CONFIDENTIAL

CANADIAN JAVELIN
IRON CONCENTRATE PIPELINE
PRELIMINARY FEASIBILITY STUDY

Prepared
by
ShelPac
Research and Development Ltd.

July, 1971

SCANNED IMAGE

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Lab(410)

PRELIMINARY FEASIBILITY STUDY
IRON CONCENTRATES SLURRY PIPELINE
FOR
CANADIAN JAVELIN LIMITED

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No. 11

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I. INTRODUCTION

ShelPac has undertaken to provide Canadian Javelin Limited with a preliminary arm's length pipeline tariff based on a reasonable rate of return for the pipeline owners, an estimate of the comparative cost for the rail system and sufficient economic information and discussion to enable the total transportation system to be examined and incorporated into your overall project. The report includes a careful definition of the boundary conditions assumed in the study.

Kilborn Engineering Company Limited and Dravo Company Limited have been engaged by Javelin to prepare the preliminary designs and cost estimates of the milling and pelletizing plants respectively. ShelPac has maintained close liaison with both Kilborn and Dravo to ensure that a co-ordinated and complete system analysis is presented.

Technical feasibility of iron ore slurry pipelining has been well proven by several years successful operation of the Savage River iron ore pipeline in Tasmania. The proposed pipeline is considerably larger than this or any other slurry pipeline now in operation and is located in an area of rugged terrain and severe climate. However, these factors are not expected to affect the technical feasibility of the project.

II. SUMMARY

This study is based on moving 9.0 million long tons per year (MMLTA) from the Julian mine and 3.0 MMLTA from the Star-O'Keefe mine to a pelletizing plant at Pte. Noire. Project life is assumed to be 30 years. A table showing system highlights of the base case follows this summary.

The preliminary arm's length tariff for each year is $2.90 per long ton, i.e., $35.0 million. To compare the total cost to Javelin of the pipeline and rail transportation alternatives, the cost of the additional milling operations required by the pipeline must be added to this pipeline tariff. These costs are $4.9 million for capital and 3¢/LT for operating and maintenance and have been included in the mill estimates submitted by Kilborn Engineering.

An estimate has been made of competitive rail costs, assuming that the Julian concentrate production would be moved over the Quebec North Shore and Labrador Railway and the Star-O'Keefe concentrate production would be moved over the Cartier Railway. The estimated capital costs to Javelin are $30.9 million and the annual costs are estimated to be $34.8 million.

The total pipeline cost to Javelin should be relatively constant over the life of the project because of low labour and maintenance costs. We anticipate that rail costs will escalate to a greater degree. However, we have not considered rail escalation in comparing total Javelin costs. The cost estimates used are the most reasonable that can be made at this time and can be modified in whole or in part by general escalation depending on the timing of construction.

The comparative costs to Javelin are summarized in the following table:

	Capital ($ Millions)	Annual Costs ($ Millions/Yr.)
Pipeline	4.9	35.0
Rail	30.9	34.8

Total present value cost to Javelin by pipeline is lower than that by rail over a range of discount factors. For example, the present value cost saving ranges from $18.0 million to $25.0 million at discount rates of 10% to 15%.

PIPELINE SYSTEM HIGHLIGHTS

SIZE

Lengths & Pipe Diameters	52 miles 8 5/8")
	73 miles 16") 294 miles in total
	169 miles 18")
Iron Concentrates throughput	12 million long tons per annum
Water Throughput	95,000 Barrels/Day or
	2,300 Gallons/Minute

SERVICES

Pump Stations	10
Pumping Load	42,000 installed horsepower
Peak power demand	25,000 KW
Employment	50

PIPELINE ECONOMICS

Capital Cost to Shipper	$4.9 million
Tariff	$2.90/LT over life
Economic Life	30 years

RAIL SYSTEM HIGHLIGHTS

SIZE:

Length of Movement:	
- Star-O'Keefe to Pte. Noire	273 miles
- Julian to Pte. Noire	283 miles
New Spur Trackage Required	40 miles
Number of Railway Cars Leased	700

COSTS:

Capital	$30.9 million
Annual charges & costs	$34.8 million

III. CONCLUSIONS & RECOMMENDATIONS

A. Conclusions

This preliminary study indicates that a pipeline system can move the Javelin production to a pelletizing plant at Pte. Noire at a lower total present value cost to Javelin than by rail over a range of discount factors.

B. Recommendations

1. Discussions should be opened with the railway companies to establish whether improved rail rates can be negotiated. At the conclusion of these negotiations, the comparative economics can be re-evaluated and a final economic analysis prepared.

2. Consideration should be given to a larger project capable of moving iron concentrates owned by others to achieve economies of scale and further reduce shipping costs.

3. A review of effects of pipeline ownership by the mining company should be made as a result of changes in tax legislation introduced by the Minister of Finance on June 18, 1971.

IV. DISCUSSION

A. BASE CASE PIPELINE

1. System Description

The pipeline system consists of slurry storage at each mine site, a gathering system, trunk line, terminal slurry storage and water clarification.

The pipeline gathering system consists of 73 miles of 16 inch pipe running south from Julian and 52 miles of 8 inch pipe running south-east from the Star-O'Keefe mine to a junction near the Moisie River and Riviere aux Pekans. The trunk line from this junction to the pelletizing plant site near Pte. Noire consists of 169 miles of 18 inch line. More complete details, including a system map, are given in Appendix A.

To produce slurry suitable for pipelining, the secondary grinding operation normally associated with the pelletizing plant is located at the mine site, and is integrated with the milling operation. Thus, the mining company will deliver a prepared slurry to surge storage for the pipeline and the slurry preparation normally associated with a pipeline is an integrated part of the mill operation. This has been provided for in the economics.

The pipeline terminal will consist of slurry storage and water clarification facilities. Custody transfer of the iron concentrate slurry to the pelletizing plant will occur at the outlet of the pipeline slurry storage; the delivered concentrates will meet the pelletizing plant feed specifications. The water will be removed by filtering in the pelletizing plant and returned to the pipeline company for clarification and disposal in the St. Lawrence River.

2. Pipeline Economics

The average over life pipeline cost to Javelin will include the preliminary arm's length tariff of $2.90 per long ton plus additional cost of grinding which is included in the milling operation for comparative purposes, i.e. $4.9 million and $0.03/LT.

B. RAIL TRANSPORTATION

1. Rail System Description

To develop rail costs for comparison with the pipeline, it has been assumed that the Julian concentrate will be moved over the Quebec North Shore and Labrador (QNS&L) Railway and the Star-O'Keefe concentrate will be moved over the Cartier Railway. In the latter case it is also assumed that the Cartier Railway will have been extended to Mount Wright prior to development of Star-O'Keefe and that only a 7 mile spur line to Star-O'Keefe is required. A 12 mile spur line will be required to connect the Julian mine to the Northern Land Co. Railway and thence to the Q.N.S. & L. It has been assumed low capacity spur lines to supply the mines would be required if the pipeline system is installed and thus only the incremental costs for high capacity lines are charged to the rail system. See Exhibit C-3 in the Appendix.

Rail transport would move the concentrates in coarse, dry form, thus drying facilities to reduce the moisture content to less than 1% are required at each mine and regrinding facilities are required at the pelletizing plant. Rail car loading and unloading facilities as well as extensive yard trackage are also required at each terminal.

The pelletizing plant is assumed to be at Pte. Noire and the Julian production will be moved over the Arnaud Railway with a short extension to the plant. The Star-O'Keefe production, however, will require a 20 mile spur from Port Cartier, the full cost of which must be charged to the Star-O'Keefe operation. Appendix B provides a more detailed discussion of the rail system.

2. Rail System Costs

Following is a summary of the rail system costs covering those facilities and services which provide processing, storage and transportation equivalent to those associated with the pipeline. Details of the development of these costs are presented in Appendix C.

RAIL SYSTEM COST ESTIMATES

	Capital	Annual Charges and Costs	
	($ Millions)	($ Millions)	($/LT)
1. Mine processing & terminals	9.3	2.7	0.23
2. Rail car leasing	-	3.1	0.26
3. Rail transportation - mines to Pte. Noire	-	28.4	2.37
4. Spur line costs (incremental)	15.0	(incl. in 3)	(incl. in 3)
5. Rail terminal & regrind facilities	6.6	0.6	0.05
TOTAL	$30.9	$34.8	$2.91

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C. COMPARATIVE ECONOMICS

A comparison of the costs to Javelin by the two modes of transport must include charges for equivalent processing and terminal operations at the mines and pelletizing plant, in addition to the transportation tariffs or rates. These are presented on the following table and are developed in more detail in Appendix D.

