SOME WOOD-TRANSPORTATION MODELING PROBLEMS ASSOCIATED WITH QUEBEC'S NEW LAND-MANAGEMENT SYSTEM

by

Jean Ouellet

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APPROVED:

William A. Duerr, Chairman

Robert B. Jensen

William E. King

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TABLE OF CONTENTS

Page

LIST OF FIGURES

LIST OF TEXT TABLES

LIST OF APPENDIX TABLES

INTRODUCTION

In 1971 and 1972, the Quebec Government presented a policy concerning the forest and its use for the general well-being of the Province's economy. This policy, called the New Land-Management System, affects all the sectors of forestry.

In this work, the author discusses the changes in wood transportation called for by the New Land Management System. Many factors outside forestry are involved. The author attempts to identify them and to appraise their probable effects on the transportation system.

All types of industries are affected by transportation costs. Among the most significant factors affecting the costs of a commodity's transportation are its weight, bulk, fragility, perishability, and hazardous qualities. Some of these factors affect the transportation of wood, which is characteristically a product of low specific value and thus especially sensitive to transportation method and distance.

As a matter of fact, the Gordon Commission (1956) wrote, "Wood, especially in its raw or relatively primary forms, is a bulky material. Having a comparatively low value-to-weight ratio, it does not usually pay to transport it over great distances. Also, being a solid of irregular form, it is, by its very nature, less easily handled than the liquid fuels and the majority of ores and mineral concentrates. Means will therefore be sought continually to effect greater weight reduction in the woods, to reduce on-site handling to a minimum, and to collect and transport the resultant product to the mills in the most efficient manner."

Transportation cost accounts for possibly more than 40 percent of the value of pulpwood at the mill. Consequently, particular attention should be given to transportation cost. In a free economy such as we live in, all improvements are a benefit in a period of very tragic inflation such as exists presently.

Transportation costs, by land or water, are a very significant factor in the implementation of intensive forestry practice. In fact, when these transportation costs reach a high level, they can justify intensive forestry practice close to the mills. Therefore, transportation distances and costs are closely related to the intensity of the forestry practiced. In consequence, the policy submitted by the Quebec Gouvernment must be guided by the fact that the resource wood tends, over time, to be concentrated always farther and farther from the mills, and that improvement in transportation is only a temporary solution.

Studies of intensive forestry should be undertaken immediately to determine their effect on the future of the forest industry in Quebec. Techniques as advanced as linear programming can be easily integrated into the development of forestry. The combination of a transportation model and computer techniques can make wood allocation very efficient and dynamic.

This work is divided into five chapters. In the first one, a description of the old land-management system is given. The reasons why the limit system has become obsolete are also enumerated.

Chapter 2 presents a list of the different transportation systems used in Quebec. Each of these systems is analyzed, and the future pros-

pects of these systems are looked at. The effects of government policy on transportation systems are also analyzed.

Chapter 3 describes the New Land Management System and its effects on wood allocation. The mechanisms of wood allocation on the public forests and the forms of allocation systems are also part of this chapter.

Chapter 4 gives the base of the transportation model that could be used to improve the efficiency of wood allocation in Quebec. The different variables are enumerated, and the matrix of costs is explained.

Chapter 5 deals with the constraints to take into account in the use of the transportation model. These are economic, political, social, and other constraints, such as those imposed by nature.

From this introductory study, recommendations will be made regarding areas of future research that promise a high payoff.

The pulp and paper industry as well as the sawmill industry and all the other wood-using industries are in a competitive market, and decisions about their future should not be postponed. Postponement could harm their competitive position vis-a-vis the rest of Canada and the United States.

CHAPTER 1

LAND-MANAGEMENT SYSTEM EXISTING PRESENTLY IN QUEBEC

The forest and the products that can be extracted from it have always been among the most important resources in Quebec. Furthermore, the forest is the principal renewable resource. The impact of the forest on Quebec's economy is reflected by the 80,000 people who are directly or indirectly related to it and by the $500 million that its people receive annually in wages and salaries. Our interest here is in the product called wood, that can be obtained from the forest. In 1972, the volume harvested was about 10 million cunits.[1/]

Table 1 gives the division of the Province by types of land uses and the area covered by lakes and the St. Lawrence River. Figure 1 shows the Province's total area and the different forest types. As we see in Table 1, the total area of Quebec is 597,700 square miles. On this large area, the population is only slightly over 6,000,000. Forests with a commercial potential cover 298,100 square miles, or 50 percent of the area of the Province.

As a result of the importance of the forest to Quebec's economy, the Department of Lands and Forests (1971), said, "The optimal utilization of the forest as a way of economic and social development consti-

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[1/] One cunit is a volume measure equal to one hundred solid cubic feet of wood.

Table 1. Distribution of Quebec's territory

ZONES			AREAS			LAND	WATER
			Sq. Mi.	1000 Ha.	%	%	%
NONFORESTED	URBAN		1,300	340	0.2	100.0	--
	AGRICULTURAL		13,700	3,550	2.3	100.0	--
	TUNDRA		115,000	29,780	22.9	89.7	10.3
	ST. LAWRENCE RIVER and lakes over 50 square miles		23,400	6,060	3.9	--	100.0
	TOTAL NONFORESTED		153,400	39,730	29.3	78.6	21.4
LIGHTLY WOODED (non commercial)	TAIGA		146,200	37,870	20.8	85.2	14.8
COMMERCIAL FORESTS	PRIVATE	SMALL (less than 2,000 ac.)	19,200	4,970	3.2	99.0	1.0
		LARGE (2,000 ac. and more)	8,700	2,250	1.5	97.7	2.3
		TOTAL PRIVATE FORESTS	27,900	7,220	4.7	98.6	1.4
	PUBLIC	PROVINCIAL JURISDICTION: DOMANIAL FORESTS	88,000	22,790	14.7	87.0	13.0
		PROVINCIAL JURISDICTION: LIMITS	88,300	22,900	14.8	90.0	10.0
		PROVINCIAL JURISDICTION: TOWNSHIP RESERVES	3,000	780	0.5	100.0	--
		PROVINCIAL JURISDICTION: EXPERIMENTAL FORESTS	100	30	--	100.0	--
		PROVINCIAL JURISDICTION: VACANT FORESTS	90,000	23,270	15.1	84.5	15.5
		TOTAL PUBLIC PROVINCIAL FORESTS	269,400	69,770	45.1	87.3	12.7
		FEDERAL JURISDICTION: INDIAN RESERVES	300	80	--	100.0	--
		FEDERAL JURISDICTION: OTHER RESERVES & PARKS	500	130	0.1	100.0	--
		TOTAL PUBLIC FEDERAL FORESTS	800	210	0.1	100.0	--
		TOTAL PUBLIC FORESTS	270,200	69,980	45.2	87.3	12.7
	TOTAL COMMERCIAL FORESTS		298,100	77,200	49.9	88.4	11.6
GRAND TOTAL			597,700	154,800	100.0	85.1	14.9

Source: Gouvernement du Quebec, Ministere des Terres et Forets. 1971. Expose sur la Politique Forestiere, Tome 1. p.9.

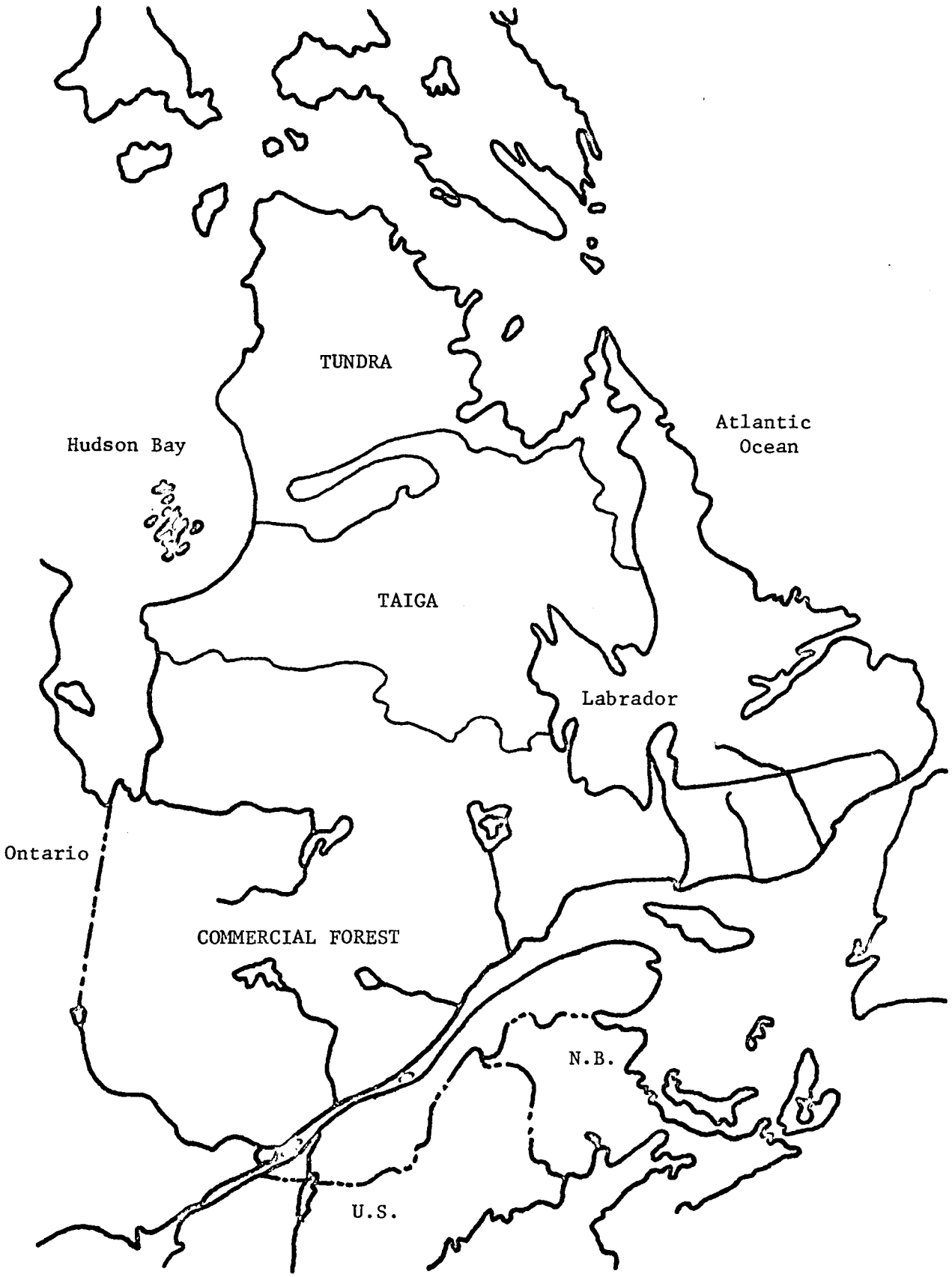

Figure 1. Forest land types in Quebec

Source: Gouvernement du Quebec, Ministere des Terres et Forets. 1971. Expose sur la Politique Forestiere, Tome 1. p.7.

tutes the global objective that Quebec's Government has fixed for the forest."

1.1 Wood allocation in the old land-management system on public forests

Under the title, Public Commercial Forests, in Table 1, are presented the different public land-management systems existing in the Province of Quebec. The domanial forests, the township reserves, the experimental and vacant forests are managed by the Department of Lands and Forests. The limit system, representing 14.8 percent of the area of the Province, is managed by individuals or companies.

Two categories of allocation system can be distinguished on the public forests: long-term contracts and short-term contracts. The long-term contracts comprise the limit system and the supply contracts. The short-term contracts are the special cut permit, the domestic permit, and the cut permit on special forest reserves.

For the purpose of this work, the limit system is of interest because it is the one that the Department of Lands and Forests has proposed to change. For reason of simplification, the pulp and paper industry will be the main sector of forestry that will be discussed in the rest of this paper.

1.2 Limit system

The area covered by limits in Quebec is 88,300 square miles. The forest limit (ordinary or special) constitutes a mode of holding, management, and allocation per se (Gouvernement du Quebec, 1971). The problems connected with the limits as an allocation method are an incomplete utilization of the allowable cut, a large number of small limits, a too-great inflexibility in the system itself, and a cross-hauling of

wood in the Province.

The annual allowable cut on the limits has been evaluated at 760 million cubic feet. The wood cut on the limits since 1949 represents only 65 percent of the allowable cut (Figure 2). The low utilization of wood coming from the limits is attributed in part to the increase in the wood supply coming from private forests and in part to the relatively new utilization of chips by the pulp and paper mills.

Nine forest companies hold 92 percent of the total area in limits, or 81,859 square miles. Nearly 120 holders share the remaining 7,188 square miles. Seventy-six ordinary and special limits have an area equal to or less than 50 square miles, and forty have 25 square miles or less.

The holders of limits leased before 1963 have exclusive rights to all the trees on their lands. These rights have never encouraged a sound wood-utilization policy and many times have been the source of conflict between sawmills and veneer plants on one side and the pulp and paper industry on the other.

The nonuse of a part of Quebec's forests should not be allowed at a time when the demand for wood is increasing, particularly in the hardwood region, and at a time when the State must allocate its wood at an optimal level, so as to minimize transportation costs.

The regime of ordinary limits makes many sawmill owners dependent upon the limit holders for their wood supplies and also for the selling price of this wood.

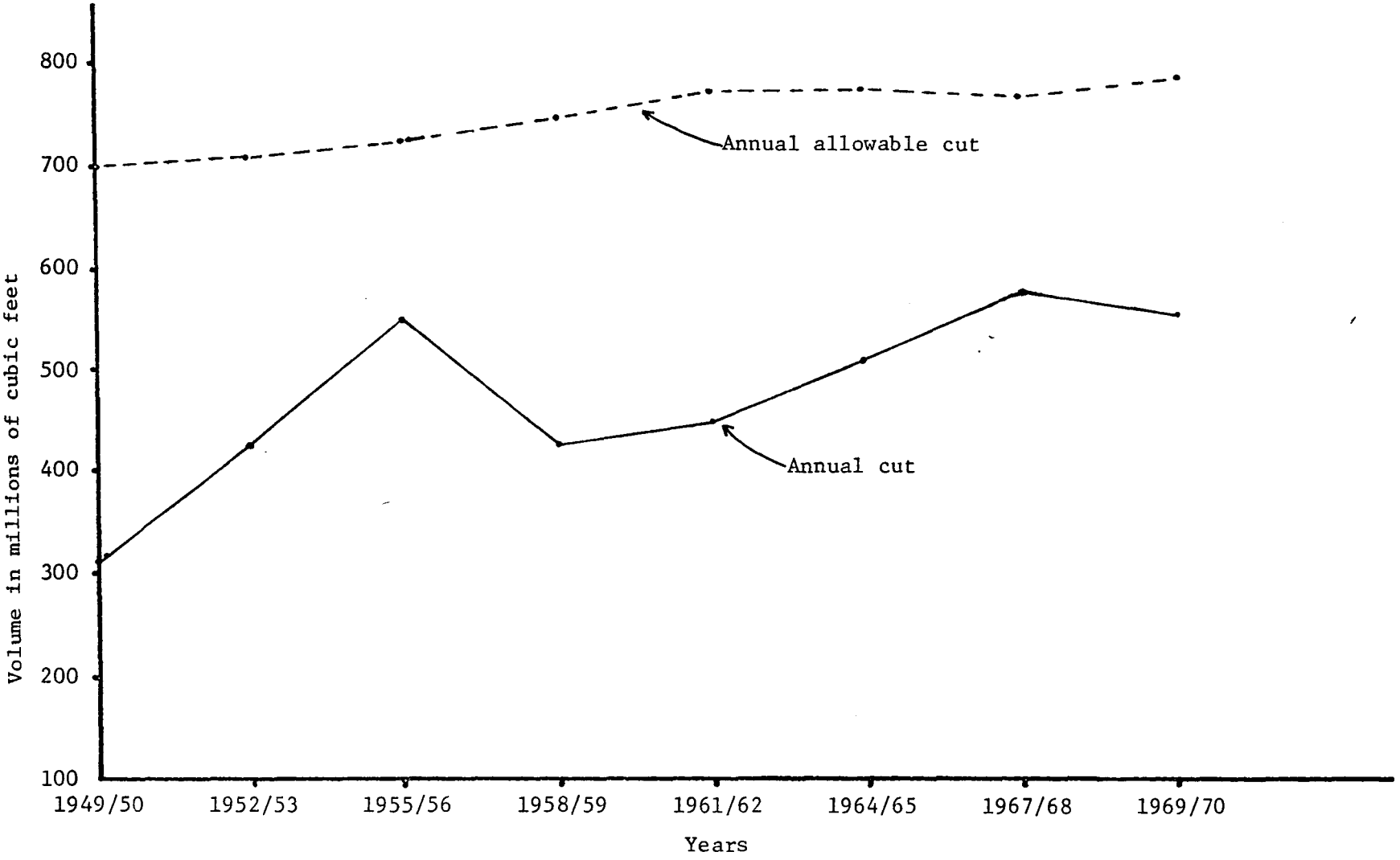

Figure 2. Volume of wood cut on the limits between 1949 and 1970 in comparison to the annual allowable cut

Source: Gouvernement du Quebec, Ministere des Terres et Forets. 1971. Expose sur la Politique Forestiere. p.187.

Figure 3 shows the quantity of wood cut by limit holders and sold on these same limits between 1949 and 1970. It is known that the total cut of wood in Quebec is around 10 million cunits. Of this 10 million, 70 percent comes from the public forests (Gouvernement du Quebec, 1971).

The location of the limits in relation to pulp mills is another factor that makes the limit system obsolete. The location of the pulp and paper mills may have been a good economic decision many years ago. But today, with increasing distances, the limit system is not very suitable to an optimal allocation of wood in Quebec. When companies first built their mills, the limit system was appropriate. However, today, with the increasing demand for wood by sawmills and the increasing cost of labor, change from the limit system to another allocation system should be investigated.

A transportation model may be the appropriate solution to the wood-allocation problem in Quebec. The preparation of such a transportation model necessitates a study of the different transportation systems used and of the different costs and constraints involved in determining the lowest possible supply cost for the pulp and paper mills of Quebec. The following chapters attempt to detail these factors.

