interest groups had successfully created a continuing opposition to kill the effort. Private business, particularly big business, demonstrated that its will was more potent than either the will or the strength of government itself.

So the matter of development of the St. Lawrence Seaway rested until after 1950 when the discovery of great new iron fields in the Labrador region, and the subsequent need for a mode of transportation to get the iron ore from the wilderness was created. The plan to get the iron ore out was to build a 350 mile railroad to carry the ore to the St. Lawrence River.

However, by now the once powerful Tidewater Association was dead. A group called the National St. Lawrence Association was doing what it could to keep the Seaway concept alive. The director, Julius Barnes and Dr. N.R. Danielian made the decision that this would be an opportune time to restructure the Association into a strong fighting force once again.

They were successful in molding a new Great Lakes-St. Lawrence Association, with the introduction of power interests into the group through a Duluth banker, Lewis Castle, as its executive committee chairman and Danielian as executive vice president, an effective fighting unit was re-established.

The development of the Seaway at this time was considered to have two additional major benefits: increased employment opportunities both during and after construction; and increased stability of employment in the iron and steel industry which was also felt to be a labour benefit arising out of the Seaway project, along with the full development of labour in the New England region.

A second development which favoured the Seaway with the iron ore discovery in Labrador was that the Steel companies and the lake ships they owned now saw arising out of the transport of the Labrador iron ore a strong personal profit in the St. Lawrence Seaway, and the steel industry, therefore, suddenly became a strong supporter of the Seaway.

The increased up-bound cargoes resulting from the movement of iron ore, balancing the down-bound cargoes of grain also helped to justify the development of the Seaway. Military interests also favoured the Seaway, as it would allow for submarine-free access route from ore field to mill which was cited as being substantially in the best interests of national defense. In addition a lot of people, as a result of the Labrador iron ore strike, were beginning to pay close, positive attention to the Seaway.

Suddenly, things began looking up.

The importance of the Seaway and Power Project to national security was outlined in a document prepared by the national Security Resources Board. It stated:

> If the Seaway is not built, a delay of at least 18 months or more after the outbreak of war would probably be needed to produce a dependable route to move the large amount of ore vitally needed for war production. The Seaway route is capable of being more thouroughly, easily and cheaply protected than alternate routes involving long stretches of open water.[38]

The next impetus for the development of the Seaway came from Canadian Prime Minister Louis St. Laurent. Tired of

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[38]Ibid., p. 33.

the many delays which had been U.S. instigated, Canada decided that it would no longer willingly accept American foot-dragging. Canada made the announcement that it planned to build its own all-Canadian Seaway.

After a bill in support of the Seaway was tabled by the House of Public Works Committee in 1951, St. Laurent went to Washington to seek President Truman's support for the all-Canadian Seaway.

Although Truman desired U.S. participation in the Seaway, he agreed to help St. Laurent by approving American participation in the power aspect of the Canadian project, as he reasoned that a Canadian Seaway was better than no Seaway at all.

After this step, the Canadian Parliament created the St. Lawrence Seaway Authority and empowered it to build a Seaway from Montreal to Lake Erie, either on its own or in cooperation with the United States.

With these developments the U.S. Congress became alarmed, realizing that tolls paid by American shippers for use of the Seaway would cover most of the cost, but that Canada would control and own the Seaway - an access into the heart of the American nation.

On January 28, 1952, President Truman told Congress that the question was "no longer whether the St. Lawrence Seaway should be built. The question before Congress now is whether the U.S. shall participate in its construction and thus maintain joint operation and control. ... It is obviously of great significance for us to have an equal voice with Canada."[39]

Representative Blatnik of the Congress said: "A bottleneck has been right here in Congress, where for too long there has been a tendency to listen to the song of certain selfish vested interests - the Eastern railroads, the coal interests, the private utility lobby and some Eastern and Gulf port cities - who have opposed it on the grounds that it might affect their own interests."[40]

Nonetheless, in June 1952, by a vote of 43 to 40, the Senate killed the Seaway bill and once again the self-serving interests of rail, private utilities, East and Gulf ports overpowered the government. A totally Canadian Seaway it was to be.

Once again the Canadian prime minister returned to Washington, once again to help develop the joint U.S.-Canadian power aspect of the project. The Federal Power Commission, aware of the mood of congress in terms of appropriating money for such an effort, asked PASNY to become the agency designated to fulfill the U.S. part of

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[39]Ibid., p. 39.

[40]Ibid., p. 40, emphasis added.

the power project.

However, even this development ran into legal battles and appeals, and the delay caused by these legal battles and appeals ultimately enabled American participation in the building of the Seaway. In 1953, Dwight Eisenhower came into office.

Although he was reluctant at first, eventually he supported U.S. participation in the Seaway. Under his guidance, and due to pressures from Canada, both the U.S. Senate, and Congress passed bills stating that the U.S. would share in the construction of the international section of the Seaway.

Congress acted to create the St. Lawrence Seaway Development Corporation, a counterpart of the St. Lawrence Seaway Authority, to oversee the construction of U.S. portions of the Seaway.

There was only one more obstacle to be crossed before construction of the Seaway could start. This was put forward by Gregory S. Prinse, General Solicitor, Association of American Railroads, who spoke in opposition to the Seaway, pointing out that "The evidence is clear and convincing that a 27-foot canal [the same depth as proposed in 1930] is already an obsolete and outmoded waterway for ocean going vessels."[41]

Once again the same old arguments were gone over and put forward, but none the less two American bills in support of the Seaway were finally passed, one by a vote of 53 to 51, on May 6, 1954.

"And so, after defeats in 1918, 1934, 1942, 1944, 1948 and 1952, after Canadian delays in 1914 and 1922 and procastination in the whole decades of 1920-30, a joint U.S.-Canadian Seaway was, at least and at last on paper, a reality. The fight had been won."[42]

Objectives of the Study

Now that the general problem has been outlined, and a brief analysis of the economic importance of the Seaway has been given in conjuction with the historical political struggle which unfolded prior to the building of the Seaway, the focus will be directed to the three main objectives of the thesis. These are to:

i) build a mathematical model that can simulate grain movements from the producer to the various ports under certain conditions and make it possible to determine the minimum total cost of transporting grain from points of supply to the various Canadian export terminals in Thunder

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[41]Ibid., p. 43.

[42]Ibid., p. 47.

Bay, Montreal, Churchill, Prince Rupert, Vancouver and Victoria under different toll structures, alternative capacities, and export quantities in order to determine the optimum utilization level of each of the ports,

ii) determine the effects of alternative Seaway toll structures on the current distribution of grain to various ports, under certain conditions.

iii) determine the implications of alternative toll structures for both public and private policies with respect to upgrading the current grain handling and transportation system.

Hartley (1957)[43] This is a study which was done by J.R. Hartley prior to the completion of the St. Lawrence Seaway. Although this study was done only for the United States, it was an attempt to measure the impacts that the building of the St. Lawrence Seaway would have on the demand for alternative handling facilities which currently existed for the export of grain. The levels at which the tolls were set varied over the range of projected tolls which were under discussion at the time. Hartley discussed various ways in which the producers and importing nations as well as consumers could benefit from the lower costs associated with moving grain through the St. Lawrence Seaway.

The conclusions of that study indicated that the Seaway, when completed, would have some significant effects on the utilization of the various port facilities in the United States. The conclusions also indicated that even a small change in tolls on the Seaway would have some effect on the amount of grain which moved through the Seaway and upon the division lines between areas which would supply the grain

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[43]J.R. Hartley, The Effects of the St. Lawrence Seaway on Grain Movements, (Indianna Bureau of Business Research, Indianna University, 1957).

for shipment through the Seaway. His main criteria for determining supply regions was minimum transport cost to ocean ports.

Implicit in the conclusion of that study was the idea that if tolls on the Seaway were to become high enough, the benefits which resulted from building the Seaway would be lost and the movement of grain would revert back to the distribution to ports which existed before the building of the Seaway.

It is reasonable to expect similar results with regard to the distribution of grain in Canada to the various Canadian ports if the tolls on the Seaway increase above current levels.

J. Lukasiewicz (1976)[44] This is an interesting study which was done on the workings of the railways in North America and points out many of the areas of inefficiency. In his book, Lukasiewicz discusses how alternative management of railways and alternative technologies could be used to improve the efficiency of railways. The study verifies the idea that it would be possible to reroute grain to other ports, even though the current amounts presently moved through specific ports are often constrained by the 'capacity' of rail lines. Many of the constraints could be removed

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[44]J. Lukasiewicz, op. cit.

from the system, increasing throughput capacities of the ports at nominal costs. If higher tolls on the Seaway were to become a reality, it is likely that some of the possibilities recommended by Lukasiewicz would come into existence in order to offset the impact of higher tolls on the Seaway. This is the type of alternative assumed to be available if the railways do in fact represent constraints on the redistribution of grain through other ports.

Bunker, A.R., (1977)[45] In this study movements of grain and fertilizer for Logan County, Illinois, were simulated using linear programming. Changes in the marketing and transportation of grain and fertilizer products were measured after imposing specified levels of waterway user charges on barge shipments. The marketing and transportation of grain and fertilizer changed only slightly at charge levels that would cover the expenses of operation and maintenance. Higher charges caused substantial switching from truck-barge to rail shipments, and some large changes in the quantity of shipments through locations occurred, but only small increases in the total marketing and transportation bill resulted.

In the method of study followed by Bunker, grain eleva-

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[45]A.R. Bunker, "Grain and Fertilizer Movements in Response to Waterway User Charges," Illinois Agricultural Economics, Vol. 17, No. 1, (January, 1977), pp. 19-26.

tors and fertilizer distributers in and near the immediate area were surveyed to determine the physical capacity of each facility to handle grain and fertilizer and also to determine the actual movement of grain and fertilizer in 1973. From this data a linear programming model was constructed and used to select the resource allocation of firms, and modes of transport that would minimize the total cost of transportation and marketing in the movement of grain and fertilizer. Various levels of waterway user charges were then added to the cost of barge transportation in the model, and the resulting changes in the grain and fertilizer marketing patterns were measured.

The study determined that the implementation of user charges for water use would reduce total traffic in the area, and that some reallocations from water to rail would occur if user charges are implemented on the waterways. The study also concluded that the total marketing and transportation cost was not large in percentage terms and that grain movement was more sensitive than was dry fertilizer to increases in user charges along the waterway.

CHAPTER III REVIEW OF RELATED THEORY

Now that the problem and objectives have been outlined, in Chapter 1, and having reviewed the revelant literature in Chapter 2, the next step is to develop a conceptual model. This conceptual model will demonstrate how the demand for export grain, transportation costs, and the three Canadian Ports interact with one another, giving a theoretical framework for analysing the impacts of alternative toll structures on the Seaway. From this conceptual framework, it will be possible to develop a mathematical model with which changes in the system can be simulated.

Ports of The System

Before a conceptual model of the system is established, it would be helpful to provide a brief description of the ports of the system.

Port of Thunder Bay

In 1976 there were 17 terminals in Thunder Bay with a storage capacity of 90.3 million bushels. In the 1974-75 crop year, 300 million bushels of grain were exported through the East Coast.[46]

> Thunder Bay is the key port in the entire eastward grain handling and transportation system. The operations at Thunder Bay have a direct bearing on the activities and operations of all eastern grain ports. Thunder Bay provides the surge storage capacity and grain cleaning facilities for all grains moved east thereof, either to export or for domestic use.[47]

Port of Churchill

The navigation season is restricted to approximately three months. The main traffic handled at this port is grain. The proximity of this port to the producers of Nothern Manitoba and Saskatchewan has led prairie people to push for greater use of the port. In the crop year 1976-77, 28 million bushels of grain moved through the port. The elevator at Churchill has a storage capacity of 5 million bushels. The Hall Commission report points out that Churchill does provide an alternative route for 5 percent of Canada's grain export and that any increase in Seaway tolls will improve the relative position of Churchill as a grain port.[48] This would seem to indicate that it may be possible to reroute grain currently moving through the Seaway to other ports provided that tolls on The Seaway increase.

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[46]Government of Canada, Hall Commission, Volume I, op. cit., p. 199.

[47]Ibid., p. 198.

[48]Ibid., p. 206.

Pacific Coast Ports

Export grain from primary elevators destined to the West Coast moves through terminal elevators at one of the three western ports; Vancouver, Prince-Rupert or Victoria. The terminals in Vancouver have a total storage capacity of 25 million bushels while the storage capacity at Prince Rupert is 2.2 million bushels. There is one terminal located in Victoria which has a storage capacity of 1 million bushels.

The two main functions of these terminal elevators are the transferring of grain from rail cars to vessels, and the cleaning of grain while in the terminal. In the crop year 1975-76, the total receipts at west coast terminal elevators were 263.6 million bushels.

Supply and Demand of Canadian Grains In Response to Alternative Toll Structures

The effects of the implementation of alternative toll structures on the Seaway would be felt at four levels. These are:

i) producer

ii) industry

iii) national, and

iv) international

In order to be able to develop a theory of how the movements of grain through each port interacts with each of the four components mentioned above, it is first essential to look at the supply and demand conditions for grain which exist in Canada.

On the supply side four significant factors are noteworthy:[49] These factors are:

i) There are a very large number of producers, who cannot by themselves affect prices in any way.

ii) In recent years there have been 'rapid' increases in supply. Because of the competitive structure of agriculture and because of the rapid development of improved production techniques, there is a constant tendency for the supply curves of various commodities to shift to the right.

iii) Asymmetrical changes in output in response to changes in price have occurred.

This is a result of the so called 'rachet response' in agriculture. This results from the tendency of producers to introduce improved technology and increase output when prices are high, leaving them with a large fixed cost in proportion to variable costs which, in turn, makes it difficult for the producers to reduce production when prices are low.

iv) Instability of output exists. Due to the dependence of output on weather and other conditions of nature, the

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[49] D.R. Campbell, op. cit., p. 195.

total agricultural output varies between years.

On the demand side in Canadian agriculture two important factors need to be kept in mind:

i) The total demand for agricultural products is increasing through time. In the domestic market, increases in the demand for food occur mainly as a result of increases in population.[50] On the export side there are two aspects. First, in developed countries, the situation is similar to that in the domestic market. Increases in the demand for food will not result from increases in real income per capita, but will occur only as populaton rises. Second, in developing countries increases in demand for food will result from increases in population and from increases in income per capita.[51]

ii) There is a higher price elasticity of demand for Canadian farm products in export markets than in the domestic market. The reason for this is the large number of substitutes for any particular agricultural product. Since, in relation to total international agricultural trade, each country is relatively small, the elasticity of demand for the exports of one country is much greater than for the

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[50] D.T. Karamchandani, "Changes in Food Expenditure Patterns," Canadian Farm Economics, Vol. 11, No. 5, (October, 1976), pp. 16-29.

[51] D.R. Campbell, op. cit., p. 200.

exports of all producers of the commodity. This situation is somewhat analagous to that of a single producer who has a highly elastic demand for his own output whereas the industry has a much less elastic demand.

Thus, although the elasticity of demand in the domestic market is low, due to the relatively higher elasticity of demand in the export market a lower limit on domestic prices is set by the possibility of exports and an upper limit by the possibility of imports.