TOTAL COMPARATIVE COSTS TO SHIPPER

	Pipeline		Rail	
	Capital ($ Millions)	Expenses & Tariffs ($/LT)	Capital ($ Millions)	Expenses & Rates ($/LT)
Mine Processing & Terminal	4.9	0.03	9.3	0.23
Rail Cars	-	-	-	0.26
Rail Transport	-	-	-	2.37
Rail Spurs	-	-	15.0	-
Pte. Noire Terminal	-	-	6.6	0.05
Pipeline Tariff	-	2.90	-	-
Total	$4.9	$2.93	$30.9	$2.91

A complete economic analysis and comparison of the above costs must take into account the shipper's cost of money and tax position. This information is not available to ShelPac for this study, but a preliminary comparison of overall costs can be made by developing the present value of total costs before taxes at various discount rates. Such a comparison indicates that the present value (P.V.) cost by rail exceeds the P.V. cost by pipeline by a considerable margin over a wide range of discount rates.

Exhibit D-2 is a graph showing this difference in present value cost vs. discount rate.

D. SENSITIVITY ANALYSIS

1. Throughput

In accordance with the terms of reference set out by Javelin, the effect on the base case of variations in throughput have not been evaluated in this stage of the study. An alternate case serving the Julian mine alone at 9.0 MMLTA is evaluated in the following section (E).

2. Capital and Operating Costs

The cost estimates used to derive the pipeline tariff are the most reasonable that can be made at this time, considering the preliminary nature of the study. Pipeline construction represents the largest single item in the capital cost. Banister Pipelines Limited has estimated the accuracy of their estimate to be within plus or minus 15%. It is our opinion that the actual cost will be lower than the estimate used due to the possibilities of finding a shorter route, as well as lower unit construction costs. These lower costs can however be offset in whole or in part by general escalation depending on the final timing of construction.

E. ALTERNATE PIPELINE PROJECT

An alternate pipeline project has been evaluated in which a direct pipeline is constructed from Julian to Pte. Noire to deliver 9.0 MMLTA only. A more complete description of this project is provided in Appendix E.

The comparable rail system will require a capital investment of $14.6 million and rail transportation rates plus operating and maintenance costs will be $25.8 million per year.

The differences in present value of costs to an independent shipper by pipeline and by rail vs. discount rate are shown in Exhibit E-2. The pipeline is more expensive than rail, up to a discount rate of 15%. The pipeline is less expensive when the discount rate is in excess of 18%. Further details of this case with cost estimates are included in Appendix E.

F. POSSIBLE PIPELINE OWNERSHIP BY JAVELIN

Possible benefits could accrue to Javelin if the pipeline assets formed an integrated part of the assets of the overall mining company. However, the proposed tax legislation introduced June 18, 1971 by the Minister of Finance needs to be thoroughly analyzed before the magnitude of any possible benefits can be calculated.

V. OTHER CONSIDERATIONS

There are a number of other factors which will have a bearing on the economics, planning and development of this project which should be considered.

1. Potential for Additional Throughput

There appears to be considerable potential for additional throughput beyond the 12.0 MMLTA on which this study is based because of the extensive ore reserves in the Labrador trough and the world-wide demand for steel. Some of the existing mines in the area are now being expanded and plans have been announced for development of several new properties. In particular, it is understood that U.S. Steel is now planning development of the Mt. Wright property at a rate of some 16.0 MMLTA. This property could readily be served by the slurry pipeline.

Capacity of the pipeline could be increased at relatively nominal cost, mainly because construction costs constitute a very high proportion of the capital cost. These are due to the severe terrain (80% rock) and will not increase substantially as pipe size is increased. When coupled with the normal economies of scale, pipeline tariffs could be lowered substantially as capacity and throughput are increased provided an extended gathering system is not required.

2. Pelletizing Plant Site

This study is based on the assumption that the pelletizing plant will be located adjacent to the Pickands Mather plant at Pte. Noire.

Alternate locations between Pte. Noire and Port Cartier would have little effect on the pipeline costs but may have a more significant effect on the rail system costs.

3. Energy Supplies

This study is based on the assumption that electric power, supplied by Quebec Hydro and Newfoundland Power Systems will be used at all pump stations, and that Quebec Hydro will require a contribution of $9.0 million towards the capital costs of transmission lines and substations.

It is suggested that LNG and diesel fuel be evaluated as alternate energy sources for the pump stations. Either of these fuels could be delivered to the pump stations by a small pipeline along with the slurry line and such a pipeline could also be used to supply the same fuel to the mines and to townsites.

4. Technical Factors

Technical feasibility of slurry pipelines has been well proven in the past few years, but there are certain factors which will require extensive study before firm commitments are made to proceed with detailed engineering design. These are discussed in the appropriate sections of the project description in Appendix A and it is anticipated that these studies would be part of a more detailed technical development of the project. The principal studies will include the following:

a) Slurry design optimization.

b) Route studies including ground temperature surveys and evaluation of alternate methods of construction.

c) Internal corrosion control.

BASE CASE PIPELINE

1. Introduction

The slurry pipeline system is designed to transport iron concentrates from the Julian mine and the Star-O'Keefe mine to a pelletizing plant and port facility at Pte. Noire.

Exhibit A-1, A-2 and A-3 are maps of the pipeline route, pelletizing plant location and port facilities.

Exhibit A-4 is a simplified Flow Chart of the milling, pipeline and pelletizing operations. This exhibit sets out the components which are included in the pipeline project.

2. Throughput

The total throughput of 12.0 MMLTA of dry iron concentrates was suggested by Canadian Javelin on the basis of estimated ore reserves at both mines and a 30-year project life. Economics are based on delivery of 9.0 MMLTA from the Julian property and 3.0 MMLTA from the Star-O'Keefe property. It is also assured that these rates remain constant throughout the project life.

3. Mill Facilities

The mills for both mines, designed by Kilborn Engineering, include grinding and screening facilities to produce a concentrate slurry having a size distribution and concentration suitable for both pipeline transport and for pelletizing.

The first stage at each mill involves autogenous grinding, classification, tailings removal and dry storage. The second stage encompasses secondary grinding, top size control, and slurry surge storage. In a rail system, this second stage, or regrind operation is normally located at the pelletizing plant, but for the pipeline system it has been transferred to the mine site to produce concentrate suitable for pipelining. Screens nave been added for positive top size control and the circuits are designed to deliver slurry at the pipeline concentration of 30% by volume. Custody transfer of the slurry from the mill to the pipeline takes place after the mill slurry surge tank.

4. Water Supply

Water requirements are 71,000 barrels/day (B/D) at Julian and 24,000 B/D at Star-O'Keefe. Tuttle Lake will be used as water supply at Star-O'Keefe and Leila Wynne Lake for Julian. The supply systems for the mills and the pipeline will be integrated.

5. Slurry Preparation

As indicated above, the primary preparation process is integrated with the mine mill and prepared slurry will be delivered to the pipeline. Slurry preparation by the pipeline is therefore reduced to a final adjustment of concentration together with custody transfer measurement, and a final check of slurry properties. Corrosion inhibitors will also be added. These operations will be fully instrumented and carried out automatically.

6. Slurry Storage

Slurry storage will be required at various points on the pipeline system to provide operating surge capacity and for emergency situations. Vertical steel tanks will be used for surge storage, equipped with mixers to maintain the slurry in suspension and to prevent particle size segregation. Preliminary plans do not include insulation and heating of these vessels.

a) Julian mine: pipeline slurry storage at this mine will be 40,000 bbls. which is the equivalent of 8 hours throughput. This will allow for a potential shut-down of two of the eight regrind mills for approximately one day.

b) Star-O'Keefe mine: pipeline slurry storage at this mine will be 15,000 bbls. which is the equivalent of 8 hours throughput. This will allow for a potential shut-down of one of the three regrind mills for approximately one day.

c) Junction: 30,000 bbls. of slurry storage capacity is proposed at the pipeline junction to provide approximately 7 hours capacity for Julian production or 21 hours for Star-O'Keefe production. It is assumed that the production of both mines will be blended at this junction, and that operating conditions in the trunk line can be adjusted for short term operation if either of the gathering legs is not operating.

d) Pte. Noire Terminal: 50,000 bbls. of slurry storage will be provided at this terminal which is equivalent to approximately 8 hours of pipeline throughput.