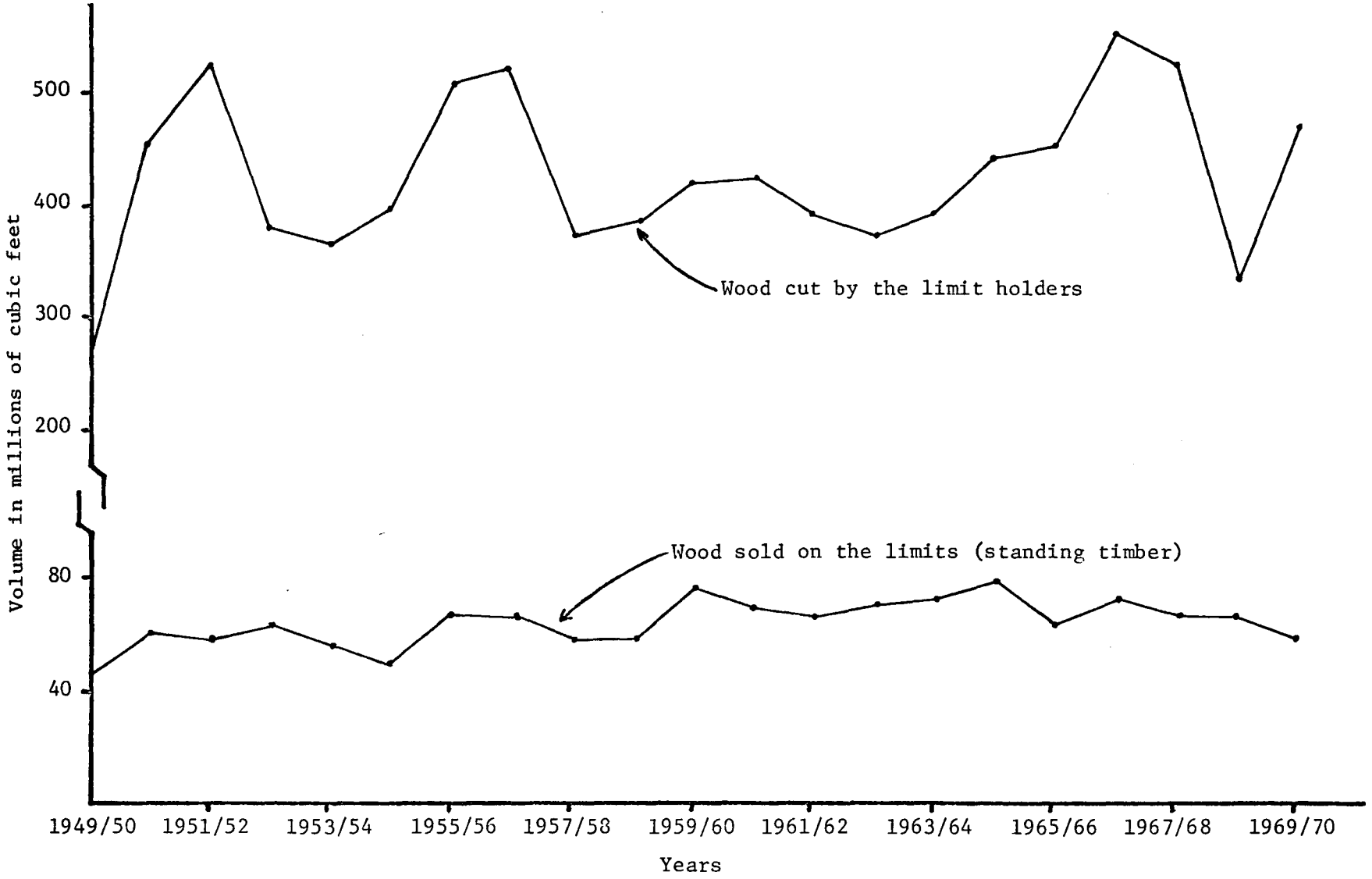

Figure 3. Wood cut and sold on the forest limits between 1949 and 1970

Source: Gouvernement du Quebec, Ministere des Terres et Forets. 1971. Expose sur la Politique Forestiere. p.189.

CHAPTER 2

THE PULPWOOD-TRANSPORTATION SYSTEMS USED IN QUEBEC

2.1 Definitions

In this chapter, attention will focus upon different methods used in the secondary transportation of pulpwood in Quebec. Lachance (1967) describes secondary transportation as "the transportation in various forms, by various methods and equipment, and in one or more phases, of raw material from the roadside to the mill, blockpile, or woodroom."

The operations of loading and unloading will be included in secondary transportation. The reason is that these two operations are directly related to the system of transportation employed.

Writers on the subject identify two categories of transportation systems, the ones readily available and those under development.

A. Systems readily available:
    1. Road
    2. Rail
    3. Water
        a. River-drive
        b. Boat-barge
        c. Rafting

B. Systems under development:
    1. Pipeline
    2. Air (helicopter and balloon)
    3. Belt

Presently in Quebec, only the first three systems are utilized, and very few experiments have been undertaken concerning the last three or any other forms.

A variation in the use of these systems over time has been noted. Figure 4 shows that the river drive lost a little of its dominance between the years 1951 and 1969. On the other hand, road transportation has gained popularity among the forest-industry owners. Later in this chapter, we will try to show what the trend will be in future years and what could have been the causes of past variation.

Between 1956 and 1969 the transportation of wood by rail stayed almost at the same level of use, showing only a slight decrease. The boat-barge method experienced growth between 1951 and 1956, principally because of the coming of the Anglo-Canadian Pulp Company and its use of barges (see part 2-222). After a period of stability between 1956 and 1960, a very significant drop occurred, relatively speaking, in boat-barge transportation. Two main causes explain this drop. First, between 1961 and 1969, many major companies increased their production of wood without utilizing the boat-barge method of transportation. Second, the financial situation of the owners of the boats and barges became very insecure, and many abandoned their operations. Table 2 gives the figures in percents for each method recognized in Figure 4.

The variations between land and water transportation can to some degree be explained on economic and geographic grounds. Fewer small streams are being used, since hauling by trucks to major rivers has been rated more economical in some regions. Meantime, many supply sources had

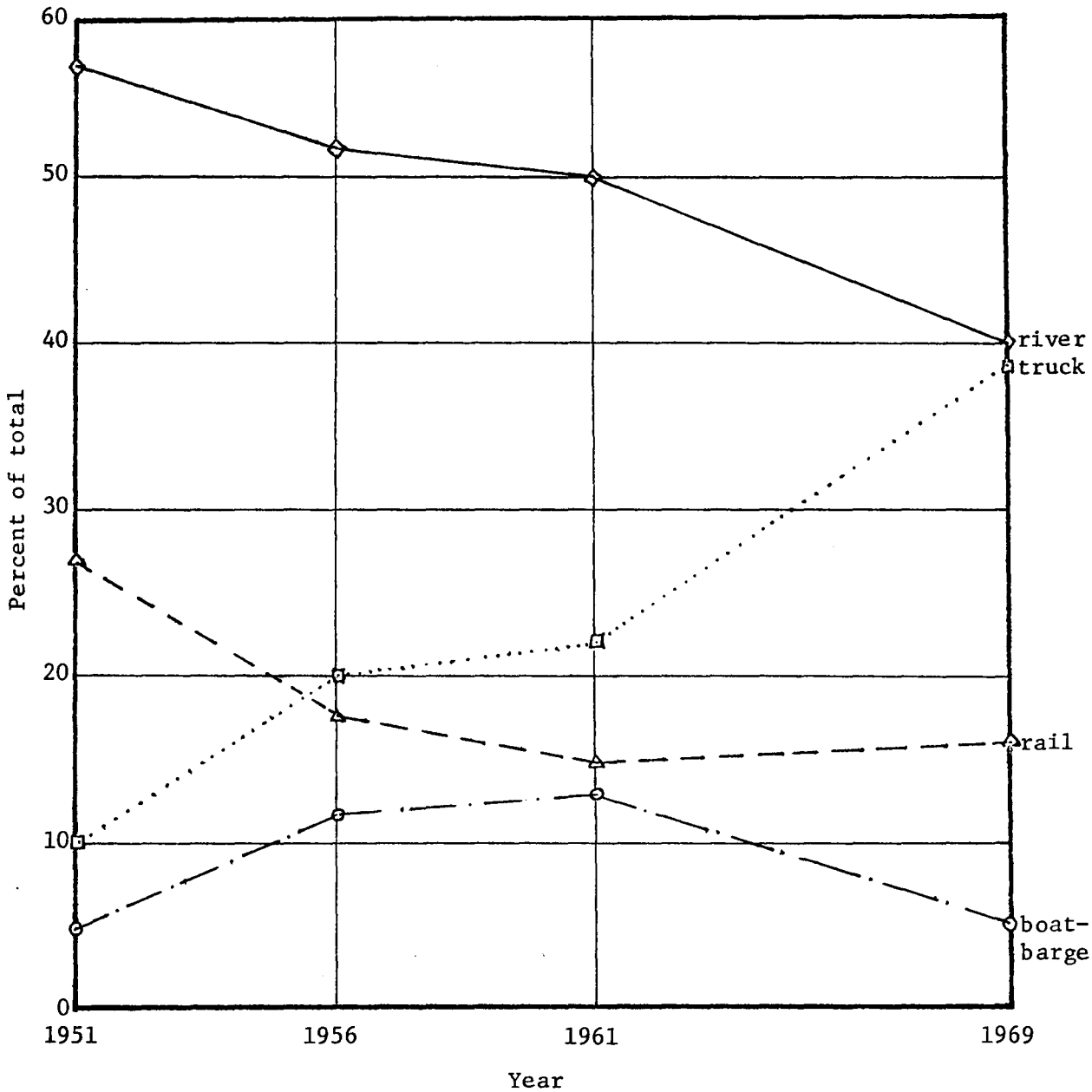

Figure 4. Secondary transportation of pulpwood, by method, between 1951 and 1969

Source: Paterson, W. G. 1971. Transport on forest roads--1980. Canadian Pulp and Paper Association, Woodlands Section Index 2597. p.1.

Table 2. Pulpwood delivery by method as a percent of the total annual production

	1951-52	1961-62	1969-70
WATER			
River-driving	58	50	40
Boat-barge	5	13	5
TOTAL	63	63	45
LAND			
Rail	27	15	16
Truck	10	22	39
TOTAL	37	37	55

Source: Lachance, Roger A. 1967. The secondary transport function and its major problems. Canadian Pulp and Paper Association, Woodlands Section Index 2426.

to be drawn upon to meet the increasing demand. Because of its inherent inflexibility, transportation by rail was not immediately available in new supply regions. This is why railroad transportation was so inactive between 1961 and 1969. However, delivery by trucks has become more advantageous in many regions where a road network already exists.

By comparing in Figure 5 the irregular flow pattern of pulpwood during a year to the stable monthly requirements, it is reasonable to suppose that the gap between land and water transportation will continue to increase in favor of land transportation. Companies prefer a constant incoming supply with small, stable inventory to a fluctuating supply and inventory, because of the cost of keeping a large inventory.

2.2 Discussion of the different systems

The different systems mentioned in section 2.1 are discussed next.

2.21 Land transportation

Land transportation is composed of truck and railroad transportation.

2.211 Truck transportation

According to Lachance (1967), "It is not exaggerating to say that over 80 percent of all pulpwood produced in eastern Canada, including Quebec, in 1967, was moved by trucks for some part of the distance from the secondary landing to the mill." There is no doubt that this figure, or a higher one, applies today.

Tables 3 and 4 give, for each major pulp and paper company in Quebec, the distances that wood was transported on private and public roads compared with other methods for the years 1970-71 and 1971-72.

Truck transportation can be divided into two categories: transportation on private roads and that on public roads. Which category is

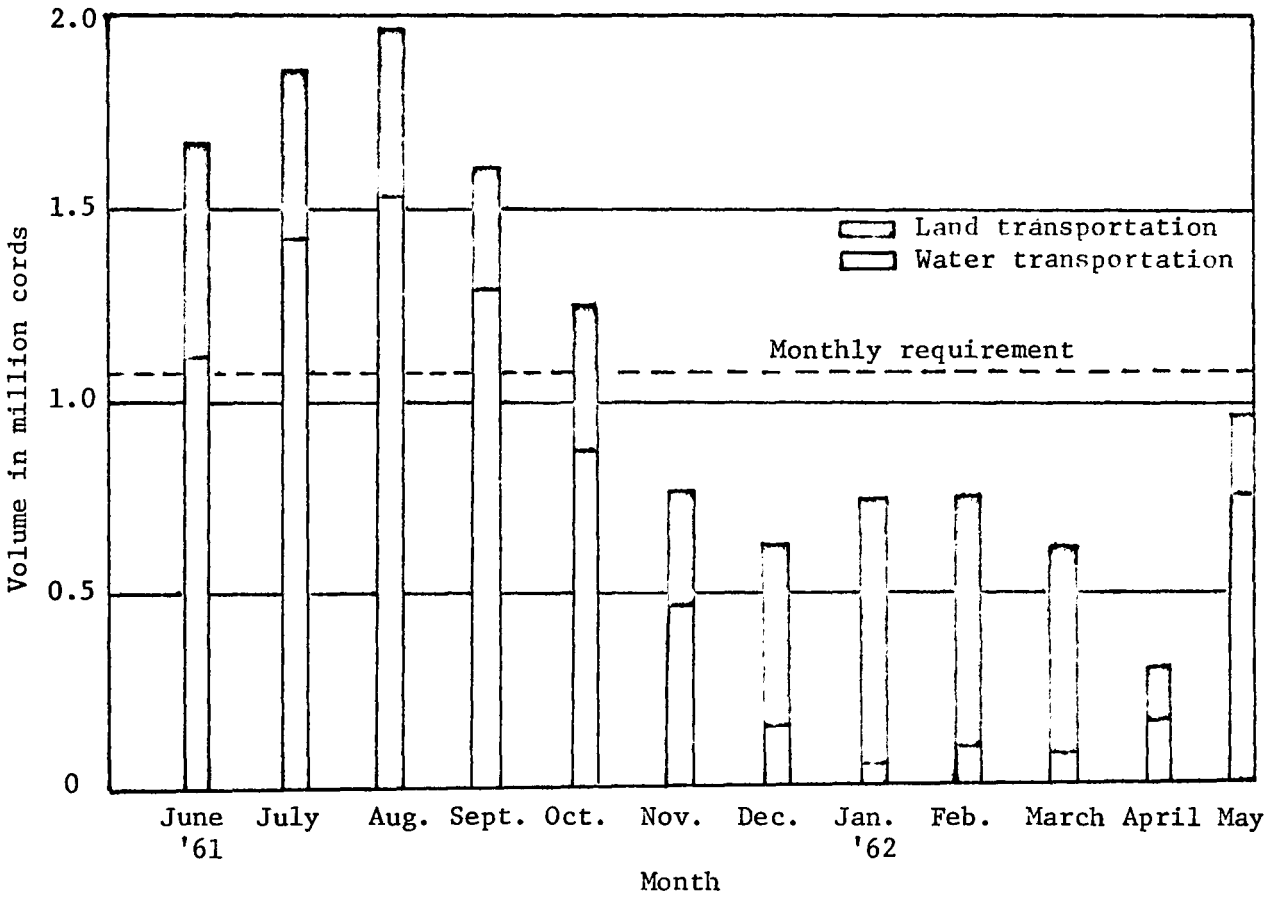

Figure 5. Pulpwood requirement and delivery by month for 1961-62

Source: Buell, A. F. 1962. Proceedings of the Wood Transportation Conference sponsored by the Traffic and Woodlands Sections. Introduction paper. p.2.

Table 3. Transportation distances and volumes by company and division, 1970-1971

COMPANY	DIVISION	CUNITS TRANSPORTED	MILES						
			OFF ROAD*	PRIVATE ROAD	PUBLIC ROAD	RAILROAD	DRIVING	BOAT-BARGE	TOTAL DISTANCE
ANGLO CANADIAN P.& P.	Forestville	306,000	23	--	--	--	70	170	263
CONSOLI-DATED BATHURST	St. Maurice	478,782	--	--	--	--	--	--	155**
	Saguenay	147,547	--	--	--	--	--	--	290**
	Chaleurs	208,146	--	40	--	--	--	--	40
	Ottawa	148,749	--	--	--	--	--	--	140**
C.I.P.	St. Maurice	296,460	--	15	--	--	150	--	165
	Maniwaki	420,000	--	--	--	--	--	--	210**
	Noranda	118,300	—	20	--	--	250	--	270
DOMTAR	Quevillon	196,000	2	--	23	--	--	--	25
	Dolbeau	80,000	1	10	--	650	--	--	661
	J. Cart.	102,586	8	--	--	--	35	--	43
E.B. EDDY	Coulonge	64,450	--	20	--	--	210	--	230
	Dumdine	20,560	--	50	--	--	185	--	235
		1,775	--	10	--	--	180	--	190
		19,975	--	15	--	--	110	--	125
		3,750	--	46	--	--	--	--	46
GASPESIA	Gaspe-	39,476	.15	5	30	70	--	--	105.15
	Chandler	8,619	.15	1	16	--	128	--	145.15
		55,280	.15	23	4	--	--	--	27.15
KRUGER	Abitibi	55,952	3	4	--	535	--	--	542
JAMES MacLAREN	Mt. Laur.	105,000	--	25	--	--	145	--	170
	Thurso								
PRICE	Saguenay	97,300	9.5	--	--	--	125	--	134.5
		71,200	6	--	--	--	75	--	81

Table 3. Transportation distances and volumes by company and division, 1970-1971 (continued)

COMPANY	DIVISION	CUNITS TRANSPORTED	MILES						
			OFF ROAD*	PRIVATE ROAD	PUBLIC ROAD	RAILROAD	DRIVING	BOAT-BARGE	TOTAL DISTANCE
Q.N.S.P.	Baie Comeau	314,000	.15	6	--	--	100	11	117.15
ST. RAYMOND	Desbiens	36,800	.13	18	112	--	--	--	130.13
	St. Raymond	6,350	.15	15	15	--	--	--	30.15

*Equivalent of primary transportation

**Breakdown not available

Source: Logging Operations Group. Canadian Pulp and Paper Association.

Table 4. Transportation distances and volumes by company and division, 1971-1972

COMPANY	DIVISION	CUNITS TRANSPORTED	MILES						
			OFF ROAD*	PRIVATE ROAD	PUBLIC ROAD	RAILROAD	DRIVING	BOAT-BARGE	TOTAL DISTANCE
ANGLO CANADIAN P.& P.	Forestville	264,100	23	--	--	--	70	170	263
ABITIBI	Beaupre	30,000	--	30	--	--	--	--	30
CONSOLI-DATED BATHURST	St. Maurice	494,008	5	3	3	--	119	--	130
	Chaleurs	70,000	4	16	12	--	--	--	32
	Saguenay	87,345	6	18	--	--	7	260	291
	Ottawa	64,416	--	19	47	--	58	--	124
C.I.P.	St. Maurice	380,000	.25	16.4	--	--	210	--	227
	Maniwaki	326,000	2	--	--	--	172	--	174
DOMTAR	Quevillon	262,000	--	23	--	89	--	--	112
	Dolbeau	124,218	8	--	--	--	40	--	48
	J. Cart.	75,700	--	--	--	--	60	--	60
	East. To.	103,050	--	9	73	--	--	--	82
	St. Alex. des Mont	21,900	--	--	80	--	--	--	80
DONOHUE	Clermont	67,113	6	2	2	--	39	--	49
E.B.EDDY	Hull	147,693	--	23	2	--	178	--	203
GASPESIA	Chandler	89,810	11	20	15	--	--	14	60
KRUGER	Abitibi	52,073	3	5	--	535	--	--	543
PRICE	Saguenay	344,000	8	--	--	--	86	--	94
Q.N.S.P.	Baie Comeau	364,727	--	8	--	--	78	--	86
ST. RAYMOND	Desbiens	5,870	--	--	30	--	--	--	30

*Equivalent of primary transportation

Source: Logging Operations Group. Canadian Pulp and Paper Association.

used depends on availability.