This situation is illustrated in Figure 3 in which AB represents domestic demand, DE represents domestic supply, BC represents foreign demand (ie. the possibility of exports) and EF represents foreign supply, that is the possibility of imports.

The segments BC and EF are virtually horizontal indicating very high elasticities of demand and supply for the small amounts of Canadian exports and imports relative to total world trade.

Figure 3 indicates that the price would be at P^o and that at the price P^o there are no imports or exports. Figure 4 indicates the position following an increase in demand relative to Figure 3. Imports will amount to GH and price will be more or less stabilized at J^o.

Figure 3[52]

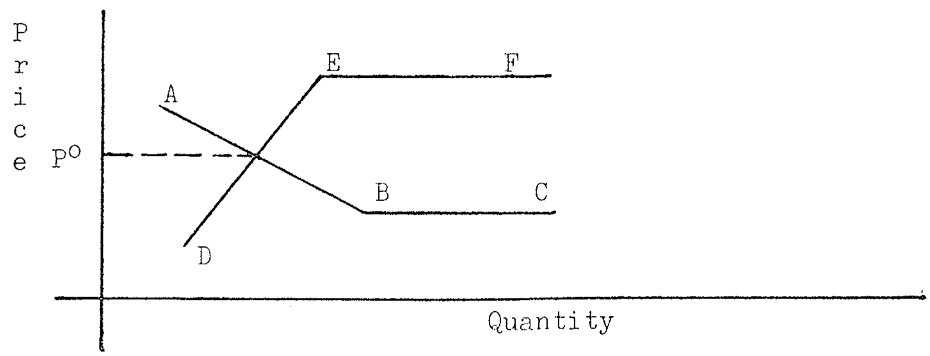
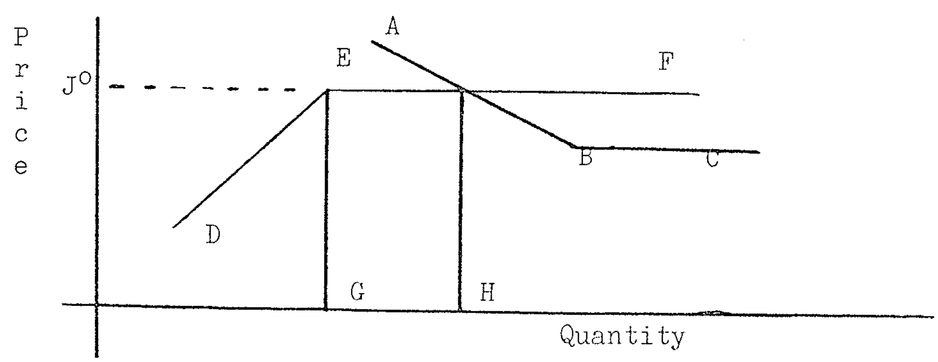


Figure 4[53]



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[52]Ibid., p. 199.

[53]loc. cit.

The problem is to determine what the impacts upon the grain handling and distribution system would be under different toll rates on the St. Lawrence Seaway. From previous discussion it seems unlikely that the tolls on the Seaway will be reduced from the present levels. Therefore, only the implications of higher tolls on the Seaway are emphasized in the this study. However, some analysis will be done with regard to the effects of lower tolls. The effects of alternative toll structures upon i) producers, ii) the transportation industry, iii) Canada, and iv) the international economy in general are examined below.

Effects on Producers

From a producer's point of view, given that he pays the tolls either directly or indirectly, if he is currently indifferent as to whether he delivers his grain east or west in terms of the price or cost he faces, the immediate effect of increased tolls would be that he would now have a desire to move his grain in a westwardly direction. Some producers which previously shipped grain eastward will now be indifferent as to which direction they now move their grain. Any producer who is located to the east of the indifference line before tolls were raised will find that it now costs him more to move his grain to export position. Conceptually, this effect is demonstrated by Bressler and King.[54] They define the 'site price' of a farm good as being equal to the market price less the transfer cost. This can be written as:

$$P(f) = P(m) - T = P(m) - f(D) \qquad (1.0)$$

where $T = f(D)$

$P(f)$ = farm gate price

$P(m)$ = market price

T = transfer cost

and transfer cost is a function of distance.[55] Combining this definition of site price with Fetter's law of market areas, it follows that "the boundary between competing markets is the locus of points so situated that the site prices for shipments made to competing markets are equal. In algebraic terms, this law can be expressed as follows."[56]

$$P(a) - t(a) = P(b) - t(b) \qquad (1.1)$$

$$\text{or} \quad P(a) - P(b) = t(a) - t(b) \qquad (1.2)$$

where P = market price

t = farm to market transfer cost

and subscripts refer to alternative markets A and B.

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[54]R.G. Bressler and R.A. King, Markets, Prices and International Trade, (New York: John Wiley and Sons, Inc., 1970) pp. 124-129.

[55]Ibid., p. 125.

[56]loc. cit.

Figure 5 shows the site price surface of farm prices around two competing markets, A and B. Assuming that the market price in both markets is fixed, the effects of two different transfer prices to market B are illustrated:

i) transfer prices are equal, with a maximum site price of (c) to market B,

ii) the terminal cost at market B is increased, resulting in a maximum site price of (d). Conceptually, this is the same as raising tolls on the Seaway, as the tolls, once in place, can be viewed as a fixed cost and are not related to the length of haul. This can be also be thought of as reducing the market price at B.

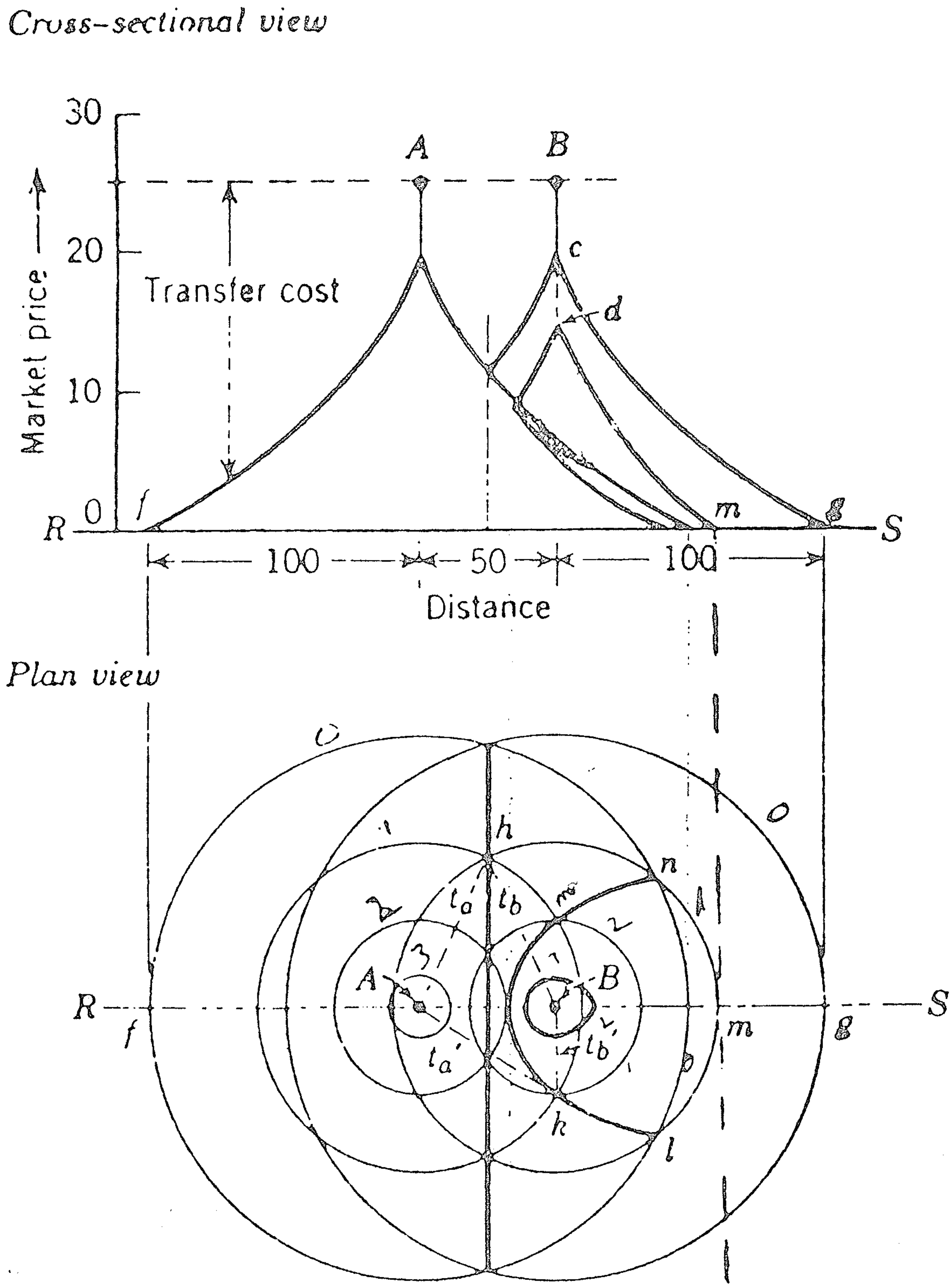
Examining case 1, it can be concluded from equation 1.2, that with equal rates of transfer costs, and equal prices, the competitive boundary will consist of a locus of points where the difference in transfer costs is equal to zero, that is, where the transfer cost to A is exactly equal to the transfer cost to B. This is indicated in Figure 5 by points such as (h), where the alternative distances are equal, and hence, the alternative site prices are equal.

If the terminal cost to B is increased as in case 2, reducing the maximum site price to (d), the market boundary is pushed toward B. Some producers to the 'east' of the perpindicular bisector now find it profitable to ship to A rather than to B. The new boundary is again the locus of points where the differences in market prices and transfer costs are equal. The new boundary is shown by the line lkmn.

Figure 5

The Allocation of Production Sites

Between Two Competing Markets



Effects on the Transport Industry

Higher tolls at the Seaway will create pressures to shift grain which currently moves through Thunder Bay to other ports, as suggested by the Hall commission report.[57]

From Figure 6 it can be seen how transport rates affect the quantity demanded and supplied at an individual port. The overall supply and demand functions at the ports are represented by D and S. When transport costs are implemented, a derived supply and demand such as D' and S' are obtained. The transport cost is represented by ab and the quantity moved through the port is Q. If transfer costs are raised to cd then new derived supply and demand equations such as S'' and D'' result, with a new (lower) quantity movement of Q'. Thus by increasing the transport costs from (ab) to (cd), the amount of the commodity moved through the port facility is reduced by Q - Q'.

In a similar analysis of the port of Thunder Bay and the linking St. Lawrence Seaway, this model demonstrates that increasing the tolls (transport costs) on the Seaway, would result in reduced total movement of commodities through the St. Lawrence Seaway.

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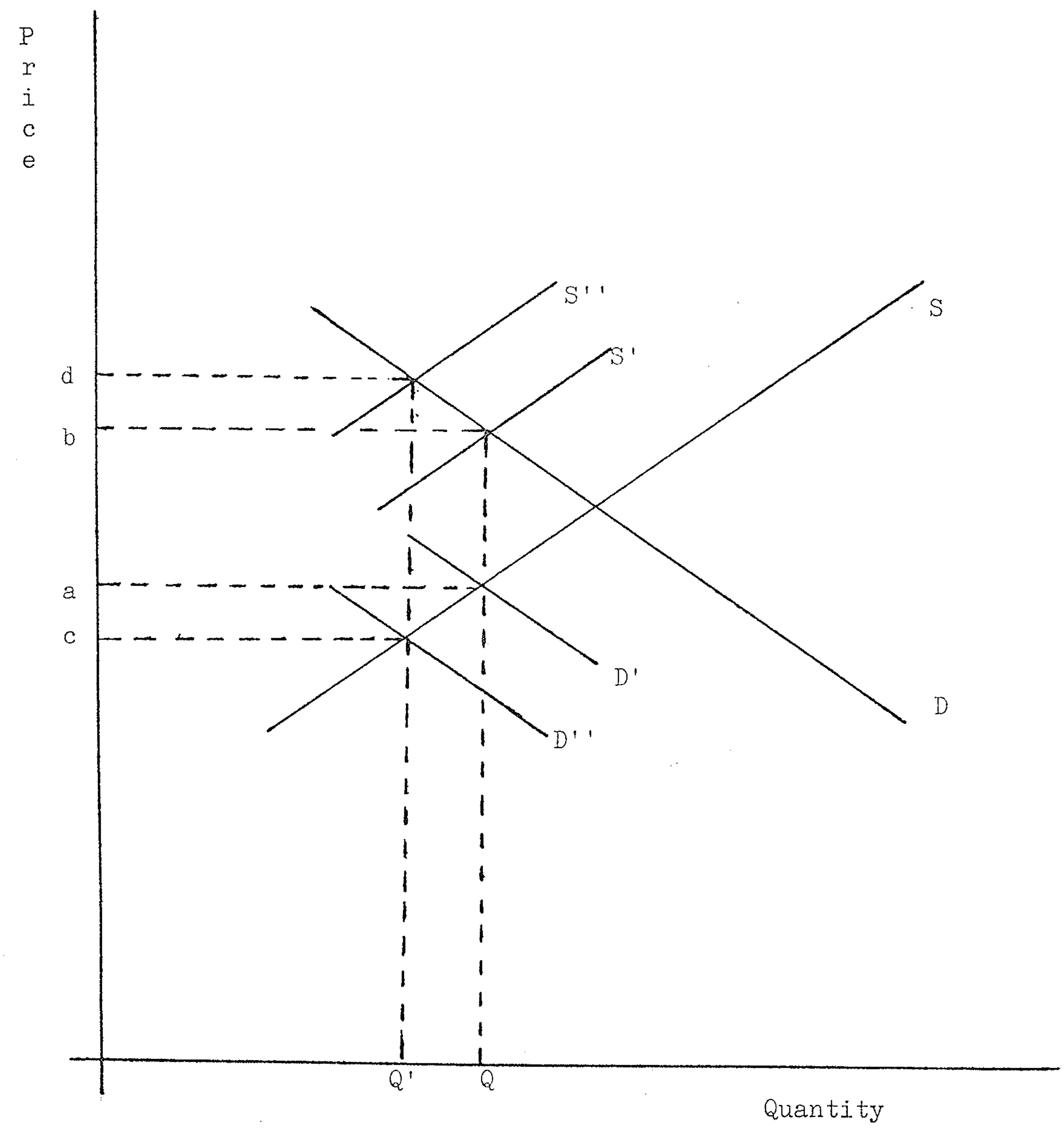
[57]Government of Canada, Hall Commission, Volume I, op. cit. p. 206.

Figure 6

The Effects of Transport Costs on the

Demand for Port Facilities



On a short run (year to year) basis the supply of grain for export is relatively fixed, while the export demand for grain is relatively elastic.[58] The aggregate supply and demand can be broken down into the supply and demand at each of the ports. This is shown in Figure 7, in which it can be seen that a horizontal summing of the supply and demand for each of the three ports gives the aggregate supply and demand position for Canadian grain exports. Algebraically this can be expressed as:

$$Q = Qt^* + Qw^* + Qc^*, \text{ and}$$

$$PQ = (Pt^*)(Qt^*) + (Pw^*)(Qw^*) + (Pc^*)(Qc^*)$$

Under current conditions, an equilibrium' position exists. If tolls on the Seaway are raised, adjustments towards the development of a new point of equilibrium in the system would take place. This new equilibrium could, in fact, offset the economic impacts of higher tolls, which would fall on the industry as a whole and ultimately upon the Canadian economy as a result of raising of the toll rates on the Seaway.

