Athabasca Tar Sands Corridor Study

Volume 8

Appendix

Corridors and Terminals

prepared for

Alberta
ENVIRONMENT

by

Athabasca Tar Sands
Corridor
Study Group

june, 1974

edmonton, alberta

ATHABASCA TAR SANDS
CORRIDOR STUDY

VOLUME 8 - APPENDIX

CORRIDORS & TERMINALS

Prepared for:

Alberta
Environment

by:

Stewart Weir Stewart
Watson & Heinrichs

June, 1974

Edmonton, Alberta

TABLE OF CONTENTS

CHAPTER I - SUPPLY & DEMAND

CHAPTER II - URBAN GROWTH IMPLICATIONS OF CORRIDOR TERMINAL LOCATION

CHAPTER III - IMPACTS OF PETROCHEMICALS ON ATHABASCA TAR SANDS CORRIDORS & TERMINALS

CHAPTER III - continued

CHAPTER IV - PRELIMINARY ASSESSMENT OF THE ALTERNATIVE CORRIDORS FROM THE ATHABASCA TAR SANDS

CHAPTER IV - continued

CHAPTER IV - continued

CHAPTER V - ADDITIONAL LEGISLATION WHICH MAY AFFECT THE ATHABASCA TAR SANDS CORRIDOR STUDY

- COMMON CARRIERS

page

LIST OF TABLES

page

LIST OF FIGURES

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER I

SUPPLY & DEMAND

Prepared for:

Alberta
Environment

By:

Seaton-Jordan & Associates Ltd.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

SUPPLY & DEMAND

INTRODUCTION

In considering the feasibility of alternate corridor terminal and processing facilities for oil produced from oil sands sources we have accepted the premise that the Government of Alberta will retain as a part of its development policy, the processing of crude oil and natural gas should, where possible, take place in Alberta. Such processing should contribute to a better balanced industrial development throughout the Province.

The attainment of these policy objectives will depend in large measure, upon five factors - revenues, supply, demand, price and direct government revenues. Each of these five factors and their impact upon the attainment of these objectives are considered in this report.

Refinery and petrochemical plant construction in recent years has slowed considerably in the United States and other industrialized areas. Two factors contribute to inhibiting refining construction in these areas.

1. Uncertainty of supply of crude oil and natural gas both as to quantity and price.
2. Environmental concerns.

In addition to these two factors, existing refining capacity has not been fully utilized as refineries are designed to handle specific types of crude oil and if such crude oil is not available they are unable to easily adjust to using alternate types of crude.

It follows that any jurisdiction that can assure a crude oil supply regardless of price will have an advantage over other areas when refinery and petrochemical locations are selected. The Alberta Government therefore can, by controlling the production of the oil from the oil sands, ensure that a maximum amount of processing will be done in Alberta.

Present producing and transportation facilities for synthetic crude from the tar sands have been developed within the constraints applied by the Alberta Government's oil sands policy of 1962. Simply stated, this policy restricted oil produced from the oil sands to a volume of approximately 5% of the total market for Alberta crude. This policy was modified in 1968 but it continued to provide that oil sands would supplement but not displace conventional oil.

This policy provided:

> "For such production from the oil sands as may be able to reach markets clearly beyond present or foreseeable reach of Alberta's conventional industry, there is no need to restrict the rate of production from the oil sands and, provided the development program meets with the approval of the Oil and Gas Conservation Board, the Government will authorize it.
>
> On the other hand, for such oil sands production as would be in competition with present or foreseeable markets for conventionally produced Alberta crude oil, the impact on the conventional industry will be carefully considered. In this instance, the Government's judgment is that the best interests of the Province will be served.
>
> (a) in the initial stages of oil sands development, by restricting production to some 5 percent of the total demand for Alberta oil - i.e. at a level of the order of that recently approved for Great Canadian;
>
> (b) as market growth enables the conventional industry to produce at a greater proportion of its productive capacity, by permitting increments in oil sands production as recommended by the Oil and Gas Conservation Board, and on a scale, and so timed, as to retain incentive for the continued growth of the conventional industry; and
>
> (c) by relating the scale and timing of increments of oil sands production also to the life index of proven reserves of conventional oil allowing the index to decline gradually from present levels but ensuring that it does not drop below 12 to 13 years. "

In February, 1968, the Government issued a statement clarifying and amending certain aspects of the 1962 policy. The principle portions of the 1968 statement that affected the criteria under which application for development would be considered are:

"With respect to an application proposing the marketing of oil sands production in markets that are beyond reach of the conventional industry, the present policy is satisfactory and will be continued with such production being unrestricted so long as the development program meets the conservation and related requirements of the Oil and Gas Conservation Board."

"With respect to an application proposing the marketing of oil sands production within reach of the conventional industry, but not in 'new' markets as defined later, the Government believes that, as at present, the application should be approved only when indicated to be desirable on the basis of the trend in the life index of the conventional industry. However, the criterion of percent utilization of productive capacity referred to in the present policy is no longer useful and will be discarded."

"The Government believes that in order to encourage greater growth in the total crude oil market than would otherwise occur and thereby permit further oil sands development, the present policy requires amendments with respect to the treatment of applications that provide for marketing a product from oil sands 'within reach' of the conventional industry. Where it can be demonstrated that the applicant's marketing proposal would provide such additional growth by the development of a 'new' market the Government is prepared to authorize further production of oil sands product at volumes equal to 50 percent of the new market. A 'new' market would be one not being served today; one over and above the normal growth in existing markets, and one representing a new increase in total markets."

"It is recognized that during the next few years it is particularly difficult to estimate market growth. In view of this the Government believes it desirable to establish specific limitations on the additional volume of oil sands production that would be approved under this amendment of the 1962 policy. Accordingly, the total volume of commercial oil sands production, including the presently authorized production, that will be permitted to enter new markets within reach of the conventional industry will be restricted to 150,000 barrels per day. Unless some wholly unforeseen set of circumstances should develop, this limit will remain in effect for five years. During this period the limit will be reviewed and, if conditions warrant, it may be increased for a succeeding period."

The results of recent action taken by the Oil Producing and Exporting Countries (O.P.E.C.) through their embargos on crude oil sold to the United States and Holland and their partial embargos on crude oil to other nations has created unprecedented shortages. Coupled with the cut back of supplies of crude oil was the dramatic increase in prices moving in a few months from a level of around $4.50 a barrel landed in the Chicago area to the present price of about $11.00. Spot sales were reported to be in the range of $18.00 - $22.00 a barrel.

Under the guidelines laid down by the Federal Government the Canadian market east of the Ottawa valley was supplied by crude oil imported from the O.P.E.C. countries, most notably Venezuela. The reduced supplies resulting from the partial embargo together with the increased costs have created a demand for Western Canadian crude to now serve this market.

There is also the realization by the Americans of their dependency for crude oil supplies from Arab countries and this has prompted an increased U.S. demand for Canadian crude oil.

The effect of these events has created a demand for Canadian crude oil that, within the capability of present producing fields and foreseeable oil sands projects, is virtually unlimited. It would seem that the "wholly unforeseen set of circumstances" mentioned in the 1968 statement respecting oil sands has occurred, to the extent that the Alberta "oil sands policy" as it is presently stated will not act as a restraint on development of the oil sands.

A second restraint on development of the oil sands was that the selling price for Alberta crude and synthetic crude had to be competitive with foreign crude oils landed on the east coast of North America. The increased prices in available crude oil supplies around the world now make it possible for the development of the oil sands to proceed at a more rapid pace than was once thought possible.

CONVENTIONAL CRUDE OIL RESERVES IN ALBERTA

At hearings held by the Energy Resources Conservation Board in September of 1971 respecting the application of Syncrude Canada Ltd., the owners of this company, Atlantic Richfield Canada Ltd., Canada Cities Service Ltd., Gulf Oil Canada Ltd. and Imperial Oil Limited jointly submitted estimates which showed a decline in the life index from a level of slightly more than 24 years at year end 1970 to only a level of 10 years at the end of 1977.

The Energy Resources Conservation Board after reviewing this data along with an independent study which had previously been carried out by the Board staff and after updating the expected total demand figures for Canadian oil, forecast that by the end of 1980 the life index of conventional crude oil would be in the range of 7 to 9 years.

At the present time the Energy Resources Conservation Board are holding a hearing into the present Alberta Prorationing and Maximum Rate Limitation plans. Two main purposes of the hearing are to determine the need for prorationing systems and establish criteria for MRL systems. The outcome from this hearing could effect the levels of production in Alberta, however it is not expected that any adjustments in the present plans or even the elimination of the prorationing system will have any material effect on the life index of conventional crude oil.

The unknown that makes the life index difficult to project is the level of discoveries of conventional crude oil that can be assumed over the period of time to 1980 and the appreciation of recoverable reserves in existing fields. In the publication "An Energy Policy for Canada" published in 1973 it was estimated that at least four billion barrels of conventional oil remains to be found in the three western provinces. This is considered to be a pessimistic forecast. The Energy Resources Conservation Board have estimated that there are approximately 8.5 billion barrels of conventional crude oil yet to be found in Alberta and their forecast of Alberta proratable crude oil life index shows a reserve addition of 400 million barrels a year over the nine year period reviewed.

It would appear obvious from the recent low discovery rate of conventional oil that the more easily found accumulations of crude oil have been discovered and the reserves remaining can only be found with a greater concentration of exploration and this of course means a greater expenditure of money.

A. Replacement Costs

The table following, which was prepared from data supplied by the Canadian Petroleum Association, indicates that the replacement costs per barrel in each of the five years preceding 1973 exceed revenue per barrel. The five year average replacement cost exceeded the five year average return by $2.04 a barrel.

TABLE 1. WESTERN CANADA - REPLACEMENT COST PER OIL - EQUIVALENT BARREL

	1968	1969	1970	1971	1972	5 year Average
Gross Revenue	2.40	2.42	2.49	2.75	2.77	2.58
Royalties	.29	.29	.30	.34	.34	.32
Net Revenue	2.11	2.13	2.19	2.41	2.43	2.26
Production Costs	.43	.44	.45	.51	.50	.47
Development Costs	.28	.26	.61	.88	2.70	.51
Finding Costs	2.68	1.57	4.70	4.95	10.98	2.32
Replacement Costs	3.34	2.27	5.76	6.34	14.18	4.30
Replacement Costs Exceed Net Revenue By	1.23	.14	3.57	3.93	11.75	2.04

To encourage exploration for these remaining deposits of crude oil it will be necessary that the Government give recognition to the increased replacement costs and provide that the rewards for not only being successful but for actual exploration itself be sufficient to maintain the necessary high level of exploration activity that will be required in order that the discoveries will be realized.

B. Royalties

This encouragement can firstly take the form of ensuring an adequate return to the producers who are successful and this can best be accomplished through a decreasing royalty rate as finding costs increase. Depending upon the return to the producer after the payment of Crown royalty this decrease of the royalty rate may not have to be substantial. It has been estimated that if the price of crude oil that is returned to the producer for his share should rise to $6.00 per barrel, it is probable that all of the remaining undiscovered reserves of oil could be found.

In any event, it should be of lesser importance to the Government to maintain a high level of royalty as a means of ensuring an adequate return for this depletable resource if this policy will act as a deterent and retard the exploration needed to discover these high cost reserves. This should be particularly true where the Province can require that crude oil produced be processed within the Province. The overall economic impact of a refining and manufacturing industry in Alberta should outweigh the loss of any direct revenues by way of the conventional royalty.

C. Drilling Incentives

A second incentive that will encourage the exploration for these undiscovered reserves is a drilling credit similar in scope to the one recently introduced. This type of drilling credit has the effect of not only reducing the royalty for those explorers who are successful but also creates a situation where the credit established through the drilling of unsuccessful wells can be

used as purchase money to acquire other attractive prospects which can then be drilled.

D. Tenure Regulations

A third incentive that will be required in Alberta will be changes in the land tenure regulations which will make petroleum and natural gas rights more readily available to those who are prepared to actively explore in the Province. It is extremely important that those companies willing to explore in Alberta and to risk their funds in the high risk venture of drilling for these remaining undiscovered reserves not be denied access to the petroleum and natural gas rights on which their particular prospects lie.

It is important that these three incentives not be dealt with in isolation but should be so structured that the rights, obligations and potential rewards for exploring in Alberta are clearly set out and that as many uncertainties as possible be removed.

The requirement for regulations which will attract exploration money to the conventional industry has always been important but it will become even more so as competition for the available funds grows. Massive amounts of capital will be required in order to build and operate oil sands plants and their necessary transportation facilities. Large amounts of capital will also be required to build new refineries or increase capacity of existing ones and to build ancillary manufacturing complexes.

As the discovery of these remaining reserves of conventional oil becomes more difficult and more expensive, the risk factor is compounded and so the difficulties of attracting the available capital to this sector of the industry increases. This can reach the point where the explorer for the conventional crude oil has only his cash flow available to him for exploration capital. At this time it will be essential that the producer receive a larger return from production to maintain the cash flow with which to continue exploration.

At this stage in the Province's exploration history it is of paramount importance that the last remaining reserves of crude oil be found. The Province's direct return for these reserves now take secondary importance. The so-called windfall profit or excess profits to the producer has no relevance in a situation such as this providing the producer continues to explore in Alberta at a satisfactory rate. The monitoring of this rate of exploration should be an obligation of the Government so that it can ensure that the remaining explorers continue to have the funds necessary to do their exploration drilling.

In summary it would seem that the life index of the conventional crude oil reserves in Alberta will decrease to a range between 7 and 9 years by the end of 1980. Whether or not this projection proves to be realistic will depend upon several factors.

(a) the success of the industry in discovering new reserves;

(b) technical advances enabling greater recovery through secondary and tertiary recovery methods;

(c) the possible increased demands from eastern Canadian markets not presently being served by Alberta crude oil;

(d) changes in the present pro-rationing system and MRL plans as a result of the present hearing;

(e) possible cut-back in exports to the United States.

To exclude the factor mentioned in (e) from our considerations leads to the conclusion that the life index of conventional crude oil in Alberta will continue to decline and that alternative supplies of synthetic crude oil as a refinery feedstock will be required to replace the expected decline in conventional crude oil production.

On the other hand, a substantial reduction of conventional crude oil being exported to the United States would have the effect of substantially increasing the life index of Alberta's conventional crude oil. It is difficult to assess at this time the impact that this type of a decision would have on the development of the Athabasca Tar Sands and on other oil sands areas, however it would allow for an earlier surplus of refinery feedstock that could be upgraded in Alberta. All of this presupposes

that although unrefined products are not being exported to the United States that refined products will be allowed to supply export markets. (See Tables 2 and 3.)

TABLE 2. REMAINING CONVENTIONAL PROVEN CRUDE OIL RESERVES AT END OF 1972

	Billion Barrels
World	670
U.S.A.	43
Canada	10
Alberta	7

TABLE 3. SUPPLY OF WESTERN CANADIAN CRUDE OIL
(Thousands of Barrels per day)

	(1)	(2)	(3)	(4)	(5)	(6)
1974	1,962	30	1,992	-	60	2,052
1975	1,961	95	2,056	-	60	2,116
1976	1,975	140	2,115	-	60	2,175
1977	1,920	185	2,105	-	78	2,183
1978	1,786	239	2,025	-	115	2,140
1979	1,604	271	1,875	-	155	2,030
1980	1,387	363	1,750	293	220	2,263
1981	1,245	385	1,630	344	235	2,209
1982	1,105	425	1,530	393	235	2,158
1983	991	454	1,445	440	475	2,360
1984	882	488	1,370	484	635	2,489
1985	779	526	1,305	526	815	2,646

(1) Existing Reserves
(2) New Reserves
(3) Total
(4) Mackenzie Delta
(5) Oil Sands
(6) Total

Source: Energy Resources Conservation Board data

E. Corridor Selection

When selecting a route for a corridor which will be used to transport refinery feedstock from the tar sands and other oil sands areas of the Province some consideration might be given to the potential of undiscovered conventional reserves of both oil and gas which may also use this corridor as a means of transporting them to the pipeline terminal. Because of the geological complexities it is difficult to make any geographic predictions of crude oil potential with any certainty, however it can be said that the geological attraction for accumulations of conventional reserves of hydrocarbons are more likely to be found either along the "West route" or the "West Coast route" rather than any of the more Easterly corridors.

ALBERTA CONVENTIONAL CRUDE OIL - DEMAND

As a result of the uncertainties existing in the world today respecting the supplies of crude oil any estimates of the demands for Alberta crude oil must, in the light of these uncertainties, be viewed as tenuous, with the very real prospect that any demand projections can be changed radically over a short period of time.

The Energy Resources Conservation Board has estimated that the Canadian demand for Alberta oil will increase from an average in 1973 of some 900,000 barrels per day to 1.1 million barrels per day in 1980. To be added to these projections would be the volumes of Alberta oil which will flow to the Montreal area commencing in 1976 of some 300,000 barrels a day.

An uncertainty which is an integral part of the demand forecast for Eastern Canada of Alberta crude oil is the potential for significant discoveries of crude oil off the Labrador and the East Coast. Should the promise of these areas be realized, it is likely that the flow of oil to the Montreal market from Alberta will become unnecessary. It is also possible, depending upon the volumes of crude oil available from the East Coast sources, that the Toronto market will be supplied from these sources rather than Alberta and Saskatchewan.

The estimates for demand of Alberta crude oil to the United States by the Energy Resources Conservation Board are that they will increase from their average of about one million barrels a day in 1973 to 1.7 million barrels a day in 1980.

Here again these demand projections must be tempered by several considerations. Firstly, the Arab embargo on United States imports may not be fully lifted or even if it is lifted the threat will always remain that this embargo will be re-imposed.

What is perhaps a more likely possibility would be for the Arab countries to restrict production in order to extend the life index of their reserves and ensure that the price does not fall to its previous level.

It must be assumed that with most Arab oil producing countries presently receiving more revenues from their oil production than they can effectively utilize there will be growing pressure to restrict production in order to extend the life index and to have these revenues continue as long as possible.

It can also be expected that this pressure to reduce production from the Arab producing countries will not come from the Arab producing countries alone. Other producing countries can be expected to follow this lead.

Syncrude Canada Ltd. during hearings held before the Energy Resources Conservation Board forecasted the United States demand for liquid hydrocarbons would expand at an average annual growth rate of 5.2 percent over the period 1970-1980, from 14.5 million barrels per day to 24 million barrels per day. They projected during the same period that the United States production would increase only slightly from 11.3 million barrels per day to 12.9 million barrels per day.

To support these demand figures the companies representing Syncrude Canada Ltd. explained that the high rate of growth was the reflection of current trends.

Limitations as to the availability of competing fuels were expected to further stimulate demand for production. In their submission, Syncrude Canada Ltd. estimated that conventional

crude oil production in the continguous 48 states would peak in 1973 at some 11.6 million barrels per day declining to ten million barrels per day in 1980. This forecast assumed that apart from the Elk Hills Naval Reserve the United States spare productive capacity would disappear in 1973. Also incorporated in this forecast was the introduction of crude oil from the Alaska North Slope of one million barrels per day in 1975 to 2.8 million barrels per day in 1980.

Relatively minor volumes of synthetic oil production from oil shales was forecast. Production from this source was projected at one hundred thousand barrels per day in 1980.

Combining these projections, demand and supply of crude oil would indicate that a deficiency of United States oil supply will exist in the magnitude of some 3.2 million barrels per day in 1970 increasing to 7.2 million barrels per day in 1976 and again increasing to 11.2 million barrels per day in 1980.

To satisfy this deficiency it has been forecast that the United States will import some two million barrels per day from the Western Hemispheric countries excluding Canada and that the balance of the deficiency depending upon the availability of Western Canadian crude oil for export must come from the Eastern Hemispheric countries and most notably the Arab oil producing countries.

By the end of 1985 production of oil from all sources is projected to amount to approximately 2.6 million barrels a day. At the same time, Canadian demand will amount to approximately 1.7 million barrels a day. The American deficiency of demand over domestic production in 1985 is projected to exceed 12 million barrels a day.

In summary it would seem that during the foreseeable future combined domestic and export markets for Canadian and Alberta crude oil will be greatly in excess of any reasonable expectation of productive capacity. (See Table 4.)

TABLE 4. SUPPLY OF WESTERN CANADIAN CRUDE OIL
(Thousands of Barrels per day)

	(1)	(2)	TOTAL
1974	818	150	968
1975	846	200	1,046
1976	875	325	1,200
1977	906	334	1,240
1978	939	346	1,285
1979	971	359	1,330
1980	1,005	365	1,370
1981	1,040	380	1,420
1982	1,076	400	1,476
1983	1,114	420	1,534
1984	1,153	440	1,593
1985	1,193	460	1,653

(1) West of Ottawa Valley

(2) Montreal Market

Source: Energy Resources Conservation Board data

A. Terminal Selection

The supposition that there will be virtually an unlimited demand for both Alberta crude oil and refined products must be tempered by the cost of transporting the hydrocarbon from the Athabasca Tar Sands to their market. With this restraint in mind the location of any terminal should take into account the existing and potential modes of transportation which could be utilized to give economic access to the markets.

CRUDE OIL PRICING

The cost to the United States for Canadian crude oil has risen from a level of about $4.50 to what is now a level of approximately $11.00 and this has been a direct result of the embargos and price increases demanded by the Arab producing nations.

It can be argued that once the Arab embargo is lifted and oil is moving freely into the United States from these sources, that the price of crude oil can be expected to slacken. Projections on future pricing levels for crude oil are even more tenuous than those respecting demand and supply, however it can be said with some certainty that once crude oil is moving freely into the United States that the price per barrel landed at Chicago will be something less than the current price of about $11.00 per barrel but it is unlikely that the price will fall below $8.00 per barrel.

It is perhaps possible that the prices will be maintained at their current levels and can even be expected to increase over the next few years. The factors that will govern the pricing of crude oil will be the availability of supply from the O.P.E.C. countries, the ability of European countries to become self-sufficient in crude oil as a result of discoveries in the North Sea and the willingness on the part of the U.S. consumer to absorb the high costs of this imported oil. This later point will be to some extent influenced by the success of the United States' Government's determination to be self-sufficient in energy requirements by 1980 which in itself may require a high wellhead price to stimulate exploration and development.

To keep the pricing of crude oil as it influences Alberta in its proper perspective, it should be remembered that only by maintaining the price of oil at a relatively high level does the exploitation of the tar sands become a viable proposition. On this point there always remains the uncertainty and the danger that should the international price for crude oil fall to its previous level, that the exploitation of the tar sands envisioned by this report is no longer viable.

It is not expected that this danger will materialize for the following reasons:

Firstly, it is expected that if the Arab oil producing countries are able to maintain the international price of crude oil at a level in excess of $8.00, that they in all likelihood will also restrict production which will not only have the effect of keeping the supply in a tight position but will achieve their aim of maintaining a desirable price.

Secondly, the ability of the United States to become self-sufficient in energy requirements by 1980 pre-supposes that they will achieve enough exploration successes and coupled with this is the proposition that the consumption per U.S. citizen will be maintained at its current levels. In other words, if the consumption were to increase by the 5.2% per year as projected by Syncrude Canada Ltd., it is improbable that the United States would be able to achieve self-sufficiency in its energy requirements by 1980 or any other period for that matter.

It may be that this uncertainty of supply coupled with the resulting increase in fuel costs may eventually promote a change in the energy consumption pattern for the United States.

The rationing of fuels for non-essential purposes in the United States could evoke a consumption change but this is not a proposition that would be looked upon with much favor by the United States citizen and it is not likely to be brought into being by the United States Government. What is more likely to happen is that there will be a small reduction in the consumption of fuels for non-essential purposes by the restraints placed upon the consumer through costs.

DIRECT REVENUE TO ALBERTA GOVERNMENT

The direct revenues from the oil and gas industry to the Government of Alberta have averaged in excess of 250 million dollars a year over the past five years. In 1973, this revenue from royalties, rentals and sales amounted to in excess of 440 million dollars being an increase of 144 million over the 296

million dollars received in 1972. Higher field prices for oil and gas, increased royalty rates and higher volumes of production accounted for this considerable increase.

However, the potential revenue even at today's production rates can be gauged by examining the return to the Federal Government on the oil export tax imposed by the Federal Government in the fall of 1973.

The original tax of 40 cents a barrel returned approximately 13 million dollars for the first two months that it was imposed (October and November).

The tax was increased to $1.90 for the month of December yielding the Government approximately 60 million dollars.

In February the tax amounted to $6.40 a barrel and yielded an estimated 180 million dollars for the month. This tax of $6.40 a barrel was to be maintained through the month of March, again returning to the Federal Government an estimated 180 million dollars. In total this federal oil export tax will have yielded one half billion dollars by the end of March, 1974.

Should the tax remain at its present level, the tax would return to the Federal Government almost 2 billion dollars during the one year it would have been in effect. At this tax rate, the Federal Government would receive in two years, revenue equal to what the Alberta Government received in the 27 year period 1947-1973 inclusive.

Even if this tax were to be lifted on April 1st, the Federal Government in the short time that the tax has been in effect would have received more money than was received in Alberta during 1973 for not only royalties on crude oil but for all royalties, rentals and sales.

The results of the recent negotiations between the two levels of Government produced a new crude oil price of $6.50 a barrel for domestic sales for a 15 month period commencing April 1, 1974. Revenues to the Alberta Government as a result of this increase in the domestic price for crude oil will amount to some 900 million dollars over this period of time. In addition to this the Province

can expect to receive one half of the oil export tax applicable to Alberta production that was collected up to March 31, 1974.

As the crude prices increase, transportation costs of both crude and finished products become less important than was formerly the case. With this very high revenue the Alberta Government will be in a position to assist in the development of alternative locations for refinery and petrochemical sites should this assistance be necessary.

ALTERNATE TERMINAL SITES FOR SYNTHETIC CRUDE OIL

In approaching the study of alternate terminal sites for synthetic crude oil from the Athabasca area and heavy crude oils from other oil sands areas in Northern Alberta, a number of basic assumptions were made:

1. That the Government of Alberta would continue its policy of:

   (a) ensuring a mineral supply for Canada's needs;

   (b) pursue all opportunities for additional processing in Alberta;

   (c) utilize mineral development to realize a more balanced regional development; and

   (d) realize the maximum return to Albertans' from exportable surpluses.

2. That the refining, processing and terminal facilities in the Edmonton area would continue to be served in at least their present capacity by Alberta crude oil both from conventional sources and from the tar sands.

3. That Canadian refinery centers located outside of Alberta and presently being served by Alberta crude would continue to expect to receive the volumes presently being delivered as long as there was a supply of crude surplus to Alberta's needs.

4. It will become a matter for consideration when any additional approvals for oil sands production are considered that the greatest amount of processing possible will take place in Alberta.

Apart from these basic assumptions the rate of growth of the refining, petrochemical and manufacturing complexes will be governed to a considerable extent by the amount of crude oil that continues to be exported into the United States.

The Energy Resources Conservation Board in their forecast of the demand for Alberta proratable crude oil have suggested that in order to maintain a life index of approximately 13.5 years by the end of 1975, it will be necessary that additional productive capacity of some 400 million barrels of crude oil per year be added to the system. The amount of oil sands production required to maintain this addition to the reserves of 400 million barrels per year will depend upon the success in discovering conventional crude oil and the implementation of additional and more efficient secondary recovery methods for existing pools.

In the event that the markets in the United States presently being supplied with Canadian crude oil are to continue, it would seem that most of the synthetic crude oil to come from the existing plant of Great Canadian Oil Sands, from the plant under construction by Syncrude Canada Ltd., and the proposed plant of Shell Canada Ltd. and the group headed by Petrofina Canada Ltd. will be required to replace conventional crude oil presently supplying markets. It is also probable that by the time all of the open pit operations in the tar sands are in production most of the synthetic crude oil will be required to supplement existing markets that will be at that time deficient in their supplies of conventional crude oil.

It can be expected that when technology is developed to the point that insitu operations can be economically conducted the availability of crude oil either for export or for upgrading in Alberta prior to export will change dramatically. The development of an economic insitu process will make available for the first time the unmineable portion (90%) in the Athabasca Tar Sands. In addition to these, the other oil sands areas of the Province, most notably those in the Cold Lake and Peace River areas, will add to the reserves of available crude oil. It can also be expected that the research required to develop a viable insitu process for oil sands will make a substantial contribution to

the enhanced recovery techniques relating to conventional crude oil reserves. At this time there will be a surplus of available refinery feedstock which is not required by refineries presently receiving Alberta crude oil. The extent of this surplus will be controlled by the economics of the recovery method and the required approval of the Government before commencing production. This surplus could then be processed in Alberta before being moved outside of the Province either to consumers elsewhere in Canada or for export.

On the other hand it is possible for the Government of Alberta to decide the crude oil normally exported is to be refined in Canada before supplying markets in the United States and present exports of crude oil will be phased out.

Should the Government decide that such a policy was desirable then there would be immediate supplies of crude oil which would be available for refining and further processing before they are sold to the export market. The amount of Canadian crude oil that would be made available for processing within the Province would be controlled by the phasing out process.

A. Crude Oil Handling Terminals

The crude oil handling facilities in the Edmonton area operated by Interprovincial Pipeline and Trans-Mountain Pipeline have present capacities of 1.4 million barrels a day and 340 thousand barrels a day respectively.

The handling facilities of these terminals can, without extending the boundaries of their present sites, be expanded to provide a handling capacity of in excess of 4,000,000 barrels a day.

These terminals are now directly linked by pipelines to the various oil fields in northern and central Alberta. As the existing fields become depleted it can be expected that these lines will be utilized, whenever practicable, to transport newly found oil to the terminal areas thereby minimizing costs and environment disturbances created by new pipeline construction.

Another aspect to be considered when determining alternate terminal locations is the possibility of utilizing these existing

terminals in furthering both the desire to process as much of the crude production in Alberta as is possible and disbursing these processing plants throughout the Province.

As the fields presently supplying crude to the Edmonton terminals become depleted, it may be possible to reverse the flow and construct processing facilities in the areas along such lines.

It may be possible to utilize these depleted reservoirs as storage for waste disposal and/or storage for upgraded liquid products and fuel supplies.

Where these facilities are constructed in the vicinity of the depleted fields they might very well serve to soften the impact on the communities serving the oil fields. In this way such communities as Drayton Valley, Devon and Swan Hills could continue as areas of employment for those presently employed there.

Continuing to use the Edmonton terminal facilities would also ensure a continued supply of crude for movement through the Trans-Mountain system.

To leave the refining of synthetic crude oils and the petrochemical complexes or at least the bulk of it to the Edmonton area has obvious merit. The existing refineries and petrochemical industries were established in the area for sound economic reasons and these will continue to exist.

As a consequence of the establishment in the Edmonton area of refineries and petrochemical plants, there has been a build-up of service industries which would also be required to service refineries and petrochemical plants located elsewhere.

It should also be expected that most of the labor force that would be imported from outside of Alberta would probably tend to want to live in a metropolitan area.

It would seem improbable that crude oil both from the mining of tar sands and from conventional sources will reach volumes exceeding the potential capacity of the existing crude oil handling facilities in the Edmonton area. However as previously pointed out the development of successful insitu process will unlock vast reserves of crude oil available for refining and

further upgrading prior to their ultimate sale to markets outside of Alberta.

The Alberta Government has already initiated the ALBERTA OIL SANDS TECHNOLOGY AND RESEARCH AUTHORITY and have charged this authority with the responsibility for achieving as rapidly as possible the breakthrough in research and technology that is essential to guarantee production of that part of Alberta's Oil Sands that cannot be recovered through a surface mining process. It must be assumed that in its initial five years the Alberta Oil Sands Technology and Research Authority will make significant advances in the techniques of in-situ mining and will ultimately provide the breakthrough that is required.

B. Gas Supply

With the probability that the gas resources of the Western Arctic will be moved down the Mackenzie Valley through Alberta and the likelihood of extensive new gas resources being discovered in western Alberta, we do not project any shortage of gas supplies for use in developing the oil sands resources.

Nevertheless it should be remembered that the Alberta Energy Corporation through its holdings in the Suffield Block of southern Alberta, has an uncommitted volume of available natural gas estimated at some 4 TCF and requiring little, if any, processing. This gas could be used as a source of fuel and feedstock to supply any part of the Province either by direct pipeline or which is more likely to be the case, an exchange of gas where gas in the area is being exported.

C. Corridor Selection

In the event that it was desirable to construct a corridor from the Athabasca Tar Sands to a terminal in the Medicine Hat area this corridor could be utilized for transporting supplies of natural gas from the Suffield Block to industries locating adjacent to this corridor.

SUGGESTED CORRIDORS TO FACILITATE PLAN FOR DECENTRALIZING OF PROVINCIAL INDUSTRIAL BASE

Given the established industrial base and services in the Edmonton - Fort Saskatchewan - Redwater area and given the facility for further expansion in this area, government policy to locate industry outside of this area should be proceeded with at a pace that will be the least disruptive and that will find general acceptance. The decentralization of the Province's industrial base must not only be acceptable to the potential industries in an economic sense but must also gain the general approval of the persons who will make up the working community for these industries. The following plan if adopted in the stages suggested would enable the government to set in motion a policy of decentralization of industry in the Province. These stages would permit the monitoring of the effects of such a policy on industries, the people required to operate and the ability of the service industries to supply these areas. The monitoring will allow any deficiencies to be overcome before a policy of decentralization is undertaken on a more massive scale.

Stage I

Adoption of the "central route" as the initial corridor

This corridor would act as a source of feedstock for the existing industries in the Edmonton area. In addition this corridor would provide a convenient means of constructing a lateral corridor from a point near Skaro and running east to a suitable industrial site adjacent to the North Saskatchewan River. This site could be offered as the location for a world sized refinery and would represent the initial phase of Government policy to decentralize and increase the industrial base of the Province. The data collected from monitoring the response of both industry and the community at large to all phases of locating in this area would assist the Government in assessing firstly, the impact of stage I and secondly, the desirability of proceeding with their policy of decentralization through stage II.

Stage II

Adoption of the Hardisty route as the second corridor

This corridor would operate as an additional source of feedstock to industries located along the North Saskatchewan River both west and east of this corridor. The portion of the corridor south of the west - east laterals could be used to move refined products and other manufactured materials to a staging area at Hardisty. The feedstock that would be moved down this corridor to the industries located on the North Saskatchewan River would initially come from the Tar Sands area. However, the proximity of the corridor to the west side of the large Cold Lake oil sands deposits make this corridor the natural one to use when full scale operations in this area are undertaken.

Stage III

Adoption of the West Coast route as the third corridor

This corridor could be used to carry a refined or unrefined product to markets that can be serviced from a west coast port. This corridor would also act as a source of feedstock for an industrial development in the Peace River area. The timing of this corridor might coincide with full scale operations of the oil sands deposits in the Peace River area.

ALTERNATE PIPELINE ROUTES

From time to time the question of moving crude bitumen directly from the Athabasca Tar Sands area to tidewater either on the West Coast or Hudson's Bay has been raised. Some years ago Japanese interests were reported to have proposed a scheme whereby crude bitumen, upgraded to the extent that it could be moved by pipeline, would be transported to a terminal in the Prince Rupert area for shipment to Japan.

A. Westerly Route

A route running west from the Athabasca Tar Sands and terminating at Prince Rupert or some other suitable port capable of handling super tankers would have the following advantages:

(a) It would provide a transportation route to tidewater for exports to the pacific rim nations, notably Japan.

(b) The product exported could be the crude bitumen upgraded to the extent that it can be moved through a pipeline or more desirably finished products.

(c) If finished or refined products are to be exported from this west coast port then consideration would have to be given to the location at which the refining of the crude bitumen would occur. The location of the refining facilities would likely be either at the beginning of the pipeline (Fort McMurray area) or at the termination of the pipeline. It would also be possible, however, to establish these refining facilities at a point or points along the route.

(d) A West Coast route could be so located as to give ready market access to the oil sands deposits in the Peace River area which are estimated to include some 21 billion barrels of recoverable crude oil.

(e) The Peace River area should be considered as a future refining and manufacturing center designed to handle not only the oil sands production from this region but also feedstocks from the Athabasca area.

B. Easterly Route

A route commencing in the Athabasca Tar Sands area and running east would seem to present the following considerations:

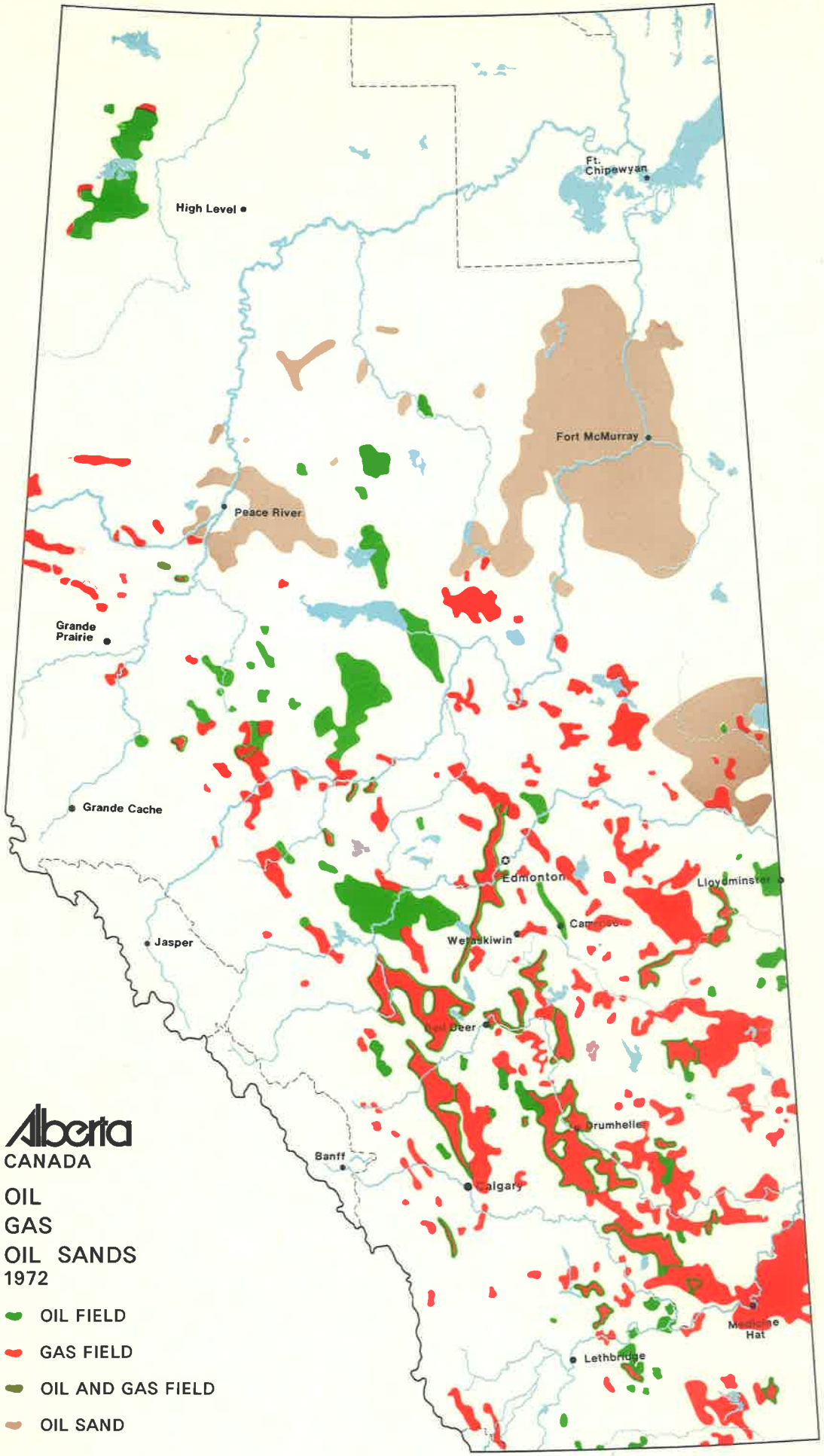
(a) If the terminal point of the pipeline was to be at Churchill, Manitoba, this would provide access to east coast markets and possibly markets in Europe. As with the west coast route this corridor could carry crude bitumen which could be exported in that state, or upgraded into finished pro-

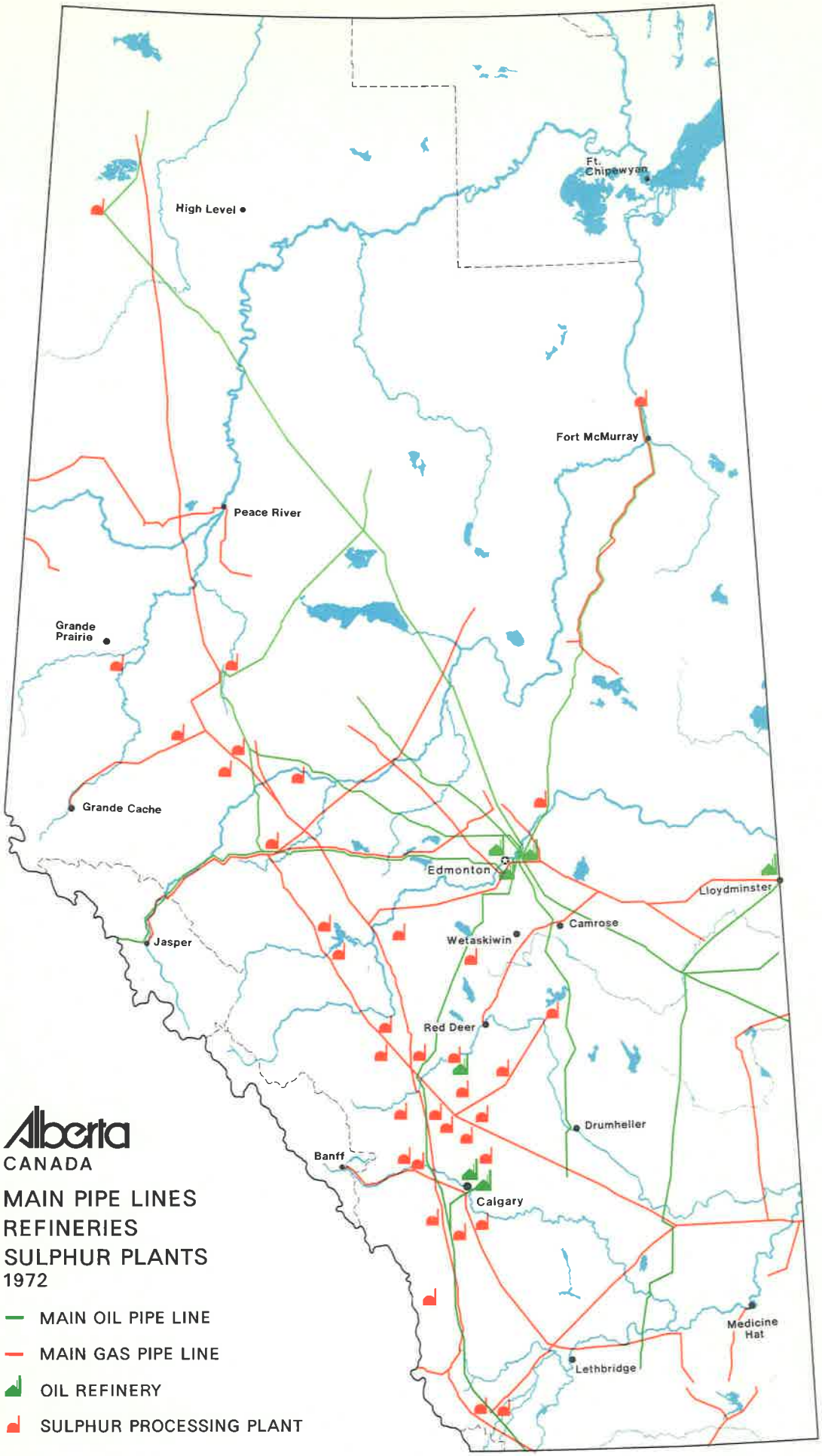
ducts at Churchill or some other suitable location.

(b) Using this corridor as an avenue to transport refined products for export gives greater emphasis to establishing a major refining complex in the Athabasca Tar Sands area.

(c) If the Eastern route were to terminate in either Saskatchewan or Manitoba then this would provide feedstocks required to promote a refining and manufacturing industry in these two Provinces. A transportation corridor providing refining and manufacturing feedstocks for Saskatchewan and Manitoba could represent a substantial input in the creation of a common industrial strategy as outlined in the communique of the recent Premiers conference of the four western provinces.

(d) The Eastern route should also assist in accelerating the development of any exploitable oil sands deposits in Saskatchewan.