2.2111 Truck transportation on private roads

Theoretically, there is no restriction upon dimension of vehicle or payload. But road conditions for the operation may be so poor as to affect significantly the payload and speed of travel. So road quality is the only major problem of hauling on private roads.

There is a close relationship between road quality and hauling efficiency, and the combined costs of road construction-maintenance and hauling have to be weighed to arrive at an optimum solution. The volume of wood that is planned to be moved on a road is probably the most important factor to be considered, since it will govern the original capital expenditure.

And, according to Lachance (1967), a general principle can be stated that "the longer the haul, the larger the payload should be, up to a point."

As a result of the present system of limits in Quebec, the pulp and paper companies own a large network of private roads. However, these roads are not all of first quality, and many of them are simply logging roads. That is to say, they are used only during the harvesting period.

2.2112 Truck transportation on public roads

Transportation of pulpwood on public roads also presents problems. There are limits to the size of payload and equipment because of highway regulations. A part of this work will discuss these regulations, so for the moment, this constraint will not be described in detail.

2.2113 Pros and cons of trucking

Truck transportation is flexible. In a short time, one can change the flow of his supply, which is almost impossible with water and railroad transportation. Trucking also reduces inventory costs through a steady year-round flow to the mill, on the condition that one's supply schedule is well planned and that he can count on his truckers.

But logging roads are very expensive to build and to maintain. The low payload factor is very costly for hauls over 100 miles. Moreover, the highway regulations which restrict any increase of the payload limit the development of new equipment. In addition, public-relations problems with environmental groups induce some companies to slow their changes from other transportation systems to trucking.

Paterson (1971) noted some facts that are bound to influence the growth rate of pulpwood trucking over the next years.

"1. The remaining river driving-towing is probably 'hard' and durable in nature, i.e., it exists on a basis of earlier long-range planning based in turn on lower interest rates than we shall probably see for some while, and hence will not be given up unless so required by legislative action.

"2. Boat-barge movement involves special water requirements (depths) which are not widely available throughout the industry.

"3. Radically new methods of overland transport normally go through a gestation period of four to seven years, followed by prototype modifications and then gradually widespread adoption. Based on this industry's acceptance of the power saw and then the skidder, a radically new

concept in carriers would have to be evident now in order to become commonplace by 1980: The only qualifiers would appear to be the ground-effect machine[2/] and the solid pipelines."

According to Hyde and Corder (1971), "trucks offer versatility because they can operate on an existing extensive highway system and can be self-unloading or use unloading facilities at a central receiver."

2.2114 Trucking costs

Trucking costs can be discussed under two headings: (1) where the objective is to attain the lowest possible cost for the truck-transportation system, choosing the best network of routes; (2) where the objective is to choose among transportation systems.

In the first case, there are two major cost headings: fixed and variable costs. Duerr (1960:61) defines fixed cost as "the cost of fixed input, that which does not change with output or with whatever alternative is being studied." And always, according to Duerr (1960), variable cost is "the cost of variable input, that which does change with output or with whatever alternative is being studied."

In the second case, considering the minimization of costs among transportation systems, the cost function can be divided into three headings: fixed costs, variable costs, and profit and return on investment. The first two have the same definitions as in the first case. Profit and return on investment can be defined as the monetary surplus left to a producer or contractor after the deduction of the cost of his

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[2/] This is the land equivalent of the hovercraft.

other inputs. The idea to consider profit and return on investment as a third category of cost comes from Hyde and Corder (1971).

At this point we would like to list the costs involved in truck transportation. They are (1) insurance, (2) depreciation, (3) licenses, (4) interest, (5) fuel, (6) tires, (7) maintenance, (8) direct labor, (9) supervision, (10) overhead, (11) profit and return on investment, (12) loading and unloading.

2.2115 Cost of transportation by truck

Cost of transportation in the trucking industry can be set in three different ways, depending on truck ownership.

The first cost system is based on internal accounting, where the wood company owns its own truck fleet. How transportation costs are determined is a completely internal affair, and the figures are unknown. The accounting system varies from one company to another.

The second system applies to all the independent truck owners (excepting contractors). They are organized under an association named "Association Nationale des Camionneurs Artisans, Inc." (ANCAI). The role of this association is to protect the small truckers and to establish parity among the prices that they receive for their work.

Finally, there are the small and medium contractors, whose prices are determined by bidding on contracts for transportation.

After studying each of these three possibilities, the company will choose the one that minimizes its total procurement cost.

2.212 Railroad transportation

Only two railroad companies exist in Canada and in Quebec, the Pacific Canadian and the Canadian National. The latter is the property

of the Canadian government and was formed by the merging of many private lines in 1919. The former is a private corporation organized in 1885. These two companies are regulated by the Canadian Transport Commission, a federal agency. Quebec's government has no authority over these two companies.

As Masson (1971) says in his article, "Railways are suited to high volume, high tonnage, and medium- or long-distance hauls; but economy can only be achieved if the traffic moves uniformly." So in some instances rail transportation and truck transportation are not in conflict. They can be considered as two complementary agents in a transportation system.

Some railroad companies are seriously considering extending their season of shipping to a full year. Such action allows the railroad to lower its average fixed costs per load. It also increases the financial feasibility of supplying more expensive and more specialized equipment at rates which are acceptable to the wood industry.

Railroad transportation of pulp raw material can be divided into two main sections, transportation of wood in round form and transportation of wood in chip form.

2.2121 Railroad transportation of roundwood

According to Lachance (1967) "A few years ago, a problem existed between the railroad companies and the pulpwood industry. The prime reason was the woodland operations themselves, these being rigidly framed, making shipping capacity seasonal. . . . This prevented the railroad companies from designing special pulpwood cars, because it was not economical to do so with equipment used only a few months a year."

And Lachance (1967) continues, "The main problems of roundwood shipment by rail are:

1. To maximize the use of pulpwood cars (12 months a year).
2. To find a better mechanical loading method for bulkhead wrap-around flat cars.
3. To avoid peaking of shipments and thus eliminate the need to have a large number of hauling units at one moment.
4. To minimize car turn-around time.
5. To maximize the volume of the load.
6. To ship a maximum volume from a minimum number of points."

This serves to illustrate that the railroad industry is less flexible than the trucking industry. But with the cooperation of the two, the transportation of roundwood by rail could be a feasible enterprise.

2.2122 Railroad transportation of chips

Chips are by nature a low-density material, and maximum compactness must be attained to load them to their maximum density and the car's capacity. The railroad industry has to face the situation of an increasing demand for chips by the pulp and paper industry. Some pulp and paper mills have transformed their reception yards, but these transformations are not standard from one mill to another. Therefore, the development of new equipment is a problem.

2.2123 Pros and cons of railroad transportation

Two main benefits favor the use of railroads in wood transportation. First, rail cars have a high capacity. Gondolas or flat cars adapted for pulpwood transportation have a capacity of at least 20 cords, compared to the 5- to 15-cord capacity of trucks. Secondly, railways can operate

all year around, regardless of weather. This decreases inventory at the pulpmills and, as a result, production costs. A third benefit is that the rail system is practically pollution-free.

On the other hand, the use of railroads entails disadvantages. Movement by rail really presupposes the elimination of the other transportation systems, a step that the managers of the pulp and paper industry hesitate to take. Furthermore, the railroads' high capitalization implies a very long-term amortization.

2.2124 Railroad costs

According to Mitchell (1963), "The total cost of moving traffic by railway includes those items of cost which vary with the volume of traffic hauled," or variable cost. The variable cost is the cost below which a rate cannot legally be set if it is to provide any contribution to overhead and to profit. Mitchell continues, "It should be noted that the costs which are unrelated to traffic volume--e.g., certain supervisory and overhead expenses--are in no way connected with the establishment of the rate floor."

The major items of expense that vary with traffic volume are the following:

1. Maintenance of equipment (cars, locomotive, and caboose).
2. Depreciation and interest on investment in equipment.
3. Fuel.
4. Wages of train crews.
5. Incidental train supplies.
6. Maintenance of roadway.
7. Wages of yard engine crews, yardmasters, etc.

8. Superintendence and train control--i.e., supervisory line employees and train dispatchers.

9. Servicing of locomotives prior to dispatch.

10. Car distribution and waybilling.

11. A portion of certain other costs such as equipment expense, shop and power plant machinery, sales staff, and other general staff which would be directly affected by the volume of traffic hauled.

2.2125 Cost of transportation by railroad

The tariffs charged by the railroad companies are contracted between them and the different pulp and paper companies. They are termed "agreed charges." These contracts are valid for a certain period of time and are determined in the following manner. A destination point is fixed--say, La Tuque (C.I.P. mill)--followed by different loading points. In the next step, classes of weight in pounds are determined. The rates are expressed in pennies per 100 pounds. Tables 5 and 6 are two examples of these agreed charges. Table 5 is for the Canadian National and C.I.P., and Table 6 is for the Canadian National and Consolidated Bathurst.

According to the Canadian National, the increase in rates is on the order of 6 to 8 percent a year or when each contract is signed. In the case where a pulp and paper company does not take advantage of these special rates, the Canadian National can cancel the preferential tariffs. If the company wishes to use the railroad thereafter, it will have to pay the regular tariffs, which are higher than the agreed charges.

2.22 Water transportation

Water transportation is utilized as mentioned in section 2.1, in three situations in Quebec: river driving, boat-barge, and rafting.

Table 5. Tariffs (pennies per 100 pounds) for the transport of chips and sawdust from different towns of Abitibi to La Tuque (1)

Town	Minimum weight of the load		
	55,000 pounds	70,000 pounds	84,000 pounds
Amos	29	24	22.5
Baraute	28	23	21.5
Beattyville	29	24	22.5
Chibougamau	33	28	26.5
Colombiere	28	23	21.5
Dufresne	28	23	21.5
Val d'Or Sub.	28.5	--	--
Landrienne	31	23	21.5
La Sarre	31	26	24.5
Macamic	28	26	24.5
Malartic	36.5	23	21.5
Matagami	32.5	30.5	29
Noranda	26	27.5	26
Press	27	21	19.5
Senneterre	31	22	20.5
Tachereau	28.5	26	24.5
Val d'Or	--	23	21.5

(1) Tariffs negotiated between C.I.P. and the C.N.R., effective January 1, 1973.

Source: Canadian National.

Table 6. Tariffs (pennies per 100 pounds) for the transport of chips, sawdust, and pulpwood from different towns of Abitibi and St. John Lake to Trois-Rivieres (1)

Town	Minimum weight of the load					
	60,000	70,000	77,000	85,000	100,000	140,000 (2)
Baraute		41	40	39	37	36
Beattyville		43	42	41	40	39
Cameroun Lake		45	44	43	42	41
Chapais		41	40	39	37	36
Chibougamau		41	40	39	37	36
Desmaraisville		43	42	41	40	39
La Dore	33	31	29	27	--	--
Millage 119	45	--	--	--	--	--
Miquelon		43	42	41	40	39
Opawika		43	42	41	40	39
Quevillon		43	42	41	40	39
Relique		43	42	41	40	39
Roberval	31	29	27	26	--	--
Rochebaucour		42	41	40	39	38

(1) Tariffs negotiated between Consolidated Bathurst and the C.N.R., and effective August 5, 1972.
(2) Tariffs for pulpwood.

Source: Canadian National.

The following sections discuss each of these situations.

2.221 River driving

As noted on page 15, river driving still represented 40 percent of the total volume of wood transported in 1969-70. Despite a continual drop since 1951, this is still the preferred system. Truck transport accounted for 39 percent of the wood in 1969-70.

Delivery of pulpwood by river driving is the slowest process of transportation if we consider a year's production (period of harvesting). In fact, the wood cannot reach the mill in the same year, but only 5 to 10 months after cut. However, it is a relatively cheap system compared with others.

During past years, many factors--increases in labor costs, interest rates, and others--have raised more and more questions concerning river driving. And as Lachance (1967) observed, "The slow delivery rate of driving often offsets the cheap cost of the operation when balancing all contributing factors such as sinkage, interest on wood inventory, brooming losses, blockpile cost (like it or not, our traditional blockpile at the mill is closely associated with river driving), increased bleaching cost because of blockpile storage, etc."

Concerning the future of river driving Hughes (1967) wrote, "Driving of wood over both short and long distances is far from becoming obsolete. This is especially true with reference to the driving and terrain conditions similar to those found in the Shipshaw management area and on many similar areas in Quebec." (The Shipshaw management area is a very rough region having many mountains and very few usable materials to build a road network.)

The decision whether to use a stream or river for driving is relevant from the point of view of managers of the different watersheds. Their decisions must take into account both the public interest and the cost of carrying on the business of the firms.

Presently the majority, if not all, of the pulp and paper companies in Quebec resort to river driving to supply part of their mills' requirements. Many regions, such as the Trois-Rivieres region, are supplied almost exclusively by river driving. For example, in the 1960s on the St. Maurice River, more than 1,000,000 cords of pulpwood were driven annually. Figure 6 shows the different in and out points on the river. The river supplied wood to seven mills, distributed among three companies. The administration of that activity was conducted by a company named Boom and Driving Co., Ltd.

2.2211 Pros and cons of river driving

River driving is simple, and, although declining, it is still the easiest method of transporting wood. However, river driving is seasonal and expensive because of the inventory problems. Also, hardwoods, a growing element in the production process, cannot be accommodated by river driving because they are too heavy to float. Increasing public-relations problems and political difficulties because of environmental concerns are two of the factors limiting the future of river driving.

2.2212 River driving costs

On big rivers, in contrast to all other systems of transportation, there are almost no fixed costs. In fact, if the river does necessitate any improvements, the costs can be charged to the staff that works on driving operations. As a result, almost the entire total cost is variable

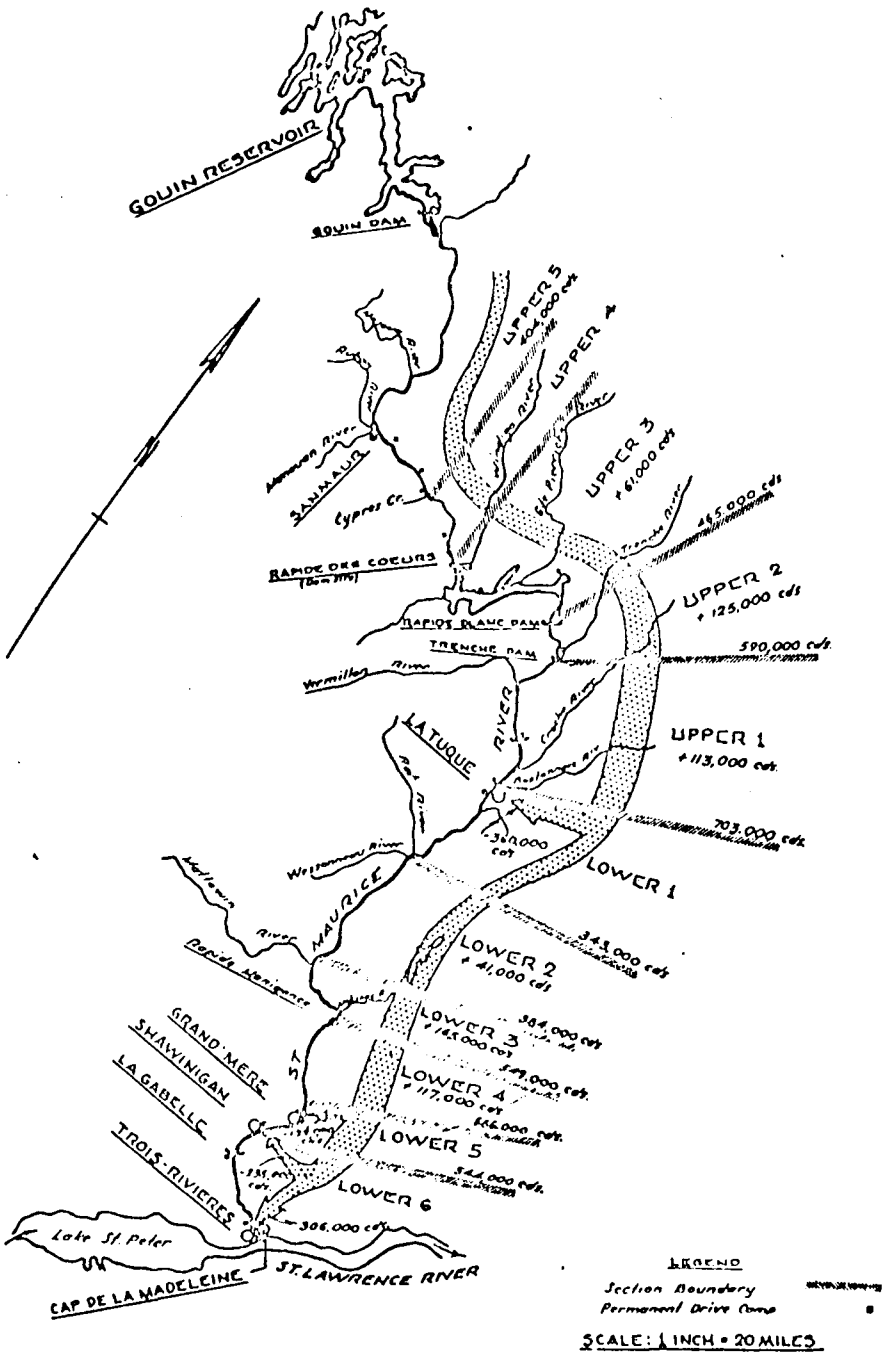

Figure 6. Where the largest log drive in the world is conducted

Source: Graham, H. E. 1962. Driving 1,000,000 cords a year. Canadian Pulp and Paper Association, Woodlands Section Index 2121. p.2.

over a year's period of time. Variable costs can be listed as follows:

1. Cost of unloading the wood in the river.
2. Cost of driving.
3. Cost of sweeping.
4. Cost of booms, dams, and improvements.
5. Cost of taking the wood from the river.
6. Interest on wood blockpile.

