AN ECONOMIC EVALUATION OF A PROPOSED ROAD

BETWEEN MOOSE LAKE AND ATIKAMEG, MANITOBA

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I INTRODUCTION

The Department of Regional Economic Expansion will be a signator of the Northlands Agreements with the Provinces of Manitoba and Saskatchewan. The Agreements cover a number of programs designed to increase both the opportunities available to the people of the Northlands and their ability to take advantage of these opportunities. Interim agreements have been signed with the Provinces of Manitoba and Saskatchewan and final agreements will be negotiated at a later date.

Under these agreements one of the major programme sectors is "Transportation and Communications", which is concerned with assisting in the "assessment, planning and development of resource-based and other opportunities for economic development in a manner which emphasizes and encourages value-added benefits in the area".[1] One of the projects planned for Manitoba under these agreements is the construction of a road to give the Town of Moose Lake year round, all weather access to The Pas.

The Moose Lake road has been selected as the subject of the current study for two important reasons. First, the road will provide an entirely new surface link between The Pas and Moose Lake, with most of the benefits concentrated in the region and therefore more easily identified. Second, some of the basic data were already available from the Manitoba Northlands Transportation Study, as well as other general sources.

This report serves a dual function. The first is to serve as an economic efficiency and partial equity analysis of the proposed road. Cost benefit analysis is the major tool in assessing the economic efficiency. It attempts

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1 Canada-Saskatchewan Interim Subsidiary Agreement on the Saskatchewan Northland.

to measure the economic costs and benefits of a project against the criterion of maximizing the social benefits derived from the investment of government funds. The economic costs and benefits of building the proposed road are evaluated in this report using the general cost benefit methodology developed by the Ottawa Evaluation Group. Another aspect of any project which must be considered is its equity effects, namely which groups in society receive the benefits from a project and which groups bear the costs. No generally accepted approach has been developed for the assessment of equity considerations. This report restricts itself to attempting to identify by major population category those groups likely to benefit from The Pas-Moose Lake project.

The second function of this report is to serve as a framework for future evaluations of similar transportation projects. Thus, in the sections that follow, the methodology and assumptions used are set out in sufficient detail to allow the same general approach to be applied to other projects. Section II contains a specific description of the proposed road and the area in which it would be built. In Section III we provide a theoretical description of the general methodology appropriate for evaluating road transportation projects. We then apply this methodology to assess the benefits and costs applicable to The Pas-Moose Lake Road in Sections IV and V respectively. The report concludes (Section VI) with a comparison of the costs and benefits and a general summary. Relevant data and other details are included in Appendices.

II DESCRIPTION OF PROJECT AND REGION

In this section we list the project characteristics and then describe The Pas and Moose Lake areas, respectively. Figure II-1 is a map of the relevant region.

Project Description

The project involves the construction of 55 miles of gravel road between Atikameg and Moose Lake, Manitoba. Atikameg is located northeast of The Pas and the two communities are connected by some 25 miles of paved road. Thus when the new road is completed the total driving distance between The Pas and Moose Lake will be some 80 miles.

The proposed road would be an all-weather facility built to Pioneer Standard (24 feet wide) and costing $4.5 million to construct. Annual maintenance will create two or three new jobs and represent a yearly cost of $1,000/mile. The all-weather road will in large measure displace the existing 60 mile winter road between The Pas and Moose Lake, which costs some $70,000 annually to construct and maintain.[1]

Construction will likely begin in 1978 and be phased over a two-year period.

The Pas

The Pas is located some 450 miles by paved road northeast of Winnipeg and is situated on the Saskatchewan River and on the Canadian National Railway line serving the port of Churchill. Largely as a result of these factors, The Pas has become a major distribution centre for northern Manitoba.

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1 Source: Manitoba's Department of Northern Affairs, Thompson.

According to local estimates, the 1974 population of The Pas was in the order of 8,000 people. However, a number of communities bordering The Pas bring the current population for the immediate area to well over 10,000. These include the Pasquia Settlement situated west of the town, and The Pas and Big Eddy Indian Reserves located across the Saskatchewan River.

The retail trading area for The Pas also includes such communities as Moose Lake (800), Cormorant (550) and Wanless (130) and encompasses a population of some 12,000 people (including The Pas).[1]

The major employer in The Pas is Manitoba Forestry Resources Ltd. (ManFor), which produces kraft paper and lumber and employs some 900 people on average and 1,050 during peak periods. The ManFor plant began operation in 1969, was taken over by the Manitoba Government in 1972 and became a Crown Corporation under its present name in 1974. The plant currently produces some 375 tons of unbleached kraft paper per day and 85 million board feet of lumber per year.

The next most important employer in The Pas is Canadian National Railways which employs 174 people on a permanent basis and 125 seasonally. The Provincial Government and the local hospital each employ about 120 people while the Northern Manitoba Vocational Centre, Manitoba Telephone System and Lambair together account for another 125 jobs.[2]

Historically, unemployment has been a major problem at The Pas. During 1975 the number of registered unemployed varied between 330 and 550 which, based

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1 Source: Manitoba Department of Industry and Commerce, 1975 Manitoba Community Reports and DREE internal documents.

2 Ibid.

on local labour force estimates, suggests an unemployment rate ranging between 9.0 and 15.0 percent.[1] The largest categories of unemployed appear to be the construction trades and transport equipment operators.[2]

A major problem amongst local band Indians would appear to be a low labour force participation rate and a high incidence of seasonal employment.

Moose Lake

Moose Lake is located some 44 miles southeast of The Pas on the west side of the lake of the same name. It is connected to The Pas on a seasonal basis by means of a winter road (60 miles) which operates from December through to April. An airstrip is located west of the community and scheduled air service is provided by Lambair three times weekly. Barging is carried out on the Summerberry River, an 80 mile waterway connecting Moose Lake and The Pas.

Moose Lake has a current population exceeding 800 of which 30 percent are Indian and most of the remainder Metis. According to 1971 information, one-third of the local population has treaty (reserve) status.

Logging, trapping and commercial fishing appear to be the mainstays of the local economy. The main employers in the community include Jock Lamb's Store, the Fishing Co-op, the local school and Moose Lake Loggers.

Moose Lake Loggers was originally conceived as a training program for local loggers but later became a Provincial Crown Corporation. Wood is cut and stockpiled locally for shipment to ManFor when the winter road is in service.

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1 Department of Manpower and Immigration, Monthly Reports of Registered Clients and Vacancies and DREE internal documents.

2 Unemployment in construction tradesmay be exaggerated since to some extent this is used as a catch-all category for miscellaneous unemployed.

As a consequence ManFor has contributed to the up-keep of the winter road.[1] During the 1974-75 season ManFor's contribution amounted to $3,000, representing $50/mile.

As is generally the case in the area, unemployment is a major problem at Moose Lake. Combined with a predominance of large families, it has resulted in major local welfare expenditures. While per capita incomes have increased significantly over the past five years they are still well below the average at The Pas. In 1973 average income per resident at The Pas was $3,153 as compared to $1,090 at Moose Lake.[2]

