EFFECTS OF A RAILWAY TO THE ARCTIC ON NORTHERN WILDLIFE

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1.0 INTRODUCTION

1.1 Proposed Railway to the Arctic

The initial proposal to build a railway to the Arctic, that is assessed in this report, was made by the Canadian Institute of Guided Ground Transport at Queen's University to the Minister of Transport in January, 1972. The summary report, Railway to the Arctic was reprinted with corrections in July, 1972(1). Subsequently additional reports were issued by CIGGT. including: An Arctic Oil Railway, December 1, 1972(2), The Use of the Arctic Oil Railway for the Transport of Liquid Natural Gas, December 22, 1972(3), The Arctic Railway-Environmental Aspects, March, 1973(4), and finally Railway to the Arctic: Reconnaissance and Right of Way Construction, July 1973(5).

Premier David Barratt of British Columbia proposed an alternate railway route through Alaska, Yukon Territory and British Columbia in a discussion with Mr. Rufus Smith, Deputy Assistant Secretary for Canadian Affairs, United States Department of State on March 13, 1973. A booklet entitled The Way Out and a number of background papers, including one entitled, The Environmental Way Out (6) were given limited distribution at that time.

1.2 Terms of Reference (as outlined under contract CWS. 7374-007)

(To) assess, through literature research and other methods, the effects of the construction and operation of a railway proposed for the transportation of oil from Alaskan and Mackenzie Delta oil fields to southern Canada via the Mackenzie Valley, and alternately via Yukon and British Columbia, on the long term productivity of wildlife species in the area adjacent to the railway, more specifically as that productivity relates to:

(a) wildlife habitat;
(b) wildlife mortality;
(c) wildlife migrations - patterns, numbers of animals involved, disruptions of traditional calving, summer or winter range uses, or of migration routes and possible effects on productivity;
(d) wildlife behaviour reactions anticipated;
(e) wildlife harvesting by indigenous and sport hunters and trappers.

"Wildlife includes ungulates (caribou, moose, mountain sheep, etc., as appropriate), large carnivores (bears, wolves), furbearers (muskrats, beaver, marten, fisher), waterfowl (ducks, geese), and rare and endangered species (birds and mammals)."

1.3 Points of Clarification

(a) Although the study is concerned with the effects of the proposed railway to carry oil, recent developments in the United States Senate indicate that the Alaskan ALYESKA line will soon be approved. In which case a Canadian route for Alaskan oil seems highly unlikely. At present it does not appear that the proven oil reserves of the Mackenzie Delta warrant the construction of separate Canadian oil line. The study has therefore been enlarged to include the possibility of a railway to carry LNG (liquified natural gas), since the transportation of natural gas from the north slope of Alaska and the Mackenzie Delta to southern markets remains a viable proposition.

(b) This study is restricted to consideration of the area north of the sixtieth parallel in the Northwest Territories, Yukon Territory and the State of Alaska.

1.4 Present Study Methods

The present environmental appraisal of the proposed railway, with particular reference to wildlife, was made on the basis of:

(a) A review of published literature and reports of various conferences and seminars
(b) interviews with Mr. C.E. Law of the Canadian Institute for Guided Ground Transport and other knowledgeable parties in the field
(c) personal research experience in northern ecology in Alaska, Yukon Territory and the Northwest

Territories, extending over many years since 1946.

A critical appraisal of the engineering and economic aspects of the CIGGT. proposal has been provided in a preliminary report, Alternate Modes Study Rail Transportation Costs for Western Arctic LNG based on CIGGT. Concepts, by Techman Ltd., Calgary, (7).

2.0 CONCLUSIONS

The proposed railway to the Arctic merits serious consideration as an alternate mode for the transportation of northern oil and natural gas resources to markets in the south. Unfortunately the published assessments of the probable impact on northern wildlife are inadequate. This is a result of inadequate baseline studies and a lack of simulated impact studies. There is also an apparent lack of integrated planning of engineering and environmental design, management proposals for lessening environmental impacts, or an intention to monitor the impact of the railway on renewable resources of the area.

A re-appraisal of the expected impacts of the proposed railway, based upon published data and personal research of this author, indicates that the railway would have serious, damaging effect on the wildlife. The most serious impact would be upon the Porcupine caribou herd during the fawning and summer periods. So great is the risk of heavy mortality to the migrating caribou herds that the survival of the herd as an important economic and aesthetic resource would be jeopardized.

Secondly, the construction of the railway will constitute a serious disturbance to staging Snow geese on the Arctic coast in early autumn. Moulting ducks in coastal lagoons may be similarly disturbed, during the summer.

Thirdly, as a common carrier, the railway will permit the access of travellers and railway personnel to hitherto remote wildlife sanctuaries. The probable associated results of wild fires and illegal hunting will lead to the reduction of wildlife populations in former sanctuaries such as the Richardson Mountains and northern Yukon Territory. The Dall sheep will greatly suffer as a result of its increased accessibility to hunters.

Fourthly, right-of-way clearance, terrain and vegetation destruction for the railway will result in lower carrying capacity for furbearers such as beaver, mink, marten and Arctic fox in trapping areas along the railway route.

Finally, the railway right-of-way will attract wintering populations of moose in the Mackenzie Valley, but these will suffer heavy mortality as a result of collisions with the frequent trains.

3.0 ENVIRONMENTAL ASSESSMENT OF THE PROPOSED RAILWAY

A proposal for the construction of a facility normally follows an orderly sequence of phases: planning, construction, operation and abandonment. Such a sequence of events provides an opportunity for the appraisal of the environmental impact of the project at each phase of its development. Such an assessment will be followed in this report.

