0622333

~~CONFIDENTIAL~~

THE ANVIL PROJECT

PRELIMINARY ECONOMIC ANALYSIS

OF A

MINERAL DEVELOPMENT OPPORTUNITY

Brian Mackenzie
September 20, 1966.

TABLE OF CONTENTS

LIST OF TABLES AND DIAGRAMS

LIST OF GRAPHS

1. INTRODUCTION

This analysis, based on limited information, considers those aspects of developing the Faro No. 1 deposit, of the Anvil Mining Corporation Limited, which are important from the Government's point of view.

The Faro lead-zinc deposit is located in the Whitehorse Mining District of the Yukon Territory. A location map on page 3 shows the property in relation to the main transportation facilities existing in the region.

During 1964, Dynasty Explorations Limited carried out airborne geophysical and geochemical reconnaissances in an area adjacent to the Pelly River, known as the Vangorda district.

In April 1965, Cyprus Mines Corporation entered into a joint venture with Dynasty to further explore this district. Ground geophysical and geochemical surveys, and drilling of previously located magnetic anomalies met with success; 2,400 claims were staked. The Faro claim group was drilled in July, 1965 and massive sulphides were intersected. Drilling has been in progress since that date.

In December 1965, Anvil Mining Corporation Limited, owned 60 per cent by Cyprus Mines Corporation and 40 per cent by Dynasty Exploration Limited, was formed to take over all claims in the Vangorda District and continue the exploration work.

In November 1965, the Parsons-Jurden Company was retained to carry out a preliminary feasibility study on the economics of developing the Faro deposit. This report was completed April 26, 1966.

Subsequently, a request* was made by Anvil for Government assistance in the following areas:

(i) construction and operation of a power facility.

(ii)provision of all-weather road transportation to tidewater.

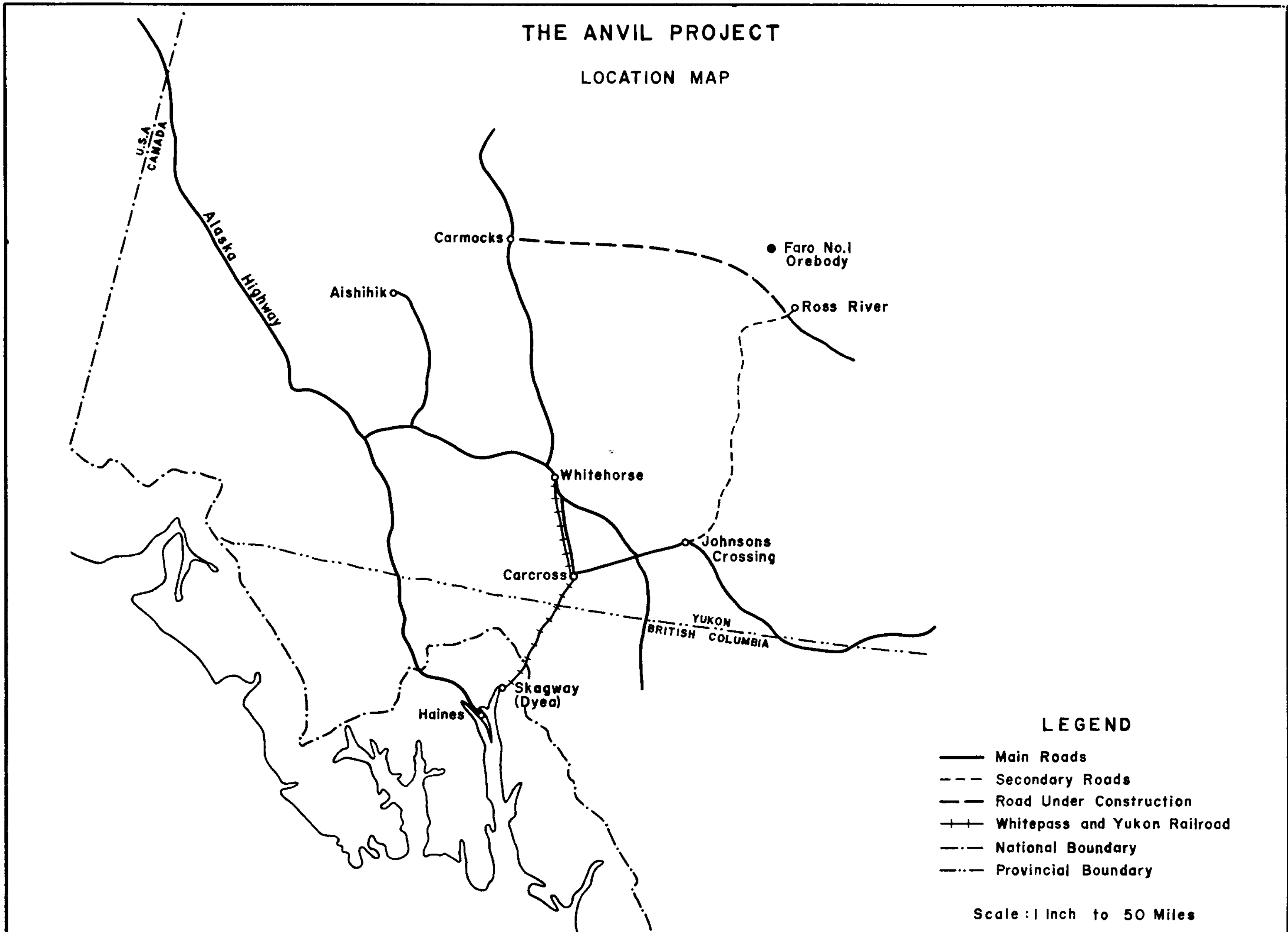
(iii)development and construction of a townsite.