2.2213 Cost of transportation by river driving

Because the companies transport their own wood, the operation is part of the process of taking the tree from the stump to the millyard. The cost of driving is compared by the companies to the cost of supplying the mill by other systems of transportation.

2.222 Boat-barge transportation

The boat-barge transportation system, except in the case of one company, has almost completely disappeared today. The situation now existing for Anglo-Canadian Pulp and Paper Company is an exception. Both shipping and receiving operations are located on the St. Lawrence River. Barging is, for Anglo-Canadian, the most economical means of transporting the wood that it harvests. Its barges, with a capacity of 3,700 cords each, are loaded by a flume at Forestville and unloaded by a clamshell bucket at Quebec City. The distance covered between the two operations is 170 miles. High capital cost of loading plants and large vessels and unloading equipment make the major problem of boat transportation one of maximum utilization. Two considerations are as follows:

1. Because of the specialized character of the equipment, it is impossible to transport payloads both ways.

2. The time required for loading is very great.

It is for the foregoing reasons that the boat-barge method is so little used in Quebec. In addition, the seasonal character of the service can be added to other reasons why the use of boats and barges is declining.

2.223 Rafting and towing

Rafting and towing are not very important transportation systems in Quebec. Primarily they aid in the river-driving operation. For example, the Quebec North Shore Paper Co. transports the majority of its wood requirements by river driving. However, the river used by this company is dammed five times along its transport route, for hydroelectric power. So, on the lakes formed by the dams, the wood has to be towed.

2.3 Variants in secondary transportation

In almost all cases of pulpwood transportation in Quebec, one finds not one transportation system, but a combination of two or more. In many instances, it is impossible for a company to transport its wood economically to its mill by using only one system. Some illustrative examples follow:

1. Anglo-Canadian Pulp and Paper Company uses truck, river driving, flume, and barge from the north of Forestville to Quebec.

2. Donohue uses truck, boat, and again truck from the south shore of the St. Lawrence River to Clermont.

3. Domtar uses truck and river driving from Laurentides Park to Donnacona.

4. Quebec North Shore Paper uses truck, river driving, towing, rafting, and flume from the north to Baie-Comeau.

Figure 7 shows the different transportation systems used by these companies.

The following chapter presents the changes proposed by Quebec's government in the land-management system.

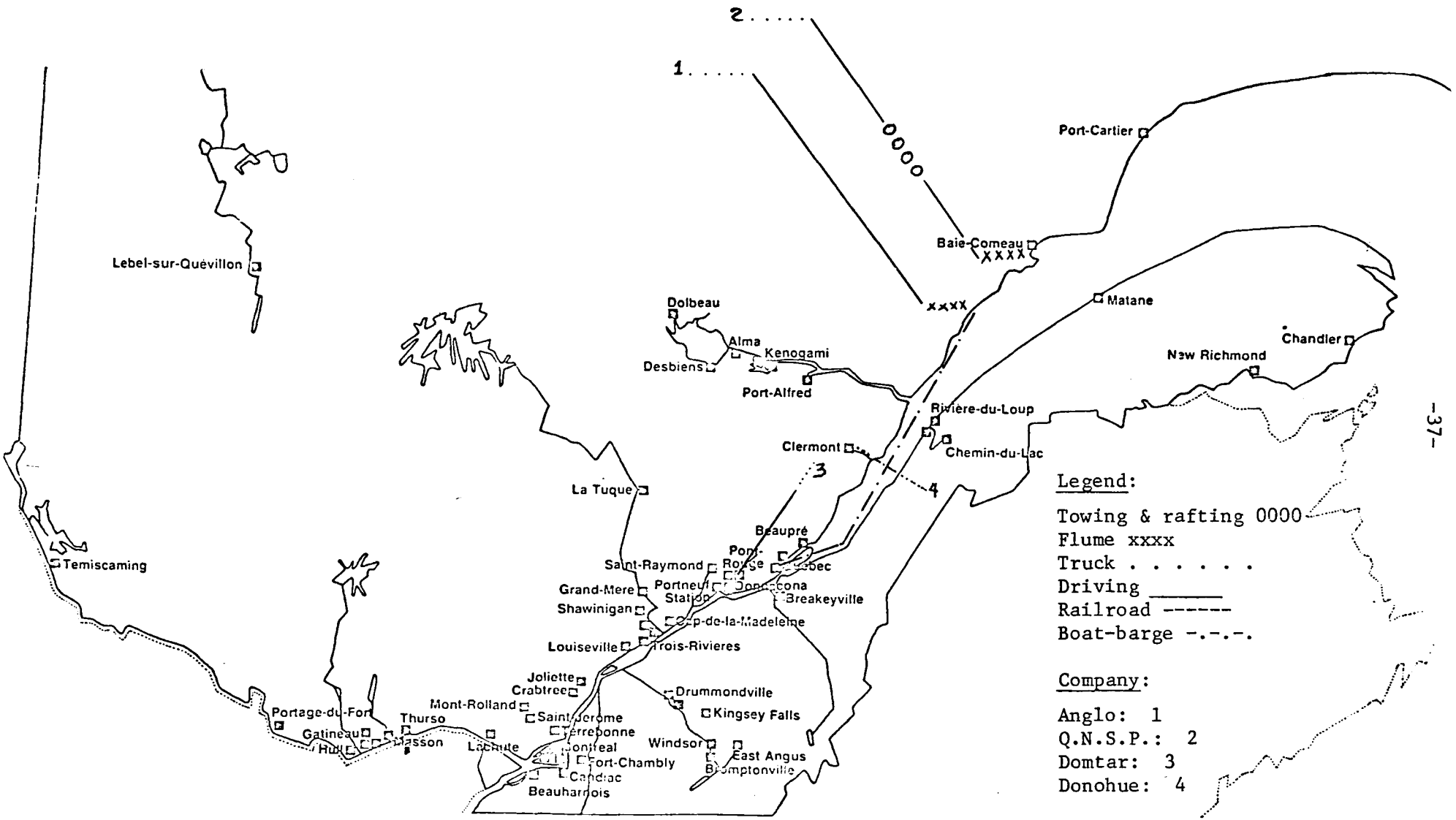

Figure 7. Transportation systems used by four companies

CHAPTER 3

CHANGES PROPOSED BY THE GOVERNMENT IN THE LAND-MANAGEMENT SYSTEM

The Department of Lands and Forests intends to separate the two functions, forest management and resource allocation, which are combined in the limit system. Consequently, many changes are proposed in the "Expose sur la Politique Forestiere, Tome 2, Reforme et Programme d'Action." This chapter presents an abstract of these changes.

3.1 Forest-management systems

In the "Expose sur la Politique Forestiere, Tome 2," forest management is defined as the whole operation required to administer a forested area--inventory, mapping, planning of cutting and silvicultural treatments, protection against destructive agents, and the construction of physical improvements. Management is defined to exclude all activity related to logging and to other forms of forest use.

For the public forests the Department of Lands and Forests proposes two systems of management, public and mixed systems. In the mixed system, the Department is associated with private industry and owners for the purpose of forest management. In the public system, the Department itself manages the forests.

The limits, township reserves, and other reserves will be abolished in their present form over a period of 10 years. The conditions of this change will be negotiated between the Department of Lands and Forests and the different permit owners according to a time table.

The lands removed from the present system and the vacant lands will be progressively formed into large management units of 1,000 square

miles or more each, corresponding to watersheds or inventory units (Figure 8).

3.11 Public land management

Public land management refers to the form of land management for the large units of forest production. It involves direct and total management by the Department of Lands and Forests.

3.12 Mixed management

In rural zones near private forests, parcels of public lands can be managed jointly with private-owner groups.

3.13 Private land management

The Department of Lands and Forests suggests many forms of management for private forests. Among them are the farm woodlot, the forestry farm, the forestry group, and any other forms compatible with the objectives of the forest policy, including the one proposed by the U.P.A.,[3/] the "Societe d'Exploitation Sylvicole."

3.2 Wood allocation

The Department of Lands and Forests intends to plan the wood supply for all the wood-using mills. In the public forests, new methods of wood allocation will be adopted, and the mechanism for setting dues (stumpage charges, protection fees, etc.) modified. For the private forests, an organization will be set up to regulate and fix the prices of products, which will be subject to allocation.

[3/] Union des Producteurs Agricoles.

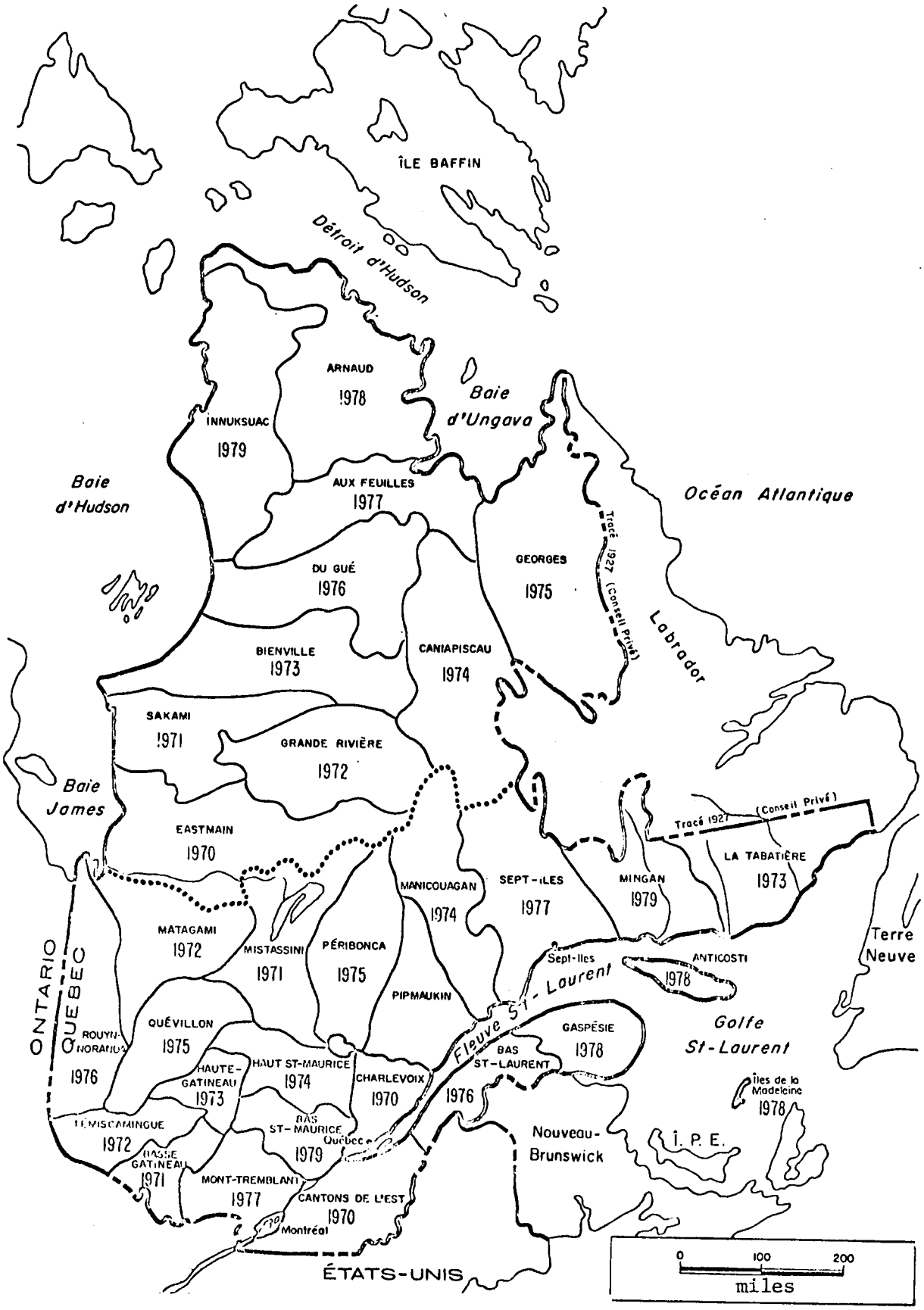

Figure 8. Decennial inventory program

Source: Gouvernement du Quebec, Ministere des Terres et Forets. 1971. Expose sur la Politique Forestiere, Tome 1. p.63.

3.21 Planning the wood supply for mills

The Department of Lands and Forests will undertake to plan the wood requirements for all mills from all sources, including imports. This will be accomplished through 5-year allocation plans established for each wood-using plant in collaboration with producers and users.

3.22 The mechanism of wood allocation in public forests

The allocation of wood will rest on two distinct bases--the natural and potential production capacity of the forests and the collective need for wood and forested areas. The following six principles are considered as the basis for arriving at the distribution of wood from the public forests:

1. Allocation of wood must be distinct from the allocation of land.

2. The notions of allocation, management, and logging must be considered separately.

3. Allocation must reflect the forest resource potential.

4. Allocation must be tied to social and economic development.

5. Allocation must promote the economizing of fiber through complete utilization of felled timber.

6. Wood distribution must reflect the multiple-use character of the forest.

3.3 Forms of allocation systems

The allocation will take three forms:

1. Contract.

2. Use permit.

3. Sale of government-produced wood.

3.31 Allocation by contract

Allocation by contract will involve long and medium-term contracts and will be used whenever stability of supply is required.

3.311 Long-term contracts

Long-term contracts will be reserved for the pulp and paper industry and will assure the right to harvest a given volume of wood of a designated description in a given area for a limited period of time. If investment levels exceed an established standard, and the value added in the manufacture of products reaches a fixed minimum, the time period will be a minimum of 20 years and a maximum of 40 years. All expired contracts will be renegotiable. The right to harvest will not include exclusive use of the land.

3.312 Medium-term contracts

Medium-term contracts will be of 5- to 10-year duration and will give the holder the right to harvest a given volume of wood of specified quality in a given area.

Implementation of allocation by contract will be spread over 10 years and will be tied into the program aimed at the abolition of limits.

3.32 Use permit

Use permits to cut timber on public lands will be issued mainly for small quantities of wood requested by small-scale manufacturers, logging concerns, farmers, and settlers. Maximum duration will be for 12 months and the permit will specify the quality, volume, and end use of the wood harvested. The same permit in simplified form will be required of contract holders for control purposes only.

3.33 Sale of government-produced wood

Occasionally the government will produce saleable wood, principally through Rexfor.[4/] Whenever possible, auction sales will be held. Volumes so disposed of will be included in distribution plans.

3.4 Accessibility of the forest

The Department of Lands and Forests will build and maintain, at public expense, the main forest access-road of a permanent character in the public forests of Quebec. These roads will be needed to develop the multiple uses of the forest.

The Department of Lands and Forests will establish the methods and means of assessing all potential users to determine the construction and maintenance costs involved. The development and maintenance of such roads will be planned for periods of 5 years and in consultation with the users. The implementation of this program will be entrusted to the "Societe de Gestion forestiere,"[5/] in collaboration with the Roads Department. The Society will have responsibility for controlling the use of these roads.

[4/] Societe de Recuperation et d'Exploitation Forestiere.

[5/] The "Societe de Gestion forestiere" or "Forest Management Corporation" will be a body established by the government. Its purpose will be the production of forest stands. Its technical services will deal with the inventory and management of state forests, the preparation of fiber allocation plans, and the preparation of logging plans. The Society "will be partly self-financed from management fees, and government contributions will also make up part of its budget."

3.5 Orientation of forest production

As is mentioned in the "Expose sur la Politique Forestiere, Reforme et Programme d'Action, Tome 2," the main emphasis for the next decades will be upon the supply of fiber for the wood industry, despite the competition for other uses of the forest.

During the next years, the need for wood and forested areas must be met while insuring permanency of supply and improving Quebec's competitive position in world markets. This will be achieved through planning forest production, protecting existing resources, and increasing silvicultural efforts.

To fill the gap between the timber demand and the timber-growth potential within each region, the following measures are recommended:

1. Improvement in the efficiency of allocation and conversion of wood.
2. Better forest protection.
3. Application of the sustained-yield principle on a 10-year basis.
4. Increase of the allowable cut by reducing the cutting cycle.
5. Silvicultural treatment, including reforestation if necessary.
6. Favoring natural regeneration of cut-over lands.
7. Reforestation of abandoned farm lands.
8. Guaranteeing the existence of forests used primarily for fiber production, protection of the environment, and recreation.
9. Optimizing the utilization of forested areas through better inter-sectoral collaboration.

An integrated system of forest and financial accounting will be required in order to assess the impact of production expenditure on the

cost of wood. Updating permanent forest statistics will be continued with priority given to the Decennial Forest Inventory program.

3.6 Effects of the new public land-management system on wood allocation

As an outcome, the changes in the land-management system will transform all the systems of allocation of wood to the mills. Presently the pulp and paper companies have transportation systems adapted to their allocation systems. But with the disappearance of the limits, supply sources of the mills will be moved, for many companies.

This movement will permit the government to assign wood with the lowest possible transportation cost to each mill. However, other costs and constraints are very significant in the determination of the supply sources for each mill. These constraints will be identified and analyzed in Chapter 4. For that purpose, a transportation model must be constructed to determine the optimal allocation system for the pulp and paper mills.

As is mentioned in Tome 2, (Reforme et Programme d'Action:72), the state will assume responsibility for access. This means that under pressures coming from many organizations, some transportation systems, such as river driving could be replaced by truck transportation. More and more, the public is becoming conscious of the pollution problem caused by river driving. An increase in the demand for forest recreation will further justify developing a road system, which could be used for the transportation of wood by truck.

CHAPTER 4

BASIC MODEL PROPOSED FOR INCREASING WOOD-TRANSPORTATION EFFICIENCY

An application of the linear-programming transportation model is proposed to minimize transportation costs. The different components needed are the objective function, the restraints, and estimates of the parameters. These are discussed in this chapter.

4.1 Definition of a transportation model

In almost all the literature covering linear programming, a definition of a transportation model can be found. It is a model for minimizing the cost of transporting a certain commodity from a number of sources to a number of destinations.[6/]

Mathematically, Dantzig[7/] defines a transportation problem as "a homogeneous product [in our case roundwood or chips] to be shipped in the amounts $a_1, a_2, \ldots, a_m$, respectively, from each of the 'm' shipping sources and received in amounts $b_1, b_2, \ldots, b_n$, respectively, by each of the 'n' shipping destinations. The cost of shipping a unit amount from the i^{th} source to the j^{th} destination is C_{ij}, and is known for all combinations (i, j). The problem is to determine the amount X_{ij} to be shipped over all routes (i, j) so as to minimize the total cost of transportation."

[6/] Taha, Operations Research, an Introduction. MacMillan Publishing Co., 1971.

[7/] Dantzig, Application of the Simplex Method to a Transportation Problem in Activity Analysis of Production and Allocation. Cowles Commission for Research in Economics, 1951.