3.1 Planning Phase

Environmental considerations in the CIGGT. summary report (1) are limited to pages 13-17. This appears to be the total environmental imput into the planning phase. The section consists primarily of the identification of environmental problems (including wildlife) that might be associated with the project. There is a vague reference to the Scandinavian literature and one direct literature reference and a reference to a verbal communication. The section closes with an implied conclusion that the projects environmental cost would be acceptable.

There is no reference to the integration of environmental considerations with engineering planning through the development of environmental criteria beyond the expression of "minimum environmental cost," on page 17. Nor is there any reference to environmental studies to be included in the initial engineering costs (including field survey, design costs, etc.) - Appendix B-1.

3.12 Prime Route Selection (Route 1)

The CIGGT. authors mention that they attempted to plot a route that avoided critical wildlife areas as indicated in the Northern Ecology Map Series issued by the Canadian Wildlife Service. In particular the route avoided the Kakiska Valley beaver trapping area, the Arctic Red River muskrat area, the Mackenzie Delta, the Peel River plateau and the Porcupine Highlands. The route however does cross the Peel River Game Preserve, and it traverses the summer range and fawning grounds of the Porcupine caribou herd along

the Arctic coast of the Yukon and Alaska. In Alaska the route crosses the National Arctic Wildlife Range. The spur line to the Richards Island oil and gas field traverses the Reindeer Preserve and would mean the moving of the herd to the eastern portion of the Preserve.

The Mackenzie River constitutes a natural boundary for many species of mammals, particularly the eastern herds of barren-ground caribou and the western Porcupine herd. It is a general geographical barrier, both winter and summer to many smaller mammals. The valley separates two mountain ranges: the Mackenzie Mountains and the smaller Franklin Range. A transportation corridor running along either of the River's banks would therefore seem less likely to act as a migration barrier. Unfortunately the river serves as an important spring and autumn migration route for birds, particularly waterfowl. Heavy rail traffic along either river bank would certainly cause a serious disturbance to migrating geese and ducks.

The proposed railway constitutes a serious threat to the Porcupine caribou herd that totalled about 110,000 animals in 1972, (Jakimchuk and McCourt (8) and Hemming, 1971, (9)). Possibly some modifications could be made to construction and operational plans to accomodate the caribou when they were in the route area. This herd constitutes an important renewable natural resource to the people of Aklavik, Fort MacPherson, Old Crow, Arctic Village and Barter Island and the loss of this herd would be an intolerable price to pay for transporting an exhaustable natural resource such as petroleum to market.

Where this route parallels the Arctic coast it poses the problem of disturbing coastal nesting waterfowl in summer and later moulting waterfowl in the coastal lagoons.

3.13 Alternate Routes

Route 2 crosses the Mackenzie Mountains, Peel Plateau and Ogilvie Mountains. (This is an area of considerable seismic risk). The route would cross much of the winter ranges of the Porcupine and Forty mile Caribou herds in the Yukon Territory and eastern Alaska (8). This would involve considerable interference with traditional migration patterns that are responses to varying snow and winter food conditions.

I am greatly concerned about the combined disturbances of both the railway and the Dempster Highway in the Ogilvie Mountains and Porcupine Plateau.

Wild populations of Dall sheep are particularly easily disturbed and driven from their lambing and feeding slopes. Heavy train traffic would undoubtedly disturb nearby bands. Unfortunately the distribution of native sheep in these mountains is not known well enough to make a quantitative appraisal. Nor is there adequate information on the distribution of rare and endangered raptors, moose or furbearers available for comment.

Route 3 follows the proposed ALYESKA oil pipeline southward, crossing the Brooks Range through Dietrich Pass. It skirts the Yukon-Porcupine flats and ascends the Yukon River to Dawson City Y.T. It then cuts diagonally across the Yukon Territory following the Pelly River and Ross River Post to Francis Lake. It descends the Francis River to Watson Lake, Y.T.

This route appears to avoid most of the critical waterfowl, sheep and caribou habitat. Its greatest impact would be on wintering moose populations in the valleys and local furbearers.

The Barratt proposal (6) continues the railway south to Lower Post, B.C. where tank farms would be built. From that point a gas pipeline could be built to Fort Nelson and Edmonton and a oil pipeline could be built southward through Prince George to Vancouver. As an alternative the gas and oil might be carried on the British Columbian Railway that is under construction from Prince George to Lower Post.

The Environmental Way Out (6) contains only general statements concerning environmental impact, mostly comparisons to tankers and pipelines, and repetitions of the CIGGT. material. There is a brief discussion of wildlife mortality:

> "Route location to avoid caribou migration routes is probably the only effective way to avoid this problem."
>
> "The apparent lack of disturbance by railways which pass through important wildlife areas in southern Canada, such as national parks, suggests, however, that many species would become accustomed to traffic" p.7.
> I have some comments on that problem under Direct mortality.

> "In order to avoid serious winter mortality problems for moose and caribou through railway operations, it would be essential to have a sufficiently high roadbed to ensure that snow removal pushes the snow completely from the railbed to avoid any tunnel effect that would trap animals travelling the roadbed, however some mortality is inevitable."

3.2 Construction Phase

Although the project's impact on northern wildlife would commence as soon as the engineering parties took to the field to survey the railway right-of-way, it is more convenient to analyze the impact on the bases of the various effects to the environment.