7. Pipeline Route

A preliminary route selection which basically followed the St. Marguerite River was presented to ShelPac by Canadian Javelin prior to the commencement of this study. Upon completing a fixed wing observation and a topographic study, it was decided that alternate routes should be examined in an attempt to find a shorter route which would involve less rock and fewer river crossings.

An alternate route was selected on the basis of a study on 1:50,000 scale topographic maps which appeared to be approximately 10% shorter than the initial Canadian Javelin route. Both routes as well as the area surrounding were examined and a third alternative, which is a combination of both aforementioned routes was selected. This route appears to have the advantages of relatively lower rock blasting, construction material availability, accessibility and hence lower cost than either of the previously selected routes. Pipeline construction engineers from Banister Pipelines Ltd. participated in this scouting.

Final route selection will of course depend on much more detailed studies and surveys. Because of the large amount of rock, pipeline construction accounts for over 40% of the total cost of this project. Extensive analyses of alternate routes and types of construction will be well justified. The need for grade limits and potential power developments by Quebec Hydro on the Ste. Marguerite River are two additional factors requiring considerable study.

8. Slurry Design

For the purpose of slurry design, the concentrate is assumed to be

100% specular hematite with a specific gravity of 5.28. The volumetric throughput, however, is based on an average S.G. of 5.15 assuming 5% silica content. Analytical studies indicate that the particle size distribution for pipelining should be 100% -200 mesh and approximately 95% -325 mesh. Dravo has advised that this is satisfactory for pelletizing although it is somewhat finer than normal pelletizing plant feed. Additional costs of the finer grinding are included in the estimates. It is assumed that inherent magnetism, chemical reactivity with water, and physical attraction between particles (e.g., cementation or flocculation) are negligible.

To ensure predictable shut-down and start-up behavior, it has been assumed that pipeline grade will be limited to approximately 10% to minimize slumping of settled material during a shut-down period. More recent research on slurry design indicates that this limit may be relaxed.

9. Pipeline System Design

a) Pipe Specifications

The pipeline will be designed in accordance with CSA Code Z-183 with modifications as necessary for high pressure slurry service. High strength steel line pipe with welded joints will be used throughout and the design for this study is based on API Grade 5L X-60 pipe. The system will be hydrostatically tested to 1.25 times maximum operating pressure for 24 hours before being placed in service.

b) Corrosion

External pipe corrosion will be prevented with coating and wrapping of all buried lines supplemented by cathodic protection.

Internal pipe corrosion will be controlled by adjusting the slurry pH and the use of inhibitors if necessary. Pipe erosion is not anticipated. An extensive corrosion testing program would be carried out as part of a more detailed technical development to clearly define the corrosivity of this slurry and to develop a corrosion control program.

c) Hydraulic Design

Exhibit A-5 is a table showing specifications of the slurry and of the system and Exhibits A-6 and A-7 are schematic drawings showing system throughputs and pump station locations respectively.

Line sizes have been selected based on a preliminary optimization of line size, pumping requirements and concentration with critical velocity as an overriding variable. A uniform concentration of 30% by volume has been used throughout the system for this study. Progressive reduction of concentration along the line due to addition of flushing water at each pump station will be considered in the final engineering designs but preliminary hydraulic analyses indicate that the selected line sizes will accommodate these variations.

The system is designed for pump discharge pressures of 2,000 psi maximum with minimum suction pressures of 50 psi. A tapered line design has been used throughout to produce the most economical system, although this restricts the flexibility for future expansion. The basic system includes a very limited amount of spare capacity but operation at less than design rates can be accommodated by reducing velocity or concentration, or by operating intermittently.

Hydraulic design for this study has been based on an average line temperature of 40°F. This is a conservative assumption as it is likely that feed to the pipeline will be at about 70°F and calculations indicate that the average line temperature will be well above ground temperatures due to the relatively high friction losses. Future studies should include ground temperature surveys and determination of heat transfer coefficients to confirm these calculations.

d) Power Supply

It is assumed that all pump stations will be electric drive supplied from the Newfoundland Power system at Julian and Quebec Hydro at all other stations.

e) Construction

Preliminary criteria for line construction have been established to obtain costs estimates for this study and these were prepared by Banister Pipelines Ltd. As indicated elsewhere, however, line construction represents a major portion of the project costs and extensive study of alternate methods of construction is recommended. The alternate methods would include surface lines covered by a soil berm and insulated lines supported above ground.

Line design must be such that freezing will not occur if a forced shut-down occurs in cold weather. This problem will require extensive study in future stages of the project but there are a number of factors which indicate that the effects on economics or feasibility of the project will not be significant:

(i) Construction estimates are based on 30 inches of cover. Although normal ground temperatures at this depth are seldom below 25°F, the line operating temperature is indicated to be in the 40°F to 50°F range due to the relatively high friction losses. A "heat sink" will thus be built up around the line which will require an extended time to drop to freezing when the line is shut down. In areas where the depth of cover must be relaxed, insulation or other methods of preventing freezing can be used.

(ii) Power supply reliability should be high, minimizing the chances of power failure with extended shut down periods.

(iii) Water supplies will be available at key points on the system to continue pumping when slurry is not available.

f) Pumps

The pumps used on the main lines will be triplex reciprocating plunger type, operating in parallel. The plunger type is selected because of the high operating pressures and the plungers will be flushed with water to minimize plunger and cylinder wear. One spare machine will be installed at each station and at least two of the pumps at each station will have variable speed drives.

Centrifugal pumps will be used for low pressure recirculating and charging service.

Pump stations will be fully housed and heated and will be designed for remote control unattended operation. Station piping will be designed for tight line operation and will include suction and discharge pulsation controls. Provision will be made for automatic flushing of pump fluid ends on shut-down. Water supplies for this service as well as for plunger flushing have not been defined at this stage of the study, but local wells, streams or partial decanting of the slurry could be used.

10. Slurry Separation and Recovery

The pipeline will deliver slurry at 30% concentration by volume (70% by weight) to the pelletizing plant filtering process. The filtrate is routed to an enclosed, heated settling tank. The fines reclaimed from these tanks can be recycled through fines filters.

11. Auxiliary Services

A private micro-wave system is included to provide continuous, high-speed communications and supervisory circuits between Star-O'Keefe, Julian and Pte. Noire as well as all pump stations. The Pte. Noire Terminal is tentatively proposed as the head operating office and dispatch centre.

Maintenance bases are included at both mine sites as well as at Pte. Noire and it is assumed that pump stations will generally be serviced by air. Living accommodation for all staff has also been included in the capital estimates.

12. Construction Timing

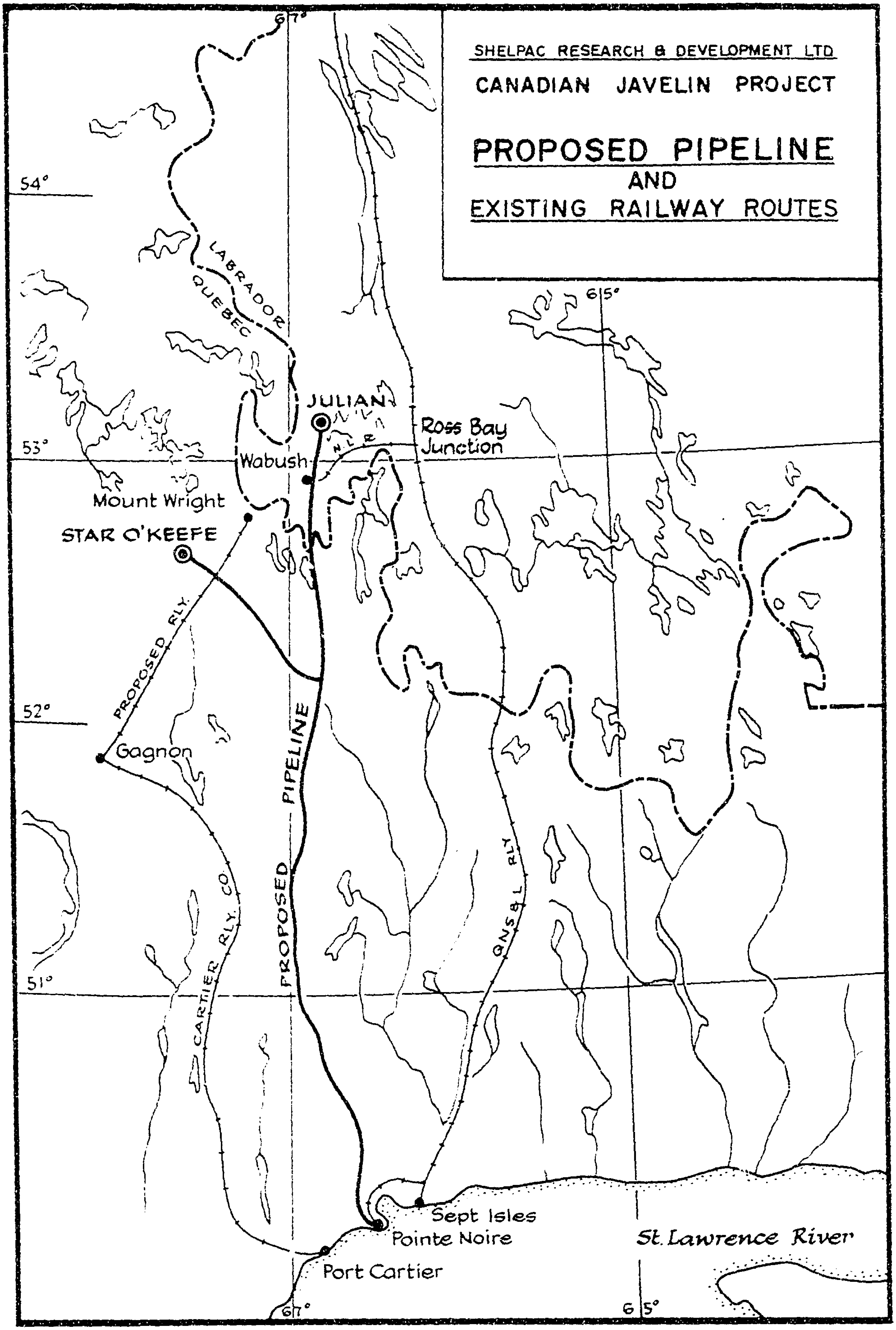
Exhibit A-8 is an Arrow Diagram showing a tentative schedule for this project. This diagram does not represent a formal CPM or PERT analysis, but it indicates that the overall time required to develop and construct the project will be approximately three years subject to some seasonal constraints on the construction phases.

