CANADIAN TRANSPORTATION RESEARCH FORUM
LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

PROCEEDINGS OF

SEVENTEENTH ANNUAL MEETING

CANADIAN TRANSPORTATION RESEARCH FORUM

Volume 1

MONTREAL, QUEBEC

MAY 26, 27 & 28, 1982

Compiled by: R. Lande
&
K. Tansey

SESSION II

"CAPACITY"

GREAT LAKES/ST. LAWRENCE SEAWAY SEASON EXTENSION-WHO NEEDS IT?*

by

Joseph L. Carroll
Professor of Business Administration

and

Director, Transportation Systems Program
Pennsylvania Transportation Institute
The Pennsylvania State University
University Park, Pennsylvania 16802

March 1982

*For presentation before the Annual Meeting of
The Canadian Transportation Research Forum,
Montreal, Quebec, May 26, 1982

Interest in extending the navigation season on the Great Lakes-St. Lawrence Seaway (hereafter the GLSLS) beyond the present season, which starts on about April 1 and ends on about December 15, developed in the 1960s after completion of the Seaway opened the Great Lakes to ocean shipping, and when it became possible to ship iron ore in the form of pellets that would not freeze. Support from Great Lakes interests such as United States Steel Corporation and various port authorities resulted in authorization of a comprehensive demonstration program to determine the feasibility of extending the navigation season. The final report for this program was published by the U.S. Army Corps of Engineers in August 1979 [1]. The Canadian interest in season extension has been somewhat more restrained, but since 1978 two studies have been produced, the most recent released in June 1981 [2].

Conclusions from the most recent Canadian and U.S. studies may be cited here:

> Following appropriate systemic and site specific environmental investigations and careful coordination with geographically-oriented engineering studies (both reaffirmation and reformulation, as appropriate) so as to ensure maximum economy of effort and environmentally compatible individual projects; design, construction and operation should be undertaken to provide the means to eventually extend the navigation season on the upper lakes to year-round and up to 10 months on Lake Ontario and the International Section of the St. Lawrence River.
>
> U.S. Army Corps of Engineers, Detroit, Michigan, 1979 [1, p. 168]

> We conclude, therefore, that under the definition used for the present study and from the Canadian point of view, season extension cannot be supported as an economically feasible proposition.
>
> Hickling-Partners Inc., Ottawa, Ontario, 1981 [2, p. 116]

The U.S. Army Corps of Engineers recommends a twelve-month navigation season on the upper four Great Lakes, and a ten-month season from Lake Erie to Montreal. This proposal, hereafter referred to as the 12/10 plan, differs from the one examined in the Canadian study which calls for a thirty-day extension (approximately a nine and

one-half month season) on the Montreal-Lake Ontario section of the Seaway with complementary extensions elsewhere in the system. The earlier Canadian study concluded that season extension to nine and one-half months or more could not be justified [3].

Many studies concerning the GLSLS have been completed in recent years, involving at one time or another, it would seem, every major consulting firm in North America. A number of circumstances have contributed to the popularity of the GLSLS as a subject of study. First, because navigation projects are tangible evidence of "doing something for the folks back home," and because beneficiaries have not had to pay their full costs, politicians have actively pursued public monies for GLSLS projects that serve their constituencies. Second, because of broad political support a number of public agencies have developed a vested interest in the GLSLS and have succeeded in obtaining funds for the study of virtually every facet of it. Finally, traffic growth on the GLSLS has not been as robust as expected. In particular, the failure of the Seaway to attract general cargo has been disappointing. Thus many recent studies have been devoted to finding ways of increasing general cargo traffic on the Seaway, a primary raison d'être for the Corps' season extension proposals as well.

This paper focuses on the three season extension studies produced by the Corps of Engineers from July 1978 through August 1979, with particular emphasis on the final report, which is the source of the oft-quoted statement that "season extension is engineeringly and economically feasible." The paper concludes with a discussion of season extension as a means for expanding the capacity of the Welland Canal as compared with alternative ways in which the anticipated congestion there might be addressed.

CORPS OF ENGINEERS' STUDIES

The three most recent studies concerning season extension are really two drafts and a final report. There are, however, significant differences between them. Each study has a technical appendix presenting the economics from which the data used here

are taken. The studies will be referred to as the July 1978 report [4], the March 1979 report [5], and the August 1979 report [6].