3.21 Loss of Habitat

The actual right-of-way is reported to cover 150 square miles (1, p. 13). This is also referred to as 'the roadbed.' Mr. C.E. Law reported in the Ecology North Debate, June 11, 1973, at Yellowknife, that this was an error. It is difficult to calculate the base of the roadbed. The top of the roadbed is reported to be between 40 and 54 feet wide (p. 13) and the slope of the sides 1:2. The actual height of the roadbed would depend upon the contour of the land and the soil type. If the roadbed was 20 feet high, the base would be approximately 125 feet wide. It would probably average slightly less. One would expect a fire break on each side. It may be assumed that the actual cleared right-of-way would be in the order of 150 to 200 feet wide. If the total length of the railway from Prudhoe Bay to Enterprise, N.W.T., is 1380 miles, the actual cleared right-of-way would probably be between 60 and 80 square miles. Adding the terminals' area of about 4 square miles does not significantly change the total area.

There would be a virtual total loss of habitat for wildlife in this area as the habitat would be so altered that it could not support the rodents, fur-bearers, big game or birds that formerly occurred there. However, this is not considered to be a significant factor because populations of valuable furbearers such as marten and foxes, and big game such as moose and caribou are not dense (1-10 per square mile) so that the totals involved are not large. In comparison much more habitat is lost each year as a result of wild fires.

Of much greater concern are the proposed alterations to a border strip one-half mile wide on each side of the right-of-way. This "further" strip "might be involved for drainage and some clearing" - p. 13. Braided stream beds are mentioned. "Channel training would have to be developed to contain these meandering rivers and it is estimated that some 75 linear miles of dike would have to be constructed for this purpose" - p. 39. These statements indicate proposed habitat alterations in a strip approximately one mile wide along the 1380 mile length of the proposed railway - a total area of 1,380 square miles. This area is significantly larger than the actual right-of-way to be destroyed. It is also significantly wider than corridors that would be purposely altered for the construction of a highway or railway.

Since no specific details have been presented it is not possible to quantify the effect of these proposed habitat alterations on the local wildlife populations. Proposed drainage projects, stream 'training' and diking would reduce the carrying capacity of the land for such aquatic mammals as muskrats, beaver, mink and otter, as well as nesting and feeding sites for waterfowl - ducks, geese and swans as well as shorebirds such as Wilson's snipe and solitary sandpiper.

Aerial surveys of the Kakiska River valley, N.W.T. indicate, on the average, one active beaver lodge per linear mile of stream (Renewable Resources Consulting Services report). The proposed manipulation of the drainage system over 1,380 square miles could be expected to produce a demonstrable decrease in the population of aquatic furbearers along the railway route.

Along the Arctic coast, stream banks are frequently utilized by Arctic foxes as traditional denning sites. Good drained sites have been in continual use for many generations of foxes. The availability of these sites may be an important factor in regulating for populations. Stream 'training' and diking in the coastal tundra area could be expected to destroy many of these denning sites.

The proposed 'clearing' of this boundary strip would also affect the carrying capacity of the land for terrestrial birds and mammals. Without specific details it is difficult to forecast the results. Much would depend upon the type of biotic community, soil type and method of clearing. Cutting the

boreal forest would decrease the carrying capacity for marten, fisher and woodland caribou. It might increase the carrying capacity for moose if succession proceeded to the shrub stage. Similiarly forest bird populations would be lowered and birds favouring shrubby habitat might increase over a period of years.

Of more profound concern would be the effect of such vegetation 'clearing' on the permafrost layer in the permafrost zone. If the clearing of the vegetation in the border strip encouraged permafrost degradation, serious slumping and erosion might occur that would profoundly change the natural habitat for wildlife.

3.22 Requirements of Granular Grade Material

The amount of granular grade material required for the railway embankment is enormous.

> "The construction of the 1,380 miles of railroad from Enterprise, N.W.T. to Prudhoe Bay,...will require from 395 million to 505 million cubic yards of sub-grade materials made up largely of pit run gravel but including about 37 million cubic yards of washed gravel, or crushed rock. In addition some 14 million cubic yards of surface ballast will be needed for the right of way plus 11 million cubic yards of fill and 5 million cubic yards of crushed rock surface-ballast for buildings and terminals" - p. 14.

These estimates of granular material needs "are some four to five times greater than the oil line, gas line and Mackenzie highway combined." (10)!

The Techman study (7) indicates that the above estimate of requirements may be too generous. They estimate a total requirement of about 400 million cubic yards. They studied the total railway alignment on contour maps. The CIGGT. study is reported to have been based on an extrapolated total requirement from a detailed study of a single section.

Where will this enormous amount of material be obtained? "This fill must be drawn from stream beds or from borrow pits located in old beaches, terminal moraines, eskers, or other gravel beds laid down in the distant past" - p. 13. It was also suggested

that some of the large terminal moraines of the Norman and Richardson Mountains might supply large amounts of gravel and fill with a minimum disruption of the terrain.

Actually there are several main sources of granular material from which the fill may be mined by several different methods:

1. River gravel beds are usually mined by means of bulldozers, and drag-lines.

2. Moraines and eskers may be strip mined by bulldozers, drag-lines and shovels. Or, a gravel pit may be dug at one side.

3. Certain sedimentary rock deposits may be quarried by blasting.

A government task force has already identified and specified the location of sources of granular construction material in the proposed "transportation corridor." Of major concern here is the tremendous amount of material needed for the railway in competition to the Mackenzie Highway.