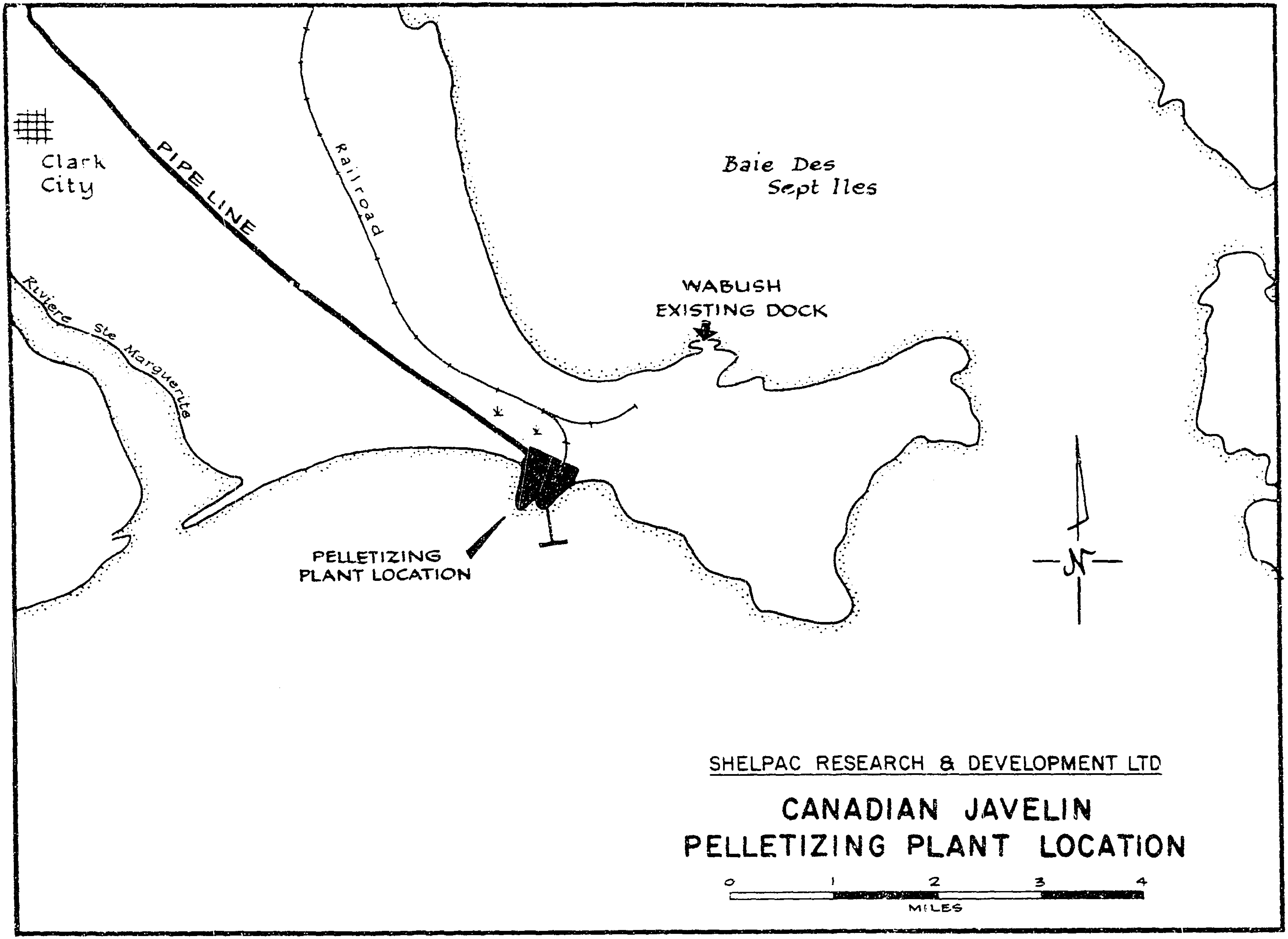
Power system construction is the critical activity on this schedule, followed by communications, supervisory control and pump station construction. Obtaining the Certificate of Public Convenience and Necessity is also on the critical path and it may be necessary to make commitments on such items as the power system before the Certificate is obtained.

Two pipeline construction crews will be required which will work in various areas of the line depending on the season. The southern end of the trunk line which involves considerable rock along the Ste. Marguerite to approximately 100 miles north of Pte. Noire can be constructed in the spring and summer months. The northern end of the trunk line which is not along the Ste. Marguerite, and the two branch lines which are generally in muskeg can be constructed in the winter months when the muskeg is in a frozen condition.

Construction access roads will be maintained from the two mine sites to the winter construction areas during the winter season only. Access to the more southerly portions of the route will be maintained year-round from Sept-Iles or according to the working access required. Land transport will generally be used for pipe, equipment and supplies and aircraft or helicopters for personnel transport.

Right-of-way grading and clearing will commence in the winter from the Wabush area to the junction point, then down the trunk leg and to the Star-O'Keefe mine simultaneously. In the first summer season, grading and access development will commence from Pte. Noire up the Ste. Marguerite River making full use of the navigability of the river when possible.


SHELPAC RESEARCH & DEVELOPMENT LTD
CANADIAN JAVELIN PROJECT
PROPOSED PIPELINE
AND
EXISTING RAILWAY ROUTES
67°
54°
LABRADOR
QUEBEC
65°
JULIAN
Ross Bay
Junction
53°
Wabush
Mount Wright
STAR O'KEEFE
PROPOSED RLY.
52°
Gagnon
PROPOSED PIPELINE
CARTIER RLY. CO.
QNS & L RLY
51°
Sept Isles
Pointe Noire
St. Lawrence River
Port Cartier
67°
65°