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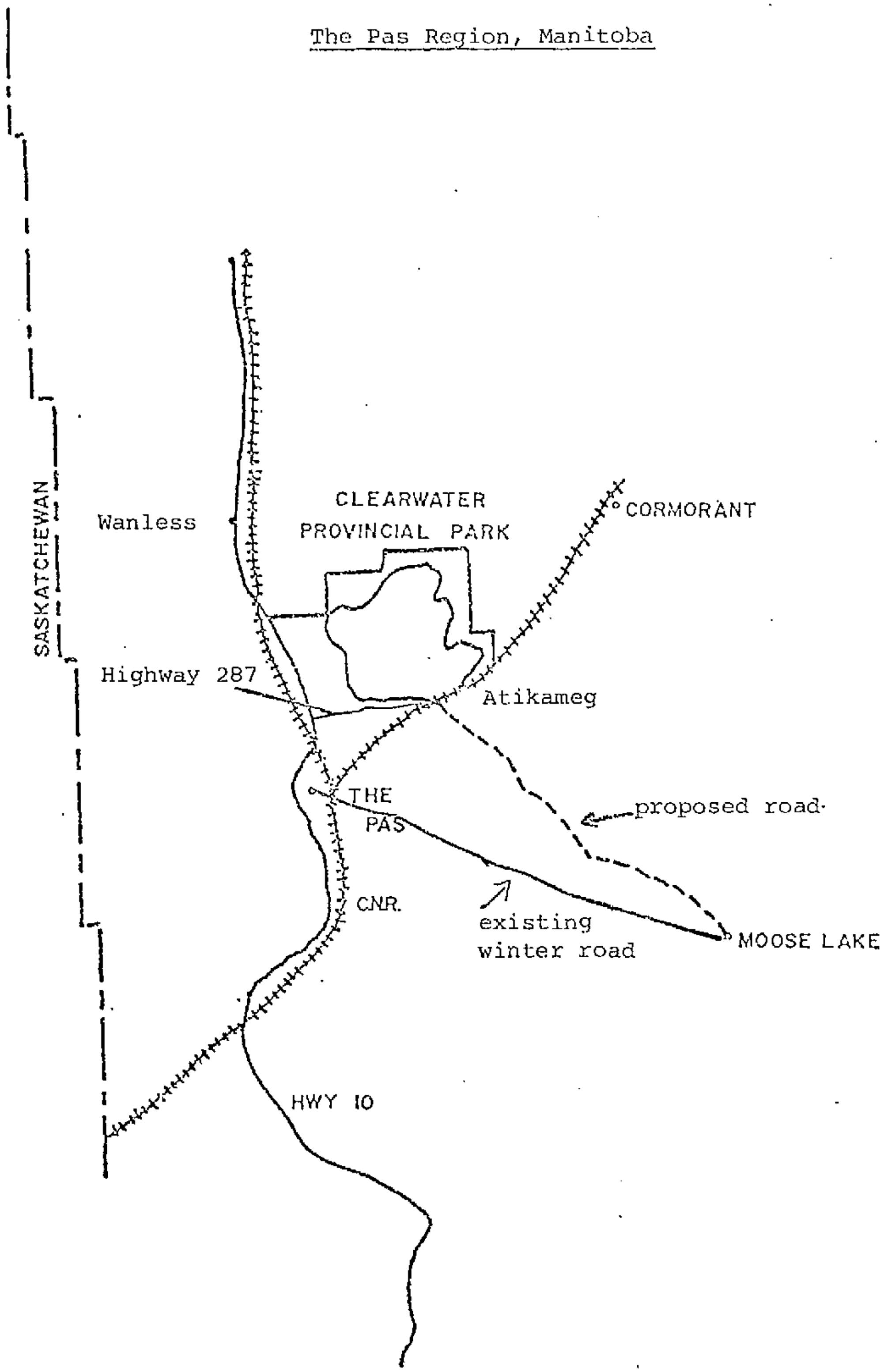
1 Manitoba Department of Northern Affairs, Community Profiles - Volume TP-7: Moose Lake, Manitoba.

2 DREE, internal document. Cormorant suffered a similar income disparity ($1,192), while Wanless was on a level much closer to The Pas ($2,526).

Figure II-1

The Pas Region, Manitoba



III METHODOLOGY FOR ASSESSING ROAD TRANSPORTATION PROJECTS[1]

Road projects can rarely be justified on strictly commercial criteria since typically benefits are freely available to patrons, in the absence of direct user charges or tariffs. Thus, the measurement of benefits generally involves imputation procedures rather than direct assessment through willingness to pay. We discuss the appraisal of benefits below and then comment on the measurement of costs.

Measurement of Benefits

Where a project involves improvements to the existing traffic infrastructure, the basic information required relates to the existing volume of traffic flowing between the relevant points and the reduction in travel costs per vehicle/mile attributable to the road project.

The bulk of the benefits stemming from road improvements are likely to accrue to traffic flows which either originally used unimproved facilities or are diverted to the improved facility. Hence, the direct benefits are cost savings reflecting such factors as lower fuel consumption, less wear and tear and maintenance and longer vehicle life. Other direct benefits include time savings, reductions in accident costs and savings in maintenance costs for the road itself. Indirect benefits (externalities) may include any induced excess of social benefits over social costs, improved mobility, access and convenience.

The basic procedure for evaluating the direct benefits consists of the

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1 Much of the analysis below is based on: A. C. Harberger Project Evaluation, MacMillan, 1972, Chapter 10; M. Roemer and J. J. Stern Appraisal of Development Projects, Praeger, 1975; H. A. Adler Economic Appraisal of Transport Projects, Indiana University Press, 1971; and DataMetrics Limited An Evaluation Framework for DREE Northlands Programs, Report prepared for Department of Regional Economic Expansion, October 1975.

following steps:

(a) Estimate the trend in current traffic volume by year by relevant mode[1] in the absence of the project under consideration.

(b) Project the estimated speed of the traffic volume by year, if sufficient data be available.

(c) Estimate the average cost per vehicle/mile for each class of vehicle or transportation mode.

(d) Estimate corresponding figures for the same traffic volumes but assuming the project under consideration were implemented.

(e) Estimate any increases in traffic volume over the base case given by (a) above. This is called generated traffic.

(f) Estimate the expected speed of total traffic based on the new total traffic volume, including generated traffic.

(g) Estimate average costs per vehicle mile for the new total volume of traffic, plus new maintenance costs for the facility.[2]

Define the following variables:[3]

i = vehicle type or transportation mode subscript .

t = time subscript

V_{it} = traffic volume for i^{th} vehicle type or mode at time t

c_{it} = average cost per vehicle mile at time t per vehicle or mode class in the absence of the project.

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1 Relevant modes are those on which the new or improved transportation facility has an impact.

2 The calculation of average cost includes all running costs, depreciation, repair costs and time costs of users. Costs will ideally reflect estimates of the relationship between average speed and the volume of traffic, by vehicle and mode type.

3 The symbols follow Harberger, op. cit.

c'_{it} = average cost per vehicle mile in the presence of the project

M_t = maintenance costs, time t, in absence of project

M'_t = maintenance costs, time t, in presence of project

B = present value of benefits

r = discount rate

Then if the project did not generate traffic, steps (a) to (d) result in an expression for present worth direct benefits of:

$$B = \sum_t \sum_i (c_{it} - c'_{it}) V_{it} (1+r)^{-t} + \sum_t (M_t - M'_t)(1+r)^{-t} \quad (1)$$

In short, the direct benefits are the present value of the cost savings attributable to the project.

Where generated traffic is involved, we designate the new volume of total traffic as V'_{it}. The c'_{it} and M'_t in formula (1) need to be re-calculated at the new higher volumes of total traffic.[1] With these adjustments formula (1) remains intact except that it excludes the gain in consumer surplus attributable to generated traffic.

If the demand curve for traffic as a function of its cost were linear, then we need to add one half the present value of the cost savings on the generated traffic to equation (1) to represent the additional consumer surplus. We can write the consumer surplus on the generated traffic (CS_g) as:

$$CS_g = 1/2 \sum_t \sum_i (c_{it} - c'_{it})(V'_{it} - V_{it}) \quad (2)$$

and this expression is added to equation (1).

These calculations are illustrated in Figure III-1 below.

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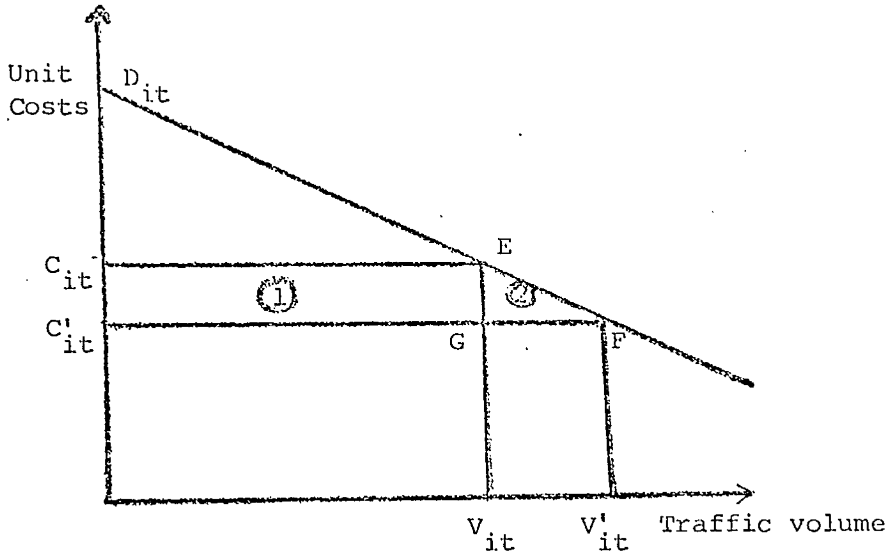
1 The generated traffic is $V'_{it} - V_{it}$.

Figure III-1

Traffic Benefits



Here D_{it} is the demand function for traffic type i at time t, and the other symbols are as before. The area designated 1 represents equation (1), excluding maintenance costs. Area 2 represents equation (2).