The severe detrimental impact that the taking of vast amounts of gravel from northern streams and rivers will have on northern fish populations is outside the scope of this study. Such action will also affect the nesting and feeding activities of northern shorebirds. However it is not possible to be more specific without knowing the precise target areas for gravel removal.

Strip-mining moraines and eskers will remove habitat for certain small mammals such as Arctic ground squirrels and some terrestrial birds as well. It is impossible to provide quantitative data without examining specific target sites.

The quarrying of sedimentary rock formations is of greater concern. Some of the proposed sites for material are rocky bluffs along the proposed route. Several of these harbour nesting sites of rare and endangered raptors (L.G.L. Ltd. reports). The destruction of these sites would be out of harmony with the international concern to protect these birds.

3.23 Construction Methods

The CIGGT. preliminary report contained misleading statements on construction methods that have led some conservationists and journalists to misunderstand how railway embankments are constructed.

> "...it is common practice in railway construction to haul fill material over substantial distances using the railway itself and ballast and gondola cars. In the construction of the Churchill line, for example, three borrow pits provided essentially all the necessary ballast materials" - p. 14. (my underlining of ballast).

It is to be noted that according to the CIGGT. report only 4 per cent of the granular material requirements is classified as ballast. Unfortunately this information is abbreviated in a later CIGGT. report to,

> "Because a railroad can build its own embankment and the train hauling fill and ballast permits great economies, it is possible to obtain all the construction materials required from a few isolated large pits." (2-p. 2-4).

This latter statement was repeated in Canadian Arctic Resources Committee's Northern Perspectives (11). The Canadian Wildlife Federation reported it as,

> "One of the great advantages of a rail line is that during the construction process, the completed segment of the rail line provides its own built-in means of transporting the enormous quantities of fill and ballast required. These materials can then be obtained from a very few carefully selected sites along the route, rather than being close at hand, necessitating the use of hundreds of sources of fill, as would be the case for a pipeline or highway. By comparison ecological disturbance would be minimal." (12)

Corneil, Law and Lake (4) later gave a more detailed description of the construction methods used on the Hudson Bay Railway and the proposed construction methods for the railway to the Arctic:

> "The northern section of the Hudson Bay Railway extends over roughly 160 miles of permafrost. The line, build in 1927-29, was staked out during the first winter. Men, with shovels, axes, and wheelbarrows, cleared and ditched the line, placing the brush and then the borrow material, removed from the ditches, on the track line. They completed their work by rough grading the track line in preparation for the skeleton track. When the track line was frozen the ties and rails were laid and some gravel from three borrow pits was used to ballast the skeleton track just prior to the spring thaw. During the summer, gravel was hauled along the line, using train haul. The gravel was dumped on the track, and then the track was jacked up through the gravel. This procedure was repeated until the final track alignment was achieved."
>
> "Similiar techniques might be used on some sections of the Arctic Railway. However, the normal construction would require embankment construction using earthmover or truck haul"...During the summer periods, when most borrow materials are easier to remove, the preliminary roadbed construction would require end dump techniques and truck haul."

In spite of this clear statement of proposed roadbed construction methods, several proponents of the proposal have continued to state on public platforms, or to write that the railway would build its own embankment from remote borrow pits (R.D. Vanderberg, in St. Catharines debate, April, 1973)

A review of the sub-grade construction methods described on pages 38-39 of the CIGGT. summary report (1) clearly indicates that sub-grade construction, which includes right-of-way clearing, grading, installation of culverts, timber trestles and bridges would proceed simultaneously in several sections along the route. This work would be undertaken by manual labour, bulldozers and large earth moving vehicles along the right-of-way and on haul roads to and from the many borrow sites along the route. This activity would take place two to three years ahead of the laying of a single skeleton track. The critical point is the construction of the bridge across the Mackenzie River near Strong Point that is not projected for completion until year 4.

It is then proposed that final grading to the final double track width and ballasting can be done from the single skeleton track by train haul as described for the Hudson Bay Railway. However, the Techman report (7) indicates that 84 per cent of the final grade is required for the single track and only 16 per cent to increase the roadbed to double track width. Under these circumstances it would probably be uneconomical to reopen the borrow pits and haul grade material a second time, a couple of years later.

The most recent CIGGT. publication (5) gives a more complete description of the proposed grade construction techniques, equipment used and the timing of each operation. Considerable attention has been directed to the method of the railway roadbed construction because of the misunderstandings of many concerned environmentalists. Instead of the ecological disturbance being "minimal" compared to the construction of a highway or pipeline as reported by the Canadian Wildlife Federation (12), the disturbance would be comparable to highway construction because of the similiarity of equipment used. Considering the amount of grade material required for the railway in comparison to the highway and pipeline needs, the ecological disturbance might be termed maximal.

The environmental impact on wildlife during the construction period would involve the additional destruction of habitat along the haul roads from the borrow sites. Techman Ltd. (7) have estimated that these roads would average 8 miles in length, with a maximum length of 20 miles to the Government specified borrow sites. This additional loss of habitat would probably include areas outside the 1380 square miles of marginal strip already assigned for habitat alteration.

Since it is clear from all the CIGGT. documents that summer construction is contemplated along the whole railway route, vehicle traffic would constitute a serious disturbance to the migration and summer nesting birds in an additional strip on each side of the haul roads. The same disturbance of mammals: furbearers and big game species would apply continually throughout the year, but to the winter noise factor one could add summer dust deposits. Summer use of the haul roads will also encourage local permafrost degradation in permafrost areas and affect drainage systems through blockages and siltation.