The programming model is:

$$\text{Minimize} \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} \cdot X_{ij},$$

subject to the constraints

$$\sum_{j=1}^{n} X_{ij} = a_i \quad \text{where } i = 1 \text{ ------ } m$$

$$\sum_{i=1}^{m} X_{ij} = b_j \quad \text{where } j = 1 \text{ ------ } n$$

$$X_{ij} \geq 0.$$

It is noted that $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$.

(See Table 7.)

If this last statement is directly applied in a wood-transportation model, it means that the quantity of wood supplied from the public forests and chips from the sawmills is equal to the quantity of wood demanded by the pulp and paper mills.

In fact, the amount of wood available in Quebec considerably exceeds the current usage by the pulp and paper mills. The way to incorporate this fact is to create a dummy mill in the transportation model. The "n" destination would be a dummy mill where all wood not allocated anywhere else would go. The cost of transporting wood to this mill would be zero (Taha, 1971:126). (See Table 8).

When the optimal solution (minimum cost) is found, since the total cost of transporting wood to the dummy mill is zero, the solution is the minimum transportation cost for the pulp and paper mills requirements.

Table 7. Two sources by three destinations, hypothetical transportation matrix

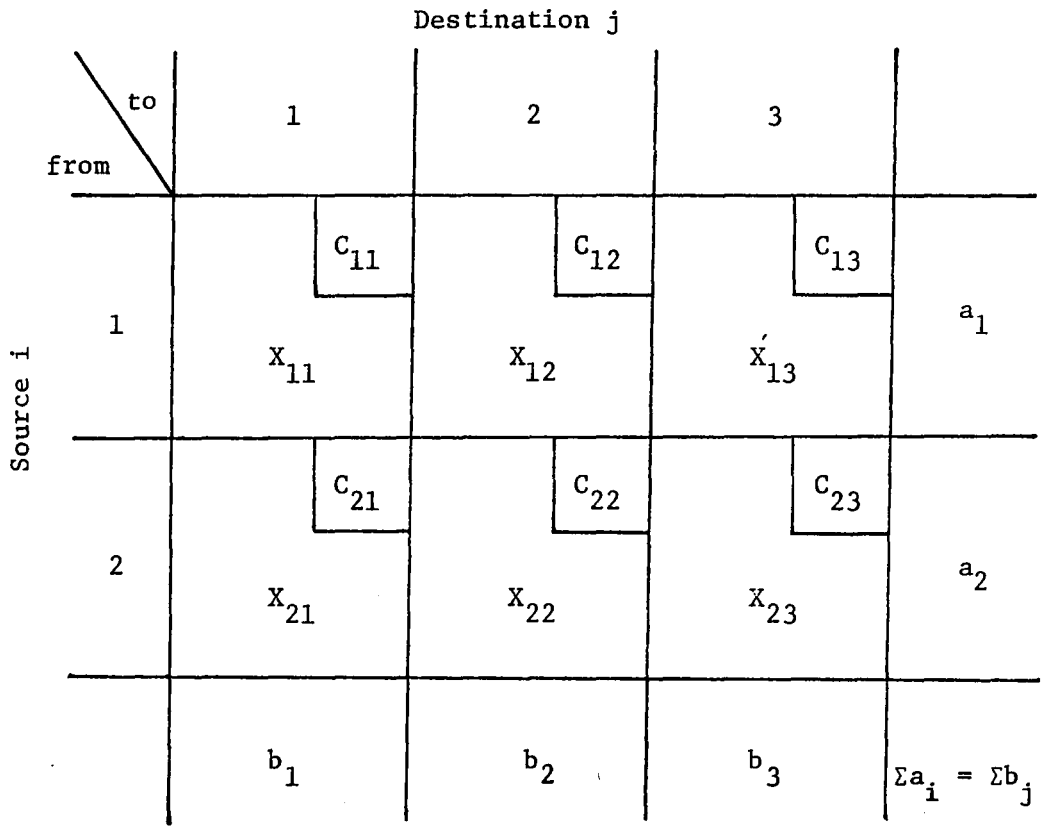

Table 8. "a_i" sources by "b_j" destinations, hypothetical transportation matrix, where the "n" destination is a dummy mill

Destination j

Source i \ to	1	2	. . .	n	
	C_{11}	C_{12}		0	
1	X_{11}	X_{12}	. . .	X_{1n}	a_1
	C_{21}	C_{22}		0	
2	X_{21}	X_{22}	. . .	X_{2n}	a_2
.	.	.	.	.	.
.	.	.	. . .	.	.
.	.	.	.	.	.
	C_{m1}	C_{m2}		0	
m	X_{m1}	X_{m2}	. . .	X_{mn}	a_m
	b_1	b_2	. . .	b_n	$\Sigma a_i = \Sigma b_j$

4.2 Transportation model in short and long run

In economic terms, "short run" is defined as the situation in which relatively many of the inputs are fixed. In the situation with which we are concerned, the locations of supply sources and of pulp and paper mills are fixed. Our problem in this respect is a short-run problem.

In the ultimate long run, all the inputs are variable. Even the supply sources can be changed. We could establish plantations near the pulp mills; moreover, the identity and location of pulp and paper mills could change. Portable mills that move to the location of mature timber are not impossible, considering the progress of technology. In the long-run case, then, the transportation problem becomes one of location or of advancement in technology.

4.3 Supply sources

The supply sources can be divided and discussed under two main headings: first by geography and second, by species.

4.31 Location of supply sources

The Department of Lands and Forests is presently planning to make an extensive inventory of the forests of Quebec.[8/] If the inventory zones are divided into blocks of 50 square miles, the degree of precision of the inventory will be very high. The data needed in the calculation of the allowable cut are given for the Mingan zone as an illustrative case in Appendix 1. The Mingan zone can be found in Figure

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8/"Les Forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan."

8, Chapter 3.

Figures are provided for each of the following categories of forest lands:

1. Productive forest lands--lands bearing or able to bear a volume of 400 cubic feet per acre.

2. Unproductive forest lands--lands that will never be able to bear a volume of 400 cubic feet per acre.

3. Exploitable forest lands--productive forest lands carrying a mature stand.

4. Nonexploitable forest lands--productive forest lands with stands at the pole stage or stands with low yield. The inaccessible forest lands are included.

The annual allowable cut is determined by species or for a group of species.[9/] The unproductive and inaccessible lands are not considered in the determination of the allowable cut. Two types of management may exist--extensive and intensive. For each, the determination of the annual allowable cut is different. The annual allowable cut set by the Government will then be used to determine the location and quantity of wood available to the pulp and paper mills.

4.311 Extensive management

4.3111 Even-aged stands

In the case of the determination of the annual allowable cut for an even-aged stand, the method employing the conservation equations

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9/ "Les forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan."

of G. Tardif is used by the Quebec Government. This method represents each stand or group of stands by a mathematical model which describes its evolution over time. The objective function of this model is to minimize the residual volume of mature timber not harvested at the end of the rotation. The model includes the following variables: the age structure of the stands, the rotation or the absolute rotation age, and the yield at maturity or rotation age. The solution of the model allows the user to determine the allowable cut as a function of time, to reveal departures from the normal distribution of age classes, and to determine, at many stages during the rotation, which are the surplus mature stands.

The model can be represented in one of the following ways:

$$V_{ij} - t_{ij}P_{ij} - R_{i1} = 0$$

$$R_{i1} + V_{i2} - t_{i2}P_{i2} - R_{i2} = 0$$

$$R_{i2} + V_{i3} - t_{i3}P_{i3} - R_{i3} = 0$$

$$\vdots \qquad \vdots \qquad \vdots$$

$$R_{i(p-1)} + V_{ip} - t_{ip}R_{ip} - R_{ip} = 0$$

where

V_{ij} = volume (cunits) at maturity
forest type "i"
age class "j"

t_{ij} = time interval (years between two successive age classes)

$T_{ij} = t_{ij}$ rotation age of the stand "i"

R_{ij} = volume of the stands at maturity and still being unharvested at the end of t_{ij}

P_{ij} = annual allowable cut (cunits) of the forest type "i" during the period "j".

The significance of each equation is that at the beginning of each period, we dispose of a volume "V_{ij}"; during the interval "t_{ij}," we deduct "$t_{ij} \cdot P_{ij}$" and there remains a residual volume (≥ 0) which is reported or used in the next period. The conservation equations constitute an undetermined system of "p" equations and of "p-1" unknowns. This model is solved by an iterative process.[10/]

4.3112 Uneven-aged stands

For uneven-aged stands, the method used by the Government for determining allowable cut is to find the minimum diameter that can be harvested and which still allows the restoration of an economical volume of timber per acre and prohibits the growth of undesirable species. The minimum diameter is based on a residual basal area of 60 square feet. The method can be applied to the stands intended for sawmilling.

The procedure to follow in the determination of the allowable cut is--

1. Determine the basal area to cut (total basal area minus 60 square feet).

2. Determine the minimum diameter to cut--from tables.

[10/] For further details see: "Normes Provisoires d'Amenagement Forestier," Service des plans d'amenagement, M.T.F., Juillet 1973.

3. Determine the volume--from stock table.

4. Determine the cutting cycle.

a. Desired maximum diameter (table) minus residual stand maximum diameter.

b. From a table, the number of years necessary for the tree of the residual stand of maximum diameter to attain the maximum diameter of harvesting is determined. That value is the cutting cycle.

5. Determine the annual allowable cut--the total volume divided by the cutting cycle.

4.312 Intensive management

Intensive management is defined as management which includes silvicultural operations. The following two sections consider the bearing of such operations upon the allowable-cut calculation.

4.3121 Even-aged stands

When intermediate cuts are to be made in a stand, and the purpose is to correct the defects of a forest badly managed or to increase the volume of wood produced, followed by a final harvest at rotation age, the determination of the annual allowable cut can be accomplished as follows:

1. Use conservation equations to obtain the annual usable volume.

2. Determine the quantity of wood cut as thinnings.

3. The annual allowable cut is the sum of steps 1 and 2.

4.3122 Uneven-aged stands

The allowable cut in uneven-aged stands is designed as the number of trees and the volume to be harvested to give the stand an optimal structure. For each stand and principal species, distribution curves of tree numbers as a function of diameter class are established. The reader can refer to "Normes Provisoires d'Amenagement Forestier," published by the Department of Lands and Forests for further details.

4.32 Supply species

It is computationally impractical to deal individually with all the tree species required by the pulp and paper mills and the sawmills. Therefore, a certain degree of aggregation must be tolerated. We propose the following species groups:

Fir, black spruce ----------FBSP

White pine, red pine ----------WPRP

Jack pine ----------JP

Cedar ----------C

Tamarack, hemlock, etc. ----------Other softwoods

Yellow birch, maple, ash, oak, beech ----------BI

Poplar, aspen, paper birch ----------PO

Basswood, etc. ----------Other hardwoods

The method for determining the annual allowable cut discussed in the preceding sections can be applied to each of the species groups.

In addition to supply by species groups, the chips produced by sawmills must also be considered as supply sources for pulp mills (Table 9).

Table 9. The transportation matrix for the "m" sources and the "n" destinations

SOURCES		DESTINATION					
		PULP MILLS					
		1 FIR-B.SPRUCE	2 W.-R. PINE	---	---	N DUMMY MILL	SUPPLY
SOURCE UNIT NO. 1	JACK PINE 1	M	M			0	A_1
	FIR-B.SPRUCE 2	C_{11}	M			0	A_2
	W.-R. PINE 3	M	C_{12}			0	A_3
	CEDAR 4	M	M	---	---	0	A_4
	O. SOFT. 5	M	M			0	A_5
	BI. 6	M	M			0	A_6
	PO. 7	M	M			0	A_7
	O.HARD. 8	M	M			0	A_8
. . .		.		. . .	. . .		. . .
SOURCE UNIT NO X	JACK PINE A	M	M			0	A_A
	FIR-B. SPRUCE B	C_{X1}	M			0	A_B
	W-R PINE C	M	C_{X2}	. . .	. . .	0	A_C
	CEDAR D	M	M			0	A_D
	O. SOFT. E	M	M			0	A_E
	BI. F	M	M			0	A_F
	PO. G	M	M			0	A_G
	O.HARD H	M	M			0	A_H
CHIP PRODUCING SAWM'LLS	I	M	M			0	A_I
	J	M	M			0	A_J
	.	.	.	. . .	. . .	.	.
	.	.	.			.	.
	.	.	.			.	.
	M	M	M			0	A_M
DEMAND		B_1	B_2	...	...	B_N	

4.4 Demand sources

Considering only the pulp and paper industry, there are 59 mill destinations. However, each mill has different tree-species requirements; and each mill will be treated as many destinations, according to the number of species groups the mill uses.

Table 9 is an example of a transportation matrix. Suppose that the pulp and paper mill of Company X in Quebec accepts the species categories fir/black spruce and white/red pines. The fir/black spruce-using component of this mill is labeled destination no. 1, and the white/red pine-using component is labeled destination no. 2, and so on for all the mills.

As is stated in TRAM,[11/] ". . . compatibility with regards to species can be insured in the final solution by assigning a very large value (M) in the cost matrix to the unit cost of transporting between destinations and the corresponding incompatible sources."

4.5 Cost matrix

The cost matrix gives the cost of transporting 1 cunit or cord of roundwood (or the equivalent chips) from each source to each destination. The cost represented in the matrix is the lowest one among the transportation methods. From one source to one destination, the cost may be for trucking. From the same source to another destination, it may be for rail transportation or some combination of methods.

11/ Ontario Timber RAM, 1971.

4.6 Logging costs included in transportation model

For the purpose of our study, logging costs are defined as the costs incurred in felling, bucking, limbing, skidding, camp construction, and overhead. This definition applies to roundwood; the cost of logging for chips is approximated by their selling price.

The purpose of including logging costs in transportation costs is to derive the cheapest wood allocation. It would be disadvantageous to draw wood from sources whose transportation-cost advantage is more than offset by high logging costs. The desired system minimizes the sum of the costs of logging and transporting wood to its destinations. It is possible that the addition of logging costs to transportation costs can completely change the results of using a transportation model.

4.61 Method for handling logging cost

A method for handling logging or extraction costs was proposed by Henderson (1958). One need merely add the logging cost to the transportation cost. The result is the procurement or delivery cost.[12/]

Hence, in the construction of the allocation model, the costs entered in the cost matrix are the procurement or delivery costs.

In the following chapter, additional constraints which can be inserted into the model are presented.

[12/] Pouliot (1966) uses "procurement cost," and Henderson uses "delivery cost."

CHAPTER 5

CONSTRAINTS TO BE INSERTED INTO THE MODEL

After the development of a general transportation model and some variants, additional constraints can be imposed on the model. These constraints affect the model by making it more representative of reality. The constraints analyzed in this chapter will be political constraints, represented by laws governing transportation; economic constraints, expressed by wood coming from the private forests; social constraints, such as those imposed by the desirability of maintaining employment in each community; the constraints imposed by forest fires, insects, and diseases; and finally, the chips produced by the sawmills and other wood-using plants. These constraints are discussed below.

5.1 Regulations and laws on transportation

Among the most important constraints in the wood-transportation model are the regulations and laws governing transportation: those of both the provincial and the federal governments. Some of the aspects that will be discussed in the following sections are the laws and regulations on highway loads and size relating to the trucking industry, the watercourses acts relating to river driving, and the federal laws on freight rates and profit establishment relating to the railroad industry.

5.11 Laws and regulations on trucking transportation

On September 14, 1971, the Lieutenant Governor in Council signed Order in Council 3142, concerning the regulation respecting weight and dimensions of motor vehicles operating on public highways in the Province

of Quebec. The reason for the order was that the transportation of wood and all other materials damages the roads. Thus a real tax must be paid by society as a whole. Moreover, the law assures the public of safety on the roads (Appendix 2).

Order in Council 3142 classifies the public highways of the Province for the purpose of the operation of any kind of motor vehicle. It determines the maximum dimensions and weight of motor vehicles; fixes the limit of weight, load included, and the speed limit of motor vehicles in periods of thaw or rain; and, finally, regulates the use and operation of motor trains on public highways.

Following the application of this Order in Council, a report published by a wood-producers' organization said that the reduction in weight of the useful load varies between 10 and 34 percent, which produces a 20-percent increase in transportation costs compared with the 1971 rates.[13/]

Therefore, this Order in Council restrains the growth of truck transportation in the wood sector. The increase in truck-transportation costs can be expected to lead to a decrease in the use of truck transportation. The amount of decrease is dependent upon the cross-elasticities among the demands for different modes of transportation. The net effect of this Order in Council will thus be to promote the use of other modes of transportation of wood relative to truck.

13/ Memoire presente au Gouvernement du Quebec par la federation des producteurs de bois du Quebec, Mai 1972.

5.12 Laws and regulations on river driving

The laws governing the driving of wood on lakes and rivers in the Province of Quebec were revised 10 years ago. The Watercourses Act, revised statutes 1964, division VI, paragraphs 31 and 32, concerning the driving of timber, says, "Subject to the provisions of this division, any person, firm, or company may, during the spring, summer, and autumn freshets, drive or float timber, rafts, and craft down any river, lake, and stream or creek in this Province."

"It shall be and always has been lawful to erect and maintain dams, slides, aprons, booms, gate-locks or other necessary works to facilitate the floating or transmission of timber, rafts or crafts down such rivers, streams, lakes, ponds or creeks, to blast rocks, dredge or remove sand-banks, or to remove trees, shrubs or other obstacles, without, however, doing any damage to such rivers, lakes, ponds, streams, or creeks."

Actually, the Watercourses Act was passed in 1916, and the 1964 revision involved only a few word changes: no fundamental changes. But now increasing pressure is coming from many conservationist groups whose goal is to stop the use of streams for driving. The pollution of streams and lakes by the deposit of bark and sinking of wood is more and more prominant in the minds of legislators. The concern of all these people is the multiple use of rivers and lakes.

More and more, the public is asking for a clean environment. Many activities such as fishing, swimming, canoeing, and camping were nonexistent or different from today when the law was passed in 1916.

However, because the Watercourses Act is very broad and because almost everything is permitted, the only effect that these pressure groups have is to narrow the interpretation of the law by the administrators. We have many reasons to believe that with the coming of the new land management system, a new law on river driving will also come. Such a law will probably limit driving to some specific streams and lakes, and only in some special instances.

5.13 Laws and regulations on railroads

Railroad transportation is under the authority of the Canadian Transportation Commission. The Commission exerts its influence through a Committee on Railroad Transportation.

According to the law on railroads, the Commission has complete control over the construction, maintenance, and operation of the railroads, including technical questions and uniformity of the accounting systems.

Except in the case of statutory tariffs and under the authority held by the Commission to protect the public against unfair tariffs, the companies are free to ask for the tariffs that they want. However, the tariffs must be compensatory, and the Commission can fix the tariffs in the case of a carrier which is located in a region by itself. In this case, the tariffs may otherwise reflect the monopoly enjoyed by the railroad.