The preceding discussion has concerned direct benefits. We now turn to indirect benefits or externalities. We are concerned here with changes in benefits or costs induced by the project which go beyond those captured by equations (1) and (2). If E is the present worth of externalities, following Harberger they can be summarized in the form:

$$E = \sum_{t}\sum_{j} D_{jt}(X'_{jt} - X_{jt})(1 + r)^{-t} \qquad (3)$$

where D_{jt} is the excess of benefits over costs for a unit change in activity j; X'_{jt} is the level of activity with the project at time t; X_{jt} is the level in the absence of the project, time t. For example, D_{jt} may be the excess of social benefits over social costs for lumber output from a sawmill, X'_{jt} would be the output with the project and X_{jt} the output without the project (time t).

In this sort of analysis, it is necessary to identify all activities where marginal social benefits exceed marginal social costs. For a road project, this typically involves traffic on other roads and diversion of traffic from other modes. Where a road feeds into another system, traffic on linking roads will increase. Other things equal, the average speed of travel on linking roads will fall. If the value of a traveller's time were H_t per vehicle hour, time t, and the level of traffic on the link road before the project were V_t, time t, then the present value of the change in travel time costs (G) attributable to the project would be:

$$G = \sum_t \left(\frac{H_t V_t}{S_t} - \frac{H_t V_t}{S'_t}\right)(1 + r)^{-t} \qquad (4)$$

where S_t = average speed before the project, period t

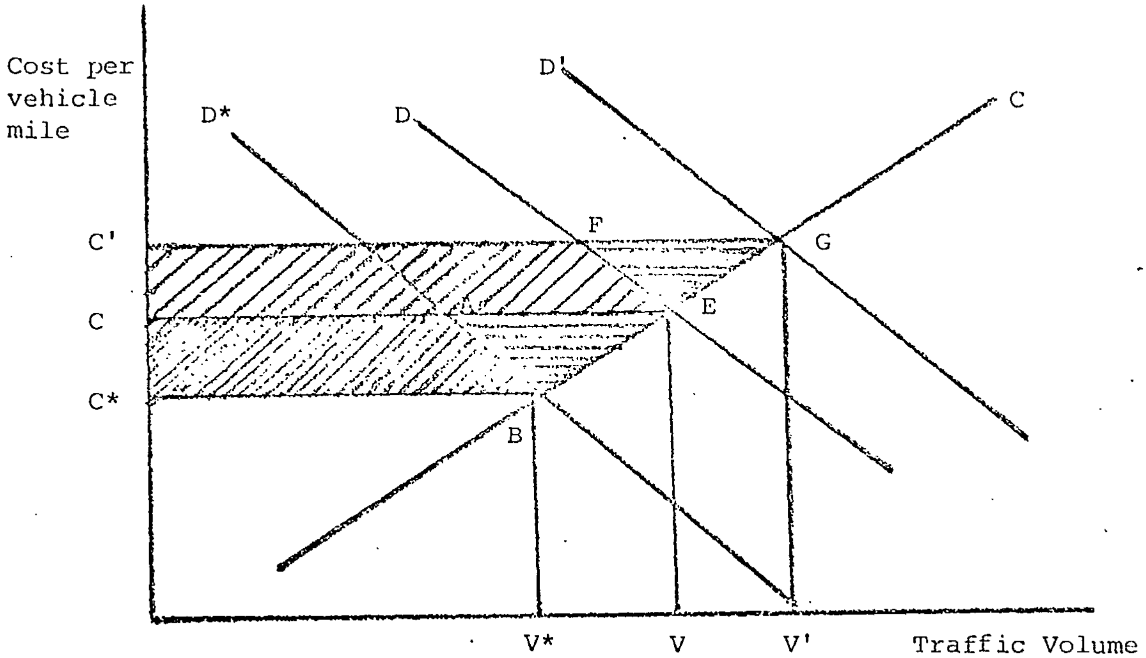
S'_t = average speed after the project, time t

If, as in the case above, the relationship between the new road and other roads were complementary, the value of G would be negative. If the new road (or road improvement) substitutes for other roads, G would be positive. In addition, we need to include the effect of such changes on the volume of traffic (generation or reduction). Figure 2 shows the situation.

The curve D is the demand curve for travel on a road other than the road on which the improvement is made. The curve C is the relevant cost curve. If the relationship of this road with the new road were competitive, the demand curve D would shift to the left, to D*, say. If it were complementary, the demand curve would shift to the right, to D', say. The respective equilibria are V, V* and V'.

Figure III-2

Road Externalities



For the competitive relationship, the indirect benefit for the volume of traffic retained by the road is the area 1 (CABC*).[1] For the complementary relationship, the indirect cost (lost consumers' surplus)[2] is C'FEC (Area 2).

Where traffic is diverted from one mode to another, and where the marginal social costs of carrying the diverted traffic by the original mode are small - as is often the case with railroads - the net external effect produced by a road will be about equal to the loss of revenue to the railroad.[3]

The other main area where a road transportation project may induce indirect benefits concerns increased output by local industries attributable

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1 Note that the benefits gained by the traffic that shifts would already be incorporated in the analysis of direct benefits through the treatment of diverted traffic. If the level of costs for the new or improved road were close to C*, then the area ABE approximates the diverted traffic benefit.

2 Moreover, the additional cost of the traffic diverted to the complementary is the area FEG.

3 For more on railroads and road inter-relationships, see Harberger, op. cit., pp. 264-269.

to the project.[1] The net benefits here are the value of the incremental output attributable to the project less the social costs[2] less that portion of any cost savings already included in the analysis of generated benefits.

<u>Measurement of Costs</u>

The direct project costs can be treated as comprising three components.

(i) material inputs (power, raw materials, fuel, etc.)

(ii) physical assets (land, machinery, equipment, inventories)

(iii) labour

Each is discussed below. We are primarily concerned with the adjustment of financial costs to social costs. Pure transfer payments - for example income taxes - are excluded.

(i) The social cost of domestic material inputs will be generally treated as equivalent to their financial costs. This assumes that either the materials are diverted from other uses where their market prices express their social value or the expansion in output is relatively small. Only if the output of materials had expanded significantly and had no other use in which their value exceeded their social cost of production would the latter be the appropriate measure. Where the materials are imported, an adjustment is required to reflect the social cost of foreign exchange, as outlined below.

(ii) Initial domestic physical resources and any subsequent increases are treated as costs, since they have alternate uses and hence opportunity costs. When such resources are released from the project, the market value

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1 This may arise through multiplied income effects or through a sufficient reduction in cost thresholds that significant additional market expansion results. However, where the road is resource specific in that its use is bound up with one operation, that operation should bear the cost of the road, and the road analysis should be subsumed in the appraisal of the operation itself.

2 Adjustments to arrive at social costs are discussed more fully below.

of the released resource is treated as a benefit.[1]

The cost of resources absorbed by the project which are directly or indirectly imported require adjustment for the shadow price of foreign exchange when a gap exists between the market exchange rate and the social exchange rate. That is, we need to adjust for the value of foreign exchange in terms of domestic currency.[2]

(iii) Labour costs require adjustment to a social basis. Such adjustments are complex and are related to the duration and rate of unemployment, the imputed cost of leisure foregone and the wage rate in alternate employment.[3] Each project must be examined individually.

Indirect costs or externalities are assessed in a manner analogous to the treatment of indirect benefits discussed beforehand.[4]

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1 We ignore the question of whether any portion of the stock of assets is financed with foreign capital, and any appropriate adjustments.

2 See G. P. Jenkins "The Social Cost of Foreign Exchange in an Economy with Trade Distortions and Differential Rates of Domestic Taxation", DREE Internal Report, 1975.

3 See Harberger, op. cit., Chapter 7; J. C. Evans "On Estimating the Social Opportunity Cost of Labour for a Hydro Electric Project in a Remote Construction Site and for Alternative Generation Facilities Near the Metropolis", DREE Staff Paper, May 1975; and G. P. Jenkins, C. Montmarquette, L. J. Weatherby "The Social Opportunity Cost of Labour in the Canadian Aircraft Industry", DREE Internal Report, September 1975.

4 After the adjustment of costs to a social basis.

IV PROJECT BENEFITS

In this section we describe and attempt to quantify the benefits arising from the new road. The first set of benefits we deal with are those accruing to passenger and cargo traffic as a consequence of transport cost savings. Next we examine a number of related benefits which in some cases may be less quantifiable or have little application in the context of the current project, but nevertheless deserve consideration. Finally, we look at possible income benefits occurring indirectly as a result of the new facility.

The road is assumed to begin operation in 1980 and to have a life of 20 years. All values are expressed in 1974 dollars.

Transport Cost Savings

Since the all-weather road is a new facility, all cost savings essentially relate to diverted and generated traffic. However, the new facility can in some measure be treated as an up-grading of the existing winter road to an all-weather road. Hence any benefits arising from the transference of traffic from the former to the latter is akin to the concept of benefits for existing rather than diverted traffic.

In the following analysis we examine the benefits accruing to diverted and generated traffic for both passengers and freight.

a. Passenger Benefits

Diverted Traffic: Forecasts were developed of existing passenger volumes to the year 2000 as a basis for calculating the savings related to diverted traffic.