Accidental fires are also a serious risk during the summer construction period.

3.24 Railway Alignment

The criteria of 1/2 per cent grade and 2.5 per cent curves place severe constraints on the roadbed alignment. It is generally believed that the proposed route is flat. Gordon Gibson wrote in a recent Maclean's article (13), "The (Makenzie) valley is flat. Extending from the ocean south more than 1,000 miles, the rise in elevation is only 900 feet - nine inches per mile." If the railway embankment were built directly on the river surface, I suppose that there would be few grade problems. However the proposed prime route following the Mackenzie Valley crosses many large tributaries and also skirts the foothills of three mountain ranges - the Franklin, Richardson and Brooks Ranges. Many of the valleys to be crossed are deep. Elsewhere the route crosses an undulating plain.

Cutbanks in areas of permanent and intermittent permafrost constitute environmental hazards because of the probability of permafrost recession in the exposed hillside and subsequent risk of slumping onto the railroad bed. The CIGGT. has recognized this problem and proposes to keep cuts to a minimum. This could only be compensated for by the extraordinary use of raised embankments.

Little quantitative data has been presented upon the height of the embankment to be constructed. Corneil, Law and Lake (4) mention the necessity of up to 6 feet of crushed rock in the insulating blanket (over permafrost). The Techman study (7) considers this to be a minimum berm height over permafrost areas. They have estimated the following embankment heights:

up to 10 feet	44 per cent of the total route
10 to 20 feet	43 per cent of the total route
20 to 30 feet	9 per cent of the total route
30 to 40 feet	2 per cent of the total route
over 40 feet	2 per cent of the total route

In summary over half the route (56 per cent), the embankment is estimated to be over 10 feet high and in a few areas it will be over 40 feet high (2 per cent). The slope is expected to be approximately 30 degrees (1 in 2). In addition to the embankment, an

unknown number of wooden trestles are expected to be built across deep ravines, as well as bridges across river valleys.

Much of the literature concerned with the construction of an elevated oil pipeline across Alaska from Prudhoe Bay, contains references to the barrier effect of a 48 inch pipe raised on pilons, or buried in a gravel berm approximately 6-8 feet high. It is generally thought that such a berm would act as a barrier to migrating caribou and probably smaller mammals moving about their home ranges. Kenneth Child (14) has studied caribou crossings of a simulated pipeline at Prudhoe Bay, by means of gravel ramps over the pipeline, or the pipeline raised on pilons in the form of a trestle.

Both of these devices repelled the majority of migrating caribou. Of a total of 5,599 animals observed approaching the structures in 1971 and 1972, 994(17.6%) used the ramps; 273(4.9%) used the underpasses; and 36(0.7%) crawled under the simulated pipeline. Of the remainder, 1924(34.4%) turned back from whence they came and 2372(42.4%) moved around the terminals of the simulated pipeline. Among Child's recommendations are the following: the elevation of the pipeline should be minimal to reduce the "optical barrier" that the elevated pipeline presents to caribou. Secondly, the gravel ramps should have a minimal slope, not exceeding 6:1. From these data it is concluded that the raised railway embankment of approximately 10 feet, with a slope of 2:1, would constitute a real barrier to normal caribou movements.

Microdrainage in the permafrost zone poses an environmental threat to the railway embankment. Across apparently level landscape, water drains in a sheet flow pattern through the active layer. This flow is virtually invisible except for the meriads of small pools between the mossy hummocks. Occasionally the drift of a paper match across such a pool indicates the direction of flow across the forest floor.

Figure 8 (p. 24), of the summary report (1), indicates that the CIGGT. planners expect the permafrost to rise in the core of the embankment. This means that the roadbed would act as a dam across the microdrainage pattern, resulting in ponding on the up-hill side and dessication of the active layer on the down-hill side. Examples of such damming were evident on

stretches of the new Mackenzie Highway south of Inuvik in June, 1973. It is difficult to appraise the effects of such habitat alterations on local wildlife. If increased ponding occurred there would be a loss of terrestrial habitat for rodents and small furbearers such as marten and ermine. However there might be increased habitat for aquatic furbearers such as muskrat and beaver, as well as waterfowl. The main environmental risk to the embankment lies in probable permafrost recession under the pond and eventual bank slumping.

3.25 Construction Personnel Problems

The demand for manpower has been estimated to vary from about 2,000 to a peak of 10,000 during the construction period (1-p.54). Such manpower requirements greatly exceed the manpower pool of the Mackenzie Valley according to the report released by Gemini North, May, 1973 (Press report). They estimate the male work force as less than 1,000 persons in the Mackenzie Valley. This would result in a heavy influx of up to 9,000 southerners in peak years, that would have a serious impact upon the local wildlife populations.

The authors of the summary report (1) appreciate the need for "controls in the form of education, strict prohibition of firearms, supervision, and active patrolling by game officers and even specially hired temporary personnel" (p. 15). However in later appendices, listing employment opportunities and capital costs then are no indications of such conservation personnel or that training programs have been planned.

3.3 OPERATIONAL PHASE

The impact of an operational railway on wildlife may be direct or indirect. Directly the impact may vary from disturbance to causing direct mortality. Whereas various management procedures of the railway may indirectly affect the wildlife.