The first widely circulated Corps study on the economic feasibility of season extension on the GLSLS was the March 1979 report which, consistent with the earlier draft, recommended year-round navigation on the upper lakes and eleven months on the Welland Canal and the Seaway, i.e., a 12/11 plan. But because of environmental concerns the August 1979 report recommended the 12/10 plan even though it was not as economically efficient as the previous plan.

As is customary, the final survey report produced by the District Engineer was reviewed by the Board of Engineers for Rivers and Harbors. The Board concluded that "navigation season extension of up to 10 months on the St. Lawrence Seaway-Great Lakes System and extending to about 10-3/4 months on the upper four Great Lakes is economically justified," assuming that Canadian cooperation would be forthcoming [7, p.1]. Additionally, the Board found that navigation on the upper Great Lakes appeared to be marginally feasible, but opposed the proposal by the Detroit District simply to monitor environmental impacts as the project proceeded and take mitigating action when appropriate. Rather, it recommended that a conventional "predictive-type" environmental impact statement be prepared. The Board had other reservations as well, but nevertheless suggested that the August 1979 report be transmitted to Congress for information. It further recommended that Canadian cooperation be actively pursued.

STUDY RESULTS COMPARED

Each of the three Corps' studies provides a number of alternative plans for varying lengths of season extension. The 12/10 plan in the August 1979 report is Plan 5, while in the two prior studies it is Plan 6. A summary of the economic findings for the 12/10 plans in all three studies is provided in Table 1.

In developing estimates of benefit and costs the Corps of Engineers followed normal procedures that include assuming a 50-year life, projecting estimates of costs and benefits over this 50-year period, and discounting cost and benefit streams at an

Table 1. Alternative U.S. Army Corps of Engineers' Estimates of Costs and Benefits of Navigation Season Extension[1] (millions of dollars)

	July 1978 Report	March 1979 Report	August 1979 Report
Total Investment[2]	948.3	810.0	451.0
Prices as of:	Feb. 1978	Jan. 1979	Oct. 1979
Discount Rate (% per annum)	6-5/8	6-7/8	7-1/8
Average Annual Benefits			
Transport Rate Savings	277.6	240.4	175.0
Winter Rate Savings	19.9	17.7	7.4
Stockpile Savings	50.9	58.1	23.3
Totals	348.4	316.2	205.7
Average Annual Costs			
Interest and Amortization	65.4	57.8	33.2
Operation and Maintenance	29.3	29.0	18.9
Totals	94.7	86.8	52.1
Benefit/Cost Ratio	3.7	3.6	4.0
Source:	Appendix E, Table E-4	Appendix E, Table 8	Appendix D, Table 41

[1]Year-round on upper four Great Lakes and connecting channels, and ten months on Welland Canal, Lake Ontario, and St. Lawrence River (Proposal 6 in first two reports, and Proposal 5 in the final report).

[2]Assumes Canada pays for 50 percent of costs in international waters, and 100 percent of costs in Canadian territory.

interest rate specified by law for water resource projects. Also as is customary, project costs and benefits are represented in average annual equivalent values. For example, Table 1 shows total estimated investment costs for each of the 12/10 plans. These investment costs are annualized under "interest and amortization", and added to estimated annual operation and maintenance costs to determine average annual costs.

The Corps identified three categories of benefits. The first, transportation rate savings, purports to represent what shippers would be able to save by using the extended navigation season on the GLSLS instead of the least-cost overland mode that would be used in the absence of season extension. Winter rate savings, the second benefit category, are presumed to accrue to the shippers of bulk commodities that would move on the GLSLS anyway, but at a lower cost than before, because of the better utilization of vessels that season extension would make possible. Finally, stockpile savings represent the estimated savings to shippers, who because of the longer season, are able to reduce the amount of stockpiled materials both at the origin and the destination. The costs and benefits identified in Table 1 are claimed to accrue to United States' interests only. It is assumed, further, that Canada will be responsible for 50 percent of the costs incurred in extending the season in international waters, and 100 percent of the costs of facilities in Canadian territory.

Between the three reports there are some rather substantial differences in the estimates of costs and benefits. In particular, the investment costs in the August 1979 report are less than half of those appearing in the report completed only a year or so before. These reductions and those in estimated operation and maintenance costs result in average annual costs of only $52.1 million in the August 1979 report as compared with $94.7 million in the July 1978 report and $86.8 million in the March 1979 report.