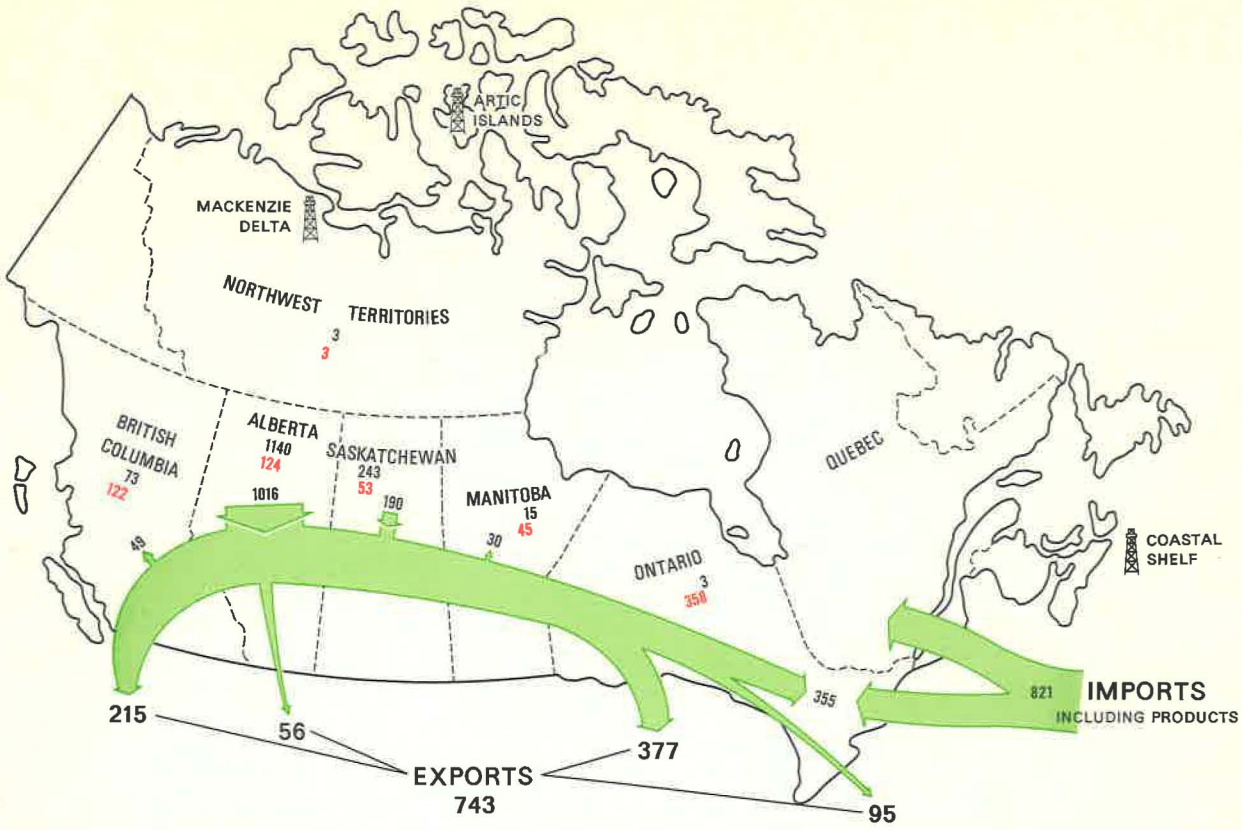

High Level
Ft. Chipewyan
Fort McMurray
Peace River
Grande Prairie
Grande Cache
Jasper
Edmonton
Lloydminster
Wetaskiwin
Red Deer
Banff
Calgary
Medicine Hat
Lethbridge
Alberta
CANADA
OIL
GAS
OIL SANDS
1972
OIL FIELD
GAS FIELD
OIL AND GAS FIELD
OIL SAND



Alberta
CANADA

MAIN PIPE LINES
REFINERIES
SULPHUR PLANTS
1972

- MAIN OIL PIPE LINE
- MAIN GAS PIPE LINE
- OIL REFINERY
- SULPHUR PROCESSING PLANT

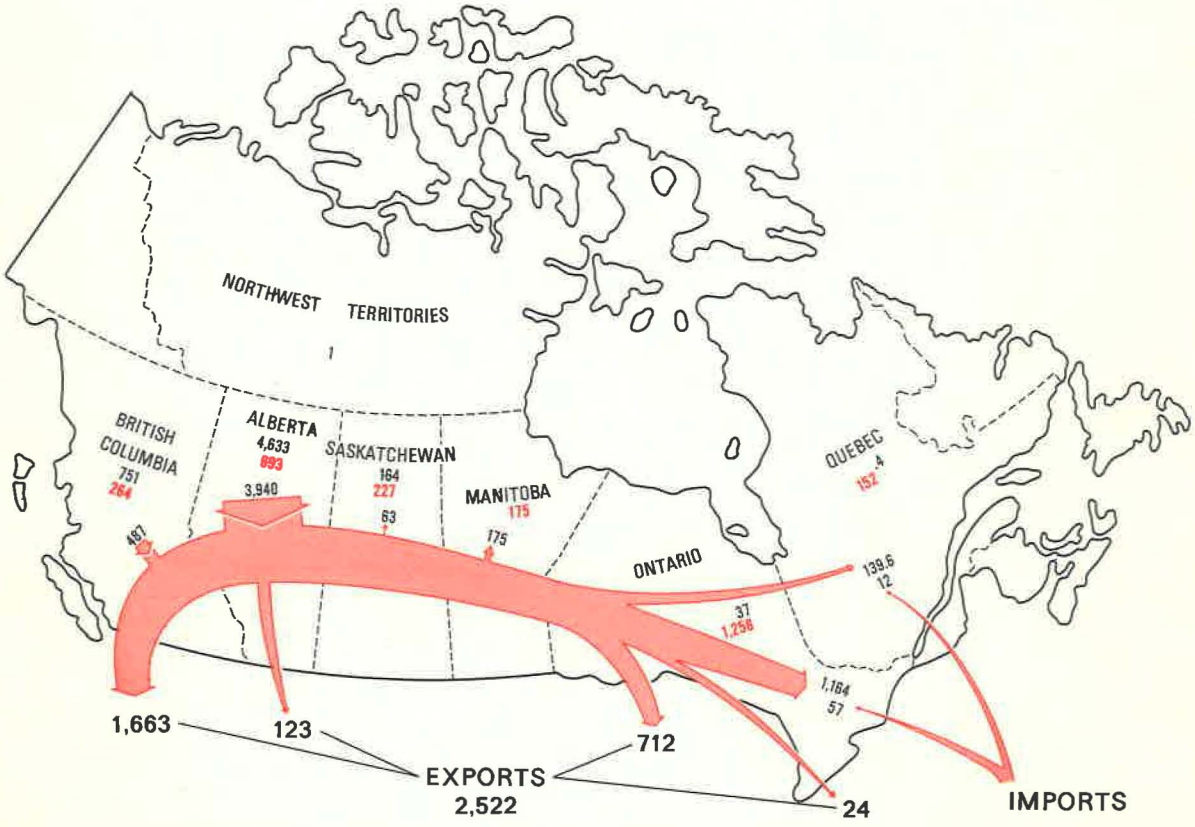


MOVEMENTS OF OIL WITHIN, TO AND FROM CANADA, 1971

CONVENTIONAL AND SYNTHETIC CRUDE OIL AND EQUIVALENT

FIGURES IN THOUSANDS OF BARRELS PER DAY

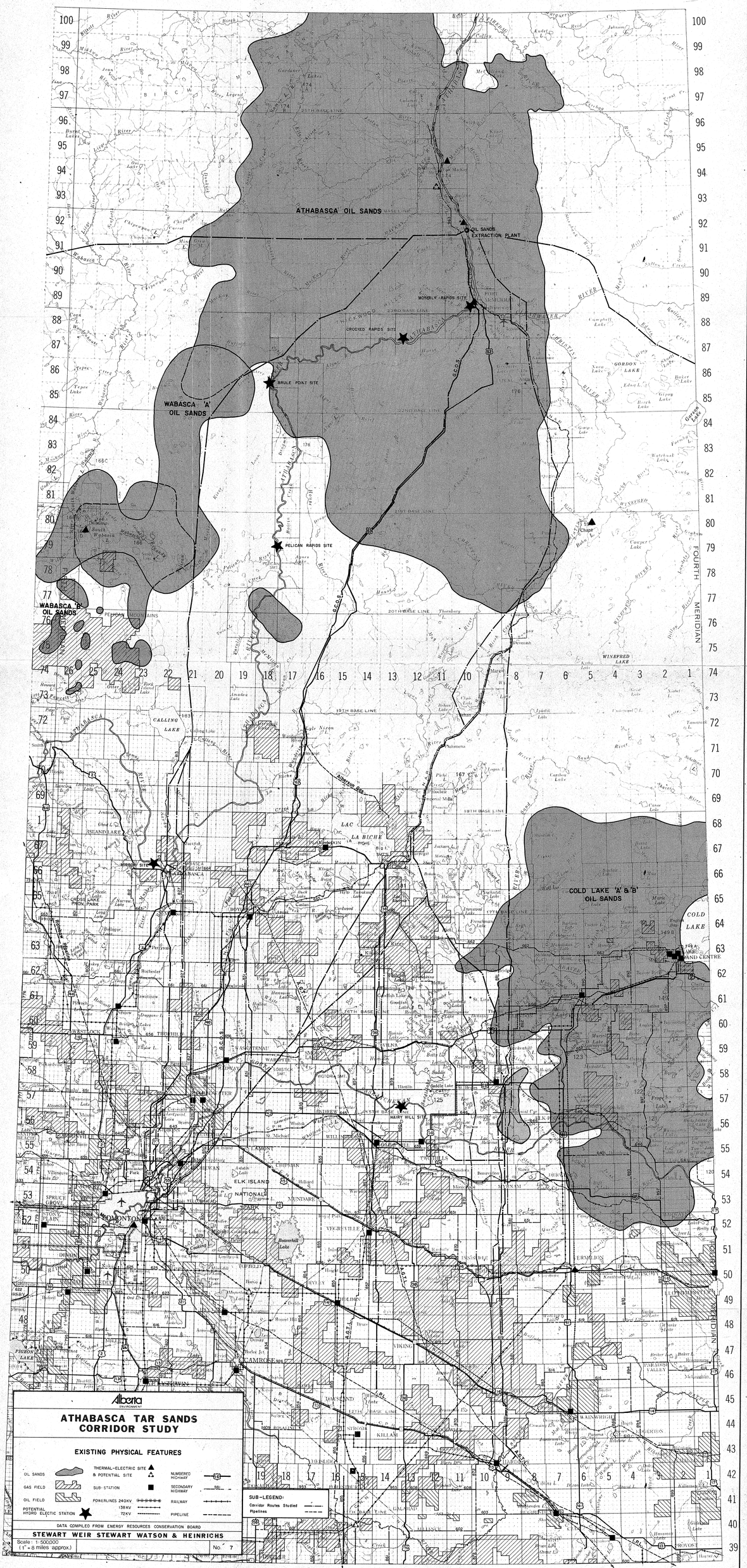
PRODUCTION BLACK (243) DOMESTIC CONSUMPTION RED (53) NEW ACTIVE EXPLORATION



MOVEMENTS OF NATURAL GAS WITHIN, TO AND FROM CANADA, 1971

FIGURES IN MILLIONS OF CUBIC FEET PER DAY

PRODUCTION BLACK (164) DOMESTIC CONSUMPTION RED (227)



Alberta ENVIRONMENT

ATHABASCA TAR SANDS CORRIDOR STUDY

EXISTING PHYSICAL FEATURES

OIL SANDS
GAS FIELD
OIL FIELD
POTENTIAL HYDRO ELECTIC STATION
THERMAL-ELECTRIC SITE & POTENTIAL SITE
SUB-STATION
POWERLINES 240KV, 138KV, 72KV
NUMBERED HIGHWAY
SECONDARY HIGHWAY
RAILWAY
PIPELINE

DATA COMPILED FROM ENERGY RESOURCES CONSERVATION BOARD

STEWART WEIR STEWART WATSON & HEINRICHS

Scale: 1:500,000 (1" = 8 miles approx.)

No. 7

Prepared From Base Map Provided By Survey Branch, Department of Highways & Transport

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER II

URBAN GROWTH IMPLICATIONS OF CORRIDOR TERMINAL LOCATION

Prepared for:

Alberta
Environment

By:

K.C. Mackenzie Associates Ltd.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

URBAN GROWTH IMPLICATIONS OF CORRIDOR TERMINAL LOCATION

INTRODUCTION

The selection of a route for a transportation corridor, including pipelines, between the Athabasca Tar Sands and the existing industrial complex of metropolitan Edmonton necessarily includes consideration of pipeline terminals at each end of the corridor. The terminal in the Tar Sands area has yet to be designated and will require further study in conjunction with the preparation of a development plan for the Tar Sands region but, for the purposes of the Transportation Corridor Study, it has been assumed that the pipeline corridor originates at a point north of the Town of Fort McMurray and that the corridor bypasses the Town to the West. The southern terminal for the corridor was originally assumed to be the existing terminal complex east of the City of Edmonton in the County of Strathcona, in an area commonly referred to as Refinery Row. The rationale for this assumption is not only the existence of the terminal facilities and the major east-west pipelines they serve, but the presence of various industries for which future production from the Tar Sands will be required as a feedstock. Although the validity of this rationale continues to be a major factor in maintaining a pipeline transportation link between the Athabasca Tar Sands and the Edmonton industrial complex, certain aspects of Provincial Government policy require a more detailed analysis and consideration of the implications of establishing the existing refinery row terminal as the only, or the major, terminal for future production emanating from the Tar Sands.

Those aspects of Provincial Government policy which complicate the matter of the southern terminal for the pipeline corridor include:

1. The desire to maximize the amount of industrial development that will result from future production from the Tar Sands within the Province of Alberta; and

2. The desire to decentralize population growth throughout the Province with a view to encouraging growth in smaller centers and discouraging economic activity which will increase the pressure for growth in the metropolitan centers of Calgary and Edmonton.

The Athabasca Tar Sands Transportation Corridor Study must therefore consider the selection of a corridor route which is capable of accommodating these Provincial Government policy objectives. An additional dimension which has therefore been added to the study is consideration of those major industrial activities which depend, in large measure, upon a large and stable long term supply of petroleum feedstocks such as those which will be produced from the Athabasca Tar Sands. The particular forms of industry considered include refining and petrochemical industry. These industries are considered in this report, in conjunction with their relationship to transportation facilities and in particular pipeline facilities, within the context of their respective urban growth implications.

CORRIDOR TERMINALS

A. The Function and Physical Characteristics of Pipeline Terminals

1. The Function of Terminals:

Pipeline terminals function within a pipeline network in a manner similar to the function performed by warehouses in the distribution of packaged goods and materials. Pipeline terminals act as temporary storage facilities in which various liquid hydrocarbons may be stored or accumulated prior to trans-shipment. Pipeline terminals are hubs of pipeline networks and they are usually the focus of a major network of pipelines, some of which transport liquid hydrocarbons from their points of origin which may be conventional crude oil deposits or synthetic crude oil plants, and some of which convey the liquid hydrocarbons to other destinations for ultimate use.

The existing terminal facilities in the Edmonton metropolitan area located in Refinery Row in the County of Strathcona provide a useful illustration of the function of terminals. These terminals are the focus of an intricate and elaborate network of pipelines which transport conventional crude oil from several oil fields in Central Alberta. This crude oil, which is owned by numerous different oil producing companies, is collected and stored in large storage tanks on the terminal site and accurate records are maintained of the ownership, quantity and quality of all oil transported to the terminal facilities. From the terminal complex oil is subsequently shipped in batches through the major pipelines which connect the City of Edmonton to major oil consuming markets in eastern Canada, the American mid-west and the Pacific coast. In addition, some liquid hydrocarbons are transported from the Edmonton terminal facilities to local refining and petrochemical industries.

2. The Physical Characteristics of Pipeline Terminals:

The Edmonton terminal facilities are described in some detail in Volume 6 - Appendix of the Athabasca Tar Sands Corridor Study on Pages 14 to 18. These facilities are typical of pipeline terminals in that they consist of relatively large tracts of flat land upon which many large oil storage tanks are located. These storage tanks are the largest single visible and physical components in the pipeline terminal which also includes some pumping facilities, elaborate underground networks of pipelines, a pipeline maintenance center and a district administration office.

Examination of Table III entitled "Edmonton Terminal Facilities" will reveal that each of the two Edmonton terminal facilities features a relatively large number of incoming supply pipelines, varying between 15 and 18, and a relatively low number of outgoing pipelines varying between 1 and 3. Table III also reveals that the site areas are relatively large, 160 to 320 acres in area, and that the terminal complexes are not labour intensive, employing only 20 to 30 employees on a daily basis.

B. Locational Criteria of Pipeline Terminals

1. Access to Supply Pipelines:

Pipeline terminals must be located at a point which allows for convenient access from supply sources by way of supply pipelines. The Edmonton terminal facilities are centrally located with respect to the numerous oil fields which are presently in production in central and northern Alberta. Based upon this criterion, the optimal location for a pipeline terminal is at a point equidistant from oil sources of supply from which liquid hydrocarbons must be transported to terminal facilities.

2. Service Industry and Suppliers:

Pipeline terminal facilities are most dependent upon proximate service industries and suppliers during the period of terminal construction. Once constructed, terminal facilities exert a relatively modest demand upon service industries and suppliers. During construction, therefore, it is convenient if the terminal facilities are located relatively near an urban center within which a large number of specialized trades, materials and services are available. Upon completion of construction, the relatively modest service and supply component exerts a less significant demand for proximity to a major urban center. However, the fact that terminal complexes are relatively dynamic in that they are required to expand in accordance with increases in in-flowing supplies results in a continuing need for construction of additional storage facilities. This feature of on-going expansion and construction therefore emerges as a location constraint which makes a location near a major urban center more attractive than an isolated location.

3. Labour:

Although the quantity of labour required to operate and maintain a pipeline terminal facility is very modest, the labour requirement may be characterized as being high quality since the industry demands a high level of technical competence in its per-

sonnel. It is a general characteristic of highly trained labour that it prefers an urban location and the amenities, opportunities and choice of life styles which are not available in smaller centers. Proximity to a larger urban center is a locational criterion of pipeline terminal facilities which relates to the relatively sophisticated labour which these facilities require.

4. Relationship to Refining and Petrochemical Industry:

The pipeline terminal facilities in metropolitan Edmonton are located in the same general area as the refining and petrochemical industries of the Edmonton area. Although this could be taken as evidence that there is a close physical interdependence between these industrial activities, there is in fact no significant functional relationship between these activities which requires that they be located adjacent to one another.

The only physical link between terminal facilities and refining or petrochemical industries is the pipeline by which liquid hydrocarbons are transported from the terminal to the refinery or petrochemical plant. Although the length of pipe is clearly a determining factor in the cost of transporting the feedstocks to the industry from the terminal, it does not emerge as a major consideration in the overall economics of the particular industry. The following section will reveal that refining and petrochemical industries are governed by significantly different locational criteria than pipeline corridor terminals.

C. Conclusions

Pipeline terminal facilities require a location which permits ready access from all sources of liquid hydrocarbon supply by way of incoming supply pipelines. The terminal facility requires a site with relatively flat land in sufficient quantity to accommodate a large amount of expansion of the number of storage tanks on the site. This expansion of storage capacity does not normally require a significant amount of expansion of the maintenance and administrative portions of the terminal facility. A terminal facility should not be regarded as a significant major economic base

activity by virtue of the fact that it does not employ large numbers of people nor does it exert major demands for service or supply activities once the construction of the terminal facility has been completed.

Although it could be regarded as desirable for refining and petrochemical industry to locate near pipeline terminal facilities because of the relatively short pipeline connection which would be required, this connection is the only functional link between such industries and terminal facilities that renders proximity desirable.

It is noteworthy that the pipeline terminal facilities which exist in metropolitan Edmonton are capable of substantial expansion upon their present sites. In fact, the capacity of the existing terminal facilities could be doubled on the present sites without adding significantly to the employment created by these facilities directly, or indirectly through additional service and supply requirements. It is therefore concluded that the capacity of the existing terminal complex could be doubled without manifesting any significant population or economic base growth in metropolitan Edmonton.

REFINING AND PETROCHEMICAL INDUSTRY

A. Differentiation of Industrial Activities

1. Refining of Conventional Crude Oil:

The refining of conventional crude oil is a process which involves the upgrading of crude oil from its natural state to a number of petroleum products and by-products. Conventional crude oil is conveyed to the refinery by means of supply pipelines which originate in the fields where natural crude oil is found and may or may not pass through a pipeline terminal. There are several instances in which natural crude oil is pumped directly from the oil fields to the Edmonton refineries without passing through either of the major pipeline terminal facilities. There are, however, instances in which conventional crude oil is supplied to refineries in Edmonton's Refinery Row through the facilities of the Interprovincial Pipeline terminal in the County of Strathcona.

2. Petrochemical Industry:

Petrochemical industry refers, in general terms, to the upgrading of selected hydrocarbons to a wide variety of plastic resins and chemicals which are, in turn, utilized in subsequent industrial and manufacturing processes. Although the nature of various petrochemical activities is described in substantially more detail in the report of Hydrocarb Consultants Ltd. which forms a part of this Volume, it should be recognized that the hydrocarbon feedstocks which are utilized as basic raw materials in petrochemical industry may originate in conventional crude oil, natural gas or synthetic crude oil. The nature of any petrochemical industry, and its locational constraints, will therefore vary significantly depending upon the particular feedstock upon which the petrochemical industry depends.

3. Bitumen Upgrading:

The process of bitumen upgrading refers, in general terms, to the upgrading of bitumen as it occurs in its natural state in the Athabasca Tar Sands to whatever derivative hydrocarbon products the upgrading process is designed to produce. The existing Great Canadian Oil Sands Plant in the Tar Sands upgrades the bitumen to a product which is called synthetic crude oil and it is noteworthy that this particular product is substantially more highly "refined" than conventional crude oil. This synthetic crude oil can be introduced into a conventional oil refinery at a later point in the process than conventional crude oil. It is significant that bitumen could be upgraded on the actual extraction site to the point that such commonly known petroleum products as gasoline would be produced and it is therefore evident that a significantly different set of locational criteria will apply to whatever industries, be they refining or petrochemical in nature, depend upon upgraded bitumen as a feedstock.

B. Locational Criteria of Industry

1. Refining of Conventional Crude Oil:

Refining of conventional crude oil has traditionally taken place near the market to which the products of the refining process are oriented. The traditional pattern of the refining of Alberta conventional crude oil has therefore been one in which crude oil intended for products to be consumed in Alberta has been refined in Alberta while crude oil intended for processing into products to be consumed in such markets as Ontario and British Columbia has been exported in crude form and refined in the ultimate market area. The simple explanation of this pattern of refining activity relates to the relatively low cost of transporting crude oil in comparison to the higher cost of transporting refined petroleum products.

At a more local scale, other locational criteria of the refining industry include the availability of an adequate supply of water, the availability of surface transporation facilities and proximity to satisfactory labour pool from which the relatively skilled labour upon which the industry depends may be drawn. These latter two criteria, particularly the proximity to a skilled labour pool, tend to favor a location reasonably near a major urban center. Another locational criterion which has become significant in recent years is that refinery operations should be so located that such undesirable side effects of their operation such as air pollution and noise will not adversely affect areas of land which are used for residential or recreational purposes.

2. Petrochemical Industry:

The locational criteria of petrochemical industry are described in detail in the report of Hydrocarb Consultants Ltd. in this Volume. In general terms, they may be summarized to include the availability of a major source of water for cooling and disposal purposes, the availability of adequate supplies of power and fuel, the availability of adequate surface transportation facilities, the availability of a relatively large pool of skilled and semi-skilled labour and, to some

extent, the availability of salt. Additional factors, of course, relate to the availability of the required feedstocks which may be natural gas, products or by-products of the conventional crude oil refining process, or such other upgraded hydrocarbons as those which will be produced from the Athabasca Tar Sands. Finally, the proximity to markets for petrochemical products can be a factor in the location of petrochemical industries although these factors tend to manifest themselves at the continental, rather than the local, scale of location analysis.

Reference to these criterion will reveal that those petrochemical industries currently located east and northeast of the City of Edmonton in an axis between Refinery Row on the south and Fort Saskatchewan and Redwater to the north are located, at the Provincial scale, according to reasonably discernable criteria.

Similar locational criteria to those which affect refinery operations in relation to residential and recreational development also affect petrochemical industries.

3. Bitumen Upgrading:

Bitumen upgrading can occur to whatever extent is considered desirable within a plant located on the actual extraction site in the Tar Sands area. The degree to which upgrading actually occurs on the site will be dictated by a number of factors including the purpose for which the upgraded bitumen is intended, the availability of transportation facilities to convey the upgraded bitumen to its point of use, and the availability of required labour and related services in the Tar Sands area. The fact that a substantial amount of the initial synthetic crude production will be required to supplement declining supplies of conventional crude oil would indicate that, in the near future, most bitumen will be upgraded to a synthetic crude oil from which will become a feedstock for refining and petrochemical activities now dependent upon conventional crude oil, including those located in Alberta and those located in the present market areas now served by conventional crude oil originating in Alberta.

C. Industrial Interdependency

There is relatively little direct functional interdependency between the refining of conventional crude oil, petrochemical industry and bitumen upgrading. Although refining and petrochemical industry do manifest similar locational criteria, their direct interdependency relates only to the possible use of certain by-products of the refining operation which may be utilized in petrochemical processes. The desirability of locating refineries proximate to petrochemical industries depends on the number and quantity of refinery by-products which will be required by a particular petrochemical industry.

Bitumen upgrading should be regarded, from the locational standpoint, as relatively independent of refining and petrochemical industry due to the site-specific nature of the bitumen upgrading process. However, the fact that liquid hydrocarbons produced from bitumen will have to be transported over relatively long distances by pipeline to refining and petrochemical plants dictates, through the sharing of a common feedstock, a reasonably proximate relationship between such refining and petrochemical activities.

D. Conclusions

Refining and petrochemical industries share a significant number of common locational criteria while the location of bitumen upgrading operations is, to a large degree, confined to the site from which the bitumen originates.

There are certain basic locational criteria such as the availability of water, surface transportation facilities, a high quality labour pool and to a certain extent, markets which will govern the location of future refining and petrochemical development in Alberta. Additional factors which will affect the location of these industrial activities which can, to some extent, be influenced by Provincial Government policy include the route by which future feedstocks for these industries will be transported from the Athabasca Tar Sands and the granting of industrial development permission subject to environmental protection legislation and regulations.

DECENTRALIZATION OF POPULATION GROWTH

A. The Policy Objective

The Provincial Government has stated a general policy for future population growth in Alberta which has the objective of distributing future population growth into those areas where smaller communities have been declining in population and economic significance. This policy objective is intended to relieve the metropolitan centers of Calgary and Edmonton from some of the strains of urban growth which affect larger urban communities and, at the same time, is intended to revitalize certain regions of Alberta which have been suffering population declines. Decentralization of population growth will be achieved through the consistent application of this policy in many sectors of governmental activity including industrial development grants, assistance for the provision of municipal facilities and housing, administration of such regulatory powers as the issuance of permits for industrial activity affecting the environment, decentralization of governmental administrative activities, and with the advent of Provincial control over corporate income tax, income tax incentives for corporations which are deemed to comply with the objectives of the policy.

B. Industrial Activity and Population Growth

Clearly the most significant factor in population location is the location pattern for employment opportunities. Any community can be expected to grow in direct proportion to the number of additional employment opportunities which it accommodates. Although the ratio between basic jobs and population varies from one industry to another, it is not unusual for one employment opportunity in basic industry to generate an additional one or two employment opportunities in subsiduary service activities, and each employment opportunity, in turn, generates an average number of additional persons which are economically supported by the job which can vary between two and four persons per employment opportunity.

The key to population decentralization is the establishment of basic employment opportunities in regions within which the Provincial Government wishes to stimulate population growth. An excellent example of basic industry employment opportunities is provided by the refining and petrochemical industries. This type of industry is described as basic industry because it generates, in and of itself, basic employment opportunities which would not otherwise exist. These basic industry employment opportunities are distinguished from service industry employment opportunities on the basis of the fact that most service industry is dependent upon basic industry for its existence.

It is evident from preceeding sections that pipeline terminal facilities cannot be regarded as significant economic base industries by virtue of the relatively small number of employees required. On the other hand, refining and petrochemical industry can be regarded as significant economic base activity by virtue of the magnitude of the employment opportunities created. A modern, integrated refining and petrochemical complex developed to serve global markets and create between 1,500 and 3,000 basic employment opportunities and support thereby a population varying between 7,500 and 15,000 persons.

Basic employment opportunities of this magnitude create an obvious and important tool through which the objective of decentralization can be achieved.

C. Advantages and Disadvantages of Industrial Agglomeration

1. Advantages:

The advantages of industrial agglomeration, that is, the concentration of industrial activity in a relatively confined area such as a single metropolitan region, include many of the reasons why industries tend to locate in relatively close proximity to one another. In one sense, these advantages might be regarded as a description and explanation of what has emerged as a natural trend in the location of industrial activity.

Industrial agglomeration can be explained in simple terms by the following observations. Firstly, most industries require ready access to a large and mobile labour pool at the unskilled, skilled and managerial levels. Access to such a labour pool is most readily assured in an area where a number of other industries already exist. Secondly, the labour pool, especially at the more sophisticated levels, tends to be attracted to larger urban settlements where housing, employment, educational, cultural and social opportunities are far more diversified than they are in smaller communities. In short, larger urban centers offer a far broader range of choice in most areas of human activity and the choices provided may not only be distinguished on the basis of quantity but also on the basis of quality. Thirdly, industrial agglomeration can be explained by the existence of numerous facilities upon which industry depends including service industry, specialized trades, high quality transportation facilities and major utility services. Fourthly, other locational criteria of a geographical nature including topography, microclimate and the availability of water and other natural materials tends to attract industrial activity to a proven industrial location. Finally, proximity to markets is a trend which nurtures industrial agglomeration. For those industries which depend upon an urban population for their market, a location in an industrially based metropolitan region provides ready access to that market. And for those industries which depend upon other more secondary industries as a market for their product, an industrial agglomeration within which that industrial market exists is a logical location for such an industry.

The foregoing factors do not exhaustively explain the trend toward industrial agglomeration but they do illustrate some fundamental reasons for the phenomenon. Any attempt to decentralize industrial activity away from an industrial agglomeration must face the facts which underlie this natural trend in order to be successful.

2. Disadvantages:

The disadvantages of industrial agglomeration can generally be described by the list of major problems which characterize large urban communities. Since large industrial agglomerations inevitable give

rise to large urban populations, many of the results of industrial agglomeration manifest themselves in urban problems.

These urban problems can be exaggerated and misunderstood but there are sufficient examples in the urbanized world to permit certain conclusions to be drawn which will be discussed under the following general headings:

a) Physical Problems: Physical problems of large communities relate to the provision of the major physical facilities which provide the basic framework upon which cities function. These physical facilities which include both transportation and communication networks do reach optimum sizes beyond which economies of scale cannot be realized. This is perhaps most evident when the provision of urban roadway systems is considered since they manifest, at various stages in their development, a lack of flexibility to accommodate additional expansion economically.

b) Social: Although there are numerous social advantages which accrue to large urban communities, there are a number of social problems which are linked to the size of an urban community. No causal link has necessarily been established between such large scale social problems as crime and delinquency and it is probable that the majority of such problems may be explained in the following subsection entitled "Administrative Problems". Nevertheless, the fact that certain social problems do prevail in some larger urban centers is a cause of concern.

c) Administrative Problems: Larger urban communities tend to manifest a wide variety of administrative problems in facing the operation of local government and its services. These administrative problems are most evident in the provision of such services as police and fire protection and social services and may be explained by the centralizing tendency which inevitably occurs when one municipal authority is attempting to provide its various services over a large area and population. This centralization of administrative function creates a gap between the governed and the government which leads to a sense of isolation and relative insignificance on the part of the urban resident. A similar gap occurs in the political arena where the distance between an elected representative and the

voters creates a communication barrier which tends to remove the elected representative from day to day contact with those whom he represents.

d) Environmental Problems: The environmental problems that relate to industrial and urban agglomeration are well documented and include such phenomena as air and noise pollution. The former is a particular concern when industrial agglomeration is taken into account since additional industrial activity not only generates additional pollution in the heat and effluent which it may emit but it also creates additional demands on the transportation system which, in turn, generates additional pollution. Although it is difficult to document with any accuracy the historical increase of air pollution in such cities as Edmonton, there are few observers that will deny the quality of the atmosphere in the Edmonton area has changed significantly in the past decade. Any advantages of additional industrial and population expansion in the Edmonton area must be weighed against environmental intangibles of this nature.

D. Fundamental Requirements of Decentralization

1. Magnitude of Economic Base:

In order to make industrial, and therefore population, decentralization successful it will be necessary to ensure that any industrial activity which is encouraged in a selected growth area be of a magnitude that can support a population unit large enough to justify the provision of normally expected urban services and conveniences. Although the optimal size of a population unit will vary in accordance with the particular service or convenience being considered, the population unit should be large enough to justify the provision at the local level of junior and senior high school facilities of an acceptable quality and retail commercial services which satisfy regular daily and weekly consumer requirements. In order to ensure the economic provision of these services at an

acceptable level a population base in the order of 10,000 to 15,000 persons is desirable. It would therefore be prudent to select a location for industrial decentralization that would, when the additional population generated by the industry has been combined with existing population, result in a population of at least 10,000 to 15,000. It should also be recognized that larger population units will support a broader range of services and facilities and thereby provide more opportunities for residents and enhance their quality of life.

2. Distance from Metropolitan Center:

In order for the true objective of industrial decentralization to be realized it will be necessary to locate decentralized industry far enough from existing metropolitan centers to discourage or eliminate daily commuting of industrial employees. Commuting patterns in larger urban centers of North America have now reached the point at which people will travel by transit or automobile for an hour or more to reach their place of employment. If the decentralization of industry is to achieve the decentralization of population growth, it is essential that this commuting distance be considered as one of the locational criteria by which an industrial decentralization site is selected.

Assuming that the automobile is the only means of commuting available to a future employee, the critical distance from an existing metropolitan center would be approximately one hour's driving time or 50 to 60 miles depending upon the quality of highway facilities. In the case of the City of Edmonton, this commuting distance could be measured from the corporate limites of the City of Edmonton although it would be more realistic to consider such satellite communities as Fort Saskatchewan, Sherwood Park and St. Albert as functional appendages of the City of Edmonton. It would therefore be more realistic to measure the potential commuting distance from these communities, rather than the City of Edmonton.

E. Decentralization Alternatives

1. Expansion of Existing Agricultural Service Centers:

One population decentralization alternative would be to locate industrial activity near existing agricultural service centers in Alberta which have experienced declines, or at best have maintained a modest rate of growth, in their populations. A single such community, or a number of such communities in a selected area, could serve as nuclei around which planned development could occur to house the population which would be supported by the industrial activity. The selection of one or more existing communities as a nucleus for growth would have to be based upon a community's need for revitalization and its capacity, including its physical, financial and political capacity, to accommodate such growth. In any case the growth anticipated for one or more communities should be sufficient in magnitude to ensure the provision of a reasonable level of urban services and amenities.

2. Development of a New Town:

The alternative to upgrading and expanding existing towns or villages is the development of a totally new town near the site upon which the decentralized industrial activity will be located. This alternative would provide a fresh start for the creation of a new and attractive community to house the population generated by industryal development. The new town concept has the advantage of providing the basis for a totally planned community in which all the foreseeable needs of the future population could be anticipated and accommodated. It has the disadvantage, however, of not having a nucleus of existing commercial and public facilities which would be available in many of Alberta's existing agricultural service centers.

F. Conclusions

The decentralization of population growth within Alberta can best be achieved through the decentralization of basic industrial

activity to selected locations within the Province. The achievement of industrial decentralization will require a substantial initiative on the part of the Government to overcome the natural tendency of industry to agglomerate in large concentrations in metropolitan centers.

The selections of locations to which industry will be decentralized should not only take into account the physical and geographical characteristics of potential locations but should also include consideration of the impact which the industrial development will have upon existing and future communities. The selection of industrial decentralization locations should also be undertaken in recognition of the need to provide the potential for future urban communities large enough to support an adequate range of public and commercial services in a location distant enough from established metropolitan centers to achieve a viability, both social and economic, which is not undermined by proximity to that metropolitan center.

RECOMMENDATIONS

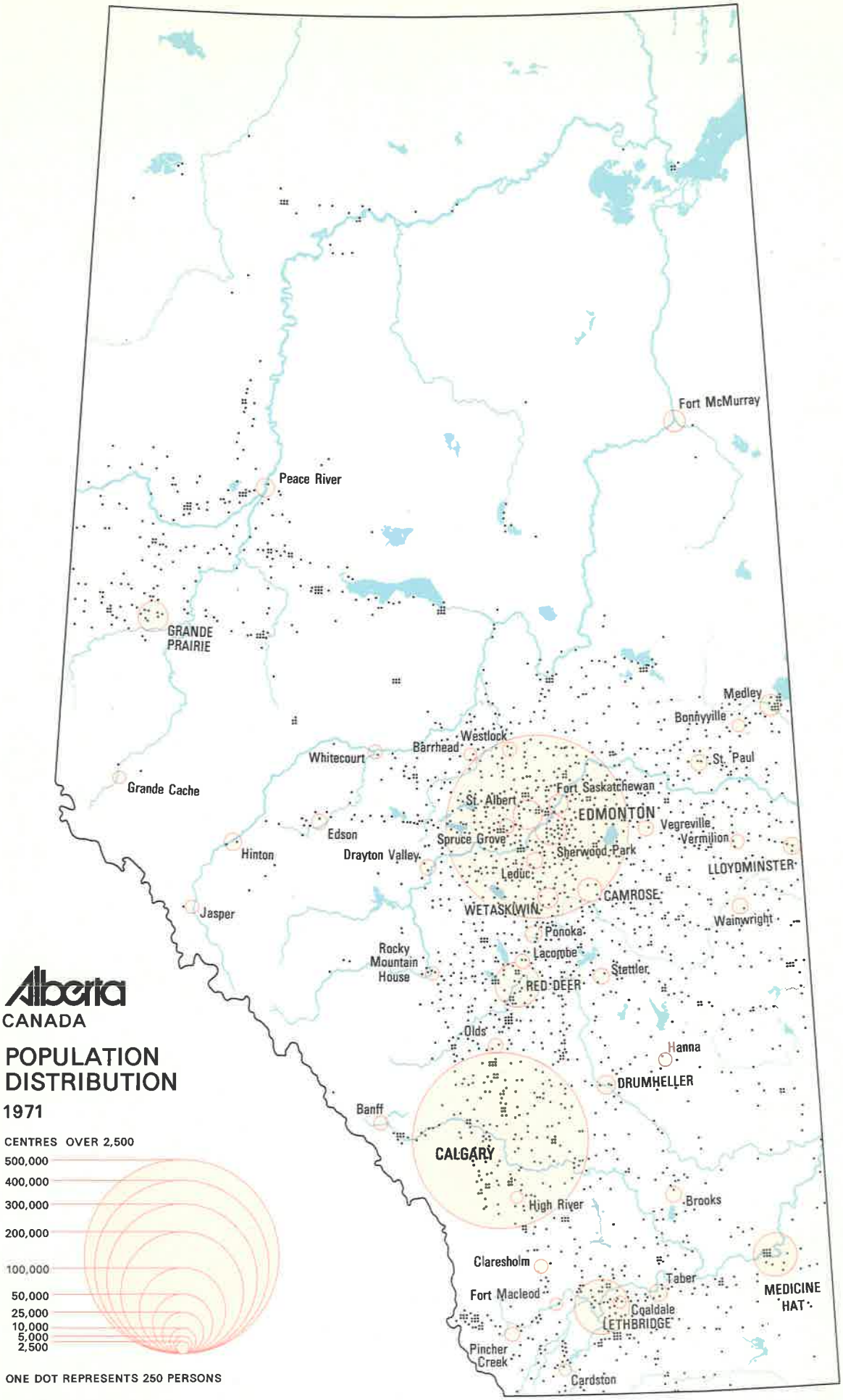
1. The pipeline component in the Athabasca Tar Sands Corridor should connect to the existing terminal complex in the County of Strathcona in order to supplement the supply of feedstocks to existing industry in the area and to utilize the existing export pipeline network. The terminal facilities have adequate capacity for expansion on their present sites to double the volume of liquid hydrocarbons presently handled and this additional expansion will result in a negligible increase in the total employment at the terminal facilities.

2. No additional heavy industry in the form of oil refining or petrochemical activity should be permitted in the metropolitan Edmonton area since it will contribute to such increasing urban problems as air pollution and will stimulate population growth through the expansion of the economic base of metropolitan Edmonton.

3. A detailed site study should be undertaken to select a site for a major industrial complex northeast of Edmonton in a location which is suitable, both physically and geographically, for heavy industrial use. The industrial complex, which could accommodate refining and petrochemical industries, would be located along the North Saskatchewan River on a site which would satisfy the physical and geographical requirements of such industry. Moreover, the site should be at least 50 miles from the City of Edmonton to ensure that any population growth stimulated by the industrial development would not reside in metropolitan Edmonton.

4. The industrial site should be purchased by the Government and all future major industries channeled to the selected location. Attractive lease terms and favorable tax treatment could be incentives to locate in the selected area, and refusal to issue environmental emission permits for industries in other locations would add an element of compulsion to the selection of this location by industrial developers.

5. Consequential population growth that would occur as the result of industries locating in the planned industrial complex should be accommodated in planned developments according to the new town concept or, alternatively, the planned expansion of selected existing communities. In each case, it would be possible for the government to select whatever alternative type of site it decides upon, and create a major land bank to accommodate the population growth which will inevitably follow industrial development. In either case, the government should ensure that any planned urban development to accommodate population growth should be assisted through financing and other means to ensure that an adequate range of urban services and amenities are available to the future population.