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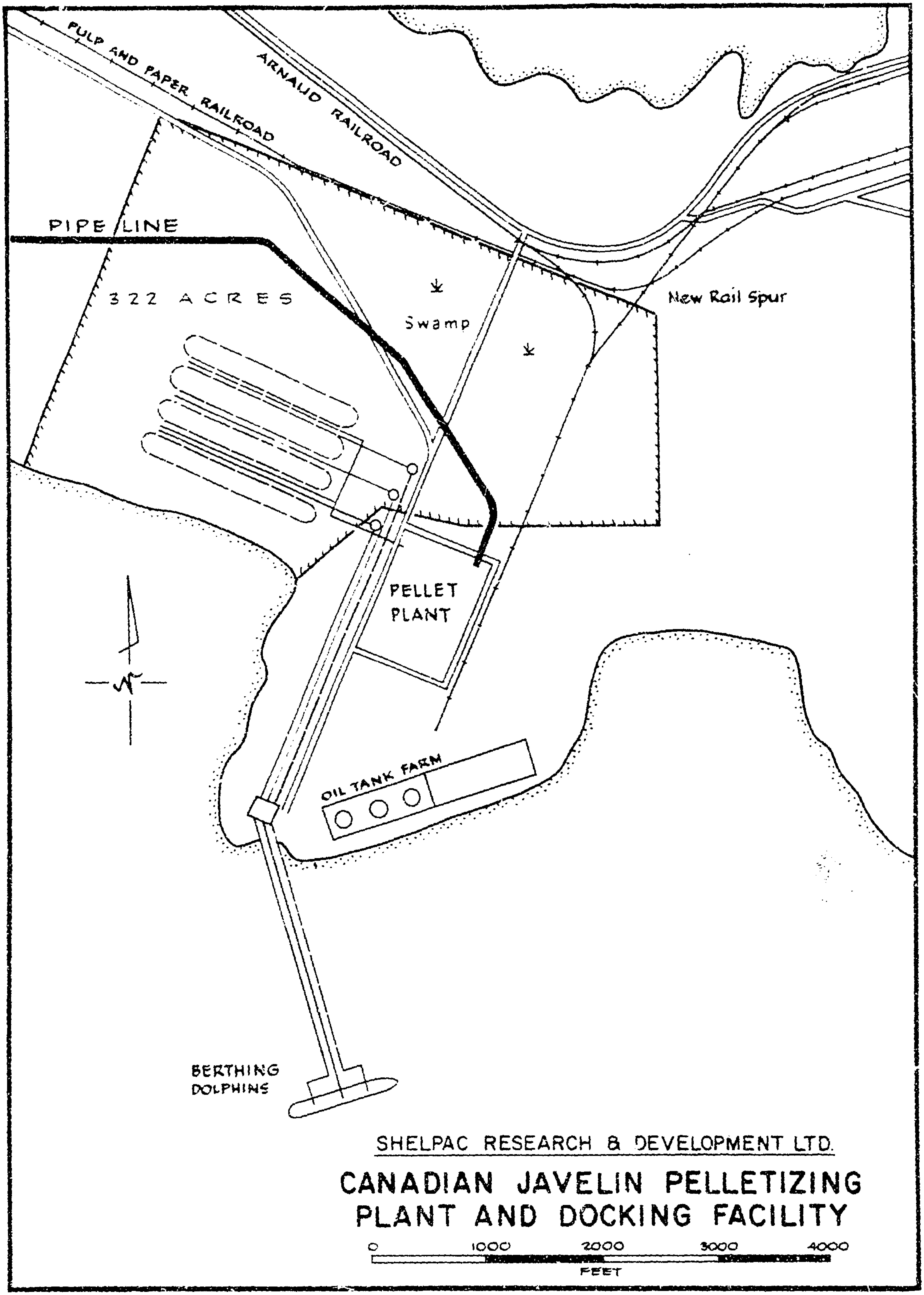
CANADIAN JAVELIN
PELLETIZING PLANT LOCATION



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CANADIAN JAVELIN PELLETIZING PLANT AND DOCKING FACILITY

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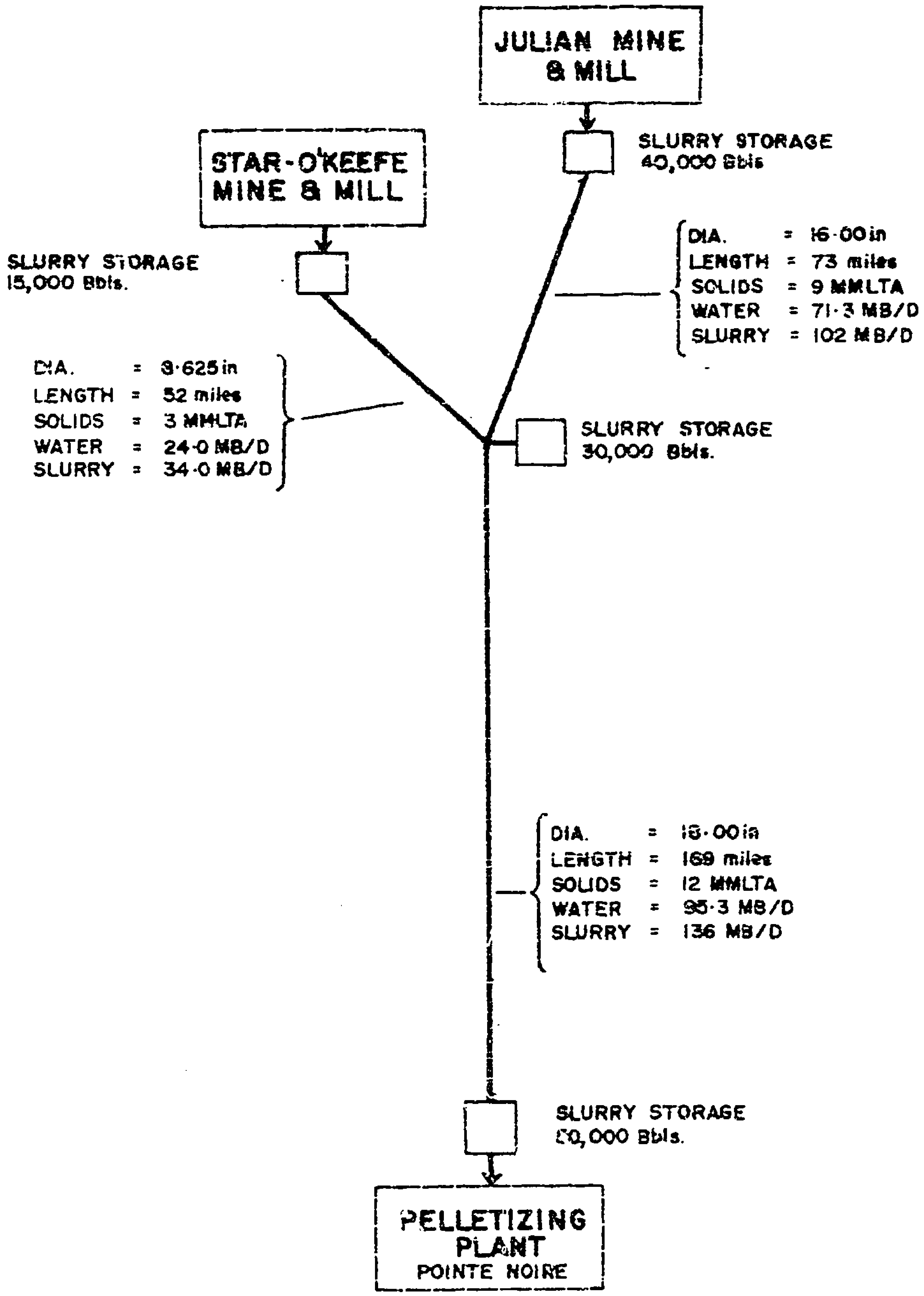
Exhibit A-4

CANADIAN JAVELIN IRON CONCENTRATES PIPELINE

BASE CASE - SYSTEM DESIGN SPECIFICATIONS

Line Section	Julian Branch	Star-O'Keefe Branch	Trunk Line
Length (Miles)	73	52	169
Outside Diameter (Inches)	16.000	8.625	18.000
Average Wall Thickness (Inches)	0.284	0.280	0.290
Concentration (% Vol.)	30	30	30
Operating Velocity (Ft./Sec.)	5.5	6.5	5.8
Critical Velocity (Ft./Sec.)	4.6	3.4	4.8
Pressure Drop (PSI/Mile)	60	170	56
Number of Pump Stations	2	4	4
Total Installed H.P.	10,180	6,730	25,240