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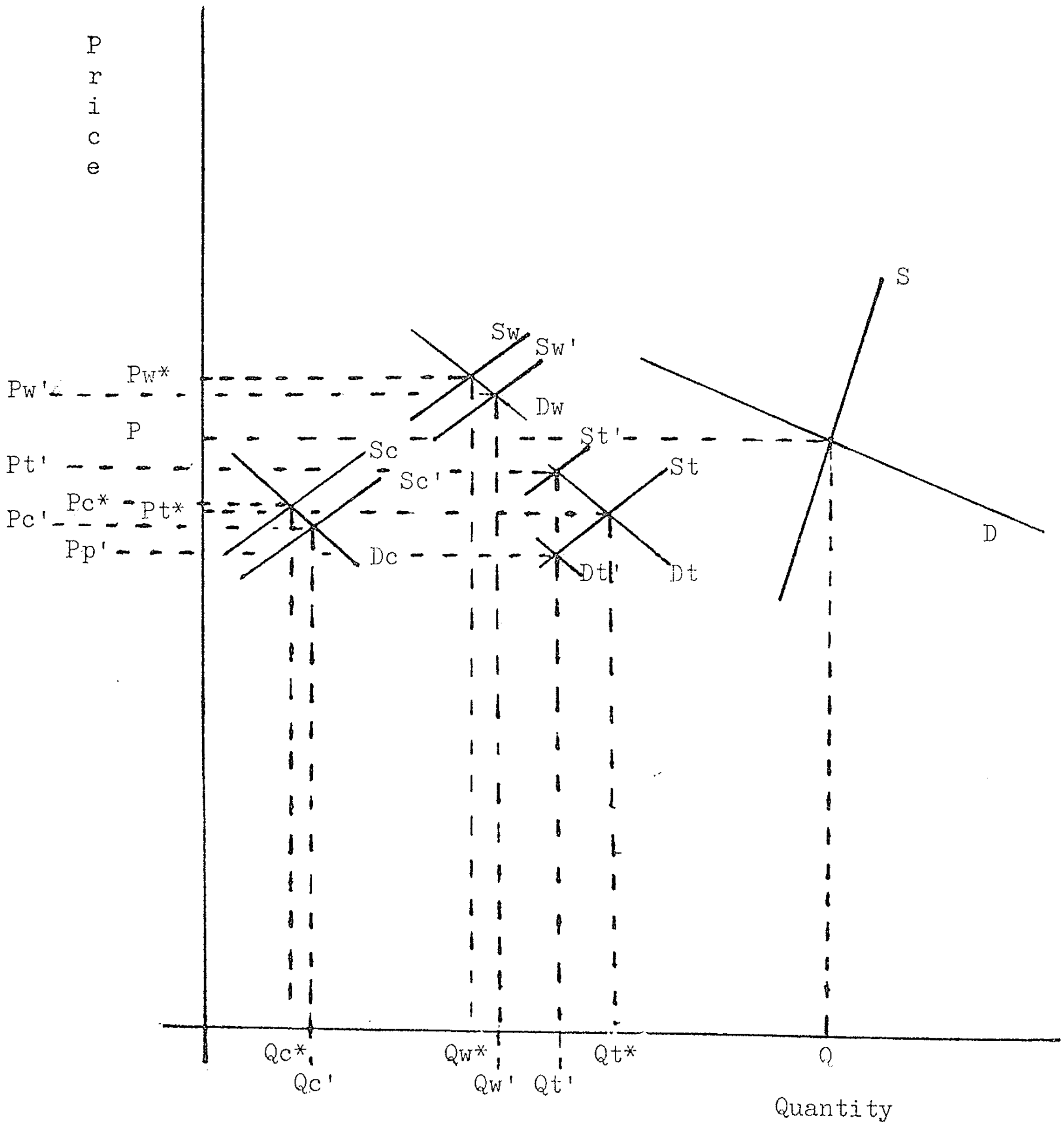
[58]Campbell, op. cit. p. 199.

Figure 7

Conceptual Model of Supply and Demand for

the Port Facilities in Canada



Qt^* = original quantity of grain exported through Thunder Bay

Qw^* = original quantity of grain exported through the west coast

Qc^* = original quantity of grain exported through Churchill

Qw' = the new quantity of grain exported through Thunder Bay

Qw' = the new quantity of grain exported through the west coast

Qc' = the new quantity of grain exported through Churchill

Pt^* = original export price for grain exported through Thunder Bay

Pw^* = original export price for grain exported through the west coast

Pc^* = original export price for grain exported through Churchill

Pt' = the new export price for grain exported through Thunder Bay

Pw' = the new export price for grain exported through the west coast

Pc' = the new export price for grain exported through Churchill

Pp' = the new price that the producer obtains for grain exported through Thunder Bay

There are various directions in which the transport industry could move as a result of the consequences of higher tarriffs on the Seaway. These are:

i) the system could stay exactly as it is now,

ii) the tendency for rationalization of rail and elevator systems could be either accelerated or slowed down,

iii) new technologies could be implemented (such as inland terminals) which could result in savings and thus lower the costs to the system,

iv) the capacities of the alternative ports could be improved by various techniques such as:

a) increasing the length of the work week at the Vancouver terminal,

b) increase the length of season at Churchill; possibly by restructuring insurance rates,

c) increase the capacity of the various terminals to store grain.

d) more fully utilize the potential capacity at the west coast. For example, the capacity at Prince Rupert could be utilized to the greatest possible extent. Further increases in throughput at the west coast could be obtained if the movement of grain through the mountains was streamlined causing less bottlenecks in the system to occur. In addition, the handling capacity of the west coast ports could be increased.

It is this, the fourth aspect of change, which would allow for the redistribution of grain currently moved through the Seaway to other Canadian ports; it is this aspect in which the remainder of this study is particularly interested and which has previously been outlined in the problem statement and objectives.

Conceptually, adjustments in the amount of grain which moves through each of the ports as a result of higher tolls on the St. Lawrence Seaway can be seen by referring to Figure 7. Initially, an increase in toll levels on the St. Lawrence Seaway will result in a reduction of the amount of grain moving through the St. Lawrence Seaway, by an amount equal to Qt* - Qt', as a result of the derived demand curve shifting to the left. Due to the inelastic aggregate supply curve S, (short run), there will now be more grain available in Canada for export than is demanded, unless the supply curves at the other ports shift to the right, that is, a shift in the supply curves from Sw to Sw' at the west coast and from Sc to Sc' at Churchill. These shifts in the supply curves result in increases in the quantities of grain moved through Churchill and the west coast from Qc* to Qc' and from Qw* to Qw' respectively. Assuming no reduction in exports the increased movement at Churchill and the west coast will offset the reduced movement through Thunder Bay as from a theoretical perspective:

$$Qt^* - Qt' = [Qc' - Qc^*] + [Qw' - Qw^*].$$

The total revenue from grain sales will remain unchanged after adjustments at each of the ports as:

$$PQ = (Pt^*)(Qt^*) + (Pw^*)(Qw^*) + (Pc^*)(Qc^*)$$
$$= (Pt')(Qt') + (Pw')(Qw') + (Pc')(Qc').$$

However, the revenue which the producers receive will be reduced by the amount:

$$PQ - [(Pp')(Qt') + (Pw')(Qw') + (Pc'Qc')].$$

Although it is not shown in Figure 7, the quantities of grain moved through the west coast and Churchill could be increased further by shifts to the right of the demand curves at each of these ports.

Conversly (not shown), if tolls on the St. Lawrence Seaway were lowered, the process of adjustment would follow the same pattern as with increased tolls, but the direction of the shifts would be reversed, resulting in increased movements of grain through the St. Lawrence Seaway.

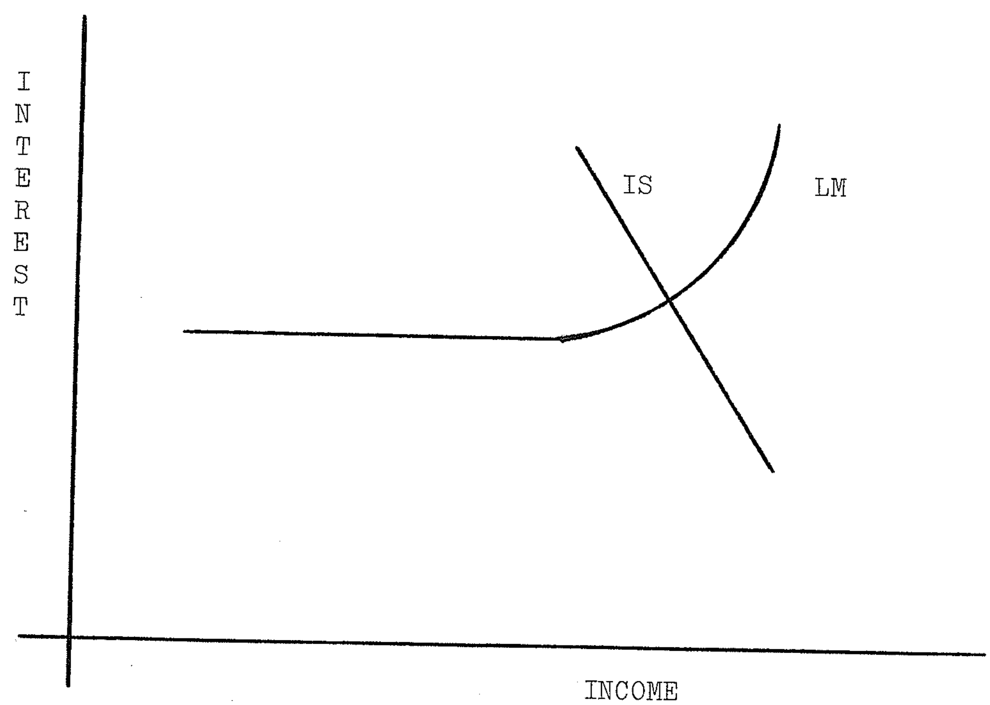
The incentive for both the Government of Canada and the grain handling and transportation system to offset the impacts of higher tolls will be substantial. For if adjustments made by the transportation industry are not able to offset or absorb the impacts of higher tolls the impacts that would fall on the Canadian economy, and in particular the economy of western Canada, could be quite significant.

Effects On the Canadian Economy; Some Conjectures

In terms of income and employment, simplest method of predicting the potential effects on the economy would be, to use the well known IS/LM model.

Figure 8

Interest and Income in Response to Changes in Trade and the Money Supply



If the price of wheat for export ultimately rises as a result of higher tolls on the Seaway, or even if production of grain for export is cut back as producers absorb the higher costs, the immediate and most obvious result would be a reduction in the amount of grain exported. However, it is possible that tolls could be shifted in the form of higher prices if a cartel were formed between Canada and the United States. If this cartel were established, the effects of alternative toll levels on the St. Lawrence could be greatly reduced. However, this cartel does not currently exist. Therefore, higher export prices for wheat will result in a reduction in the amount of grain exported. The economic consequence of this can be divided into two parts.

i) the IS curve, which represents points of equilibrium in the product market, would shift to the left resulting in lower levels of income, and possibly lower levels of interest. The magnitudes of each will be determined by the region of the LM curve which contains the equilibrium. The LM curve can be in any one of three regions. These are:

a) Keynesian

b) transitional

c) Classical

The result of such a shift would be to lower the levels of income and employment in the Canadian economy.

ii) a second impact on the Canadian economy could come about as a result of less exports of grain due to higher prices resulting from higher tolls as less foreign exchange would be spent in Canada on goods for export. Rather it is reasonable to assume that the importing nations would spend their scarce foreign exchange on food supplies purchased elsewhere. This will result in a net decrease in Canadian foreign exchange earnings, which means a reduction in the supply of money in Canada. As the LM curve represents points of equilibrium in the money market, a reduction in the money supply will result in the LM curve shifting to the left. This would further reduce the income and employment levels in Canada.[59]

Conversely, as the Canadian economy slowed as a result of less exports of grain, the value of the Canadian dollar would decline in the world money market. This would have the same effect as reducing export prices. This would then result in increasing exports, with resulting shifts to the right in the IS and LM curves, possibly back to the original equilibrium position.

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[59]Wonnacott, Paul, Macroeconomics, (Chicago: Richard D. Irwin, Incorporated, 1974) pp. 117-141.

International Effects

In the international trade between countries the result of Canada exporting less wheat would be shown by a disturbance in the balance-of-payments, other things being equal. Canada would now be importing relatively more than it exports; assuming equilibrium existed before the disturbance. This will result in an outflow of capital from Canada, which, in turn would lead to a reduction in the value of Canadian currency. This would make Canadian goods relatively cheaper in foreign markets which, in turn, would increase Canadian exports. This would tend to offset a reduction in domestic demand due to the lower money supply in Canada and thus a new equilibrium in the balance-of-payments would be created.

Introduction to the Model

In the previous chapter, a conceptual model of how changes in the levels of tolls on the St. Lawrence Seaway affect i) producers, ii) the demand at the ports (industry), iii) The Canadian economy, and iv) the international equilibrium was discussed. In order to establish the magnitude of the effects of alternative tolls on the St. Lawrence Seaway on the first two items,[60] it is necessary to first determine a system in which transport costs at the various relevant levels, ranging all the way from the producer to the ocean liners, are minimized.

There are several types of models which could be used in this particular study. Some of these are flow models such as General Purpose Simulation Systems (G.P.S.S) and the more common mathematical models such as linear programming (LP), quadratic programming (QP) or even regression analysis.

Models such as the G.P.S.S. or even a model in Fortran could be built to determine the impacts of changes of tolls within the system. However, these types of models have

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[60]The effects on income, employment, and the balance of payments, etc. are beyond the scope of the project.

several disadvantages:

i) they tend to be relatively costly and time consuming to build,

ii) like all models, they are simplifications of the real world and may fail to represent important elements or relaticnsips.[61]

iii) a computer simulation model can be used to measure the impact of making changes in the system but it can not easily determine the optimal reallocation of resources. Since optimization is in fact the major objective of this study, a G.P.P.S. type of model would be very difficult to apply tc the problem at hand and has, therefore, not been selected for analysing the particular optimization problem in this study.

It may have been possible tc use a regression model for this particular study. The main problem with regression models, as with simulation models, is that they do not readily lend themselves to the determination of an optimum point. For this reason, a regression or other type of econometric model was not considered further.

On the other hand, a mathematical programming technique such as linear programming or quadratic programming is

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[61]Bierman, Bonini and Hausman, <u>Quantitative Analysis for Business Decisions,</u> (Chicago: Richard D. Irwin, Incorporated, 1973) p. 393.

rather simple to use when compared to the construction and application of a more complex computer simulation model. Mathematical programming models have the added advantage of having the ability to find the optimum point in a system. Since the objective of this study is to optimize the allocation of resources within the system, the use of mathematical programming was considered preferable to the use of a computer simulation. A programming technique also can give just as powerful a result as can another type of model while at the same time being much simpler to use. For these reasons, mathematical programming was chosen over the use of a computer simulation model.