Alberta
CANADA

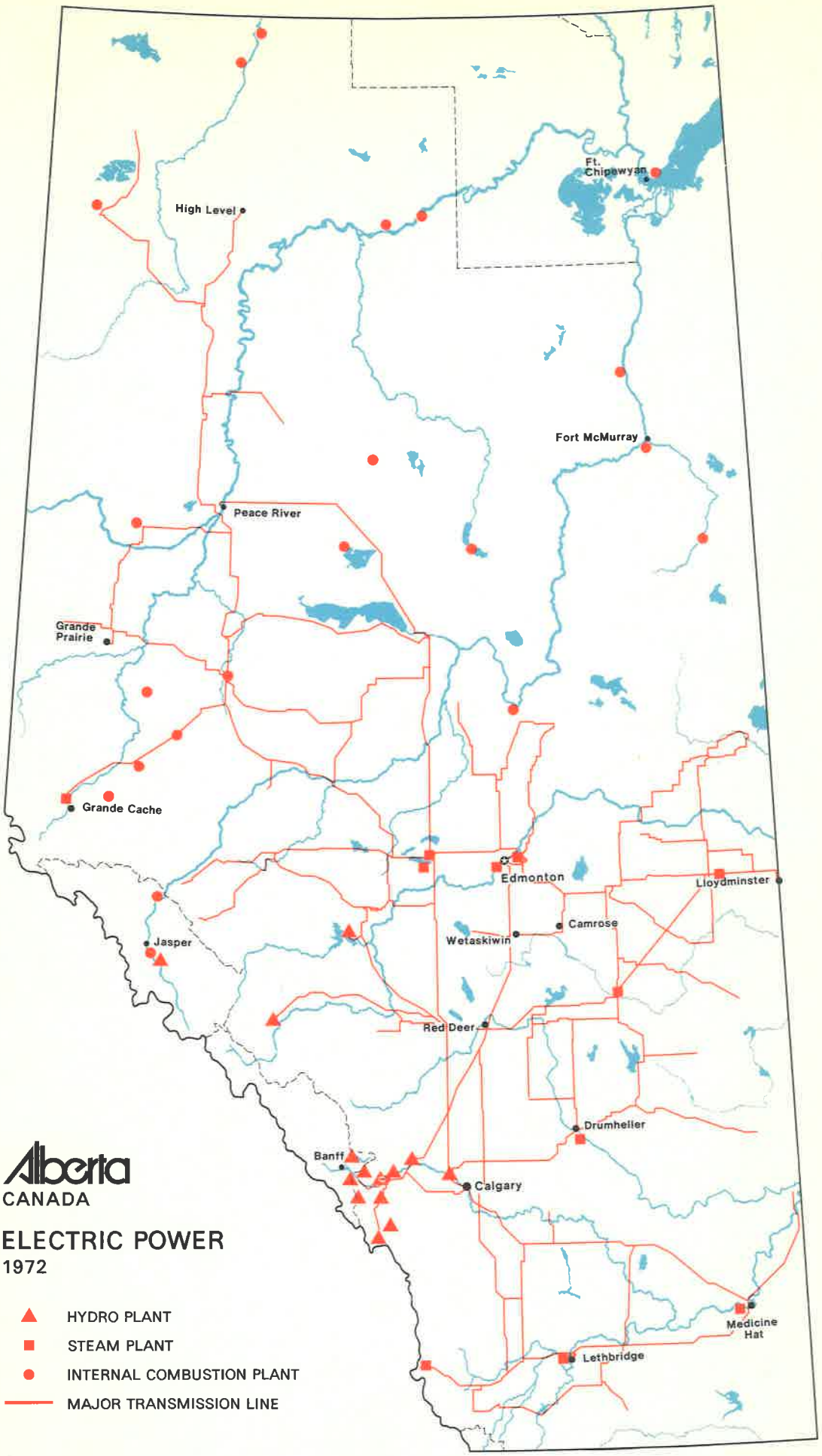
POPULATION DISTRIBUTION

1971

CENTRES OVER 2,500

500,000
400,000
300,000
200,000
100,000
50,000
25,000
10,000
5,000
2,500

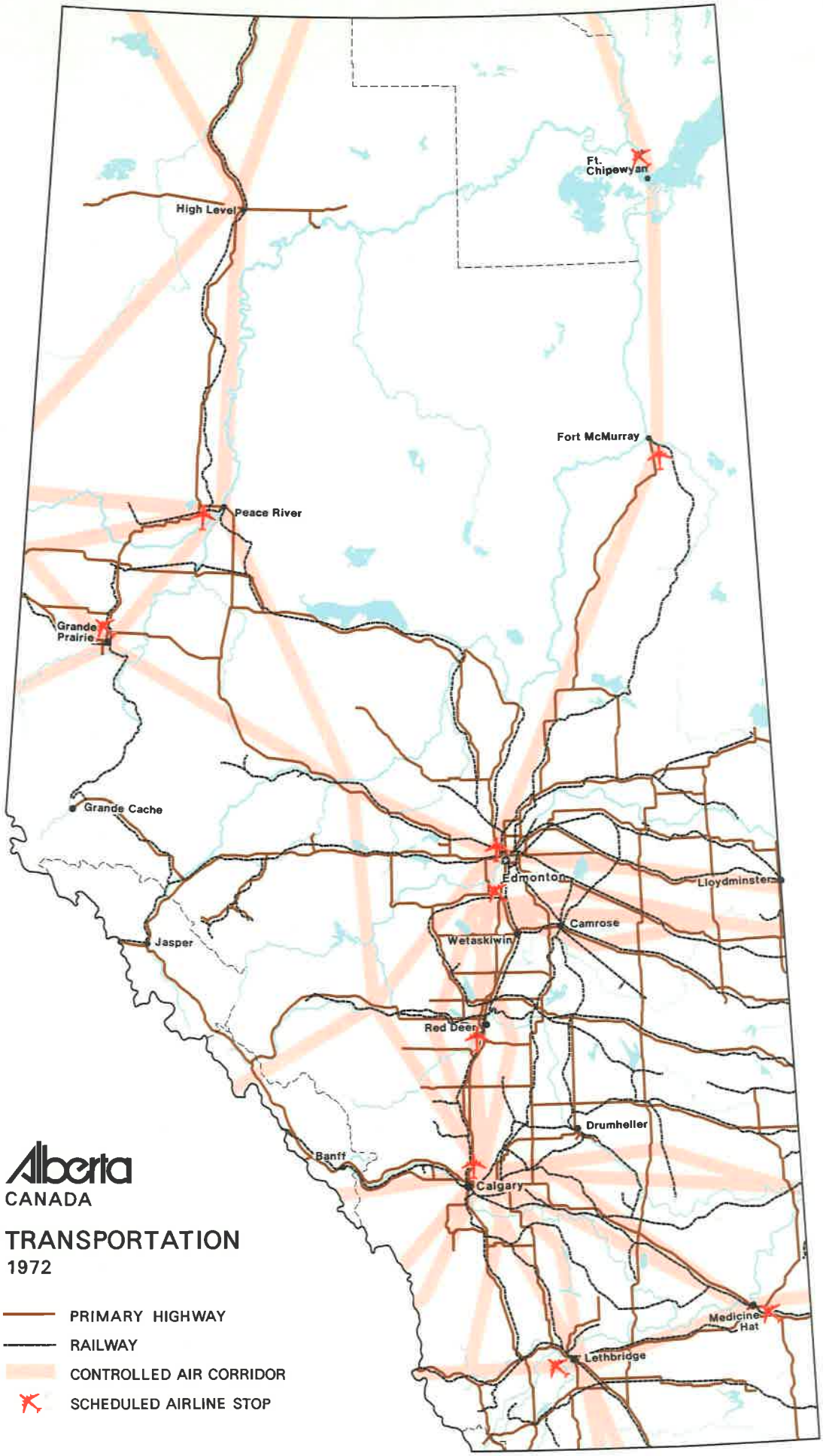
ONE DOT REPRESENTS 250 PERSONS



Alberta
CANADA

ELECTRIC POWER
1972

- ▲ HYDRO PLANT
- ■ STEAM PLANT
- ● INTERNAL COMBUSTION PLANT
- — MAJOR TRANSMISSION LINE



Alberta
CANADA

TRANSPORTATION
1972

PRIMARY HIGHWAY
RAILWAY
CONTROLLED AIR CORRIDOR
SCHEDULED AIRLINE STOP

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER III

IMPACTS OF PETROCHEMICALS ON

ATHABASCA TAR SANDS

CORRIDORS & TERMINALS

Prepared for:

Alberta
Environment

By:

Hydrocarb Consultants Ltd.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

IMPACTS OF PETROCHEMICALS ON ATHABASCA TAR SANDS CORRIDORS & TERMINALS

INTRODUCTION

Bitumen and heavy oil are the resource materials that are recovered from the Alberta Tar Sands. These viscous hydrocarbons contain a low hydrogen to carbon ratio. This ratio must be adjusted in order to upgrade them into useful products. This is done by coking (removal of carbon) or by hydrogenation(addition of hydrogen), or by a combination of the two processes. The long petroleum molecule is thereby cracked into lighter hydrocarbons, ranging from methane through ethane, LPG's, naptha, kerosene, to gas oils. The relative proportions of these different hydrocarbons is a function of the plant design, and the degree of hydrogenation.

The principal motivation for commercial development of the Alberta Tar Sands has been to produce "synthetic crude oil" as a supplementary feedstock for petroleum refineries.

(a) Lighter hydrocarbons and some side stream products could be segregated and used as selected feedstocks for manufacturing petrochemicals. Traditionally, petroleum refineries take conventional crude oils as feedstock and convert them primarily into commercial liquid fuels.

(b) In the process of refining conventional, or synthetic crude oil, light hydrocarbons are formed, and these refinery off-gases as well as other refinery streams, are often used as petrochemical precursors. Hence a large segment of the petrochemical industry is closely related to petroleum refining, and proximity of location is an important consideration.

Over the next 12 years Alberta's production of conventional crude oil will decline, and refiners will become increasingly more reliant upon feedstocks from the tar sands. As this trend evolves, the bitumen upgrading activity (at the source), and the petroleum refining activity will become more closely inter-related.

This introduces some interesting possibilities for future planning of the relative locations of: bitumen upgrading and refining, pipelines and terminals. More refining must be done at the bitument source. On the other hand, future techniques may possibly be developed to move heavier oils to central refineries.

The ultimate pattern will depend upon many factors, including governments' planning for industrial and regional developments. Part of this planning should make provision for advanced stages of a petrochemical industry, to further upgrade the lighter hydrocarbons.

This report will describe the nature of the petrochemical industry, and the factors which influence its location - with particular emphasis on the longer range relationship to the contemplated tar sands corridor.

PETROLEUM AND PETROCHEMICALS

A. Global Factors

The primary products of the petrochemical industry comprise plastic resins and chemicals which are derived predominantly from petroleum. The petroleum materials that have been used as hydrocarbon feedstocks to make petrochemicals originate in conventional crude oil and natural gas. The proportion of hydrocarbons consumed by the petrochemical industry from these traditional sources is small compared with the consumption of hydrocarbons for fuel. For example, in 1972 the United States petrochemical industry consumed only 15% of the ethane contained in the natural gas, the balance was burned as fuel.

The economic benefits of upgrading to petrochemicals are very significant, since they include many secondary industries producing an infinite variety of consumer items. This helps to explain why the petrochemical industry comprises an essential element of the economies of the world's leading nations, namely: the United States, European Economic Community, and Japan. Both Europe and Japan are obliged to import most of the required raw materials.

This is a high technology industry which has been forced, by international competition, to develop progressively larger capacity production facilities. The economy of large scale production is essential to establishing and maintaining a viable petrochemical industry.

B. Canadian Petrochemical Industry

Canada's petrochemical industry has been concentrated in Sarnia and Montreal until the present. Both of these process centers rely primarily upon local petroleum refineries for their feedstocks. Conventional crude oil from Alberta feeds the Sarnia refineries. The area's viability for chemical processing was much enhanced by the natural gas pipeline, which also originates in Alberta.

Montreal has been supplied with off-shore crude, but is beginning to draw on Alberta supplies. Although there is a close interrelationship between the companies operating in Sarnia and Montreal respectively, neither of these process centers was planned for optimum integration.

It is interesting to note that the very large petroleum refineries being developed in the Maritimes could stimulate major petrochemical facilities. Sarnia, Montreal, and the Maritimes all enjoy the important competitive advantages of marine transportion and proximity to major markets.

C. Alberta's Petroleum Industry

Alberta has a well developed petroleum industry, whose principle activities were the production and export of conventional crude oil and natural gas.

1. Alberta - Crude Oil

The crude oil is collected by an extensive system of liquid pipelines culminating in the Interprovincial Pipe Line (I.P.P.L.) terminal in east Edmonton. From here most of the crude is exported via the Interprovincial pipeline to the Great Lakes regions of the

United States and eastern Canada. The balance of Alberta's crude oil exports are delivered from the I.P.P.L. terminal to the west coast, through the Trans-Mountain pipeline.

We can now identify the basic geographical parameters for the flow of liquid hydrocarbons in Alberta. The focal point is the terminal which collects the oil, and distributes it - mainly as exports to the east.

The synthetic crude oil now originates in the mineable region of the Athabasca Tar Sands deposit - and this represents the most northerly parameter for our corridor study.

The I.P.P.L. terminal receives most of its oil from the conventional system, plus a relatively small supply of synthetic crude oil from the mineable tar sands. Outgoing shipments comprise pipeline exports to the east and west, plus a small proportion to Alberta refineries in the proximity of the terminal.

Significant changes in the oil flow pattern will have occurred by 1985. In this time frame, conventional crude oil reserves are nearly depleted, and have been supplanted by synthetic crude oil, mostly from the Athabasca deposit. Although exports continue to take the larger proportion of deliveries, the quantity of oil consumed by Alberta refineries will have increased substantially.

This liquid flow pattern, with its epicentre at a terminal, could shift, or be shifted, to the east, and possibly to the south. The dominant influences of the Athabasca Tar Sand deposit, and eastern exports, appear to dictate these geographical parameters.

2. Alberta - Petroleum Refining

Until very recently, petroleum refining in Alberta has been limited to small refineries to supply localized markets. Several of the international oil companies have operated small refineries, many of which have been concentrated in the proximity of the I.P.P.L. terminal, to process commercial liquid fuels as part of their integrated marketing system.

More recently, however, Gulf Oil Canada Limited has built an 80,000 barrel/day refinery in east Edmonton in order to consolidate

their petroleum refining activities for western Canada. Imperial Oil Limited has adopted a similar strategy, and is currently constructing a 140,000 barrel/day refinery, also in east Edmonton. It is quite conceivable that other international oil companies may pursue a similar course of action, especially if encouraged to do so by provincial government policies or incentives.

Imperial Oil Limited plans are particularly significant to our future concept of energy corridors and may provide some useful clues for possible future trends. They plan to transport the heavy oil recovered from their in-situ experiments in the Cold Lake oil sands deposit to their new Strathcona refinery for processing with conventional crude oil. They also plan to export refined products, notably gasoline, to the Lakehead via the I.P.P.L. This latter development could extend the market area for refined products from Alberta, and thereby enhance the province's future role as a petroleum refining center.

Any terminal which collects and distributes oil in Alberta (either at the existing I.P.P.L. terminal site, or at a new location) would continue to be a logical focal point for existing and new refinery complexes.

3. Alberta - Natural Gas

Alberta has abundant reserves of natural gas which will sustain the present rate of supply for about 25 years. Furthermore, the prospects for additional new discoveries are optimistic. The Province will also have access to Arctic gas which may be transported by the proposed new pipeline up the Mackenzie Valley.

Natural gas is a mixture of natural occurring hydrocarbons, of which the main component is methane. Other components include: ethane, propanes, butanes, pentanes, and occasionally some higher hydrocarbons. The relative proportions of these ingredients vary with the nature of the reservoir, which may also be contaminated with hydrogen sulphide.

The hydrogen sulphide must be removed from the sour gas by stripping of the H_2S to elemental sulphur.

The pentanes and highers are separated as condensate near the wellhead to facilitate transportation of the gas stream. Most of the liquid condensates are collected separately and added to the conventional crude oil gathering and distribution systems.

Most of the propanes and butanes are also removed from the gas stream at strategically located extraction plants. In recent years these materials have found a lucrative market for convenience heating, where they are sold as liquified petroleum gases (LPG's). Separate distribution systems within Alberta have been provided for LPG's, most of which are exported through the I.P.P.L. terminal, or alternately, separate lines to the south and southeast.

Pentanes + and LPG's are often classified collectively for statistical purposes, and referred to as natural gas liquids. It is interesting to note that some of the published statistics for the demand and supply of Alberta crude oil sometimes include natural gas liquids.

Up to and including the present time, very little of the ethane has been extracted from the gas stream in Alberta. It is being exported as a minor component (5 to 7% by volume) along with the methane. Since ethane has a higher heating value than methane, its presence in the gas stream enriches the value of the gas when used as fuel.

From this cursory review of the composition of natural gas, it is apparent that many of the lighter hydrocarbons required as feedstocks by the petrochemical industry can be obtained from natural gas mixtures as an alternative or supplementary source to refinery off-gases.

D. Alberta - Petrochemicals

In the past there has been very little incentive for establishing manufacturing facilities in Alberta for petrochemicals, due primarily to high transportation costs, aggravated by remoteness from major markets. In terms of upgrading natural hydrocarbons, the history of two of Alberta's established chemical plants is of interest to our current studies.

For many years, Chemcell, now Celanese Canada Limited, manufactured a line of organic chemicals by the vapor phase oxidation of LPG's. In 1971 these chemical operations were discontinued due to several factors, including process obsolescence, transportation costs, and tariff differentials with the U.S.A. The company, however, continues to manufacture cellulose acetate fibres at its established plant site east of Edmonton.

Since 1954 Canadian Industries Limited has operated a plant in east Edmonton for the manufacture of polyethylene resin, some of which is now converted at the same site to plastic films and industrial bags. This operation is, in effect, a prototype model for the large scale petrochemical development recently proposed for Alberta. The C.I.L. plant extracts ethane from a natural gas stream, converts the ethane into ethylene, and polymerizes the ethylene into polyethylene resin. Although technically significant, the C.I.L. Edmonton plant has been constrained by the competitive disadvantages historically associated with its Alberta location.

FEEDSTOCKS IN ALBERTA

The global demand for hydrocarbons, both as fuels and as petrochemical feedstocks, now exceeds the supply from conventional sources, and, therefore, most of the international petrochemical corporations are looking to Alberta for their feedstock supplies. Hence Alberta has an historic opportunity to exploit this demand to ensure the development of an integrated process industry in the Province.

If properly conceived, such a plan would enable Alberta to achieve several of its basic objectives, e.g.:

- the upgrading of its natural resources.
- the stimulation of secondary industry.
- population growth, with a more balanced distribution towards currently less populated areas.
- the creation of new jobs, involving a high level of education.

The extent to which Alberta is able to exploit this temporary opportunity will depend upon a clear understanding of upgrading potential for the various hydrocarbon feedstocks.

A. Petroleum Refining

Conventional crude oil provides the feedstock to the petroleum refineries which produce commercial liquid fuels, such as: gasoline, jet motor fuels, and heating oils.

Until very recently, petroleum refining in Alberta has been limited to small refineries to supply localized markets. Several of the international oil companies have operated Alberta refineries, many of which have been concentrated in the proximity of the I.P.P.L. terminal, where feedstocks are readily available. This location was also able to provide other facilities essential to a refinery, e.g., water, power, transportation facilities, and manpower.

More recently, Gulf Oil Canada Limited has built an 80,000 barrel/day refinery in east Edmonton in order to consolidate their petroleum refining activities for western Canada. Imperial Oil Limited has adopted a similar strategy, and is currently constructing a 140,000 barrel/day refinery, also in east Edmonton. It is quite conceivable that other international oil companies may pursue a similar course of action, especially if encouraged to do so by provincial government policies or incentives.

The Government of Alberta should encourage the continued growth of its petroleum refining industry as an integral part of its policy to promote orderly industrialization. In addition to becoming the refining center for western Canada, Alberta could also supply refined products to more distant markets - possibly by pipeline shipments to the Great Lakes region, or to the west coast.

The historic relationship between petroleum refining and the conventional crude oil industry is readily apparent. For purposes of our corridor study, however, we must give special consideration to the future pattern of developments.

The Alberta Energy Resources Conservation Board has predicted "peak producibility from existing conventional reserves at 1.92 million barrels/day in 1977." Hence the crude oil transferred through the existing I.P.P.L. terminal will decline in rate, starting in 1977.

Synthetic crude oil can be used to supplement crude oil as refinery feedstock. By 1980, synthetic crude oil production is expected to reach 220,000 barrels/day (from mineable tar sands), and by 1985, is projected to expand to 815,000 barrels/day (still mostly from mineable tar sands). After 1985, the synthetic crude oil production is predicted to increase by 150,000 barrels every two years to a level of 1.94 million barrels/day by the year 2000.

Although it is conceivable that some refined products may eventually be made at the bitumen source, it is logical to expect that the southern terminal of the synthetic crude oil pipeline will be a focal point for an expanded refining industry.

While still on the subject of refinery feedstocks, we must also consider the future possibility of a conventional crude oil pipeline from the Mackenzie Delta. The Alberta Energy Resources Conservation Board has predicted that: "Mackenzie delta reserves would come on at 293,000 barrels/day in 1980 and rise to 1.2 million barrels/day in 1998."

B. Liquid Hydrocarbon Terminal

We have now identified four interrelated factors pertaining to the future terminal activities for liquid hydrocarbons, namely:

- the existing I.P.P.L. terminal.
- expanded petroleum refining.
- future synthetic crude oil production.
- Mackenzie delta oil pipeline.

The existing I.P.P.L. terminal could continue to handle all of Alberta's crude oil production, which will decline in throughput after 1977. The synthetic crude oil production from the G.C.O.S. plant is also distributed through the existing terminal. The present terminal is capable of major expansion to handle greater throughput volumes.

A new synthetic crude oil pipeline is imminent to serve Syncrude, and, possibly other future tar sands plants. This new line could be brought into the I.P.P.L. terminal directly, or alternately, it could be routed farther east to provide a new transfer point for future

refineries. This latter option would encourage industrial growth further away from the established industrial sites, and more distant also from Edmonton. The choice of a more easterly location must be made carefully to ensure the viability of future industrial developments. A basic consideration pertains to the magnitude and nature of such developments. In this regard, the petrochemical industry could be a major factor.

C. Petrochemical Industry

Petrochemicals represent a very complex industry because of the multiplicity of possible feedstocks and products. Alberta has three principal sources of hydrocarbon feedstocks for petrochemicals, namely: natural gas, petroleum refineries, and bitumen distillates.

Methane is the starting material for one segment of the petrochemical industry. Natural gas is the most abundant and most economical source of methane. By means of a relatively simple process of reforming with air, methane can be converted into methanol or ammonia.

Methanol has many industrial uses, notably, as a precursor to formaldehyde, which can be further processed into resins such as those used for plywood adhesives, or into petaerythritol, which is manufactured by Celanese in Edmonton.

Ammonia is a large volume commodity chemical for which there is a heavy demand, especially as a fertilizer. It can be applied to the soil directly, or as an ammonium compound such as urea. The recent profusion of plans for new production facilities to produce methanol, ammonia, and ammonium compounds in the southeast regions of the Province, reflects the availability of natural gas feedstock in this area, and the geographical proximity to major markets.

These petrochemicals derived from methane comprise a relatively independent segment of the chemical industry, which does not require complex transfers of materials from other segments of the industry. Alberta's production capacity for these methane based products can be expected to grow very substantially without any significant im-

pact on the tar sands industry and its energy corridor. The main thrust of this growth could logically occur in the southern part of the Province, since the two A.G.T.L. systems, i.e., the Plains and the Foothills Division, culminate in the southeast and southwest corners of Alberta. This southern region also contains the gas reserves in the Suffield Block.

Ethane is another important source of petrochemicals. It occurs in refinery off-gases, and also in the light ends of bitumen distillates however, its preferred source is natural gas. The most logical geographical sources of ethane from natural gas are Cochrane and Empress, since all of the exported gas passes these two point. Ethane is the most efficient feedstock for ethylene, which is the building block for a prolific family of plastics and chemicals.

Ethylene can be converted directly into polyethylene resins (as presently done by C.I.L. at Edmonton on a small scale) or converted to PVC resin by adding chlorine (which is produced from salt, of which Alberta has enormous deposits), or converted to polystyrene resins by adding benzene. These resins, collectively, supply most of today's vast plastics fabricating industry, which manufactures an infinite profusion of consumer, industrial, and building products. The manufacturing possibilities in the plastics field are virtually unlimited, and are adaptable to geographical decentralization within the Province.

Another major derivative of ethylene is ethylene glycol, which is used extensively as an antifreeze, and also in the manufacture of synthetic resins.

For these reasons, Alberta's future as a potential petrochemical center will depend in large measure upon its posture regarding the manufacture of ethylene and its derivatives. At the present time, four major proposals are being contemplated, any one of which could have a profound effect upon the Province's future role in ethylene petrochemicals. One proposal would export ethane out of Alberta and out of Canada. A related proposal would make ethylene from ethane in Alberta and export practically all of the ethylene to the U.S.A. and Sarnia. Another proposal would convert Alberta ethane to ethylene, all of which would be processed within the Province. The other proposal

would consume 170,000 barrels/day of conventional crude oil from Alberta to produce ethylene and its derivatives in Sarnia. The magnitude of these potentially competitive proposals attests to the overwhelming significance of ethylene and its hydrocarbon feedstocks in the development of a petrochemical industry.

It is beyond the scope of this report to comment on the relative merits of these proposals. For the purpose of our analysis, we have assumed that Alberta will take the necessary action to ensure that its hydrocarbon resources are utilized preferentially within the Province to ensure the establishment of the most viable and the most fully integrated petrochemical industry.

A petrochemical complex, based primarily on ethane, could be located in several alternative locations within the Province, provided that they could satisfy other essential factors, such as: water, power, salt, transportation, and manpower. It is almost inevitable, however, that the product mix for an expanded chemical industry will dictate proximity to liquid hydrocarbon sources and other materials. For example, salt beds are important to the petrochemical industry since they supply salt for chlorine manufacture,and, also,permit underground cavern storage.

Benzene will be required for manufacturing styrene, and it could be derived from either condensates, refinery streams, or naphtha (from synthetic crude).

Higher hydrocarbon feedstocks, i.e., LPG (propanes, butanes) and naphtha will also be utilized as feedstocks for the expansion of Alberta's petrochemical industry into a broader line of products, such as: polypropylene and butadiene. The principle sources of these feedstocks include: the oil terminal, petroleum refineries and the tar sands industry.

In geographical terms, the long range development of a highly integrated petrochemical industry would be enhanced by locating near petroleum refining and related hydrocarbon sources. Hence, there is a logical and synergistic future relationship between the integrated petrochemical industry, the petroleum refining industry, the tar sands industry, and the oil terminal.

LOCATION CRITERIA FOR PETROCHEMICAL INDUSTRY

A. Site Selection

The selection of a viable site for an integrated petrochemical facility is a complex undertaking which must consider many critical factors, in addition to feedstocks. Government and industry must coordinate their respective efforts in selecting industrial sites, especially for major developments. This chapter describes some of the priority factors in site selection.

B. Cooling Water

Large scale petrochemical plants require an abundant supply of water for process cooling, steam generation, and other uses. For example, a global scale ethylene complex will require approximately 7,000 I.G.P.M., even if designated for complete re-circulation of cooling water. Alberta's principal river systems, which warrant consideration for this purpose, include the Athabasca, the North Saskatchewan and the South Saskatchewan rivers. The Peace River is too remote to qualify. In locations where electric power is plentiful and inexpensive, forced air can be used as an alternative cooling medium.

C. Power and Fuel

Some elements of the chemical industry are large consumers of electric power - notably the electrochemical processes, such as the production of chlorine and caustic soda. Modern day gas compressors and liquid pumps require large units which may also depend upon electric power (or alternately steam).

The critical feature of electric power for the process industry is that it must be reliable; that is, free of interruptions and uniformly controlled with regard to voltage and flow rates.

A petrochemical complex also consumes large quantities of steam for process heating, and this steam must be generated at the site. Depending upon the cost of purchased power, and the availability of low cost fuel, the industry may elect to generate its own steam and power as an integrated system.

The decision to generate or purchase electric power usually involves extensive negotiations with utility companies. Purchased power is desirable, at least for stand-by requirements, and hence proximity to the main power grid is important.

D. Manpower

An integrated ethylene complex, of the size and type being considered for Alberta will create about 1500 direct jobs. Potential additional industrial growth in both the chemical and refining sectors could add proportionately to this permanent manpower demand.

The level of education and training required to staff process plants is more demanding than for most other heavy industries. A high percentage of personnel requirements comprise professionals and para-professionals. Candidates for operator training should have secondary matriculation. The maintenance force must include skilled tradesmen. These special manpower specifications reflect the high degree of automation, and the need for adequate safety precautions. Historically, large urban centers have attracted the more skilled segment of the labor force, consequently, industry tends to locate, when possible, within ready access to such centers.

The Alberta Government has adopted a policy of encouraging new industrial developments away from the major urban centers. This might best be accomplished by planning site locations sufficiently remote from a large city to discourage daily commuting, but near enough to ensure viable access to essential specialized services.

E. Transportation

Transportation is a major factor in locating a petrochemical industry. For Alberta, this poses the most serious competitive challenge, relative to the established global producing centers which enjoy the benefits of marine transportation.

If Alberta achieves its full potential as a petrochemical producer, a large proportion of the industry's products will comprise plastic resins, and possibly fabricated plastic commodities.

Hence, ready access to highly competitive transportation by rail and highway will be essential to the location of the new petrochemical facility.

Some of industry's products may be exported as liquids; for example, ethylene glycols. Although it is conceivable that pipelining technology may progress sufficiently to encompass such liquid products, it is more probable that railway tank cars will continue as the preferred transportation mode. Therefore, good rail access is critical also to these products.

It is possible that Alberta's future petrochemical industry may export some gaseous products; for example, ethylene oxide or butadiene. The merits of doing so would be debatable in terms of the Province's motivation to maximize the extent of its processing. In the context of transportion, however, these hazardous materials would also move by railway tank cars.

Any consideration of the pipeline movement of ethane or ethylene out of Alberta would be inappropriate to this study, since it would preclude (or at least severely restrict) the development of a petrochemical industry in the Province.

1. Plant Size

In order to be viable, Alberta's future petrochemical industry must be sized for global competition. This is necessary to keep the unit capital and operating costs competitive, but also to ensure cost savings in transportation.

A general concept of the quantities involved can be acquired by projecting the possible evolution of the industry. Within possibly three years, Alberta could have at least one global-sized ethylene complex which could process one billion pounds/year of ethylene, to approximately 700,000 short tons of plastic resins. Furthermore, it is conceivable that a second complex of similar proportions could follow within 2 years. The combined products from these contemplated would represent a transportation demand of approximately 1½ million short tons of products.

2. Markets

The markets to be served by Alberta's future petrochemical industry will determine the direction and distance factors for the transportation requirements of the products. It is axiomatic that the production of a profusion of plastic resins and chemicals within the Province will stimulate further processing and fabricating, however, until Alberta's population increases substantially over its present level, the actual consumption of end products within the Province will represent a small proportion of the total capacity.

The Canadian domestic market will provide the best return on the sale of products. Capturing the new markets in Canada is, therefore, a priority sales strategy, and it is contingent upon Alberta's processing program preempting competitive proposals. The markets tend to relate to population densities, and, therefore, most of the products sold domestically must be transported east to southern Ontario and Quebec.

New Canadian market demands will not absorb the total capacity of Alberta's contemplated petrochemical industry, and, hence, substantial proportions of its products will be exported to the United States, Japan or to other offshore markets.

The United States will probably represent a second priority market, especially if our federal authorities are able to negotiate more equitable trading conditions for Canadian petrochemical products. Alberta's product shipments to the U.S.A. would probably go eastward to the mid-west and northeast States,and, possibly, also, southwest to the west coast States.

For eastbound shipments, it is conceivable that the Great Lakes could provide an economical link in the transportation system - at least seasonally.

Product shipments to Japan and other Pacific rim markets would probably go by railway to B.C. coast for transfer to ships.

The projected marketing pattern dictates that the plastics and chemical products must have fast, reliable, and economical access to the main inter-provincial railway lines (for long hauls) and to highways (for short hauls).

F. Land Requirements

The area of land used for petrochemical processing depends upon the degree of integration of the individual developers.

In Sarnia, for example, the industrial plants are dispersed over a five mile strip along the St. Clair River. Except for the interchange of some feedstocks, the individual corporate developers are not well integrated. Most of the major corporate developers have purchased property on the river, and as much land as possible for expansion inland.

By contrast, the industrial development of the Europort in Holland is more consolidated because of more centralized planning by government, which leases the land to individual corporate developers. Another example of government planning is a new industrial park in the province of Quebec.

The main thrust of the petrochemical industry developments anticipated for Alberta will probably be well integrated, and lend themselves to considerable consolidation of shared facilities. Based upon these premises, it is conceivable that a land area of about 10 square miles should be designated as a preferred location within which to locate those petrochemical developments which fit the integrated pattern. Additional land may be required for refineries and salt mining.

This concept would be consistent with the Government's philosophy of corridor developments whereby the optimum utilization of land is designated in advance and encouraged. The type of land required for petrochemical developments should be gently contoured, well drained, and so located as to facilitate environmental protection.

One of the options available to the Alberta Government would be to develop a large tract of land for refinery and petrochemical development and, possibly also, provide common services.

G. Salt Deposits

Salt deposits are important to the petrochemical industry in two respects, namely, as a raw material for chlorine, and, also,

as a medium for economical underground storage.

The most complete text relating to the salt deposits of Alberta is contained in the Research Council Bulletin 29. Although this report is concerned mainly with the area north and east of Edmonton, there is also some information on the salt deposits outside the area.

The evaporates were deposited in a land-locked sea, fed from oceans to the northwest. The depositional edge forms a line through High Level, Edmonton and Medicine Hat. This depositional edge contains horizons of salt between layers of shale. The solids content of the salt beds decreases in an easterly direction and the salt beds thicken.

At Fort Saskatchewan, the largest interval of salt which can be extracted efficiently in a brine is between 50 and 100 feet. At Redwater this interval exceeds 200 feet, and at Two Hills and Hardisty, the thickest brinable section exceeds 400 feet. The quality of the salt improves in an easterly direction, and the depth to the top of the main salt bed decreases from 4,000 feet at Edmonton, to less than 2,000 feet at Two Hills and Hardisty. In addition to the large Prairie Evaporate salt deposit, three other deposits are present at Two Hills. One of these, the Upper Lotsberg is buried below 2500 feet and contains more than 300 feet of brinable salt.

Less detail is available on the salt bed at Empress, but it is reported to exceed 200 feet in thickness.

A special minerals lease is required to excavate salt caverns. These leases will not be issued if there is a danger that the cavern will interfere with the rights of companies holding Petroleum and Natural Gas leases.

A paper by Hermit Allen and Charles Hamilton in the C.I.M. Bulletin, December, 1973, gives storage facility costs of $47.00/barrel for surface storage of propane, and $4.00 to $5.00/barrel for surface storage of crude oil. Salt cavern storage is estimated to cost between $1.00/barrel and $2.00/barrel for caverns exceeding 500,000 barrel capacity.

COMPARISON OF PROVINCIAL REGIONS

A. Regions Studied

In order to compare several general regions within the Province, a study was conducted into their respective physical features. The regions selected were not intended to be restrictive, but merely to provide background data for an ultimate site selection. The comparative information is summarized in the chart appended.

B. Edmonton - Fort Saskatchewan - Redwater

1. Feedstock

This region is the center of the refining industry in Alberta. Refinery gases could be available from the Gulf and Imperial refineries, and, possibly also from smaller refineries. Canadian Industrial Gas & Oil have a series of pipelines in this district, as do Northwestern Utilities.

2. Water Supply

The minimum supply of water in the North Saskatchewan River is governed by upstream dams. The minimum during winter months is 2,000 cubic feet/second. The maximum during spring runoff is 42,000 cubic feet/second, with a mean flow of 3,800 cubic feet/second. There are a number of industrial users of this water within the Edmonton - Redwater corridor, and it will be necessary to monitor effluents very carefully.

3. Transportation

This area is well served by highway, railroad and airports. Both C.N.R. and C.P.R. have systems in this region. All railroad lines on each system are capable of accommodating the maximum size of rolling stock (263,000 lbs. gross). All the major highways in the region (#15, 16, 55 and 37) are rated at 72,000 lbs., which is currently the maximum loading in the province.

Edmonton is served by an International Airport, a Municipal Airport, and there is a further airport in the planning stages.

4. Existing Power Supply

This area is well served by Calgary Power, through two lines at 240 KV, and three lines at 138 KV. There should be little difficulty in acquiring all power requirements from the existing utilities.

5. Land Availability

This region is governed by three planning authorities. The Edmonton Regional Planning Board has zoned large areas in this region as recreational. These are mainly the low lying areas along the river. The Municipal District of Sturgeon, occupying the northwest side of the river, is currently considering the adoption of a general plan for industrial development, which would see the area north of the Sturgeon River zoned for light industry.

The County of Strathcona, which governs the area southeast of the North Saskatchewan River, and southeast of the urban districts of Fort Saskatchewan, has no general plan at this time. Land prices within this region vary from a low of $700/acre in the Redwater area to more than $1,000/acre close to Edmonton.

6. Storage Potential

Edmonton is on the depositional edge of the salt deposits. The salt improves in quality and quantity to the east.

7. Manpower

Edmonton is a large metropolitan area, with a large labor pool and all social amenities. A number of attractive dormitory towns are located nearby. The total population of this metropolitan area exceeds 550,000. There should be no problem in acquiring qualified construction and maintenance personnel in this area, and there should be no problem in attracting qualified personnel to this area from other parts of the country.

8. Related Industries

Imperial Oil owns a refinery at Edmonton and a fertilizer plant at Redwater.

C.I.L. own a petrochemical plant on the outskirts of Edmonton.

Sherritt Gordon owns a metallurgical and fertilizer plant at Fort Saskatchewan.

Other refineries are owned by Gulf, Texaco and Chevron.

Other chemical plants are owned by Dow, Chemcell, Inland Chemicals and Thio-pet Chemicals.

The area is also a terminal for Interprovincial Pipelines and Trans Mountain Pipelines.

9. Summary

This is the main Alberta center for chemical industry, and a logical area for expansion, since this would allow continuous interchange of products between chemical plants. Several feedstocks are available from existing gas lines and refineries. The water supply in the North Saskatchewan River is adequate. Transportation is excellent. Power supply in the area is abundant, and there should be little difficulty in acquiring power for the petrochemical industry from existing utility companies. Living conditions are attractive.

Natural gas transmission pipelines in this area serve the Chemcell plant and the City of Edmonton. They are currently inadequate to furnish the ethane requirements of a large petrochemical industry based on ethylene. The development of global scale petrochemical plants, using ethylene feedstock, will require additional pipelines into the area to carry natural gas or ethane (or ethylene) from extraction plants outside the area.

C. Vegreville - Two Hills - Myrnam

1. Feedstock

This area is traversed by the Alberta Gas Trunk Line System

District 3. It is doubtful that there is sufficient feedstock from this line to feed an extensive petrochemical industry, but additional reserves are available slightly south of here.

2. Water Supply

The North Saskatchewan River flows through this region, and although the figures are not available, the flow rates should be slightly higher than those at Edmonton due to a number of smaller streams entering the river between Edmonton and Two Hills.

3. Transportation

This region is served by Canadian Pacific Railways, with a track which is adequate to carry any size of rolling stock that is currently available (263,000 lbs. gross). Highways 45 and 36 at Two Hills have a 72,000 capacity, as does Highway 16 at Vegreville. This area has no air service at the moment.

4. Power Supply

Power is supplied by Alberta Power through a 138 KV system. This would not be adequate for a petrochemical complex. Additional power may be forthcoming if it were decided to establish heavy industry in this area. The coal deposits in this area are low grade lignites which are not currently used for power generation in Alberta. The large Battle River generating plant at Forestburg, which uses sub-bituminous coal, is within 100 miles of Two Hills.

5. Available Land

Farmland in the area currently sells for approximately $100/acre. Town serviced land costs approximately $1,000/acre. The mill rate is currently 72 to 74 mills.

6. Storage Potential

Salt deposits in this region are excellent, both in quality and quantity. The total thickness of the three major salt beds in this region exceeds 1000 feet.(ref. Alberta Research Council Bulletin 29).

7. Manpower

This region is approximately 65 miles from Edmonton, with a current population of approximately 5000. Considerable urban development would be required to attract new population to this region.

8. Related Industries

Canadian Salt Company currently operates a chlor-alkali plant employing 45 persons. There is excellent potential for expansion of this type of operation. Several gas plants exist in this region.

9. Summary

This is a potentially attractive location for petrochemical industries in the Province. The water supply in the North Saskathchewan River is adequate and appreciable volumes of gas are available. Facilities for bulk transportation on railroads and highways is adequate. The salt deposits in this region are immense. This is an ideal location for an expanded chlor-alkali industry and the subsequent caverns would be ideal for storing hydrocarbons. Ample cheap land is available at this time.

D. Hardisty - Wainwright Area

1. Feedstock

This area is traversed by two lines of the Alberta Gas Trunk system, and the main I.P.P.L. oil transmission line.

2. Water Supply

The major stream in this region is the Battle River, which has a maximum flow of 1700 cubic feet/second, and a minimum flow of 40 cubic feet/second. Extensive diversionary and impoundment systems would be required to provide sufficient water for an extensive petrochemical industry in this area.

3. Transportation

Wainwright is served by the Canadian National Railway, maximum capacity 263,000 lbs. Hardisty is served by the Canadian Pacific Railway, maximum capacity 263,000 lbs. Highways 14 through Wainwright, and 13 through Hardisty, are both rated at 72,000 lbs. maximum. There is no commercial air service into this region.

4. Power Supply

Hardisty has 138KV tap from Alberta Power linked through the provincial grid to Calgary Power at Vermilion. The Battle River generating stations are nearby, and there are additional sub-bituminous coal deposits in the region, which should be exploitable for additional generating capacity.

5. Available Land

Farmland in the area is currently selling around $150/acre. Town serviced land costs approximately $1200/acre. Taxes are 74 to 76 mills.

6. Storage Potential

Good quality salt deposits are present in the Prairie Evaporates. The total thickness of brinable salt may exceed 400 feet. Home Oil is currently using underground storage caverns for natural gas.

7. Manpower

This region is located approximately 130 miles from Edmonton, with a current population of approximately 5000. Significant urban development would be required to attract new population to this area.

8. Related Industries

Home Oil and Gibson Oil are currently producing petroleum in the area. The I.P.P.L. trunk line passes through, and there are several gas plants located within this region.

9. Summary

This area is unattractive to industries requiring large volumes of water. Salt storage possibilities are good, transportion is reasonable. Large volumes of gas and oil are available. The area is beyond reasonable commuting distance with the major metropolitan areas of the Province.

E. Medicine Hat - Empress Area

1. Feedstock

Large volumes of natural gas are produced in this region, and Empress is the major collecting center for gas leaving the Province. In addition, the Suffield Block could produce large quantities of gas which is not committed to present markets. Natural gas sales contracts usually contain restrictive specifications on the BTU value of the gas.

Uncommitted gas in the Suffield Block is not yet subjected to these requirements so there are fewer restrictions on the use of this gas as a source of petrochemical feedstocks.

2. Water Supply

The South Saskatchewan River at Medicine Hat has a minimum winter flow of 1200 cubic feet/second, a mean flow of 3000 cubic feet/second, and a maximum flow of 48,000 cubic feet/second.

3. Transportation

The Canadian Pacific Railroad serves Medicine Hat on the main line with 263,000 lbs. capacity. Two regional lines join at Empress, which also have 263,000 lbs. capacity. Highway 41 - Empress to Medicine Hat - has a 72,000 lb. capacity, and the Trans Canada Highway through Medicine Hat also has a 72,000 lb. capacity. Medicine Hat has a regional airport which is serviced on a regular schedule.

4. Power Supply

Medicine Hat is served by Calgary Power on a 138 KV ring. Empress is served by a 138 KV tap from this ring.

Sub-bituminous coal deposits are present west of Medicine Hat and lignites are found to the east. These deposits have not been exploited in the past due to the abundance of cheap natural gas, but the Energy Resources Conservation Board is now discouraging the use of gas for power generation. There should be adequate coal available in this region to produce all the power required for expanded industrial use.

5. Available Land

Serviced land in Medicine Hat costs $3500/acre. Surrounding unserviced land sells for $600/acre. Surrounding land within 15 to 20 miles, which is not amenable to irrigation,sells for $80 to $200/acre.

6. Storage Potential

Medicine Hat is on the depositional edge of the Prairie Evaporates. Storage potential in the immediate region of Medicine Hat is poor. Empress has appreciable salt beds and it should be possible to construct caverns in excess of 200 feet high.

7. Manpower

Medicine Hat is a medium sized city with a population under 50,000. There are many social amenities, and the climate is better than most Alberta communities. It should be not difficult to attract personnel to this location.

8. Related Industries

There are a large number of gas processing plants around Medicine Hat. Northwest Nitro-Chemicals has a plant in the City; currently a methanol plant in under construction, owned jointly by A.G.T.L. and Allarco. A number of fertilizer plants have recently been proposed for this area.

9. Summary

This is an attractive area for chemical industries based on natural gas. Transportation is good. Storage possibilities are good. Living conditions are good. The current power supply is inadequate, and it is doubtful that the Energy Resources Conservation Board would permit the use of natural gas to generate further power in this region. The water supply from the South Saskatchewan River is less than that available from the North Saskatchewan River, particularly during winter. Some water treatment facilities would be required in this area.

F. Calgary - Cochrane Region

1. Feedstock

Alberta Gas Trunk Line has a major line running through this area, and Hudson's Bay Oil and Gas have an oil pipeline.

2. Water Supply

The Bow River has a minimum flow of 1000 cubic feet/second, a mean flow of approximately 2000 cubic feet/second, and a maximum flow of 30,000 cubic feet/second. This volume of water is probably inadequate for a major industrial development without storage and cooling facilities.

3. Transportation

The Canadian Pacific Railroad main line crosses this region with the capability for handling rolling stock of 263,000 lbs. gross weight. The Trans Canada Highway has a maximum loading of 72,000 lbs. Calgary has air connections regionally and internationally.

4. Power Supply

Calgary Power has a number of generating facilities in this area. There are three 138 KV lines passing through Cochrane.

5. Available Land

Town serviced land at Cochrane cost $7000 to $8000/acre. Zoning within the region is controlled by the Calgary Regional Planning Commission. The mill rate is currently set at 57 mills.

6. Storage Potential

There are no recorded salt beds in this region. All storage facilities would have to be built on surface.

7. Manpower

Calgary is a large metropolitan area with all social amenities. There is a large labor pool available for construction and operating personnel. The population of the metropolitan area is approximately 450,000.

8. Related Industries

Domtar Chemicals has a plant in this region and there are several gas plants.

9. Summary

This area contains oil and gas transmission lines for feedstocks, but there is probably insufficient material for an extensive petrochemical complex. The area is very attractive for personnel, being close to recreational facilities and a large metropolitan center. The power supply is good, the water supply is probably too low to support a number of petrochemical plants. Storage facilities are not available in underground salt beds so storage would be an extensive item in constructing chemical plants based on the natural gas industry.

G. Fort McMurray

1. Feedstocks

Refinery gases may become available from the bitumen upgrading

facilities which are planned for this area. The aromatic content of the synthetic crude is a potentially valuable feedstock for petrochemicals.

2. Water Supply

The Athabasca River is one of the largest streams in the Province, with a minimum flow of 3700 cubic feet/second, and a mean flow of 18,000 cubic feet/second.

3. Transportation

The current load limit on the Northern Alberta Railway is 176,000 lbs. gross. Plans are in existence to upgrade this to 220,000 lbs. Highway 63 has a load limited to 72,000 lbs. There is an airport with regularly scheduled flights to Edmonton by Pacific Western Airlines.

4. Power Supply

The present facilities of Alberta Power only provide 25 KV. A 240 KV line is currently under construction between Mitsue and Fort McMurray. Other power may become available as further tar sands plants are developed.

5. Available Land

Almost all of the surrounding land is provincial forest and is unserviced.

6. Storage Potential

Fort McMurray is on the erosional edge of the Prairie Evaporates. Substantial beds are present west of town, which should exceed 200 feet in thickness.