There is likewise a significant reduction in estimated benefits over the same period. Transportation rate savings, the overwhelmingly most important source of benefits, are reduced by a hundred million dollars a year from July 1978 to August 1979. In addition, both winter rate savings and stockpile savings are cut

by over 50 percent. In spite of the changes in costs and benefits the benefit-cost ratios remains about the same in the three reports.

The data in Table 2 indicate where the Corps reduced initial investments required for season extension. For example, between July 1978 and August 1979, investments for ice breaking were reduced from over $600 million to less than $170 million. Expenditures for ice control structures, compensating works, and harbor investments were also reduced by over 50 percent over the same period. The only increase in estimated costs was for the environmental plan of action, which rose from slightly over $50 million to more than $113 million.

The changes in traffic estimates between the three studies are not nearly as pronounced as changes in costs. Table 3 shows that for the year 2000 the tonnages diverted from alternate modes, benefited by winter rates, and saved from stockpiles are more or less the same in all three reports. The savings, on the other hand, vary significantly. For example, the per ton savings expected to accrue to traffic benefited by the winter rates are less than 30 percent in the August report of what they were the previous March. Likewise, stockpile savings per ton are reduced by about one-half, and savings on diverted traffic by about one-third. For the currently recommended 12/10 season extension plan, expected savings per ton in the year 2000 are:

(1) $6.77 per ton savings on traffic diverted from other modes.

(2) $0.04 on traffic benefiting from winter rates.

(3) $1.06 on every ton saved from stockpiles.

The last set of figures in Table 3 represents the incremental tonnages in the year 2000 expected to be attracted to the GLSLS as a result of the 12/10 season extenson plans. Additional iron ore shipments dominate the tonnages, but the unit savings are nominal. The primary source of benefits to season extension comes from general cargo and perhaps some grain diverted from other modes.

Table 2. Alternative U.S. Army Corps of Engineers' Estimates of Investment Costs Incurred for Navigation Season Extension[1] (millions of dollars)

Activity	July 1978 Report	March 1979 Report	August 1979 Report
Ice Breaking	618.7	391.9	165.5
Ice Breaker Moorings	16.8	20.0	13.9
Aids to Navigation	12.5	13.1	9.3
Ice Control Structures	14.5	15.5	7.2
Lock Modifications	35.2	42.5	22.8
Dredging	72.0	82.1	55.8
Compensating Works	47.7	56.1	17.2
Environmental Plan of Action	50.4	125.3	113.6
Other	7.7	16.8	11.7
Total Lakes and Channels	875.5	763.3	417.0
Total Harbor Investments	72.8	46.7	33.9
Total Investment Costs	948.3	810.0	451.0
Source:	Appendix E, Table E-1	Appendix D, Table 1	Appendix D, Table 39

[1]Year-round on upper four Great Lakes and connecting channels, and ten months on Welland Canal, Lake Ontario, and St. Lawrence River.

Table 3. Alternative U.S. Army Corps of Engineers' Estimates of Tonnage and Savings in Year 2000 for Navigation Season Extension[1] (millions of dollars and short tons)

	July 1978 Report	March 1979 Report	August 1979 Report
Annual Tonnages			
Tons Diverted from Alternative Modes	25.1	21.6	27.2
Tons Benefitted by Winter Rates	154.3	151.0	188.4
Tons Saved from Stockpile	28.9	32.6	25.3
Annual Savings			
Transportation Rate Savings	239.4	214.4	184.0
Winter Rate Savings	19.6	21.8	7.4
Stockpile Savings	50.8	67.9	26.7
Total Benefits	309.8	304.1	218.1
Unit Savings			
Diverted Traffic	9.55	9.92	6.77
Traffic Benefited by Winter Rates	0.127	0.144	0.039
Stockpile Tonnages	1.76	2.08	1.06
Incremental Tonnages Attracted			
Grain	2.8	1.8	3.7
Coal	3.5	4.9	6.2
Iron Ore	14.4	13.5	14.7
General Cargo	4.4	1.4	2.1
Totals	25.1	21.6	26.7
Source:	Appendix E, Tables E-2 and E-3	Appendix E, Tables 2 and 5	Appendix D, Tables 13 and 14

[1]Year-round on the upper four Great Lakes and connecting channels, and ten months on Welland Canal, Lake Ontario, and St. Lawrence River.

CORPS' TRAFFIC AND SAVINGS ESTIMATING PROCEDURES

Traffic and savings estimates were provided by the Great Lakes-St. Lawrence Seaway Traffic Model, which is a collection of submodels designed to produce computer-generated benefit streams needed for project justification. The model performs in the following manner:

Step 1. It develops forecasts for GLSLS potential traffic for the nineteen states which are presumed to represent the tributary area for the GLSLS system.