One of the more common types of programming models which could be used in this study is linear programming. However, before selecting linear programming (LP) for the analysis the major limitations and weaknesses of LP must first be dealt with. The following is a description of each of the major limitations of LP and either a description of how the limitation was dealt with, or justification for each limitation.

The first (and possibly most serious) problem with the LP technique is the assumption of linearity. When dealing with rail costs, the debate as to their linearity has gone on for a long time. Prior to the second world war, it was generally assumed that there were increasing returns to scale. As early as 1893, writers such as Wellington had emphasized the higher proportion of fixed costs in railway transport.[62]

From a marginal cost analysis, the conclusion of increasing returns to scale is consistent, since the 'fixed capital' outlay needed for the movement of any amount of traffic does not change as output increases, at least until the capacity of the system is fully utilized. However, the concept of declining marginal cost in railway operations has been contested. The argument that declining marginal cost was typical of the early stages of railway was put forward by Healy in 1940, when he said:

> Under present conditions of maturity, most main line railroad facilities and the operation thereon have had a chance to become closely adjusted to the density of traffic handled and the revenue derived therefrom, so that average unit costs tend to be nearly uniform over a wide range of densities and the cost of handling additional increments of business are not likely to be much below the average costs.[63]

Heads, however, does not conclude in favour of one side of the argument over the other. Instead, he suggests, what he calls the conventional view, "that, with the exception of pipelines, where economies exist for other modes they are

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[62]John Heads, The Economic Basis for Transport Subsidies, (Ottawa: Canadian Transport Commission, 1975) p. 15.

[63]Ibid., pp. 16f. from De Melverda, H.A.A. "The Illusion of Fixed Costs," International Economic Papers, 1952, pp. 155-177.

likely to be less than for rail."[64]

However, when determining the cost of moving grain by rail, the Commission on the Cost of Transporting Grain By Rail argued that: "While accepting the principle of specifity, the commission is compelled to note that, contrary to the belief of some, the subsitution of specific costs for system average or allocated costs does not necessarily result in substantial improvements in the accuracy or reliability of the cost estimate."[65] The commission argues further that "specific costs, are in fact no better than the technique or study used to obtain them."[66] The Commission then concludes that "there is no difference between the accounting dollars and the dollars derived on the unit cost basis."[67]

With regard to the question of linearity of railroad costs provided that the utilization of facilities or densities of traffic is kept in what can be reffered to as the relevant range, in conjunction with the commission and Healy, it is possible to conclude that the application of linearity to railway costs, is a reasonable assumption.

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[64]Ibid., pp. 18f.

[65]The Commission on the Cost of Transporting Grain by Rail, Report, Volume I, 1976, p. 32.

[66]loc. cit.

[67]Ibid., p. 33.

Also, the additional effort necessary for the determinaton of specific or actual costs may not give any better indication of costs.

A second major limitation of LP is that uncertainty is not allowed. LP models assume known values for costs, constraint requirements, etc. when in reality such factors may not be known. In this study there are several unknown parameters. However, it is possible to obtain estimates of the supply capabilities of the exporting regions and of the handling capabilities of the ports.

The handling capacity at Churchill was determined in this study to be 25,000,000 bushels or 625,000 tons of grain annually. This was estimated by studying the amount of grain that had moved through Churchill in recent years.[68] The Canada Grains Council has also forecast that in 1985 some 25 million bushels of grain will move through Churchill.[69]

Due to the nature of the study the handling capacity at Thunder Bay was relatively easy to determine as the capacity at Thunder Bay would not become a constraining point in the analysis. As many as 600,000,000 bushels or 15,000,000 tons

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[68]Government of Canada, Hall Commission, Vol. III, op. cit., p. 52.

[69]Grain Handling and Transportation Commission, Report of The Thunder Bay Sub-Committee, (Winnipeg: Canada Grains Council, 1977) p. 10.

of grain had been moved through Thunder Bay in 1971/72, and since the present throughput capacity at Thunder Bay is sufficient to meet projected movements until 1985,[70] it was determined that this amount could be handled again if necessary and the handling capacity for simulation purposes, therefore, was set at 15,000,000 tons.

The determination of the handling capacity for the West Coast Ports was a different matter however. The problems there are twofold. First, in recent years the west coast facilities have been criticized for not being able to meet the demand with which they are currently faced. Second, it is very difficult to measure or determine what the capacity of the west coast ports actually is. First of all, it is unreasonable to use past movements of grain moving through the ports as the loss of the Burrard Terminal makes these figures non-representative of current expectations of capacity. Another factor which makes past figure a poor choice is that increases in the size of the facilities in Vancouver, for which the expected completion date is November 1, 1978, will result in the handling capacity of the west coast ports being even greater. However, the Canada Grains Council[71] has estimated that by 1979, annual exports of

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[70]Ibid., p. 86.

[71]Grain Handling and Transportation Committee, Pacific Coast Study, (Winnipeg: Canada Grains Council) p. 160.

450,000,000 bushels or 11,125,000 tons of grain will be within the capability of the west coast system.[72] This estimate was then used for the handling capacity at the west coast.

With regard to the parameter of the costs of moving grain by rail, for the purposes of simulation, there are at least three alternatives for the rail 'rates' or 'costs' to be used in the model. These are:

i) Crow's Nest Statuary Rates

ii) The recommendations of the Commission on the Costs of Transporting Grain by Rail (CCTGR), and

iii) some other alternative.

Ideally, some other alternative would be the actual costs of moving grain by rail. In a world of perfect competition, perfect information, etc., this cost would be adequately reflected in the rail rates. However, these conditions do not exist. In fact, imperfect competition in the form of monopoly power exists for all practical purposes with regard to the movement of grain by rail. This has resulted in the regulation of rail rates for the movement of grain. Although the issue is beyond the scope of this study, this regulation has existed in the form of the 'Crow's Nest Rates' and has been hotly debated for some time.

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[72] It should be noted that this figure does not allow for bottlenecks in the transportation system.

For the purposes of this study, the calculation of the actual costs of tranpsorting grain by rail would be difficult, if not, impossible.[73] Fortunately, the use of actual costs of moving grain by rail is not necessary in this study, as the primary objective is not to determine total cost, but to determine the demand for the various ports under alternative toll structures on the St. Lawrence Seaway. Therefore, attempts at finding the 'actual' or 'specific' costs of transporting grain by rail will not be made. This leaves the remaining choice of rail 'rates' (or 'costs') between the Crow Rates and CCTGR's recommendations. The report of the Grain Handling and Transportation Commission recommended that the difference between the Crow Rates and the actual cost of moving grain by rail be paid directly to the railways and the Crow Rates be maintained.[74] The arguments in favour of the retention of the Crow's Nest rates are expressed earlier in the report, where it is stated that:

> Anything else would be a violation of promises made to the producers of western Canada.... This Commission feels that the Government must continue to subsidize the transportation of export grain and that the full cost, as determined by the Commission

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[73]It took the CCTGR some three years to study the question of what it costs the railways to move grain (1974-1976).

[74]Government of Canada, Hall Commission, Volume I, op. cit., p. 545.

> on the Costs of Transporting Grain by Rail, must not be imposed on the producers. The contribution Western grain makes to Canada's balance of payments position demands that a substantial part of any increase be borne by the federal government in the National interest.[75]

Applying the same argument to this study, the impact of higher tolls at the Seaway on the producers must be minimized, as the cost to the user is more important than the cost to government due to the importance of grain exports to Canada. Therefore, simulations in this analysis used the Crow's Nest rates of transporting grain on the railways. The result of this is that although total cost might not be minimized, the cost to the user would be minimized. The costs of transporting grain by rail, to be paid by government subsidy, or by the railways, can then be calculated by using the results of the Costs of Transporting Grain by Rail. An additional reason for using the Crow Rates in the analysis, is that this reflects current conditions more accurately than would some other choice of rail rates. This is an important factor as the model will be simulating 'real world' market coditions. The prices which the shippers are now paying are the Crow Rates. Therefore, when making the decisions as to which port to deliver their grain, the deciding factor with regard to transport cost will be what the Crow Rate from the point of

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[75]Ibid., p. 336, emphasis added.

supply to the port is, not the actual transport cost (whatever it may be). This argument can also be used to strengthen the basis for using linear cost functions in the model. Since shippers are faced with only a linear cost, a model which is going to simulate market conditions and actions should use linear costs even if under certain conditions the costs become non linear.

A third limitation of LP is that there is no guarantee that it will give integer valued solutions. This is a particularly serious problem when optimizing a system in which only discrete increments in scale are possible, such as when determining the optimum number of trucks to have in an organization. However, in this study there is no requirement that the solution be integer valued. The 'resource' which is to be allocated optimally in this study is grain, and there is no problem with divisibility of a bushel(s) of grain.

A fourth limitation of LP is that it assumes that decisions are made in a static enviroment. There is no consideration of the sequencing required for individual activities. It is possible to consider the iterative procedure used in determing the solution to an LP problem as being the stages of a multi-period analysis. However, that will not adequately represent the decision process in such a procedure.[76]

In this study, the problem with the assumption of a static enviroment is that at certain times bottlenecks may develop at a port and may temporarily change the shipping pattern. This problem could have been dealt with by running simulations over short time periods such as a week. However, there was one major concern associated with running the simulations over short time periods. In order to run the simulations over short time periods, the data would have to be disaggregated from annual to weekly or monthly data, since the only data available for the supply regions was annual. In order to disaggregate the data several additional assumptions and a considerable amount of extra time would have been required for the collection of additional data on bottlenecks etc. It is not likely that the slight refinements in the model would warrant the additional time and assumptions which would have been required in order to simulate with a weekly or monthly time period. In fact, even if some other type of simulation method had been selected to deal with the problem of annual data, assumptions such as; a constant (steady) flow of grain through the port for the period which the port is open would have to be

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[76]Charlton, P.J., and Thompson, S.C., "Simulation of Agricultural Systems," Journal of Agricultural Economics, Vol. 21, No. 3, (September, 1973), p. 374.

made. Therefore, even though LP assumes a static enviroment, due to the data availability for this study other types of models also would have had to assume either a static environment or constant flows of grain from the prairie points to the ports for export.

In summary there are at least four limitations invloved in the use of linear programming. These are:

i) the assumption of linearity,

ii) the assumption of certainty of information,

iii) results are not guaranteed to be in integer form, and

iv) the assumption of a static environment is required.

Each of these limitations has been considered. These individual limitations have been dealt with as above or these individual limitiations have been determined not to be debilitating to this study for the purposes of simulation.

A major advantage of using LP is that an algorithim for the transportation problem, a problem in which the costs of moving a homogeneous commodity from (n) points of supply to (m) warehouses or points of demand are minimized, is readily available for use and computer application. This particular algorithim greatly simplifies the amount of time necessary to analyse the different alternatives which must be considered in order to minimize the cost of transportation. The model does this without requiring any additional assumptions other than those inherent in LP models.

The hypothesis upon which the study is formulated is that at certain levels of tolls on the St. Lawrence Seaway, it will become desirable to move grain which currently moves via Thunder Bay through other Canadian ports such as the West Coast or through Churchill if the handling capacity is available. Through the use of the LP transportation algorithim it will be possible to determine at what Seaway toll levels if any, it becomes beneficial to shift grain movement through other ports.

The Model

The model will have as its purpose the minimization of the impacts of alternative toll structures at the St. Lawrence Seaway on producers and the grain industry. The objective function is to minimize user transport charges, including tolls, of moving export grain from the country elevator to export position. The constraints on the model are the available export supplies in each region[77] and the throughput capacities of the ports. Algebraically, the model can be expressed as:

$$\text{minimize } Z = \sum_{i=0}^{n} \sum_{j=1}^{m} C_{ij} X_{ij}$$

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[77]A rail block is defined as a region.

subject to:

$$\sum_{j=1}^{m} X_{ij} = F_i \qquad i = 0,1,2....n$$

$$\sum_{i=0}^{n} X_{ij} = W_j \qquad j = 1,2,3....m$$

$$\text{all } X_{ij} \geq 0$$

with C(ij) representing the unit cost of moving grain from region (i) to terminal (j).

x(ij) is the amount transferred from the i(th) region to the j(th) terminal

F(i) = production capacity of region i

W(j) = the throughput capacity or demand at terminal (j)

n = 49

m = 3

F(i) i = 0,1,2......49 then represents the 49 rail blocks in the Grain Handling and Transportation System. F(o) is a dummy supply block which is used only if the total capacity at the ports is greater than the total available supply from the 49 rail blocks. C(oj) is set to be equal to zero in order to ensure that the total cost of moving grain is not affected by the movement of grain from region (o) to port

(j) as this grain is never actually moved because it does not exist.

W(j) j = 1,2,3 then represents the three port facilities in Canada, namely Thunder-Bay-East-Coast, Churchill, and the west-coast which includes Prince Rupert, Victoria and Vancouver.

By analysing the model under different toll rates on the Seaway, the impact of alternative toll structures on the producers as well as the amount of resource reallocation which is optimal can be determined. The reason for this is that the model will by its nature reallocate resources efficiently leaving only the net impacts of changes in the system.

Determination of the Constraints and the Underlying Assumptions

Prior to the implementation of the model, an estimate of the available grain for export from each of the rail blocks had to be made. The reason why an estimate, instead of the actual amount, was used, was the unavailability of data. The primary data for the supply of grain for the 49 rail blocks were obtained for a six year period, 1971-72 through

1976-77, from the Canadian Grain Commission.[78] The data in this source included total receipts of primary grains at each of the prairie points and were disaggregated for wheat, durum wheat, oats, barley, rye, flax and rapeseed. However, no information was available on the destinations to which the grain moved from each block. In order to deal with this problem, it had to be assumed that a constant porportion of receipts in each rail block was subsequently exported. This assumption enabled the calculation of the supply of export grain for each block to be:

$$C(kel) = E(k) * C(kl) / \sum_{l=1}^{49} C(kl) \qquad k=1,2,3,...7$$

where C(kel) = the amount of the Kth variety of grain exported from block (l)

C(kl) = the amount of receipts of the Kth variety of grain received in block (l), and

E(k) = total exports of the Kth variety of grain. This calculation was done for each of the various types of grains, that is with k = 1,2 3,...7 giving a final result of the grain which was exported from each of the blocks in a particular year.

The next step in the establishment of the model is to obtain a homogeneous product which could easily be handled

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[78]Canadian Grain Commission, Summary of Primary Elevator Receipts at Individual Prairie Points, (Winnipeg: Canada Grains Council, Economics and Statistics Division 1971-1977).

by the transportation algorithim. The problem was that the data for receipts and exports were in the form of bushels while the freight rates were available in terms of weight. In order to overcome this problem, either the bushel volumes could be changed to weights and then aggregated or the freight rate per unit of weight could be changed to a freight rate per bushel for each type of grain. With the latter, the average freight rate per block would vary each year with changes in production and export patterns of the various crops. Therefore, the former alternative was chosen for this study in order that changes in production patterns can be shown in different amounts of total production instead of in different freight rates. A second advantage of the former approach is that it gives a constant freight rate over time making comparisons from year to year simpler to understand.