Exhibit A-6



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CANADIAN JAVELIN
IRON CONCENTRATE PIPELINE

PIPELINE SCHEMATIC

NOV.'70

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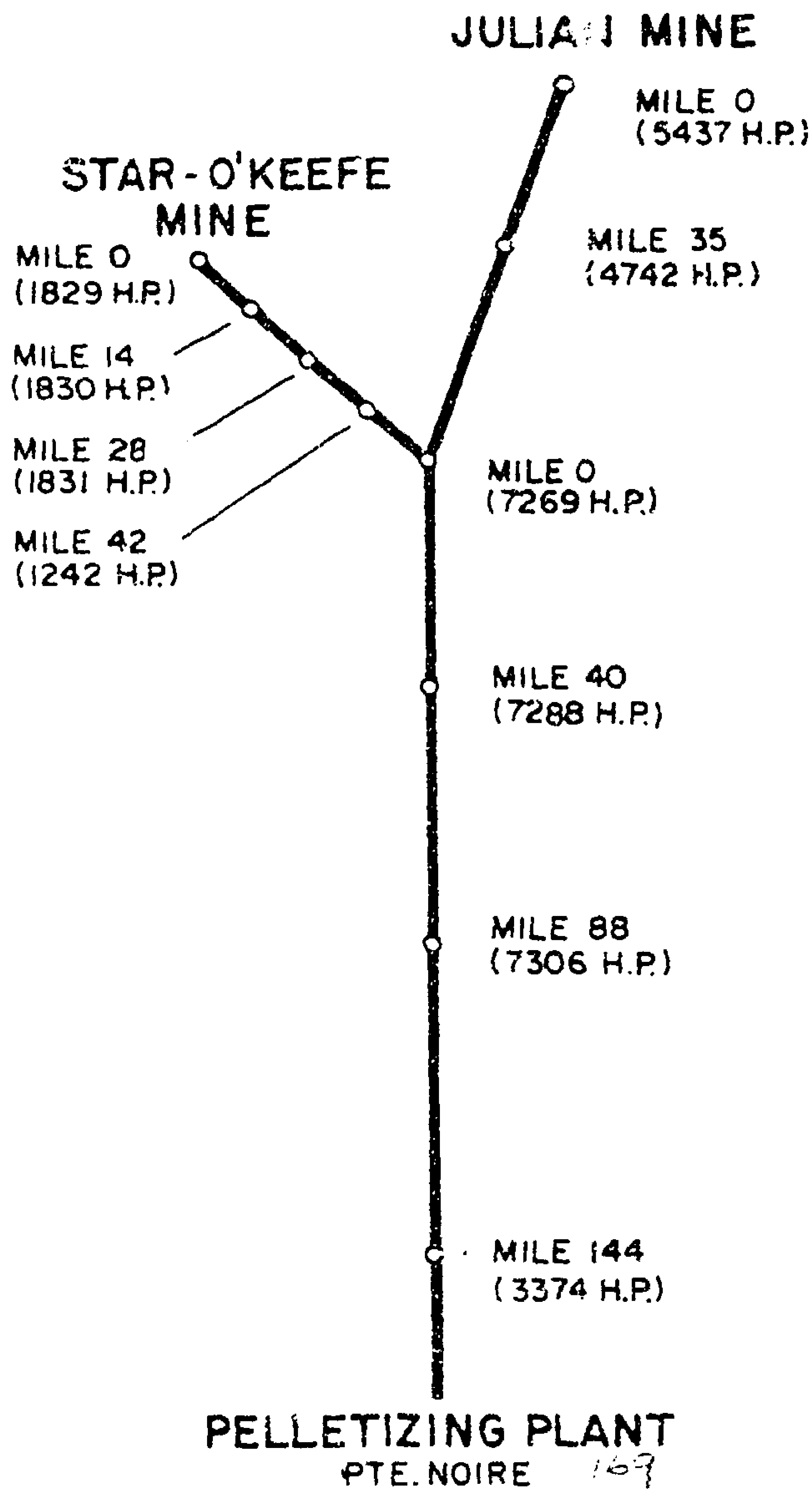

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SHELPAC RESEARCH & DEVELOPMENT LTD.

CANADIAN JAVELIN
IRON CONCENTRATE PIPELINE

PUMP STATIONS

NOV. '70

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RAIL SYSTEM DESCRIPTION

1. Introduction

To develop rail shipping costs for comparison with the pipeline it is assumed that the Julian production will be moved via the Quebec North Shore and Labrador Railway (QNS&L) and Star-O'Keefe production via the Cartier Railway. In the latter case it is also assumed that this railway will have been extended to the Mount Wright property of U.S. Steel prior to development of Star-O'Keefe. The following paragraphs discuss details of facilities, rates and costs for the complete rail systems and Exhibit B-1 is a flow sheet of the system using rail transport.

2. Throughput

Rail costs have been developed on the same basis as those of the pipeline; i.e., 9.0 MMLTA from Julian and 3.0 MMLTA from Star-O'Keefe, both to the same pelletizing plant at Pte. Noire.

3. Mill Facilities

The mills for both mines include autogenous grinding circuits, spiral concentration, cycloning and tailings disposal. The coarse concentrates will be filtered to 4% moisture and then dried to 1% water content for open car shipping. The drying stage in the rail case is a major difference between the pipeline and rail material preparation operations. It represents a substantial cost which must be charged against the rail operation.

4. Rail Car Loading & Unloading

Dry concentrate transfer conveyors, storage silos and car loading bins are required at each mine site. In addition, 5 miles of yard trackage will be required at Julian and 3 miles at Star-O'Keefe for car locating and switching.

At Pte. Noire car unloaders, conveyors, and concentrates storage will be required as well as 5 miles of yard trackage.

5. Rail Routes

a) Julian Production

To transport the 9.0 MMLTA production from the Julian mine to Pte. Noire, movement on three railways and one spur line is required. The mine will be connected to the Northern Land Company Railway by a new 12 mile spur line. The route then will be 12 miles along this Julian spur, 28 miles from the spur junction along the Northern Land Company Railway to the Ross Bay Junction on the Q.N.S. & L., 220 miles down the Q.N.S. & L. from the Ross Bay Junction to the Arnaud Railway Junction and 23 miles on the Arnaud system to the pelletizing plant at Pte. Noire including a 1 mile extension to enter the unloading area. Thus a total of 283 miles travel is required.

b) Star-O'Keefe Production

The 3.0 MMLTA production from the Star-O'Keefe mine is assumed to be transported on the Cartier Railway system including a proposed extension from Gagnon to Mount Wright. For this study, it is further assumed that the extension will be constructed and available for use prior to start-up of the Star-O'Keefe mine. The production would take the following route: 7 miles on a connecting spur line to the Mount Wright Railway, 56 miles along the Mount Wright system to the Cartier Railway near Gagnon, 190 miles from Gagnon to Port Cartier along the Cartier system and 20 miles from Port Cartier to the pelletizing plant at Pte. Noire along a new spur line. Hence, a travel length of 273 miles in involved.

6. Rail Operations

It is assumed that modern unit train operations will be used on each system with direct hauls from mine to pelletizing plant. Intermediate switching of locomotives and crews should not be required at rail company transfer points. It is assumed that the principal operating railways, the Q.N.S. & L. and the Cartier Railway will provide locomotives, crews, and fuel as well as all other incidental operating costs for the complete operation.