7. Manpower

Fort McMurray is a remote northern community. Many social amenities are in the planning stage. The dynamic growth of this

area has led to an acute housing shortage which could continue for a number of years. The current population is approximately 10,000, but this is increasing at a rapid rate.

8. Related Industries

The bitumen plant of Great Canadian Oil Sands is currently in production. The Syncrude Plant is currently just entering the construction phase. Shell, Fina and Home Oil are proposing to build bitumen upgrading plants in this area. Refinery gases from these operations could become a valuable source of petrochemical feedstocks in the future.

9. Summary

This area has good potential, but is remote and still lacks a number of amenities. The water supply is very good and salt storage is possible in the western parts of the region. It will probably be a number of years before this region can be considered as a site for the petrochemical industry.

ENVIRONMENTAL CONSIDERATIONS

The Province of Alberta has enacted legislation to regulate the permissible levels of emissions from industrial and other operations. The petrochemical industry is particularly sensitive to the need for environmental protection. Provided that environmental regulations are clearly defined, and mutually understood in advance of plant design, the source emissions can be controlled to prescribed standards. The judicious selection of plant sites is important to facilitate adherence to ambient standards.

A. Atmospheric Emissions

In order to ensure effective dispersion of atmospheric emissions chemical plants should be located to take advantage of favorable meteorological conditions, such as: wind direction, and freedom from inversions.

B. Liquid Effluents

The Clean Water Act defines the permissable levels of specific liquid effluents in terms of cumulative effects. Tolerable amounts of liquid effluents may be discharged to flowing streams for disposal, subject to adequate monitoring. Liquid effluents which cannot be tolerated in natural streams may be discharged to underground disposal wells. Obviously, the geology of the subterranean structure must be known, and a strata selected which will ensure containment.

C. Human Habitat

The relative locations of the petrochemical complex and the serving communities should be planned so as to minimize the probability of any human discomfort. For example, communities should be located on the windward side of the industry. The distance separating them should be controlled to avoid future encroachment, and still permit comfortable commuting. The concept of one central community should not be too rigidly enforced, but should permit reasonable freedom of individual choice within a given area.

D. Land Use

The conversion of agricultural land to industrial use is a contentious subject, and therefore, requires careful consideration. Many countries such as Holland, have found that the long range benefits of industrialization justify replacing relatively small areas of farmland, especially when agricultural productivity from remaining farms can be increased. The issue is further alleviated whenever the land allocated to industrial use has little or no value for agriculture. It is axiomatic that the total regional planning should strive to preserve and enhance recreational and wildlife areas.

CONCLUSIONS AND RECOMMENDATIONS

The data presented in this report has been thoroughly analysed and coordinated with other participants on our project team. In

conclusion, we would submit the following recommendations.

1) The pipeline corridor from mineable tar sands should be routed through a new liquid hydrocarbons transfer station, to be located north of Skaro on the south side of the North Saskatchewan River. An interconnecting line would extend to the existing I.P.P.L. terminal.

2) The Alberta Government should acquire a tract of land comprising 20 square miles or more, on the south side of the North Saskatchewan River, somewhere between Deerland and Ukalta. This would be reserved for future development of the process industry - i.e., petroleum refining, and the related segment of the petrochemical industry.

3) When liquid hydrocarbons are available by pipeline from the Cold Lake Oil Sands deposit, the new Skaro transfer station could accommodate their delivery.

4) Future liquid hydrocarbons from the Peace River tar sands deposit, and conventional crude oil from a Mackenzie Valley pipeline could be terminalized either at the new Skaro transfer station or at the existing I.P.P.L. terminal.

5) One or more communities should be planned and developed within reasonable commuting distance of the process site, to provide choice living conditions for the resident work force. Housing, education, health services, and transportation are critical factors in this regard.

6) When the industrial and urban concentration at this new location reach viable levels, similar developments could be planned further east, or at a more advanced stage, possibly even in the mineable tar sands region.

TABLE 5. POTENTIAL PETROCHEMICAL CENTERS

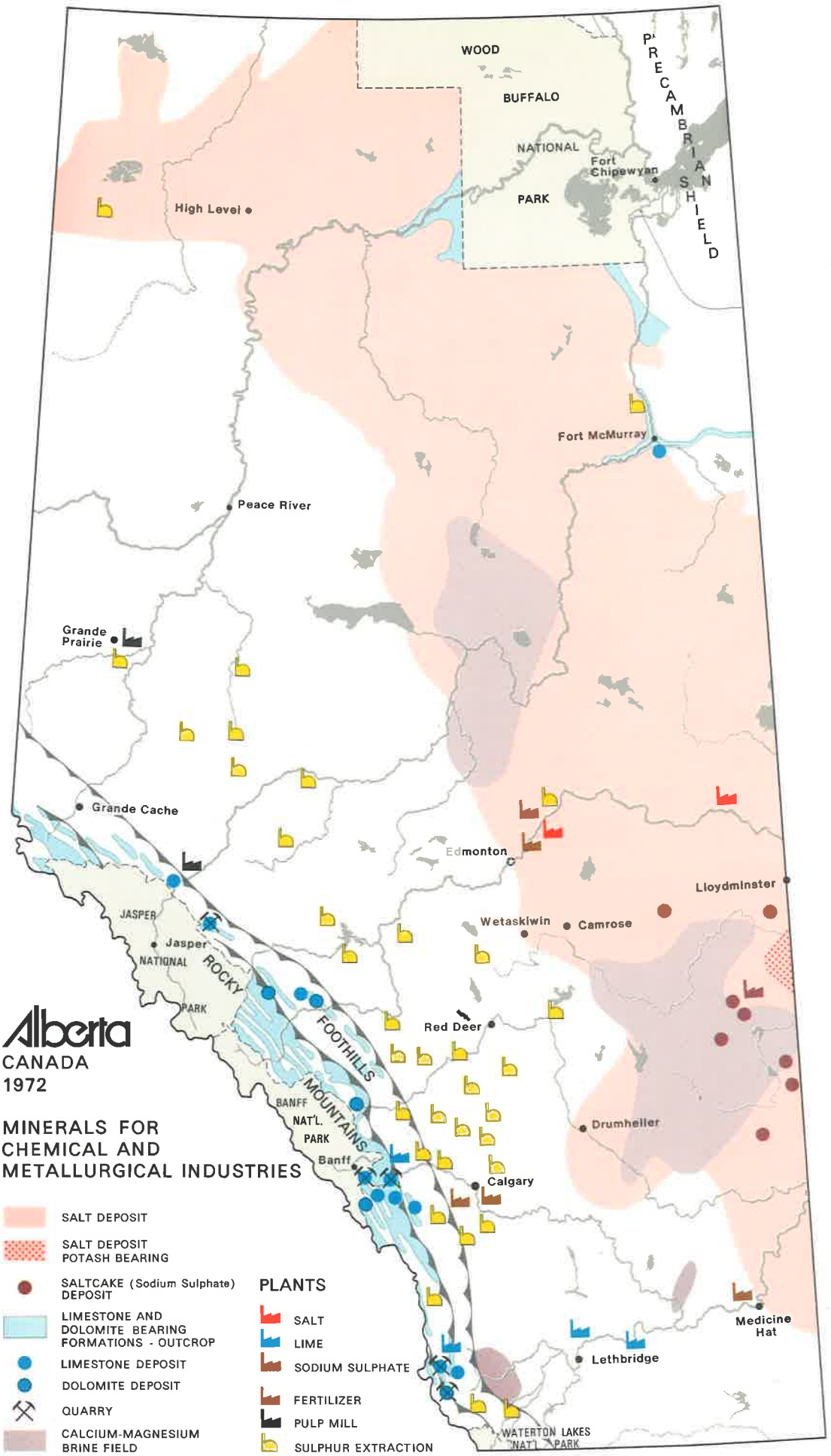
	FEEDSTOCK	WATER SUPPLY	RAILROAD	HIGHWAYS & AIRPORTS
Edmonton Fort Saskatchewan Redwater	Ref. Gases Gulf, Imperial, Texaco, Chevron,etc Can.Ind.Gas & Oil N.U.L.- Gas	North Sask. River Min. 2000 cfs Mean 3800 cfs Max. 42,000 cfs	CNR built to nat. specs. Will accommodate any rolling stock that can travel on trunk lines. 263,000 lbs gross. CPR south of N. Sask. River 263,000 lbs gross	Hwys 15, 16, 55, 37 All 72,000 lbs. Airports: Full schedule International,Municipal Additional Airport planned.
Vegreville Two Hills Myrnam	A.G.T.L. District 3	North Sask. River Flow rates must be greater than Edmonton but precise figures not available.	Two Hills - CPR 263,000 lbs gross	Hwys 45,36 at Two Hills 72,000 lbs. Hwy 16 at Vegreville 72,000 lbs. No air service.
Hardisty Wainwright	A.G.T.L. District 3 I.P.P.L.	Battle River Min. 40 cfs Max. 1700 cfs	Wainwright - CNR Hardisty - CPR 130# Rail 263,000 lbs gross	Hwy 13 72,000 lbs. No air service.
Medicine Hat Empress	A.G.T.L. All Districts	South Sask. River Max. 48,000 cfs Mean 3000 cfs Min. 1200 cfs	CPR Regional lines to Empress 263,000 lbs gross Med.Hat Main Line CPR 130# Rail 263,000 lbs gross	Hwy 1 (Empress to Med. Hat) 72,000 lbs. Trans Canada Hwy 1 72,000 lbs. Scheduled air service.
Calgary Cochrane	A.G.T.L. District 1	Bow River Min. 1000 cfs Mean 2000 cfs Max. 30,000 cfs	CPR Main Line 130# Rail 263,000 lbs gross	Trans Canada Hwy 1 72,000 lbs. Fully scheduled air service. Regional and International
Fort McMurray	Ref. Gases from Bitumen upgrading facilities. Aromatic Content of "Synthetic Crude"	Athabasca River Min. 3700 cfs Mean 18,000 cfs	NAR - Axle load of 55,000 lbs on 100# Rail(220,000 lbs. gross)planned for future.Currently 105 mi. of 65 lb. rail. Limit loads to 44,000 lbs axle load(176,000 lbs gross)	Hwy 63 72,000 lbs after 1974 Scheduled Regional Air Service. P.W.A. to Edmonton.

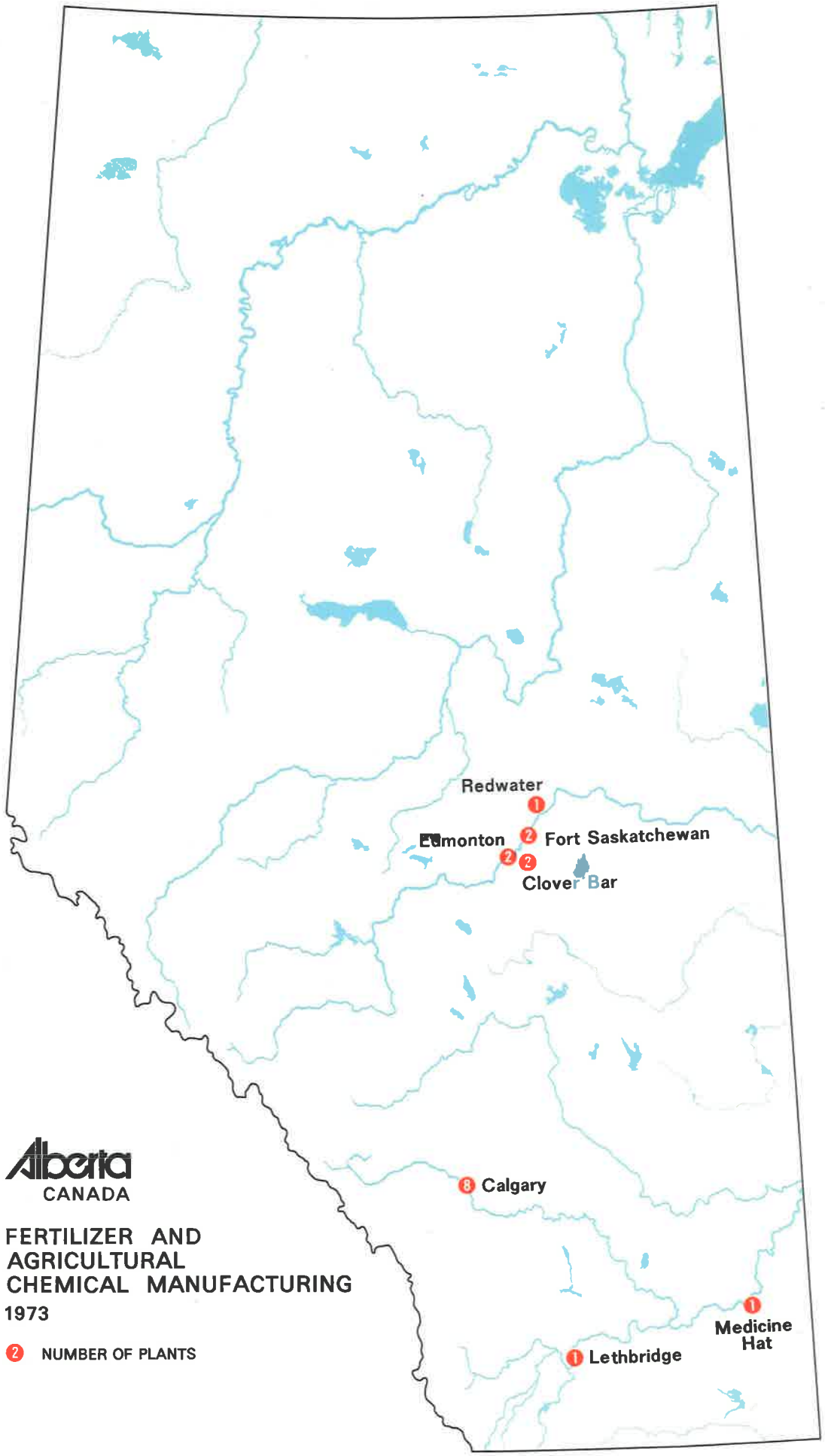
POTENTIAL PETROCHEMICAL CENTERS

	AVAILABLE LAND	STORAGE POTENTIAL	MANPOWER
Edmonton Fort Saskatchewan Redwater	River Valley land is generally zoned for recreational use. Prices vary from $700/acre near Redwater to $1,000/acre plus near Edmonton. Prime land is still available at these prices.	Edmonton is on the depositional edge of salt deposits. Salt improves in quantity and quality to the east. Ft. Sask. has some salt but it is not very desirable for quality or quantity for storage facilities.	Large metropolitan area has large labor pool and all social amenities.Dormitory towns are close. Population of Metro Area - 550,000
Vegreville Two Hills Myrnam	Farmland $100/acre Town Serviced - $1,000/acre Taxes - 72 - 74 mills	Salt deposits are excellent for quality and quantity. Total of three major beds may exceed 10,000 feet.	Approx. 65 mi. from Edmonton. Current population of region approx. 5,000. Will require significant development to attract new population.
Hardisty Wainwright	Farmland $150/acre Town Serviced - $1,200/acre Taxes - 74 - 76 mills	Good quality salt deposit in prairie evaporates, possibly 400 feet thick. Home Oil uses underground storage for gas.	Approx. 130 mi. from Edmonton. Current population approx. 5,000. Will require significant development to attract new pop.
Medicine Hat Empress	Serviced town land - $3,500/acre Surrounding land at Med. Hat - unserviced at $600/acre Non-irrigable land within 15-20 mi. at $80 to $200/acre	Medicine Hat is on the depositional edge of prairie evaporates. Storge potential is poor. Empress has appreciable salt beds. Caverns in excess of 200' high should be feasible.	Medium sized city. Many social amenities. Good climate. Total population - 50,000
Calgary Cochrane	Town land at Cochrane - $7,000 to $8,000/acre Zoning by Calgary Regional Planning Commission Taxes - 57 mills	No significant salt beds in this region.	Large metropolitan area. Has large labor pool and all social amenities. Population of Metro Area - 450,000
Fort McMurray	Most of surrounding land is Provincial forest. Not serviced.	McMurray is on the erosional edge of the prairie evaporates. Substantial beds are present west of the town - which should exceed 200 feet.	Remote northern town. Many social amenities in planning stage. Dynamic growth leads to housing shortage. Population approx. 10,000-growing fast.

POTENTIAL PETROCHEMICAL CENTERS

	POWER SUPPLY	RELATED INDUSTRIES	SUMMARY
Edmonton Fort Saskatchewan Redwater	Calgary Power 2 x 240 KV 3 x 138 KV	Imperial Oil,C.I.L. Petrochem.,Sherritt Gordon,Dow Chemical, I.P.P.L.,Trans Mtn. Gulf,Texaco,Chevron, Inland Chemicals, Thio-pet Chemicals	This is the main Alberta center for the chemical industry and a logical area for expansion. Several feedstocks are available. Water supply is adequate. Transportation is excellent. Power supply is abundant. Living conditions are attractive. Underground salt deposits exist in this region.
Vegreville Two Hills Myrnam	Alberta Power 138 KV	Chlor-Alkali Plant - 45 employees Several gas plants.	This is a potentially attractive location. Water supply is adequate. Appreciable volumes of gas & oil are available. Transportation is adequate. Salt deposits are immense for chlor-alkali and storage caverns. Ample cheap land is available. Commuter service with Edmonton area is feasible.
Hardisty Wainwright	Calgary Power 138 KV tap to Hardisty tied to Alberta Power	Home Oil Gibson Oil I.P.P.L. High Grade Feeders	This area is unattractive to industries requiring large volumes of water. Storage possibilities are good. Transportation is reasonable. Large volumes of gas & oil are available. The area is beyond reasonable commuting distance with a major metropolitan area.
Medicine Hat Empress	Calgary Power 138 KV on a Ring 138 KV tap to Empress	North West Nitro Chem Methanol plant under construction(A.G.T.L./ Allarco). A number of fertilizer plants have recently been proposed.	This is an attractive area for chemical industries based on nat. gas. Transportation is good. Storage possibilities are good. Living conditions are good. Current power supply is inadequate. Relatively low water supply. Will require extensive water treatment facilities.
Calgary Cochrane	Calgary Power 3 x 138 KV from Hydro Generators	Domtar Chemicals Several gas plants.	This area contains oil and gas transmission lines for feedstock. The area is very attractive for personnel,being close to recreational facilities and large metropolitan centers. Power supply is good. Water supply is low. Storage facilities are not available in salt beds.
Fort McMurray	Alberta Power 25 KV 240 KV line under construction	G.C.O.S. in production Syncrude under construction. Shell, Fina, Home plants proposed. Refinery gases may become available for chemical industry.	This area has good potential but is remote and lacks many amenities. Water supply is very good. Salt storage is possible in the western parts of this region. It will probably be a number of years before this region can be considered as a site for the chemical industry.


WOOD
BUFFALO
NATIONAL
PARK
Fort Chipewyan
PRECAMBRIAN SHIELD
High Level
Fort McMurray
Peace River
Grande Prairie
Grande Cache
Edmonton
Lloydminster
Wetaskiwin
Camrose
JASPER
NATIONAL
PARK
Jasper
ROCKY
FOOTHILLS
MOUNTAINS
Red Deer
BANFF
NAT'L.
PARK
Banff
Drumheller
Calgary
Medicine Hat
Lethbridge
WATERTON LAKES
NAT'L. PARK
Alberta
CANADA
1972
MINERALS FOR
CHEMICAL AND
METALLURGICAL INDUSTRIES
SALT DEPOSIT
SALT DEPOSIT
POTASH BEARING
SALTCAKE (Sodium Sulphate)
DEPOSIT
LIMESTONE AND
DOLOMITE BEARING
FORMATIONS - OUTCROP
LIMESTONE DEPOSIT
DOLOMITE DEPOSIT
QUARRY
CALCIUM-MAGNESIUM
BRINE FIELD
PLANTS
SALT
LIME
SODIUM SULPHATE
FERTILIZER
PULP MILL
SULPHUR EXTRACTION

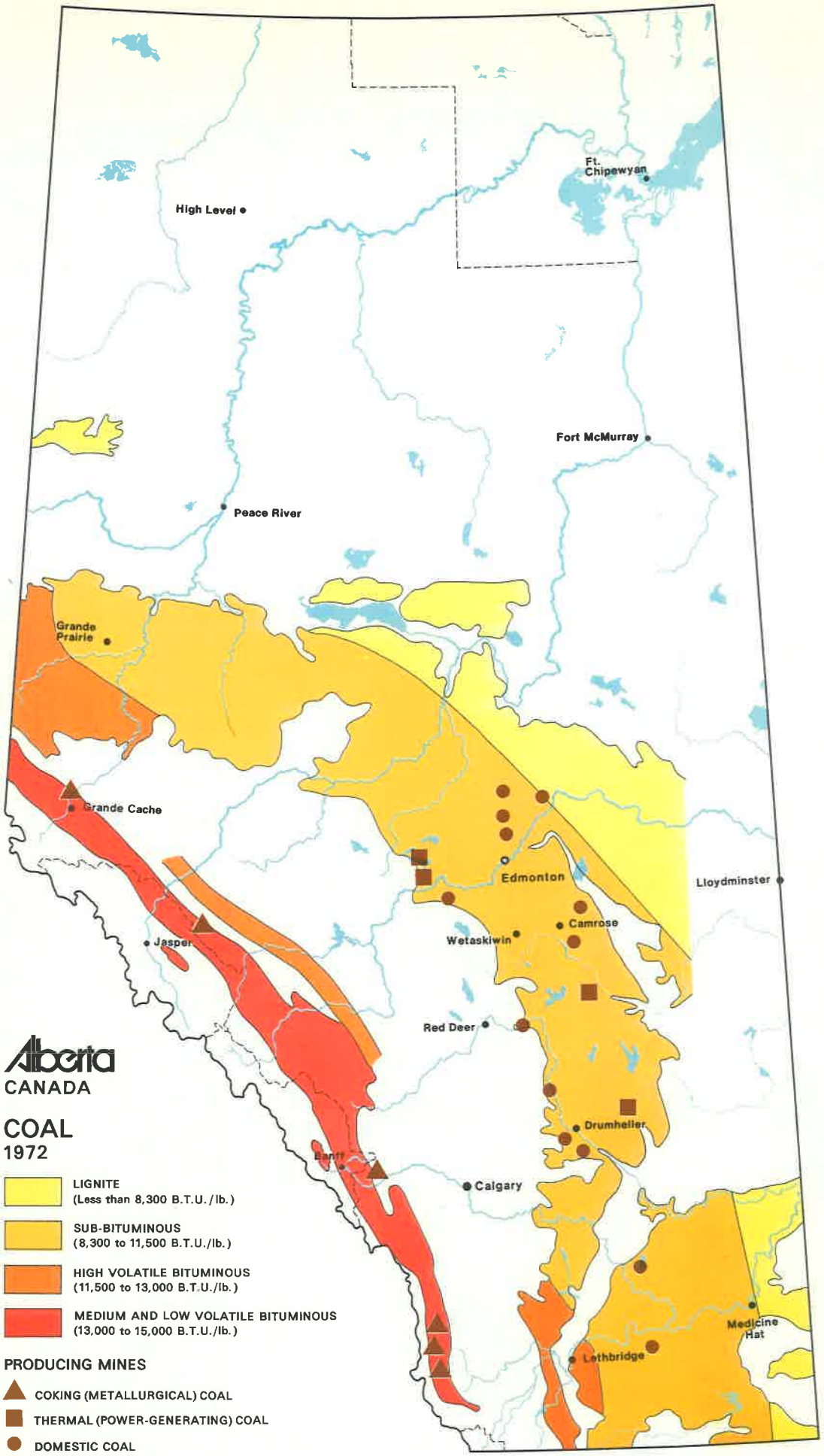


Alberta
CANADA

FERTILIZER AND AGRICULTURAL CHEMICAL MANUFACTURING

1973

2 NUMBER OF PLANTS


Ft. Chipewyan
High Level
Fort McMurray
Peace River
Grande Prairie
Grande Cache
Edmonton
Lloydminster
Camrose
Wetaskiwin
Jasper
Red Deer
Drumheller
Banff
Calgary
Medicine Hat
Lethbridge
Alberta
CANADA
COAL
1972
LIGNITE
(Less than 8,300 B.T.U./lb.)
SUB-BITUMINOUS
(8,300 to 11,500 B.T.U./lb.)
HIGH VOLATILE BITUMINOUS
(11,500 to 13,000 B.T.U./lb.)
MEDIUM AND LOW VOLATILE BITUMINOUS
(13,000 to 15,000 B.T.U./lb.)
PRODUCING MINES
COKING (METALLURGICAL) COAL
THERMAL (POWER-GENERATING) COAL
DOMESTIC COAL

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER IV

PRELIMINARY ASSESSMENT OF THE ALTERNATIVE CORRIDORS FROM THE ATHABASCA TAR SANDS

Prepared for:

Alberta
Environment

By:

Stewart Weir Stewart
Watson & Heinrichs

K.C. Mackenzie Associates Ltd.

Bolter Parish Trimble Ltd.

Siemens Realty & Appraisal
Services Limited

Edmonton, Alberta

PRELIMINARY ASSESSMENT OF THE
ALTERNATIVE CORRIDORS FROM THE
ATHABASCA TAR SANDS

DESCRIPTION OF THE THREE POSSIBLE ROUTES FROM THE ATHABASCA TAR SANDS TO EDMONTON

A. West Route

This route leaves the Athabasca Tar Sands at Tar Island which has been designated as an arbitrary starting point for the northern terminus of all corridor proposals. The route heads west from Tar Island, then southwest along the Thickwood Hills where it crosses Buffalo Creek at Tp. 84 Rge. 20. From here it heads directly south passing east of Pelican Lake and east of Calling Lake. It crosses the Athabasca River near the Town of Athabasca at one of two alternate places, either Tp. 68 Rge. 21 or Tp. 66 Rge. 22. Then it heads south past the Town of Thorhild on the west side. It follows a route from here cutting between the Town of Gibbons and Bon Accord, crossing the North Saskatchewan River at Oliver and finally terminate in the Edmonton Industrial area. Total length is 274.9 miles.

B. Central Route

This route leaves Tar Island (an arbitrary starting point) and follows the G.C.O.S. pipeline right-of-way to the Edmonton terminus. It goes through designated residential area Nos. 3 and 5 in Fort McMurray (in a 100 foot right-of-way) from the G.C.O.S. plant then heads south and west along Highway 63 through Marianna Lake and Wandering River. It crosses Highway 46 between Atmore and Grassland then west of Boyle, east of Newbrook, just east of Radway crossing the North Saskatchewan River on the northeast corner of Tp.56 Rge. 21. It heads southwest passing between Fort Saskatchewan and Josephburg to the Edmonton terminus. Total length is 271.9 miles.

C. East Route

From Tar Island the East route heads south and slightly east. Some distance after crossing the Athabasca River it crosses the Clearwater River at Tp. 88 Rge. 8 and generally follows the Northern Alberta

Railway right-of-way to Lac La Biche. From Lac La Biche it goes west across the north end of Beaver Lake, then south and west from the Beaver Metis Colony No. 7 through agricultural farmland passing west of Smoky Lake and crossing the North Saskatchewan River at Tp. 58 Rge. 18. The route continues southwest bypassing Elk Island Park, just west of Josephburg and into the Edmonton terminus. Total length is 292.5 miles.

THE ALTERNATE ROUTES WHERE THEY DEVIATE FROM THE EAST ROUTE PREVIOUSLY DESCRIBED

A. Hardisty Route

The Eastern route has three additional routes. The one from Devenish to Hardisty leaves the East route at Devenish and heads south to the east of Pinehurst Lake and continues south to Beaver River crossing the river at Tp. 63 Rge. 9. This route continues south to the I.P.P.L. at Hardisty bypassing Drysdale Lake, to the east of St. Paul and crosses the North Saskatchewan River at Tp. 55 Rge. 9. It passes Myrnam, crosses the Vermilion River at Tp. 51 Rge. 9, past Mannville and Irma and crosses the Battle River at Tp. 43 Rge. 9 before going into the I.P.P.L. at Hardisty. Total length is 326.9 miles (Fort McMurray to Hardisty).

B. Vegreville Route:

This route leaves Lac La Biche to the west of Beaver Lake and heads south for the I.P.P.L. just north of Strome. It crosses the Amisk River at Tp. 63 Rge. 14, to the west of Whitefish Lake, to the west of Vilna and crossing the North Saskatchewan River at Tp. 57 Rge. 14. It continues past Warwick and Vegreville to the east, crossing the Vermilion River east of Vegreville and south on into the I.P.P.L. line north of Strome. Total length is 321.9 miles (Fort McMurray to Strome).

C. Tweedie - St. Paul Route

A third alternative on this east route is one that leaves Tweedie, heads south to the east of Beaver Lake, then southeast to Beaver River at Tp. 62 Rge. 10. From here it heads south and

a little east of Drysdale Lake joining the Hardisty alternative east of St. Paul. Total length is 343.0 miles(Fort McMurray to Hardisty).

PRELIMINARY CONCLUSIONS - CORRIDOR ROUTE TO EDMONTON

The preliminary assessment of the three alternative corridor routes to Edmonton from the Land Appraisal point of view are contained in the following passages.

Public hearings, environmental concerns and optimal land usage strongly indicate an overall preference for the corridor concept for pipelines and powerlines with its route to be selected so as to incorporate, where feasible, existing transportation facilities. Should technical compatibility factors provide the same indications or extra costs prove to be acceptable when balanced with the other preferences, then it can be expected that the corridor method will be adopted.

In various discussions five separate areas have been considered from Edmonton to Fort McMurray:

A: Immediate Edmonton Area - Terminals to Highway 55, or crossing of the North Saskatchewan River west of Fort Saskatchewan,

B: Agriculture - Urban Transition Area - Highway 55 to east of Fort Sasktachewan area or in Gibbons vicinity,

C: Agricultural Area - East of Fort Saskatchewan to Lac La Biche, Wandering River, or Athabasca Big Bend regions,

D: Wilderness Area to Fort McMurray,

E: Environs of Fort McMurray.

In a general way, three corridor routes have been identified, for preliminary discussion purposes, as:

West Route

From the Edmonton terminals to Clover Bar then north adjacent to existing pipeline rights-of-way crossing the North Saskatchewan River in the region of Oliver (Area A), along an existing Railway right-of-way to the vicinity of Gibbons (Area B), thence north passing slightly west of Thorhild and east of Athabasca (Area C) and in the wilderness region (Area D) west of the Athabasca River to Mildred Lake (GCOS plant) thus bypassing Fort McMurray altogether.

Central Route

Originates at Edmonton terminals, follows railway, sewer, and other pipelines to Highway 55 (G.C.O.S. route - Area A), and continuing on G.C.O.S., other pipelines and powerlines through the southeast Fort Saskatchewan region (Area B) then north along the G.C.O.S.-Highway 63 route (Areas C and D) and through Fort McMurray expansion areas 3 and 5 in existing 100' right-of-way.

East Route

Starting from the Edmonton terminals the route here is due east to some distance southeast of the junction of Highways 16 and 55, possibly 3 - 5 miles east then north-northeast through Area B, east of Josephburg into Area C, passing Metis Colony No. 7 to the southeast of it, around the east side of Lac La Biche, along the Northern Alberta Railway right-of-way through Area D and bypassing Fort McMurray to the east of it.

In Area A, from the environmental point of view, the Western route passes through areas of gravel workings, some industrial uses and into acreage subdivision where controls would be somewhat difficult to maintain, while the Central route has the crossings of the Old Man and Pointe aux Pins valleys and creeks to contend with and the Eastern route has few problems in these respects.

The Western and Central routes have little difference in length while the Eastern is much longer in the southern portion.

The Central route is preferable from the land use and fragmentation point of view since it would be a widening of an existing corridor containing railway, sewer line and pipelines. The other two, while incorporating existing pipeline right-of-way for short distances, would require greater disturbance of land use patterns over greater distances.

Land values are not too dissimilar among the three routes but the East and West routes could provide greater acquisition difficulties because they are not now so closely involved with a corridor type of usage. The Central route might be more expensive on a unit base although over a shorter distance than the Westerly one and slightly longer than the Easterly one.

In Area A a definitive study is necessary, even urgent, because if the corridor is to be gone ahead with, land should be acquired as soon as possible before further usages are put into effect and prices increase to their next level.

In Area B, the transition area, environmental considerations are little different among them. The Eastern route would traverse the least expensive lands while there would be little difference between the other two depending on definitive parcel selection.

In Area C, the Western route would pass through the land of the highest quality up to the area south of Athabasca, the Eastern through the lowest of the three with the Central being somewhere in between. It would appear that in the area south of Athabasca, the Western route would encounter fewer problems in soils and drainage systems (rivers and creeks) again dependent on more definitive study, the Eastern route the most and the Central somewhere in between.

Land values in Area C would be higher, overall, in the southern portion of the eastern route, partly because of its greater length with there being not too much to choose from this point of view as to the other two. The northern portions of Area C would be lowest in the Eastern route and slightly higher in the Central than in the Western and over a longer distance.

In the wilderness Area D there appear to be radical differences with the Western route being much longer in wetlands and unstable surface areas. The Eastern route has significant wetland areas, muskeg and hill terrain; most difficult from the pipelining and consequentialy environmental stability points of view. Additionally, the Eastern and Western routes would require new construction drawbacks while the Central corridor, already so served, is on higher more stable ground and has considerably fewer river and stream crossings. It has the "advantage" of having been fairly recently developed while the Eastern route, in which the old railway has fairly well settled into the environment, would require substantial opening up although not quite to the extent of the Western route.

In Area E Fort McMurray environs, the existing 100' right-of-way passes through town development areas 3 and 5 of which 3 is undeveloped while 5 has the right-of-way contained to its 100' for

about one-half of its north-south length. If it is possible to find another suitable river crossing upstream from that of GCOS then Area 5 might be gone around. Otherwise, the existing could be used for pipelines if suitable arrangements can be made with GCOS and the Town of Fort McMurray with transmission lines being routed around Area 5 since they do not face the same problems as pipelines in river crossings.

On an over-all routing, the Central corridor is the shortest and creates the least additional environmental disturbance. Further study of land use and land value in Areas A and B might indicate a combination of the West and Central routes i.e. using the west to the Gibbons area and continuing with other existing rights-of-way to join the Central route north and east of Thorhild. Alternatively the Eastern route could be used in Area A having it join the Central in Area B.

In conclusion, it appears reasonably certain at this stage that Area A requires further definitive study which would indicate the preferences in Area B. Area E also requires further study while in Areas C and D, the Central (GCOS) route appears overwhelmingly to be preferable from the dollar economic and environmental standpoints.

Considering the people and communities who could be affected by each of the three choices there do not appear to be any really significant differences except in respect of the Eastern route from Lac La Biche north.

The Town of Lac La Biche could well be over-estimating the economic impact of the corridor which would merely be passing by them although there would undoubtedly be some benefit. Further north, the isolated communities could be subjected to influences which many people in these communities would find unwelcome. Some would retreat into even more isolated communities and lose the benefit of the railway which is an integral part of their lives. It would seem at this stage, therefore, that the environmental and dollar economic "advantages" of the Central route would outweigh the minimal net benefits to the people near the Eastern route and its closer proximity to the possible development of deposits in the vicinity of Cold Lake.

EVALUATION OF CORRIDOR ROUTE ALTERNATIVES

A. Introduction

The evaluation of the three alternative generalized corridor routes from the standpoint of the human settlement pattern consists basically of the application of the location constraints as described in our initial report to the three alternative corridor routes. In order to maintain consistency with our initial report, the three corridor alternatives are examined on the basis of the five defined regions of the corridor study area.

B. The Fort McMurray Region

The principal constraints affecting corridor location in this region are the probable location of the southern terminal of the Tar Sands gathering system at a point northwest of Fort McMurray, and the expansion requirements of Fort McMurray itself. A third constraint would be the most desirable crossing point of the Athabasca River, but the definition of this constraint is left to other members of the study group.

The combined effect of these two constraints favors a corridor approach to Fort McMurray from the south or west. Although no major problem is foreseen if a properly located pipeline corridor is placed through an area of future urban expansion, it is significant that such a corridor would have little mutli-use potential for other transportation facilities such as powerlines or highways. It is therefore recommended that a total bypass concept be applied to corridor location southwest of Fort McMurray in an alignment that could accommodate not only pipelines, but major powerlines and, in the distant future, a highway bypass around Fort McMurray to the Tar Sands area. Although the Department of Highways presently does not foresee the need for such a bypass, it should be recognized that, in the long run, Highway 63 will become an urban arterial route connecting expansion areas to the existing center of Fort McMurray. At such time as the Highway takes on an urban function, it will no longer be satisfactory as a through-trucking route for vehicles having a destination beyond Fort McMurray.

In the Fort McMurray region it is therefore recommended that a modification of the west or central corridor routes be adopted. The detailed alignment chosen should accommodate the long-range bypass needs of major transportation facilities, and incorporate the pipeline, powerline and highway components of a transportation corridor. This corridor alignment would also serve to define the limit for southwesterly expansion of the Fort McMurray settlement.

C. The Wilderness Region

The constraints imposed upon corridor location within this region are relatively minor due to the absence of a significant pattern of human settlement. The most intense pattern of settlement lies along the east corridor route alternative where, our previous studies indicated a degree of social fragility exists in the communities along the NAR which corridor development might tend to aggravate.

It is therefore recommended that either of the west or central corridor route alternatives would be preferable since no significant human settlement constraint is evident in this region.

D. The Settled Agricultural Region

The major corridor location constraint in this region is the pattern of rural settlement which derives from the grid pattern of rural settlement which derives from the grid pattern of subdivision in the region. In order to minimize land acquisition and land use fragmentation it is desirable to maintain a corridor alignment as close as is feasible to being directly north-south or east-west. Based upon this constraint, the east corridor route alternative emerges as being the least desirable by virtue of its oblique alignment from southwest to northeast. Such a route would tend to increase the degree of fragmentation of land where the corridor passed through agricultural areas.

The west corridor route alternative appears to present the greatest opportunity for a direct north-south alignment through the settled agricultural area although the central route does provide the opportunity to create an almost equally large proportion of corridor which would follow a direct north-south alignment.

Some modification of either the west or central corridor route alternative is therefore recommended for this region.

E. The Region of Metropolitan Influence

In addition to the rural pattern of settlement, the future expansion of various urban settlements becomes a location constraint for the corridor. Within this region the distinction between the generalized corridor route alternatives become less meaningful by virtue of the proximity of the alternative corridor routes within this region. It would be feasible to combine any route through the region of metropolitan influence with the major component of any of the three alternatives which are posed.

Assuming the desirability of maintaining corridor alignments parallel to either axis of the township subdivision grid, the two major location constraints within this region become the future expansion of such communities as Fort Saskatchewan, Gibbons, Bon Accord and Redwater, and the direction which the corridor will take from the Edmonton terminal of the corridor.

Alternative routes are outlined suggesting an optimal corridor route and a secondary route. Both routes assume that the initial portion of the corridor would follow east - west subdivision lines and proceed eastward from the Edmonton pipeline terminal complex. The optimal route follows an alignment parallel to Highway 16 East to a point from which it proceeds directly north on the east side of Fort Saskatchewan. This alignment would avoid any planned residential expansion of Fort Saskatchewan and would also bypass existing and proposed industrial expansion of the Fort Saskatchewan area. By virtue of the fact that this route follows the existing lines of subdivision, and that it bypasses only one major settlement for which foreseeable expansion is anticipated, it is suggested as the optimal route. The secondary route involves more jogs to avoid existing communities and such other features as existing highways, railways and waterways.

The optimal route in the region of metropolitan influence could be adapted to tie into any of the three generalized route alternatives. However, in view of the fact that it ties most directly to the Central corridor route in an alignment which, in

the settled agricultural region, is capable of following existing lines of subdivision, the optimal route should be regarded as a logical component in the central corridor route alternative.

F. The Edmonton Metropolitan Region

The single most important constraint with this region, as discussed previously, is the need to follow existing lines of subdivision in an east-west direction. This constraint may be translated into two route alternatives: one which would follow Highway 16 to the east in an alignment parallel to and immediately south of the Highway; and, one which proceeds directly east from the Edmonton pipeline terminal.

The route paralleling existing highways would tend to adopt more comprehensively the concept of multiple use transportation corridors in that the corridor would follow an existing transportation facility. The space consumed by the pipelines and powerlines could, at the same time, serve as a major green strip of buffer between the Highway and any development that might take place to the south such as the extension of Sherwood Park. It is the combination of multiple transportation uses and the possibility of creating a meaningful buffer zone that makes this route the most desirable within the Edmonton metropolitan region.

The alternative route, proceeding directly east of the Edmonton pipeline terminal, would traverse that area which is proposed for future expansion of Sherwood Park. In the event that a pipeline corridor in this location were to become a component in the green space system of the expanded community, it could be a desirable injection of open space into an urban area. On the other hand, it would preclude the possibility of carrying power transmission lines through the urban area and would therefore not be a multi-use corridor. If, however, this route was developed as a multi-use corridor, with powerlines, it could be used as a northern boundary to the proposed expansion of Sherwood Park and thereby contain the development of that community to something more modest than is contemplated under present developers proposals. A significant factor in choosing between these minor route alternatives might be the desires of Sherwood Park with respect to the future size of their community.

G. Conclusions

On the basis of the foregoing discussion, the generalized corridor route which emerges as being most desirable from the standpoint of the human settlement pattern is a modified version of the Central route. Assuming that appropriate adjustments in this route are made in the Edmonton metropolitan region and the Fort McMurray region, this route in combination with the constraints that will be defined by other members of the study group, is likely to emerge as the most desirable route from the composite standpoint of the study group.

ATHABASCA TAR SANDS TO EDMONTON
CORRIDOR STUDY - ROUTE ASSESSMENT

An assessment of the advantages and disadvantages of the West, Central and East route proposals for the location of the proposed corridor from the Athabasca Tar Sands to Edmonton must of course take into account the type of facility to be accommodated in each proposal and the effect that the construction and operation of each facility will have.

Certain facilities exist now or are to be constructed in any case, i.e. the N.A.R. exists in the location of the East route, Highway 63 and a 50' pipeline corridor exists in the location of the Central route, a powerline is proposed to be constructed from Edmonton to Tar Island in the vicinity of the location of the West route from Edmonton to Calling Lake and a powerline is proposed to be constructed from Mitsue to join the proposed West route from about Tp. 84 Rge. 20, northeast of Wabasca Lake to Tar Island.

It does not appear within the realms of common sense or economics to:

(a) construct an all-weather access road (public along the East route;

(b) construct a railway along the Central or West routes;

or (c) construct an all-weather access road (public) along the West route beyond the existing roads leading to Calling Lake.

The considerations that are then left for assessment appear to be as follows:

(a) East Route:

1. Existing - N.A.R.
2. To Construct - pipeline(s) and powerline(s).

(b) Central Route:

1. Existing - Highway 63
   - 50 ft. wide pipeline right-of-way with two pipelines serving G.C.O.S.
2. To Construct - additional pipeline(s).
   - powerline(s).

(c) West Route:

1. Existing - highway and road system from Edmonton to Calling Lake.
2. To Construct - pipeline(s) Edmonton to Tar Island.
   - access road.

The assessment of the environmental impact the existing facilities have had for the Central and East routes was reported in our study contained in Volume 4. In general, the existing pipelines in the Central route have had a minimal adverse environmental impact, the N.A.R. has had a moderate adverse environmental impact and the highway, Hwy. 63 has had a moderate to high adverse environmental impact. All these effects are in relation to river and stream crossings.

We have added the proposed three routes to our Environment Sensitivity Map and have prepared the following table, listing the effects the construction and operation of the various facilities will have from the point of view of stream and river crossings. The facilities being considered in each case are those set forth above to be constructed for each route. Note that the economics of the various proposals have not been considered but obviously should and will have a major bearing on the final choice.