One other calculation had to be made before the model could be implemented and that was the calculation of the freight rate that would be charged for the movement of grain from each of the points of supply - in this case each of the 49 rail blocks. The figures which were obtained from the Canadian Wheat Board were in the form of cents per 100 weight for each of the supply points. This was transformed into an average rate for each of the blocks by weighting each prairie point with the 10 year average receipts for that point. Each of these weights was multiplied by the freight rate for that point and these values were totaled for each block in order to determine the average rate for each block. These values were then divided by 20 to create a rate per ton instead of a rate per 100 weight.

Given the above model specification and data, it was possible to run simulations under different toll structures on the St. Lawrence Seaway in order to determine the impacts of such changes.

The first step in the analysis determined what the base period or base year for the supply of grain for export was to be. One of the alternatives was to use a single year and simulate on the basis of that year, similar to the study done by CCTGR[79] in which all calculations were made relative to the crop year 1973/74. The biggest weakness with that type of analysis is that the year used as a base period may not have been a 'typical' year for the industry, making any generalizations which can be drawn from that type of study ambigious. The biggest advantage of such a study, however, is that it avoids the additional time, expense and confusion that are involved when simulation is done using different time periods and then analysing the results from each different period.

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[79]Commission on the Cost of Transporting Grain by Rail, op. cit.

The alternatives to using a single base period for analysis are to use a long term or short term average. A short term average is not necessarily better than using a single year for a base period. Depending upon the years involved the average value of a two or three or even a five year period may not be any more 'typical' of the industry than a one year base period is. A long term average has the advantage of at least appearing to be 'typical'. However, in the case of Canadian export grain there are two problems with a long term average. First, since 1970, although the total of Canadian exports has shown a substantial amount of variability, there appears to be a trend of increasing total exports over time. In addition, there is the problem that forecasts for future exports of Canadian grain indicate that there will be a tendency to increase total exports over the next few years.[80] Therefore, a long term average for supplies will very likely underestimate the impacts of changes over the next few years, if it were used in a simulation. The best alternative to these options is, then, to use a fairly recent year as a basis for simulation and assume that this year is 'typical' in the grain industry. That type of analysis will more accurately reflect the impacts which will result from increasing exports in the

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[80]Government of Canada, Hall Commission, Vol. III, op. cit., p. 54.

future than would either a long or short term average.

Sample simulations were done with both 1976/77 and 1975/76 crop years. Tables 26 and 27 of Appendix 1 show that redistribution of supplies of grain from Thunder Bay to the West Coast ports was the same for both years. For this reason further simulation was done only for the crop year 1976/77, the latest year for which information was available at the time of writing.

The Range of Tolls for Simulation Purposes

In order to evaluate the impact of toll changes at the Seaway on the distribution of grain supplies at the various ports, the model had to be run over some relevant range of tolls. The 1979 toll level is at $0.59 per ton,[81] giving a basis for the range to be selected. Simulations were then run with a range of tolls from $0.00 to $2.00 per ton, with increments of $0.05 per ton in order to determine the impacts of alternative toll levels on the grain handling and transportation system.

There were several reasons why a toll of $0.00 was established as a floor for the simulations. First, in a study of alternative toll structures, and their impact on the movement of grain, higher as well as lower toll levels must be considered in order for the analysis to be complete. The toll level of $0.00 is not so far from the current toll levels that results from simulation of tolls at this level would be meaningless. Second, the St. Lawrewnce Seaway is

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[81]The St. Lawrence Seaway Authority, The Seaway, Operations, Outlook, Statistics, 1977, (Ottawa: The St. Lawrence Seaway Authority, 1977) p. 3.

the only waterway in North America which has tolls,[82] and in order to fully answer the question of how toll structures affect demand at the ports, tolls at levels of $0.00 would have to be included. Although, conceptually, the concept of negative tolls could have been analysed, there is no existing situation in North America where negative tolls exist and the idea was given no further consideration.

The highest toll level simulated, $2.00 per ton, was selected as it enabled a 'reasonable' range of alternative toll levels to be analysed, while not extending too far beyond current toll levels, and what could be considered as a relevant range.

In order to test the model's ability to distribute grain to various ports, a trial simulation was run with 1977/1978 supplies of export grain and at the average toll level for that crop year which was $0.4833 per ton. The actual distribution of export grain to the ports in 1977/1978 was 55% through Thunder Bay, 40% through the west coast and 5% through Churchill. In the model, 52%, 45%, and 3% of the total amount of export grain moved through Thunder Bay, the west coast and Churchill respectively, when simulated with a $0.48 toll. This is only a few percentage points removed from the actual movements through the respective ports.

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[82]The question of implementing user charges on some U.S. waterways is currently being debated.

Given that the model simulated the "real world" conditions reasonably well in terms of the distribution of grain to the various Canadian ports, it was reasonable to assume that it will have the ability to simulate accurately under alternative toll structures. Given this assumption, it was possible to simulate movements under alternative toll structures on the St. Lawrence Seaway.

Effects of Alternative Tolls on the Participants in the Grain Industry

There are several participants in the grain transportation industry who will be affected by raising tolls on the St. Lawrence Seaway. These are:

i) the producers

ii) the ports

a) Thunder Bay - St. Lawrence Seaway

b) West Coast Ports

c) Churchill

iii) the Canadian economy, and

iv) the world grain market.

In order to calculate how each of these groups is affected, it is necessary to refer to Tables 4 and 5. Table 4 shows the optimum distribution of export grain to the ports,[83] with alternative toll structures on the St.

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[83]Assuming no capacity constraints at the ports.

Lawrence Seaway. The information for Table 4 is obtained directly from the computer outputs shown in Appendix 1. The information in Table 4 can be thought of as the demand schedule for each of the ports with alternative toll levels on the Seaway.

Table 5 shows the breakdown of costs of moving the export grain to port position under alternative toll structures. The usercost represents the amount of transport costs paid by the producers. This includes the payments made on the Crow Rate and the toll on the Seaway. The Other Cost represents the difference between what the producer pays, and what the rail costs actually are as determined by the CCTGR. The distribution of this difference is currently split between the railway and the government. The information in these two tables is virtually all that is needed in order to delineate the effects of alternative toll structures on the Seaway on each of the four groups.

Table 4

The Number of tons (000) moving Through the Ports
Under Alternative Toll Levels

TOLL LEVEL	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
$0.00	625.00	13126.75	6449.15	20200.90
.05	625.00	11991.65	7584.25	20200.90
.10	625.00	11991.65	7584.25	20200.90
.15	625.00	11511.10	8064.80	20200.90
.20	625.00	11511.10	8064.80	20200.90
.25	625.00	11170.60	8405.30	20200.90
.30	625.00	11170.60	8405.30	20200.90
.35	625.00	11170.60	8405.30	20200.90
.40	625.00	10794.95	8780.95	20200.90
.45	625.00	10463.90	9112.00	20200.90
.50	625.00	10463.90	9112.00	20200.90
.55	625.00	9617.35	9958.55	20200.90
.60	625.00	9134.00	10441.40	20200.90
.65	625.00	8487.10	11088.80	20200.90
.70	625.00	8487.10	11088.80	20200.90
.75	625.00	8487.10	11088.80	20200.90
.80	625.00	8340.20	11235.70	20200.90
.85	625.00	8340.20	11235.70	20200.90
.90	625.00	8004.80	11571.10	20200.90
.95	625.00	7651.10	11924.80	20200.90
1.00	625.00	7651.10	11924.80	20200.90
1.25	625.00	6859.05	12716.85	20200.90
1.50	625.00	6640.95	12934.95	20200.90
1.75	625.00	5149.30	14426.60	20200.90
2.00	625.00	3616.10	15959.80	20200.90

Table 5

System Costs Under Alternative Toll Structures

TOLL LEVEL	USER COST $ (000)	CHANGE $(000)	OTHER COSTS[84] $ (000)	CHANGE $ (000)
$0.00	85,036	---	142,010	---
.05	85,626	590	141,994	-16
.10	86,227	601	141,996	21
.15	86,833	605	142,127	130
.20	87,375	543	142,073	-54
.25	87,970	594	142,246	173
.30	88,521	551	142,234	-12
.35	89,087	565	142,246	12
.40	89,623	536	142,460	214
.45	90,159	536	142,704	243
.50	90,676	516	142,692	-11
.55	91,172	496	143,425	732
.60	91,615	443	143,846	421
.65	92,057	441	144,522	676
.70	92,458	400	144,483	-39
.75	92,905	447	144,522	39
.80	93,310	404	144,685	163
.85	93,742	432	144,711	26
.90	94,124	381	145,156	445
.95	94,529	405	145,725	569
1.00	94,889	360	145,687	-37
1.25	96,645	1,755	147,078	1,309
1.50	98,347	1,702	147,604	526
1.75	99,766	1,417	151,560	396
2.00	100,887	1,122	156,404	484

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[84]Other Costs include the rail costs for moving grain to export position which are not included in the Crow Rate. These other costs were calculated using Snavely's conversion figure for the Crow Rate as determined by the Comission on the Cost of Transporting Grain by Rail (1974).

Effects on Producers

The producers effects of higher tolls on the Seaway occur in two different ways. First, the additional cost would be felt in the form of a slightly lower farm gate price on grain moving through the Seaway. The total impact of this would vary depending on the amount of grain moving through the port of Thunder Bay. The amount of export grain in the model moving through the Seaway varies from 3.6 million tons with tolls set at $2.00 per ton to 13.1 million tons with $0.00 tolls on the Seaway (Table 4). With tolls set at $0.90 per ton, 8.005 million tons of export grain move through the Seaway and 11.571 million tons move through the west coast (Table 4) At this toll level, any further movement of grain through the west coast ports becomes impossible due to a lack of available capacity.

From Table 4 it can be seen, assuming no rerouting of grain, for a $0.01 increase in tolls, the total cost increases $131,267.50 if the distribution of grain through the ports does not change from that simulated with $0.00 tolls. Similarly, it can be seen that if the distribution of grain to the ports does not change from that simulated for $2.00 tolls, the increase in total cost given a $0.01 increase in tolls is $36,161.00. This cost would be distributed 'evenly' to all producers in western Canada due to the pooling of export sales for the board grains. There are approximately 155,000 permit bock holders in western Canada. Thus, the increase in cost to an individual producer would be less than $1.00. On the average each farmer in western Canada produces 130 tons of grain for export. In fact, for all practical purposes, this cost (the cost of lower export prices for grain moving through the seaway) would be zero.

Second, there is a set of producers who will feel the impacts of higher tolls in a more serious and direct manner. These are the producers who have to reroute their grain that would have gone through Thunder Bay had the toll levels been lower. The cost per producer, per block, is shown in Table 6. A complete description of the block numbers and their corresponding names is shown in Table 28 in Appendix 1. The 'costs' in Table 6 are calculated by multiplying the volume of grain (1976/1977) exported from that block by the difference in the Crow Rates of moving grain to the west coast instead of to Thunder Bay. This number is then divided by the number of permit holders in that block in order to determine the 'cost' per producer.

Table 6

Cost Per Permit Book Holder Of Rerouting Grain From Thunder Bay to The West Coast

BLOCK#	COST PER PRODUCER	BLOCK#	COST PER PRODUCER
00	$0.00	61	$0.00
01	0.00	62	0.00
03	0.00	63	0.00
05	0.00	64	0.00
07	0.00	71	300.72
09	0.00	72	230.73
11	0.00	73	226.39
13	0.00	74	0.00
15	205.04	75	142.48
17	102.89	76	4.87
19	87.35	77	109.40
21	39.55	78	110.93
23	47.99	79	136.18
25	123.08	81	5.24
27	102.14	82	0.00
29	1.46	83	0.00
31	183.67	84	0.00
33	259.91	85	0.00
35	313.36	86	0.00
37	0.00	87	0.00
39	0.00	90	0.00
41	0.00	95	0.00
43	0.00	98	0.00
45	0.00		
47	0.00		
49	0.00		

It can be seen from Table 6 that changes in the toll rates have a limited effect upon individual producers within the affected block. These increases can be as little as $1.46 per permit book holder per block per annum. However, when the toll levels enter the current toll levels $0.59 per ton the increase in cost to the producer in the affected block is over $100.00 per producer. When the toll levels become even higher, this cost per producer goes as high as $300.00. This cost change has been calculated at the Crow Rates and if the rail rates are raised to compensatory levels then these figures would be increased by 2.5 to 3.5 times. With the ever declining number of producers, this increase in cost per affected producer will become even steeper.

From the discussion above, it can be concluded that the cost to individual producers is not particularly large, given the current rate structure for both toll rates and rail rates. However, the costs to producers become more significant, at least to certain groups of individuals, as the toll rates increase to higher levels (beyond $1.00 per ton) and if compensatory rail rates are used.

It should be made clear that the total cost to the user determined by this model is biased downward from the actual cost. The biggest cause of this downward bias is the nature of the model, and the assumptions which are made in the model. The model assumes a steady flow of grain from the point of supply to the port as well as a steady or constant demand at the ports. In actuality, a temporary shortage of supply at one of the blocks, or a surge demand at one of the ports could result in a less efficient distribution of grain to the ports than is determined by the model. The model minimizes the total cost to the user. Although the Canadian Wheat Board, when determining deliveries to the ports certainly considers the transport cost, due to the nature of the Grain Handling and Transportation System the actual costs will be higher than the 'optimum cost' level as determined in a linear programming model. When the cost determined by the model used in the study is compared with the cost determined by CCTGR,[85] it was found to be under estimated by as much as 19 per cent. Therefore, any savings which resulted from rerouting grain in the model may, in fact, be somewhat less than the savings which are actually possible for the users of the system.

It can be concluded from the above that in the event of higher tolls on the St. Lawrence Seaway, rerouting of grain through other ports would, at least in part, offset the costs, but that total cost to the users would still

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[85]Commission on the Cost of Transporting Grain by Rail, op. cit.

increase.

Appendix 2 shows which rail blocks supplied the east and west coast under alternative toll structures. From these maps, it can be concluded that the boundary determining which direction producers ship their export grain, moves eastward as tolls on the St. Lawrence Seaway increase.

Effects of Alternative Tolls on the Ports

The effects on the ports are in the form of redistribution of the receipts of export grain at the ports.

The information in Table 7 is derived from Table 4. The rate of change of total tonnage represents the absolute change in tonnage moved through the west coast divided by the absolute change in tolls for the various toll ranges. Similarly, the rate of change of user cost in Table 8 is derived form Table 5. The calculation of the rate of change in Table 8 is done by dividing the absolute change in user cost by the absolute change in toll for each toll range specified.

Table 8 shows that over the simulated range of tolls, the rate of increase in total cost to the producers decreases as the toll level increases. The reason for this is that with higher toll levels, less grain moves through the Seaway. Therefore, the increase in total cost for a given increase in tolls becomes smaller as the 'base' toll increases, since there is less grain moving through the facility. For the rates of change in the number of tons of grain moved through the west coast, as shown in Table 7 other than in the range of $1.00 to $1.50 tolls, the rates of change in the number of tons of grain moved through the west coast increase. These rates of change can be thought of as the elasticities of demand at the west coast, with various toll structures on the St. Lawrence Seaway. In the $1.00 to $1.50 toll range a peculiar situation developed resulting in the rate of change in this range being much lower than the rates of change in other ranges. The blocks involved are #75, #27 and #15 namely Saskatoon, Prince Albert South and Kamsack respectively.