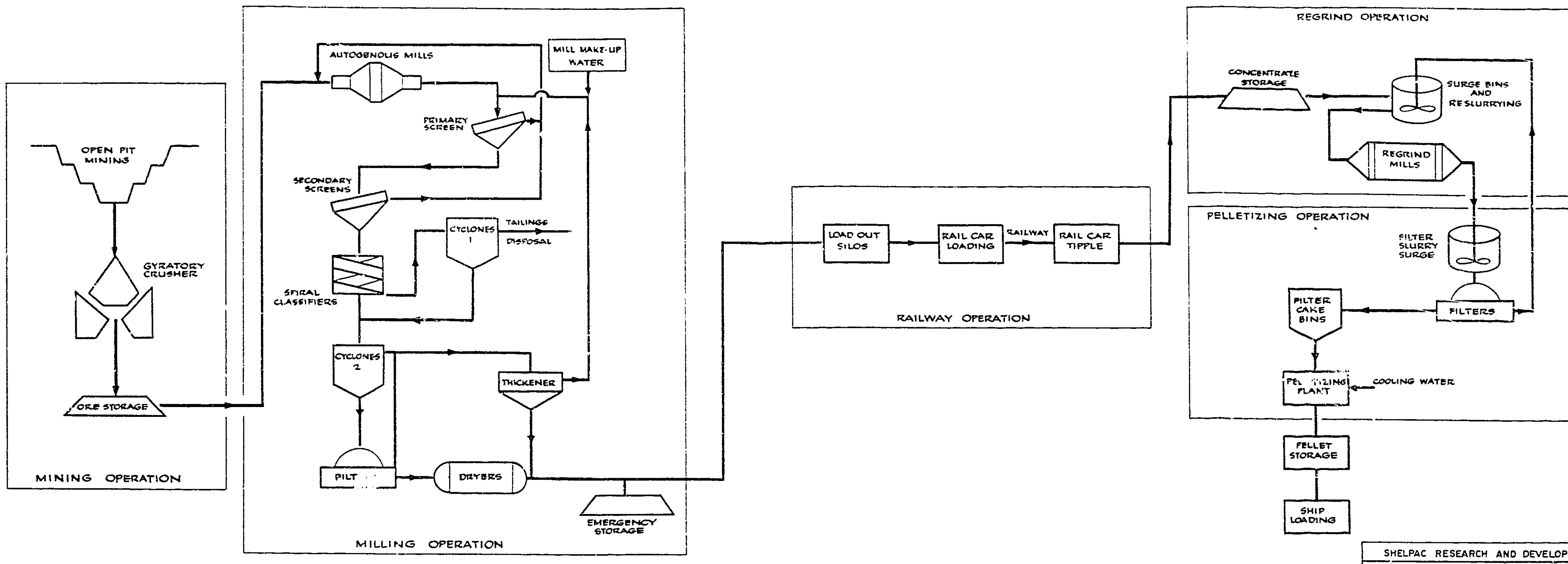
7. Car Requirements

It is assumed that 100 car unit trains will be used, consisting of 100 ton open top cars. Turn around time is estimated to be 48 hours. Julian production will therefore require 500 cars and Star-O'Keefe throughput will need a minimum of 167 cars. Allowing for down time and maintenance, etc. a total of 700 cars is assumed to be required. The tariff rates for the Q.N.S. & L. Railway, the Cartier Railway, the Northern Land Company Railway and the Arnaud Railway are all set on the basis of cars supplied by the shipper. Economics have been based on these cars being leased. A comparison of leasing vs. owning the cars would be the subject of a more detailed study.

8. Concentrate Preparation for Pelletizing

Unlike the pipeline transportation case, the concentrate regrind operation is located at the Pte. Noire terminal. The coarse material will be reslurried using water from local sources. The slurry produced is then pumped to the regrind circuits with no top size control units. The fine grind slurry is then filtered, the cake from which is conveyed to the pelletizing plant storage bins. The filter effluent is recycled to the slurrying tanks. This system uses an open, coarse grind emergency storage whereas the pipeline system employed a slurry surge storage.

Exhibit 5-1



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CANADIAN JAVELIN IRON CONCENTRATE PIPELINE PROJECT

RAILWAY SYSTEM FLOW CHART

RAIL SYSTEM COST ESTIMATES

Rail system costs to move concentrates from the mines to Sept-Iles include rail rates plus the cost of rail system extensions and rolling stock and also include processing and terminal facilities which are necessary. These costs have been developed as follows:

1) Processing & Terminal Costs: Exhibit C-1 shows details of the mine, pelletizing and terminal facilities which must be charged to the rail system to provide processing and transportation equivalent to that of the pipeline.

2) Rail Transportation: Exhibit C-2 shows the rail rates which have been used to cover locomotives, fuel, labour and track maintenance and for lines owned by other companies, track amortization is also included. The costs are developed as follows:

   a) Q.N.S. & L. - $1.72/L.T. in accordance with the published tariff for 9.0 MMLTA.
   b) Northern Land Co. Railway - 28¢/L.T. as reported by Javelin.
   c) Arnaud Railway - 26¢/L.T. as reported by Javelin.
   d) Cartier Railway - Gagnon to Port Cartier - $1.80/L.T. estimated at 9.5 mils per ton mile which is equivalent to Q.N.S. & L. rate for 3.0 MMLTA.
   e) Cartier Railway - Mt. Wright to Gagnon - 56¢/L.T. estimated on basis of 10 mils per ton mile which is equivalent to rates reported for Northern Land and Arnaud Railways.
   f) Javelin spur lines - as these lines will be constructed and owned by Javelin, rail rates do not include track amortization and have therefore been estimated at 5 mils per ton mile. For simplification it is assumed that the rates include track maintenance.

3) Rail spur costs - these lines have been estimated to cost a total of $500,000 per mile. The full cost of the 20 mile spur from Port Cartier to Pte. Noire is charged to the rail system as the concentrates are the only traffic which would move over this line and the line would not be required for the pipeline system. The spurs to the mines, however, would be required for both the pipeline and rail systems, as they would be used to move mine supplies. A heavier class of construction would be necessary for the rail system to handle the unit train operation and the incremental cost of this higher grade of construction is charged to the rail system. The charges are listed on Exhibit C-3.

4) Rail cars - are assumed to be leased at rates shown in Exhibit C-3.

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

PROCESSING AND TERMINAL COSTS - RAIL SYSTEM

COST ITEM	CAPITAL ($000)	OPERATING & MAINTENANCE ($000/Yr.)
Julian (9.0 MMLTA)		
Filtering	900	140
Drying	1,460	1,600
Open Storage	1,130	20
Load-Out Silos	2,150	200
Yard Track and Switching	500	30
	6,140	1,990
Star-O'Keefe (3.0 MMLTA)		
Filtering	340	50
Drying	750	530
Open Storage	600	10
Load-Out Silos	1,170	100
Yard Track and Switching	300	20
	3,160	710
Pte. Noire (12.0 MMLTA)		
Car Unloading	1,900	260
Emergency Storage	1,960	110
Surge Bins & Conveyors	1,740	120
Re-Slurrying	500	80
Yard Track and Switching	500	30
	6,600	600
TOTAL RAIL SYSTEM TERMINAL COSTS	15,900	3,300

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

RAIL TRANSPORTATION RATES

RAIL LINE	LENGTH (Miles)	RATE ($/L.T.)
Julian to Pte. Noire		
Julian Mine to Northern Land Co. Railway	12	.06
Northern Land Co. Ry. to Ross Bay Junction of Q.N.S. & L.	28	.28
Ross Bay Junction Q.N.S.& L. on to Arnaud Ry.	220	1.72
Arnaud Railway to Pte. Noire	23	.26
Pte. Noire Spur	1	.01
TOTAL	284	2.33
Star-O'Keefe to Pte. Noire		
Star-O'Keefe Mine to Mount Wright Junction	7	.03
Mount Wright Railway Junction to Cartier Ry. Co. at Gagnon	56	.56
Cartier Ry. Co. at Gagnon to Port Cartier	190	1.80
Port Cartier to Pte. Noire	20	.10
TOTAL	273	2.49

Annual charge for Julian = 2.33 x 9.0 MMLTA = $20.97 million

Annual charge for Star-O'Keefe = 2.49 x 3.0 MMLTA = $ 7.47 million

Total Annual Charge = $28.44 million

Average Unit Rate = $\frac{28.44}{12}$ = $2.37/L.T.

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SCANNED IMAGE

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

RAIL SPUR CAPITAL COSTS - $000

	Total Cost	Incremental Costs Charged to Rail System
Julian Spur - 12 miles	6,000	3,000
Arnaud Spur - 1 mile	500	250
Star-O'Keefe Spur - 7 miles	3,500	1,750
Port Cartier to Pte. Noire - 20 miles	10,000	10,000
TOTAL	20,000	15,000

Note: Rail spur maintenance is included in the rail transportation estimates.

RAIL CAR LEASING & MAINTENANCE COSTS

Total cars required	-	700
Leasing charge	-	$3,250/car/year
Maintenance Cost	-	$1,200/car/year
Total Charge	-	$4,450/car/year

Annual charge for 700 cars = 700 x $4,450 = $3,115,000/year

Unit charge $= \frac{3,115,000}{12,000,000}$ = $0.26/long ton.

Economic Analysis

1. Assumptions

   a) Income tax rate is 52% throughout project life.

   b) Economic life is 30 years.

   c) Project has no salvage or going concern value at end of the 30 year life.

   d) All capital expenditures occur in the twelve month period preceding start-up.

   e) Operating and maintenance costs are constant throughout project life.

   f) A separate company will be incorporated to construct and operate the pipeline.

   g) Tariff rates for both pipeline and rail are on the basis of dry concentrates (less than 1% moisture).

   h) Pipeline and rail costs do not include any allowance for material losses.

   i) Line fill will be provided and owned by the shipper.

2. Comparison of Costs to Shipper by Pipeline and Rail

   A comparison of the costs to an independent shipper by the two modes of transport must include charges for equivalent processing and transport operations at the mines and pelletizing plant in addition to the transportation tariffs or rates. The costs of these additional facilities have been developed by Kilborn Engineering and Dravo and are included in their estimates of the mine and pelletizing plant facilities. They are included in this report only for the purpose of providing a clear comparison of the economics of the total pipeline and rail systems.