During the 1974-75 operating season the winter road carried some 2,500 passenger vehicles and it appears that a similar volume will be recorded this year.[1] With the all-weather road in operation much of the traffic will shift to the new facility. However, it is assumed that the costs for passenger vehicles are about the same on both types of road and therefore no benefit is identified.[2] Since present winter road passengers are not expected to enjoy any cost savings from the new facility, our forecasts are confined strictly to air passenger traffic.

It is estimated that in 1974 The Pas-Moose Lake market accounted for 1,500 origin-destination (O&D) air passengers and that this traffic was growing at an annual rate of 7.0 percent.[3] For our purposes we have assumed that traffic growth is not sustainable at such a rate over the long term, but will gradually decline from 1974 levels until 1990 when it will level off at 3.0 percent, the expected population growth rate.[4] Table IV-1 provides estimates of population and air passenger growth to the year 2000.

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1 Manitoba Department of Highways.

2 Although the distance between the two centres is 20 miles shorter by winter road, this would be offset somewhat by the reduced fuel consumption, lower maintenance costs and higher speeds attainable on the pavement between Atikameg and The Pas. See Jan de Weille "Quantification of Road User Costs", World Bank Staff Occasional Papers Number 2, 1967.

3 Hickling-Johnston Management Consultants, Manitoba Northlands Transportation Study: General Appendix (Confidential Draft), The Native North, Exhibit 30.

4 Hickling-Johnston Management Consultants, Manitoba Northlands Transportation Study: An Economic Evaluation of Transport System Alternatives (Confidential) assumes a 3.5 percent population growth rate (p. 9). We reduce this rate of growth to 3.0 percent. This is supported by historical growth in the Western Northlands. See. A. Romaniuk, "A Demographic Study of the Western Northlands", DREE internal document.

Table IV-1

Estimated Annual Population & Air Passenger Growth Rates

1974-2000

	Population	Air Passenger (Base Case)
1974	3.50 %	7.0 %
1980	3.50	5.0
1985	3.25	4.0
1990	3.00	3.0
1995	3.00	3.0
2000	3.00	3.0

Applying the growth rates in Column 2 of Table IV-1, we estimate that by the year 2000 air passenger traffic would reach 4,151 O&D trips.

Although the traffic data lack detail, it seems probable that the majority of air passengers are Moose Lake residents travelling to and from The Pas for retail purchases. Non-resident traffic would consist mainly of government personnel, wholesalers and other individuals having business to conduct at Moose Lake. However, it is expected that this latter category would account for a lesser proportion of total traffic.

Since the all-weather road will provide a convenient alternative to air service, it is assumed that 93 percent of future air passenger traffic would be diverted to the new facility.[1] The 1974 air passenger fare between The Pas and Moose Lake was $15.00 one-way compared with an estimated cost by gravel road of $8.75.[2] Applying the difference of $6.25 to our estimate of diverted traffic yields the total benefit accruing to this segment of traffic

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1 PMLP Consultants, Manitoba Northlands Transportation Study: Evaluation of Transport Alternatives (Confidential Draft), p. 71. PMLP used a network model to estimate diverted traffic. The 93 percent figure was derived from this analysis

2 Ibid.

with the new road in operation.[1]

Generated Traffic: It is expected that generated passenger traffic will amount to 150 percent[2] of base case air traffic. PMLP arrived at this estimate for generated traffic by reviewing the experience at similar communities where the same type of improvement has been made. This is not unreasonable recognizing the relatively short distance between The Pas and Moose Lake and the fact that the new road will permit unrestricted year-round travel. The traffic generation only reflects price effects. Since travel costs on the all-weather road are expected to be the same as on the winter road, no corresponding generated traffic has been identified for traffic diverted from the winter road, although it is recognized that the convenience of the new facility would have a stimulative effect on traffic.

Thus, forecasts of generated traffic were developed by applying a factor of 1.5 to the base case projection of air traffic. Assuming a linear demand curve for passenger travel, half our previous passenger saving (i.e. \$3.125) has then been applied to yield the total benefit accruing to generated traffic.

The passenger benefits arising from the new road are summarized in Table IV-2. Expressed in 1974 dollars, the benefits accruing to diverted traffic are expected to increase from \$12,250 in 1980 to approximately \$24,000 in the year 2000. Over the same period generated passenger benefits will increase from \$9,900 to \$19,500. Total passenger benefits rise from \$22,000 in 1980 to \$43,500 in the year 2000.

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1 We assume that travel by air and motor vehicle will maintain the same real cost differential over the life of the project. It is recognized that this differential may widen reflecting the fuel intensive nature of air travel. However, this would be difficult to estimate because of the varying mix of aircraft types.

2 PMLP, op. cit., p. 71.

b. Freight Benefits

Diverted Traffic: For the new road diverted freight traffic will consist entirely of resupply freight[1] currently moving by air, barge and winter road.

For freight resupply traffic the new road will obviate the need for a winter road between The Pas and Moose Lake. However, for the movement of pulpwood from Moose Lake to Manfor's plant at The Pas the elimination of the road would likely result in higher trucking costs. On its present shipments of pulpwood from Moose Lake, Manfor is unrestricted as to load size. With respect to the new road, Manfor would be subject to certain load limitations, particularly because of its link-up with the pavement at Atikameg. In the absence of a winter road this would be reflected in higher ton-mile costs. It is therefore likely that even with the new road in operation Manfor will continue to use and maintain the winter road. For this reason we do not assign any benefits to Manfor's pulpwood movements.[2]

Forecasts of traffic on each of the three existing modes were developed to the year 2000 by applying the population growth rate. Freight traffic is expected to grow at the same rate as population. Total cost forecasts were then developed for each mode by applying corresponding shipping costs.[3]

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1 Consumables such as fuel and household goods which move in on a regular basis.

2 While Manfor would presumably assume the full cost of operating and maintaining the winter road, no social cost saving would be generated. The Government would enjoy a financial saving, but the same quantity of resources would be required to maintain the road regardless of who pays. Since Manfor will continue to use the winter road and is mainly responsible for its deterioration, no maintenance cost saving has been identified as a consequence of the all-weather road becoming operational.

If Manfor did shift its pulpwood shipments to the new road, the following adjustments to our analysis would be required. The benefits would increase by the saving in yearly operating costs ($70,000 in 1974). However, costs would rise to reflect increased maintenance on both the new road as well as the paved link between Atikameg and The Pas, and possible higher capital outlays on the new road to sustain the extra loads. It is doubtful whether the additional traffic would lead to significant congestion costs.

3 PMLP, op. cit., p. 71.

These are as follows:

	Cost/Ton
Air	$ 121.90
Barge	29.80
Winter Road	12.01

It is assumed that when the all-weather road becomes operational all resupply traffic currently moving by air, barge and winter road will shift to the new facility. Forecasts of cargo traffic on the new road were therefore developed by combining the traffic forecasts for the existing three modes. Cost forecasts were then derived by applying the estimated unit cost of shipping over the new road, $6.81/ton.[1]

The series of benefits accruing to diverted traffic were then estimated by combining the projected costs for the three existing modes and from this total deducting the corresponding cost projections for the new road.

Generated Traffic: It is estimated that generated freight traffic will amount to 60 percent[2] of the base case traffic. Again, assuming a linear demand curve, the unit cost benefit accruing to generated traffic is estimated at one-half the difference between the weighted average cost on existing modes ($27.81/ton) and the cost expected to prevail on the new road ($6.81/ton). This difference was then applied to the forecast of generated traffic to yield the corresponding benefit.

Table IV-2 summarizes the benefits accruing to freight traffic. Over the 20-year life of the project diverted cargo benefits will increase from $100,000 to $186,400. For generated freight the corresponding benefits will increase from $30,000 in 1980 to $55,700 in the year 2000. Total cargo benefits

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1 Ibid.