A copy of the Parsons-Jurden feasibility study was provided by the Company to facilitate a Government evaluation of the project economics.

This analysis examines the project economics with special reference to the request for assistance. Firstly, it examines the Parsons' feasibility study. Then, on the basis of certain departures in assumptions and estimates, a partially independent evaluation is carried out. An analysis of the results leads to several recommendations and conclusions.

---

* See letter dated June 27, 1966 from Kenneth Lieber, President, Anvil Mining Corporation Limited to The Honorable Arthur Laing, Minister of Northern Affairs and National Resources. (pp. 112-113)


THE ANVIL PROJECT
LOCATION MAP
U.S.A.
CANADA
Alaska Highway
Carmocks
Faro No.1
Orebody
Aishihik
Ross River
Whitehorse
Johnsons
Crossing
Carcross
YUKON
BRITISH COLUMBIA
Skagway
(Dyea)
Haines
LEGEND
Main Roads
Secondary Roads
Road Under Construction
Whitepass and Yukon Railroad
National Boundary
Provincial Boundary
Scale : I Inch to 50 Miles

2. SUMMARY OF IMPORTANT ASSUMPTIONS

PARSONS-JURDEN PRELIMINARY FEASIBILITY STUDY*

This study consists of a detailed analysis of the economics of developing the Faro No.1 orebody, based on preliminary information. Many assumptions must necessarily underly such an analysis. Those assumptions which are of importance to a Government analysis of the project economics are outlined below.

Transportation

With respect to the movement of output from the plantsite to tidewater, several transportation alternatives are outlined.(PFS: Section 10) Operating costs are developed for each. Capital cost estimates are made for tidewater facilities, trucks and related transportation auxiliaries. In no case do the transportation alternatives assumed actually exist. All require the development of further transportation facilities. However, the capital cost of such facilities are not included in the project evaluation. The assumption implied is that the Government will provide the basic transportation facility.

---

* Development of the Faro No. 1 Ore Body
Preliminary Feasibility Study
for: The Anvil Mining Corporation Limited
by: The Ralph M. Parsons Construction Co. of Canada, Ltd.
April 26, 1966.

References to the above report prefixed: PFS

It is proposed, as one of the transportation alternatives, that the Canadian Government participate either "through direct or indirect subsidizing of the White Pass and Yukon system" for an extension of the existing line from Whitehorse to the plantsite with concomitant conversion to standard-gauge; "or by construction of a new rail link from tidewater to the immediate plantsite area. This latter consideration has a somewhat parallel precedent in the development of the Pine Point property in the Northwest Territory". (PFS: 10-2) It is suggested that these alternatives appear to have the greatest economic impact on the project's viability. (PFS: 10-7)

Townsite

The Parsons' evaluation does not include any allowance for the capital cost of a townsite. (PFS: 12-6, 13-3) Again it is implied that the Government will provide this facility.