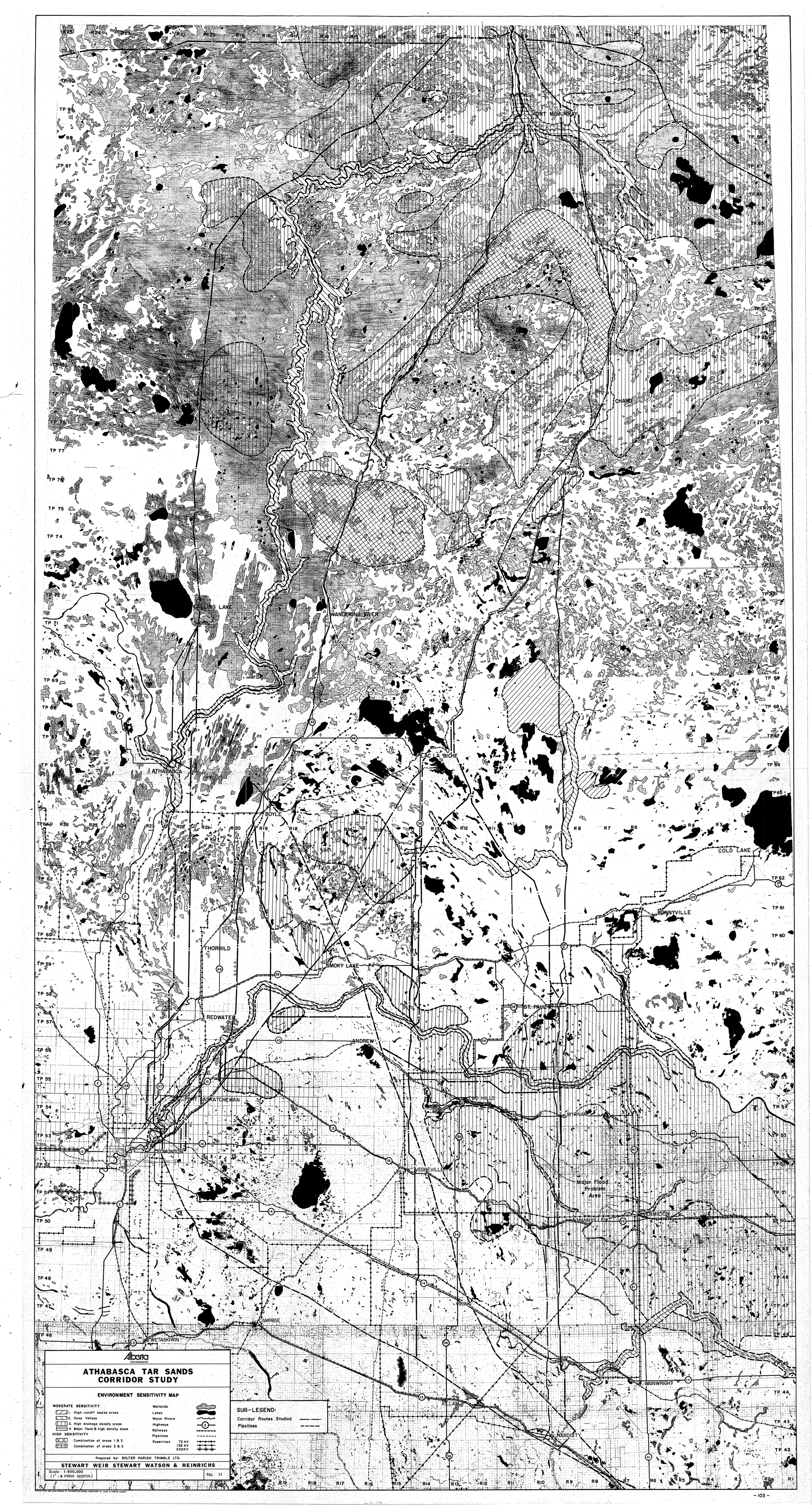

ATHABASCA TAR SANDS
CORRIDOR STUDY
ENVIRONMENT SENSITIVITY MAP
MODERATE SENSITIVITY
1. High runoff source areas
2. Deep Valleys
3. High drainage density areas
4. Major flood & high density areas
HIGH SENSITIVITY
Combination of areas 1 & 3
Combination of areas 2 & 3
Wetlands
Lakes
Major Rivers
Highways
Railways
Pipelines
Powerlines
72 KV
138 KV
240KV
SUB-LEGEND:
Corridor Routes Studied
Pipelines
Major Flood Problem Area
Prepared by: SOLTER PARISH TRIMBLE LTD.
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1:500,000
(1" = 8 miles approx.)
No. 11
FORT MCMURRAY
CHARD
CONKLIN
CALLING LAKE
WANDERING RIVER
LAC LA BICHE
ATHABASCA
BOYLE
COLD LAKE
BONNYVILLE
THORHILD
SMOKY LAKE
ST. PAUL
REDWATER
ANDREW
FORT SASKATCHEWAN
EDMONTON
VEGREVILLE
MANNVILLE
VERMILION
VIKING
KILLAM
HARDISTY
WAINWRIGHT
LAMPRSE
WETASKIWIN

TABLE 6. CORRIDOR ASSESSMENT

	East	Central	West
Existing Facilities -			
- Railway	Yes	No	No
- Highway	to be built	Yes	to be built
- Pipelines	No	Yes	No
- Powerline	No	No	No
Facilities to be Constructed -			
- Railway	No	No	No
- Road	Yes	No	Yes
- Pipeline(s)	Yes	Yes	Yes
- Powerline(s)	Yes	Yes	Yes
No. Rivers to be Crossed	14	15	14
No. Creeks to be Crossed	180	134	105
Miles of High Run-off Area	nil	31	nil
No. of Deep Valleys to be Crossed	2	4	4
Miles of High Drainage Density Area	103	88	31
Potential Extent of Pollution Due to Failure	High	Moderate-High	Small

An examination of the above table indicates that if the facilities specified are to be constructed, then the West route is the best from the point of view of adverse environmental impact, the Central route is next best and the East route is the worst.

Thousands of miles of pipelines and powerlines have been constructed and are being maintained throughout Alberta without access roads and we do not feel that access roads as such are necessary in the case under consideration. Winter constructed roads of course are required during construction but unlike access roads, do not need culvert or bridge stream crossings.

If however, it is decided that an access road is necessary along the proposed pipeline(s) and/or powerline(s) then the Central route

is the most desirable alternative since Hwy. 63 presently exists and no new culverts or bridges need be constructed at stream crossings.

The East route, following the existing N.A.R. is not desirable with or without a road of any kind. The numerous, unspoiled streams and rivers on this route, almost all supporting desirable fish resources should not be subjected to road crossings which will, even with the greatest construction care, have some adverse environmental effect.

In summary then, the order of preference for the various routes are as follows:

(a) Facilities to be Constructed, not including an Access Road

1. West Route (best)
2. Central Route
3. East Route (worst)

(b) Facilities to be Constructed to Include an Access Road

1. Central Route (best)
2. West Route
3. East Route (worst)

In all cases, natural forested separations should be left between the various facilities where possible. Environmentally, at stream crossings, the stream will suffer less adverse effects by several smaller clearings and crossings than by one wider clearing and crossing. It is also generally accepted, that the visual impact of powerlines along highways is a factor to be avoided if possible and the two should be separated.

The engineering and safety features of powerlines and pipelines in the same corridor require consideration and the visual, safety and radio interference features of powerlines and highways in the same corridor require careful evaluation.

ASSESSMENT OF THE THREE ALTERNATIVE ROUTES TO EDMONTON FROM THE WILDLIFE STANDPOINT.

In this study we are concerned primarily for those species which could suffer losses through destruction of habitat or harrassment of

individuals. This might occur either during the corridor construction phase or later as a result of activities along the route or in previously inaccessible areas nearby. For endangered species such as the whooping crane or the peregrine falcon and other such as the woodland caribou, otter, wolverine, great blue heron, bald and golden eagles and white pelican which are becoming increasingly scarce, the proximity of the route to known nesting areas, migratory stopovers or home ranges must also be considered.

The central route is the only one of the three proposed routes to already contain a highway. Since the major impact in building a transportation corridor occurs with the construction of a road (Vol. 6, Chapter iv), by comparison, very little additional environmental damage or harrassment of animals is expected to occur with the addition of pipeline and power facilities along this route (there would be no need for a railway since one already exists along the eastern route).

In contrast, both the eastern and western routes would require construction of a road (probably a two-lane all-weather type) for servicing of power and pipeline facilities. For the western route, this would have the effect of opening up the wilderness area north of Pelican Lake where no road presently exists. While this may be of interest to hunters and trappers, this is not in the best interests of a large number of wildlife species, nor would this route be favored by the numerous proponents of wilderness areas who, like myself, see the necessity of preserving what remains of our once vast primitive areas. The probably long term effects of placing a road in this area are best illustrated by referring to the examples presented in Figures 4-9, Chapter iii, Volume 4. Here, the former and present ranges in Alberta of six species of large mammals are included to show the effects of human interference. I doubt that further comment is necessary!

The eastern route is sensitive for a number of reasons. First, even though a railroad does exist within the forest zone of this route, few persons outside of residents in the area who fish or operate traplines (Vol. 4, Chapter iii, Fig. 10) would bother to venture out on foot, motorbike or skidoo along the railroad right-

of-way. However, with the construction of a road a similar situation would arise here as described for the Western route. Second, the Gordon Lake area is of particular concern to the Canadian Wildlife Service because this lake and others in the vicinity are heavily utilized by migrating waterbirds. Any roads built in the vicinity of these lakes would eventually result in increased human traffic into this sensitive region to the probable detriment of birds utilizing this area (remember, we are considering the long term as well as the immediate effects). The plight of the woodland caribou is a third example. This species has been observed crossing the railroad tracks south of Behan during the seasonal migration (Vol. 4, Chapter 3, Fig. 3, Appendix p. 216). These are shy creatures and it is quite possible that the presence of a road in combination with the existing railroad would act as an effective barrier in preventing these animals from completing their migratory pattern. In the agricultural zone, the main concern is the destruction of wetlands important to breeding and migrating waterfowl.

Of the three routes, then, the Central corridor is the only one to have received any 'checks' for first choice (Tables 7 & 9). This route will cause the least impact on birds and mammals and is therefore the best route of the three.

EXPLANATION OF TABLES

Tables 7 and 9 describe the possible environmental impact on birds and mammals within the study area for the West, Central and East proposed routes from Tar Island to Edmonton. Each of the three routes has been subdivided into the urban and industrial fringe in the Edmonton area (U), the agricultural zone north of Township 68 (A) (somewhat north of this for the Central route - refer to Fig. 1, p. 169, Volume 4, Cultivated, Pasture and Wooded Lands) and the forest zone north of the agricultural area to Fort McMurray (F).

Symbols have been used to denote positive (+), negative (-) or neutral (o) effects on members of a species. A check (✓) has been added to indicate, where possible, a first choice among the

three routes. To illustrate, the American bittern, for example, is a common summer resident in the agricultural and forest zones. This bird prefers the borders of potholes and shallow lakes where cattails and other emergent plants are found. It is not apt to be found in the urban and industrial fringe; therefore a 'o' has been placed in the 'U' category for the West, Central and East routes. The construction of a road or pipeline will involve drainage of wetlands wherever these are encountered. Since a corridor along any of the three routes may prove detrimental to members of this species by destroying suitable habitat, a negative (-) has been placed in the agricultural and forest zones of the three routes. However, a check (✓) has been added to both the agricultural and forest zones of the central route indicating this to be the best of the three routes in these two catagories. The reasoning behind this is that since a highway already exists along this route, no further roads will be built for the servicing of corridor facilities. Also, since one pipeline exists already, additional lines could be added alongside the existing line or beside the highway with limited disturbance to the environment. In both the East and West routes, however, considerable natural drainage may be disturbed for construction of the road and pipelines.

Some 'o's have been added because members of a species do not occur in a particular area. For example, the willow ptarmigan winters only in the northern forests of our study region. Therefore, a 'o' has been placed in the urban and agricultural categories. Other 'o's have been added because although members of a species may be found in a particular zone, the corridor will not likely affect the bird of its habitat. To avoid confusion the checklists of birds and mammals occurring in the study area should be used for reference (Volume 4, Chapter III, Tables 2, 3). Another point worth mentioning is that although a species may be listed in the checklist as a common breeding bird in the northern forests, it will migrate through the agricultural zone on its way to and from wintering grounds in the south. This has been taken into consideration during preparation of the matrix. In addition, both the impact during the construction phase and the possible long-term effects have been considered.

TABLE 7. Possible impact of the three proposed routes on birds in the study area.

Species	Comparison of 3 routes: West U	West A	West F	Central U	Central A	Central F	East U	East A	East F
Common Loon	o	o	-	o	o	-	o	o	-
Arctic Loon	o	o	-	o	o	-	o	o	-
Red-throated Loon	o	o	-	o	o	-	o	o	-
Red-necked (Holboell's) Grebe	o	-	-	o	-	-	o	-	-
Horned Grebe	o	-	-	o	-	-	o	-	-
Eared Grebe	o	-	-	o	-	-	o	-	-
Western Grebe	o	o	-	o	o	-	o	-	-
Pied-billed Grebe	o	-	-	o	-	-	o	-	-
White Pelican	o	-	-	o	-	-	o	-	-
Double-crested Cormorant	o	-	-	o	-	-	o	-	-
Great Blue Heron	o	-	-	o	-	-	o	-	-
American Bittern	o	-	-	o	-	-	o	-	-
Whistling Swan	o	-	-	o	-	-	o	-	-
Canada Goose	o	-	-	o	-	-	o	-	-
White-fronted Goose	o	-	-	o	-	-	o	-	-
Snow Goose	o	-	-	o	-	-	o	-	-
Blue Goose	o	-	-	o	-	-	o	-	-
Ross' Goose	o	-	-	o	-	-	o	-	-
Mallard	o	-	-	o	-	-	o	-	-
Gadwall	o	-	-	o	-	-	o	-	-
Pintail	o	-	-	o	-	-	o	-	-
Green-winged Teal	o	-	-	o	-	-	o	-	-
Blue-winged Teal	o	-	-	o	-	-	o	-	-

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
American Widgeon	o	-	-	o	↙	↙	o	-	-
Shoveler	o	-	-	o	↙	↙	o	-	-
Redhead	o	o	-	o	↙	↙	o	o	-
Ring-necked Duck	o	-	-	o	↙	↙	o	-	-
Canvasback	o	o	-	o	↙	↙	o	o	-
Lesser Scaup	o	o	-	o	↙	↙	o	o	-
Common Goldeneye	o	-	-	o	↙	↙	o	-	-
Barrow's Goldeneye	o	-	-	o	↙	↙	o	-	-
Bufflehead	o	-	-	o	↙	↙	o	-	-
Oldsquaw	o	o	-	o	o	↙	o	o	-
Harlequin Duck	o	-	-	o	↙	↙	o	-	-
White-winged Scoter	o	o	-	o	o	↙	o	o	-
Surf Scoter	o	o	-	o	o	↙	o	o	-
Ruddy Duck	o	o	-	o	↙	↙	o	o	-
Hooded Merganser	o	-	-	o	↙	↙	o	-	-
Common Merganser	o	o	-	o	↙	↙	o	o	-
Red-breasted Merganser	o	o	-	o	o	↙	o	o	-
Turkey Vulture	o	o	o	o	↙	o	o	-	o
Goshawk	o	o	-	o	↙	↙	o	o	-
Sharp-shinned Hawk	o	o	-	o	↙	↙	o	o	-
Cooper's Hawk	o	o	o	o	↙	o	o	o	o
Red-tailed Hawk	o	o	+	o	↙	↙	o	o	+
Broad-winged Hawk	o	o	+	o	↙	↙	o	o	+
Swainson's Hawk	o	o	o	o	o	o	o	o	o
Rough-legged Hawk	o	o	o	o	o	o	o	o	o
Golden Eagle	o	o	o	o	↙	o	o	o	o

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Bald Eagle	o	o	-	o	o	-	o	o	-
Marsh Hawk	o	o	+	o	o	+	o	o	+
Osprey	o	o	-	o	o	-	o	o	-
Peregrine Falcon	o	o	-	o	o	o	o	o	o
Pigeon Hawk	o	o	o	o	o	o	o	o	o
Sparrow Hawk	o	o	+	o	o	+	o	o	+
Spruce Grouse	o	o	-	o	o	-	o	o	-
Ruffed Grouse	o	o	+	o	o	+	o	o	+
Willow Ptarmigan	o	o	+	o	o	+	o	o	+
Sharp-tailed Grouse	o	o	+	o	o	+	o	o	+
Ring-necked Pheasant	o	o	o	o	o	o	o	o	o
Gray (Hungarian) Partridge	o	o	o	o	o	o	o	o	o
Whooping Crane	o	-	-	o	-	-	o	-	-
Sandhill Crane	o	o	-	o	o	-	o	o	-
Virginia Rail	o	-	o	o	-	o	o	-	o
Sora Rail	o	-	-	o	-	-	o	-	-
American Coot	o	-	-	o	-	-	o	-	-
Semipalmated Plover	o	o	-	o	o	o	o	-	-
Piping Plover	o	o	o	o	o	o	o	-	o
Yellow Rail	o	-	-	o	-	-	o	-	-
Killdeer	o	o	o	o	o	o	o	o	o
American Golden Plover	o	o	o	o	o	o	o	o	o
Black-bellied Plover	o	-	-	o	-	-	o	-	-
Ruddy Turnstone	o	o	-	o	o	o	o	-	-
Common (Wilson's) Snipe	o	-	o	o	-	o	o	-	o
Whimbrel	o	o	-	o	o	-	o	-	-
Upland Plover	o	o	o	o	o	o	o	o	o

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Spotted Sandpiper	o	-	-	o	↙	↙	o	-	-
Solitary Sandpiper	o	o	-	o	o	↙	o	o	-
Willet	o	-	o	o	↙	o	o	-	o
Greater Yellowlegs	o	o	-	o	o	↙	o	o	-
Lesser Yellowlegs	o	-	-	o	↙	↙	o	-	-
Knot	o	o	-	o	↙	↙	o	-	-
Pectoral Sandpiper	o	-	-	o	↙	↙	o	-	-
White-rumped Sandpiper	o	o	-	o	↙	↙	o	-	-
Baird's Sandpiper	o	-	-	o	↙	↙	o	-	-
Least Sandpiper	o	-	-	o	↙	↙	o	-	-
Dunlin	o	o	-	o	↙	↙	o	-	-
Long-billed Dowitcher	o	-	-	o	↙	↙	o	-	-
Stilt Sandpiper	o	o	-	o	o	↙	o	o	-
Semipalmated Sandpiper	o	-	-	o	↙	↙	o	-	-
Buff-breasted Sandpiper	o	o	o	o	↙	↙	o	o	o
Marbled Godwit	o	-	o	o	↙	o	o	-	o
Hudsonian Godwit	o	o	-	o	↙	↙	o	-	-
Sanderling	o	o	-	o	↙	↙	o	-	-
Red Phalarope	o	o	-	o	↙	↙	o	-	-
Wilson's Phalarope	o	-	-	o	↙	↙	o	-	-
Northern Phalarope	o	-	-	o	↙	↙	o	-	-
Parasitic Jaeger	o	o	-	o	↙	↙	o	-	-
Long-tailed Jaeger	o	o	-	o	↙	↙	o	-	-
Glaucous-winged Gull	o	o	-	o	↙	↙	o	-	-
Herring Gull	o	o	-	o	↙	↙	o	-	-
California Gull	o	o	-	o	↙	↙	o	-	-

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Ring-billed Gull	o	o	-	o	o	o	o	-	-
Mew Gull	o	o	-	o	o	o	o	-	-
Franklin's Gull	o	-	-	o	-	-	o	-	-
Bonaparte's Gull	o	o	-	o	o	-	o	-	-
Sabine's Gull	o	o	-	o	o	o	o	-	-
Forster's Tern	o	-	o	o	-	o	o	-	o
Common Tern	o	o	-	o	o	o	o	-	-
Caspian Tern	o	o	-	o	o	o	o	-	-
Black Tern	o	-	-	o	-	-	o	-	-
Domestic Pigeon (Rock Dove)	o	o	o	o	o	o	o	o	o
Mourning Dove	o	o	+	o	o	+	o	o	+
Black-billed Cuckoo	o	o	o	o	o	o	o	o	o
Great Horned Owl	o	o	+	o	o	+	o	o	+
Snowy Owl	o	o	+	o	o	+	o	o	+
Hawk Owl	o	o	+	o	o	+	o	o	+
Barred Owl	o	o	o	o	o	o	o	o	o
Great Gray Owl	o	o	o	o	o	o	o	o	o
Long-eared Owl	o	o	+	o	o	+	o	o	+
Short-eared Owl	o	o	+	o	o	+	o	o	+
Boreal (Richardson's) Owl	o	o	o	o	o	o	o	o	o
Saw-whet Owl	o	o	o	o	o	o	o	o	o
Common Nighthawk	o	o	+	o	o	+	o	o	+
Ruby-throated Hummingbird	o	o	+	o	o	+	o	o	+
Belted Kingfisher	o	o	o	o	o	o	o	o	o
Yellow-shafted Flicker	o	o	o	o	o	o	o	o	o
Pileated Woodpecker	o	o	-	o	o	-	o	o	-

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Yellow-bellied Sapsucker	o	o	o	o	o	o	o	o	o
Hairy Woodpecker	o	o	-	o	o	-	o	o	-
Downy Woodpecker	o	o	o	o	o	o	o	o	o
Black-backed Three-toed Woodpecker	o	o	o	o	o	o	o	o	o
Northern Three-toed Woodpecker	o	o	o	o	o	o	o	o	o
Eastern Kingbird	o	o	+	o	o	+	o	o	+
Eastern Phoebe	o	o	+	o	o	+	o	o	+
Say's Phoebe	o	o	o	o	o	o	o	o	o
Yellow-bellied Flycatcher	o	o	-	o	o	-	o	o	-
Traill's (Alder) Flycatcher	o	o	+	o	o	+	o	o	+
Least Flycatcher	o	o	+	o	o	+	o	o	+
Western Wood Pewee	o	o	o	o	o	o	o	o	o
Olive-sided Flycatcher	o	o	o	o	o	o	o	o	o
Hoyt's Horned Lark	o	o	+	o	o	+	o	o	+
Tree Swallow	o	o	o	o	o	o	o	o	o
Violet-green Swallow	o	o	o	o	o	o	o	o	o
Bank Swallow	o	o	o	o	o	o	o	o	o
Barn Swallow	o	o	o	o	o	o	o	o	o
Cliff Swallow	o	o	o	o	o	o	o	o	o
Purple Martin	o	o	o	o	o	o	o	o	o
Gray (Canada) Jay	o	o	o	o	o	o	o	o	o
Blue Jay	o	o	o	o	o	o	o	o	o
Black-billed Magpie	o	o	o	o	o	o	o	o	o
Common Raven	o	o	o	o	o	o	o	o	o
Common Crow	o	o	o	o	o	o	o	o	o
Black-capped Chickadee	o	o	-	o	o	-	o	o	-

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Mountain Chickadee	o	o	o	o	o	o	o	o	o
Boreal Chickadee	o	o	-	o	o	-	o	o	-
White-breasted Nuthatch	o	o	o	o	o	o	o	o	o
Red-breasted Nuthatch	o	o	-	o	o	-	o	o	-
Brown Creeper	o	o	-	o	o	-	o	o	-
House Wren	o	o	+	o	o	+	o	o	+
Winter Wren	o	o	-	o	o	-	o	o	-
Long-billed Marsh Wren	o	-	-	o	-	-	o	-	-
Short-billed Marsh Wren	o	+	o	o	+	o	o	+	o
Catbird	o	o	o	o	o	o	o	o	o
Brown Thrasher	o	o	o	o	o	o	o	o	o
Robin	o	o	+	o	o	+	o	o	+
Varied Thrush	o	o	o	o	o	o	o	o	o
Hermit Thrush	o	o	-	o	o	-	o	o	-
Swainson's Thrush	o	o	-	o	o	-	o	o	-
Gray-cheeked Thrush	o	o	-	o	o	-	o	o	-
Veery	o	o	o	o	o	o	o	o	o
Mountain Bluebird	o	o	+	o	o	+	o	o	+
Eastern Bluebird	o	o	o	o	o	o	o	o	o
Townsend's Solitaire	o	o	o	o	o	o	o	o	o
Golden-crowned Kinglet	o	o	o	o	o	o	o	o	o
Ruby-crowned Kinglet	o	o	o	o	o	o	o	o	o
Water (American) Pipit	o	o	+	o	o	+	o	o	+
Sprague's Pipit	o	o	+	o	o	+	o	o	+
Bohemian Waxwing	o	o	o	o	o	o	o	o	o
Cedar Waxwing	o	o	+	o	o	+	o	o	+

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Northern Shrike	o	o	+	o	o	+	o	o	+
Loggerhead Shrike	o	o	+	o	o	+	o	o	+
Starling	o	o	o	o	o	o	o	o	o
Solitary Vireo	o	o	o	o	o	o	o	o	o
Red-eyed Vireo	o	o	-	o	o	-	o	o	-
Philadelphia Vireo	o	o	+	o	o	+	o	o	+
Warbling Vireo	o	o	o	o	o	o	o	o	o
Black and White Warbler	o	o	-	o	o	-	o	o	-
Tennessee Warbler	o	o	o	o	o	o	o	o	o
Orange-crowned Warbler	o	o	-	o	o	-	o	o	-
Yellow Warbler	o	o	+	o	o	+	o	o	+
Magnolia Warbler	o	o	+	o	o	+	o	o	+
Cape May Warbler	o	o	+	o	o	+	o	o	+
Black-throated Blue Warbler	o	o	o	o	o	o	o	o	o
Myrtle Warbler	o	o	o	o	o	o	o	o	o
Audubon's Warbler	o	o	o	o	o	o	o	o	o
Black-throated Green Warbler	o	o	-	o	o	-	o	o	-
Blackburnian Warbler	o	o	-	o	o	-	o	o	-
Bay-breasted Warbler	o	o	-	o	o	-	o	o	-
Blackpoll Warbler	o	o	-	o	o	-	o	o	-
Pine Warbler	o	o	o	o	o	o	o	o	o
Palm Warbler	o	o	+	o	o	+	o	o	+
Ovenbird	o	o	-	o	o	-	o	o	-
Northern Waterthrush	o	o	-	o	o	-	o	o	-
Connecticut Warbler	o	o	+	o	o	+	o	o	+
Mourning Warbler	o	o	+	o	o	+	o	o	+

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Yellowthroat	o	o	-	o	o	-	o	o	-
Wilson's Warbler	o	o	o	o	o	o	o	o	o
Canada Warbler	o	o	+	o	o	+	o	o	+
American Redstart	o	o	+	o	o	+	o	o	+
English (House) Sparrow	o	o	o	o	o	o	o	o	o
Bobolink	o	+	o	o	+	o	o	+	o
Western Meadowlard	o	+	o	o	+	o	o	+	o
Yellow-headed Blackbird	o	-	-	o	-	-	o	-	-
Redwinged Blackbird	o	-	-	o	-	-	o	-	-
Baltimore Oriole	o	o	+	o	o	+	o	o	+
Rusty Blackbird	o	o	-	o	o	-	o	o	-
Brewer's Blackbird	o	+	+	o	+	+	o	+	+
Common Grackle	o	o	o	o	o	o	o	o	o
Brown-headed Cowbird	o	o	o	o	o	o	o	o	o
Western Tanager	o	o	-	o	o	-	o	o	-
Rose-breasted Grosbeak	o	o	-	o	o	-	o	o	-
Evening Grosbeak	o	o	-	o	o	-	o	o	-
Purple Finch	o	o	o	o	o	o	o	o	o
Pine Grosbeak	o	o	-	o	o	-	o	o	-
Bray-crowned Rosy Finch	o	+	o	o	+	o	o	+	o
Hoary Redpoll	o	o	o	o	o	o	o	o	o
Common Redpoll	o	o	o	o	o	o	o	o	o
Pine Siskin	o	o	+	o	o	+	o	o	+
American Goldfinch	o	+	+	o	+	+	o	+	+
Red Crossbill	o	o	o	o	o	o	o	o	o
White-winged Crossbill	o	o	o	o	o	o	o	o	o

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Savannah Sparrow	o	+	+	o	+	+	o	+	+
Leconte's Sparrow	o	o	-	o	o	-	o	o	-
Nelson's (Sharp-tailed) Sparrow	o	o	-	o	o	-	o	o	-
Vesper Sparrow	o	+	+	o	+	+	o	+	+
Slate-coloured Junco	o	o	+	o	o	+	o	o	+
Oregon Junco	o	o	o	o	o	o	o	o	o
Tree Sparrow	o	o	+	o	o	+	o	o	+
Chipping Sparrow	o	o	+	o	o	+	o	o	+
Clay-coloured Sparrow	o	o	+	o	o	+	o	o	+
Harris' Sparrow	o	o	+	o	o	+	o	o	+
White-crowned Sparrow	o	o	+	o	o	+	o	o	+
White-throated Sparrow	o	o	-	o	o	-	o	o	-
Fox Sparrow	o	o	+	o	o	+	o	o	+
Lincoln's Sparrow	o	-	-	o	↙	↙	o	-	-
Swamp Sparrow	o	-	-	o	↙	↙	o	-	-
Song Sparrow	o	o	+	o	o	+	o	o	+
McCowan's Longspur	o	o	o	o	o	o	o	o	o
Lapland Longspur	o	o	+	o	o	+	o	o	+
Smith's Longspur	o	o	+	o	o	+	o	o	+
Snow Bunting	o	o	o	o	o	o	o	o	o

TABLE 8. Summary of Table 7: Possible impact of the three proposed routes on birds in the study area.

(a) West Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	252	191	79
May improve conditions (+)	0	8	53
May be detrimental (-)	0	53	120
First choice among the 3 routes (✓) (where a choice could be made)	0	0	0

(b) Central Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	252	191	98
May improve conditions	0	8	53
May be detrimental (-)	0	53	101
First choice among the 3 routes (✓) (where a choice could be made)	0	96	99

(c) East Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	252	168	80
May improve conditions (+)	0	8	53
May be detrimental (-)	0	76	119
First choice among the 3 routes (✓) (where a choice could be made)	0	0	0

TABLE 9. Possible impact of the three proposed routes on mammals in the study area.

Species	Comparison of 3 routes								
	West			Central			East		
	U	A	F	U	A	F	U	A	F
Common Cinereous Shrew	o	o	+	o	o	+	o	o	+
Hayden Cinereous Shrew	o	o	o	o	o	o	o	o	o
American Saddle-backed Shrew	o	o	o	o	o	o	o	o	o
Dusky Mountain Shrew	o	o	+	o	o	o	o	o	o
American Water Shrew	o	o	o	o	o	o	o	o	o
Northern Pigmy Shrew	o	o	+	o	o	+	o	o	+
Little Brown Bat	o	o	+	o	o	+	o	o	+
Silver-haired Bat	o	o	o	o	o	o	o	o	o
Pale Big Brown Bat	o	o	+	o	o	+	o	o	+
Hoary Bat	o	o	o	o	o	o	o	o	o
White-tailed Prairie Hare	o	o	o	o	o	o	o	o	o
American Varying Hare	o	o	+	o	o	+	o	o	+
Canada Woodchuck	o	o	+	o	o	+	o	o	+
Richardson Ground Squirrel	o	o	o	o	o	o	o	o	o
Striped Ground Squirrel	o	o	o	o	o	o	o	o	o
Franklin Ground Squirrel	o	o	o	o	o	o	o	o	o
Little Northern Chipmunk	o	o	+	o	o	+	o	o	+
Mackenzie Red Squirrel	o	o	+	o	o	+	o	o	+
Hudson Bay Flying Squirrel	o	o	+	o	o	+	o	o	+
Richardson Pocket Gopher	o	o	o	o	o	o	o	o	o
Canada Beaver	o	o	±	o	o	-	o	o	-
Boreal White-footed Mouse	o	o	o	o	o	o	o	o	o
Richardson Lemming Vole	o	o	±	o	o	-	o	o	-

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Athabasca Red-backed Vole	o	o	o	o	o	o	o	o	o
Prairie Phenacomys Vole	o	o	o	o	o	o	o	o	o
Mackenzie Phenacomys Vole	o	o	-	o	o	-	o	o	-
Drummond Meadow Vole	o	o	+	o	o	+	o	o	+
Chestnut-cheeked Vole	o	o	+	o	o	+	o	o	+
Little Upland Vole	o	o	o	o	o	o	o	o	o
Northwestern Muskrat	o	-	-	o	-	-	o	-	-
House Rat	o	o	o	o	o	o	o	o	o
House Mouse	o	o	o	o	o	o	o	o	o
Hudson Bay Jumping Mouse	o	o	+	o	o	+	o	o	+
Saskatchewan Jumping Mouse	o	o	o	o	o	o	o	o	o
Alaska Porcupine	o	o	-	o	o	-	o	o	-
Prairie Coyote	o	o	o	o	o	o	o	o	o
Northwestern Coyote	o	o	o	o	o	o	o	o	o
Northern Timber Wolf	o	o	-	o	o	-	o	o	-
Saskatchewan Timber Wolf	o	o	-	o	o	-	o	o	-
Northern Plains Red Fox	o	o	o	o	o	o	o	o	o
British Columbia Red Fox	o	o	-	o	o	-	o	o	-
American Balck Bear	o	o	-	o	o	-	o	o	-
Emperor Grizzly	o	o	-	o	o	o	o	o	o
Hudson Bay Marten	o	o	-	o	o	-	o	o	-
Alaska Marten	o	o	-	o	o	-	o	o	-
British Columbia Fisher	o	o	-	o	o	-	o	o	-
Richardson Weasel	o	o	-	o	o	-	o	o	-
Least Weasel	o	o	-	o	o	-	o	o	-
Prairie Long-tailed Weasel	o	o	o	o	o	o	o	o	o

Species	West			Central			East		
	U	A	F	U	A	F	U	A	F
Hudson Bay Mink	o	o	-	o	o	-	o	o	-
American Wolverine	o	o	-	o	o	-	o	o	-
American Badger	o	-	o	o	-	o	o	-	o
Northern Plains Skunk	o	o	o	o	o	o	o	o	o
Mackenzie Otter	o	o	-	o	o	-	o	o	-
Canada Lynx	o	o	-	o	o	-	o	o	-
Manitoba Wapiti	o	o	-	o	o	o	o	o	o
Rocky Mountain Mule Deer	o	o	+	o	o	+	o	o	+
Dakota White-tailed Deer	o	o	+	o	o	+	o	o	+
Northwestern Moose	o	o	+	o	o	+	o	o	+
Western Woodland Caribou	o	o	-	o	o	-	o	o	-

TABLE 10. Summary of Table 9: Possible impact of the three proposed routes on mammals in the study area.

(a) West Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	60	58	23
May improve conditions (+)	0	0	16
May be detrimental (-)	0	2	21
First choice among the 3 routes (✓) where a choice could be made)	0	0	0

(b) Central Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	60	58	26
May improve conditions (+)	0	0	15
May be detrimental (-)	0	2	19
First choice among the 3 routes (✓) (where a choice could be made)	0	10	20

(c) East Corridor

	Urban/industrial fringe	Agricultural zone	Forest zone
Not likely to affect (o)	60	58	26
May improve conditions (+)	0	0	15
May be detrimental (-)	0	2	19
First choice among the 3 routes (✓) (where a choice could be made)	0	0	0

USE OF THE CANADA LAND INVENTORY MAPS FOR THE ROUTE ALTERNATIVE ASSESSMENT

In the other volumes prepared for this study, specifically Volume 4, Part 1 and 2, Volume 5, and Volume 6, we have attempted to assess the areas of our study with respect to the existing conditions and facilities. The generalized corridors as shown on Figure 7 , Page 52, Route Alternatives were analyzed according to the Canada Land Inventory Maps. They are: Present Land Use, Soil Capability for Agriculture, Land Capability for Forestry, Land Capability for Outdoor Recreation, Land Capability for Wildlife - Ungulates, Land Capability for Wildlife - Waterfowl, Water Capability for Sport Fish. This combined with the information gathered in the previous appendices is used to obtain an assessment of the routes described. In addition, supplementary routes of possible corridors are listed so that comparisons can be made with combinations of different route segments. Also, the Interprovincial pipeline was analyzed from Edmonton to north of Strome and from there to Hardisty for comparison purposes.

The environs of Tar Island which we have arbitrarily designated as our starting point and head in a southerly direction. The West route stays on the west side of the Athabasca River until the Town of Athabasca, then goes straight south to Edmonton as the terminal. The Central route follows the G.C.O.S. line to Edmonton. The East route follows the N.A.R. to Lac La Biche, and then diagonally straight through to Edmonton or alternately from Lac La Biche south through Vegreville to the Interprovincial Pipeline (I.P.P.L.). The Hardisty route leaves the N.A.R. about Devenish and heads south through the west ridge of the Primrose Lake Air Weapons Range to connect with the I.P.P.L. at Hardisty.

The analysis was made with all the available Canada Land Inventory Maps and mileages calculated in each class of the seven sets of maps. Where data was unavailable, that mileage was totalled and placed at the end of the table of each set.

PRESENT LAND USE

Taken from Canada Land Inventory Maps:

Red Deer 83A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I; Sand River 73L; Pelican 83P; Winefred Lake 73M.

Using air photo interpretation, a classification system, as shown below, evolved which permitted the rapid mapping of broad areas.

A. Present Land Use Classification

Mapping Symbol and Description

B Urban Areas - built up portions of cities, towns, villages and hamlets. Also isolated units such as manufacturing plants, rail yards, military camps.

E Mines, Quarries and Gravel Pits.

O Outdoor Recreation - private or public recreational purposes (resort areas, parks, golf courses, etc.).

H Horticulture - intensive production of specialized agricultural commodities (market gardens, nurseries, sod, poultry, and fur farms).

G Orchards and Vineyards.

A Crop Land - field crops or land in the process of being cleared for field crops.

P Improved Pasture and Forage Crops - grazing land, hay and forage crops, rough pasture.

K Unimproved Pasture and Range Land - natural grasses, grassland and abandoned farmland, and open woodland.

T Productive Woodland - trees 20 feet in height with canopy cover occupying more than 30% of the area. Artificially restocked and planted areas are included.

U Non-productive Woodland - trees under 20 feet in height with canopy cover occupancy less than 30% of the area, largely cut-over or burnt-over land (no evidence of grazing).

M Swamp, Marsh and Bog - open wetland.

S Sand Flats, Dunes and Beaches - exposed sand surfaces biologically unproductive in present state.

L Biologically Unproductive Land Surfaces - rock barrens, badlands, eroded river banks, unvegetated land surfaces.

X Water Surfaces.

Caution: Land-use information deteriorates with time if used solely for inventory. If used to show changes in land use through time and spacial relationships between land use and other land capabilities as will be shown in the Capability Maps following its life, its usefulness is substantially extended.

B. Assessment of Routes for Present Land Use

The assessment of the route alternatives for Present Land Use as given in Table 11 which shows mileages for each land class for the route alternatives looked at. This quantitative assessment was used to choose a route which best suited the conditions expressed in this set of Canada Land Inventory Maps.

From the Tar Sands area, which we have designated as the northern terminus, the Central route causes the least disturbance to the mineable tar sands, followed by the East and West routes respectively. In the environs of Fort McMurray a modified version of the Central route could be adopted. This route would avoid sub-

division areas numbers 3 and 5, if a suitable river crossing could be found. The West route would not cross the Athabasca River until the Town of Athabasca where close detail to a crossing would be necessary. The East route crosses the Clearwater River at an undesirable area above Fort McMurray. The Central route has the most ideal crossing. From the Fort McMurray area through the forested area to the beginning of the agricultural zone, the three routes generally traverse unproductive woodland and swamp. The East route is affected by greater amounts of wetlands followed respectively by the Central and West routes. Therefore, in the forested area, the West route is most suitable using the present land use classification although the Central route would probably take preference since the highway exists and additional pipelines and powerlines could be easily accommodated. In the agricultural belt the East route would branch into three separate routes; one to Edmonton, one to Vegreville, and one to Hardisty. According to soils expertise, cropland can, with proper reclamation procedures, be restored quite easily and therefore the longer distance through farmland would give that particular route preference. In order of preference the three routes through the agricultural area are Central, West and East routes since the land could be restored to its previous use with minor irregularities. From the agricultural area to the Edmonton fringe area the three "Central" routes generally follow similar land use patterns. Considering subdivision proposals in the foreseeable future one would try to avoid the Central and East routes and concentrate on the West route until they reach the presently designated green belt area in East Edmonton.

A slight modification of the Central route to Edmonton would be most preferable considering best land usage, construction, reclamation, social and economic values.

TABLE 11 PRESENT LAND USE	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
	WEST	CENTRAL	EAST	Ft.McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS B	.4	-	.9	-	.9	-	-	-	-	-	-	-	-
CLASS A	59.4	80.2	51.4	-	-	.4	51.0	48.0	21.85	63.6	20.2	50.1	18.2
CLASS P	7.8	9.2	4.7	-	-	.6	4.1	5.0	1.00	5.5	1.4	6.0	2.0
CLASS K	9.0	12.6	3.6	-	-	.4	3.2	16.9	11.50	20.8	2.6	32.9	1.6
CLASS T	25.4	14.1	24.2	-	4.3	11.0	8.9	3.0	.60	16.4	16.4	4.3	25.0
CLASS U	32.6	16.7	62.4	-	28.4	2.0	32.0	.3	.75	25.5	10.4	6.0	16.3
CLASS M	5.6	3.1	3.5	-	.9	1.0	1.6	2.5	.60	5.4	1.6	.7	3.0
CLASS S	-	-	.1	-	-	-	.1	-	-	-	-	-	.1
CLASS X	.8	.2	.9	-	-	.2	.7	.2	.30	1.3	.2	.5	1.0
Unavailable Data	134.9	135.8	140.9	120.1	20.7	-	-	-	-	-	53.5	-	-
Total Mileages	275.9	271.9	292.5	120.1	55.2	15.6	101.6	75.9	36.60	131.0	106.3	100.5	67.2

Note: Class shown in miles.

SOIL CAPABILITY FOR AGRICULTURE

Taken from Canada Land Inventory Maps:

Red Deer 82A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I;

and Maps prepared by T.W. Peters and Associates

Sand River 73L; Pelican 83P; Winefred Lake 73M; Algar Lake 84A; Waterways 74D.

As is shown below, the mineral soils are grouped into seven classes on the basis of the soil survey information. Soils in Class 1, 2, 3, and 4 are considered capable of sustained use for cultivated field crops; those in Classes 5 and 6 only, for perennial forage crops; those in Class 7 for neither.

Important factors on which the classification is based are:

(1) Soils will be well managed and cropped under a largely mechanized system.

(2) Land requiring improvements (including clearing), that can be made economically by the farmer himself, is classed according to its limitations or hazards in use after the improvements have been made. Land requiring improvements beyond the means of the farmer himself is classed according to its present condition.

(3) The following are not considered: distance to market, kind of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators and hazard of crop damage by storms.

This classification does not include capability of soils for trees, tree fruits, small fruits, ornamental plants, recreation or wildlife.

Classes are based on intensity, rather than kind, of their limitations for agriculture. Each class includes many kinds of soils and many of the soils in any class require different management and treatment.

A. Soil Capability for Agriculture Classification

Class 1. Soils in this class have no significant limitations in use for crops.

Class 2. Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.

Class 3. Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.

Class 4. Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.

Class 5. Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops and improvement practices are feasible.

Class 6. Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible.

Class 7. Soils in this class have no capability for arable culture or permanent pasture.

0 Organic soils - soils with an accumulation of sedge or peat moss over 12 inches thick. Areas of deep organic accumulation that are mainly soft sphagnum moss found chiefly on the surface of bogs are considered to be non-arable and should remain as water reservoirs. Many areas are in the depressional spots within the larger sandy areas.

B. Assessment of Routes for Soil Capability

From Fort McMurray to about Wandering River, Alberta, capabilities for agriculture is very limited. We are primarily in the gray-wooded soil zone from Wandering River north, having extensive wet soils around the base of the high lands. In the higher land and in the peat bogs, one would encounter frost in the middle of summer. Highway 63 goes through a lot of wetland which is good for growing alfalfa, hay or coarse cereals, but, is too wet in its native state for cropping.

Where Wandering River starts to flow east we are on higher land having a short growing season with frost leaving late in the spring and coming early in the fall.

There are still quite a few problems associated with these soils. Powerline and pipeline construction encounters problems in silt-loam textured soils which have no stability or are wet.

In the sand areas, destruction of ground vegetation is a problem. Since little remains to hold the sand down, wind erosion can occur. There is very little organic matter on sandy soils; they are leached of any nutrients and once peat matter is gone only sand remains. Organic soils and peats are hard to handle in the summer. It is difficult to construct a pipeline through peat bog in summer so this digging is done in the winter. If the pipeline should break one has a difficult time gaining access; therefore one tries to avoid this type of area for highways and pipelines. Powerline construction does not encounter much trouble. Concrete slabs are sunk and towers built for stabilization.

In the vicinity of Wandering River one encounters heavy clay. One can get onto the land when the clay has a certain moisture content. If plowed when too wet, big clods are created that are hard to break down. When backfilling treads through which a pipeline has been built, much time must be spent packing down in order to permit a decent foothold for plants.

South of Wandering River we come into agricultural land, primarily used for growing coarse grains and hay. Around Boyle,

Thorhild and Egremont one comes into our number one climate where most crops can be grown with reasonable success, i.e. wheat, oats, barley, rye and rape.

In the more settled areas pipelines do not cause much trouble if the organic matter or six to eight inches of topsoil is removed and replaced after digging and backfilling the trench. In a year a good feedbed will assure a good crop.

On the black soils between Edmonton and Fort Saskatchewan after backfill a crop had its highest yield over the trench. Yields were slightly less in machine tracks and rose again on the other side of the tracks levelling off to the general yield of the crop that was growing there. This all took place within about one year. This is not an area of great concern if one avoids the sandy areas and gray wooded soils which occur between Wandering River and Fort McMurray. Once exposed, the gray material is disrupted; it is just a pure corpse of silium. This causes problems in reconditioning the soil once the highway or pipeline has disturbed the area.