Step 2. It screens the potential traffic for that which might move over the GLSLS during the extended season and which is "sensitive" to rates.

Step 3. For alternative season extension plans it calculates the potential rate savings to shippers of using the GLSLS rather than the least costly alternative.

Step 4. It develops capacity estimates for the various components of the GLSLS system.

Step 5. Finally, it counts as National Economic Development (NED) benefits all shippers' savings determined in Step 3 on traffic not exceeding the capacity constraints identified in Step 4.

The model and its application to GLSLS season extension have been discussed elsewhere by the author and others [8,9]. It will suffice here to identify only a few of the more serious shortcomings found in the March 1979 report and which appear to have been carried over into the final report.

First, the nineteen state tributary area is unreasonably large. A recent study concludes: "The findings with respect to the effective export and import hinterlands leads to a rejection of the nineteen-state hinterland traditionally attributed to the Great Lakes" [10, p. 167]. One suspects that politics rather than economics determined the number of states included in the GLSLS hinterland originally. Assuming such a large service area for the GLSLS results in substantially more potential import and export traffic than actually exists.

Second, the screening process in Step 2 is based on nothing more than the judgment of a consulting firm well known for its work on behalf of the Corps in justifying other waterway projects such as the Tennessee-Tombigbee Waterway. There are no data to support the mystical setting of "switches" that determine how much of the potential traffic from Step 1 to analyze for rate savings.

Third, no attempt was made to assess the predictive capability of the model. Indeed, some of the traffic predictions are clearly at variance with recent history. For example, in the March 1979 report the forecasting and screening tasks, together with calculations of rate savings, resulted in substantial volumes of containerized general cargo being diverted to the Seaway both with and without season extension! That this rather remarkable outcome was modified significantly five months later suggests the ease with which the model can be manipulated.

Fourth, the Corps assumed that forecast traffic in excess of the capacity of locks on the GLSLS system would continue to move between the same origins and destinations but at higher rates charged on the alternative modes or routes. No support was provided for this profound assumption which, in fact, makes little sense since substitution possibilities abound. For example, and within limits, upper lakes ore can be substituted for Labrador ore, and Western coal for Eastern coal. Perhaps the biggest mistake that can result from this line of reasoning is thinking that when "capacity" is reached, goods will be "blocked" from reaching their destination.

Finally, numerous assertions to the contrary notwithstanding, the Corps' benefit estimates do not indicate how much better the United States would be with season extension than without it. For one thing, rate savings to shippers are not the same as cost savings to the nation, a fact that even the Corps will not dispute. Second, and more important, a substantial proportion of the shippers' savings in each of the three benefit categories will not directly benefit U.S. interests. So long as traffic moves through a U.S. port, the savings credited to it are presumed by the Corps to accrue to U.S. interests. Thus any winter rate or stockpile savings on coal for Ontario Hydro moving from Conneaut, Ohio, to Toronto by Canadian Steamship Lines is

considered as a benefit to the United States. Likewise, shipper savings from season extension for a shipload of Volkswagons delivered to Detroit by a foreign flag carrier is claimed by the Corps as a National Economic Development benefit. One doubts that Congress really intends to use season extension as a means of dispensing foreign aid.

The likely adverse consequences of season extension in respect to U.S. (and Canadian) interests were discussed 13 years ago in a report that the Corps chose to ignore. After concluding that as much as 40 percent of the lower transport costs resulting from Seaway improvements would flow to overseas customers, EBS Management Consultants states:

> It should be noted that the additional general cargo traffic generated for the Seaway System by an extension of the sailing season is traffic that is diverted from other inland distribution routes. As a result, there are disbenefits to certain segments of the U.S. and Canadian economies while benefits accrue to Seaway associated segments. For instance, the benefits gained by lower transportation costs are partially offset by the diminished revenue traffic available to the inland modes which would have carried the traffic had the Seaway remained closed. In the case of export traffic, the revenues which might have gone to U.S. or Canadian inland modes for the haul from mid-continent to the Atlantic Coast instead go partially if not wholly to foreign-flag steamship lines. Likewise on import general cargo movements, revenues which might have gone to domestic inland transport firms would go instead to the foreign-flag lines carrying the general cargo to the interior Great Lakes ports. Furthermore, if import cargo enters the U.S. through the North Atlantic coast, there is a better chance that it would be carried in U.S.-flag merchantmen. There is little chance of it being carried by U.S.-flag vessels directly into the Great Lakes due to lack of U.S. and Canadian flag general cargo service on that route.
>
> [11, pp. VIII-14-15]