Power

Power delivery costs are based on a mine mouth thermal power plant at Carmacks. (PFS: 11-1) It is assumed that the capital cost of the power plant facility and its operation are borne by the Government, capital cost being amortized in the power charge at 10 per cent per year. (PFS: 11-2)

The power costs assumed in the rate of return analysis are 8 mils for the electrolytic zinc processing alternative and 10 mils for all other alternatives. (PFS: 8-1)

Markets

A description is given of lead and zinc supply-demand conditions on a national and international level with forecasts to 1968. (PFS: Section 9)

It is proposed to market concentrates 30 per cent to the United States and 70 per cent to Japan, and metal 50 per cent to both the United States and West Germany.[PFS: 4-4] No further marketing details are given.

Smelter Schedule

Implicit in the rate of return analysis for the concentrate alternatives is a toll smelter schedule. This schedule is not detailed in the preliminary feasibility study but is manifest in the sales, smelting and refining cost figures shown in the cash flow analysis.[e.g. PFS: Table 3-8] Subsequently, the following details were obtained from Parsons:

(i) ASARCO custom smelter schedule (p. 86)
(ii) Smelter schedule of Ataka, New York, applicable to Japanese smelters (p. 87)
(iii) The assumed toll smelter schedule for the preliminary feasibility study, derived from (i). (p. 83)

Price

Two sets of prices were assumed in the rate of return analysis, f.o.b. customers port[PFS: 3-3]: (i) Pb 11.0 U.S.¢/lb, Zn 11.5 U.S.¢/lb.
(ii) Pb 12.5 U.S.¢/lb, Zn 13.0 U.S.¢/lb.

This then is assumed to be the price range that will most probably prevail over the 20 year productive life of the project.

Tax Allowances

For tax purposes, a 20 year straight line depreciation method has been used. Depreciation for the first three production years is deferred to the fourth and fifth years.[PFS: 3-5] Exploration and development expenses, including the cost of pre-production stripping and pit preparation, are depreciated as capital costs.[PFS: 5-18]

Ore Reserves

The study was initiated on the basis of the 1965 drilling program; 40 million tons of ore with a combined lead-zinc content of

12.0 per cent was assumed. These reserves were based on a pattern of 12 holes which intersected the mineralized zone at 400 foot centers.* The results from 7 more intersections, drilled in the early months of 1966, revised the ore reserve grade to a combined content of 10.6 per cent. This revised grade was used in the rate of return analysis. (PFS: 4-2)

Process Technology

Preliminary bench scale flotation tests indicated a 55 per cent lead concentrate and a 52 per cent zinc concentrate.(PFS: 4-2) More recent laboratory tests indicated recovering higher quality selective concentrates: a 70 per cent lead concentrate and a 55 per cent zinc concentrate.(PFS: 3-3)

No metallurgical test work has been done for the smelting and refining alternatives.(PFS: Table 1-1) The processing alternatives assumed (PFS: 3-2, 3-3) are:

A	Selective concentrates for toll smelting (55% Pb, 52% Zn)
A-1	" " " " " (70% Pb, 55% Zn)
B	Electrolytic zinc-blast furnace lead
B-1	Electrolytic zinc-toll smelting of lead concentrates (70% Pb, 55% Zn)
C	New Jersey vertical retort zinc-blast furnace lead
D	Imperial smelting process

Location of Processing Facilities

It is assumed that smelting and refining facilities, for the applicable alternatives, are located at the minesite.(PFS: 6-4)

General Comments

The Parsons' feasibility study represents a thorough analysis of the problem. A lack of clarity in the text is no doubt due to the

---

* See: "Anvil Mining Corporation, Ltd. Preliminary Report on Faro No. 1 Ore Body and 1966 Budget Request" January 15, 1966.

time constraints that the consultants were forced to work within. Anvil requested several important revisions in the basic assumptions at a late date.(PFS: 4-2, 4-3) The statement of assumptions, indexing, paginating and referencing to the back-up calculations in the addendum, all leave something to be desired. Canadian and United States dollar figures are both used, and seldom are monetary units specified.

If the Government is to consider mining feasibility studies on a regular basis, then it may be useful to set down certain guidelines as to the form and content of Government submissions. In this way both parties would be able to save time.