2 Ibid. PMLP again relied on experience gained at other communities in similar circumstances.

Table IV-2

Benefits Arising From Diverted and Generated Traffic

	Passenger Traffic (O&D Trips)		Passenger Benefits (1974 Dollars)		Freight Traffic (Tons)		Freight Benefits (1974 Dollars)		
	Diverted from Air	Generated*	Diverted from Air	Generated	Diverted	Generated	Diverted	Generated	Total Benefit
1980	1,960	3,161	$ 12,250	$ 9,878	4,760	2,860	$ 100,471	$ 30,030	$ 152,629
1981	2,054	3,314	12,838	10,356	4,927	2,960	103,980	31,080	158,254
1982	2,148	3,465	13,425	10,828	5,097	3,060	107,651	32,130	164,034
1983	2,243	3,618	14,019	11,306	5,269	3,160	111,156	33,180	169,661
1984	2,337	3,770	14,606	11,781	5,446	3,270	115,076	34,335	175,798
1985	2,430	3,920	15,188	12,250	5,626	3,380	118,739	35,490	181,667
1986	2,523	4,070	15,769	12,719	5,808	3,490	122,544	36,645	187,677
1987	2,614	4,217	16,338	13,178	5,990	3,600	126,575	37,800	193,891
1988	2,703	4,359	16,894	13,622	6,184	3,720	130,599	39,060	200,175
1989	2,789	4,499	17,431	14,059	6,375	3,830	134,692	40,215	206,397
1990	2,873	4,634	17,956	14,481	6,570	3,950	138,754	41,475	212,666
1991	2,959	4,773	18,494	14,916	6,768	4,070	142,977	42,735	219,122
1992	3,048	4,916	19,050	15,363	6,970	4,190	147,184	43,995	225,592
1993	3,139	5,063	19,619	15,822	7,180	4,320	151,752	45,360	232,553
1994	3,234	5,216	20,213	16,300	7,395	4,450	156,214	46,725	239,452
1995	3,330	5,372	20,813	16,788	7,616	4,580	160,723	48,090	246,414
1996	3,430	5,532	21,438	17,288	7,846	4,720	165,752	49,560	254,038
1997	3,533	5,699	22,081	17,809	8,080	4,860	170,596	51,030	261,516
1998	3,639	5,870	22,744	18,344	8,323	5,000	175,803	52,500	269,391
1999	3,748	6,045	23,425	18,891	8,573	5,150	181,064	54,075	277,455
2000	3,860	6,227	24,125	19,459	8,829	5,310	186,433	55,755	285,772

* Generated passenger traffic was estimated on the basis of base case total air traffic rather than diverted volumes.

rise from $130,500 in 1980 to $242,000 in the year 2000. The freight benefits are of a much greater magnitude than the passenger benefits.

These calculations of benefits all presume that transportation costs relating to the base case traffic flows - i.e. the flows experienced in the absence of the project - do not include any economic rents.[1]

Other Potential Benefits Not Already Included in Travel Costs

a. Time Savings

Actual travel time on the new road will likely be greater than on existing air passenger service. However, when the added time required to travel to and from the airstrip is considered, differences in elapsed time in door-to-door travel are likely insignificant. The all-weather road, therefore, will not result in any overall savings in travel time over existing means of transportation between The Pas and Moose Lake: no benefit has been identified in this respect.

Over such short distances, convenience becomes an important element and not travel time per se. While the individual may spend greater time enroute compared with the air mode, this is offset somewhat by the fact that he can travel at his own convenience and not the airline's. Similarly he is not restricted seasonally, as is the case with the winter road. Therefore, where passenger travel is concerned the convenience factor becomes an important benefit of the new road. This element is difficult to quantify and we do not attempt to do so here.[2]

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1 This assumption is reasonable, given overt regulation of transportation tariffs. If economic rents were enjoyed, their loss would be deductible from the benefits attributable to the project.

2 Ideally, we would need some indication of willingness to pay for the additional convenience.

b. Inventory Reduction

Year-round access can also yield benefits related to freight re supply since it reduces the level of normal inventory required. Where transportation is seasonal in nature, goods must be stockpiled in anticipation of the period when access is limited, thereby tying up capital and creating additional interest costs. In the case of Moose Lake the combination of barge and winter road provide surface access for all but two or three months out of the year. During the remainder of the year air transport likely assists in the resupply function. Therefore, no benefit has been assigned, although the greater ease of transportation will undoubtedly reduce the average level of inventory related to activity levels in the area.

c. Motor Vehicle Accidents

Completion of the all-weather road will likely increase the number of motor vehicle accidents occurring between The Pas and Moose Lake simply as a consequence of the larger volume of traffic. The associated economic cost may be measured in terms of property damage, lost productivity of accident victims, medical care expenditures and vehicle repair costs. No attempt has been made to measure this element since it is expected to be small relative to the other costs and benefits of the project.

d. Traffic Congestion

When a new road feeds into an existing link, as is the case here, another set of costs that can be identified are those related to traffic congestion. As traffic increases, average speeds fall resulting in higher overall vehicle operating costs as well as increased travel time. However, discussions with local sources indicate that traffic congestion would not be a significant factor in the present case.

e. Regional Income Benefits

If we assume that net local expenditures represented by the project would not otherwise be made, and that they draw idle resources into operation, then the multiplied incomes become relevant to the stream of benefits attributable to the project through creating additional real incomes in the rest of the region.

We express the regional income multiplier as:

$$K = \frac{1}{1 + m - [c(1-t_p)g + v + s(t_p g + t_c b)]}$$

where c = marginal propensity to consume

g = personal share of gross income

b = business share of gross income

v = marginal propensity to invest

m = marginal propensity to import

t_p = marginal tax rate on personal income

t_c = marginal corporation tax rate

s = provincial share of tax revenue

We assign the following values to the coefficients, based on original Prairie data:

$c = 0.95$, $v = 0.1$, $g = 0.7$, $b = 0.25$, $m = 0.6$, $t_p = 0.2$, $t_c = 0.15$, $s = 0.75$.

The resulting multiplier[1] (K) is approximately 1.2.

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1 Details of the regional income model used is given in Appendix B.

Table IV-3

Multiplied Net Income Benefits

$ M 1974

	Local Expenditures	Induced Gross Income (a)	Income less Social Costs (b)
	(1)	(2)	(3)
1978	370.0	74.0	66.6
1979	370.0	74.0	66.6
1980	26.1	5.2	4.7
1981	26.5	5.3	4.8
1982	26.8	5.4	4.9
1983	27.1	5.4	4.9
1984	27.4	5.5	5.0
1985	27.7	5.5	5.0
1986	28.0	5.6	5.0
1987	28.3	5.7	5.1
1988	28.7	5.7	5.1
1989	29.0	5.8	5.2
1990	29.4	5.9	5.2
1991	29.7	5.9	5.3
1992	30.0	6.0	5.4
1993	30.4	6.1	5.5
1994	30.7	6.1	5.5
1995	31.1	6.2	5.6
1996	31.4	6.3	5.7
1997	31.7	6.3	5.7
1998	32.1	6.4	5.8
1999	32.4	6.5	5.9
2000	32.8	6.6	5.9

(a) 0.2 times Column (1) (b) Column 2 x 0.9

We estimate local expenditures as $500M in each year of the construction period and $43.7M in the first year of road operation - 1980 - rising to $58.9M by 2000. From these figures we deduct unemployment insurance and welfare payments which would have been paid to unemployed workers directly or indirectly absorbed by the project;[1] the corresponding numbers are $370M, $26.1M and $32.8M. The multiplied income is 20 percent of the net figures. We assume the income is split 30 percent to gross profits and economic rent and 70 percent to salaries, wages and other labour payments. The extent to which these labour payments provide jobs for previously unemployed persons is difficult to ascertain. If we make the strong assumption that all labour payments reduce unemployment, directly or indirectly, then the income benefits are the total labour payments less the social opportunity cost of labour. The latter is estimated as about 10 percent of the wage bill for construction workers,[2] and we adopt the same figure here. The social opportunity cost related to the gross profits portion of income is equally difficult to ascertain. For ease of calculation, we set this at 10 percent as well.

On this basis, the stream of induced net income benefits attributable to the project is shown in Table IV-3.

Summary

The major benefits arising from the new road will relate to diverted and generated traffic with the greatest emphasis in this respect on freight resupply. Other benefits (both negative and positive) which either have a smaller bearing on the project or are less quantifiable include increased

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1 We require net local expenditures generated by the project; our assumption is that savings in unemployment insurance and welfare will not be translated into corresponding increases in regional government spending.

2 See Section V.

convenience, reduced inventory requirements, a higher motor vehicle accident rate and increased traffic congestion. Beyond these more direct effects, net local expenditures on the project may yield net regional income benefits.

V PROJECT COSTS

In this section we identify the costs of constructing and maintaining the new road together with related adjustments to reflect the social cost of project resources. Table V-1 shows the estimated financial cost of road construction and the different components included in that cost.

Table V-1

Annual Road Construction Costs, 1978 and 1979

(000's)

Fuel	$ 325
Labour & Supervision	450
Maintenance	245
Depreciation	645
Transport (Equipment & Personnel)	70
Camp Costs	55
Insurance, Interest, Profits, etc.	460
	$ 2,250

Since detailed planning for the road has not yet commenced, the figures in Table V-1 were gathered from industry and government sources and are only approximate.[1] The estimated total cost of $4.5 million compares closely with estimates prepared by PMLP and reflects costs of approximately $80,000 - $100,000 per mile.[2] No cost has been identified for the social cost of land acquisition, since much of the land in question is muskeg with no alternate use.