As the block "Saskatoon" runs almost perfectly in an east west direction, whereas other blocks such as Medicine Hat, block #81, are often almost circular in shape or at least run in a northwest-southeast or northeast-southwest direction, the relative cost of rerouting the grain from east to west will be less than with a more typical block. "Prince Albert South" is also a bit unusual as it is a very long block running north/south. In the $1.50 toll simulation, this particular block moves grain to Churchill rather than to Thunder Bay for the first time. The unusual nature of these two blocks results in the relative increase in total cost of rerouting grain for this block being less than it would be for other blocks.

Table 7

Rates of Change in tons (000) of
Movements of Grain Through The West Coast
Given a $0.01 Toll Increase

TOLL RANGE	RATE OF CHANGE OF TOTAL TONNAGE
0.00 - 0.50	53.257
0.50 - 1.00	56.256
1.00 - 1.50	20.203
1.50 - 2.00	60.497
0.00 - 2.00	47.553

Table 8

Change in Direct Cost to producers Due to a $0.01
Increase in Toll Levels

TOLL RANGE	RATE OF CHANGE OF COST TO USERS
$0.00 - 0.50	$112814.20
0.50 - 1.00	84252.00
1.00 - 1.50	69161.60
1.50 - 2.00	50799.20
0.00 - 2.00	79256.75

With these two blocks having this peculiarity, a smaller readjustment of grain moving from Thunder Bay to the West coast is sufficient to obtain the same relative saving that would occur with rerouting grain from a more typical block. In other words, one would expect the rate of change in total tonnage moved to the west coast to be somewhat greater than what it actually is in the simulated toll range of $1.00-$1.50, due to the peculiar nature of the blocks involved.

Given the above exception for the one particular range of tolls, the rate of change of total tonnage moved through the west coast is increasing as tolls on the St. Lawrence Seaway increase. This means that additional savings are possible[86] with increased movements of grain westward, resulting in a declining rate of change of total cost to the user as the tolls are increased.

It is also possible to conclude that in the current toll range of $0.50 to $1.00 a ton, a $0.01 per ton increase in tolls will result in an additional 56,256 tons of grain moving to the west coast. Also, a conclusion that is perhaps even more significant, is that if tolls go above the $0.90 per ton level, the current capacity levels on the west coast will not be adequate to handle the demand. Although the model simulated an increase in total cost of $59980.40

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[86]As more grain moves westward the impacts of toll increase become less.

per $0.01 increase in toll, in the range of $1.00 to $2.00 tolls per ton, once the west coast reaches its maximum handling capacity, at the level of $0.95 per ton, the actual increase in total costs given a 1 cent increase in the toll level was found to be $76,511.00. Thus $75,511.00-$59,980.4=$16,530.60 per annum would be lost to the users of the system each year.[87] This loss could be recaptured provided that the handling capacity at the west coast ports was increased. The total cost to the systems would be 2.67[88] times this amount or approximately $45,000 per annum.

This is relatively small cost when compared to the total transportation costs. Thus the pressure from higher tolls on the St. Lawrence Seaway will be unlikely, by itself, to result in increased capacity at the west coast ports, unless the toll increase is as high as $0.20 to $0.30 a ton.[89] However this pressure in combination with other pressures such as increasing total exports could very well call for an expansion of the west coast facilities, unless Canada is willing to face the possibility of lost sales of export

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[87]Assuming current export prices and the crow or statutory grain rates for the railways are in existence.

[88]CCTGR's figure for increasing the crow rates in order for them to be compensatory.

[89]The increase being phased in by the St. Lawrence Seaway Authority from 1978 through to 1980 is a $0.20 per ton increase.

grain.

The effects on the ports themselves in terms of throughput are relatively easy to determine. Table 4 gives a breakdown of the distribution to the ports under different toll structures.

Perhaps the most important implication of these figures is that the handling capacity for the west coast ports which has been determined to be 11.875 million tons[90] will no longer be able to meet the demand for their facilities when tolls on the Seaway reach $0.95 per ton. The cost of not increasing the capacity at the west coast, given exports at a 1977 level, has been determined above to be $16,530 per annum per $0.01 toll increase. This is a relatively small cost to the system as a whole. However, if there are lost sales due to an excess demand at the west coast then the cost would become significantly higher.

The port of Churchill is unaffected by changes in the tolls. Under all simulated conditions, the capacity at the port of Churchill was fully utilized.

For the ports of Thunder Bay and the St. Lawrence Seaway, the impacts of higher tolls will be felt in the form of decreased demand for port and Seaway facilities. The major benefit of higher tolls on the Seaway would be felt in

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[90]Grain Handling and Transportation Committee, <u>Pacific Coast Study</u>, op.cit., p. 160.

the form of increased revenue for the Seaway which would make the operation of the Seaway a more viable one. The increase in revenue to the Seaway from a $0.01 increase in toll levels is approximately $91,340 given that the increase in tolls originates from a toll of $0.60 per ton, that is, $9,134,000.00 times $0.01. As grain movements through the Seaway represent about 1/3 of total tonnage moved through the Seaway, the total increase in revenue would be in the range of $300,000. If such increases in revenue will be enough to enable the Seaway to be a self supporting operation rather than have the structure deteriorate and become obsolete,[91] then it may be in the interest of the transportation industry to have higher tolls.

The Canadian Situation

The magnitude of the impact that higher tolls will have on the railways and taxpayers can be seen in Table 5 in the column labelled Other Costs. Over the entire range of tolls, the increase in Other Costs per $0.01 increase in tolls is $6.695 million. For the range of tolls from $0.00 to $1.00 the increase in other Costs per $0.01 in tolls is $1.8385 million. This increase in other costs is small when compared to the total of these Other Costs. If the Rail

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[91]A development which could cost the grain handling and transportation system far more than higher tolls will.

rates were to become compensatory then a cost of this magnitude would be payed by the producers.

It is unlikely that toll increases on the St. Lawrence Seaway will have any substantial effect on Canada's position as an exporter of grain. As long as the railways can continue to deliver the grain to the west coast ports and the ports can handle the changing volumes there should be no change in Canada's position as an exporter. However, with an ever increasing demand for west coast facilities the cost of any stoppage of work at the west coast due to a strike, or bottlenecks in the rail system, becomes relatively higher. In fact problems such as these do affect Canada's credibility as a supplier of grain for exportand increasing the tolls on the Seaway do in fact increase the risk that exports will be lost.

This would mean that, given higher tolls on the Seaway, in order to ensure Canada's position as an exporter, additional efforts in terms of labour/management relations as well as in the streamlining of grain movements through the Rocky Mountains would be necessary.

World Situation

Canada only has a small share in the world market.[92] The magnitude of the impacts on the world grain market are

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[92]Canada has 15% to 20% of total world trade.

further diminished as the redistribution of grain to other ports is less than 1% of Canada's total exports, for a $0.01 increase in tolls. Therefore it is unlikely that changes in tolls on the St. Lawrence Seaway would have any impacts on the world grain market.

CHAPTER VI: IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS

Policy Implications

Whether or not to alter the Seaway toll structure is the central policy question. At first the answer to that question may seem rather obvious. However, there are many underlying features to this question. For example, one of the many concessions necessary in order for passage of the legislation favouring constructing the Seaway was that the Seaway be self supporting. This concept is more complex than it appears as many similar types of transport systems are either partially or fully subsidized by government. Determination as to whether the Seaway should be required to be self supporting was beyond the scope of this study. However, when toll structures are to be altered, the Seaway can not be considered simply as a closed system. Arguments such as those proposed by the St. Lawrence Seaway Authority, which stated:

> In assessing the possible impact of the proposed increase (an increase in toll levels on the Seaway is being phased in over the three year period from 1978-1980), it was found that present tolls on the Seaway constitute a very small portion of both transportation costs and the value of the major commodities moving via the waterway. ... One would expect, therefore, that the proposed increase will have little or no adverse impact upon the forecast

rate of growth in Seaway traffic[93]

must be considered to be shortsighted at best. Although the conclusion may be correct, many other factors should also be considered in the analysis.

These factors can have implications not only for the Seaway itself, but also for other parts of the transportation system and the Canadian economy. With respect to a commodity such as export grain, for which the elasticity of demand is high and for which alternative delivery routes for export exist, even a small change in the cost of moving a commodity through a particular route may result in changes in the amount of the commodity moved through that particular route.

In this study, it was observed from both a theoretical perspective and application of the model used, that changes in the toll levels will have an effect on the amount of grain moving through the St. Lawrence Seaway. If tolls are raised on the Seaway,[94] several implications follow and need to be considered. Higher tolls on the Seaway will result in more export grain moving through the west coast and, therefore, less export grain moving through the Seaway.

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[93]St. Lawrence Seaway Authority, <u>Operations, Outlook, Statistics,</u> op. cit., p. 4.

[94]A situation which is much more likely than the lowering of tolls.

Thus, several effects or implications result from raising the tolls on the Seaway.

i) The revenue increases accruing to the Seaway Authority may be less than expected, due to a reduction in the amount of grain moving through the Seaway.

ii) Due to the complementary nature of grain and iron ore[95] if the movement of one changes relative to the other, resulting in higher costs, further reductions in the movement of goods through the Seaway may result. The reason is that the higher transport costs associated with empty backhauls would be passed on to the user. This could result in an overall reduction of demand for Seaway facilities. This would further reduce the increases in revenue to the Seaway that were expected to result from higher tolls.

iii) An increase in the amount of grain handled at the west coast will place additional pressure on Canada's grain handling and transportation system. Several related implications arise from this. These are: a) as more grain moves towards the west, the average length of haul for moving grain to port position would likely increase. Thus, in addition to higher costs of moving grain to port by rail, due to the extra travelling distances involved, the already

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[95] The same ships can be used to transport grain downstream and iron ore upstream. This reduces the costs associated with empty backhauls. Thus the transport cost of moving grain and iron ore through the Seaway is kept low.

strained rail system would have additional pressures placed upon it to perform efficiently; b) related to this are the additional problems and pressures which will arise due to increased movements of grain through the west coast. In recent years, the grain handling and transportation system has not been able to get necessary grain supplies to the west coast during the winter months. Higher tolls, resulting in more demand for west coast facilities may further aggravate this problem. The final result will then be to increase pressures to enlarge the handling capacity of the west coast terminals; c) with regard to Churchill, higher tolls on the Seaway will give the proponents of Churchill development additional ammunition, but it will not ease the constraints at Churchill resulting from the limited length of season and the general condition of the rail line to Churchill. Higher tolls on the St. Lawrence Seaway are not likely to make the capital investments necessary at Churchill[96] viable from an economic standpoint.

Alternatively, lowering the tolls on the St. Lawrence Seaway will increase the demand for the Seaway and reduce pressures at the west coast and Churchill. The effects of that would be to strengthen the case for the alleviation of

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[96]The investments in rail and terminal facilities necessary in order to increase the handling capacity at Churchill.

problems (such as bottlenecks at the canals) with regard to the movement of commodities through the Seaway by expansion, and of improving the existing facilities.

Limitations of Study

There are several limitations of the results and conclusions developed in this study. The major queston dealt with in this study was: would alternative toll structures on the St. Lawrence Seaway, result in a redistribution of grain to Canadian ports? The model did not consider the possiblity of production patterns of producers changing to non export (local) crops, as a result of alternative toll structures on the Seaway. No attempt was made to do a marginal cost analysis of rerouting grain to other ports. All of the analysis was done with the underlying assumption of linearity. The reasons for this were discussed in Chapter IV, where it was argued that in the relevant range, average system costs would be sufficient, since the primary objective of this study was not to determine total transport cost, but is to determine the demand for the various Canadian grain ports under alternative toll structures on the Seaway. The analysis that followed was consistent with this objective. However, from the point of view of determining a wider range of implications of alternative toll structures, as the analysis goes beyond current (existing) conditions, the results of this study should be considered as broadly indicative rather than 'actual' or 'specific'.

Another limitation of the study is that congestion at the terminal elevators, on the rail lines or at the primary elevators may manifest itself in the form of non linear costs. This problem was not considered in the model used in this analysis. Admittedly, congestion at various points in the Grain Handling and Transportation System will be a factor in the decision making process of shippers. Some of the problems associated with congestion at various points in the system were discussed in Chapter IV. At that point it was argued that complications resulting from attempting to model for a non static enviroment would in fact offset many of the gains to be derived from the use of such a model. With regard to the hypothesis on which the study is based, that is, as tolls on the Seaway increase the demand for west coast port facilities will increase, as more grain is shipped to the west coast congestion at the west coast may incresse. This could in fact, reduce the tendency for additional grain to be delivered to the west coast as tolls on the Seaway increase. Therefore, the results derived from this study indicate trends in the demands at the various Canadian ports under alternative toll structures on the St. Lawrence Seaway, but the results do not necessarily indicate the 'actual' demand for each port for each alternative toll structure on the Seaway.

Recommendations for Further Study

Several dimensions for further study arise from this analysis. These are to:

A. study the possibilty of changes in production patterns on the prairies as a result of alternative toll structures on the Seaway. Related to this would be the study of the effects, if any, on the feed grain industry in western Canada, and of the livestock feeder industry in eastern Canada as a result of alternate toll levels on the Seaway;

B. relax the assumption of linearity in costs and study the marginal costs of rerouting grain to other ports; linear analysis.

C. determine the feasibility of reducing the bottlenecks at the west coast by lowering tolls at the Seaway and/or lowering export prices of grains moving through the Seaway, thus increasing the demand for the Seaway and reducing the demand for west coast facilities. Concurrent with this is the question: how much would it cost to have ocean liners pick up export grain at the east coast instead of at the west coast.

D. analyse the overall efficiency of the Seaway vis a vis rail for the movements of export commodities from Thunder Bay to the east coast. Concurrent with this, it would be highly useful to study the impacts of increasing the capacity of the St. Lawrence Seaway (by extending the length of season and or removing bottlenecks which exist along the waterway,) on the distribution of export grain to the various Canadian ports.