3. DECISION - MAKING CRITERION

It is assumed in the Parsons' feasibility study that the economic criterion by which investment alternatives are ranked and decisions made is rate of return.(e.g. PFS: 3-1) The alternative generating the highest rate of return is the preferred investment. In that part of the present analysis where the project is considered from the firm's point of view, rate of return is also used in order to have a standard for comparison with the feasibility study results. A computer program was developed to handle the rate of return calculation.

It is important to realize that selection using this criterion implicitly assumes that each alternative bears the same amount of uncertainty. If this assumption is violated, then selecting results on the basis of rate of return may be erroneous if the alternative offering the highest rate of return is more uncertain than one or more of the other alternatives. For example, if two alternatives offer potential returns of 20 per cent and 15 per cent respectively, but the former is more uncertain than the latter, then the alternative offering the highest rate of return would not necessarily be the preferred investment. The selection would depend on whether the greater uncertainty borne by the first alternative was more or less than the 5 per cent premium which it is expected to return. If the uncertainty is more than 5 per cent greater than the second alternative, the second alternative, projecting the smaller rate of return, would be preferred. In the case where the least uncertain alternative also offers the highest expected rate of return, the rate of return selection criterion remains valid, but the true premium for the preferred alternative will be greater than the difference in rate of return by the amount of the uncertainty differential.

Although rate of return is a useful method, sound within the context of its assumptions, and appealing because it reduces to a single readily understandable figure, the discounted cash flow method perhaps possesses a flexibility which allows one to approach reality more closely.* With this method, cash flows are discounted at a rate which represents an opportunity cost of equivalent uncertainty. Alternatives of differing uncertainties are, therefore, discounted at differing rates. A positive net present value indicates an attractive investment. The alternative with the largest ratio of net present value to investment is usually selected as optimum. Under certain circumstances, which Massé outlines, the rate of return method and the discounted cash flow method select different alternatives as optimum.

---

* There is an exhaustive discussion of the relative merits of these two criteria in decision-making literature. For an excellent comparison of these two criteria see: <u>Optimal Investment Decisions</u>, pp. 6-29

Pierre Massé,
Prentice Hall,
1962

4. MARKET OUTLINE

The price pattern for lead and zinc over the past 6 years is shown in Graph 15, page 14 . A moderate softening of the supply conditions for lead and zinc will probably occur in the period 1967-1968 and price declines are expected. Prices of 14.0 ¢/lb. for lead and 14.5 ¢/lb. for zinc could be considered probable although such estimates are most uncertain. Forcasts of price beyond this period are even more prone to error. Considering that the Anvil Project probably will not commence production before 1969 and that a 20 year productive life is assumed, price must be regarded as one of the most uncertain parameters in the project analysis. Also, price is a critical variable in the project evaluation. One is only justified in using 'most probable' estimates in the rate of return analysis because the discounting of future prices to a confident level removes a portion of the uncertainty element from the calculation and, thus, the resulting rate of return cannot be validly compared with the uncertainties inherent in the project. The difficulty can be eased by considering a most probable range of prices.

Price apart, there remains the problem of securing markets. In the Parsons' feasibility study it is assumed that concentrates are to be marketed 30% in the U.S. and 70% in Japan and metal 50% to both the U.S. and West Germany. No further marketing details are offered. Some of the general factors to be considered in such a marketing strategy are:

(i) The development of large lead mines and smelters in Missouri, now in progress, will result in imports of lead concentrate remaining at their present level and imports of refined lead being completely eliminated by 1968. Anvil will probably face an extremely difficult lead metal market and a tight lead concentrate market in the U.S.

(ii) In Japan both lead consumption and smelter production are growing rapidly, and a large increase in imports of lead concentrates should result. The present surplus in zinc smelter production should be eliminated by 1967 and imports of zinc concentrate will increase. Anvil concentrates will probably find ready markets in Japan.

(iii) For U.S. imports an initial large increase and a long-run moderate increase for both zinc metal and zinc concentrates are indicated. Anvil zinc concentrates and zinc metal will probably be able to secure markets in the U.S.

(iv) In Europe large increases in zinc mine output will generate increases in European smelter production at a more rapid rate than consumption. A decrease in the import of refined zinc is therefore indicated. Supplies of lead concentrate are increasing in Europe, stimulating smelter expansions. Only moderate increases can be expected for refined lead imports. Anvil would appear to face a difficult zinc metal market and a tight lead metal market in West Germany.

These are but general statements. Specific details of Anvil's anticipated marketing strategy could materially change this outlook.