It is estimated that construction would take two years, with 1978-79 being the most likely time frame.[3] Approximately 60 - 65 men would be employed over this period.

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1 Department of Regional Economic Expansion (Winnipeg) and McLean Construction, The Pas.

2 PMLP, op. cit., p. 71.

3 The work year for this type of project is approximately six months long.

We estimate that initial yearly maintenance on the road would amount to $1,000 per mile, representing a $55,000 expenditure annually (1974 figures).[1] However, labour costs would account for about 50 percent of yearly maintenance expenditures and based on recent experience it is expected that these would undergo real increases of 2.0 percent annually over the life of the project.[2] Road maintenance would generate two or three jobs of the machine operator type. These would be year round jobs, constituting grading in the summer and snowplowing in the winter.

In the next section we deal with economic adjustments to construction and maintenance costs.

Economic Adjustments

a. Labour

Of the total projected work force, approximately 25 would be unskilled, either native or non-native. Given the labour situation at The Pas these unskilled workers would probably be drawn from the unemployed. A further 25 men would be skilled machine operators, a certain proportion of which would be natives.[3] According to the Canada Manpower Centre at The Pas it is unlikely that any substantial number of these operators would be drawn from the unemployed. Some of the native operators who are not particularly mobile might be drawn from the unemployed, but this is by no means certain and would depend upon the construction situation at the time the road was built. The remainder of the workers would be of the skilled type (surveyors, etc.) and would probably be drawn from other employment outside the region.

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1 Source: DREE (Winnipeg).

2 We assume constant real labour costs during the construction period.

3 Based on discussions with the Canada Manpower Centre at The Pas.

The assumptions used in calculating the labour cost adjustments are as follows:

(1) all unskilled workers would be otherwise unemployed.

(2) all skilled workers would be otherwise employed at comparable jobs at the same wage rate.

(3) the construction work period is six months in both 1978 and 1979.

(4) the wage paid to an unskilled worker in this employment is \$4.00/hour or \$160/week.[1]

(5) each unskilled worker is assumed to have three dependents - a wife and two children, one under sixteen and one over sixteen.

(6) in the absence of this project the unskilled workers would be collecting \$100/week from welfare or unemployment insurance compensation.[2]

Given the above assumptions, the social opportunity cost of skilled labour is the wage bill paid, and therefore no adjustment need be made. The social opportunity cost of the unskilled labourer hired from the ranks of the unemployed is the value of his leisure time over and above unemployment compensation.[3] If the unemployment benefits were to be increased, we expect that these individuals would be less willing to accept the marginal employment opportunities available to them. The net income they would receive from employment over and above the unemployment benefits they lose would be less than the value of the leisure they would have to give up. Therefore on average the wage rates for the alternative employment opportunities will have to increase until the net of tax difference between the wages and the unemployment insurance payments is

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1 Ibid. In the case of maintenance, wages must be adjusted upwards to reflect real increases in the long-term price of labour.

2 Ibid.

3 Methodology for SOCL of unemployed workers follows that of G. Jenkins, C. Montmarquette and L. J. Weathers, The Social Opportunity Cost of Labour in the Canadian Aircraft Industry, a Department of Industry, Trade and Commerce internal paper.

at least equal to the value placed on the leisure foregone when working.[1] The social opportunity cost of a voluntary unemployed worker can therefore be written:[2]

$$SOCL = (W^A(1-t_e) - UIC(1-t_u)$$

where UIC is the gross of tax value of unemployment benefits per period

t_e is the marginal tax rate if the worker accepts alternative employment

t_u is the marginal tax rate for UIC

W^A is the alternative wage prevailing in the region

Given the assumptions noted above, the SOCL for an unemployed worker becomes:

$$SOCL = (\$160 \quad (1-.27)\ ) - 100(1-0)$$

$$= \$17 \text{ per week}$$

If 25 unemployed, unskilled workers are employed for 26 weeks per year the social opportunity cost of labour is $11,050. The financial cost of hiring these workers is $104,000. Therefore the social benefit of hiring unemployed workers becomes $92,950 per year for each of the two construction years: the value of their revenue product less their opportunity cost.

We assume that one of the men employed on annual maintenance will be unskilled and drawn from a pool of unemployed; hence the social opportunity cost of employing him will be his supply price.

If we adopt our previous assumptions, based on a normal work-year the social opportunity cost is $884 compared with a financial cost of $8,320; the corresponding social benefit is $7,436.[3]

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1 Since Unemployment Insurance Commission benefits are temporary it may be worth less to a worker in present value terms than in their absolute value when compared to the alternative wage rate. This means that this measure of the value of leisure understates its true value and therefore it is a minimum estimate of the social opportunity cost of an unemployed worker. However, a continuation of welfare payments would offset this effect.

2 This formula gives a maximum value of leisure for the involuntary unemployed.

3 (52 x $160) - (52 x $17) = $7,436. (Expressed in 1974 dollars.)

The above analysis is predicated on the assumption that The Pas - Moose Lake project would have no effect on the migration habits of the unskilled labour pool in the area. This implies that provision of a short period of construction work would not induce any unskilled workers to remain in the area who otherwise would have left, nor would have encouraged any unskilled workers to move into the region. Given that the majority of the unskilled workers will be native labour, this assumption is reasonable.

b. Foreign Exchange

Tariffs, sales taxes and subsidies mean that the market rate for foreign exchange will not necessarily serve as a measure of social values. Therefore it is necessary in social cost benefit analysis to express foreign exchange generation in terms of domestic currency, adjusted to a social basis. It has been estimated that the market foreign exchange cost of imported goods should be increased by 13 percent to reflect social costs.[1] There are no foreign exchange earnings from the project.

Because the cost figures obtainable for The Pas - Moose Lake road are tentative, it was not possible to obtain a detailed breakdown of all possible foreign expenditures relating to the project. However, from the detail available it is evident that most of the supplies, material and labour required to build the road would be obtained domestically. The chief exception would be the machinery and equipment used on the project, as reflected in the financial depreciation costs.

Construction industry averages indicate that as a whole about 80 percent of equipment is imported. However, for road construction in the North a higher

1 Glenn P. Jenkins, The Social Cost of Foreign Exchange in an Economy with Trade Distortions and Differential Rates of Domestic Taxation, March 1975.

proportion would tend to be domestically produced due to the type of equipment used.[1] Since no definite figures were available we assumed 50 percent of the equipment used in the project would be imported. Therefore the upward adjustment of financial cost to economic cost to reflect the foreign exchange used by the project is $42,000 in both 1978 and 1979.[2] This analysis assumes the machinery and equipment employed have alternate uses.

Summary

The financial cost of the new road will be $4.5MM split equally between the two construction years 1978 and 1979, while maintenance will rise from $58M in 1980 to $71M by the year 2000, reflecting assumed real increases in the price of labour. Adjustments have been made to account for the social cost of project resources. In the case of labour there is a downward adjustment of $93M in each construction year and $8.4M in 1980 rising to $12.4M by the year 2000. For foreign exchange there is an upward adjustment in each construction year and no further adjustments thereafter.

With all adjustments made the economic cost of construction will be $2,199M in both 1978 and 1979. The economic cost of maintenance is estimated to range from $50.4M in 1980 to $58.8M by the year 2000.

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1 Based on discussions with the Department of Industry, Trade and Commerce.

2 $445,000 x .50 x .13 = $41,925.

Table V-2

Financial and Economic Costs

(M 1974 $)

	Financial Cost	Economic Adjustments		Economic Cost
		Labour (negative)	Foreign Exchange* (positive)	
1978	2,250.0	93.0	42.0	2,199.0
1979	2,250.0	93.0	42.0	2,199.0
1980	58.4	8.4	--	50.0
1981	59.0	8.5	--	50.5
1982	59.6	8.7	--	50.9
1983	60.2	8.9	--	51.3
1984	60.8	9.1	--	51.7
1985	61.4	9.2	--	52.2
1986	62.0	9.4	--	52.6
1987	62.6	9.6	--	53.0
1988	63.2	9.8	--	53.4
1989	63.9	10.0	--	53.9
1990	64.5	10.1	--	54.3
1991	65.1	10.4	--	54.7
1992	65.8	10.6	--	55.2
1993	66.4	10.8	--	55.6
1994	67.1	11.0	--	56.1
1995	67.8	11.3	--	56.5
1996	68.5	11.5	--	57.0
1997	69.1	11.7	--	57.4
1998	69.8	12.0	--	57.8
1999	70.5	12.2	--	58.3
2000	71.2	12.4	--	58.8

* Assumes that there is no material foreign exchange component for road maintenance.