Train Frequency

The initial CIGGT. proposal called for 20-168-car unit trains per day in each direction to carry oil from Prudhoe Bay to Trout River, travelling at speeds of 60 m.p.h. full and 70 m.p.h. on the empty return trip. These trains would be approximately two miles long and would take approximately two minutes to pass a point on the track. Thirty-four minutes later another train would pass by. If the railway were also used to carry LNG as proposed by Lake (3), nine more trains of 70 cars each would be added in each direction and the interval between trains would be cut to about 23 minutes between trains, that took approximately two minutes to pass a point. If other commodity and passenger trains were added the traffic would be even heavier, (up to 24 service trains a day in each direction, in addition to the oil trains are contemplated (1) p. 35).

The passage of these trains would involve the combined disturbances of intense noise and headlights during periods of darkness to local wildlife. This continual disturbance could be expected to cause the abandonment of a strip on each side of the tracks by resident furbearers and nesting birds. The width of the strip abandoned would depend upon specific tolerances to such disturbances. This could only be determined by experimental studies conducted on existing lines. Some species might become fairly tolerant of such regular disturbance.

The train traffic would have a much more damaging effect on migratory mammals such as caribou, moose, Arctic foxes, grizzly bears and wolves. Those animals that intended to cross the tracks during their regular migrations would have to wait for quiet "windows" between trains. The length of these time slots would depend upon the amount of disturbance caused by an

approaching train and by a departing train. Again little information is available on the effects of such disturbances upon the various species. If the disturbances associated with the passage of each train discouraged game from crossing the tracks five minutes before a train arrived and for five minutes after a train passed a spot, this would cut the open "windows" down to 13 minutes between trains carrying both oil and LNG. This would mean that migrating animals would have only half the total time available each day to migrate across the tracks (Service and passenger trains would be additional).

The type of disturbances associated with operating railways include: the height and slope of the embankment, length of trestles and bridges (dealt with under construction phase) frictional noise of the engines and cars, engine noise, diesel horn, exhaust fumes, headlights and snowbanks. The only disturbance mentioned in the CIGGT. summary report is the diesel horn - "Male moose seem to treat the diesel horn as a challenge with very definite detriment to the moose." Headlights are also known to attract and confuse mammals during periods of darkness (18).

3.32 Disturbance of Caribou Migrations

The CIGGT. summary report (1) contains the erroneous statement "The experience of the Northern Manitoba Railway is that there has been virtually no interaction between the railway and caribou migrating across this region."

I studied the caribou migrations in northern Manitoba in 1948 (15). I conducted aerial surveys along the Hudson Bay Railway route from Churchill south to the Nelson River in April of that year. Again in November-December, I studied the southward migration of caribou into Manitoba from a base at Ilford, Manitoba. During that period I made a patrol by gas-car along the railway from Ilford to Churchill and return. I interviewed railway engineers and section men along the route with reference to the interaction between the trains and the migrating caribou.

During this latter period the caribou were migrating southeastward along the Hudson Bay coast. I observed that their trails deviated as a result of the railway track. The caribou paralleled the tracks for

a considerable distance on the western side before venturing to cross the tracks and continue their migration southeastward to winter ranges near Fort Albany. The tracks in the snow showed that several bands walked down the tracks for a distance, some of these plunged down the embankment again to the western side, others crossed over to the east. We intercepted several such bands during our trip.

All railway personnel interviewed reported many incidents of seeing caribou on the tracks or crossing the tracks in front of gas cars and trains. The engineers reported instances of caribou running down the track ahead of the trains. Occasionally trains were stopped to allow the bands to cross the track, or to permit passengers to photograph caribou running along beside the trains. There were other reports of direct caribou mortality as a result of the engines hitting caribou on the tracks. Such interactions had been of normal occurrence for many years. There were frequent datelined stories from The Pas, Manitoba in the national press of caribou migrating across the Hudson Bay Railway during the period 1947-50.

I studied the caribou migrations closely from 1947 to about 1955. During that period the numbers of caribou crossing the Hudson Bay Railroad into northeastern Manitoba declined. After 1957, or 1958, there have been virtually no barren-ground caribou cross the railway to the eastward. The herds have all stayed west of the railway.

A similiar result was reported by Klein (16) after a railway had been constructed through the mountainous habitat of wild reindeer in Norway. The railway divided the reindeer winter habitat into two sections and eventually they abandoned the eastern portion of their normal winter range.

Evidence presented by Klein (16) for Scandinavia and by Banfield (17) for the northern Yukon Territory, indicate that caribou are attracted to cleared rights-of-way for winter travel routes because the snow is more firmly packed by sun and wind than in the nearby wooded areas. However the CIGGT. authors do not believe that caribou would be attracted to the railway embankment because the snowfall is less than in Scandinavia. However observations at Prudhoe Bay and Inuvik indicate that snowdrifts in the lee of pipeline berms may create a serious hazard to caribou crossing

the berms. Similiar observations were made on the Hudson Bay Railway.

It has been observed that wolves also hunt along the cleared rights-of-way. Caribou plunging off a raised roadbed into a snowdrift would face an additional handicap in escaping predation.

3.33 Disturbances to Waterfowl

The proposed railway route follows the banks of the Mackenzie River from the Liard River to Sans Sault rapids. The Mackenzie River acts as an important spring and autumn migration route for ducks and geese. The heavy traffic proposed for the rail line would be expected constitute a disturbing effect upon the regular movements and rest periods of many of those birds.

The northern foothills of the British Mountains facing the Arctic Coast from the Blow River west to about the Canning River serve as an important staging area for half a million Lesser Snow Geese that nest in the Western Arctic Islands, particularly Banks Island. They fly to this region after the nesting season is over and the moulting period is past. Large flocks of geese graze along the gentle slopes from about mid-August to mid-September. Their reserves of fat having been depleted during the nesting and moulting periods, they feed for prolonged periods in order to amass fat reserves prior to the long migration southward.