Highway construction people have followed well-drained soil to cut down some of the problems associated with sand and wet soil. If the highway is followed few drainage problems would be encountered and maintenance of the pipeline would be simplified.

From the high lands north of Wandering River, there are some areas of slumping. This is a problem one will have when two or three materials, i.e. sand over till or clay, loam over clay, have water moving between the layers. A good job has been done in constructing pipelines over dryer land.

A lot of people complain about these pipelines cutting through their property especially in the better soils but with modern techniques it does not take too long for these areas to regrow and come back in full production.

From Devenish south to east of Pinehurst Lake the majority of the soils in this area are Organic and Gleysolic or wetland soils. The Podzolic and Brunisolic soils are found mainly in the same areas which have dune-like topography. The Luvisolic soils are found on till material and this material is found on knobs of gently rolling to rolling topography.

This is a sensitive area from an environmental standpoint because of the predominance of wetlands and the sandy nature of many of the well-drained soils.

The Pinehurst Lake to Beaver River portion of the corridor consists of Brunisolic soils of a sandy nature. The topography is more subdued, being undulating to gently rolling (slopes of 3 - 9 percent). There should be very few problems in the establishment of a corridor in this area.

From the Beaver River to Drysdale Lake the soils are mainly Dark Gray and Gray Luvisols developed on medium textured alluvial lacustrine material. The topography is level to gently rolling. As with most Gray Luvisolic soils[1] the main problem here is the vegetating of the disturbed soil. As there is very little organic material in these soils, and the leached sandy nature of the upper horizons, establishment of vegetative cover is more difficult than on the Black Chernozemic soils. However, with proper cultivation and the seeding of legumes and grasses these soils can be rehabilitated fairly readily. This area is extensively cultivated for agricultural purposes.

South of Drysdale Lake to the North Saskatchewan River the soils and topography vary considerably. Adjacent to St. Paul there is a large area of Black Chernozemic soils on relatively level topography. Closer to the river the topography becomes rougher and Gray Luvisolic soils predominate. The upper surface of the soil profile may be quite sandy and gravelly in areas. This area adjacent to the river would be moderately sensitive to disturbance. The area adjacent to St. Paul is farmed extensively and would present relatively few problems in a corridor.

South of the North Saskatchewan River to Mannville the proposed corridor passes through an undulating to rolling hummocky moraine. The soils vary from Black Chernozemic to Gray Luvisolic and have a loam to clay loam texture. They are developed on glacial till. The low areas in the rolling hummocky moraine may be either peaty or intermittent sloughs. The problem in this area outside of the steep slopes is the variability in soils from the top of the knoll to the wet spots in the depressions. There is considerable acreage being farmed in this area.

From Mannville south to Irma the topography is mostly rolling and it is called a hummocky moraine area. The soils are mainly Black Chernozems of a loam texture developed on glacial till of a clay loam to loam texture. The level of gently rolling areas are cultivated whilst the rougher topography is usually left in pasture.

Topography is the main consideration in this area as it is quite complex. This area extends from Irma to near Hardisty. It is perhaps more rolling nature with complex slopes. The soils are Dark Brown Chernozemic and have a loam to clay loam texture. They are developed on glacial till of a clay loam texture. Near Hardisty there are alluvial soils of a sandy loam to sand in texture. Here disturbances of these soils may be followed by soil drifting, otherwise in this portion of the corridor topography is the main feature to be considered.

From Tweedie to the southeast corner of Lac La Biche the corridor passes through rolling land then it passes along the southern edge of Lac La Biche on gently rolling topography and south to a few miles north of the Amisk River. This area has Gray Luvisolic soils of a loam to clay loam texture. These soils are developed on glacial till of a clay loam to clay texture. This portion of the route has fairly large agricultural settlement. From the Amisk River south to west of Vilna the topography is rolling and hilly. The soils are Gray Luvisols. The areas of concern are those of rough topography, rolling or steeper. With the Gray Luvisolic soils the usual precautions have to be taken to establish vegetation.

West of Vilna to the North Saskatchewan River the topography is more subdued. The soils are a mixture of Gray and Dark Gray Luvisols. However, just north of the river there is a very sandy area of Brunisolic soils. These soils are difficult to revegetate because of low nutrient status and low water holding capacity. They are very subject to wind erosion.

From the North Saskatchewan River to Warwick the proposed corridor passes through a level to gently rolling area of Black Chernozemic soils. The soils are primarily developed on glacial

till. At intervals there are areas of Solonetzic soils whose subsoil is quite saline. Relatively few problems would be encountered here.

In the area from Warwick to Vegreville the route passes through a clay lacustrine area which follows the Vermilion River. The soils are Solonetzic[2] and have a very saline subsoil and groundwater is relatively close to the surface. Farther back from the river on slightly higher ground Solonetzic soils are developed on glacial till. Groundwater discharge areas are common in this area.

From Tweedie southeast to the Beaver River the corridor passes through a rough moraine area. The topography is ridgey, slopes are 9 - 15 percent, and the ridges are orientated in a northwest - southeast direction as a rule. The soils are Gray Luvisols of a loam - clay loam texture developed on glacial till. There should not be many problems here as the corridor runs along the slopes rather than up and down and the usual precautions have to be taken in handling Gray Luvisolic soils.

From Beaver River to Drysdale Lake the route follows a southeast direction. The topography is level to gently rolling. The soils are mainly Gray and Dark Gray Luvisols developed on glacial till and alluvial lacustrine deposits. The texture is mainly loamy. This area is a fairly well settled agricultural area.

From the soil standpoint the order of preference for routes would be the Central, East, Vegreville, Hardisty and West routes respectively.

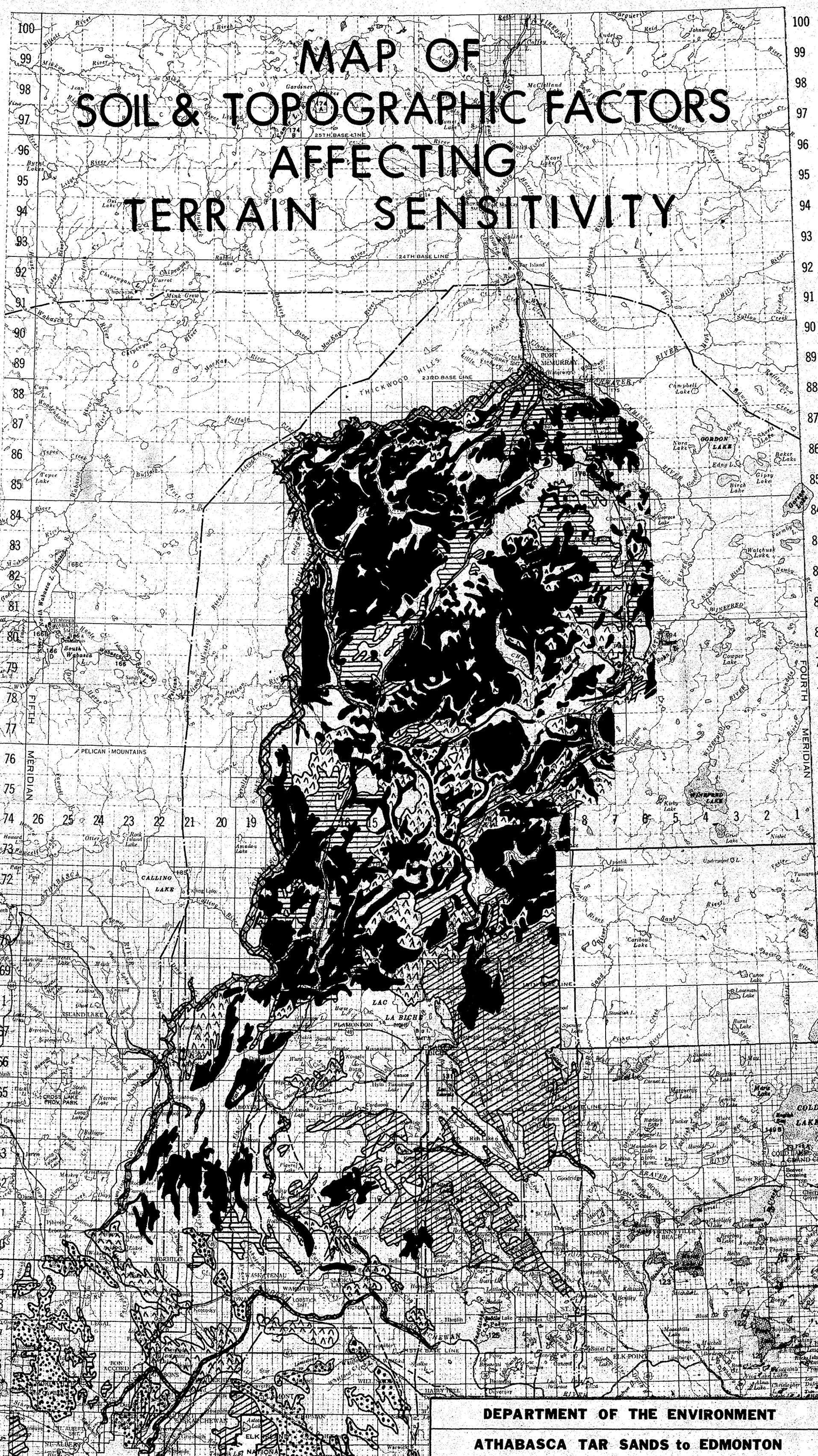
---

(1) Gray Wooded Soils and Their Management. Bull. B-71-1 Dept. of Extension, University of Alberta. 1971.

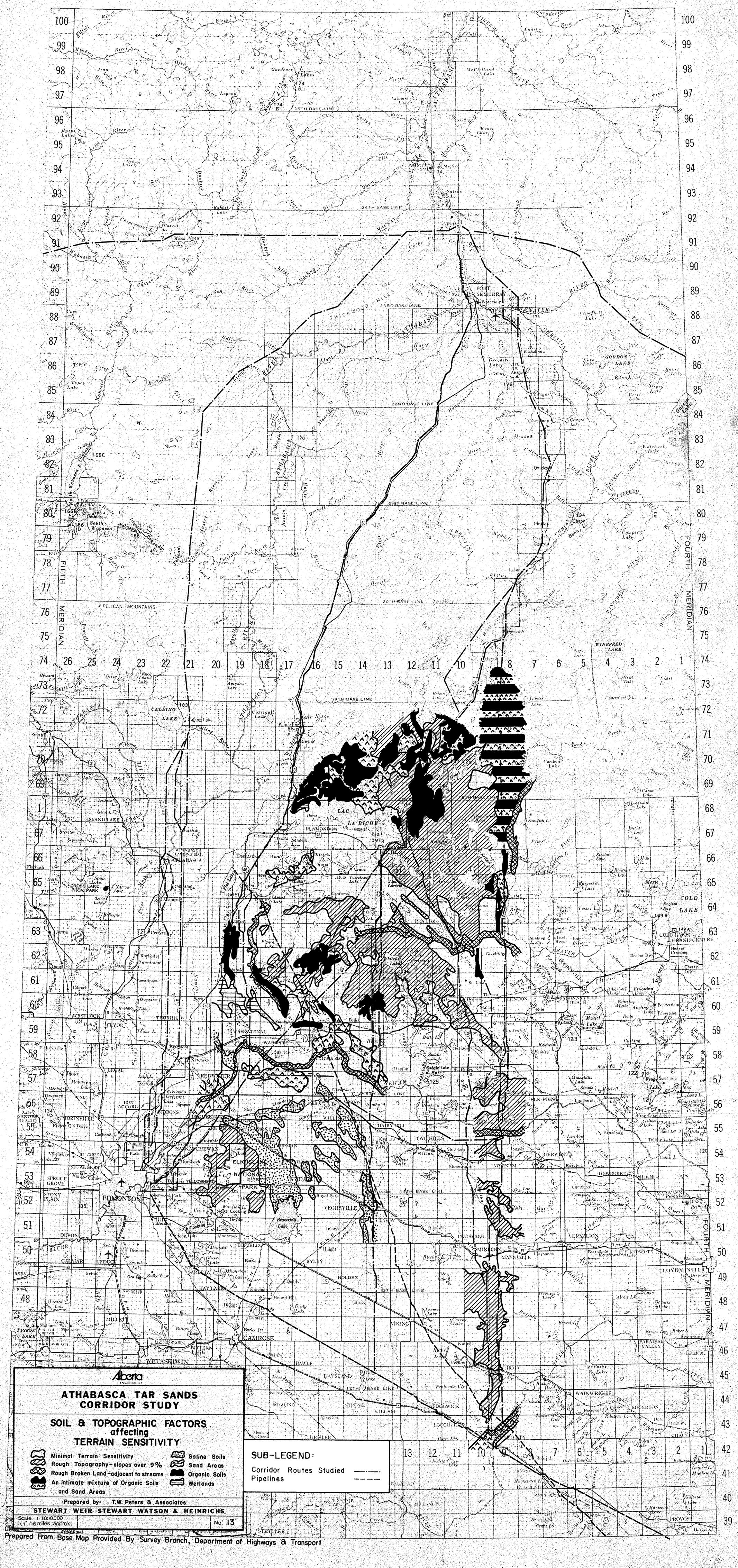
(2) Solonetzic Soils Technology and Management. Bull. B-73-1. Dept. of Extension, University of Alberta. 1973.

TABLE 12 SOIL CAPABILITY FOR AGRICULTURE	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
	WEST	CENTRAL	EAST	Ft. McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1	15.8	7.9	25.6	-	-	-	25.6	2.0	-	12.8	-	-	-
CLASS 2	15.8	15.8	17.7	-	-	-	17.7	40.5	13.8	30.6	-	9.9	-
CLASS 3	23.6	39.4	5.9	-	-	-	5.9	21.8	9.9	34.5	17.7	33.5	15.9
CLASS 4	41.4	49.3	23.6	-	-	1.9	21.7	9.5	1.0	25.5	16.7	47.3	7.9
CLASS 5	39.4	104.4	121.2	61.1	25.6	12.7	21.8	2.1	2.0	19.7	11.8	3.9	31.5
CLASS 6	7.9	9.9	22.7	17.7	-	-	5.0	-	9.9	4.9	2.0	5.9	-
CLASS 7	1.0	17.7	2.0	2.0	-	-	-	-	-	-	-	-	-
Organic 0	95.5	5.9	55.2	20.7	29.6	1.0	3.9	-	-	3.0	7.9	-	11.9
Unavailable Data	35.5	21.6	18.6	18.6	-	-	-	-	-	-	50.2	-	-
Total Mileages	275.9	271.9	292.5	120.1	55.2	15.6	101.6	75.9	36.6	131.0	106.3	100.5	67.2

MAP OF SOIL & TOPOGRAPHIC FACTORS AFFECTING TERRAIN SENSITIVITY



Prepared From Base Map Provided By Survey Branch, Department Of Highways & Transport


ATHABASCA TAR SANDS
CORRIDOR STUDY
SOIL & TOPOGRAPHIC FACTORS
affecting
TERRAIN SENSITIVITY
Minimal Terrain Sensitivity
Rough Topography - slopes over 9%
Rough Broken Land - adjacent to streams
An intimate mixture of Organic Soils and Sand Areas
Saline Soils
Sand Areas
Organic Soils
Wetlands
SUB-LEGEND:
Corridor Routes Studied
Pipelines
Prepared by: T.W. Peters & Associates
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1:1000000
(1" =16 miles approx.)
No. 13
Prepared From Base Map Provided By Survey Branch, Department of Highways & Transport

LAND CAPABILITY FOR FORESTRY

Taken from Canada Land Inventory Maps:

Tawatinaw 83I; Sand River 73L; Pelican 83P; Winefred Lake 73M.

The classes shown below of all mineral and organic soils are grouped based upon their inherent ability to grow commercial timber.

Important factors on which the classification is based are:

(1) All known or inferred information about the unit including subsoil, soil profile, depth, moisture, fertility, land form, climate and vegetation.

(2) Associated with each class is a productivity range based on the mean annual increment of the best species or group of species adapted to the site at or near rotation age. Productivity classes are expressed in gross merchantable cubic foot volume to a minimum diameter of four inches. Thinnings, bark, and branch wood are not included. Productivity as expressed is that of "normal", i.e. fully-stocked stands. Only good management produces stands of this volume.

(3) The following are not considered: location, access, distance to markets, size of units, ownership, present state or special crops such as Christmas trees.

The classes are based on the natural state of the land without improvements (i.e. no fertilization drainage, poor amelioration practices). With improved forest management, productivity may change (limitations allowed, classes changed). However significant changes will only be achieved through costly and continuing practices.

A. Land Capability for Forestry Classification

Class 1. Lands having no important limitations to the growth of commercial forests (more than 110 cu.ft. per acre per year).

Class 2. Lands having slight limitations to the growth of commercial forests (91-110 cu.ft. per acre per year).

Class 3. Lands having moderate limitations to the growth of commercial forests (71-90 cu.ft. per acre per year).

Class 4. Lands having moderately severe limtiations to the growth of commercial forests (51-70 cu.ft. per acre per year).

Class 5. Lands having severe limitations to the growth of commercial forests (31-50 cu.ft. per acre per year).

Class 6. Land having severe limitations to the growth of the commercial forests (11-30 cu.ft. per acre per year).

Class 7. Lands having severe limitations which preclude the growth of commercial forests (less than 10 cu.ft. per acre per year).

B. Assessment of Routes for Forestry

The Land Capability for Forestry is the one Canada Land Inventory Map which has very little information for the northeast part of the province. But, with the aerial survey which was done of the area along with many field trips, a general consensus of the area can be made.

We are in generally a region of productive woodland for all three routes leaving the northern terminus of Tar Island to a point south near Fort McMurray except for the regions of the Tar Sands operation being mined.

From Fort McMurray south to Wandering River on the Central route, Athabasca on the West route and Spencer Lake on the East route, we move continually in and out of the productive and non-productive woodland areas. These routes also cross many marsh and wetlands areas where there is little woodland of significant value.

South of these three specific regions, the land is entirely transformed into agricultural use.

TABLE 13	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
FORESTRY	WEST	CENTRAL	EAST	Ft.McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1	-	-	-	-	-	-	-	-	-	-	-	-	-
CLASS 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CLASS 3	5.8	3.9	3.0	-	-	-	3.0	-	-	3.9	3.9	1.0	-
CLASS 4	52.3	124.4	67.9	-	11.8	14.6	41.5	-	-	40.4	33.5	1.0	56.4
CLASS 5	2.5	-	3.9	-	-	-	3.9	-	-	2.6	-	-	-
CLASS 6	2.0	1.0	4.8	-	3.8	-	-	-	-	-	1.0	-	-
CLASS 7	39.0	22.5	22.0	-	16.7	1.0	-	-	-	3.9	12.8	-	10.8
Unavailable Data	174.3	120.1	210.8	120.1	22.9	-	44.4	75.9	36.6	80.2	55.1	98.5	-
Total Mileages	275.9	271.9	312.4	120.1	55.2	15.6	92.8	75.9	36.6	131.0	106.3	100.5	67.2

LAND CAPABILITY FOR OUTDOOR RECREATION

Taken from Canada Land Inventory Maps:

Red Deer 83A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I; Sand River 73L; Pelican 83P.

The classes shown below are differentiated on the basis of the intensity of outdoor recreational use, or the quantity of outdoor recreation which may be generated and sustained per unit area of land per annum under "perfect market conditions" (uniform demand and accessability for all areas, i.e. locations relative to population centers and to present access does not affect the classification).

Intensive activities (those in which relatively large numbers of people may be accommodated per unit area) and dispensed activities (which normally require a relatively large area per person) are recognized.

Some important factors concerning classification are:

(1) to provide a reliable assessment of the quality, quantity and distribution of the natural recreation resources within the settled areas.

(2) of an essentially reconnaissance nature, based on interpretation of aerial photographs, field checks and available records, and the maps should be interpreted accordingly.

(3) designed in accordance with present popular preferences in non-urban outdoor recreation (Urban areas i.e. over 1,000 people with permanent urban character, are not classified).

(4) The land is ranked according to its natural capability under existing conditions whether in natural or modified state; not assumptions concerning its capability given further major artificial modifications.

(5) Sound recreation land management and development practices are assumed for all areas in practical relationship to the natural capability of each area.

(6) Water bodies are not directly classified. Their recreational values accrue to be adjoining shoreland or land unit.

(7) Opportunity for recreation afforded by the presence in an area of wildlife and sport fish are indicated but the ranking does not reflect the biological productivity of the area. Wildife capability follows later.

A. Land Capability for Outdoor Recreation Classification

Class 1. Lands in this class have very high capability for outdoor recreation.

Class 2. Lands in this class have a high capability for outdoor recreation.

Class 3. Lands in this class have a moderately high capability for outdoor recreation.

Class 4. Lands in this class have a moderate capacity for outdoor recreation.

Class 5. Lands in this class have a moderately low capability for outdoor recreation.

Class 6. Lands in this class have a low capability for outdoor recreation.

Class 7. Lands in this class have a very low capability for outdoor recreation.

B. Assessment of Routes for Outdoor Recreation

The Canada Land Inventory Maps for Outdoor Recreation as shown by the table gives very little capability for any of the routes proposed and any of the routes could be used and not interfere with outdoor recreation. This is not true as is shown for the Wildlife Capability series to follow. The explanation for this classification should be made by the Canada Land Inventory before any distinct selection of any route.

TABLE 14	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
OUTDOOR RECREATION	WEST	CENTRAL	EAST	Ft.McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1	-	-	-	-	-	-	-	-	-	-	-	-	-
CLASS 2	-	-	-	-	-	-	-	-	-	-	-	-	-
CLASS 3	-	2.0	-	-	-	-	-	-	-	-	-	-	-
CLASS 4	2.0	13.9	3.9	-	-	-	3.9	2.0	-	2.0	-	.5	.5
CLASS 5	128.9	108.1	41.4	-	1.0	6.8	33.6	48.8	22.8	34.4	35.5	52.2	34.0
CLASS 6	82.7	131.3	78.8	-	5.9	8.8	64.1	25.1	13.8	94.1	33.5	47.8	32.7
CLASS 7	33.8	1.0	-	-	-	-	-	-	-	.5	1.0	-	-
Unavailable Data	28.5	25.6	168.4	120.1	48.3	-	-	-	-	-	36.3	-	-
Total Mileages	275.9	271.9	292.5	120.1	55.2	15.6	101.6	75.9	36.6	131.0	106.3	100.5	67.2

LAND CAPABILITY FOR WILDLIFE - UNGULATES

Taken from Canada Land Inventory Maps:

Red Deer 83A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I; Sand River 73L; Pelican 83P; Winefred Lake 73M; Algar Lake 84A; Waterways 74D.

Generally the needs of all ungulates are alike; each individual and species must have a significant quality and quantity of food, protective cover and space to meet its needs for survival, growth, and reproduction. The ability of the land to meet those needs is determined by the individual requirements of the species or group of species under consideration, the physical characteristics of the land and those factors such as climate that influence the plant and animal communities.

The maps were divided into units on the basis of physiographic characteristics important to wild ungulates. The degree of limitation associated with each unit determined the capability classes below.

This classification system is based on two important guidelines:

(1) Capability ratings on the basis of the optimum vegetational stage (successional stage) that can be maintained with good wildlife management practices.

(2) Capability ratings assigned do not reflect present land use (except heavily populated urban areas), ownership, lack of access, distance from cities, or amount of hunting pressure.

A. Land Capability for Wildlife Classification - Ungulates

Class 1. Lands in this class have no significant limitations to the production of ungulates.

Class 2. Lands in this class have very slight limitations to the production of ungulates.

Class 3. Lands in this class have slight limitations to the production of ungulates.

Class 4. Lands in this class have moderate limitations to the production of ungulates.

Class 5. Lands in this class have moderately severe limitations to the production of ungulates.

Class 6. Lands in this class have severe limitations to the production of ungulates.

Class 7. Lands in this class have limitations so severe that there is no ungulate production.

B. Assessment of Routes for Ungulates

The effect of the five proposed corridors from Tar Island to the south is not really as great as is sometimes anticipated in areas where development has not yet taken place. Not all forested areas are important as habitat for Ungulates.

From Tar Island south to Fort McMurray each of the three route proposals pass through some sensitive areas which are mostly winter ranges. The West route passes near an important winter area for both caribou and moose west of the Thickwood Hills. From there south, no areas need be considered until Athabasca where major winter ranges occur and continue down the Tawatinaw River to about Rochester. From there into Edmonton no further complications in sensitive areas can be foreseen.

The Central route has not many limitations in regard to Ungulates. The major one is from Tar Island through Fort McMurray which is a class 2 winter range for moose and deer along the Athabasca River. Except for a minor range for moose and deer near the Hangingstone River where the route crosses Highway 63 by the House River north of the 20th Base Line and along the route from Wandering River south for 15 miles, this area is relatively free of sensitive areas. From Redwater to Edmonton it passes through some class 1 production areas

for deer, moose and elk which could be avoided if it proved necessary.

The East route passes the Steepbank River which is a minor winter range for moose and then a high class winter range for both deer and moose at the Clearwater River crossing. It generally keeps away from the winter ranges for caribou which are located between Highway 63 and the N.A.R. At Quigley, Leisner and Conklin it goes through minor deer and moose winter ranges. South and west of Lac La Biche the Eastern route passes some winter ranges of importance west of Lac Lacroix, the Amisk River, and north of Smoky Lake. Where it crosses the North Saskatchewan River is a minor winter range (minor winter ranges are used only during the most severe winters like this past one). It follows some high production areas for moose, elk and deer from the North Saskatchewan River into the Edmonton terminal although these could be avoided with slight alterations of the route.

The Vegreville route which leaves the East route around Lac La Biche passes moose, elk and deer winter ranges of class 3 west of Lac Lacroix and on the Amisk River. From there until the North Saskatchewan River is a relatively safe area. At the North Saskatchewan River crossing and south of the river are capability areas of class 1 and winter ranges for moose, elk and deer as far as Willingdon. South to Strome there are no further areas which could cause problems for Ungulates.

The Hardisty route, however, is more sensitive for Ungulates. The Sand River is an important winter range for almost its entire length. There is further areas of high Ungulate capability south of the North Saskatchewan River, the Vermilion River and the Battle River for winter ranging. Between Mannville and Hardisty there is a large production area for Ungulates.

According to this assessment the Central, West, East, Vegreville and Hardisty routes are the best respectively for a corridor from Fort McMurray to Edmonton.

TABLE 15	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
UNGULATES	WEST	CENTRAL	EAST	Ft.McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1	1.0	1.0	3.0	1.0	-	-	2.0	5.9	3.0	3.0	1.0	29.6	-
CLASS 2	28.6	34.5	58.1	1.0	2.0	-	55.1	60.1	19.2	85.6	13.8	52.2	15.8
CLASS 3	24.9	30.6	26.8	17.9	-	-	8.9	9.9	9.4	9.9	2.0	18.7	9.9
CLASS 4	205.6	194.0	191.8	91.0	53.2	15.6	31.7	-	2.0	28.6	89.5	-	41.5
CLASS 5	9.9	11.8	11.8	7.9	-	-	3.9	-	3.0	3.9	-	-	-
CLASS 6	5.9	-	1.0	1.0	-	-	-	-	-	-	-	-	-
CLASS 7	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Mileages	275.9	271.9	292.5	119.8	55.2	15.6	101.6	75.9	36.6	131.0	106.3	100.5	67.2

Prepared From Base Map Provided By Survey Branch, Department of Highways & Transport

LAND CAPABILITY FOR WILDLIFE - WATERFOWL

Taken from Canada Land Inventory Maps:

Red Deer 83A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I; Sand River 73L; Pelican 83P; Winefred Lake 73M; Algar Lake 84A; Waterways 74D.

Generally, the needs of all waterfowl are alike; each individual and species must be provided with a sufficient quality and quantity of food, protective cover and space to meet its needs for survival growth and reproduction. The ability of the land to meet these needs is determined by the individual requirements of the species or group under consideration, the physical characteristics of the land, and those factors that influence the plant and animal communities.

The maps were divided into units on the basis of physiographic characteristics so important to waterfowl populations. The degree of limitation associated with each unit determined the capability classes below.

This classification system is based on two important guidelines:

(1) Capability ratings on the basis of optimum vegetational stage (successional stage) that can be maintained when good wildlife management is practiced.

(2) Capability ratings assigned do not reflect present land use (except heavily populated urban areas), ownership, lack of access, distance from cities or amount of hunting pressure.

A. Land Capability for Wildlife Classification - Waterfowl

Class 1. Lands in this class have no significant limitations to the production of waterfowl.

Class 2. Lands in this class have very slight limitations to the production of waterfowl.

Class 3. Lands in this class have slight limitations to the production of waterfowl.

Class 4. Lands in this class have moderate limitations to the production of waterfowl.

Class 5. Lands in this class have moderately severe limitations to the production of waterfowl.

Class 6. Lands in this class have severe limitations to the production of waterfowl.

Class 7. Lands in this class have such severe limitations that almost no waterfowl are produced.

B. Assessment of Routes for Waterfowl

Using the Canada Land Inventory Maps for Land Capability for Waterfowl for an assessment of the three routes, we notice very little effect leaving the Tar Island area except for the noted waterfowl staging areas of Gordon Lake, Birch Lake, Gipsy Lake, Garson Lake and a few smaller lakes which are east of the Eastern Corridor Alternative. This corridor should not noticeably affect or disturb these areas.

Otherwise none of the three corridor proposals (West, Central, East) affect waterfowl until Heart Lake and Logan Lake on the East route, Wandering River on the Central route and the Westlock-Thorhild areas on the West route.

The East route is near the staging areas of Heart Lake and Logan Lake and also near the staging and production areas of Lac La Biche. This route is to the east of staging and production areas of the Missawawi Lake, Kinusiu Lake area and does not affect the farmland for waterfowl again until it reaches Smoky Lake, Beaverhill, Elk Island and east of Fort Saskatchewan.

The Central route has areas of concern (besides Wandering River) at Charron Lake, east of Strome, Flat Lake (a staging and production area), a production area along the Redwater River, and the area just east of Fort Saskatchewan.

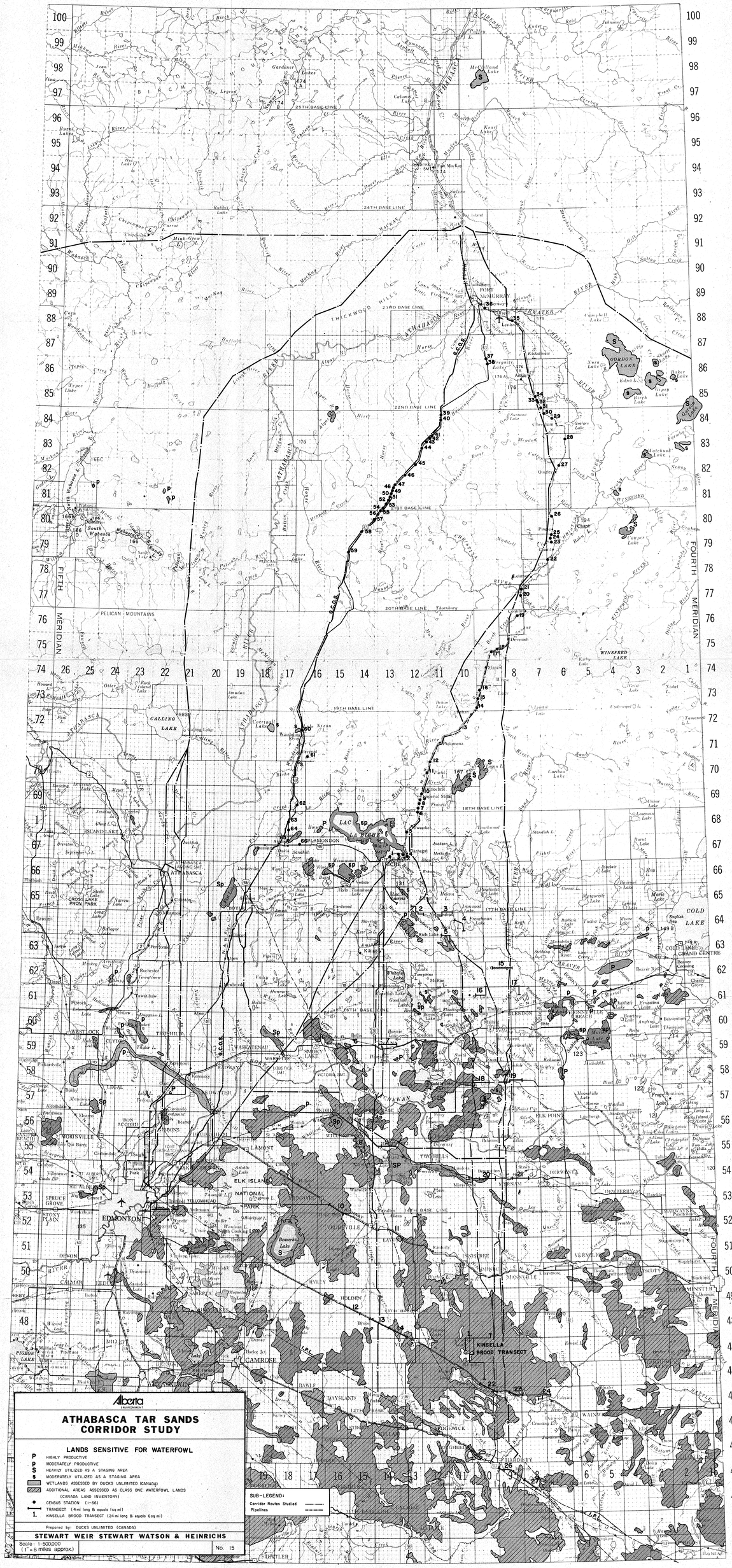
The Western route is only affected by production areas of the Bridge Lakes and Redwater River, and Manawan Lake (south of Legal) which is a staging and production area.

Where the East route divides and heads south along the Vegreville and Hardisty routes we enter into some very sensitive waterfowl areas. The Vegreville route passes through sensitive class 1 areas east of Andrew and Willingdon, near two staging and production areas. South of here is a relatively safe area to the terminal near Strome.

The Hardisty route touches sensitive areas near St. Paul, near a staging area, two areas north of Myrnam and goes through the middle of a very large class 1 area near Kinsella before it reaches the Hardisty terminal.

Analyzing these five routes for the waterfowl capability it seems that the West (followed by the Central, East, Vegreville and Hardisty routes) route seems to be the one which would cause the least amount of impact.

TABLE 16	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
WATERFOWL	WEST	CENTRAL	EAST	Ft. McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1	-	-	8.9	-	-	-	8.9	20.7	13.8	10.8	1.0	29.8	1.0
CLASS 2	-	-	3.0	-	-	-	3.0	2.0	-	-	-	2.0	2.0
CLASS 3	11.8	9.9	20.7	1.0	-	2.0	17.7	23.6	9.9	28.1	-	15.0	3.9
CLASS 4	5.9	11.8	29.6	-	5.1	7.8	16.7	23.7	3.0	32.5	2.0	24.9	18.2
CLASS 5	34.5	32.5	74.4	27.8	13.1	-	33.5	5.9	5.9	32.5	29.7	20.9	23.9
CLASS 6	192.1	177.3	153.9	89.3	37.0	5.8	21.8	-	4.0	26.1	72.6	7.9	18.2
CLASS 7	32.6	40.4	2.0	2.0	-	-	-	-	-	1.0	1.0	-	-
Total Mileages	275.9	271.9	292.5	120.1	55.2	15.6	101.6	75.9	36.6	131.0	106.3	100.5	67.2


ATHABASCA TAR SANDS
CORRIDOR STUDY
LANDS SENSITIVE FOR WATERFOWL
P HIGHLY PRODUCTIVE
PS MODERATELY PRODUCTIVE
S HEAVILY UTILIZED AS A STAGING AREA
S MODERATELY UTILIZED AS A STAGING AREA
WETLANDS ASSESSED BY DUCKS UNLIMITED (CANADA)
ADDITIONAL AREAS ASSESSED AS CLASS ONE WATERFOWL LANDS (CANADA LAND INVENTORY)
CENSUS STATION (1-66)
TRANSECT (4 mi long & equals 1 sq mi)
KINSELLA BROOD TRANSECT (24 mi long & equals 6 sq mi)
Prepared by: DUCKS UNLIMITED (CANADA)
STEWART WEIR STEWART WATSON & HEINRICHS
Scale - 1:500,000 (1" = 8 miles approx.)
No. 15
SUB-LEGEND:
Corridor Routes Studied
Pipelines
KINSELLA BROOD TRANSECT
Prepared From Base Map Provided By Survey Branch, Department of Highways & Transport

WATER CAPABILITY FOR SPORT FISH

Taken from Canada Land Inventory Maps:

Red Deer 83A; Wainwright 73D; Edmonton 83H; Vermilion 73E; Tawatinaw 83I; Sand River 73L; Pelican 83P; Winefred Lake 73M.

Generally, the needs of all fish are much alike; each individual and species must be provided with a sufficient quality and quantity of food, protective cover and space to meet its needs for survival, growth and reproduction. The ability of a water body, stream, lake or artificial reservoir to meet these needs is determined by the individual requirements of the species or group under consideration, the physical and chemical characteristics of the environment, and those factors that influence primary and secondary productivity.

As shown below, the water bodies are divided into units on the basis of physical, chemical and biological characteristics important to fish populations. The degree of limitation determines the capability class.

This classification system is based on the following important considerations:

(1) Capability ratings are established on the basis of physical, chemical and certain biological parameters but do not necessarily reflect present fish population.

(2) Waters are initially divided into types of habitats depending on whether it can support cold water species (trout, Arctic grayling and mountain whitefish) or warm water species (northern pike, walleye, perch or goldeye). The habitat is then classified as to its ability to produce one of these broad groups.

Present land use is considered where extensive distribution of fish habitat has occurred.

A. Water Capability Classification for Sport Fish

Class 1. Waters in this class have no significant limitations on sport fish production.

Class 2. Waters in this class have few or minor limitations on sport fish production.

Class 3. Waters in this class have several minor limitations or few serious limitations on sport fish production.

Class 4. Waters in this class have numerous and severe limitations on sport fish production.

B. Assessment of Routes for Sport Fish

Water capable for sport fish should be avoided when developing a corridor from the Athabasca Tar Sands. Lakes can be avoided but some rivers and streams lay in the path of the corridor and alternatives are not possible or feasible then a crossing must occur. The best possible crossing considering ecological and engineering impact will dictate the route taken.

Starting with the West route from Tar Island, this route will cross the Beaver River (a minor river crossing) just west of Ruth Lake. It then proceeds through the Thickwood Hills and crosses the Buffalo Creek (insignificant for fisheries) near the Athabasca River. Minor rivers crossed from there are the Pelican River and Calling River before it involves two major river systems, the Deep Creek and Athabasca River which are of major sport fish potential. At Colinton it crosses Lone Pine Creek (a major creek), Pine Creek (a medium potential creek), Kennedy Creek (a minor creek). This route crosses the Redwater River, a major crossing, the Sturgeon River near Gibbons and on into Edmonton crossing the North Saskatchewan River east of Oliver and into the terminal.

The Central route crosses minor creeks (Popular and Conn Creeks) and then the Athabasca River at Fort McMurray. Around the 22nd Base Line it crosses two medium potential streams and then nothing of significance until the House River at the existing G.C.O.S. crossing.

The Wandering River, La Biche River, and Punk Creek are the next sensitive streams crossed. Near Redwater, the Redwater River and North Saskatchewan River have good capability for sport fish and

should be watched closely when crossing. There are no further stream crossings which would prove difficult from here to the Edmonton terminal.

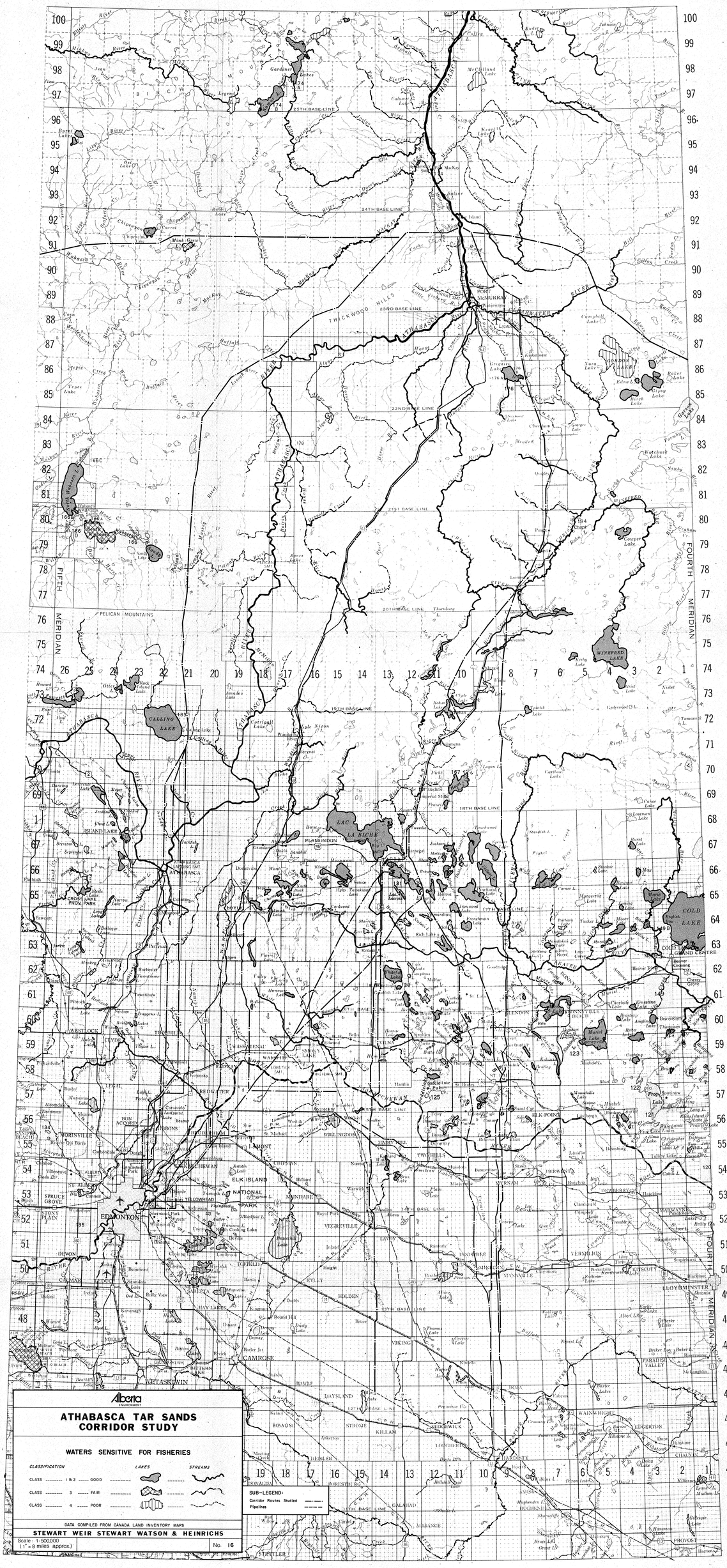
Following the East route to Edmonton, the route would have to cross many sensitive or high capability streams. The route first crosses the Clark Creek northeast of Fort McMurray and then crosses the Clearwater River at Tp. 88 Rge. 7. From here to Lac La Biche there is stream after stream to cross which most are of high fisheries capability. They are; Cottonwood Creek, Kettle River, Parry Creek, Wadell Creek, Christina River, Birch Creek, Sunday Creek, Wiau River, Logan River, Owl River, Piche River and a few other rivers and creeks not named. It crosses the Beaver River south of Lac La Biche then southwest across the Amisk River, White Earth River, Smoky River and the North Saskatchewan River south of Warspite. It crosses the Beaverhill Creek north of Bruderheim and on into the Edmonton terminal.

The Vegreville part of the East route leaves Lac La Biche and heads straight south to the I.P.P.L. line at Strome. It crosses the Beaver River, the Amisk River, The North Saskatchewan River and the Vermilion River which are considered important for sport fish potential.

The Hardisty route leaves Devenish and also heads straight south to the I.P.P.L. line at Hardisty. Good potential streams for fisheries crosses are: Punk Creek west of Keith Lake, Amisk River and the North Saskatchewan River to the Two Hills area. The only other important river to cross is the Battle River north of Hardisty.

Assessing the routes from the sport fish potential and capability of the streams, the West, Central, Hardisty, Vegreville and East routes respectively are the routes to follow.