Anvil's concentrate markets appear less uncertain than its metal markets. However, before a development decision can be taken, detailed marketing analyses, for both concentrate and metal alternatives, will be required by Anvil.

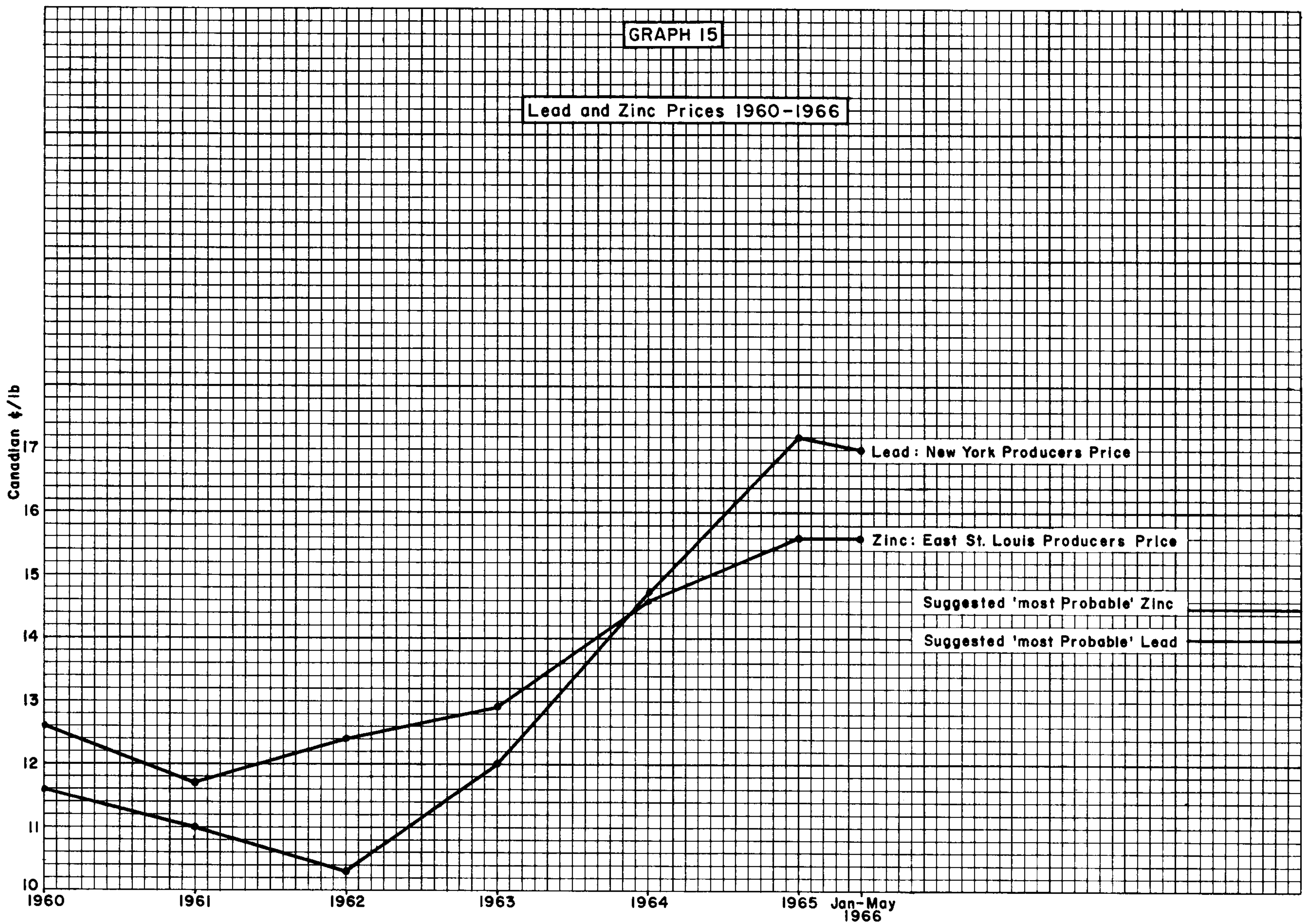
References:

(1) ____________________; Report of the Ninth Session of the Study Group; held in Tokyo, Japan, from 1-5 November, 1965; International Lead and Zinc Study Group.

(2) ____________________; Lead and Zinc: Free World Supply and Demand; Lead Industries Association, Inc. and American Zinc Institute, Inc.; New York, 1965.