The railroad industry is so closely related to the Canadian Transportation Commission (a federal entity) that no changes are expected under the New Land Management System as a provincial undertaking. A new governmental organization should be set up to plan, with the two

railroad companies, the tariffs that could be charged for carrying wood coming from the supply sources to the pulp and paper mills.

In taking responsibility for supplying wood to the pulp mills, the Government will have a direct effect upon wood transportation. To allocate the wood at lowest cost, the Government must know what all the alternative costs are. As we have seen, the Provincial Government has no control over the railroad industry. The only course of action available to the Province in this case is to discuss tariffs with the two railroad companies in an effort to obtain agreement on rates favorable to the flow of wood. These rates, expressed in pennies per hundred pounds, can be inserted into the cost matrix and used in determining the choice of the cheapest transportation system from each source to each mill.[14/]

A representation of this choice is given in Tables 10 and 11. The cost of transportation from origin 1 to destination 1 is determined for each type of carrier. If, for one or more types, it is impossible to determine the cost, then it is considered infinite. In these cases, those types of carrier are ignored, and our choice is the carrier which has the lowest cost. The carrier chosen is then placed in the cost matrix (Table 11) and used in the transportation problem.

5.2 Wood produced on private forests

As we have seen in Table 1, private forests represent 4.7 percent of the total land area of the Province of Quebec, or 27,900 square miles;

[14/] 1 ton of chips = 100 cubic feet.

Table 10. Representation of the transportation cost C_{11}

	Destination 1
Source 1	Cost by truck
	Cost by river-driving
	Cost by boat-barge
	Cost by railroad

Table 11. Representation of the cost matrix

		Destination				Total
	i \ j	1	2	. . .	n	
Source	1	C_{11}	C_{12}	. . .	C_{1n}	a_1
	2	C_{21}	C_{22}	. . .	C_{2n}	a_2
	...	...	...	. . .	...	. . .
	m	C_{m1}	C_{m2}	. . .	C_{mn}	a_{mn}
Total		b_1	b_2	. . .	b_n	$\Sigma a_i = \Sigma b_j$

and their production accounts for 3,000,000 cunits a year.

The private forests can be subdivided under two headings:

1. Large private forests, of 2,000 acres and more. The majority of these forests are owned by the pulp and paper companies and provide almost 7 percent of the requirements of the forest industry.

2. Small private forests, under 2,000 acres. These are grouped into some 15 "Offices of Producers." They produce 1.3 million cunits of pulpwood, or about 23 percent of the need of the pulp and paper industry (Gouvernement du Quebec, 1971).

Figure 9 shows the location of the private forests in relation to the pulp and paper mills. As we can see, a majority of the pulp and paper mills are located near the private forests. It is understandable that they constitute a major source of supply for these mills.

Each year the Office of Producers fixes the quantity of wood that they want to sell to each mill. After that, the producers and the companies set a price for the wood. Because the wood produced by these small producers is covered by the "law concerning the price of pulpwood sold by farmers and settlers," the mills must, in the majority of cases, buy the wood. This situation makes the planning of wood procurement difficult for the companies (Gouvernement du Quebec, 1971).

In light of what has been said in the preceding paragraphs, it is very important to consider the wood coming from private forests as a constraint in our transportation model.

5.21 Method for handling the wood coming from private forests

The government, in its "Expose sur la Politique Forestiere, 1972, page 57," proposes that "when there is a contraction in the demand for

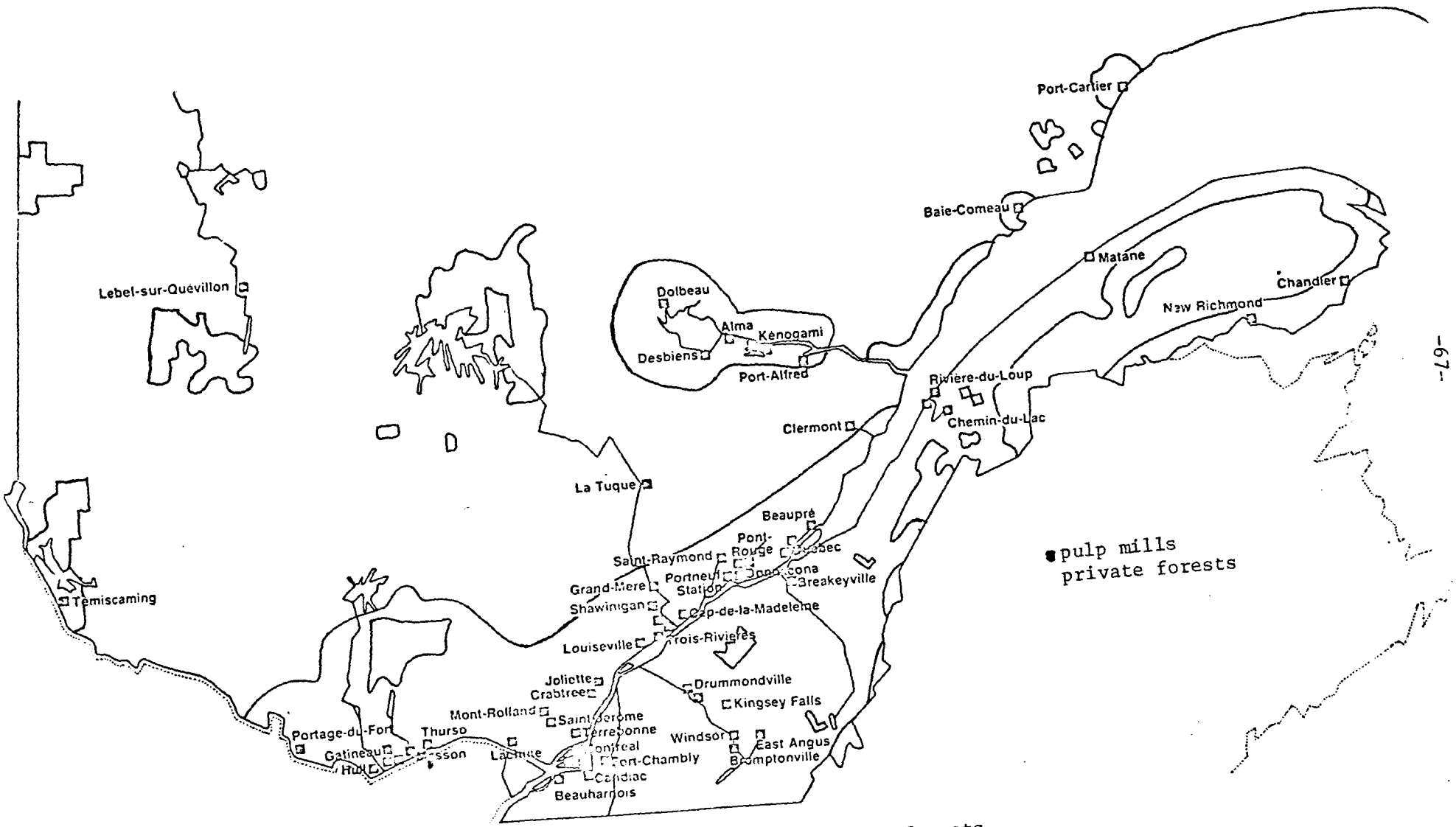

Figure 9. Location of Quebec's pulp mills and the private forests

paper, the wood users themselves and the private producers must absorb the contraction in proportion to their production capacity--except that in the interest of timber conservation, there will be no contraction in the use of chips or of salvaged wood." It will be seen in following sections that the author questions this policy. The reasons for the questioning will be explained.

There are many reasons to believe that the foregoing requirement will run counter to another policy of the Government, that is, to maintain a high level of employment in the Province. Almost all the small producers of wood are farmers, and it is among this class of society that we find one of the lowest levels of per-capita income. Therefore, we intend to propose here a different solution to this problem: In the case of a recession, the shrinkage in demand for wood would be borne by the public lands. In effect, the Government would directly support the loss, and the private producers and farmers would not be affected. In the short run, retraining of farmers for other employment is almost impossible; their assimilation into the manufacturing industry is a long-run process.

The general opinion is that the productivity and motivation of the farmers who work on private lands are lower than of the people who work on public lands. In the latter case, workers have a quota to produce per day in order to keep their jobs. In the former case, farmers are their own bosses, and they can produce, if they wish, only what they need in order to live. In addition, people working on public lands receive unemployment insurance in the event that they stop working. Farmers do not receive unemployment insurance.

On the public lands, the worker can lose his job, but on the private lands, the farmer can lose his job and his land. For many farmers, the cutting of wood is an operation necessary to life. During the winter months, farmers have nothing else to do but cut wood. The income provided by that activity can help them to pay taxes and keep their farms.

For all these reasons, we believe that the Government should study the situation carefully before deciding to decrease the percentage of wood coming from the private forests.

5.3 Social constraint

Another very important constraint that must be taken into account during the processing of the transportation model is the social constraint. By social constraint we mean the desirability of maintaining full employment in each community. This constraint may be related to the method of handling the wood coming from the private lands.

An action undertaken by the Department of Lands and Forests realistically cannot oppose actions undertaken by other departments. Some departments, such as DREE (Department of Regional Economic Expansion, of the federal government), subsidize industries. The subsidized industries may be located in regions where the Department of Lands and Forests has decided to reduce the production of wood so as to minimize transportation costs.

The economy of some villages and regions is entirely dependent upon the wood industry. Imagine a village whose only income is provided by the cutting and transportation of wood. If the Government suspended its demand for wood from that region, the economy of that village would

be completely destroyed. Consequently, the Department of Lands and Forests for political reasons must be very cautious in its choice of actions in such circumstances.

Politically, a thoughtless move could be very prejudicial to the New Land Management System.

5.31 Method of handling the social constraint

The policies of the different departments should be complementary. In order to avoid the problems associated with contradictory Government policies, we propose the formation of a task force having as its objective to determine the effects of the money injected into the economy of certain regions by different Governmental departments. An input-output model of the Province of Quebec can be useful in making these determinations.

Plans should be determined for the future and proposed to the Department of Lands and Forests.

5.4 Constraints imposed by forest fires, insects, and diseases

As noted on pages 66 and 68, section 5.21, the Government has a very determined policy concerning the recovery of wood. They say that for obvious economic reasons, recoverable wood has to be salvaged. A variation of 1 or 2 years in the harvesting of a healthy stand does not have a significant effect on the quality of the wood. However, in a stand affected by fire, insects, or diseases, immediate action is of vital importance.

5.41 Method of handling the constraint imposed by forest fires, insects, and diseases

We propose two methods to solve the problem of wood salvaged after catastrophes.

First, the real transportation cost should be put in the cost matrix and the wood allocated where it will minimize the total transportation cost. Afterwards, the Department of Lands and Forests can subsidize the company penalized by the use of this wood.

Second, there is the alternative of substracting the damaged wood from the model. Subsequently, the Government would arbitrarily allocate this wood among the users.

However, if this wood is located where no harvesting would have occurred anyway, it should be left there. If the cost of harvesting is higher than the price of this wood, the wood should be ignored.

5.5 Constraint imposed by chips

By referring to section 5.4, the first paragraph, we can see that the Department of Lands and Forests intends to leave the production of chips at the same level, should a recession in the demand for paper occur. Their reasoning is that chips represent a large percentage of the production of sawmills and other wood-using plants, which are mostly individually owned and completely independent of the pulp and paper industry owners.

A recession in the demand for paper does not mean that the situation is necessarily the same for other wood industries. By allowing a diminution in the buying of chips by the pulp and paper industry the Department would, in fact, hold up the progress and development of

sawmills and other chip producers.

The use of chips by the pulp and paper mills is an important part in their operation. For example, in 1971, 22 of the 56 pulp and paper mills used chips (Table 12). For each mill which uses chips, the numbers of tons and the total value are reported for softwoods and hardwoods.

Table 12. Utilization of chips in Quebec in 1971

	SOFTWOODS		HARDWOODS	
	TONS	VALUE ($)	TONS	VALUE ($)
F. F. Soucy Riviere du Loup	23,447	672,331	- - -	- - -
Domtar Packaging Ltd. East-Angus	93,931	2,855,502	- - -	- - -
Domtar Fine Papers Windsor	30,971	946,783	20,054	343,926
Gaspesia P. & Co. Ltd. Chandler	43,673	1,495,295	- - -	- - -
Domtar Newsprint Ltd. Dolbeau	31,468	923,157	- - -	- - -
The Price Kraft Co. Kenogami	156,883	4,455,443	- - -	- - -
The Price Mill Co. Kenogami	15,843	483,090	- - -	- - -
Consolidated-Bathurst Grand-Mere	27,683	917,056	- - -	- - -
C.I.P. Co. Temiscaming	28,452	834,471	- - -	- - -
Domtar Newsprint Ltd. Trois-Riviere	12,848	443,965	- - -	- - -
Thurso P. & P. Co. Thurso	2,433	36,716	18,859	354,068
Domtar Pulp Ltd. Lebel sur Quevil.	186,249	4,579,866	- - -	- - -
C.I.P. Co. La Tuque	280,751	9,785,602	4,995	147,378
Masonite Co. Gatineau	41,278	1,439,044	20,481	523,275
Canadian Gypsum Co. Joliette	1,108	17,138	557	7,359
Consolidated-Bathurst Trois-Rivieres	68,537	2,234,366	15,415	502,067
The Price Co. Ltd. Alma	2,377	67,911	- - -	- - -
Abitibi Paper Co. Ltd. Beaupre	44,138	1,504,895	- - -	- - -
Consolidated-Bathurst Port-Alfred	56,310	2,089,830	5,511	186,889

Table 12. Utilization of chips in Quebec in 1971 (continued)

	SOFTWOODS		HARDWOODS	
	TONS	VALUE ($)	TONS	VALUE ($)
Consolidated-Bathurst New Richmond	54,074	1,531,487	- - -	- - -
Consolidated-Bathurst Pontiac	58,978	1,829,849	60,721	2,080,104
C.I.P. Co. Matane	462	7,230	308	4,820

Source: Gouvernement du Quebec.

CONCLUSION

The objective of this study is to describe some wood-transportation questions raised by Quebec's New Land-Management System and to catch a glimpse of the use of a linear-programming transportation model to answer these questions.

The study, as stated often in the course of this report, is only a broad survey. It represents, perhaps, an outline for intensive work that the Department of Lands and Forests will wish to pursue. Chapter 5, especially, points up the opportunity and the need for major research on the handling of special constraints upon the transportation pattern.

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Appendix I

Tables providing the figures used for the determination of the annual allowable cut.

Appendix Table I. Area of each watershed in the Mingan zone

Watersheds	Area acres	sq. mi.
(350) Magpie River	1,975,110	3,086
(351) St. Jean River	1,398,073	2,184
(352) Mingan River	597,544	934
(353) Romaine River	3,374,348	5,272
(354) Piashti River	614,836	961
(355) Watshishou River	439,078	686
(356) Nabisipi River	551,993	862
(357) Aguanus River	1,561,972	2,241
Total	10,512,954	16,426

Source: Les Forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan.

Appendix Table II. Distribution of the total area by land categories in the Mingan zone

Land categories	Area	
	acres	sq. mi.
Forest Lands		
Productive	8,643,380	13,505
Unproductive	761,533	1,190
Total		
Forest lands	9,404,913	14,695
Water	1,108,041	1,731
Total	10,512,954	16,426

Source: Les Forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan.

Appendix Table III. Distribution of the total area of the Mingan zone (acres)

Class	All the watersheds	Magpie	St. Jean	Mingan	Romaine	Piashti	Watshishou	Nabisipi	Aguanus
Exploitable softwoods	4,125,909	671,586	776,724	413,930	1,020,018	274,025	279,576	235,130	454,920
Exploitable mixed	86,504	44,342	2,956	---	6,838	---	---	14,751	17,617
Exploitable lands	4,212,413	715,928	779,680	413,930	1,026,856	274,025	279,576	249,881	472,537
Non-exploitable lands	4,430,967	1,061,427	487,825	84,444	1,621,137	222,726	101,554	216,635	635,219
Subtotal Productive lands	8,643,380	1,777,355	1,267,505	498,374	2,647,993	496,751	381,130	466,516	1,107,756
Dry bared	466,575	47,706	54,557	51,493	72,084	5,917	2,959	5,885	225,974
Wet bared	294,958	5,825	5,816	8,725	133,099	6,967	981	27,610	105,935
Subtotal Unproductive lands	761,533	53,531	60,373	60,218	205,183	12,884	3,940	33,495	331,909
Total Forest lands	9,404,913	1,830,886	327,878	558,592	2,853,176	509,635	385,070	500,011	1,439,665
Water	1,108,041	144,224	70,195	38,952	521,172	105,201	54,008	51,982	122,307
Total area	10,512,954	1,975,110	1,398,073	597,544	3,374,348	614,836	439,078	551,993	1,561,972

Source: Les Forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan.

Appendix Table IV. Productive forest lands (Volume by species, diameter groups and land categories in 100 cubic feet); Mingan Zone, Magpie Watershed

Species	D.B.H.						
		Exploitable		Non-exploitable		Productive	
	All	4 - 9	10 & +	4 - 9	10 & +	4 - 9	10 &
White Spruce	198,399	116,431	81,968	---	---	116,431	81,968
Black Spruce	6,129,036	4,381,649	464,460	1,282,927	---	5,664,576	464,460
Fir	4,183,872	3,154,768	855,833	161,921	11,350	3,316,689	867,183
Tamarack	461	461	---	---	---	461	---
Total Softwoods	10,511,768	7,653,309	1,402,261	1,444,848	11,350	9,098,157	1,413,611
Paper Birch	769,699	411,035	358,664	---	---	411,035	358,664
Aspen	26,646	25,900	---	746	---	26,646	---
Total Hardwoods	796,345	436,935	358,664	746	---	437,681	358,664
Total	11,308,113	8,090,244	1,760,925	1,445,594	11,350	9,535,838	1,772,275

Source: Les Forets du Quebec, M.T.F., Direction Generale des Forets, Service de l'inventaire forestier, Zone Mingan.

Appendix II

Order in Council 3142

Arrêté en conseil
Chambre du Conseil Exécutif

Numéro 3142

Québec, le 14 septembre 1971.
Présent: Le Lieutenant-gouverneur en conseil.

CONCERNANT la réglementation relative à la pesanteur et aux dimensions de véhicules automobiles circulant sur les chemins publics du Québec.