TABLE 17	Edmonton to Fort McMurray			Sections of East Route				Supplementary Routes					
FISHERIES	WEST	CENTRAL	EAST	Ft.McMurray to Devenish	Devenish to Tweedie	Tweedie to LacLaBiche	LacLaBiche to Edmonton	Edmonton to Vegreville	Vegreville to Hardisty	LacLaBiche to Vegreville	Devenish to St. Paul	St. Paul to Hardisty	Tweedie to St. Paul
CLASS 1 & 2	57.0	105.0	116.0	54.0	10.0	16.0	37.1	-	-	52.0	43.0	-	44.0
CLASS 3	79.0	95.0	80.0	30.0	6.0	-	33.0	-	-	54.0	-	82.9	12.0
CLASS 4	140.0	72.0	96.0	36.0	39.0	-	31.5	75.9	36.6	24.0	63.0	27.6	11.2
Total Mileages	276.0	272.0	292.0	120.0	55.0	16.0	101.6	75.9	36.6	130.0	106.0	100.0	67.2



Prepared From Base Map Provided By Survey Branch, Department of Highways & Transport

ROUTE SELECTION: FISH AND WILDLIFE

A multi-disciplinary approach was taken in the selection of a corridor route. Not only economic, engineering and environmental considerations were used in decision making, legalistic, socio-cultural, and political aspects were also considered by people concerned with these fields in our study group. Assuming that regional development and processing of liquid hydrocarbons within Alberta are desirable objectives then location constraints of industrial parks related to the oil industry will necessarily dictate the direction of a large part of the corridor. However within the context of the above considerations, environmental preservation is a major aspect of route selection.

The choice of a corridor route was necessarily subjective in the absence of extensive field data. A thorough evaluation of fish and wildlife of the five proposed corridors would include the densities range and numbers of species seasonally or permanently occupying the corridor areas. A basic premise was used in the selection of a corridor. This premise was that: the public does not wish the construction and maintenance of a corridor to contribute to the harassment or extirpation of any species of animal now existing within the province. Should this be the case I would recommend that:

(a) Any rare or endangered species of wildlife within the study area, such as the Swan Hill grizzly bear, the peregrine falcon and the whooping crane be strictly avoided;

(b) That colonies of birds such as the great blue heron, the double breasted cormorant, the white pelican, gulls, terns and most shorebirds not be harassed;

(c) That courting (dancing) grounds of sharptail grouse be left undisturbed during spring and fall activity periods;

(d) That harassment of birds on major staging areas (tradition migration rest areas) be avoided;

(e) That denning areas of the rarer types of furbearers such as the otter, fisher and wolverine be widely circumvented;

(f) That construction of the corridor through wintering areas of deer, elk, moose or caribou be done in late summer or fall in order not to harass these animals when conservation of energy is a life and death necessity.

Although certain colonial birds such as the white pelican may appear to be abundant in one area, such as St. Paul, the distribution of the bird in Canada is infrequent and its status is rare. It is my belief that construction and maintenance of the corridor would have little effect compared to that which would be experienced should the corridor pass through an area which had previously been inaccessible. The new presence of a pipeline is a sign to the avid hunter and fisherman that virgin country is at his fingertips if his back-country transport will get him there first. I have witnessed this type of thinking in many areas of the southwestern part of the province. People may contend that land is of no value unless it is used. It is my belief however that the presence of man does not make land valuable. I also believe that not all land should be used for the benefit of men living today. I have a hunch that future generations would be very critical if we left them nothing untouched to work with or to recreate within.

Two methods were used in assessing the effect of corridor construction and maintenance upon fish, birds and mammals. One method assessed the potential of the corridor based upon the known habitat, behavior and range of species of birds and mammals. The second method was to assess the affect of the corridor upon wildlife using Canada Land Inventory Maps, ARDA Sport Fishery data, personal interviews and company field trips.

The potential effect of the corridor upon birds and mammals of the vicinity was determined using the following assumptions:

1. That the corridor will be up to one-half mile wide in the forested area except for the Town of Fort McMurray.

2. That the corridor would be from 500 to 1000 feet wide in the agricultural area;

3. That the corridor would be from 300 feet to one-half mile in width in the urban fringe area;

4. That 200 foot buffer strips would be included in the corridor in the forest and agricultural areas;

5. That all towns between Fort McMurray and Edmonton would be bypassed;

6. That an access road will be constructed in areas where no roads presently exist in order to service the corridor;

7. That highways, secondaries or gravel roads will be used wherever possible;

8. That major stream and river crossings will be done during winter months when the body of water is frozen;

9. That the pipe will be buried deeply in such crossings;

10. That where possible trees will be left in the agricultural zone;

11. That the Central corridor will follow the G.C.O.S. route if possible.

A. Potential Effects

In order to give some idea of the species, status and range of birds and mammals within the study area Tables 18 and 20 and summaries of the tables will be presented. These tables were adapted from information presented in Godfrey's (1966) Birds of Canada, and in the book of Dewer and Soper (1966) Mammals of Alberta. These tables and those presenting the probable effect of corridor construction and maintenance upon wildlife will follow those of Ms. Joanna Jacks in order to illustrate that this is a subjective analysis in which a difference of opinion among biologists can exist, but a similar conclusion reached.

1. Birds:

Of the 191 reproducing species, 19 are permanent residents while 162 (65.8%) are seasonal residents. Seventeen (17) of the 29 permanent breeding residents are found throughout the study area while 113 (45.2%) of the 162 seasonal breeders are found throughout the area. Of the seasonal dwellers 13.6 percent inhabit only the mixed wood forest area and 16.7 percent only the aspen parkland area. Eight (8) of 29 permanent residents (27.6%) inhabit only the mixed wood forest while 13.8 percent inhabit only the aspen parkland. Fifty-four (54) (21.6%) of 250 bird species using the study area are migrants en route to the boreal forest, tundra or Arctic Coast. Most are shorebirds or waterfowl. Ten (10) species of birds winter in the study area. Three (3) of the 10 species also breed in the northern part of the study area.

As illustrated in Table 19, improvement rather than deterioration of habitat will occur for many species of bird. Habitat for the majority of members belonging to the hawk, woodpecker, swallow, crow, thrush, vireo, warbler and sparrow families will be improved due to corridor construction in the forest area. Members of these families prefer edge or open areas to feed or nest beside. Habitat of strictly tree dwelling birds will be destroyed even though a buffer strip is created. Habitat of arboreal birds in the corridor right-of-way will deteriorate in the agricultural zone because most trees encountered will be removed. Wetland habitat of waterfowl, shorebirds and blackbirds will be temporarily and often permanently destroyed due to corridor construction. As illustrated in Table 19, the Central corridor is potentially much less disruptive or destructive to birds than the other proposed corridors. Although a minor difference in effect is predicted in the urban and agricultural areas of the five corridors, a major difference exists in the forest area. Even though the effect of corridor construction should be little different in the agricultural areas of the West and Central corridors, the Central corridor is obviously preferred because the degree of disruption due to corridor con-

struction will be much smaller. This is stated with certainty because the Central corridor will follow the right-of-way of the G.C.O.S. line, whereas a completely new corridor will have to be constructed in the other routes. The Central corridor is greatly preferred above all others in the forest area because a major access road already exists (Highway 63), as well as the 100 foot wide G.C.O.S. line. Construction of a corridor in the forest areas of the Western and Eastern corridor would entail the clearing of a right-of-way as well as the construction of an access road in an area where none presently exists. It is true that the railway right-of-way could be followed by the Eastern corridor. However it was designed to follow land slope of least grade which necessitates passing through countless muskeg and bog areas. If developed parallel to the railway, the Eastern corridor will probably lay several miles east in order to largely avoid engineering and construction difficulties of pipeline and road construction in muskeg.

The second most desirable corridor for birds appears to be the Hardisty route. Clearing of the right-of-way will improve habitat conditions for more birds in the forest of this area than in the other corridors. However, this choice of routes does not rank one species of bird over another in importance due to rarity or endangered status of the species. The Hardisty corridor may well benefit 31 fairly common species of bird but be detrimental to several rare species of bird. My choice of corridors based upon Table 19 would be:

(1) the Central corridor

(2) the Hardisty corridor

(3) the Western corridor

(4) the Vegreville corridor

(5) the Eastern corridor

Considering rarity of each species as well as numbers of species my choice would be as follows:

(1) the Central corridor
(2) the Eastern corridor
(3) the Vegreville corridor
(4) the Western corridor
(5) the Hardisty corridor

The Central corridor is unanimously believed to be the most suitable corridor for the preservation of wildlife by both Ms. Joanna Jacks and myself. Since she considered only the Western, Central and Eastern routes, no further comparisons can be made with her choice of routes.

2. Mammals:

Sixty species or subspecies of mammal inhabit the study area. Fifty percent occur regularly in the study and 50 percent sporadically (Volume 4 Chapter III p.203). Only 28 percent of those found regularly occur throughout the study area. As shown in Table 18 of Birds little difference in rating occurs yet the choice of routes is unanimously the Central one - except in the urban zone. Since few species of mammal occur in this zone, and none of them are rare, this portion of the corridor is not believed to be as destructive to wildlife as the forest and agricultural areas. The clearance of the corridor right-of-way would benefit mice, the prairie and least weasel, the skunk, white-tail and mule deer and moose to name a few. However mammals which prefer isolation from man such as the timber wolf, bear, fisher, marten, wolverine, elk and woodland caribou, would be negatively affected by corridor construction. Small ground-dwelling mammals such as voles would also be negatively affected by construction activities.

Without considering one species of mammals more important than another, the order of preference of corridors is as follows:

(1) the Central corridor
(2) the Eastern corridor
(3) the Vegreville corridor
(4) the Hardisty corridor
(5) the Western corridor

Table 18. Possible Impact of the Proposed Routes on Birds in the Study Area.

Species	Comparison of Routes														
	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Common Loon	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Arctic Loon	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Red-throated Loon	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Red-necked (Holboell's) Grebe	o	-	-	o	✓	✓	o	-	-	o	-	-	o	o	-
Horned Grebe	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Eared Grebe	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Western Grebe	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Pied-billed Grebe	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
White Pelican	o	o	-	o	✓	✓	o	-	o	o	-	-	o	-	o
Double-crested Cormorant	o	o	o	o	✓	✓	o	-	o	o	-	-	o	-	o
Great Blue Heron	o	-	-	o	✓	✓	o	-	o	o	-	-	o	-	o
American Bittern	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Whistling Swan	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Canada Goose	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
White-fronted Goose	o	-	-	o	✓	✓	o	-	o	o	-	-	o	-	o
Snow Goose	o	-	-	o	✓	✓	o	-	o	o	-	-	o	-	o
Blue Goose	o	-	-	o	✓	✓	o	-	o	o	-	-	o	-	o
Ross' Goose	o	-	-	o	✓	✓	o	-	o	o	-	-	o	-	o
Mallard	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Gadwall	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Pintail	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Green-winged Teal	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Blue-winged Teal	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
American Widgeon	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Shoveler	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Redhead	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Ring-necked Duck	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	o
Canvasback	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Great Scaup(M)	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Lesser Scaup	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Common Goldeneye	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Barrow's Goldeneye	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	o
Bufflehead	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Oldsquaw	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Harlequin Duck	o	-	o	o	✓	o	o	o	o	o	-	o	o	o	o
White-winged Scoter	o	-	-	o	✓	o	o	-	o	o	-	-	o	-	o
Surf Scoter	o	o	-	o	✓	o	o	-	o	o	-	-	o	-	o
Ruddy Duck	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Hooded Merganser	o	-	✓	o	✓	-	o	-	-	o	-	-	o	-	-
Common Merganser	o	-	✓	o	✓	-	o	-	-	o	-	-	o	-	-
Red-breasted Merganser	o	-	✓	o	✓	✓	o	-	-	o	-	-	o	-	-
Turkey Vulture	o	o	o	o	✓	o	o	o	o	o	-	o	o	o	o
Goshawk	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	✓ +
Sharp-shinned Hawk	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	✓ +
Cooper's Hawk	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	✓ o
Red-tailed Hawk	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Broad-winged Hawk	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Swainson's Hawk	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Rough-legged Hawk	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Ferragirous Hawk	o	✓	o	o	o	o	o	o	o	o	-	o	o	-	o

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Golden Eagle	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Bald Eagle	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Marsh Hawk	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Osprey	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Peregrine Falcon	o	o	-	o	o	✓	o	o	o	o	o	o	o	o	o
Pigeon Hawk	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	✓ +
Sparrow Hawk	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Spruce Grouse	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Ruffed Grouse	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Willow Ptarmigan	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Sharp-tailed Grouse	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Ring-necked Grouse	-	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Gray (Hungarian) Partridge	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Whooping Crane	o	✓ o	o	o	-	o	o	-	-	o	-	-	o	-	-
Sandhill Crane	o	-	-	o	-	o	o	-	o	o	-	-	o	-	o
Virginia Rail	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Sora Rail	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
American Coot	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Semipalmated Plover	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Piping Plover	o	o	o	o	✓	✓	o	-	-	o	-	-	o	-	-
Yellow Rail	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Killdeer	-	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
American Golden Plover	o	o	-	o	o	o	o	-	o	o	-	o	o	-	o
Black-bellied Plover	o	-	-	o	o	o	o	-	o	o	-	o	o	-	o
Ruddy Turnstone	o	-	-	o	-	o	o	-	o	o	-	o	o	-	o
Common (Wilson's) Snipe	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Whimbrel	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Upland Plover	o	-	-	o	-	o	o	-	o	o	-	o	o	-	-
Spotted Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Solitary Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Willet	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Greater Yellowlegs	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Lesser Yellowlegs	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Knot	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Pectoral Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
White-rumped Sandpiper	o	o	-	o	o	o	o	-	o	o	-	-	o	-	o
Baird's Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Least Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Dunlin	o	o	-	o	-	o	o	-	-	o	-	-	o	-	-
Long-billed Dowitcher	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Short-billed Dowitcher	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Stilt Sandpiper	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Semipalmated Sandpiper	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Buff-breasted Sandpiper	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Marbled Godwit	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Hudsonian Godwit	o	-	o	o	o	o	o	-	o	o	-	o	o	-	o
Sanderling	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Red Phalarope	o	-	-	o	-	o	o	-	-	o	-	-	o	-	-
Wilson's Phalarope	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
American Avocet	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Northern Phalarope	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Parasitic Jaeger	o	o	-	o	o	o	o	-	o	o	o	o	o	-	o
Glaucous-winged Gull	o	-	-	o	-	o	o	-	-	o	-	o	o	-	o
Herring Gull	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
California Gull	+	-	-	+	✓	o	+	-	-	+	-	-	+	-	-
Ring-billed Gull	+	-	-	+	✓	o	+	-	-	+	-	-	+	-	-
Mew Gull	o	-	-	o	✓	o	o	-	-	o	-	-	o	-	-
Franklin's Gull	o	-	-	o	✓	o	o	-	-	o	-	-	o	-	-
Bonaparte's Gull	o	o	-	o	o	✓	o	o	-	o	-	-	o	-	-
Sabine's Gull	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Forster's Tern	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Common Tern	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Caspian Tern	o	o	-	o	o	o	o	-	o	o	o	o	o	-	o
Black Tern	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Domestic Pigeon(Rock Dove)	-	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Mourning Dove	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Black-billed Cuckoo	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Great Horned Owl	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Snowy Owl	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Hawk Owl	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Barred Owl	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Great Gray Owl	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Long-eared Owl	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+
Short-eared Owl	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Boreal(Richardson's)Owl	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Saw-whet Owl	o	o	-	o	o	✓	o	o	-	o	o	-	o	o	-
Common Nighthawk	o	o	+	o	o	+	o	o	+	o	o	✓ +	o	o	+
Ruby-throated Hummingbird	+	-	+	+	✓	+	✓ +	-	+	✓ +	-	+	✓ +	-	+
Belted Kingfisher	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Yellow-shafted Flicker	o	-	+	o	✓	+	o	-	+	o	-	✓ +	o	-	+

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Pileated Woodpecker	o	o	-	o	✓ o	o	o	o	-	o	o	-	o	o	-
Yellow-bellied Sapsucker	o	o	o	o	o	✓ o	o	o	o	o	o	o	o	o	o
Hairy Woodpecker	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Downy Woodpecker	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Black-backed Three-toed Woodpecker	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Northern Three-toed Woodpecker	o	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-
Eastern Kingbird	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Eastern Phoebe	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Say's Phoebe	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Yellow-bellied Flycatcher	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Traill's(Alder)Flycatcher	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Least Flycatcher	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Western Wood Pewee	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Olive-sided Flycatcher	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Hoyt's Horned Lark	o	o	✓ +	o	o	+	o	o	+	o	✓ o	+	o	o	+
Tree Swallow	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-	o
Bank Swallow	o	✓ o	✓ o	o	o	-	o	-	-	o	-	-	o	-	-
Barn Swallow	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-	o
Cliff Swallow	o	-	o	o	✓ o	o	o	-	o	o	-	o	o	-	o
Purple Martin	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Gray(Canada)Jay	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Blue Jay	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Black-billed Magpie	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Common Raven	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Common Crow	o	-	+	o	✓ -	+	o	-	+	o	-	✓ +	o	-	+
Black-capped Chickadee	✓ -		+	-	✓ -	+	-	-	+	-	-	+	-	-	+
Boreal Chickadee	✓ -		-	-	✓ -	✓ -	-	-	-	-	-	-	-	-	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Red-breasted Nuthatch	o	-	-	o	✓ -	-	o	-	-	o	-	-	o	-	-
Brown Creeper	o	-	-	o	✓ -	✓ -	o	-	-	o	-	-	o	-	-
House Wren	-	-	+	-	✓ -	✓ +	-	-	+	-	-	+	-	-	+
Winter Wren	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Long-billed Marsh Wren	o	-	-	o	✓ -	✓ -	o	-	-	o	-	-	o	-	-
Short-billed Marsh Wren	o	-	+	o	✓ -	+	o	-	+	o	-	+	o	-	+
Catbird	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-	o
Brown Thrasher	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-	o
Robin	+	-	+	+	✓ -	+	+	-	+	+	-	+	+	-	+
Varied Thrush	o	o	-	o	o	✓ o	o	o	o	o	o	-	o	o	o
Hermit Thrush	o	-	-	o	✓ -	✓ -	o	-	-	o	-	-	o	-	-
Swainson's Thrush	o	✓ -	+	o	-	+	o	-	+	o	-	+	o	-	+
Gray-cheeked Thrush	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Veery	o	✓ -	+	o	-	+	o	-	+	o	-	+	o	-	+
Mountain Bluebird	o	-	✓ +	o	✓ -	+	o	-	+	o	-	+	o	-	+
Golden-crowned Kinglet	o	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-
Ruby-crowned Kinglet	o	o	-	o	o	✓ -	o	o	-	o	o	-	o	o	-
Water (American) Pipit	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Sprague's Pipit	o	o	+	o	o	+	o	o	+	o	o	+	o	✓ o	+
Bohemian Waxwing	o	-	o	-	-	o	o	-	o	o	-	o	o	-	o
Cedar Waxwing	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Northern Shrike	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Loggerhead Shrike	+	o	+	+	o	+	+	o	+	+	o	+	+	✓ o	+
Starling	+	-	+	+	✓ -	+	+	-	+	+	-	+	+	-	+
Solitary Vireo	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Red-eyed Vireo	o	-	+	o	✓ -	+	o	-	+	o	-	✓ +	o	-	+
Philadelphia Vireo	o	-	+	o	-	+	o	-	+	o	-	✓ +	o	-	+

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Warbling Vireo	-	-	+	-	✓	+	-	-	+	-	-	+	-	-	+
Black and White Warbler	o	✓	-	o	-	-	o	-	-	o	-	-	o	-	-
Tennesse Warbler	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Orange-crowned Warbler	o	-	+	o	✓	+	o	-	+	o	-	✓	o	-	+
Yellow Warbler	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
Magnolia Warbler	o	-	+	o	✓	+	o	-	+	o	-	✓	o	-	+
Cape May Warbler	o	-	+	o	✓	+	o	-	+	o	-	✓	o	-	+
Black-throated Blue Warbler	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Myrtle Warbler	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Chestnut-sided Warbler	o	o	✓	o	-	o	o	o	o	o	o	o	o	o	o
Black-throated Green Warbler	o	-	-	o	✓	✓	o	-	-	o	-	-	o	-	-
Blackburnian Warbler	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Bay-breasted Warbler	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Blackpoll Warbler	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Pine Warbler	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Palm Warbler	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Ovenbird	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
Northern Waterthrush	o	-	-	o	✓	-	o	-	-	o	-	-	o	-	-
Connecticut Warbler	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Mourning Warbler	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Yellowthroat	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Wilson's Warbler	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
Canada Warbler	o	-	-	o	✓	-	o	-	-	o	-	-	o	-	-
American Redstart	o	-	+	o	✓	+	o	-	+	o	-	+	o	-	+
English(House)Sparrow	✓	-	+	-	✓	+	-	-	+	-	-	+	-	-	+
Bobolink	o	-	o	o	✓	o	o	-	o	o	-	o	o	-	o
Western Meadowlark	o	+	+	o	+	+	o	+	+	o	✓	+			

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Yellow-headed Blackbird	o	-	-	o	✓–	✓–	o	-	-	o	-	-	o	-	-
Redwinged Blackbird	o	-	-	o	✓–	✓–	o	-	-	o	-	-	o	-	-
Baltimore Oriole	-	-	o	✓–	✓–	o	-	-	o	-	-	o	-	-	o
Rusty Blackbird	-	-	-	–	✓–	✓–	-	-	-	-	-	-	-	-	-
Brewer's Blackbird	o	+	+	o	+	+	o	+	+	o	+	✓+	o	✓+	+
Common Grackle	o	+	+	o	+	+	o	+	+	o	+	✓+	o	✓+	+
Brown-headed Cowbird	o	+	+	o	+	+	o	+	+	o	+	✓+	o	✓+	+
Western Tanager	o	-	✓+	o	✓–	+	o	-	+	o	-	+	o	-	+
Rose-breasted Grosbeak	-	-	-	–	✓–	✓–	✓–	-	-	✓–	-	-	✓–	-	-
Evening Grosbeak	-	-	-	–	✓–	✓–	✓–	-	-	✓–	-	-	✓–	-	-
Purple Finch	+	-	+	+	✓–	+	✓+	-	+	✓+	-	+	✓+	-	+
Pine Grosbeak	+	-	+	+	✓–	+	✓+	-	+	✓+	-	✓+	✓+	-	+
Gray-crowned Rosy Finch	o	-	o	o	✓–	o	o	-	o	o	-	o	o	-	o
Hoary Redpoll	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Common Redpoll	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Pine Siskin	+	-	+	+	-	+	+	-	+	+	-	+	+	-	+
American Goldfinch	+	o	+	+	o	+	+	o	+	+	o	+	+	o	✓+
Red Crossbill	o	-	+	o	-	+	o	✓–	+	o	-	+	o	-	+
White-winged Crossbill	o	-	+	o	-	+	o	✓–	+	o	-	+	o	-	+
Savannah Sparrow	+	+	+	+	+	+	+	+	✓+	+	+	✓+	+	✓+	✓+
Leconte's Sparrow	o	-	+	o	✓–	+	o	-	+	o	-	✓+	o	-	+
Nelson's(Sharp-tailed)Sparrow	o	-	-	o	✓–	✓–	o	-	-	o	-	-	o	-	-
Vesper Sparrow	+	+	+	✓+	+	+	✓+	+	+	✓+	+	✓+	✓+	✓+	+
Slate-coloured Junco	✓–	-	+	-	✓–	+	-	-	+	-	-	✓+	-	-	+
Oregon Junco	✓–	-	+	-	✓–	+	-	-	-	-	-	✓+	-	-	+
Tree Sparrow	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Chipping Sparrow	+	-	+	+	✓–	+	✓+	-	+	✓+	-	✓+	✓+	-	+

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Clay-coloured Sparrow	o	o	+	o	o	+	o	o	+	o	o	+✓	o	o	+
Harris' Sparrow	o	o	+	o	o	+	o	o	+	o	o	+✓	o	o	+
White-crowned Sparrow	o	o	+	o	o	+	o	o	+	o	o	+✓	o	o	+
White-throated Sparrow	o	o	+	o	o	+	o	o	+	o	o	+✓	o	o	+
Fox Sparrow	o	-	-	o	-✓	-✓	o	-	-	o	-	-	o	-	-
Lincoln's Sparrow	o	-	-	o	-✓	-✓	o	-	-	o	-	-	o	-	-
Swamp Sparrow	o	-	-	o	-✓	-✓	o	-	-	o	-	-	o	-	-
Song Sparrow	o	-	+	o	-✓	+✓	o	-	+	o	-	+	o	-	+
McCowan's Longspur	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Lapland Longspur	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Smith's Longspur	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Snow Bunting	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+

TABLE 19. Summary of Table 18: Possible impact of the five proposed routes on birds in the study area.

	Urban/industrial fringe	Agricultural Zone	Forest Zone
(a) West Corridor			
Not likely to affect (o)	221	68	44
May improve conditions (+)	14	6	90
May be detrimental (-)	15	176	116
First choice (✓) among five possible routes (where choice could be made)	7	7	6
(b) Central Corridor			
Not likely to affect (o)	223	67	89
May improve conditions (+)	14	6	80
May be detrimental (-)	13	177	81
First choice (✓) among five possible routes (where choice could be made)	8	162	75
(c) East Corridor			
Not likely to affect (o)	224	58	67
May improve conditions (+)	14	6	81
May be detrimental (-)	12	186	102
First choice (✓) among five possible routes (where choice could be made)	7	2	0
(d) Hardisty Corridor			
Not likely to affect (o)	224	55	55
May improve conditions (+)	14	6	81
May be detrimental (-)	12	189	114
First choice (✓) among five possible routes (where choice could be made)	6	2	31
(e) Vegreville Corridor			
Not likely to affect (o)	224	56	68
May improve conditions (+)	14	6	81
May be detrimental (-)	12	188	101
First choice (✓) among five possible routes (where choice could be made)	7	7	6

TABLE 20. Possible Impact of the Proposed Routes on Mammals in the Study Area.

Species	Comparison of Routes														
	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Common Cinereous Shrew	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Hayden Cinereous Shrew	o	-	o	o	↙-	o	o	-	o	o	-	o	o	-	o
American Saddle-backed Shrew	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Dusky Mountain Shrew	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
American Water Shrew	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Northern Pigmy Shrew	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Little Brown Bat	+	-	+	+	↙-	+	+	-	+	+	-	+	+	-	+
Silver-haired Bat	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Pale Big Brown Bat	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Hoary Bat	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
White-tailed Prairie Hare	+	+	+	+	↙+	↙+	↙+	+	+	↙+	+	+	↙+	+	+
American Varying Hare	o	-	o	o	↙-	o	o	-	o	o	-	o	o	-	o
Canada Woodchuck	o	-	+	o	↙-	+	o	-	+	o	-	+	o	-	+
Richardson Ground Squirrel	+	o	o	↙+	o	o	+	o	o	+	o	o	+	o	o
Striped Ground Squirrel	o	-	o	o	↙-	o	o	-	o	o	-	o	o	-	o
Franklin Ground Squirrel	o	-	o	o	↙-	o	o	-	o	o	-	o	o	-	o
Little Northern Chipmunk	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Mackenzie Red Squirrel	o	-	o	o	↙-	o	o	-	o	o	-	o	o	-	o
Hudson Bay Flying Squirrel	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Richardson Pocket Gopher	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Canada Beaver	o	-	-	o	↙-	↙-	o	-	-	o	-	-	o	-	-
Boreal White-footed Mouse	+	o	-	+	o	o	+	o	o	+	o	o	+	o	o
Richardson Lemming Vole	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
Athabasca Red-backed Vole	+	o	o	+	o	o	+	o	o	+	o	o	+	o	o
Prairie Phenacomys Vole	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Mackenzie Phenacomys Vole	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Drummond Meadow Vole	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
Chestnut-cheeked Vole	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Little Upland Vole	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
Northwestern Muskrat	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-
House Rat	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
House Mouse	+	-	o	+	-	o	+	-	o	+	-	o	+	-	o
Hudson Bay Jumping Mouse	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Saskatchewan Jumping Mouse	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Alaska Porcupine	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
Northwestern Coyote	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Northern Timber Wolf	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
Saskatchewan Timber Wolf	o	o	o	o	o	-	o	o	-	o	o	-	o	o	-
Northern Plains Red Fox	o	-	o	o	-	o	o	-	o	o	-	o	o	-	o
British Columbia Red Fox	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
American Black Bear	o	-	-	o	o	-	o	o	-	o	o	-	o	o	-
Emperor Grizzly	o	o	-	o	o	o	o	o	o	o	o	o	o	o	o
Hudson Bay Marten	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
Alaska Marten	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
British Columbia Fisher	o	o	-	o	o	-	o	o	-	o	o	-	o	o	-
Richardson Weasel	+	o	+	+	o	+	+	o	+	+	o	+	+	o	+
Least Weasel	+	o	+	+	o	+	+	o	+	+	o	+	+	o	+
Prairie Long-tailed Weasel	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Hudson Bay Mink	o	-	-	o	-	-	o	-	-	o	-	-	o	-	-

Species	West			Central			East			Hardisty			Vegreville		
	U	A	F	U	A	F	U	A	F	U	A	F	U	A	F
American Wolverine	o	o	-	o	o	- ✓	o	o	-	o	o	-	o	o	-
American Badger	o	-	o	o	- ✓	o	o	-	o	o	-	o	o	-	o
Northern Plains Skunk	o	-	+	o	- ✓	+	o	-	+	o	-	+	o	-	+
Mackenzie Otter	o	o	- ✓	o	o	-	o	o	-	o	o	-	o	o	-
Canada Lynx	o	-	+	o	- ✓	+	o	-	+	o	-	+	o	-	+
Manitoba Wapiti	o	o	-	o	o	o ✓	o	o	o	o	o	-	o	o	o
Rocky Mountain Mule Deer	o	-	+	o	- ✓	+	o	-	+	o	-	+	o	-	+
Dakota White-tailed Deer	o	-	+	o	-	+	o	-	+	o	-	+	o	-	+
Northwestern Moose	o	o	+	o	o	+	o	o	+	o	o	+	o	o	+
Western Woodland and Caribou	o	o	-	o	o	o ✓	o	o	-	o	o	-	o	o	o

TABLE 21. Summary of Table 20: Possible impact of the five proposed routes on mammals in the study area.

	Urban/industrial fringe	Agricultural Zone	Forest Zone
(a) West Corridor			
Not likely to affect (o)	52	32	17
May improve conditions (+)	8	1	17
May be detrimental (-)	0	27	26
First choice (✓) among five possible routes (where choice could be made)	0	0	2
(b) Central Corridor			
Not likely to affect (o)	52	32	20
May improve conditions (+)	8	1	19
May be detrimental (-)	0	27	21
First choice (✓) among five possible routes (where choice could be made)	1	27	21
(c) Eastern Corridor			
Not likely to affect (o)	52	32	19
May improve conditions (+)	8	1	18
May be detrimental (-)	0	27	23
First choice (✓) among five possible routes (where choice could be made)	5	0	5
(d) Hardisty Corridor			
Not likely to affect (o)	52	32	18
May improve conditions (+)	8	1	18
May be detrimental (-)	0	27	24
First choice (✓) among five possible routes (where choice could be made)	5	0	4
(e) Vegreville Corridor			
Not likely to affect (o)	52	32	20
May improve conditions (+)	8	1	18
May be detrimental (-)	0	27	22
First choice (✓) among five possible routes (where choice could be made)	5	0	0

B. Known Areas of Concern

1. Introduction:

The sensitive areas for fish and wildlife known at present should be listed in order that each person can weigh the selection of routes. We have an idea of the number of species of fish, birds and mammals inhabiting the study area. However little is known about densities of various species in various types of habitat within the area. In cases where it is known that a species is rare/or endangered, we feel a preservation of that species is a necessity. Therefore an attempt shall be made to describe sensitive areas as well as areas in which rare species are known to live.

Most information about fish and wildlife of the study area was made available from individuals outside the study group. This being a feasibility study little time could be afforded for field research. The environmental study was a general area examination of fish and wildlife because exact locations of corridors has not been decided. Furthermore many portions of the corridors could not be observed from existing roads. The two aerial surveys made by myself were not done in winter conditions when ungulates would be visible. Large migratory birds were just beginning to inhabit thawing lakes and potholes during the first week of May when the last aerial survey of the Central and Hardisty corridors were flown. Consequently, field data collected by the study group is based primarily on three automobile trips and one railway speeder trip of Ms. Joanna Jacks and upon three automobile trips and two aerial surveys by myself. Mr. Ernie Ewaschuk (biologist for Ducks Unlimited, Edmonton) made a brief survey of waterfowl along the Central corridor. Dr. Martin Paetz (Chief Fisheries Biologist, Alberta Environment) and Mr. Ed. Griffiths (Fishery biologist, Alberta Environment) have made available their data of the study area. Personal interviews of Fish and Wildlife officers and biologists of the area were conducted. Canada Land Inventory

Maps concerning waterfowl, fish and ungulates were examined. Thus a somewhat fragmented picture of fish and wildlife in the study area was composed.

Following is a description of sensitive areas for fish and wildlife along each proposed corridor.

2. The Western Corridor:

The Forest Area:

The forest area of the Western corridor is largely occupied by people. From the Tar Island area as far as the Calling Lake area very few roads exist, and then are only seasonal roads. Construction of the corridor through this area would necessitate the building of an access road which would provide easy access to the Thickwood Hills and Pelican mountain areas. The Thickwood Hills area south of the MacKay River is known to be a wintering area for caribou and moose. From the MacKay River south to the Pelican mountain area the grizzly (Swan Hill) is known to roam. The Western route will bypass the eastern end of Pelican Lake which contains a grizzly denning area. As you may know the Swan Hill grizzly is a rare and endangered species. Woodland caribou roam through the forested area west of Athabasca River almost as far south as the townsite of Athabasca. Densities of moose are high in this area (Blaire Rippon, personal communication). Pelican Lake contains a nesting colony of great blue herons.

The Agricultural Area:

Agricultural land will be encountered first just east of Calling Lake. The corridor may affect the reproductive activities of shorebirds and waterbirds if not properly timed. From here south to Edmonton one stream and three rivers with excellent fishing potential would be crossed (CLI Map - Sport Fishery, and ARDA information, Bill Griffith, 1973). They are Deep Creek, the Athabasca, the Tawatinaw and the Redwater Rivers. The Athabasca River coulee which will be crossed provided excellent winter range for deer and moose (CLI - Ungulates, personal observation). This

corridor will pass through the Rochester Biological Study Area east of Rochester. Waterfowl production is high in the Redwater River area and Gibbons area (CLI-Waterfowl, personal observation). The Gibbons area through which the corridor will pass contains many large aspen poplar groves which make excellent habitat for deer.

The Urban Fringe Area:

The Western corridor will be in the urban fringe area after crossing the North Saskatchewan River. The river in this area was noted to contain substantial populations of staging waterfowl (early April, 1973). A fringe of trees runs along the bank of the North Saskatchewan River. Many species of small bird probably inhabit this area although observations were made at a time prior to northern migration of small birds.

3. The Central Corridor:

The Forest Area:

The forest area extends from the Athabasca Oil Sands to the Wandering River. This corridor will follow the Great Canadian Oil Sands route for most of its length. From Fort McMurray south to Boyle this corridor runs parallel to Highway 63. From Boyle south to Edmonton the corridor runs parallel to Highway 45. Since a 100 foot corridor right-of-way already exists as well as suitable access roads, further environmental damage will be minimal. Few moose and deer utilize the area from Tar Island to Fort McMurray even though a suitable range exists. I suspect that a combination of hunting and disturbance by vehicles and machines used in connection with the exploration and development of the Athabasca Oil Sands has caused the population to decline. Deer and moose are relatively scarce for most of the corridor length in the forested area. The highway and access roads have permitted a heavier hunting pressure than previously exists (Al Boggs, personal communication). Just south of the Town of Fort McMurray this corridor will run parallel to the banks of the Hangingstone River. Aside from being a high drainage density area with steep ravines, which would be subject

to erosion from construction activities, the aesthetics of the area would be significantly affected. About 25 miles south of Fort McMurray, this corridor will pass through caribou range. The Athabasca, Lower Horse and Lower Wandering Rivers which must be crossed have a good sports fishery potential for arctic grayling and northern pike (Volume 4 Chapter III, Bill Griffith,1973). The Wandering River which also contains walleye (Martin Paetz, ARDA Sports Fishery Capability, 1973) will be crossed several times. If great care is not taken during and after construction erosion and siltation of streams could occur. This construction could affect fishing potential of the river.

The Agricultural Area:

This area begins near Wandering River and continues south to the industrial fringe area of Edmonton. Two rivers having good sports fishery potential shall be crossed, the La Biche and Redwater. The La Biche River contains northern pike, walleye, cisco, goldeye and mountain and lake whitefish (Martin Paetz ARDA Sports Fishery Capability, 1973). Six miles south of La Biche River, Charron Lake will be bypassed. It is an important lake for staging waterfowl. The route will bypass another major waterfowl staging area at Flat Lake near Boyle. South of Boyle about 8 miles, the corridor will pass about one mile west of Long Lake Provincial Park. The sandy country around Long Lake has a good population of deer. Raptors such as redtail, Swainson and Harrier hawks are common along this portion of the corridor.

The Urban Area:

The Central corridor will pass through urban development areas No. 3 and No. 5 of Fort McMurray. The corridor will give a small park area to residents adjacent to the pipeline area. In early April of 1974 serious erosion was noted in the powerline right-of-way adjacent to urban development area No. 3. Most erosion could have been avoided if construction of the powerline had occurred in summer and the area had been sewn to grass. The slopes adopted by the powerline is considered excessive here and along the coulees of the Athabasca River.

Should the Central corridor follow the G.C.O.S. route through the Town of Fort McMurray I would hope the powerlines would by-pass the townsite in order that the green belt area through the town might provide a greater range of recreational activities.

The Central corridor will follow the C.P.R. railroad to the Edmonton Industrial area. Little environmental disturbance is expected if potholes are avoided.

4. The Eastern Corridor:

The Forest Area:

This corridor will go east across the Athabasca River from the present oil sands development area. From here it will proceed southward across the Clearwater River. Hereafter it follows the N.A.R. route to Lac La Biche. From Lac La Biche it proceeds cross country to Edmonton. The forest area ends near Lac La Biche. The corridor will pass through several streams and rivers with a good game fish potential. From north to south these are the Athabasca River, the Clearwater River, Cottonwood Creek, Pony Creek, the Christina River, and Birch Creek (CLI Map Volume 4 Chapter III, p.49). The Clearwater River provides habitat for walleye, northern pike, arctic grayling and mountain whitefish (Bill Griffith, Volume 4 Chapter III p.63-64). The gentle undulating partially treed slopes provide excellent winter habitat for moose and a few deer which inhabit the area. The corridor will pass within one mile of Gregoire Lake Provincial Park which lies some 25 miles south of Fort McMurray. A single whooping crane was reported (Al Boggs, personal communication) using the Lake in May of 1974. The Christina River contains a good population of walleye and northern pike (Bill Griffiths, ARDA Sports Fishery Capability, 1973). It also contains an otter population (Al Boggs, personal communication). From Kettle River south to Philomena the corridor will pass through land known to be inhabited by woodland caribou. Ms. Joanna Jacks has found a caribou crossing area over the N.A.R. tracks south of Behan. Except for lynx, beaver, red squirrel and coyotes, furbearers are scarce in the forest area. Few waterfowl raptors or small birds were observed in the forest area.

The Agricultural Area:

Agricultural land around Lac La Biche is marginal until south of the Amisk River. From Lac La Biche the Eastern corridor heads southwest past Warspite and Bruderheim to the Edmonton Industrial Area. The corridor will cross one good sports fishing river and one good stream. These are the Amisk River and White Earth Creek. The 200 to 300 foot slopes of White Earth Creek provide excellent deer winter range. Care must be taken in designing the corridor through this area because White Earth Creek is a scenic area. This corridor will bypass Smoky Lake which is a major staging area for waterfowl and shorebirds (CLI Maps Volume 4 Chapter III, p.47). Potholes are numerous in the vicinicy of Smoky Lake, Bruderheim and Fort Saskatchewan. Where possible permanent potholes should be avoided. If impossible construction should occur in late fall or winter to avoid disruption to the reproductive cycle of waterfowl, shorebirds and other wetland animals.

The Urban Area:

The corridor will be similar to the Central corridor in this area. Several aspen poplar groves and potholes may be encountered if the route north of Sherwood Park is adopted.

5. The Vegreville Corridor:

This corridor is similar to the Eastern corridor from the oil sands area as far south as Lac La Biche. Instead of proceeding to the Edmonton Industrial Area it will proceed due south past Vilna, Willingdon, Vegreville and Bruce and terminate in the I.P.P.L. line at Wavy Lake near Strome, Alberta. In the agricultural area only the Amisk River crossing may endanger sports fishing should a major spill occur. Slopes of the Amisk River are steep and sandy and the danger of erosion is high. From the North Saskatchewan River south to Wavy Lake this corridor will traverse land studded with potholes and having a high waterfowl production (CLI Maps Volume 4, Chapter III, p.47, and personal observation). The large rolling hills extending from the North Saskatchewan River south to Willingdon contain many large poplar groves which makes excellent habitat for deer.

6. The Hardisty Corridor:

This corridor is similar to the Eastern corridor from the Athabasca Oil Sands area to Devenish. From this station stop, the corridor will head due south past Glendon, St. Paul, Myrnam, Mannville and Irma to terminate in the I.P.P.L. storage area east of Hardisty. From Devenish south to the Beaver River this corridor will traverse mixed wood forest. South of the Beaver River marginal agriculture is encountered until Yelling Creek. From Yelling Creek south to Hardisty is largely good agricultural land.

The Forest Area:

A major environmental concern of the Hardisty corridor is the stream and river crossings. In addition to high quality sports fishing streams and rivers crossed by the Eastern corridor in the forest area, the Hardisty corridor will cross two streams and one river of good potential. These are Sunday and Punk streams, and the Beaver River (Volume 4 Chapter III, p.49). It will bypass Spencer, Seibert, and Pinehurst Lakes all of which have an excellent fishing potential. Seibert Lake is a trophy northern pike lake at present. From a point near Devenish as far south as the Ipiatik River the corridor will pass through woodland caribou range as well as that of moose, deer and black bear. Corridor construction would run parallel to the Sand River for a distance of 35 miles and at a distance of one to three miles away. The slopes of the Sand and Beaver Rivers encountered by the corridor provide excellent winter range for moose and deer. Should this portion of the corridor proceed, an all-weather access road will have to be built since few if any roads exist from Devenish south to Punk Creek (which drains Pinehurst Lake). Some arrangements must be made with the Canadian Armed Forces in order that the corridor may pass through land presently within the Primrose Air Weapons Range. Since a demand for an all-weather road already exists in towns such as Devenish, Conklin, Chard, it is feared that the corridor access road will be extended for the entire length of the corridor even though a railway exists for about half of the length. Contact with other larger communities and the outside world would lead to the decline of an ancient traditional life style of native

peoples in the area. The quality of hunting, fishing and trapping which now exists would decline as contact grew.

The Agricultural Area:

Just south of St. Paul the corridor will bypass Lower Therien Lake which contains a pelican colony, an eagle and an osprey eyrie (personal communication, Fish and Wildlife Officer, St. Paul). The Hardisty corridor will traverse good deer range from Glendon south to Hardisty. The rough sand hill country from Mannville to Irma appears to be most suitable for deer since farming activities and access roads are very limited. The North Saskatchewan River crossing will be through an area which contained a very dense population of wintering deer. According to Blaire Rippon about 200 deer were seen in a 10 to 15 mile stretch of coulees north of Myrnam. Beaver, muskrat and waterfowl as well as deer were abundant in the rough rolling terrain between Mannville and Irma. Potholes are abundant. Most of those over two acres in size were noted to have a beaver lodge (aerial survey, April 21, 1974). The aspen poplar provide suitable food and cover for deer. Raptors and small birds are abundant throughout the agricultural zone of this corridor. The corridor will pass through at least one sharptail dancing ground south of Irma near Grattan coulee. The potholes of Grattan coulee are a staging area for at least 200 whistling swans (personal observation). The country south of Irma is dotted with many ephemeral and seasonal potholes making ideal habitat for waterfowl and shorebirds. Redtails, Swainson, Harrier and Coopers hawks as well as kestrels are common in the area. Sharptail dancing grounds are found within several miles of either side of the Battle River near Hardisty. Construction of the corridor should occur in late fall or winter in order to avoid disruption of spring and fall courtship dancing. With its thick overstory of willow, alder and/or poplar, the Battle River Valley provides suitable habitat for furbearers including mink and lynx, and for many birds. West and south facing coulee slopes provide suitable winter range for a healthy population of deer (personal observation).

7. Conclusion:

On the basis of information obtained about fish and wildlife of the five corridors, I would state with a good degree of certainty that the Central corridor will be least disruptive to fish and wildlife. The order of preference of corridors is as follows:

(a) the Central corridor
(b) the Western corridor
(c) the Eastern corridor
(d) the Vegreville corridor
(e) the Hardisty corridor

I would hope that the denning area of the grizzly bear be widely circumvented in the Western corridor.

The activities of men are generally incompatible with requirements of various species of animals. Most species are able to adapt to man to a certain degree. However a rapid increase in hunting, fishing, trapping, mining and developing would cause a rapid decline in the quantity and quality of wildlife. Wilderness areas, for me, are the most stimulating experience of the Canadian environment. My wish is that we preserve a portion of this environment for generations to follow.