The proposed railway route passes through the entire length of this staging area. It is well known that these snow geese are easily disturbed by human activity and the passage of aircraft at this time. It is expected that the heavy railway traffic would continually disturb nearby flocks of geese and that they would rise at the approach of a train and fly off, or recircle back to feed after the train had passed. Since no direct information is available on this type disturbance, it is difficult to appraise its significance. However, in view of the critical energy balance of these birds at this time, any serious disruption of their feeding habits would seriously affect their ability to undertake their normal migration routine. They might have to make additional stops on the southward flight 'to refuel.' Considering the critical weather conditions at that period, such a

changed routine might be critical.

We do not know if the disturbance of the passage of frequent trains would seriously interrupt the feeding routine of a large part of the total population. Nor do we know whether alternate staging areas are available to this population of geese. It is therefore difficult to give an accurate appraisal of the potential severity of the impact upon the Lesser Snow Goose population. However, the proposed railway poses the threat of a serious impact on these geese that might threaten the continuation of their regular migration routine.

3.34 Direct Mortality of Wildlife

The probability of the trains causing direct mortality of wildlife was briefly discussed in the CIGGT. summary report, p. 15-16. Reindeer mortality in Scandinavia was mentioned. Klein (16) has reviewed the effects of railways upon Scandinavian reindeer. In Sweden, in the decade 1955-64, 22,000 reindeer were killed by trains, including 3,800 killed in 1964 alone. Approximately 1,000 reindeer are killed annually in Finland. The CIGGT. authors thought that this information was "not entirely pertinent." They mentioned that "the snowfall in the North American Arctic is minimal -- thirty to forty inches maximum -- compared to several times that amount in Scandinavia." Further more they referred to the wind packed snow-drifts "on the barren grounds" capable of carrying vehicles or caribou. These comments were also applied to the extensive Boreal Forest of the Subarctic, through which much of the route extends. Without more detailed comparison of the Canadian and Alaskan and Scandinavian railway routes, it seems safe to assume that the Scandinavian situation is pertinent to the proposal.

Much closer comparison can be made with the experience of the Alaska Railway. The destruction of moose along the Alaska Railway was studied by Rausch (18). There are about 500 miles of railway in Alaska. Although no accurate figures had been kept prior to 1955, the annual kill of moose by trains had been estimated from 90 to 1,500 animals. Based upon railway personnel reports and spring ground checks along the right-of-way, Rausch estimated that 366 moose were killed by trains between December 22, 1955 and April 15, 1956. The annual kill for the winter of 1955-56 was thought not to exceed 425-450 animals.

The reasons for the mortality were varied, but the availability of browse along the right-of-way and the fact that the railway offered a plowed road to serve as a travel route between natural feeding areas attracted moose to the roadbed. More moose were killed at night because they were confused by the headlight. The blowing of the horn frightened the moose, but often it confused them so that they were unco-ordinated in their attempts to escape.

The proposed railway to the Arctic would undoubtedly duplicate many of the same hazards in crossing the winter moose habitat of the Mackenzie Valley and could be expected to exact a considerable toll from the moose population of this region.

I have already briefly mentioned the fact that caribou were regularly killed by trains along the Hudson Bay Railway prior to 1955. It was such a well known fact that unfortunately I collected no precise data. I didn't expect that it would be stated in 1972, "that there has been virtually no interaction between the railway and caribou migrating across this region" (1-p.16).

There is similiarly a well recognized regular mortality of big game along the railway lines in Banff, Jasper, Kootenay, Glacier and Yoho National Parks. The railway men normally inform the chief park warden's office of railway kills and the local wardens are despatched to verify the kill, salvage the meat if possible, kill cripples and dispose of the carcass. While I was stationed at Banff, Alberta, I joined wardens several times to examine railway kills of moose, mule deer and elk in the Bow Valley. I also examined railway kills in the Athabaska Valley of Jasper Park.

During 1950 to 1954, attempts were made to record these incidents on wildlife cards in the Banff office.

There were several special hazards that increased big-game mortality. These included deep snowfalls, rock cuts, snow fences and the proximity to natural game licks. Near the Jasper Park Lodge turnoff north of Jasper, there is a railway cut followed by a high fill, close to a natural bighorn sheep lick. Bands of sheep were frequently trapped in the steep walled cut by trains with regular sheep mortality. It seemed that this hazard was an important factor in controlling the population of that particular group of sheep. I

recall hearing that a large number of sheep (23?) had been killed simultaneously by a train in that cut, about 1956.

All these data point to the conclusion that the high traffic volume of unit trains along the proposed arctic railway would result in a high mortality of moose, woodland caribou and particularly migrating barren-ground caribou along the Arctic coast from the Blow River to Prudhoe Bay.

There would also be a regular mortality of local furbearers such as marten, foxes, muskrat, mink and beaver that attempted to cross the tracks.

3.35 Train Derailments

The CIGGT. initial summary report included the consideration of derailments p. 34. It was estimated that there could be as many as 52 minor derailments and 8 major derailments ("involving several cars") per year. Such derailments would introduce several environmental hazards. There would be the considerable risk of oil spills resulting in local environmental damage as well as the risk of an ensuing wild fire. The fire might be initiated by friction during the derailment, or in the subsequent clean-up operations because burning is a recognized clean-up method (19).