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APPENDIX 1

Selected Tables

Table 1

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $2.00 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	204.50	0.00	0.00	204.50
13	420.50	39.90	0.00	460.40
15	0.00	0.00	432.45	432.45
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	0.00	0.00	410.70	410.70
27	0.00	0.00	361.30	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	0.00	471.50	471.50
35	0.00	0.00	366.10	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 1 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	0.00	629.25	629.25
72	0.00	0.00	469.50	469.50
73	0.00	0.00	463.45	463.45
74	0.00	472.50	0.00	472.50
75	0.00	0.00	577.70	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	11383.90	290.20	11674.10
TOTAL	625.00	15000.00	16250.00	31875.00

Table 2

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $1.75 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	192.60	11.90	0.00	204.50
13	0.00	460.45	0.00	460.45
15	432.40	0.00	0.00	432.40
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	0.00	0.00	410.70	410.70
27	0.00	0.00	361.30	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	0.00	366.10	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 2 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	0.00	469.50	469.50
73	0.00	0.00	463.45	463.45
74	0.00	472.50	0.00	472.50
75	0.00	0.00	577.70	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	9850.70	1823.40	11674.10
TOTAL	625.00	15000.00	16250.00	31875.00

Table 3

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $1.50 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	432.40	0.00	0.00	432.40
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	192.60	0.00	218.10	410.70
27	0.00	0.00	361.30	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 3 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	0.00	577.70	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	8359.05	815.05	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 4

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $1.25 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	214.30	218.10	0.00	432.40
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	0.00	0.00	361.30	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 4 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	0.00	577.70	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	8140.95	1033.15	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 5

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $1.00 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	0.00	146.95	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 5 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	7348.90	1825.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 6

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.95 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	0.00	353.70	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	0.00	146.95	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 6 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	7348.90	1825.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 7

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.90 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	0.00	146.95	361.30
29	0.00	0.00	480.55	480.55
31	0.00	0.00	335.35	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 7 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6995.20	2178.90	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 8

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.85 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	0.00	146.95	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 8 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6659.85	2514.25	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 9

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.80 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	0.00	146.95	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 9 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6659.85	2514.25	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 10

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.75 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 10 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6512.90	2661.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 11

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.70 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 11 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6512.90	2661.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 12

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.65 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 12 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	0.00	647.40	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	6512.90	2661.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 13

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.60 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 13 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	647.40	0.00	647.40
79	0.00	0.00	482.85	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	5865.50	3308.60	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 14

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.55 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 14 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	0.00	846.55	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	5382.65	3791.45	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 15

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.50 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 15 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	4536.10	4638.00	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 16

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.45 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	0.00	331.05	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 16 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	4536.10	4638.00	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 17

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.40 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	0.00	375.65	375.65
21	0.00	0.00	340.50	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 17 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	4205.05	4969.05	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 18

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.35 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	0.00	340.50	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 18 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3829.40	5344.70	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 19

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.30 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	0.00	340.50	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 19 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3829.40	5344.70	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 20

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.25 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	0.00	340.50	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 20 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3829.40	5344.70	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 21

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.20 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	340.50	0.00	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 21 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3488.90	5685.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 22

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.15 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	340.50	0.00	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	0.00	480.55	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 22 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3488.90	5685.20	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 23

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.10 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	340.50	0.00	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	480.55	0.00	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 23 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3008.35	6165.75	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 24

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.05 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	340.50	0.00	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	480.55	0.00	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 24 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	0.00	496.90	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	0.00	638.20	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	3008.35	6165.75	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 25

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.00 per ton

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	185.10	185.10
01	0.00	77.65	0.00	77.65
03	0.00	391.00	0.00	391.00
05	0.00	242.35	0.00	242.35
07	0.00	169.80	0.00	169.80
09	0.00	293.00	0.00	293.00
11	0.00	204.50	0.00	204.50
13	0.00	460.45	0.00	460.45
15	0.00	432.45	0.00	432.45
17	0.00	353.70	0.00	353.70
19	0.00	375.65	0.00	375.65
21	0.00	340.50	0.00	340.50
23	0.00	331.05	0.00	331.05
25	410.70	0.00	0.00	410.70
27	214.30	146.95	0.00	361.30
29	0.00	480.55	0.00	480.55
31	0.00	335.35	0.00	335.35
33	0.00	471.50	0.00	471.50
35	0.00	366.10	0.00	336.10
37	0.00	0.00	280.05	280.05
39	0.00	0.00	368.10	368.10
41	0.00	0.00	342.05	342.05
43	0.00	0.00	334.10	334.10
45	0.00	0.00	163.50	163.50
47	0.00	0.00	449.70	449.70
49	0.00	0.00	335.25	335.25

Table 25 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	278.30	0.00	278.30
62	0.00	704.70	0.00	704.70
63	0.00	445.10	0.00	445.10
64	0.00	501.80	0.00	501.80
71	0.00	629.25	0.00	629.25
72	0.00	469.50	0.00	469.50
73	0.00	463.45	0.00	463.45
74	0.00	472.50	0.00	472.50
75	0.00	577.70	0.00	577.70
76	0.00	496.90	0.00	496.90
77	0.00	846.55	0.00	846.55
78	0.00	647.40	0.00	647.40
79	0.00	482.85	0.00	482.85
81	0.00	638.20	0.00	638.20
82	0.00	0.00	451.25	451.25
83	0.00	0.00	770.10	770.10
84	0.00	0.00	571.30	571.30
85	0.00	0.00	309.30	309.30
86	0.00	0.00	364.50	364.50
87	0.00	0.00	414.15	414.15
90	0.00	0.00	593.75	593.75
95	0.00	0.00	396.60	396.60
98	0.00	0.00	120.35	120.35
EXCESS	0.00	1873.25	7300.85	9174.10
TOTAL	625.00	15000.00	13750.00	29375.00

Table 26

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.65 per ton with 1976 supplies

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	166.15	166.15
01	0.00	68.55	0.00	68.55
03	0.00	352.30	0.00	352.30
05	0.00	224.35	0.00	224.35
07	0.00	152.85	0.00	152.85
09	0.00	307.30	0.00	307.30
11	0.00	181.95	0.00	181.95
13	0.00	381.70	0.00	381.70
15	14.40	371.55	0.00	385.95
17	0.00	326.70	0.00	326.70
19	0.00	0.00	361.75	361.75
21	0.00	0.00	366.75	366.75
23	0.00	0.00	346.30	346.30
25	297.30	0.00	0.00	297.30
27	313.35	0.00	0.00	313.30
29	0.00	0.00	434.20	434.20
31	0.00	249.25	0.00	249.25
33	0.00	455.55	0.00	455.55
35	0.00	388.25	0.00	388.25
37	0.00	0.00	254.95	254.95
39	0.00	0.00	393.00	393.00
41	0.00	0.00	287.95	287.95
43	0.00	0.00	274.75	274.75
45	0.00	0.00	143.30	143.30
47	0.00	0.00	518.55	518.55
49	0.00	0.00	358.70	358.70

Table 26 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	235.95	0.00	235.95
62	0.00	617.80	0.00	617.80
63	0.00	373.00	0.00	373.00
64	0.00	478.70	0.00	478.70
71	0.00	519.80	0.00	519.80
72	0.00	434.20	0.00	434.20
73	0.00	451.80	0.00	451.45
74	0.00	368.50	0.00	368.50
75	0.00	527.65	0.00	527.65
76	0.00	0.00	555.35	555.35
77	0.00	0.00	803.85	803.85
78	0.00	0.00	588.75	588.75
79	0.00	0.00	456.65	456.65
81	0.00	0.00	637.45	637.45
82	0.00	0.00	528.60	528.60
83	0.00	0.00	791.40	791.40
84	0.00	0.00	720.30	720.30
85	0.00	0.00	276.20	276.20
86	0.00	0.00	324.65	324.65
87	0.00	0.00	382.45	382.45
90	0.00	0.00	551.15	551.15
95	0.00	0.00	310.80	310.80
98	0.00	0.00	83.10	83.10
EXCESS	0.00	7532.30	5332.95	12865.25
TOTAL	625.00	15000.00	16250.00	31875.00

Table 27

Optimum Distribution of Grain (000 tons) from Each Block to Each of The Ports With Tolls Set at $0.00 per ton with 1976 supplies

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
00	0.00	0.00	166.15	166.15
01	0.00	68.55	0.00	68.55
03	0.00	352.30	0.00	352.30
05	0.00	224.35	0.00	224.35
07	0.00	152.85	0.00	152.85
09	0.00	307.30	0.00	307.30
11	0.00	181.95	0.00	181.95
13	0.00	381.70	0.00	381.70
15	0.00	385.95	0.00	385.95
17	0.00	326.70	0.00	326.70
19	0.00	361.75	0.00	361.75
21	0.00	366.75	0.00	366.75
23	0.00	346.30	0.00	346.30
25	297.30	0.00	0.00	297.30
27	313.35	0.00	0.00	313.50
29	14.35	419.80	0.00	434.15
31	0.00	249.25	0.00	249.25
33	0.00	455.55	0.00	455.55
35	0.00	388.25	0.00	388.25
37	0.00	0.00	254.95	254.95
39	0.00	0.00	393.00	393.00
41	0.00	0.00	287.95	287.95
43	0.00	0.00	274.75	274.75
45	0.00	0.00	143.30	143.30
47	0.00	0.00	518.55	518.55
49	0.00	0.00	358.70	358.70

Table 27 (continued)

BLOCK#	CHURCHILL	THUNDER BAY	WEST COAST	TOTAL
61	0.00	235.95	0.00	235.95
62	0.00	617.80	0.00	617.80
63	0.00	373.00	0.00	373.00
64	0.00	478.70	0.00	478.70
71	0.00	519.80	0.00	519.80
72	0.00	434.20	0.00	434.20
73	0.00	451.80	0.00	451.45
74	0.00	368.50	0.00	368.50
75	0.00	527.65	0.00	527.65
76	0.00	555.35	0.00	555.35
77	0.00	803.85	0.00	803.85
78	0.00	588.75	0.00	588.75
79	0.00	456.65	0.00	456.65
81	0.00	637.45	0.00	637.45
82	0.00	0.00	528.60	528.60
83	0.00	0.00	791.40	791.40
84	0.00	0.00	720.30	720.30
85	0.00	0.00	276.20	276.20
86	0.00	0.00	324.65	324.65
87	0.00	0.00	382.45	382.45
90	0.00	0.00	551.15	551.15
95	0.00	0.00	310.80	310.80
98	0.00	0.00	83.10	83.10
EXCESS	0.00	2981.25	2384.00	5365.25
TOTAL	625.00	15000.00	8750.00	24375.00

Table 28

Block Numbers and Corresponding Block Names

BLOCK#	NAME	BLOCK#	NAME
01	Winnipeg North	61	Keewatin
03	Winnipeg South	62	La Riviere
05	Winnipeg West	63	Carberry
07	Brandon North	64	Brandon
09	Brandon West	71	Weyburn
11	Melville	72	Pasqua
13	Dauphin	73	Bulyea
15	Kamsack	74	Bredenbury
17	Saskatoon Main	75	Saskatoon
19	Saskatoon South	76	Wilkie
21	Saskatoon West	77	Assinaboia
23	Saskatoon North	78	Swift Current
25	Prince Albert East	79	Outlook
27	Prince Albert South	81	Medicine Hat
29	Prince Albert West	82	Brooks
31	Saskatoon East	83	Lethbridge
33	Regina South	84	Vulcan
35	Regina West	85	Calgary
37	Biggar North	86	Red Deer
39	Biggar West	87	Edmonton
41	Edmonton North	90	N.A.R. West
43	Edmonton South	95	N.A.R. East
45	Edmonton West	98	G.S.L. Railway
47	Hanna South	00	British Columbia
49	Hanna West		