ATTENDU QU'en vertu de l'article 49 du Code de la route (S.R.Q. 1964, chapitre 231 et ses amendements), le lieutenant-gouverneur en conseil peut, par règlement:
a) classifier les chemins publics de la Province pour les fins de la circulation des véhicules de toutes sortes;

b) déterminer les dimensions et la pesanteur maximum des autobus, véhicules de commerce et véhicules de livraison qui peuvent y circuler;
c) fixer la limite du poids, charge comprise, et de la vitesse des véhicules autorisés à y circuler en période de dégel ou de pluie;
h) réglementer l'emploi et la circulation de convois automobiles dans les chemins publics;

IL EST ORDONNÉ, en conséquence, sur la proposition du ministre des Transports:
QUE le présent arrêté en conseil soit adopté immédiatement et que la réglementation ci-annexée entre en vigueur le 1er mars 1972;
QUE les arrêtés en conseil numéro 1045 du 27 mai 1964, numéro 2481 du 29 décembre 1964, numéro 133 du 26 janvier 1966, numéro 2605 du 14 août 1968, numéro 20 du 8 janvier 1969, numéro 4069 du 17 décembre 1969 et numéro 3759 du 7 octobre 1970 soient abrogés le dernier jour de février 1972;
QUE l'arrêté en conseil numéro 1371 du 7 avril 1971 soit abrogé et remplacé par le présent arrêté en conseil;
QUE les dispositions de l'arrêté en conseil numéro 1372 du 7 avril 1971 s'appliquent au présent arrêté en conseil.

Le greffier du Conseil exécutif,
JULIEN CHOUINARD.

Réglementation relative à la pesanteur et aux dimensions des véhicules circulant sur les chemins publics du Québec.

1. *Classification des chemins*

Pour les fins de la présente réglementation les chemins publics du Québec appartiennent à une seule et même catégorie.

2. *Dimensions maxima des véhicules*

Les dimensions maxima de tout véhicule ou de tout ensemble de véhicules, chargement compris, circulant sur tout chemin public dans la province sont les suivantes, pourvu que la nature, l'état et les dimensions des chemins publics, y compris les ponts, le permettent:
A) Longueur en pieds:
a) Tout véhicule, sauf l'autobus: 35;

Order in Council
Executive Council Chamber

Number 3142

Québec, September 14, 1971.
Present: The Lieutenant Governor in Council.

CONCERNING the Regulation respecting the weight and dimensions of motor vehicles operating on public highways in the Province of Québec.

WHEREAS pursuant to section 49 of the Highway Code (R.S.Q. 1964, chapter 231 and its amendments), the Lieutenant-Governor in Council may, by regulation:
(*a*) classify the public highways of the Province for the purposes of the operation of any kind of motor vehicle;
(*b*) determine the maximum dimensions and weight of autobuses, commercial vehicles and delivery cars which may operate thereon;
(*c*) fix the limit of weight, load included, and the speed limit of motor vehicles operating thereon in periods of thaw or rainy periods;
(*d*) regulate the use and operation of motor trains on public highways.

IT IS ORDERED, therefore, upon the recommendation of the Minister of Transport:
THAT this Order in Council be adopted forthwith and that the regulation annexed hereto come into force on March 1, 1972;
THAT Orders in Council number 1045 of May 27, 1964, number 2481 of December 29, 1964, number 133 of January 26, 1966, number 2605 of August 14, 1968, number 20 of January 8, 1969, number 4069 of December 17, 1969 and number 3759 of October 7, 1970 be repealed on the last day of February, 1972;
THAT Order in Council number 1371 of April 7, 1971 be repealed and replaced by this Order in Council;
THAT the provisions of Order in Council number 1372 of April 7, 1971 apply to this Order in Council.

JULIEN CHOUINARD,
Clerk of the Executive Council.

Regulation respecting the weight and dimensions of motor vehicles operating on public highways in the Province of Québec.

1. *Classification of highways*

For the purposes of this Regulation, Québec highways shall be considered as belonging to one and the same category.

2. *Maximum dimensions of vehicles*

The maximum dimensions of any vehicle or combination of vehicles, load included, operating on any highway in the Province shall be the following, provided the nature, condition and dimensions of the public highways, including bridges, so permit:
(A) Total length in feet:
(*a*) Any vehicle except an autobus: 35;

b) Autobus: 40;
c) Ensemble de véhicules: 65;
d) Remorque immatriculée pour la première fois au Québec après le 30 octobre 1970, sauf dans le cas de la maison roulante: 45;
e) Semi-remorque immatriculée pour la première fois au Québec après le 30 octobre 1970 et mesurée entre le centre du pivot de la sellette d'attelage et la partie extrême arrière: 42½.

Conformément aux dispositions intitulées « Permis » apparaissant au paragraphe 3 de la présente réglementation, un permis pourra être émis par le ministre, pour chacune des remorques et semi-remorques dont la longueur excède, selon le cas, la longeur spécifiée aux sous-paragraphes *d*) et *e*) du présent paragraphe et qui ont été immatriculées au Québec avant le 31 octobre 1970.

Il est interdit de circuler sur le chemin public avec un ensemble de véhicules formé de plus d'un véhicule-tracteur attelé à deux remorques ou semi-remorques. Dans un tel cas, le dispositif d'attelage de chacun des véhicules formant l'ensemble doit être suffisamment solide pour résister à tous les effets provoqués par le remorquage et doit être agencé de telle sorte que lorsque l'ensemble de véhicules circule en ligne droite, aucun des véhicules remorqués ne puisse se déplacer de plus de trois pouces d'un côté ou de l'autre par rapport au véhicule tracteur.

B) Hauteur en pieds: 13½;
C) Largeur en pieds: 8½.

Cependant les rétroviseurs extérieurs pourront excéder cette largeur.

3. *Charge et poids total en charge*

Sujets aux restrictions imposées par l'autorité compétente quant à la résistance des ponts, des viaduc, des voies élevées et autres ouvrages d'art du même genre et en conformité avec les dispositions intitulées « bandage de roues » apparaissant à la présente réglementation, les véhicules automobiles circulant sur tout chemin public au Québec sont soumis aux prescriptions suivantes:

I. La charge maximum totale transmise au sol par tout essieu simple ne doit pas excéder vingt-deux mille (22,000) livres;

II. La charge maximum totale transmise au sol par un essieu en tandem ne doit pas excéder trente-huit mille (38,000) livres;

III. La charge maximum totale transmise au sol par un essieu avant de tout véhicule automobile ne doit pas excéder douze mille (12,000) livres. Cependant, dans le cas d'un véhicule automobile sans semi-remorque ni remorque, cette charge maximum pourra être portée à dix-neuf mille (19,000) livres.

Pour les fins de la présente réglementation, les mots « essieu simple » incluent tous les essieux placés en succession dont les axes des extrêmes sont à une distance de quarante (40) pouces et moins, ainsi que les essieux, placés en succession dont les axes extrêmes sont à une distance moindre que quatre-vingt-seize pouces et qui ne sont pas agencés pour transmettre au sol des charges égales entre elles, que le véhicule soit en charge ou non, ceci à moins que lesdits essieux fassent partie de deux tandems placés en succession.

(*b*) Autobus: 40;
(*c*) Combination of vehicles: 65;
(*b*) A trailer registered for the first time in Québec after October 30, 1970, except mobile homes: 45;

(*c*) A semi-trailer registered for the first time in Québec after October 30, 1970, and measured from the centre of the pivot of the coupling device to the rear extremity of the trailer: 42½.

Under the provisions entitled "Permits", which appear in Part 3 of this Regulation, a permit must be obtained from the Minister for each trailer and semi-trailer whose length exceeds the respective specification mentioned in subparagraphs (*d*) and (*e*) of this paragraph, and which was registered in Québec before October 31, 1970.

No combination of vehicles exceeding in number one tractor unit coupled to two trailers or semi-trailers shall operate on the public highway. The coupling device of each vehicle forming such combinations must be of sufficient strength to withstand all the stresses occasioned by the tow, and must be so fitted that when the combination is travelling in a straight line neither of the towed vehicles shall swing, or deviate, from the course of the tractor unit by more than three inches on either side.

(B) Height in feet: 13½;
(C) Width in feet: 8½.

The exterior rear-view mirrors may, however, protrude beyond this width.

3. *Load and gross vehicle weight*

Subject to the restrictions imposed by the competent authorities respecting the maximum load capacity of any bridge, viaduct, elevated highway, or similar construction, and pursuant to the provisions under the heading "Tires" of this Regulation, the following specifications shall govern the operations of all motor vehicles operating on Québec highways.

I. The maximum axle load of any single axle shall not exceed twenty-two thousand (22,000) pounds;

II. The maximum axle load of any tandem axle shall not exceed thirty-eight thousand (38,000) pounds;

III. The maximum axle load of any front axle shall not exceed twelve thousand (12,000) pounds. However, in the case of a motor vehicle without a trailer or semi-trailer, this maximum total load may be increased to nineteen thousand (19,000) pounds;

For the purposes of this Regulation the expression "single axle" includes all the axles from front to rear where the centres of the outside axles are at a maximum distance of forty (40) inches; also the axles from front to rear where the distance between the centres of the leading and rear axles is less than ninety-six inches and whose assembly is such that the axle load weights are unequally distributed, whether the vehicle is loaded or not; this interpretation shall not apply if the said axles form part of two tandems positioned one after the other.

Pour les fins de la présente réglementation, les mots « essieu en tandem » signifient deux essieux ou plus, placés en succession dont les axes des essieux extrêmes sont à une distance supérieure à quarante (40) pouces mais inférieure à quatre-vingt-seize (96) pouces et qui sont conçus et agencés pour transmettre au sol des charges égales entre elles.

Poids maximum total en charge

Véhicule d'une seule unité:

a) véhicule muni de deux essieux simples:
41,000 livres

Cependant lorsque la distance entre le centre de chacun des essieux est inférieure à huit (8) pieds, ce poids total en charge est de 37,000 livres;

b) véhicule muni d'un essieu simple à l'avant et d'un essieu tandem à l'arrière: 57,000 livres

Cependant lorsque la distance entre le centre de l'essieu avant du véhicule et le centre de l'essieu avant de son tandem est inférieure à huit (8) pieds, ce poids total en charge est de 51,000 livres;

c) véhicule muni d'un essieu en tandem à l'avant et d'un essieu en tandem à l'arrière: 76,000 livres

Cependant lorsque la distance entre les centres des essieux les plus rapprochés des deux tandems est inférieurs à dix (10) pieds, ce poids total en charge est de 68,000 livres.

Ensemble de véhicules

d) véhicule-tracteur attelé à une semi-remorque formant un ensemble muni de trois essieux:
56,000 livres;

e) véhicule-tracteur attelé à une remorque formant un ensemble muni de trois essieux:
56,000 livres;

f) véhicule-tracteur attelé à une remorque formant un ensemble muni de quatre essieux:
78,000 livres;

g) véhicule-tracteur attelé à une semi-remorque formant un ensemble muni de quatre essieux dont deux sont en tandem à l'arrière de l'ensemble:
72,000 livres.

Cependant lorsque cet ensemble de véhicules, muni de quatre essieux, ne comporte pas d'essieu placé en tandem et en autant qu'aucun espacement entre les centres d'essieux successifs ne soit inférieur à huit (8) pieds, le poids total en charge pourra être porté à 78,000 livres;

h) véhicule-tracteur attelé à une semi-remorque formant un ensemble de véhicules muni de cinq essieux dont quatre forment deux tandems: lorsque la distance entre le centre de l'essieu arrière du premier tandem et le centre de l'essieu avant du deuxième tandem est égale ou supérieure à dix (10) pieds:
88,000 livres;

Cependant à chaque pied soustrait de cette distance de dix (10) pieds correspond une diminution de deux mille (2,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant.

For the purposes of the present Regulation, the words "tandem axle" mean two or more axles in an assembly where the distance between the centres of the leading and rear axles is greater than forty (40) inches but less than ninety-six (96) inches, and which are so designed and assembled that the axle loads are equally distributed between each axle.

Gross vehicle weight

Single unit vehicle:

(*a*) vehicle with two single axles:
41,000 pounds;

However, when the distance between the centre of each axle is less than eight (8) feet, the gross vehicle weight shall be 37,000 pounds;

(*b*) vehicle with a single axle in front and a tandem axle in the rear: 57,000 pounds;

However, when the distance between the centre of the front axle and the centre of the forward axle of the tandem is less than eight (8) feet, the gross vehicle weight shall be: 51,000 pounds;

(*c*) Vehicle with a tandem axle in front and a tandem axle in the rear: 76,000 pounds.

However, when the distance between the centres of the two nearest axles of each tandem is less than ten (10) feet, the gross vehicle weight shall be:
68,000 pounds.

Combination of vehicles

(*d*) Tractor unit coupled to a semi-trailer, forming a three-axle combination: 56,000 pounds;

(*e*) Tractor unit coupled to a trailer, forming a three-axle combination: 56,000 pounds;

(*f*) Tractor unit coupled to a trailer, forming a four-axle combination: 78,000 pounds;

(*g*) Tractor unit coupled to a semi-trailer, forming a combination of four axles, two of which are in tandem at the rear of the combination: 72,000 pounds;

However, when such a four-axle combination does not have any axles in tandem, and if the distance between the centres of two adjacent axles is not less than eight (8) feet, the gross vehicle weight may be increased to: 78,000 pounds;

(*h*) Tractor unit coupled to a semi-trailer, forming a combination of vehicles totalling five axles, four of which form two tandems: when the distance between the centre of the rear axle of the first tandem and the centre of the front axle of the second tandem is equal to or greater than ten (10) feet: 88,000 pounds.

However, for every foot by which such ten-foot (10') distance is reduced, there shall be a corresponding reduction of two thousand (2,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

Lorsque la distance entre les centres des essieux du tandem arrière est égale ou supérieure à huit (8) pieds: 94,000 livres;

i) véhicule-tracteur attelé à une remorque formant un ensemble muni de cinq essieux dont deux forment un tandem. Lorsque la distance entre le centre de l'essieu arrière simple ou de l'essieu avant du tandem du véhicule-tracteur et le centre de l'essieu arrière de l'ensemble est égale ou supérieure à vingt-six (26) pieds: 94,000 livres.

Cependant à chaque pied soustrait de cette distance de vingt-six (26) pieds correspond une diminution de mille (1,000) livres du poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

j) véhicule-tracteur attelé à une remorque formant un ensemble muni de six essieux dont quatre forment deux tandems.

Lorsque la distance entre le centre de l'essieu avant du tandem du camion et le centre du dernier essieu du tandem arrière de la remorque est égale ou supérieure à trente-sept (37) pieds: 110,000 livres.

Cependant à chaque pied soustrait de cette distance de trente-sept (37) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

k) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de cinq essieux simples. Lorsque la distance entre le centre de l'essieu arrière du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à trente-cinq (35) pieds: 100,000 livres.

Cependant à chaque pied soustrait de cette distance de trente-cinq (35) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

l) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de six essieux dont deux forment un essieu en tandem à l'arrière du train.

Lorsque la distance entre le centre de l'essieu arrière du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à quarante-cinq (45) pieds: 116,000 livres.

Cependant à chaque pied soustrait de cette distance de quarante-cinq (45) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

m) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de six essieux dont deux forment le tandem du camion-tracteur.

Lorsque la distance entre le centre de l'essieu avant du tandem du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à quarante-sept (47) pieds: 116,000 livres.

When the distance between the centres of the axles of the rear tandem is equal to or greater than eight (8) feet: 94,000 pounds;

(i) Tractor-unit coupled to a trailer, forming a combination of five axles, two of which form a tandem. When the distance between the centre of the single rear axle or front axle of the tandem of the tractor-unit and the centre of the rear axle of the combination is equal to or greater than twenty-six (26) feet: 94,000 pounds;

However, for every foot by which such twenty-six (26) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(j) Tractor-unit coupled to a trailer, forming a combination of six (6) axles, four of which form two tandems.

When the distance between the centre of the front axle of the tractor tandem and the centre of the rear axle of the rear tandem of the trailer is equal to or greater than thirty-seven (37) feet: 110,000 pounds.

However, for every foot by which such thirty-seven (37) foot distance is reduced, there shall be corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(k) Tractor-unit coupled to a semi-trailer and trailer, forming a combination of five single axles. When the distance between the centre of the rear axle of the tractor unit and the centre of the rear axle of the train is equal to or greater than thirty-five (35) feet: 100,000 pounds.

However, for each foot by which such thirty-five (35) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(l) Tractor-unit coupled to a semi-trailer and trailer, forming a combination of six axles, two of which form a tandem axle at the rear of the train.

When the distance between the centre of the rear axle of the tractor-unit and the centre of the rear axle of the train is equal to or greater than forty-five (45) feet: 116,000 pounds;

However, for each foot by which such forty-five (45) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(m) Tractor-unit coupled to a semi-trailer and trailer, forming a combination of six axles, two of which form the tandem of the tractor-unit.

When the distance between the centre of the front axle of the tractor-unit tandem and the centre of the rear axle of the train is equal to or greater than forty-seven (47) feet: 116,000 pounds;

Cependant à chaque pied soustrait de cette distance de quarante-sept (47) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

n) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de six essieux dont deux sont en tandem sous la semi-remorque.

Lorsque la distance entre le centre de l'essieu arrière du camion-tracteur et le centre de l'essieu arrière du train de charge est égale ou supérieure à cinquante-deux (52) pieds: 116,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

o) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de sept essieux dont quatre forment deux essieux en tandem placés, l'un à l'arrière de la semi-remorque et l'autre à l'extrémité arrière du train.

Lorsque la distance entre le centre de l'essieu arrière du camion-tracteur et le centre du dernier essieu du train est égale ou supérieure à cinquante-deux (52) pieds: 115,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

p) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de sept essieux dont quatre essieux forment deux tandems placés, l'un à l'arrière du tracteur et l'autre à l'arrière de la semi-remorque.

Lorsque la distance entre le centre de l'essieu avant du tandem du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à cinquante-deux (52) pieds: 121,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

q) camion-tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de huit essieux dont six forment trois essieux en tandem.

Lorsque la distance entre le centre de l'essieu avant du tandem du tracteur et le centre de l'essieu arrière du train est égale ou supérieure à cinquante-deux (52) pieds: 126,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant.

However, for each foot by which such forty-seven (47) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*n*) Tractor-unit coupled to a semi-trailer and trailer, forming a combination of six axles, two of which are in tandem supporting the semi-trailer.

When the distance between the centre of the rear axle of the tractor and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 116,000 pounds;

However, for each foot by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight; and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*o*) Tractor-unit coupled to a semi-trailer and trailer forming a combination of seven axles, four of which form two tandem axles, one of which is at the rear of the semi-trailer and the other at the extreme rear of the train.

When the distance between the centre of the rear axle of the tractor and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 115,000 pounds;

However, for each foot by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*p*) Tractor-unit coupled to a semi-trailer and trailer forming a combination of seven axles, four of which form two tandems, one being at the rear of the tractor and the other at the rear of the semi-trailer.