The TERA Report

That the principal impact of season extension will be simply to transfer income among various groups has been confirmed by TERA, Inc., a consulting firm retained by the Corps of Engineers to analyze the modal impacts of season extension on the GLSLS. Using what were claimed to be the same forecasts and other data supplied by the Corps' GLSLS model in the August 1979 report, TERA calculated the net revenue changes for

Table 4. Estimated Revenue Losses and Gain for Season Extension
Plan 5, August 1979 Report
(millions of dollars)

Transport Mode	1990	2000	2010
Rail	-69.7	-149.1	-379.1
Truck	-69.3	-114.4	-113.7
Barge	- 3.3	- 5.1	- 5.1
Great Lakes Marine	+294.4	+483.2	+553.4
Ocean Marine	-304.5	-496.9	-496.9

Source: [12, Appendix A]

affected modes resulting from the implementation of the Corps' 12/10 season extension plan. These revenue impacts are shown in Table 4 for selected years. Clearly Great Lakes' marine interests are expected to gain at the expense of the other modes.

TERA also concluded that there would be significant shifts among the various states, with only Minnesota experiencing a favorable impact on employment and income as a result of season extension. The big losers are expected to be New York, Michigan, and Pennsylvania. Also, ports on the Great Lakes are expected to benefit at the expense of coastal ports, particularly on the East and Gulf coasts. It would not be surprising if the TERA findings have had a chilling effect on the political support for season extension.

CONCLUSIONS REGARDING THE CORPS' STUDIES

Early interest in season extension was prompted by the desire of large shippers on the Great Lakes to increase utilization of their fleets. Later, attention focused on the Seaway and overseas traffic, and the hypothesis that season extension was a "necessary condition" for attracting this traffic, particularly general cargo. In addition Seaway advocates have attributed the failure of the Seaway to attract general cargo traffic to ignorance on the part of shippers concerning the advantages of the Seaway compared to alternative routings.

The primary function of the GLSLS model used by the Corps was to determine the traffic and savings on general cargo diverted to the Seaway by extensions to the navigation season. The reliability of the model was never tested. It predicted substantial increases in containerized general cargo traffic even without season extension at the same time that this traffic was declining precipitously. Rather than question the validity of the model the Corps apparently preferred to believe that shippers are unable to choose the mode or route that best serves them.

In the August 1979 report the Corps responded to criticism of its general cargo forecasts by reducing the growth in this traffic without season extension. The reason for this change was not explained. Indeed, the Corps never attempted to explain any of the changes made from one report to another. For example, no explanation is provided as to why $618.7 million is required for ice breaking in the July 1978 report, while only $165.5 million is needed for the same task in the August 1979 report. Likewise the differences in traffic and savings estimates are not explained. It is particularly difficult to rationalize these differences since the reports strongly suggest that data collection and modeling were completed prior to the first draft.

In the final analysis the Corps of Engineers' conclusions regarding season extension are not very convincing. However comprehensive and complex the GLSLS model may be, and no matter how costly it was to develop, its predictive capability has never been confirmed, nor is it likely to be because of the questionable assumptions and arbitrary judgments upon which the model depends. The economic feasibility of the Corps' recommended plan rests, finally, on the benefits attributed to general cargo traffic diverted from alternative modes and routes. Experience suggests such diversion is highly unlikely with or without season extension. Furthermore, whatever benefits there might be will almost certainly accrue in large part to non-U.S. interests. It would appear, therefore, that implementation of the Corps' plan for season extension is not a prudent course of action for the United States irrespective

of the potentially adverse environmental impacts of season extension that are of concern to many.

SEASON EXTENSION AND CAPACITY OF THE WELLAND CANAL

Season extension has been considered as an attractive way of increasing the capacity of the Welland Canal. The Board of Engineers, for example, concluded that "season extension has merit as a means of providing additional capacity for the Welland Canal and St. Lawrence River" [7, p. 13]. The Hickling-Partners study is less sanguine, anticipating no more than a three to six percent increase in the Welland's capacity from a thirty day extension.