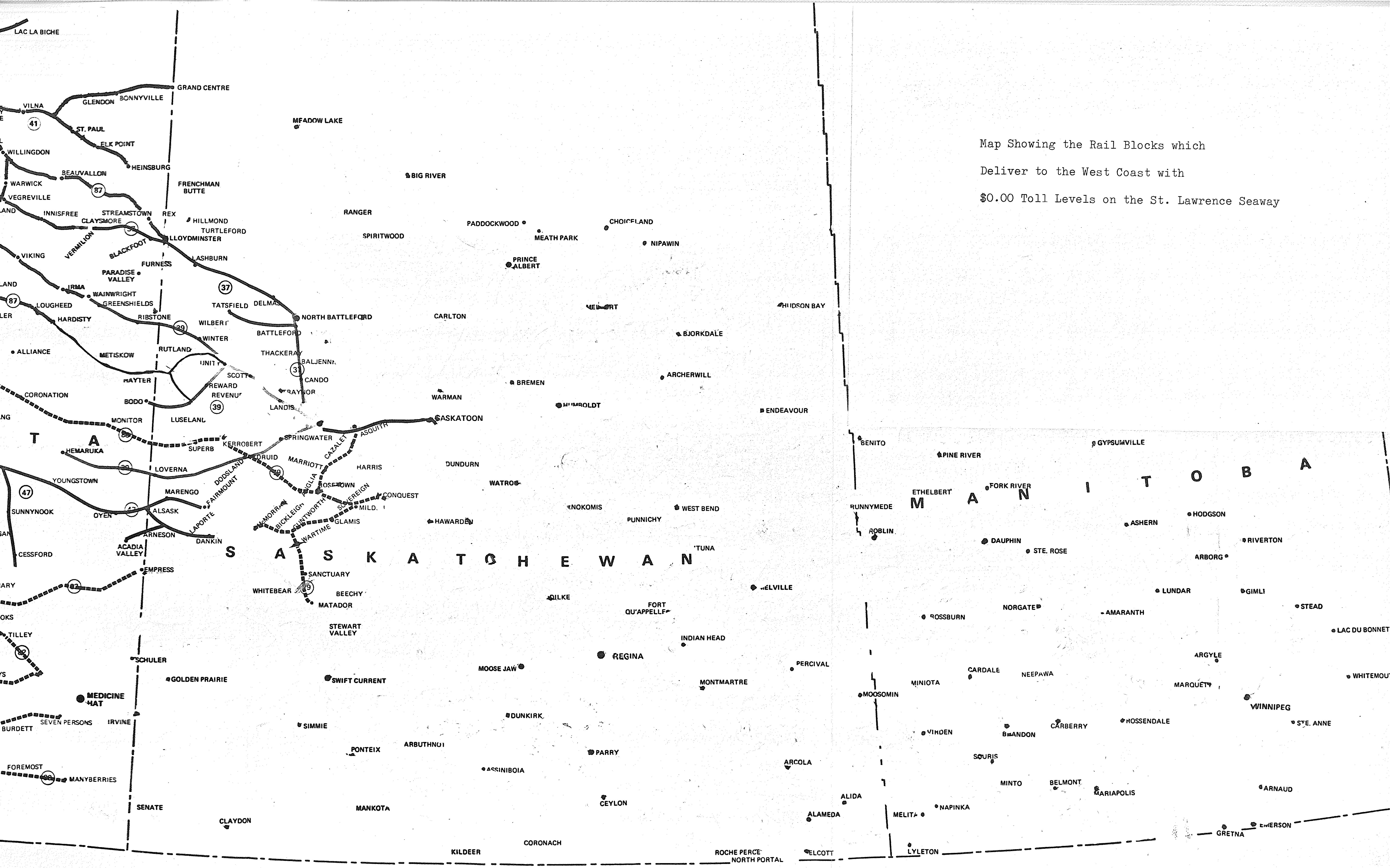
APPENDIX 2

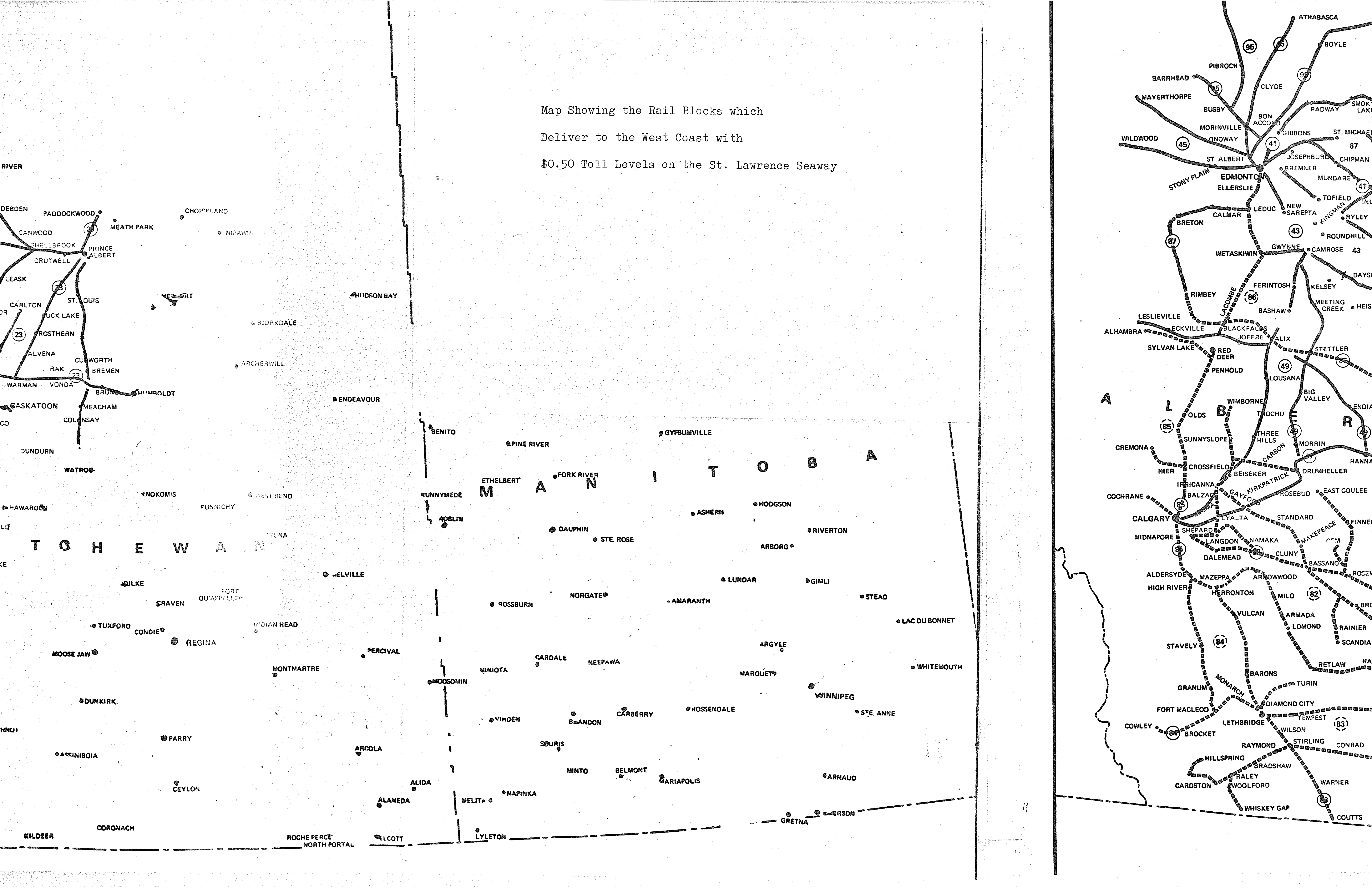
Maps Showing the Distribution of Grain to the Ports Under Alternative Toll Structures

Map Showing the Rail Blocks which

Deliver to the West Coast with

$0.00 Toll Levels on the St. Lawrence Seaway





Map Showing the Rail Blocks which

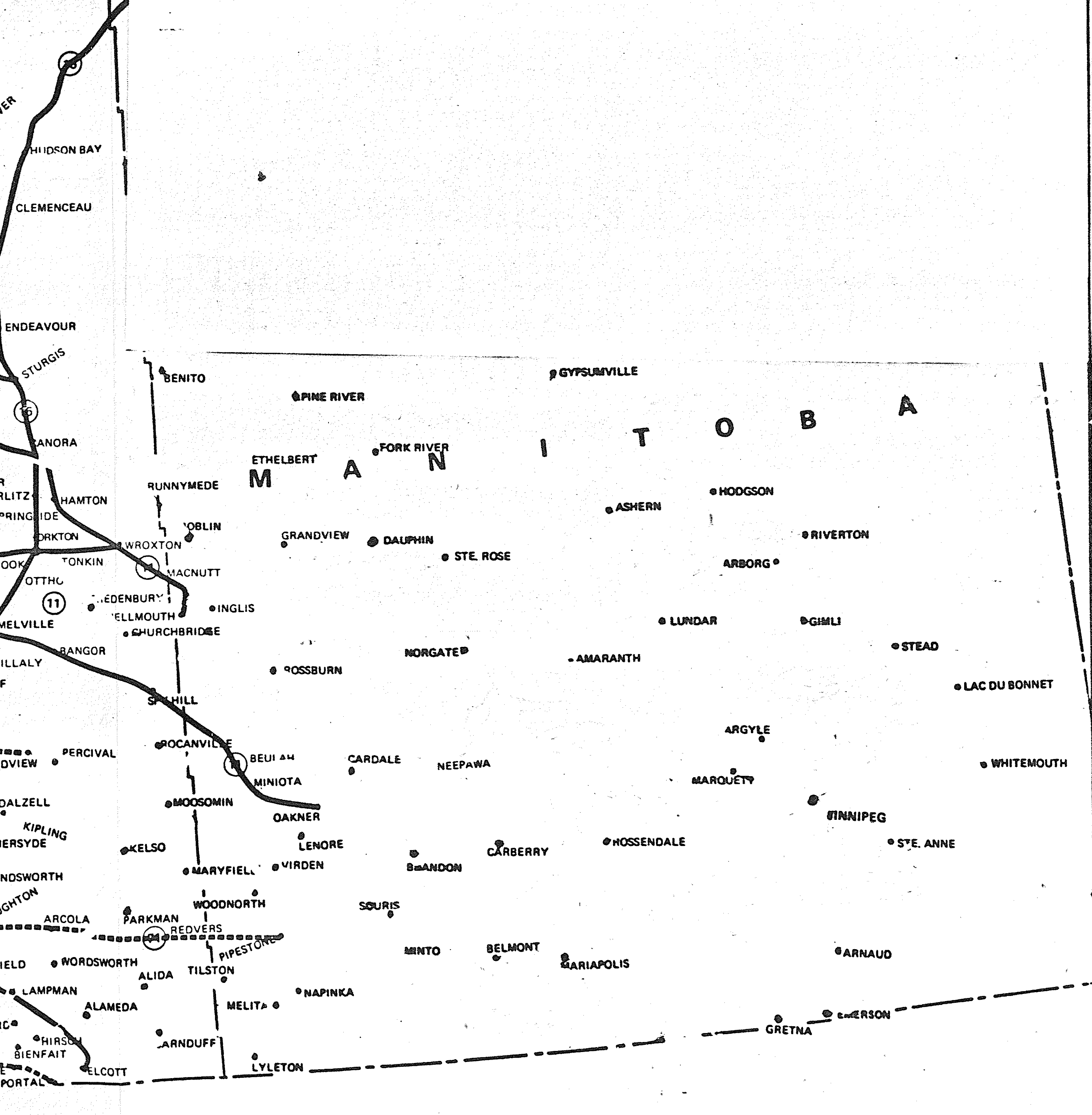
Deliver to the West Coast with

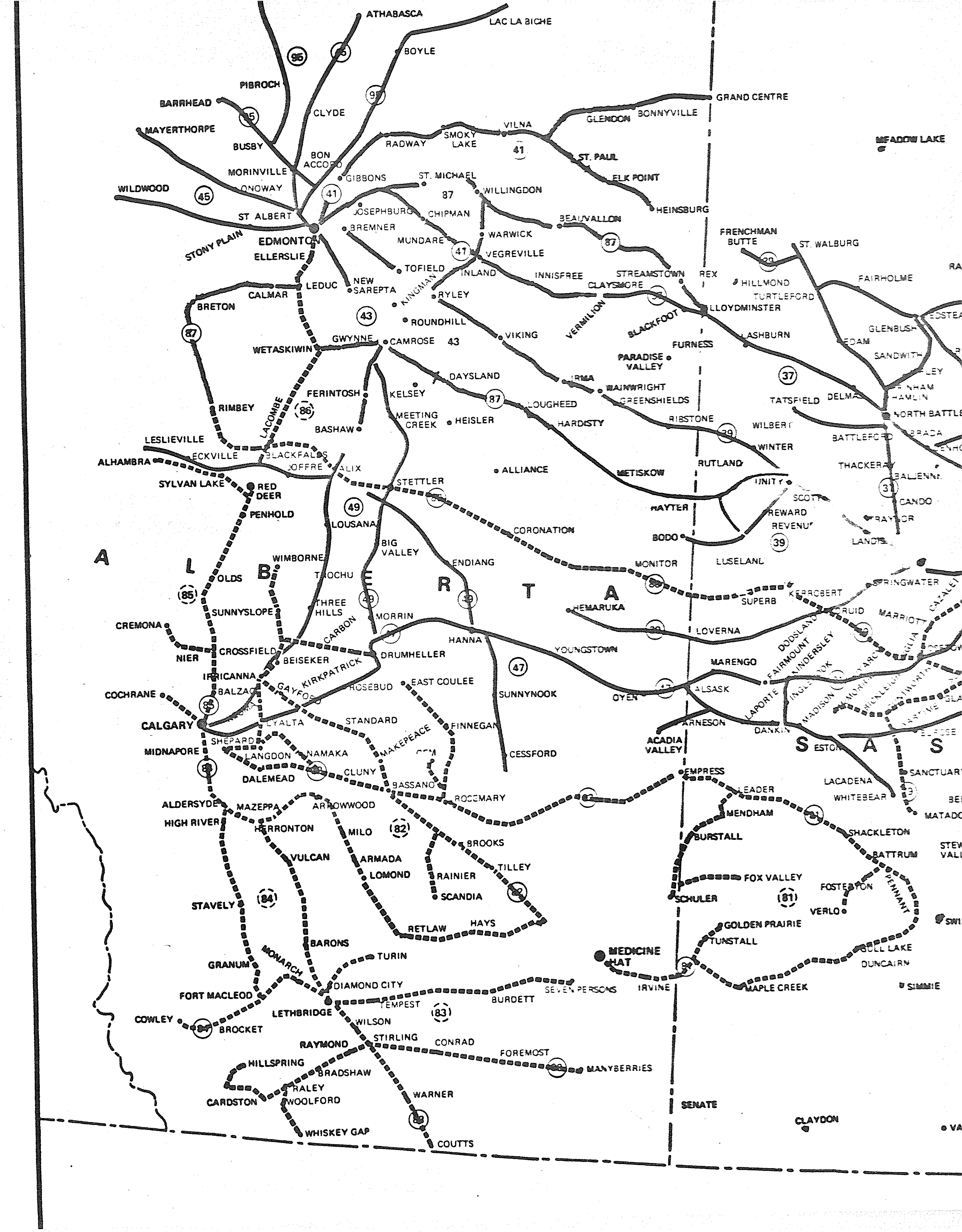
$0.50 Toll Levels on the St. Lawrence Seaway

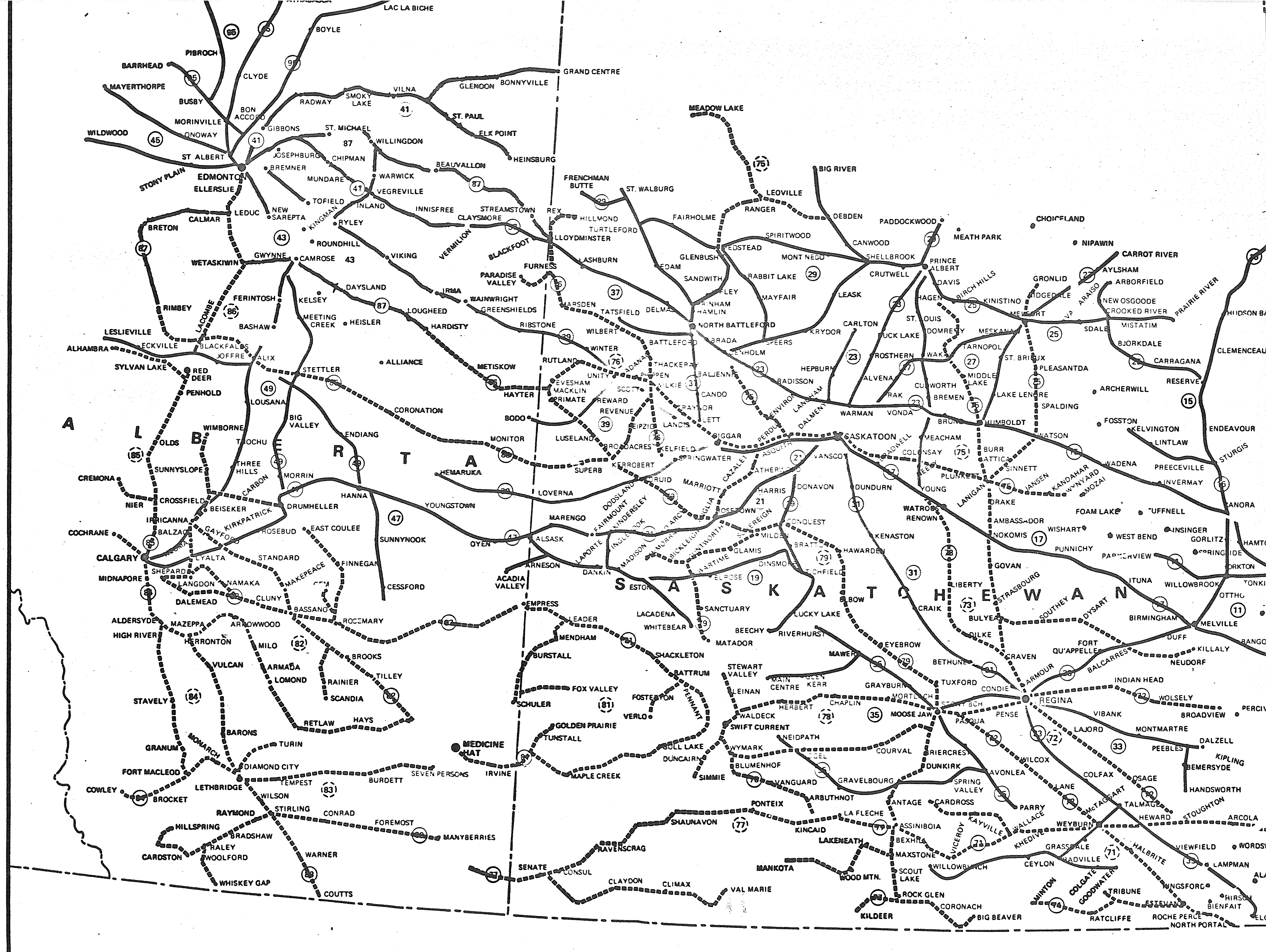
Map Showing the Rail Blocks which

Deliver to the West Coast with

$2.00 Toll Levels on the St. Lawrence Seaway






ALBERTA
SASKATCHEWAN
EDMONTON
CALGARY
RED DEER
LETHBRIDGE
MEDICINE HAT
LLOYDMINSTER
NORTH BATTLEFORD
PRINCE ALBERT
SASKATOON
HUMBOLDT
REGINA
MOOSE JAW
SWIFT CURRENT
WEYBURN
MELVILLE