VI COST BENEFIT COMPARISONS AND CONCLUSIONS

In this section first we bring together the streams of costs and benefits developed in sections IV and V for purposes of comparison. Second, we look at some of the distributional characteristics of the project. Third, we summarize and conclude the evaluation.

Comparison of Costs and Benefits

After adjustment, the social costs in 1974 dollars of the road project are given in the final column of Table V-2. The undiscounted sum of these costs over the 23 year period 1978 to 2000 is $5,539,200.

The social benefits in 1974 dollars from the project, excluding estimated multiplied income benefits, amount to $4,514,000 (undiscounted) over the period 1980 to 2000 (Table IV-2).

If we treat the project as also having the function of reducing regional unemployment, and assuming the secondary effects of the project do absorb unemployed resources, then a total of $244,400 (1974$, undiscounted) (Table IV-3) could represent induced regional income benefits. On this basis, total undiscounted benefits would rise to $4,758,000, still less however than undiscounted costs.

We now account for differences in the timing of the incidence of costs and benefits by expressing the results on a present worth basis. Using a discount rate of 10 percent as representing the social opportunity cost of public funds,[1] the present worth benefits (excluding multiplied benefits) are 1,517,000 and present worth costs are $4,614,000 (1974 dollars).[2] The net difference is 3,097,000.

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1 See Glenn P. Jenkins "A Note on the Social Opportunity Cost of Government Expenditure in Canada" DREE, Ottawa, (undated).

2 Present worth in 1978.

If we add in multiplied income benefits, the net present worth loss falls to $2,983,000.

The higher figure for discounted losses compared with undiscounted losses reflects the concentration of social costs at the start of the project, while the benefits from traffic flows increase as a function of time.

Two key factors in the analysis are the generation coefficients used (150 percent for passenger traffic and 60 percent for freight traffic) and the rate of growth of diverted air traffic, which declines from 7 percent in 1974 to the population growth rate of 3 percent by 1990. Both factors are subject to considerable uncertainty. Thus, a pertinent question is by how much would each factor have to increase to eliminate the computed present value loss? In other words, what values would have to be attributed to each factor to yield an internal social rate of return of 10 percent for the project. By iteration, we find that the generation coefficient would have to increase eight fold to 1200 percent for passenger traffic and 500 percent for freight traffic to eliminate the project's estimated social loss. Alternatively, the annual rate of diverted traffic growth would need to be sustained at 15 percent from 1974 to year 2000. These are extreme values. Hence, we conclude that even if the generation and growth factors used were conservative - and there is no intention to make them so - insertion of more optimistic but still realistic figures would not be of sufficient magnitude to eradicate the social loss.

Distributional Aspects

The major recipients of local benefits from the new road will be the natives residing at The Pas and Moose Lake, and in particular the latter. The native population would appear to represent the largest single category of unemployed in the region and it would therefore likely benefit the most through employment on road construction and maintenance. The new road will also permit greater year-round mobility by the predominantly native population at Moose Lake. Therefore, as a group they will likely be the major users of the road and derive most of the traffic benefits. The multiplied income benefits would be more dispersed and less identifiable with any single group.

Our analysis excludes certain aspects of the project which are difficult or impossible to quantify. Probably the most important of these is the greater convenience, contact and access to outside communities which the road would permit. If we consider the primary target population for the project as households at Moose Lake, the social loss calculated above allows expression of the minimum value the intangible or excluded benefits the road should confer for the project to be socially worthwhile. The present value loss in 1974 dollars per household - assuming some 250 households at Moose Lake - is about $11,500. This translates into an equivalent monthly cost over 20 years (at a 10 percent discount rate) of some $100/household. What this figure means is that if the project were socially desirable, each household should subjectively value its worth at at least $100/month over twenty years, exclusive of those benefits already included in the analysis of cost savings.

Conclusions

The proposed all-weather road between The Pas and Moose Lake will divert traffic to itself from both the air mode and from an existing winter road between the two communities. No cost savings are envisaged for traffic diverted from the winter road. Cost savings are envisaged for diverted air traffic and associated stimulated traffic (passenger and freight). Such savings are expected to rise steadily from $153,000 in 1980 - the first year of road operation - to $286,000 by year 2000 (1974 dollars) for an undiscounted total of $4,514,000. Most of these benefits relate to freight traffic. The inclusion of possible multiplied income benefits from the absorption of previously unemployed resources by the project would raise undiscounted benefits to $4,758,000.

However, at this level, total benefits would still not exceed total social costs. After adjusting financial costs for the social costs of labour and foreign exchange, undiscounted 'economic' costs are $5,539,200 (1974 dollars). The bulk of these costs are incurred during the construction period of 1978 and 1979.

When the streams of benefits and costs are discounted at a social discount rate of 10 percent, the difference between costs and benefits are exacerbated. The present value social loss is $3.1 million (1974$) or $3.0 million, according to whether multiplied income benefits are excluded or included, respectively. The magnitude of these losses is relatively robust with respect to any likely range of underestimation of benefits in the analysis.

The native population in The Pas - Moose Lake region is the single group that will likely benefit the most from the new road, primarily in terms of greater mobility, reduced travel costs and improved employment opportunities.

The quantified social losses incurred by the project can be interpreted as the social value to which intangible or excluded quantifiable benefits should approximate if the project were to be socially worthwhile. If the target population were treated as the households at Moose Lake, the average household should value any such excluded benefits as at least equivalent to $100/month over a twenty year period.

APPENDIX A: COMPUTATIONAL TABLES*

Table A-1

Benefits to Diverted Passenger Traffic

	Air Trips Without Road	Diverted to Road	Cost Differential	Benefit to Diverted Traffic
1980	2,107	1,960	$ 6.25	$ 12,250
1981	2,209	2,054	-	12,838
1982	2,310	2,148	-	13,425
1983	2,412	2,243	-	14,019
1984	2,513	2,337	-	14,606
1985	2,613	2,430	-	15,188
1986	2,713	2,523	-	15,769
1987	2,811	2,614	-	16,338
1988	2,906	2,703	-	16,894
1989	2,999	2,789	-	17,431
1990	3,089	2,873	-	17,956
1991	3,182	2,959	-	18,494
1992	3,277	3,048	-	19,050
1993	3,375	3,139	-	19,619
1994	3,477	3,234	-	20,213
1995	3,581	3,330	-	20,813
1996	3,688	3,430	-	21,438
1997	3,799	3,533	-	22,081
1998	3,913	3,639	-	22,744
1999	4,030	3,748	-	23,425
2000	4,151	3,860	-	24,125

* All monetary values in this Appendix are in 1974 dollars.

Table A-2

Benefits to Generated Passenger Traffic

	Generated Passengers	Cost Differential	Benefits to Generated Traffic
1980	3,161	$ 3.125	$ 9,878
1981	3,314	-	10,356
1982	3,465	-	10,828
1983	3,618	-	11,306
1984	3,770	-	11,781
1985	3,920	-	12,250
1986	4,070	-	12,719
1987	4,217	-	13,178
1988	4,359	-	13,622
1989	4,499	-	14,059
1990	4,634	-	14,481
1991	4,773	-	14,916
1992	4,916	-	15,363
1993	5,063	-	15,822
1994	5,216	-	16,300
1995	5,372	-	16,788
1996	5,532	-	17,288
1997	5,699	-	17,809
1998	5,870	-	18,344
1999	6,045	-	18,891
2000	6,227	-	19,459

Table A-3

Cost of Freight Resupply on New Road

	Diverted Freight (Tons)					
	Air	Barge	Winter Road	Total	Unit Cost on New Road	Total Cost on New Road
1980	380	1,880	2,500	4,760	$ 6.81	$ 31,900
1981	393	1,946	2,588	4,927	-	33,000
1982	407	2,013	2,677	5,097	-	34,100
1983	420	2,081	2,768	5,269	-	35,300
1984	435	2,151	2,860	5,446	-	36,400
1985	449	2,222	2,955	5,626	-	37,700
1986	463	2,294	3,051	5,808	-	38,900
1987	479	2,368	3,149	5,996	-	40,200
1988	494	2,442	3,248	6,184	-	41,400
1989	509	2,518	3,348	6,375	-	42,600
1990	524	2,595	3,451	6,570	-	43,900
1991	540	2,673	3,555	6,768	-	45,200
1992	556	2,753	3,661	6,970	-	46,600
1993	573	2,836	3,771	7,180	-	47,900
1994	590	2,921	3,884	7,395	-	49,400
1995	607	3,008	4,001	7,616	-	50,900
1996	626	3,099	4,121	7,846	-	52,400
1997	644	3,192	4,244	8,080	-	54,000
1998	664	3,287	4,372	8,323	-	55,600
1999	684	3,386	4,503	8,573	-	57,300
2000	704	3,487	4,638	8,829	-	59,000