The Newsletter of the Environmental Protection Board (10) mentions, "Track repairs...could also involve damage to the surrounding vegetation and subsequent terrain degradation as repairs would involve the off-track equipment proposed to be used by repair crews."

I was unable to find any information of hazards associated with LNG derailments. It would seem logical that the rupture of LNG tank cars would be a definite risk in major derailments. Since explosions and flares are a risk in the rupture of gas pipelines, it seems logical that explosions and fires would be similiar risks in the derailment of LNG trains. In addition there would be the possible brief action on rails, bridges, roadbed and nearby vegetation of an escaping liquid at approximately -250°C. All life forms would be instantly killed. One wonders what the effect would be upon the strength of steel in tracks and possibly trestles and bridges if the derailments occurred there.

Large mammals could be expected to be the cause of

some minor derailments. Rausch (18) reported that a moose had derailed a freight car in Alaska.

3.36 Human Access

The proposed railway will traverse considerable terrain, particularly in the northern Yukon, heretofore inaccessible to pedestrian traffic. This will mean that passengers and railway personnel will gain ground access to formerly remote wildlife habitat. In this way any sanctuary effect of replenishing trapping and hunting areas from nearby unharvested areas will be lost. Ground access will be provided to much of the summer range of the Porcupine caribou herd.

Such human access will introduce undesirable impacts such as: illegal hunting and trapping, wild fires and human camp waste disposal, upon the native wildlife. Increased camping activity will bring increased contact with grizzly bears and the risks of injury to tourists unfamiliar with this species. There will also be an increased disturbance of nesting waterfowl that may affect North American waterfowl populations. Increased human access will make the conservation officers' duties more difficult and call for an increase in game and forest protective services at greater cost to the public.

In this connection the proposed railway would have less of an undesirable impact than the proposed highway. The highway will provided unrestricted access to the terrain by travellers, while passengers could only disembark from a train at regular stops. This permits some control of travellers but will lead to a nodular pattern of environmental impact.

3.37 Incidental Management Techniques

Several normal railway management techniques will have a detrimental impact upon wildlife. In the Territories where wildlife constitutes an important economic resource, these techniques will be more importance than in southern Canada. Any attempt to fence the right-of-way would have a serious detrimental effect on such migratory mammals as caribou and possibly others such as moose, bears and foxes. Snow-fencing would have a similiar local effect in upsetting local movements. The continual clearance of culverts would involve the reduction of harvestable beaver populations,

or the taking of beaver at seasons when their pelts were not prime.

Of greater overall impact would be the regular clearing of the right-of-way by the application of herbicides. This would result in the loss of food for small herbivores and secondarily furbearers in trapping areas along the right-of-way, as well the destruction of food for moose populations.

3.4 Abandonment Phase

No attention has been paid to this phase by the CIGGT. planners, although the petroleum resources that the railway proposes to transport are finite and may be exhausted in about 25 years. The railway as a carrier of passengers and commodities would then face direct competition with highway, barge and air modes of transportation. Abandonment of the railway might ensue, judging by events elsewhere and this phase should be considered.

It would seem that if the railway were abandoned, the roadbed, trestles, cuts and bridges would remain and act as a barrier to the normal movements of the native mammals. Plant succession would be extremely slow in the Arctic and Subarctic.

5.0 DISCUSSION

It seems from a review of the CIGGT. public documents, as well as those from other groups that support the proposed railway, that insufficient attention has been paid to the subject of the railway's impact on northern wildlife.

5.1 Environmental Impact Assessment

It has been found elsewhere in other endeavours that a thorough environmental appraisal follows through several logical steps.

(a) Baseline studies - the obtaining of baseline data through literature research and inventory studies

(b) Problem identification

(c) Experimental studies - The testing of probable impact under simulated conditions

(d) Management proposals to lessen undesirable impacts to acceptable limits

(e) Integrated engineering and environmental planning

(f) Monitoring during construction, operation and abandonment phases of the project to assess management techniques and provide an information feedback loop.

The CIGGT. proposal is inadequate on all these points, with the possible exception of (2) - problem identification. The literature review particularly as respect to caribou populations in the northern Yukon was inadequate. No references were made to co-ordinated planning, experimental studies, or monitoring. There were hints of management in route selection, but no direct mention of possible management techniques with reference to the frequency of the horn blasts and moose mortality or of wildlife mortality generally. There was no mention of the limitation of construction to the winter period to lessen the environmental impact.

A full scale environmental appraisal of the project, including alternate routes would probably add significantly to the cost.

5.2 Recommendations

A great deal of the environmental baseline data that has been gathered for the proposed Arctic gas and oil pipelines, and for the Mackenzie and Dempster highways is directly applicable to the proposed "Railway to the Arctic." As much of this information that is available should be examined and assessed by the railway proponents in the light of their project impact.

The current impacts of northern railways upon wildlife should be quantitatively studied. The railway from Seven Isles to Shefferville, Quebec, the Hudson Bay Railway, the northern Alberta Resource Railway, as well as the Alaskan Railway provide examples on which more accurate assessments of impacts on wildlife could be made.

Before approval might be granted for the construction of a railway, a more substantial impact statement should be filed by the developers including management techniques to lessen the damage to wildlife populations and a sociological assessment of the railways effect on the traditional native uses of wildlife resources.

The cumulative impact of a railway, highway (and possibly a natural gas pipeline) in a restricted transportation corridor merits consideration. Together these facilities constitute a formidable barrier to the free movements of mammals. This might have serious implications in the Reindeer Preserve as well as in the Richardson Mountains west of Fort MacPherson.

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