Capacity problems are perceived differently by affected parties and by different professions. Waterway interests in the United States, for example, support the provision of new locking facilities where congestion and delays have developed, this support no doubt related to the fact that historically they have not had to pay for the facilities provided. In the past the Corps of Engineers has generally favored new construction as well, but in recent years has implemented improvements in locking operations, or what are popularly referred to a "non-structural alternatives," as a means of increasing lock capacity and thereby reducing congestion. The St. Lawrence Seaway Authority, of course, has been actively engaged in improving operating conditions on the Welland Canal for over fifteen years.

Economists tend to view capacity and congestion problems differently than engineers. What may be a "facilities problem" to an engineer is often perceived by an economist to be a "pricing problem." Thus congestion may result not only from inadequate or inefficiently operated facilities, but also from the failure to impose on users appropriate charges that serve to "ration" the use of congested facilities.

The rationale for lockage (congestion) fees is hardly new [13], nor is their use in Canada, such fees being introduced on the Welland in 1967. What is new is the total commitment of the present administration to user fees in general, and of the Corps of Engineers to congestion fees in particular.

Assistant Secretary of the Army Public Works, William R. Gianelli, was recently quoted as follows:

> "Corps studies have shown that congestion fees can substantially increase the economic benefits in these situations by diverting users receiving marginal benefits, thus reducing the delay costs for the remaining traffic. Additional benefits are also received by deferring the need to expand lock capacity because better use is made of existing locks." [14, p. 7]

Thus there is now official support in the United States for what Canada intended to do anyway, which is to reintroduce this year lockage fees on the Welland Canal.

It appears, then, that future waterway capacity analyses in the United States will have to consider the role of congestion fees in moderating traffic to insure efficient use of facilities. The use of unconstrained forecasts and physical criteria alone to determine the feasibility of capacity additions is past. It would be surprising, therefore, if without further analysis the Corps would now advocate season extension as an effective means of increasing the capacity of any part of the GLSLS system.

REFERENCES

1. U.S. Army Engineer District, Detroit. Survey Study for Great Lakes and St. Lawrence Seaway Navigation Season Extension. Main Report and Final Environmental Impact statement. Detroit, August 1979.

2. Hickling-Partners, Inc. Great Lakes and St. Lawrence Seaway Season Extension Study. Prepared for The Marine Transportation Administration and The Strategic Planning Group, Transport Canada. Ottawa, Ontario, June 1981.

3. LBA Consulting Partners, Ltd. The Seaway in Winter: A Benefit-Cost Study. Ottawa, October 1978.

4. U.S. Army Engineer District, Detroit. Survey Study for Great Lakes-St. Lawrence Seaway Navigation Season Extension. Preliminary Draft, Appendix E. Detroit, July 1978.

5. U.S. Army Engineer District, Detroit. Survey Study for Great Lakes and St. Lawrence Navigation Season Extension. Draft, Volume II, Appendix E. Detroit, March 1979.

6. U.S. Army Engineer District, Detroit. Final Survey Study for Great Lakes and St. Lawrence Seaway Navigation Season Extension. Volume IV, Appendix D. Detroit, August 1979.

7. Letter to Chief of Engineers from U.S. Army Board of Engineers for Rivers and Harbors. Subject: Final Survey Report on Navigation Season Extension for the Great Lakes and St. Lawrence Seaway. Washington, D.C., 18 March 1981.

8. Carroll, J. L., Gittings, G. L., and Meade, C. L. Season Extension on the Great Lakes/St. Lawrence Seaway: A Critique of the Recommended Plan of the Corps of Engineers. The Pennsylvania Transportation Institute, University Park, Pennsylvania, July 1979.

9. Great Lakes Basin Commission. Economic Review of Navigation Season Extension. Ann Arbor, June 1, 1979.

10. Heilman, R. L. and Schenker, E. Great Lakes International Trade: Hinterland Served and Shipper's Route Options. University of Wisconsin, Milwaukee, December 1980.

11. EBS Management Consultants, Inc. An Economic Analysis of Improvement Alternatives to the St. Lawrence Seaway System. Washington, D.C., January 1969.

12. TERA, Inc. Intermodal Impact of Great Lakes/St. Lawrence Seaway System Season Extension. Arlington, Virginia, December 1979.

13. Sainsburg, G. V. "Tolls, A Means to Greater Efficiency," Catalogue No. 1215. St. Lawrence Seaway Development Authority, Ottawa, December 1968.

14. Weekly Letter. American Waterway Operators, Washington, D.C., March 5, 1982.