When the distance between the centre of the front axle of the tractor tandem and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 121,000 pounds;

However, for each foot by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*q*) Tractor-unit coupled to a semi-trailer and trailer forming a combination of eight axles, six of which form form three tandem axles.

When the distance between the centre of the front axle of the tractor tandem and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 126,000 pounds;

However, for each foot by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

Si toutefois l'un des essieux simples n'est pas localisé, soit sous la partie arrière de la semi-remorque ou soit sous la partie avant de la remorque, le poids total est réduit de mille (1,000) livres;

r) camion tracteur attelé à une semi-remorque et à une remorque formant un ensemble muni de neuf essieux dont huit forment quatre essieux en tandem.

Lorsque la distance entre le centre de l'essieu avant du tandem du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à cinquante-deux (52) pieds: 125,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

s) camion-tracteur attelé à deux semi-remorques ou remorques formant un ensemble muni de sept essieux dont tous sauf l'essieu avant du tracteur, forment des essieux en tandem.

Lorsque la distance entre le centre de l'essieu avant du tandem du camion-tracteur et le centre de l'essieu arrière du train est égale ou supérieure à cinquante-deux (52) pieds: 123,000 livres.

Cependant à chaque pied soustrait de cette distance de cinquante-deux (52) pieds correspond une diminution de mille (1,000) livres de poids total en charge et cette diminution est répartie sur l'ensemble des essieux, sauf l'essieu avant;

t) dispositions particulières s'appliquant aux sous-paragraphes « *o*), « *p*), « *q*), et « *r*) du présent paragraphe.

Lorsque la distance entre le centre du dernier essieu de la semi-remorque et le centre du premier essieu de la remorque est égale ou supérieure à dix et demi (10½) pieds une charge d'au plus trois mille (3,000) livres pourra être enlevée de l'essieu avant et reportée sur le reste des essieux du train de charge, ceci sans que les maxima par essieu simple et par essieu tandem fixés par les clauses I et II du présent paragraphe ne soient excédés.

Dispositions spéciales concernant la charge et le poids total en charge

Afin de donner à chacun la possibilité de s'ajuster aux clauses concernant les maxima de charge par essieu, ces maxima seront majorés de la manière suivante:

i) à partir de la date de mise en vigueur de la présente réglementation et jusqu'au dernier jour de février 1973, la charge maximum par essieu simple est majorée de deux mille (2,000) livres et la charge maximum par essieu en tandem est majorée de quatre mille (4,000) livres;

ii) entre le premier jour de mars 1973 et le dernier jour de février 1974, les majorations prévues au sous-paragraphe i) du présent paragraphe seront diminuées de mille (1,000) livres par essieu simple et de deux mille (2,000) livres par essieu en tandem;

iii) à partir du premier jour de mars 1974, aucune majoration de charge par essieu ne sera accordée.

If, however, none of the single axles is positioned either under the rear of the semi-trailer or under the front part of the trailer, the total weight shall be reduced by one thousand (1,000) pounds;

(*q*) Tractor unit coupled to a semi-trailer and trailer forming a combination of nine axles, of which eight form four tandem axles.

When the distance between the centre of the front axle of the tractor tandem and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 125,000 pounds;

However, for each foot by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*s*) Tractor-unit coupled to two semi-trailers or trailers forming a combination of seven axles, all of which, except the front axle of the tractor, form tandem axles.

When the distance between the centre of the front axle of the tractor tandem and the centre of the rear axle of the train is equal to or greater than fifty-two (52) feet: 123,000 pounds;

However, for each foot distance by which such fifty-two (52) foot distance is reduced, there shall be a corresponding reduction of one thousand (1,000) pounds in gross vehicle weight, and this reduction shall be distributed over the total axle assemblies, with the exception of the front axle.

(*t*) Special provisions governing sub-paragraphs (*o*), (*p*), (*q*) and (*r*) of this paragraph.

When the distance between the centre of the last axle of the semi-trailer and the centre of the first axle of the trailer is equal to or greater than ten and one-half (10½) feet, a weight of not more than three thousand (3,000) pounds may be transferred from the front axle and redistributed over the remaining axle loads of the train, provided that the maximum weights per single and tandem axle fixed in clauses I and II of this Part are not exceeded.

Special provisions concerning load and gross vehicle weight

In order that everyone may adjust to the clauses concerning maximum axle loads, these maxima will be increased as follows:

(*i*) From the date of the coming into force of this Regulation until and including the last day of February, 1973, the maximum axle load per single axle shall be increased by two thousand (2,000) pounds and the maximum load per tandem axle shall be increased by four thousand (4,000) pounds;

(ii) Between the first day of March, 1973 and the last day of February, 1974, the increases provided for in subparagraph (*i*) of this paragraph will be reduced by one thousand (1,000) pounds per single axle and by two thousand (2,000) pounds per tandem axle;

(iii) Upon, from and after the first day of March, 1974, no increase in axle load shall be permitted;

Malgré ces majorations de charge par essieu, il est à noter que le poids total en charge de tout véhicule automobile ou de tout ensemble de véhicules automobiles ne doit jamais excéder le poids total en charge fixé par la présente réglementation pour chaque catégorie de véhicules automobiles et d'ensembles de véhicules automobiles.

Cas particulier

Le ministre des Transports ou toute personne désignée par lui à cette fin peut, s'il le juge à propos et aux conditions qu'il détermine, émettre des permis spéciaux afin d'autoriser la circulation, sur les chemins publics, de véhicules automobiles ayant un nombre ou un agencement d'essieux non prévu au présent paragraphe.

Cependant le nombre de ces permis émis à une même personne ne doit pas excéder cinq pour cent du nombre de tous les camions et camions-tracteurs possédés et immatriculés au Québec par ladite personne.

Un tel permis n'est valide que pour une durée maximum d'une année, à partir de sa date d'émission, et peut être cancellé en tout temps, lorsque la circulation du véhicule ou de l'ensemble de véhicules pour lequel il a été émis est une cause de danger pour les autres usagers de la route, ou lorsque ledit véhicule ou ledit ensemble de véhicules endommage anormalement le chemin public. À son échéance et pour des raisons valables, ce permis pourra être renouvelé aux mêmes conditions.

Ce permis est émis aux taux fixés par l'arrêté en conseil numéro 319 du 5 février 1969.

Bandages de roues

Le poids maximum par pouce de largeur de bandage pneumatique ne doit pas excéder cinq cents (500) livres pour les pneus de moins de six (6) pouces et ne doit pas excéder six cents (600) livres pour les pneus de six (6) pouces ou plus. Cette largeur est celle estampée sur le pneu par le manufacturier.

Pour les véhicules automobiles munis entièrement ou partiellement de bandages pleins, faits de caoutchouc ou d'autres matières ayant une élasticité équivalente, tous les poids maxima mentionnés dans la présente réglementation devront être réduits de vingt-cinq (25) pour cent.

Intervalle minimum entre véhicules lourds

Les véhicules automobiles qui, avec ou sans remorque ou semi-remorque, ont une pesanteur totale, chargement compris, de vingt mille (20,000) livres ou plus, ne doivent pas se suivre sur les chemins publics à intervalle plus rapproché que trois cents (300) pieds d'espace libre. En plus de cette restriction, de tels véhicules ne doivent pas s'arrêter ni se dépasser sur les ponts, viaducs ou sur toute autre structure du même genre.

Permis

Le ministre des Transports, ou toute autre personne désignée par lui à cette fin, lorsqu'il s'agit de chemins à l'entretien par le gouvernement provincial et toute cor-

Notwithstanding these increases in axle load it must be noted that the gross vehicle weight of any motor vehicle or combination thereof must never exceed the gross vehicle weight stipulated in this Regulation for each category of motor vehicle and combination thereof.

Special cases

The Minister of Transport, or any person designated by him for the purpose, may, if he so deems it expedient, and upon the conditions determined by him, issue special permits authorizing the operation on public highways of motor vehicles having a number or assembly of axles not provided for in this paragraph.

However, the number of such permits issued to the same holder shall not exceed five per cent of the total number of trucks and tractors owned and registered in Québec by the said holder.

Such permits shall be valid for a maximum period of one year only, starting from its date of issue; they may be cancelled at any time when the operation of the vehicles or combinations of vehicles for which they are issued endangers other highway users, or when the said vehicles or combinations of vehicles cause abnormal damage to the public highway. Upon their expiry and upon justifiable grounds, such permits may be renewed subject to the same conditions.

These permits shall be issued at the rates established by Order in Council No. 319 of February 5, 1969.

Tires

The maximum load per inch of tire width of a pneumatic tire shall not exceed five hundred (500) pounds for tires of less than six (6) inches, and shall not exceed six hundred (600) pounds for tires of six (6) inches or more. This width shall be the one stamped on the tire by the manufacturer.

For motor vehicles entirely or partially equipped with solid tires, made of rubber or any other substance of equivalent elasticity, all the maximum weights mentioned in this Regulation shall be reduced by twenty-five (25) per cent.

Minimum distance between heavy vehicles

Motor vehicles which, with or without trailers or semi-trailers, have a total weight, load included, of twenty thousand (20,000) pounds or more, shall not follow each other on public highways at a distance of less than three hundred (300) feet of clear space.

In addition to this restriction, such vehicles shall not stop or pass one another on bridges, viaducts, or on any other similar structure.

License

When the roads affected are under the maintenance of the Provincial Government, or of a municipal corporation, the Minister of Transport, or any person so

poration municipale pour les autres chemins, peuvent s'ils le jugent à propos et aux conditions qu'ils déterminent, émettre des permis spéciaux ou généraux autorisant le transport par véhicules automobiles de machines ou autres gros objets indivisibles et la circulation de véhicules tels que roulottes, grues mobiles, machinerie agricole ou autres du même genre, montés sur pneumatiques, dont le transport ne peut se faire sans excéder les limites de longueur, hauteur, largeur et pesanteur totales fixées par la présente réglementation.

En cas d'urgence exceptionnelle et si la chose est jugée d'intérêt public par l'autorité compétente, de tels permis spéciaux pourront aussi être émis pour le transport d'objets, matériaux ou produits qui sont divisibles, dont le transport ne pourrait se faire sans excéder les limites de longueur, hauteur, largeur et pesanteur totales fixées par la présente réglementation.

De tels permis pourront indiquer les dates du transport, le parcours à suivre et les conditions spéciales nécessaires à la protection des chaussées et des ponts. Ils pourront fixer, s'il y a lieu, la garantie spéciale devant être fournie préalablement pour couvrir le coût de la réparation des dommages que pourraient subir les chaussées et les ponts.

Le propriétaire ou le conducteur de tout véhicule, machine, objet, matériau ou produit ainsi transporté, à qui un tel permis est émis, est responsable de tous les dommages causés à la chaussée ou aux ponts du fait de ce transport.

Si le permis l'exige, le porteur devra communiquer avec le chef de la Sûreté du Québec ou avec un de ses représentants autorisés, pour lui permettre de faire surveiller et contrôler ce transport.

Les permis spéciaux ou généraux sont émis aux taux fixés par l'arrêté en conseil numéro 319 du 5 février 1969.

Interdiction en période de dégel ou de pluie

Pendant les périodes d'interdiction spécifiées par le ministre de la Voirie ou par toute personne désignée par lui à cette fin, à cause du dégel ou de la pluie, les charges par essieu et les poids totaux en charge fixés au paragraphe 3 de la présente réglementation seront ceux déterminés par avis dans la *Gazette officielle du Québec* et publiés dans les journaux de Québec, Montréal, Trois-Rivières, Sherbrooke, Sorel, Hull, Chicoutimi, Rivière-du-Loup et Rouyn, ou en cas d'urgence, par la radio, la télévision ou par des signaux routiers placés aux endroits appropriés.

4. *Dispositions spéciales concernant les remorques de transports de poteaux*

Nonobstant les maxima de longueur fixés aux sous-paragraphe *a, b, c, d* et *e* du paragraphe 2 de la présente réglementation, les ensembles de véhicules formés d'un véhicule-tracteur et d'une remorque spécialement agencée pour le transport des poteaux pourront circuler sur les chemins publics tout en transportant des chargements de poteaux, de tuyaux, de pièces de charpente ou de structure, ou autres matériaux du même genre pourvu que:

designated by him may, if he deems it expedient, and under the conditions which he may determine, issue special or general permits authorizing the transportation by motor vehicle, of machines or other large indivisible objects, and also the operation of vehicles such as house-trailers, mobile cranes, farm machinery or other like vehicles, mounted on pneumatics, which could not be moved without exceeding the total length, width and weight limits prescribed in this Regulation.

In exceptional circumstances, and if deemed to be in the public interest by the competent authorities, such special permits may also be issued for the transportation of divisible objects, materials or products, which cannot be transported without exceeding the total length, height, width and weight limits prescribed in this Regulation.

Such permits may indicate the dates of transportation, the route to be followed and the special conditions necessary for the protection of roads and bridges. A special guarantee may be required prior to the permit issuance to cover the cost of possible damage to roads and bridges.

The owner or driver of any vehicle, machine, object, material or product thus transported, to whom such a permit is issued, shall be responsible for any damage caused to roads or bridges attributable to such movement.

If so stipulated on the permit, the holder shall advise the Québec Provincial Police Chief, or one of his representatives, of the transportation details in order to permit police surveillance and control of the movement.

Special or general permits shall be issued at the rates fixed by Order in Council number 319 of February 5, 1969.

Interdictions during periods of thaw or rain

During periods of interdiction due to thaw or rain, and so declared by the Minister of Roads, or by any person designated by him therefor, the axle loads and the gross vehicle weights fixed in Part 3 of this Regulation shall be those announced in the *Québec Official Gazette* and published in the newspapers of Québec, Montreal, Trois-Rivières, Sherbrooke, Sorel, Hull, Chicoutimi, Rivière-du-Loup and Rouyn, or, in an emergency, by radio, television, or by highway signals placed at the appropriate locations.

4. *Special provisions concerning Pole-Trailers*

Notwithstanding the maximum lengths fixed in subparagraphs *a, b, c, d* and *e* of Part 2 of this Regulation, vehicle combinations consisting of a tractor and trailer specially equipped for the transportation of poles, may operate on public roads while carrying loads of poles, pipes, framework or structural pieces, or similar type structures, provided that:

a largeur fixée au paragraphe 2 de la présente réglementation ne soit pas excédée;
la longueur des véhicules, chargement compris, n'excède pas quatre-vingt-dix (90) pieds, hors tout;
la pesanteur fixée au paragraphe 3 de la présente réglementation, pour chaque catégorie de véhicules, ne soit pas excédée.

En plus des feux prévus à l'article 29 du Code de la route, toute remorque de transport de poteaux qui circule la nuit, sans chargement, sur les chemins publics, doit être munie d'au moins deux feux de couleur jaune ou ambre fixée, au moins un de chaque côté, à peu près à mi-chemin entre les deux extrémités du véhicule et agencés de manière à être visibles la nuit, d'une distance d'au moins cinq cents (500) pieds du côté gauche et du côté droit.

De plus, la partie extrême arrière de la remorque doit être munie d'au moins un réflecteur ou de tout autre appareil équivalent, de couleur rouge, ayant une surface réfléchissante de pas moins de douze pouces carrés. Ce réflecteur ou cet appareil doit être agencé de manière à réfléchir, la nuit, les rayons lumineux auxquels il est soumis, et cette lumière réfléchie doit être visible d'une distance d'au moins six cents (600) pieds par tout automobiliste qui s'en approche de l'arrière, avec feux de route allumés.

Tout chargement qui excède de plus de six (6) pieds l'arrière d'une remorque de transport de poteaux doit être muni d'au moins un feu de couleur rouge, fixé à pas plus de trois (3) pieds de l'extrémité arrière de ce chargement. Ce de feu route doit être visible, la nuit, d'une distance d'au moins cinq cents (500) pieds de l'arrière et des deux côtés.

La nuit, toute remorque à poteaux doit être munie de feux de couleur jaune ou ambre, fixés à intervalle de pas pas plus de vingt (20) pieds, sur toute la longueur du chargement. Ces feux doivent être visibles d'une distance d'au moins cinq cents (500) pieds, de chaque côté de la remorque.

Tous les feux exigés au présent paragraphe doivent être des feux à lumière fixe et être tenus allumés durant la nuit ou en tout autre temps, lorsque les conditions de visibilité l'exigent.

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the width fixed in Part 2 of this Regulation shall not be exceeded;
the length of the vehicles, load included, shall not exceed ninety (90) feet, over-all length;
the weight fixed in Part 3 of this Regulation for each class of vehicle shall not be exceeded.

In addition to the lighting requirements prescribed in section 29 of the Highway Code, all pole-trailers operating without loads on public highways at night must be equipped with at least two fixed yellow or amber lights, one on each side, located at approximately mid-point of the vehicle's length, and placed in such a way as to be visible at night from a distance of at least five hundred (500') feet on both right and left sides.

Moreover, the extreme rear of the trailer must be equipped with at least one red reflector, or similar device, having a reflecting surface of at least twelve square inches. This reflector, or similar device, must be so fitted to reflect, at night, the light rays directed upon it, and such reflected light must be visible from a distance of at least six hundred (600') feet by any motorist approaching from the rear with upper headlamp beams in operation.

Any load which protrudes more than six (6) feet from the rear of a pole-trailer must be equipped with at least one red light fixed at a distance of not more than three (3) feet from the extreme rear of such load. This red light must be visible, at night, from a distance of at least five hundred (500') feet behind and on both sides of the vehicle.

At night, all pole-trailers must be equipped with yellow or amber lights placed at intervals of not more than twenty (20') feet along the entire length of the load. These lights must be visible from a distance of at least five hundred (500') feet on each side of the trailer.

All the lights stipulated in this Part must be fixed lights, and must remain lighted at night or at any other time when conditions of visibility so require.

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SOME WOOD-TRANSPORTATION MODELING PROBLEMS ASSOCIATED WITH QUEBEC'S NEW LAND-MANAGEMENT SYSTEM

by

Jean Ouellet

(ABSTRACT)

This thesis describes the system of timber limits used in Canada's Quebec Province and the methods of wood transportation associated with it. Each of these wood-transportation methods is weighed, and its future under the New Land-Management System proposed by the Department of Lands and Forests is assessed.

This New Land-Management System is analyzed, primarily from the viewpoint of wood transportation. The base of a transportation model using linear programming is introduced. The supply sources are defined, and the method of calculating the allowable cut of timber is presented. The wood industries which produce chips are considered as supply sources additional to roundwood from the forests. For the purpose of this paper, the demand sources or destinations are the 59 pulp and paper mills presently operating in Quebec.

The proposed transportation model would be subject to some exogenous constraints. These are political constraints--e.g., laws governing transportation; economic constraints, which include wood coming from the private forests; social constraints, such as those imposed by the desirability of maintaining employment in each community; and the constraints introduced by forest fires, insects, and diseases. Methods for handling these constraints are discussed.