Table A-4

Cost of Freight Resupply Without Road

	Air	Barge	Winter Road	Total
1980	$ 46,322	$ 56,024	$ 30,025	$ 132,371
1981	47,907	57,991	31,082	136,980
1982	49,613	59,987	32,151	141,751
1983	51,198	62,014	33,244	146,456
1984	53,027	64,100	34,349	151,476
1985	54,733	66,216	35,490	156,439
1986	56,440	68,361	36,643	161,444
1987	58,390	70,566	37,819	166,775
1988	60,219	72,772	39,008	171,999
1989	62,047	75,036	40,209	177,292
1990	63,876	77,331	41,447	182,654
1991	65,826	79,655	42,696	188,177
1992	67,776	82,039	43,969	193,784
1993	69,849	84,513	45,290	199,652
1994	71,921	87,046	46,647	205,614
1995	73,993	89,638	48,052	211,623
1996	76,309	92,350	49,493	218,152
1997	78,504	95,122	50,970	224,596
1998	80,942	97,953	52,508	231,403
1999	83,380	100,903	54,081	238,364
2000	85,818	103,913	55,702	245,433

Table A-5

Benefits to Diverted Freight Traffic

	Freight Cost Without Road	Freight Cost on New Road	Benefits to Diverted Traffic
1980	$ 132,371	$ 31,900	$ 100,471
1981	136,980	33,000	103,980
1982	141,751	34,100	107,651
1983	146,456	35,300	111,156
1984	151,476	36,400	115,076
1985	156,439	37,700	118,739
1986	161,444	38,900	122,544
1987	166,775	40,200	126,575
1988	171,999	41,400	130,599
1989	177,292	42,600	134,692
1990	182,654	43,900	138,754
1991	188,177	45,200	142,977
1992	193,784	46,600	147,184
1993	199,652	47,900	151,752
1994	205,614	49,400	156,214
1995	211,623	50,900	160,723
1996	218,152	52,400	165,752
1997	224,596	54,000	170,596
1998	231,403	55,600	175,803
1999	238,364	57,300	181,064
2000	245,433	59,000	186,433

Table A-6

Benefits to Generated Freight Traffic

	Generated Freight	Cost Differential*	Benefits to Generated Traffic
1980	2,860	$ 10.50	$ 30,030
1981	2,960	-	31,080
1982	3,060	-	32,130
1983	3,160	-	33,180
1984	3,270	-	34,335
1985	3,380	-	35,490
1986	3,490	-	36,645
1987	3,600	-	37,800
1988	3,710	-	39,060
1989	3,830	-	40,215
1990	3,950	-	41,475
1991	4,070	-	42,735
1992	4,190	-	43,995
1993	4,320	-	45,360
1994	4,450	-	46,725
1995	4,580	-	48,090
1996	4,720	-	49,560
1997	4,860	-	51,030
1998	5,000	-	52,500
1999	5,150	-	54,075
2000	5,310	-	55,755

* One-half the weighted average freight cost on the three existing modes.

APPENDIX B: A REGIONAL INCOME MULTIPLIER

The income multiplier discussed here is static. All the reaction is expected to occur within one time period, and all variables are related only to other current variables. The multiplier is derived from a relatively simple Keynesian demand model for a regional economy. Total income (Y) is equal to the sum of the expenditures which comprise it, namely consumption expenditures (C), investment expenditure (I), government current expenditures (G), and export expenditures (X). Imports (M), are subtracted, since they do not generate any income for the area. Thus, we have

$$Y = C + I + G + X - M \tag{1}$$

The nature of these components is discussed below.

Consumption

We assume aggregate consumption can be represented as a linear[1] function of aggregate disposable personal income:

$$C = C^* + c(1-t_p)g\,Y \tag{2}$$

where C^* is exogenously determined consumption

g is personal share of gross income

t_p is marginal tax rate on personal income

c is marginal propensity to consume additional income[2]

The consumption expenditures include sales tax.

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1 For each relation discussed, it need only be linear over the range of income changes to which the analysis is applied.

2 c is assumed constant. Although it does vary by region and over time, the likely range of values of c is relatively small.

Investment

Investment by government and private sector is represented by a linear function of income:

$$I = I^* + vY \qquad (3)$$

where I^* is exogenously determined component of investment

v is marginal propensity to invest extra income

Government Current Expenditures

Government is expected to spend all the extra tax revenue available to it corresponding to current expenditures.

$$G = G^* + s\,(t_p gY + t_c bY) \qquad (4)$$

where G^* is exogenously determined government expenditure

s is the local share of tax revenue

t_c is corporation tax rate

b is business share of gross income (Y)[1]

In this formulation, all federal tax is treated as a leakage. However, increases in federal government revenues may induce rises in local federal spending. Lack of data preclude measurement of any such impact.

Imports and Exports

Imports are generally expressed as a fixed proportion of gross income, because of difficulties in separating the import component of private consumption, investment and government expenditures. Thus, we write

$$M = mY \qquad (5)$$

1 The shares of GDP accruing as income in the personal (g) and business sectors (b) do not necessarily sum to one. The discrepancy is small, on average some 3 percent of GDP in any one year in the case of Alberta.

Exports are considered exogenous.[1]

Changes in Income

If the change in any variables were written as Δ, then the system of equations can be summarized as follows:

$$\begin{aligned} \Delta Y &= \Delta C + \Delta I + \Delta G + \Delta X - \Delta M \\ \Delta C &= c\,(1-t_p)g\ \Delta Y \\ \Delta I &= \Delta I^* + v\ \Delta Y \\ \Delta G &= s(t_p g + t_c\ b)\ \Delta Y \\ \Delta M &= m\ \Delta Y \end{aligned} \qquad (6)$$

ΔI^* is the exogenously determined increase in investment. Collecting terms we can write the change in Y as

$$\Delta Y = \frac{\Delta I^*}{1 + m - [c\ (1-t_p)g + v + s(t_p g + t_c b)]} \qquad (7)$$

The denominator would be the same if the increased expenditures were considered to be a change in exogenously determined government expenditures.

The Multiplier

The multiplier K is the denominator of equation (7).

$$K = \frac{1}{1 + m - [c\ (1-t_p)g + v + s\ (t_p g + t_c b)]} \qquad (8)$$

It can be calculated readily by assigning values to the parameters.

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1 This does not allow for increases in export demand induced by leakages in regional purchasing power. Some research suggests such effects may be small. See A. J. Brown et al "Regional Multipliers", National Institute Economic Review, No. 40, May 1967.

While this multiplier includes some dynamic elements within a period such as an investment propensity, it does not consider interrelated time periods in consumption habits nor does it consider long run dynamic elements which may occur, for example, through the migration of labour to the province, when the availability of local resources is constrained.

If sufficient data were available, the model could identify the effects of indirect taxes. However, such an adjusted multiplier would be more applicable to provinces than smaller regions.[1]

The Coefficients

The following values are assigned to the coefficients:

$C = .95$, $v = .1$, $g = .7$, $b = .25$,

$t_p = .2$, $t_c = .15$, $m = .6$, $s = .75$

The values were drawn from other work[2] on prairie multipliers and adjusted, by judgment, to reflect the particular characteristics of The Pas area.

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1 The model could be improved by including some types of external transfers (U) such as unemployment insurance and welfare payments. These are treated as negatively related to the level of regional income

$$U = U^* - uY$$

$$\Delta U = -u\Delta Y$$

where u is transfer payment coefficient.
U is a payment from the Federal Government to the Province. It is included in the Province total income as follows:

$$Y = C + I + G + U + X - M$$

The related multiplier would be

$$K' = \frac{1}{1+m - [c(1-t_p)g + v + s(t_c g + t_c b) - u]}$$

For this project the effect on unemployment insurance is considered in the multiplicand.

2 See DataMetrics Limited Alberta Economic Impact: AGTL-Dow Refinery Project, Submission of Alberta Gas Trunk Line Company Limited and Dow Chemical of Canada, Limited, Re Application No. 8911 to the Alberta Energy Resources Conservation Board, January 19, 1976.

Specifically, the shares of gross income (g and b) were retained, as was the corporation tax rate. In an area of lower average income, the personal tax rate was reduced and the marginal consumption rate increased in relation to aggregate Alberta data. Input leakages are greater in a smaller area; hence the marginal propensity to import was raised. The size of the region affects the investment propensity as well, making it lower than in a large area. The local share of tax revenue was set at 75 percent.

Applying these coefficients to equation (8), the multiplier (K) is estimated at 1.2.

The Multiplicand

The relevant multiplicand during construction or operation is the net local value added as a result of the project. This value added includes local labour payments and purchases of local supplies and services less the unemployment and welfare benefits that the project displaces.

The operation of the income multiplier implies an absence of supply constraints. Resources must be available if the full multiplier were to operate. The assumption seems applicable to the region concerned.