THE CENTRAL CORRIDOR: FISH AND WILDLIFE

The Central corridor adopted by the study group was identical to that proposed as far as the town of Boyle. Instead of continuing to the Edmonton Industrial Area along the G.C.O.S. route, the route will head due south to a terminal site near Skaro, Alberta which is about 14 miles east of Redwater. This change in course was instigated because of the change in location of the terminal site. This change in location of site was deemed necessary for two main reasons.

(1) It is desirable to process liquid hydrocarbons within the province, especially those produced here rather than have industry related to hydrocarbons develop totally outside the province.

(2) Regional development is believed to be preferrable to massive urban development. The accumulation of major industries in the Strathcona area of Edmonton will trigger major engineering problems in designing transportation, water and sewage treatment facilities. Population growth would soon tax the facilities of the Edmonton business area. Town planners have predicted that Edmonton cannot comfortably absorb a population of over one million people.

If the public finds the above proposals acceptable, then industrial sites involving liquid hydrocarbons will have to be constructed in locations where water, power, transportation and communication facilities are available. Salt deposits should be thick enough to provide adequate amounts for manufacture of PVC's and for storage of oil and its derivatives. Manpower will have to be enticed to the site from the city through offering suitable work incentives and essential services in existing towns or newly developed towns which would house this force. These would include health, educational and recreational facilities. Desirable features of the industrial site for industry will be preplanned utilities and services, and land tax-concessions due to the use of non-arable land.

A terminal site was selected about 55 miles northeast of Edmonton near Skaro. This site will occupy up to 4 square miles of non-farmed land some 14 miles east of Redwater and 5.5 miles south of the North Saskatchewan River. The soil is mainly sand with some clay. In some areas such as the north-central portion a thin layer of dark soil overlies the sand. Over half of the terminal site area has an aspen-balsam poplar overstory with various shrubs and willows such as mooseberry, dogwood, Bebbiana willow, saskatoon, chokecherry and pincherry below. Grasses and herbs noticed are similar to that of the Andrew Industrial site four miles due east.

The Andrew site lies two to five miles south of the North Saskatchewan River and has a total area of 24 square miles. Lands occupied by the industrial site is rough hummocky terrain of clay-sand, sandy or peat soil (in bog areas). Sand hills begin four miles west of #855 secondary running north to Smoky Lake and south

to Andrew. The overstory vegetation is basically jackpine, aspen and balsam poplar in raised sandy area. Bog areas have black and white spruce, birch, willow and alder. Shrubs found here are typical of aspen parkland and similar to the Skaro terminal site. Buckbrush and silverberry were observed on the industrial site area but not the terminal site area. Grasses noticed while walking were pine grass, northern wheat grass, brome grass, rough fiscue and redtop in the drier areas. Sedges, rushes, cattails and willow cover wetland areas. Various species of sparrows (the song, vesper, chipping, tree, field and swamp sparrow) are common. The robin, bluebird, sparrow hawk (kestrel) and eastern kingbird are frequently observed on power or telephone lines through the area. The hermit thrush, veery and various warblers can be heard in the poplar stands. Blackbirds (red-winged, yellow-winged, tricolored), the cowbird and marsh wren are common in wetland areas. Dabbling and diving ducks, coots, grebes, gulls, terns, sandpipers, killdeers and marsh hawks frequent wetland areas. Dabbling ducks observed were the mallard, pintail, blue and green-winged widgeon, gadwall and shoveller. Diving ducks observed were the canvasback, redhead, ring-neck, lesser-scaup, ruddy and bufflehead, and white-winged scoter. Common shorebirds observed were the piping plover, the killdeer of the plover family, the marbled godwit, upland plover, spotted sandpiper, willet, greater and lesser yellowlegs, short-billed dowitcher, and the sanderling of the sandpiper family. Wilson's phalarope and the common snipe are also common shore dwellers here. The herring, California, ring-bill, and Bonoparte gulls were in the vicinity of wetlands scavenging and preying upon small birds, mammals or eggs. Common and black terns and the rough-winged swallow skim the air above potholes for insects and may skim the water for larvae or insects. Abandoned buildings provide a home for rock doves and the barn swallow. Tree swallows make their home in old woodpecker holes. Yellow shafted flickers, yellow billed sapsuckers, hairy and downy woodpeckers are common drummers of the forest.

Traill's flycatcher and the olive sided flycatcher are commonly seen at the edge of poplar groves darting out after moths, etc. The high musical whistle of the black-capped chickadee is heard in the groves of black and white spruce. The short-eared

owl. Swainson's hawk. red-tail hawk and Cooper's hawk are common twilight hunters of the sky. Smallest but not least, the tiny ruby-throated hummingbird may be heard buzzing through forest of flowers. On overcast days the mosquitoe hawk may be seen skimming open areas for mosquitoes. At dusk his buzz-dive is quite audible for several hours.

Few mammals were observed in and about Skaro or Andrew. Mammals observed were Richardson's pocket gopher, the American varying hare, the Mackenzie red squirrel, the little northern chipmunk, the northern muskrat and the badger. Tracks, droppings or mounds indicated that mice, pocket-gopher, weasel, porcupine, skunk, coyote and deer are present.

Clearing of vegetation would destroy species of birds primarily, since mammals appear to be scarce in the area. The soil is sandy or silty sand in the raised areas in both the Andrew and Skaro sites; thus great care will have to be taken to avoid erosion especially due to wind. The numerous grass bogs in the Andrew site contain a fair population of breeding ducks and shorebirds. Site construction would necessitate the drainage of these grass bogs which produce a horrendous population of mosquitoes.

A. Boyle to the Skaro Terminal

The Corridor Development Plan (Volume 1 Part 2) recommends the adoption of the Central corridor. This corridor would run to a terminal at Skaro (east of Redwater 14.5 miles). Industrial sites would be constructed north of Two Hills and Myrnam, and east of Hardisty if decentralization of population and development of secondary oil industries within Alberta is believed desirable. If this plan is adopted the corridor will head due south from the G.C.O.S. line near Boyle past Long Lake Provincial Park, Hollow Lake, Waskatenau to the Skaro terminal. From the G.C.O.S. line north of Boyle, the townsite, the land is flat and largely farmed. Many poplar groves remain and from the evidence of deer antlers hanging upon farm and town houses, it appears to be excellent deer country. The soil appears to be black Chernozoam. The corridor may bypass Skeleton Lake within one mile. This lake

is an extensive resort area. Greater care must be taken to disguise the corridor. The existing powerline which passes within 200 yards of the west end of Skeleton Lake is poorly disguised especially for a resort area. South of Boyle, the soil is silt and sand in the raised areas and peat in the lower muskeg areas. The topography is rough and hummocky from Boyle south for about 12 miles. From the Hollow Lake area south to the North Saskatchewan River it is almost flat. The soil appears to turn from basically clay near Hollow Lake south for six or eight miles to black Chernozoam.

The raised areas are mainly aspen poplar. The understory is similar to that at Andrew. Certain areas have some balsam poplar and white spruce. The muskeg areas often contain an overstory of white birch, larch, and black spruce. The inderstory is basically willow, mooseberry, and Labrador tea.

The west side of the secondary road running north and south past Long Lake Provincial Park appears to be the better route for a corridor because fewer farms will be encountered, the topography will be less rough. Slightly more muskeg will be encountered from Boyle to Long Lake on the west side of the highway than on the east. Deer were seen north of the Long Lake turn-off and deer sign was abundant in most areas. Care will have to be taken to revegetate the soil in sandy areas. It was observed that the A.G.T.L. line which runs southeast from Atmore past the west end of Skeleton Lake past Vegreville, Viking and Hardisty to the I.P.P.L. area had several sandy areas in the hummocky terrain east which had eroded badly. Few potholes occur from the Atmore area south to the North Saskatchewan River. Waterfowl production in this area is low. Small perching birds will be most affected by the corridor in the removal of trees.

Care will have to be taken to avoid Pine Creek Cemetery one mile north of the proposed river crossing. The river crossing appears to be in one of the most suitable areas in terms of slope and stability of the river hill. Wildlife is relatively sparse here compared to neighboring areas downstream. South of the river the corridor will traverse black soil farmland for four

or five miles until reaching the rolling sand hummocks of the Skaro Terminal site. This section of the corridor is dotted with numerous seasonal and semi-permanent potholes which provide excellent habitat for waterfowl waders and shorebirds. Poplar groves are frequent within the farmland and almost continuous in the terminal site making excellent deer habitat. Raptors were frequently observed along the length of the Boyle - Skaro corridor.

B. Skaro Terminal to Edmonton

The corridor will traverse good farmland diagonally for a distance of about 13 miles before encountering the C.N.R. right-of-way near Bruderheim. From here to Edmonton the corridor may follow the C.N.R. right-of-way except in two or three areas where farms or large sloughs will have to be avoided. The corridor will have to detour around the cemetery east of the tracks near Josephburg and several large potholes north of it. One large farm just north of Highway 16 will have to be bypassed although the corridor may follow the C.N.R. tracks to the Edmonton Industrial area or may go straight south from Akenside for a distance of four miles and then due west to the Edmonton Industrial area.

From the Skaro terminal site area until Highway #45 some six miles southwest the land is flat, open and farmed. Habitat for deer, waterfowl and most birds is poor. Southwest of Highway #45 seasonal, semi-permanent and permanent potholes are abundant as far as Greisbach. Several small streams will have to be crossed. These are Beaverhill, Astotin, Ross and Point Aux Pin streams. Only Beaverhill Creek has much of an overstory of poplar which could provide cover for perching birds. Some beaver activity was noticed along the stream bed. Waterfowl were noticed north of Highway #45, near Josephburg and near Campeltown in the alternative route in the Edmonton Industrial area.

C. Skaro Terminal Site to Andrew Industrial Site

One farm will be encountered one mile east of the west corner of the Skaro terminal site. Farmland exists in the corridor east for about two miles from the south end of the proposed corridor. Further north is treed primarily by aspen and balsam poplar. Four

miles east of the southwest corner of the Skaro terminal site some pine trees are encountered which increase in occurrence as one goes east. Just east of the four mile and five mile crossroads east of the southeast corner of the Skaro terminal farms will be encountered. Most of the corridor to Andrew is treed primarily by poplar. The southwestern end is farmed or grassland, the soil being very sandy.

D. Andrew Industrial Site

The site area begins four miles east of the southeast corner of the Skaro terminal site and continues east for nine miles. It has an area of 24 square miles, most of which is in rough hummocky terrain of sandy, clay sand or peat soil. The sandy hills begin four miles west of #855 secondary running north to Smoky Lake. One mile west of #855 secondary a large slough more than 100 acres is encountered. This slough attracted ducks, terns, and blackbirds. Several large sloughs are encountered on the north side of the Andrew Industrial Site east of the secondary road. One about 3.8 miles east of the secondary road attracts many ducks. At least five occupied farms are found within the industrial site area, most on the south side near the crossroads. Raptors, especially Harrier hawks, red-tail hawks, Swainson's hawks, goshawks and kestrels are frequently seen in the site area. Perching birds such as warblers flycatchers, sparrows, thrushes, and chickadees are abundant. Most potholes are heavily overgrown with sedge and willow making them unsuitable for waterfowl or shorebirds.

E. Andrew Industrial Site to Two Hills Industrial Site

The corridor will traverse good farmland having black Chernozemic soil for most of the distance from Andrew to Two Hills. Egg Creek will be crossed just east of the Andrew site. The land is fairly flat for about four miles east of Egg Creek but becomes gently rolling. Potholes are numerous and several are more than 20 acres in size. Most have a high density of waterfowl; mallard and pintail being most common. Cucumber Lake which will be crossed north of Willingdon attracts many ducks especially lesser scaup. Raptors are abundant in the area. Near Hairy Hill the hills grow

larger but the terrain is still gently rolling. For a distance of five miles few potholes occur. About three miles west of the Two Hills industrial site potholes become more numerous. Several large potholes and lakes exist here, but these contain few ducks. Deer cover is excellent in the Two Hills area west of the site.

F. Two Hills Industrial Site

The Two Hills industrial area begins two miles north and two miles west of Two Hills and continues east five miles. The area envisaged by the industrial site consists of about 19 square miles of fairly good farmland. The northwest corner of the site is rough and sandy. Much of the northwest side of the site is grassland. Potholes are frequent and usually contain waterfowl.

G. Two Hills Industrial Site to Myrnam Industrial Site

Heading east from the Two Hills site is grassland to the north and farmland south for five miles. Here an immense slough running about one mile in sandy hummock terrain is encountered. Cover for deer in the country is excellent. Deer tracks were observed. The terrain east from here until the Myrnam site is rough and hummocky. The soil is silt-sand, or sandy. The land is grazed by cattle. Aspen and poplar are the dominant overstory cover. A high density of farms will be encountered through this area. Potholes and sloughs are frequent but few waterfowl were observed (June 5/74). The interspersion of grassland and poplar make this area excellent habitat for deer and small birds.

H. Myrnam Industrial Site

The industrial site consists of some 18 square miles of relatively poor agricultural land. The soil appears to be sandy loam or clay loam. The terrain is sharp and rolling and contains few potholes. Those which exist attract a good population of waterfowl. Four farms are situated on the north side of the southeast corner of the site. Two streams pass through the center area of the site. Due to numerous closely spaced groves of poplar, habitat for deer appears to be excellent.

I. Hardisty Industrial Site

The industrial site area was not delineated since its existence is 20 or more years in the future. Should the site be constructed near the Home Oil storage terminal one mile east of Hardisty, grassland known to be used by a large herd of wintering deer will be destroyed. The industrial site would be situated in a valley where the danger of inversions of cold air would be severe. The Battle River upon which the site will border, contains excellent habitat for willow grouse, pheasants, partridge, deer, lynx, and coyotes. Improvement of water supply of the Battle River necessitated by the volumes of water needed by a petrochemical plant would destroy a great deal of willow, alder and poplar habitat along the river valley.

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER V

ADDITIONAL LEGISLATION WHICH MAY AFFECT THE ATHABASCA TAR SANDS CORRIDOR STUDY

COMMON CARRIERS

Prepared for:

Alberta
Environment

By:

Swist & Co.
Edmonton, Alberta

Commissioned by:

Stewart Weir Stewart
Watson & Heinrichs

ADDITIONAL LEGISLATION WHICH MAY AFFECT THE ATHABASCA TAR SANDS CORRIDOR STUDY

INTRODUCTION

In reviewing the contemplated Athabasca Tar Sands Corridor, we have been examining the Navigable Waters Protection Act being Chapter N-19 of the Revise Statutes of Canada. Any navigable waters between Edmonton and Fort McMurray which would be necessary to cross with the corridor would be those that have been judicially interpreted in a very broad sense and would include any rivers that are capable of consistent commercial shipping.

THE NAVIGABLE WATERS PROTECTION ACT 1970 RSC cap. N-19

Constitutional Aspects.

Under S. 91(10) (Navigation and Shipping) the Federal Government has jurisdiction over all navigable waters.

> (Reference re Validity of Industrial Relations and Disputes Investigation Act (1955) SCR 529.)

The theoretical division between S. 91(10) and those powers granted to the Province - when translated into concrete terms and applied to navigable rivers creates the following split in jurisdiction:

> 1. The proprietary rights of the river bed and banks is vested in the Provinces.
>
> 2. Control over navigation per sae is vested in the Federal Government.

Based on this jurisdiction division, the Federal Government enacted the Navigable Waters Act, the relevant sections of the Act being as follows:

> S.5 (1) No work shall be built or placed in,upon, over, under, through or across any navigable water unless
> (a) the work and the site and plans thereof have been approved by the Minister upon such terms and conditions as he deems fit prior to commencement of construction;

(b) the construction of the work is commenced within six months and completed within three years of the approval referred to in paragraph (a) or within such further period as the Minister may fix; and
(c) the work is built, placed and maintained in accordance with the Plans, the regulations and the terms and conditions set out in the approval referred to in paragraph (a).

S.5 (2) Except in the case of a bridge, boom, dam or causeway, this section does not apply to any work that, in the opinion of the Minister, does not interfere substantially with navigation. 1956, c.41, s. 3; 1968-69, c. 15, s. 3.

S.6 (1) Where any work to which this Part applies is built or placed without having been approved by the Minister or is built or is not built or placed in accordance with plans so approved, or having been so built or placed, is not maintained in accordance with such plans and the regulations, the Minister may
(a) order the owner of the work to remove or alter the work;
(b) where the owner of the work fails forthwith to comply with an order made pursuant to paragraph (a), remove and destroy the work and sell, give away or otherwise dispose of the materials contained in the work; and
(c) order any person to refrain from proceeding with the construction of the work where, in the opinion of the Minister, the work interferes or would interfere with navigation or is being constructed contrary to this Act.

(2) Where an owner or person fails to comply with an order given to him pursuant to paragraph (1)(a) or (c), he is liable on summary conviction to a fine not exceeding five thousand dollars.

Additionally S.6 (3) states that if the Minister removes or destroys obstructions to navigation the costs are recoverable from the party creating the obstruction.

If then the transportation corridor is to cross navigable rivers, with a possibility of creating an obstruction, the Federal approval appears prudent and mandatory. Parenthetically it should be noted that whether or not an obstruction to navigation exists has been broadly interpreted. In an Ontario case the Courts held that wires over a navigable river constituted an obstruction since it prevented the landing of float planes.

The Procedure for Federal Approval

1. One month prior to application, the applicant gives one month's notice of application in the Canada Gazette.

2. Pursuant to S.5 (1) of the Act, the local authority or person constructing shall submit to the Minister of Transport:

(a) application for approval;
(b) a site plan;
(c) a summation of the proposed work;
(d) description of the proposed site.

3. The Minister is then required to decide:

(a) whether the project interferes substantially with navigation;

(b) whether approval shall be given vis-a-vis danger to navigation - interference with navigation (see S.5 (2) - S.9 (3)).

If no substantial interference exists in the course of this corridor, in the opinion of the Department, approval is not necessary and the criteria enumerated above in (b) becomes superfluous.

4. The constructing party may provide statutory notice of the project by registering the plan and description of the site at the relevant Land Titles Office.

5. Construction must conform to the original plan and if alterations are necessary, these alterations must be submitted for approval. (S.9 (2)).

6. The Department of Transport fixes a time period within which construction is to be completed, but S.9 (4) permits application for a time extension.

FISHERIES ACT 1970 R.S.C. F-14

The Transportation Corridor could come into conflict with the following provisions of the Federal Fisheries Act:

Construction of Fishways

20. (1) Every slide, dam or other obstruction across or in any stream where the Minister determines it to be necessary for the public interest that a fish-pass should exist, shall be provided by the owner or occupier with a

> durable and efficient fishway, or canal around the slide, dam or other obstruction, which shall be maintained in a good and effective condition by the owner or occupier, in such place and of such form and capacity as will in the opinion of the Minister satisfactorily permit the free passage of fish through the same; where it is determined by the Minister in any case that the provision of an efficient fishway or canal around the slide, dam or other obstruction is not feasible, or that the spawning areas above the slide, dam or other obstruction are destroyed, the Minister may require the owner or occupier of such slide, dam or other obstruction to pay him from time to time such sum or sums of money as he may require to construct, operate and maintain such complete fish hatchery establishment as will in his opinion meet the requirements for maintaining the annual return of migratory fish.

To add vitality to S.20 (1) - the Act provides that all fishways shall be kept open (S.20 (2)) and if necessary the Minister may construct fishways and canals and recover the expenses of construction from those parties who created the obstruction.

The Federal Fisheries Act would only affect the Transportation Corridor - if it was to be constructed over rivers - in a manner to impede - or affect fish spawning - or fish movement. In such cases adequate spillways and canals would be needed.

THE WILDLIFE ACT 1970 R.S.A. c.391

The following sections of the Alberta Wildlife Act appear relevant to the creation of the Corridor.

> S.30 (2) No person shall at any time hunt, disturb or take any game bird in a bird sanctuary, unless he is the holder of a license or permit expressly authorizing him to do so.
>
> S.58 (1) No person shall molest or destroy a den or usual place of habitation of any fur-bearing animal or fur-bearing carnivore other than that of a coyote or skunk on privately owned land.

The Regulations delineate the boundaries of these Wildlife Reserves.

PRIMROSE RANGE AGREEMENT (How it Affects the Hardisty Route)

A. Introduction

In respect of the "Primrose Range Lease," we have done an investigation which is contained below. Our educated guess is that the lease cannot be broken by the Province and that because of the nature of the use of the Primrose Range, i.e. National defence, the interest of the Federal Government as lessee may not be capable of expropriation.

Obviously some agreement is in order, or alternately a route change ought to be made to avoid the Primrose Range.

B. The Primrose Range Agreement

In "capsule" form this agreement states:

> "In consideration for monies and other services, the Province agrees to make a certain 1,297,999 acres available to the Federal Government for purposes of defence for a period of 20 years plus additional periods."

Additional terms of possible relevance state:

> 1.(a) Reserve the area for the exclusive use of Canada for twenty (20) years from 1st April, 1954 and for such further period as the area may be required for the purposes of national defence with a right of access thereto from 1st April, 1952.
>
> 2.(f) For each ten (10) year period this agreement is in force and unless the use of the area is urgently required for military purposes give consideration to the setting aside of a portion or portions of the area and to permitting the Province, its servants, agents or licensees to cut and remove timber continuously for a period or periods of time, and give the Province at least one year prior to the date on which they may be used notice of the portion or portions to be set aside and the length of time they may be used for these purposes.

> 3.(c) Except as otherwise herein provided this agreement shall take effect from 1st April, 1954, and shall remain in full force and effect for a continuous period of twenty (20) years and thereafter shall be automatically renewed from year to year unless Canada gives notice to the Province of its intention to terminate the agreement, such notice to be given by registered mail addressed to the Minister of Lands and Forests of the Province at least sixty (60) days prior to the expiration of the then current year.
>
> 3.(f) Canada shall have the right to terminate this agreement on giving, at any time prior to first of April in any year, one year's notice.

The agreement is silent on whether or not the Provincial Government can cancel or terminate this agreement.

Characterization of this Agreement

1. It appears clear that this agreement is not a licence and is a lease. At page 624 The Law of Real Property 3rd Ed., Megarry & Wade the authors state:

> "It is the essence of a lease that the tenant should be given the right to exclusive possession, that is, the right to exclude others."

It appears to have to be the parties intention and they did in fact do this by clause 1 (a) cited above. Therefore, the Federal Government appears to have all those rights and liabilities of a Lease-holder.

2. Assuming this is a Lease, what type of Lease is it? Clauses 1(a), 2(c), and 2(f) appears to produce conflicts as to the duration of the Lease. 1(a) suggests that it is a Lease in perpetuity in which case it would be void. 2(f) speaks in terms of ten year intervals. 2(c) is probably the governing section in which case it is a lease for twenty years and at the end of that period it becomes a yearly tenancy.

Assuming the above is correct; can the Province terminate or cancel this yearly tenancy where the Lease is silent as to the Lessor's rights in this regard?

At page 650, Megarry & Wade (infra) states:

> "It should be noted that the Landlord has no right to determine the Lease at the renewal dates before 1926, if L granted T a lease for 21 years with a perpetual right of renewal, it was T alone who had the right to decide each 21 years whether or not to renew the Lease. This position is preserved save that now the Lease continues unless determined, instead of requiring renewal, the tenant may contract out, but he need no longer contract in."

This appears to be the Canadian situation also, since a termination of a renewable Lease could very well constitute a derogation from the original plant.

Can the Province or companies expropriate if necessary?

It is suggested that the Federal Government is in no higher position than any other party which obtains a Lease from the Provincial Government. Therefore, if the company wishing to build has (a) expropriating powers, (b) provides notice to the Federal Government as a tenant - difficulties should not accrue.

The exception to the above is found in the B.N.A. Act. If the Federal Government declares the area to be under exclusive Federal Jurisdiction and that an intersecting transportation corridor is not in the National interest - then the corridor could not cross the Primrose Range. This appears remote.

Alternately, if the Provincial Goverment is going to purchase all lands then expropriation would be unnecessary in this area.

COMMON CARRIERS

THE PROBLEM

Through previous discussions of the Transportation Corridor Committee, it was agreed that it may be useful to transform the existing Great Canadian Oil Sands pipeline from a private carrier to a carrier for various companies so as to conform to the objectives of the proposed Transportation Corridor.

There are at least three possible ways in which this transformation could be accomplished:

(i) by agreement between Great Canadian Oil Sands, the Government, and other related parties;

(ii) by expropriation; or

(iii) by transforming the private carrier to a common carrier.

The first alternative is accomplished through negotiation, and though a viable alternative, need not be discussed further in this report.

The procedures for expropriation are equally well known, and their extrapolation here would prove redundant. Therefore, this paper is designed to discuss the conversion of an existing private pipeline to the objectives of the transportation corridor by having it declared a common carrier.

Within this third alternative, two major questions arise:

1. Can the Provincial Government transform the existing Great Canadian Oil Sands pipeline from a private carrier to a common carrier?

2. If the Provincial Government can take this step, what is the correct procedure to achieve this end?

This alternative may prove viable, depending upon the answers to these questions.

DEFINITIONS

For purposes of clarity, a brief description of the concept of "Common Carriers" may be useful.

William & Meyers, Oil and Gas Law, defines a common carrier to be: "A person engaged in the transportation of petroleum as a public utility and a common carrier for hire." The key distinguishing feature appears to be that the "individual (is) engaged directly or indirectly, in the transportation of crude oil and petroleum or products thereof, for hire ..." (William & Meyers Index p.70).

In contrast, an oil company engaged in the business of producing and refining oil and using its privately owned pipeline for the sole purpose of transporting oil from its wells to its refinery would not appear to be a common carrier. (Associated Oil Co. v. Railroad Commission of California, 169 p.62). Whether or not a pipeline is a common carrier then, would appear to depend upon the purpose for which it was constructed and the subsequent use thereof. If a company is engaged in the business of transporting oil and gas for hire or transporting oil and gas from other producers, it would appear that such activities would cause the line and the company to be classified as a common carrier.

LEGISLATION

As in many jurisdictions in the United States of America, existing Alberta legislation contemplates the transformation of a private carrier to a common carrier by way of declaration.

Section 49(1) of The Oil and Gas Conservation Act, R.S.A. 1970 states that upon obtaining the approval of the Lieutenant Governor in Council, application can be made to the Oil and Gas Conservation Board for an order declaring that the proprietor of a pipeline is a common carrier throughout Alberta or within a designated portion of Alberta.

Section 49(2) of the said Act stipulates that once a proprietor has been so designated, he shall not discriminate in any manner between persons for whom oil, gas, or synthetic crude is transported. Section 49(3) specifically stipulates that the common carrier shall not discriminate in favor of his own products.

Since the Board has jurisdiction to designate companies as common carriers, they are given the corresponding power to declare that a pipeline proprietor is no longer a common carrier.

Collateral to this power, and pursuant to Section 51 of the said Act, the Board, upon application and with approval of the Lieutenant Governor in Council, may declare a proprietor to be a common purchaser. This purchaser must then purchase from the specified group offering oil for sale without discrimination. As in the case of a common carrier, the Act specifically prohibits the common purchaser from discriminating in favor of himself. And further, as stipulated in respect to common carriers, the Board may relieve a party from the requirements of a common purchaser by an appropriate Order.

THE APPLICATION

After considerable research. C.H.Hebb in his article Common Carrier, Common Purchaser and Common Processor Orders 1969 (20) Alberta Law Review #3 at page 439 states:

> "The only recent common carrier application was made by Prairie Utility Management Ltd., for an order declaring Cretaceous Pipelines Ltd., to be a common carrier of dry residue gas produced from the Willingdon Field. In that application Prairie Utility Management Ltd., was applying to have Cretaceous Pipelines Ltd., declared a common carrier of Prairie's gas produced from the Willingdon Field to be carried to the towns of Hairy Hill and Two Hills with a tie-in to a line to serve the community of Willingdon. Cretaceous had been using its 19-mile line almost exclusively for the transport of natural gas from the Willingdon Field to a chemical plant at Duvernay where the gas was used to produce electricity. The order making Cretaceous Pipelines Ltd. a common carrier of gas produced from the Willingdon Field and the Hairy Hill Field was granted in January, 1963."

This paucity of applications and decisions places much of the following analysis into the area of speculation.

Notwithstanding S.110(1) of the Oil and Gas Conservation Act which contemplates that the Board may make an Order on its own initiative without a hearing, S.49(1) appears clearly to intend that a common carrier should be designated only "upon application" and "after a hearing". The applicant merely notifies the Board by letter that it wishes to bring an application to have a named party designated a common carrier pursuant to Section 40 of the Oil and Gas Conservation Act. The Board then stipulates a date for the hearing. Since the Board would likely consider the application to be contentious and affecting rights of other parties, it would itself give the affected parties ten days notice or instruct the applicant to do so.

Service upon affected parties is deemed to have occurred 24 hours after the notice has been sent by mail to the registered address given by the company when it obtained its license to operate in Alberta. (Sections 105 and 117 of The Oil and Gas Conservation Act)

If necessary, the Board has jurisdiction to demand that witnesses appear and produce any documentation that the Board considers relevant. Failure to attend or failure to produce documentation may result in an application by the Board to the Courts to have the parties cited for contempt. (Sections 119, 120, 121, The Oil and Gas Conservation Act.)

In conducting a hearing, the Board is not bound by the strict rules of evidence, and merely has to stay within the boundaries established by the principles of Administrative Law.

Once the Board has made a decision, Section 122 of the Act makes it clear that the Board may review, change, or alter their previous decision. Presumably, since the original decision can only be made "upon application" and "upon a hearing" (Section 49), a change in the decision could also only occur upon application and a hearing. However, this is uncertain.

An application to have a proprietor of a pipeline declared a common carrier shall include the following information to facilitate the Board's decision:

> A map showing the location of the proprietor's pipeline; the location of other pipelines which could provide an alternate route; and the location of the applicant's facilities.

Further, the applicant must discuss the following factors:

1. the details of the supply of oil or synthetic crude which is intended to be shipped through the pipeline.
2. the available capacity of the proprietor's pipeline.
3. the practicality of having the applicant's oil routed through this pipeline.
4. the economics of the alternative modes of transporting the oil.
5. the availability of markets for the crude oils which the applicant proposes to ship or data showing the reasonable expectations of a market for these oils.

(See Regulation 151/71)

PROBLEM AREAS

The intial problem with this seemingly straightforward application is: Who is entitled to bring such an application?

Section 49 enumerates only two conditions precedent before the Board can declare a proprietor to be a common carrier - namely: (a) upon application, and (b) after a hearing. Theoretically, it seems open for anyone to make such an application. Without reference to the probability of success, it is suggested that there is nothing expressly in Section 49 to prohibit applications by any person or association. Therefore, it is suggested that, primie facie, there is no express prohibition against an application by the Provincial Government or an agency thereof.

Assuming a Provincial agency has status to bring such an application, the question then, is: Would the lack of a direct proprietor interest in extracting and delivering the synthetic crude constitute grounds for dismissing the government's application? The answer here again is uncertain because the principles to be applied by the Board in reaching a decision are unstated in the common carrier sections. Reference, then, to the objects and application of the Act appears to provide the sole guideline to determine the principles upon which the Board will grant and refuse orders. Section 5 of the Oil and Gas Conservation Act outlines the objects and Application of the Act to be:

(a) to effect the conservation of, and to prevent the waste of, the oil, gas and crude bitumen resources of Alberta,

(b) to secure the observance of safe and efficient practices in the locating, spacing, drilling, equipping, completing, reworking, testing operating and abandonment of wells and in operations for the production of oil, gas and crude bitumen,

(c) to provide for the recording and the timely and useful dissemination of information regarding the oil, gas and crude bitumen resources of Alberta, and

(d) to control pollution above, at or below the surface in the drilling of wells and in operations for the production of oil, gas and crude bitumen and in other operations over which the Board has jurisdiction.

As stated by C.H. Hebb, Common Carrier, Common Purchaser and Common Processor Orders, Alberta Law Review 20 (1969) Vol. 3 at page 442:

> "The unique extension inherent in the common carrier, common purchaser and common processor procedures is that they are an extension of the doctrine of correlative rights beyond the land itself. The concept of giving an opportunity to every person to secure a fair share of the oil or gas beneath his land has been extended to include the opportunity to have his oil or gas transported, purchased or processed. Thus, producers from different pools may apply to have the

owner of the facility declared a common carrier or processor who is forbidden to discriminate between production from different pools. The opportunity for every person to secure a fair share of the oil or gas beneath his land is effectively correlated with all other producers in the Province of Alberta."

Mr. Hebb then concludes:

" It is clear that the above described procedures are not directly related to Section 4(a), the conservation of oil and gas resources. It is hard to conceive of any case where these procedures would involve a prevention of waste of oil and gas resources. Almost exclusively the procedures relate to the expanded concept of each owner having an opportunity of obtaining his just and equitable share of the production of any pool."

If, then, the raison d'etre of the common carrier sections is to insure that each producer has a fair opportunity to have his oil or gas transported, it seems that a government agency, not being a producer, would not come within the intended purpose of the sections. Failure of the oil producers themselves to make the application would produce the irresistable inference that they had in fact a fair opportunity to transport their synthetic crude.

The regulations made under Section 49 would appear to provide collateral support for the opinion that a governmental agency not having a direct proprietary interest in the tar sands would not be entitled to succeed on this application. The applicant is required to produce a map showing the location of their facilities. Not only does this regulation suggest that the Legislature contemplated that only producers would be "applicants", but the failure to show any facilities within the mapped area may be considered by the Board as non-compliance with a mandatory regulation.

It is our conclusion, then, that only persons at associations with a proprietory interest which would be directly benefited would be successful on these typs of applications. Further, it is our suggestion that to show the requisite interest, the applicant must be a producer who requests the common carrier order to enable the transfer of his oil, gas,

or synthetic crude. A governmental agency lacking these requirements, it seems, would face the aforesaid objections.

It is often useful to examine the possible results from a judicial or quasi-judicial body's decision when one is attempting to predict their decision. Reviewing some of the different factual situations from which applications could arise, the results flowing from such an order could be quite consequential.

An order declaring a proprietor to be a common carrier could produce any of the following results:

(a) A pipeline working at near capacity could find the volume of its own oil being transported to be reduced. This could easily occur where the applicant's volume of supplies greatly exceeded that of the proprietor since Section 40 (3) expressly prohibits discrimination in favor of his own oil.

(b) Reduction in the flow of his own oil may necessitate looping by the proprietor to ensure his oil reaches the market. Pre-existing commitments, the financial necessities of maintaining a specific flow level, and the desire to maintain economics of scale, may totally remove any real element of free choice in respect to the looping decision from the proprietor.

(c) The proprietor's existing forecasts and long range capital expenditure plans for pipelines would be completely nullified by a common carrier order.

Although the Board would recognize that if these contingencies occurred the proprietor could apply to be "declassified", it is submitted that potential results of this nature would cause the Board to be reluctant to grant an order. Consequently, the desire to maintain the status quo would tend to offset the government's arguments showing the need to transform a private carrier into a common carrier.

COMPENSATION

Additionally, the problems of compensation raises substantial unanswerable problems. It seems clear from the Act that the Energy Resources Conservation Board would have no jurisdiction to establish the tarriff. Application would have to be made to the Public Utilities Board since Section 2(j)(iv) of the Public Utilities Board Act 1970 R.S.A. c.302 defines a public utility to mean:

> "Any oil pipeline the proprietor of which is declared by the Oil and Gas Conservation Board (now the Energy Resources Conservation Board) to be a common carrier."

The lack of jurisdiction in the Energy Resources Conservation Board to establish tarriffs produces a unique situation from a decision making standpoint. They would not have the control to temper the results. They would not have the control to temper the hardships to the proprietor by increasing the tarriff. This would fall under the purview of the Public Utilities Board. Therefore, it is suggested that this inability to "financially soften" their decision would increase the Board's desire to not grant such an order.

The area of compensation raises further questions:

(a) could a proprietor obtain compensation by showing that additional looping was necessary because of the order;

(b) conversely, could a proprietor obtain compensation for reduced flow in his own oil as being a direct result of an order;

(c) could a proprietor argue that this order was in fact an expropriation because the reduction in the flow of his oil evidences the loss of a proprietory right.

It is noticeable that the Public Utilities Board Act 1970 R.S.A. 302 does not contain provisions directly giving the Board authority to grant compensation for this type of loss. Presumably, if loss occurred, the sole financial solution to be offered by the Board is increased tarriffs pursuant to Section 101 of the Public Utilities Board Act. Whether this would produce or is capable of producing reasonable compensation would appear to be another unknown factor.

CONCLUSIONS

1. Of the three alternatives posed for converting existing pipelines to the use of various purchasers, agreement appears to be the most politically and economically viable.

2. If agreement is impossible, expropriation provides a fast method to obtain access and utilization of the pipeline.

3. The procedures for expropriation are reasonably established through practise and precedents.

4. The principles for compensation via expropriation are reasonably well defined through precedent and practise.

5. The cost of expropriation would be substantial and presumably would be borne by the Provincial Treasury.

6. The deficiencies in the common carrier provisions make both the practise and principles of compensation uncertain.

7. There is an arguable case to the effect that a non-producer has no status to obtain a common carrier order.

8. The common carrier legislation does give the synthetic crude producers status to apply for a common carrier order.

9. Assuming the Province had the status to obtain an order, the direct cost to the Provincial Treasury would be nominal vis-a-vis the cost of expropriation.

10. The cost of transforming a private carrier to a common carrier presumably would be passed on to the public as part of the cost of various petroleum products.

Consequently, if the Provincial Government, of its own volition, attempts to obtain an Order from the Board declaring Great Canadian Oil Sands to be a common carrier, the application should be brought by a Crown Corporation or agency which has investments in tar sands production. It is suggested that this could place the Government in a position to meet the test posed by the writers: that is; "an applicant seeking a declaration, declaring a pipeline facility a common carrier, must be a producer (or have an interest) in production) of transportable crude."

ATHABASCA TAR SANDS

CORRIDOR STUDY

CHAPTER VI

FLOW PATTERNS
LIQUID HYDROCARBONS

Prepared for:

Alberta
Environment

By:

Stewart Weir Stewart
Watson & Heinrichs

Edmonton, Alberta

FLOW PATTERNS
of
LIQUID HYDROCARBONS

Following is a series of flow maps covering the years 1975, 1980, 1985, 1995 and 2005. These provide a schematic view of flow patterns of liquid hydrocarbons within Alberta. They have been made to aid in locating and confirming the corridors and terminals in this study. The size of arrows indicate the approximate flow. The sites are speculative.

Presently nearly all the flows are into the Edmonton area with a lesser amount into the Hardisty area. The flows into these areas will gradually decrease as the conventional oil fields become depleted. It is anticipated that these will be replaced in the future by flows from the Alberta Oil Sands. Also it may be possible to reverse the flows to potential petrochemical plants or for the transport of processed refinery products. Please refer to Chapters 1 and 2, Volume 8.

1975

ATHABASCA TAR SANDS CORRIDOR STUDY

SCHEMATIC VIEW OF FLOW PATTERNS OF LIQUID HYDROCARBONS FOR THE PURPOSE OF LOCATING TERMINALS & CORRIDORS IN STUDY AREA

Alberta ENVIRONMENT

- (T) MAJOR TERMINAL
- (R) MAJOR REFINERY
- (P) MAJOR PETROCHEMICAL
- CRUDE OIL (conventional & synthetic)
- REFINERY PRODUCTS
- PETROCHEMICAL FEEDSTOCK
- OIL SANDS
- OIL PIPELINE
- GAS PIPELINE

NOTE:
- Sites shown are speculative.
- Size of arrow indicates approx. flow.
- Mackenzie flow shown with *.
- Total number of sites to be developed depends upon many factors, (materials, manpower, environment, economic, etc.)

STEWART WEIR STEWART WATSON & HEINRICHS

Scale: 1:1,500,000 (1"=24miles approx.)

No. 17

Prepared From Base Map
Produced by the Surveys Branch, Department of Highways and Transport

NORTHWEST TERRITORIES

BRITISH COLUMBIA

SASKATCHEWAN

MONTANA

1980

ATHABASCA TAR SANDS CORRIDOR STUDY

SCHEMATIC VIEW OF FLOW PATTERNS OF LIQUID HYDROCARBONS FOR THE PURPOSE OF LOCATING TERMINALS & CORRIDORS IN STUDY AREA

Ⓣ MAJOR TERMINAL
Ⓡ MAJOR REFINERY
Ⓟ MAJOR PETROCHEMICAL

CRUDE OIL (conventional & synthetic)
REFINERY PRODUCTS
PETROCHEMICAL FEEDSTOCK

OIL SANDS OIL PIPELINE ------ GAS PIPELINE ——·——

NOTE: - Sites shown are speculative.
- Size of arrow indicates approx. flow.
- Mackenzie flow shown with *.
- Total number of sites to be developed depends upon many factors, (materials, manpower, environment, economic, etc.)

STEWART WEIR STEWART WATSON & HEINRICHS

Scale: 1:1,500,000 (1"=24miles approx.)

No. 18

Prepared From Base Map
Produced by the Surveys Branch, Department of Highways and Transport

NORTHWEST TERRITORIES

BRITISH COLUMBIA

SASKATCHEWAN

MONTANA

1985

ATHABASCA TAR SANDS CORRIDOR STUDY

SCHEMATIC VIEW OF FLOW PATTERNS OF LIQUID HYDROCARBONS FOR THE PURPOSE OF LOCATING TERMINALS & CORRIDORS IN STUDY AREA

- (T) MAJOR TERMINAL
- (R) MAJOR REFINERY
- (P) MAJOR PETROCHEMICAL
- CRUDE OIL (conventional & synthetic)
- REFINERY PRODUCTS
- PETROCHEMICAL FEEDSTOCK
- OIL SANDS
- OIL PIPELINE ------
- GAS PIPELINE —·—·—

NOTE: - Sites shown are speculative. - Size of arrow indicates approx. flow. - Mackenzie flow shown with *. - Total number of sites to be developed depends upon many factors, (materials, manpower, environment, economic, etc.)

STEWART WEIR STEWART WATSON & HEINRICHS

Scale: 1:1,500,000 (1"=24miles approx.)

No. 19

Prepared From Base Map
Produced by the Surveys Branch, Department of Highways and Transport


1995
Alberta ENVIRONMENT
ATHABASCA TAR SANDS CORRIDOR STUDY
SCHEMATIC VIEW OF FLOW PATTERNS OF LIQUID HYDROCARBONS FOR THE PURPOSE OF LOCATING TERMINALS & CORRIDORS IN STUDY AREA
Ⓣ MAJOR TERMINAL
Ⓡ MAJOR REFINERY
Ⓟ MAJOR PETROCHEMICAL
CRUDE OIL (conventional & synthetic)
REFINERY PRODUCTS
PETROCHEMICAL FEEDSTOCK
OIL SANDS
OIL PIPELINE
GAS PIPELINE
NOTE: - Sites shown are speculative.
- Size of arrow indicates approx. flow.
- Mackenzie flow shown with *.
- Total number of sites to be developed depends upon many factors, (materials, manpower, environment, economic, etc.)
STEWART WEIR STEWART WATSON & HEINRICHS
Scale: 1:1,500,000 (1"=24miles approx.)
No. 20
Prepared From Base Map
Produced by the Surveys Branch, Department of Highways and Transport
NORTHWEST TERRITORIES
BRITISH COLUMBIA
SASKATCHEWAN
MONTANA
Athabasca oil sands
Buffalo Head Hills oil sands
Peace River oil sands
Wabasca 'A' oil sands
Wabasca 'B' oil sands
Cold Lake 'A' 'B' oil sands
WOOD BUFFALO NATIONAL PARK
JASPER NATIONAL PARK
BANFF NATIONAL PARK
WILLMORE WILDERNESS PARK
FORT McMURRAY
EDMONTON
CALGARY
RED DEER
LETHBRIDGE
MEDICINE HAT
LLOYDMINSTER
GRANDE PRAIRIE
PEACE RIVER
SLAVE LAKE
ATHABASCA
HARDISTY
FIFTH MERIDIAN
FOURTH MERIDIAN
SIXTH MERIDIAN

2005

Alberta
ENVIRONMENT

ATHABASCA TAR SANDS CORRIDOR STUDY

SCHEMATIC VIEW OF FLOW PATTERNS OF LIQUID HYDROCARBONS FOR THE PURPOSE OF LOCATING TERMINALS & CORRIDORS IN STUDY AREA

Ⓣ MAJOR TERMINAL
Ⓡ MAJOR REFINERY
Ⓟ MAJOR PETROCHEMICAL
CRUDE OIL (conventional & synthetic)
REFINERY PRODUCTS
PETROCHEMICAL FEEDSTOCK
OIL SANDS
OIL PIPELINE
GAS PIPELINE

NOTE: - Sites shown are speculative.
- Size of arrow indicates approx. flow.
- Mackenzie flow shown with *.
- Total number of sites to be developed depends upon many factors, (materials, manpower, environment, economic, etc.)

STEWART WEIR STEWART WATSON & HEINRICHS

Scale: 1:1,500,000 (1"=24miles approx.)

No. 21

Prepared From Base Map
Produced by the Surveys Branch, Department of Highways and Transport