Exhibit D-1 shows a comparison of the details of the overall system costs by the two methods of transport. Exhibit D-2 is a graph showing the present value cost to shipper vs. discount rate for the two systems of transport and Exhibit D-3 is a table of the same information.

SCANNED IMAGE

CANADIAN JAVELIN PIPELINE PROJECT

PIPELINE & RAIL COST COMPARISON

Base Case

Cost Item	PIPELINE Capital	PIPELINE Operating & Maintenance	RAIL Capital	RAIL Operating & Maintenance
	($000)	($000/yr.)	($000)	($000/yr.)
Mine Processing & Terminal				
JULIAN				
Filtering	120	20	900	140
Drying	-	-	1,460	1,600
Covered Storage	1,480	40	-	-
Open Storage	-	-	1,130	20
Load-Out Silos	-	-	2,150	200
Classification & Size Control	1,800	200	-	-
Yard Track & Switching	-	-	500	30
TOTAL	3,400	260	6,140	1,990
STAR-O'KEEFE				
Filtering	50	7	340	50
Drying	-	-	750	530
Covered Storage	750	20	-	-
Open Storage	-	-	600	10
Load-Out Silos	-	-	1,170	100
Classification & Size Control	700	73	-	-
Yard Track & Switching	-	-	300	20
TOTAL	1,500	100	3,160	710
Rail Car Leasing	-	-	-	3,115
Rail Transport	-	-	-	28,410
Rail Spurs	-	-	15,000	-
Pipeline Tariff	-	35,000	-	-
Pelletizing Plant				
Terminal & Processing	-	-	6,600	600
Total Cost to Shipper	4,900	35,360	30,900	34,825

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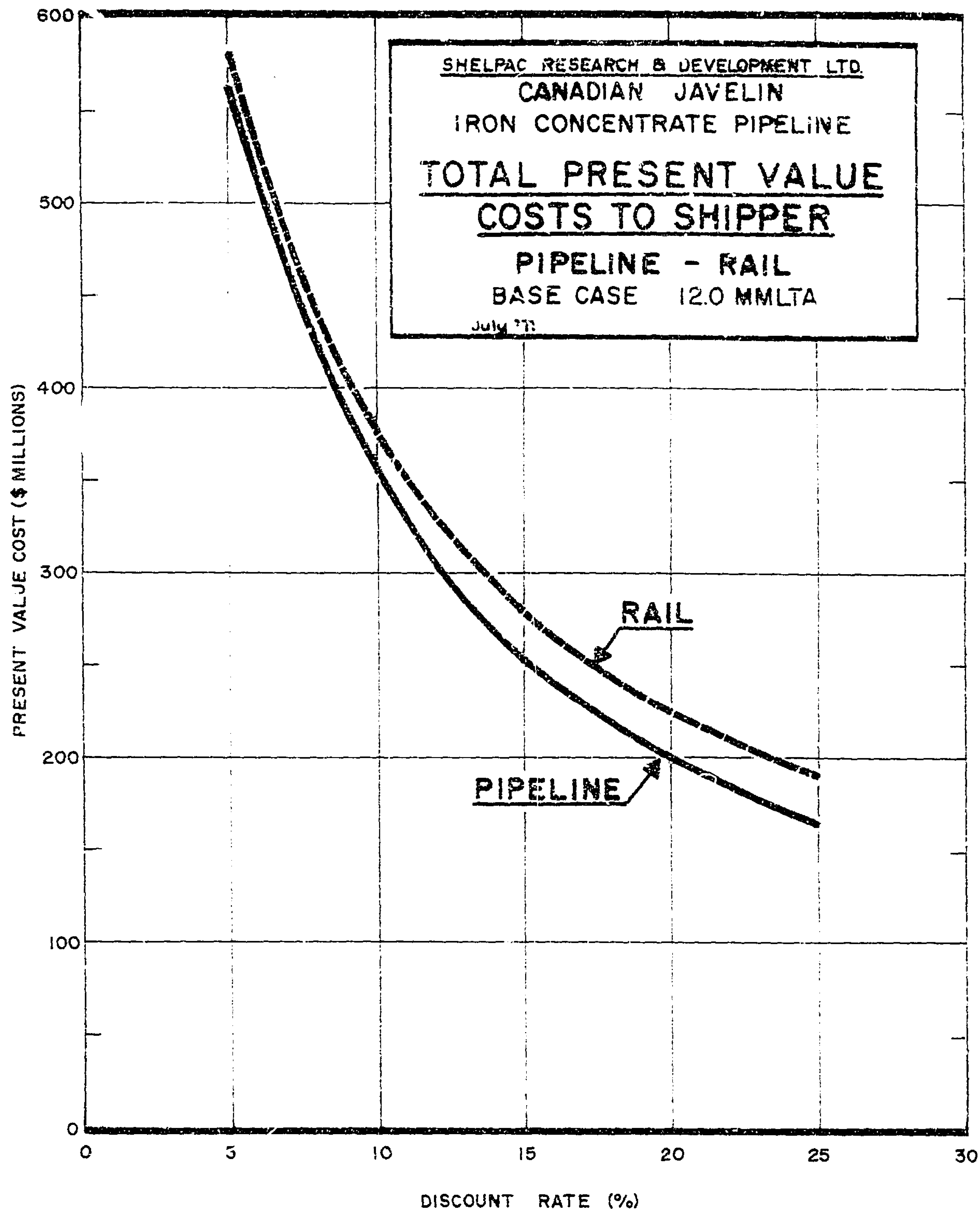
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CANADIAN JAVELIN
IRON CONCENTRATE PIPELINE
TOTAL PRESENT VALUE
COSTS TO SHIPPER
PIPELINE - RAIL
BASE CASE 12.0 MMLTA
July '77
RAIL
PIPELINE
PRESENT VALUE COST ($ MILLIONS)
600
500
400
300
200
100
0
0
5
10
15
20
25
30
DISCOUNT RATE (%)

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

PIPELINE AND RAIL COMPARISON - BASE CASE

TOTAL PRESENT VALUE COSTS AND

PIPELINE SAVINGS TO SHIPPER

($ Millions)

Discount Rate	P.V. Cost Rail	P.V. Cost Pipeline	P.V. Saving Pipeline
5%	580	562	18
10%	377	355	22
15%	279	254	25
20%	224	199	26
25%	190	164	27

ALTERNATE PIPELINE

1. Pipeline Description and Costs

An alternate case has been evaluated in which only the Julian production would be moved by pipeline. Throughput is assumed to be 9.0 MMLTA, and the pipeline route is identical to that of the base case except that the Star-O'Keefe branch is eliminated. Terminal and processing facilities at Julian are the same as in the base case but the pelletizing plant facilities have been reduced to 9.0 MMLTA capacity. This system will require 242 miles of 16" pipeline.

2. Rail System

The rail system for this alternate case is identical to the rail system serving Julian in the base case. The costs are taken directly from previous appendices except for the capital cost of the terminal and processing facilities at Pte. Noire. The estimate of $5.2 million has been developed for a 9.0 MMLTA capacity plant from the estimate of $6.6 million for a 12.0 MMLTA plant.

3. Economic Analysis

Economics of this case have been developed in the same manner as that of the base case.

4. Comparative Cost to Shipper

Exhibit E-1 is a summary table comparing the total costs to an independent shipper by pipeline and by rail for this alternate case. Exhibit E-2 shows the present value of the costs vs. discount rate in tabular form.

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

ALTERNATE PIPELINE CASE

COMPARATIVE COSTS TO SHIPPER

	PIPELINE		RAIL	
	Capital ($000)	Operating ($/LT)	Capital ($000)	Operating ($/LT)
Julian Terminal & Processing	3,400	0.03	6,150	.22
Rail Cars	-	-	-	.26
Rail Transport	-	-	-	2.33
Rail Spurs	-	-	3,250	(incl. in 3)
Pte. Noire Terminal & Processing	-	-	5,200	0.06
Pipeline Tariff	-	3.05	-	-
TOTAL	3,400	3.08	14,600	2.87

CANADIAN JAVELIN IRON CONCENTRATE PIPELINE

PIPELINE AND RAIL COMPARISON - ALTERNATE CASE

TOTAL PRESENT VALUE COSTS AND PIPELINE SAVINGS TO SHIPPER

Discount Rate	P.V. Cost Rail	P.V. Cost Pipeline	P.V. Saving Pipeline
5%	422	441	(19)
10%	271	278	(7)
15%	198	199	(1)
20%	157	155	2
25%	132	128	4