(3) ____________________; Market Guide: Lead;
Engineering and Mining Journal, Metal and Mineral Markets, April 26, 1965.

(4) ____________________; Market Guide: Zinc
Engineering and Mining Journal, Metal and Mineral Markets, March 28, 1966.



GRAPH 15
Lead and Zinc Prices 1960-1966
Canadian ¢/lb
10
11
12
13
14
15
16
17
1960
1961
1962
1963
1964
1965
Jan-May 1966
Lead: New York Producers Price
Zinc: East St. Louis Producers Price
Suggested 'most Probable' Zinc
Suggested 'most Probable' Lead

5. SELECTION OF BASIC ALTERNATIVES

For the evaluation it was decided to consider five processing alternatives and five transportation alternatives, making in total twenty-five processing-transportation combinations.

Processing Alternatives:

It was assumed that the processing facility would be located at the mine site. For the processing to metal alternatives this may not be the optimum location. Generally, mineral processing installations exist beyond the life of any individual raw material source. The location of the Anvil processing installation should take this factor into account. Modern base metal smelters and refineries are usually located on international shipping routes but the unusual political boundaries of this area of the Canadian north mitigate against such a location from a national perspective. Power cost in the mine area is another factor influencing location, particularly for the electroytic zinc alternative.

The following factors influenced the selection of processing alternatives:

(i) Details of the assumed smelter schedule were not included in the Parsons' feasibility study. For the present evaluation a schedule was synthesized from the aggregate sales, smelting and refining cost figures used in the cash flow analysis of the toll smelting alternatives.(e.g. PFS: 3-8) The figures evolved, therefore, will not exactly agree with figures calculated from the detailed schedule (p. 85) which was received too late for inclusion in the analysis. It was also decided that since the details of the Parsons' schedule were lacking, a check on the synthesized figures should be made using a detailed smelter schedule. The COMINCO schedule was used for this purpose. (pp. 79-81) This is a hypothetical case assuming the COMINCO schedule operative at those same points in the U.S. and Japan where the Parsons' schedule applies.

(ii) The New Jersey zinc process, using vertical retorts, is a classical labour intensive batch method. Since labour will be at a premium in this remote area, and since technology has developed more efficient processes (a new metallurgical plant employing this method has not been built for a considerable time), it was decided to eliminate this process from the analysis.

(iii) Results of the Parsons' feasibility study indicate that the toll smelting alternatives should realize significantly higher returns that any of the processing alternatives. Also, although markets for lead and zinc metal might be more uncertain than for lead and zinc concentrates, it could possibly be in the national interest to have processing facilities developed in a remote area that offered good potential for further mineral development. It was decided that a mixed alternative, processing a portion of the output to metal, and shipping the remainder as concentrates for toll smelting, might offer a suitable compromise between firm and national objectives.

(iv) The companies original bench scale flotation results, 55 per cent lead concentrate and 52 per cent zinc concentrate, were considered most probable and accepted for the evaluation.

The following five processing alternatives were, therefore, selected for consideration:

(i) Production of selective concentrates (55 per cent Pb and 52 per cent Zn) for toll smelting using the COMINCO smelter schedule. (pp. 79-81)

(ii) Production of selective concentrates (55 per cent Pb and 52 per cent Zn) for toll smelting using the synthesized Parsons' schedule. (similar to Parsons Case A, PFS: 7-7 to 7-9) (p. 83)

(iii) Production of slab zinc by electrolysis, pig lead by blast furnace smelting, using conventional lead refinery and blast furnace slab fuming facility. (similar to Parsons Case B, PFS: 7-7 to 7-9 and 7-10 to 7-17)

(iv) Utilization of bulk concentrate to produce crude lead and zinc by the imperial smelting process, zinc refined by distillation and lead refined in the conventional manner. (similar to Parsons Case D, PFS: 7-9 to 7-10 and 7-22 to 7-25)

(v) Mixed Case: 50 per cent of mine output to selective concentrates for toll smelting, 50 per cent of mine output to bulk concentrates for the production of crude lead and zinc by the imperial smelting process, zinc refined by distillation and lead refined in a conventional manner.

Transportation Alternatives:

Seven transportation alternatives were originally considered. Two were subsequently rejected because on the basis of capital and operating costs they were obviously inferior to other alternatives. The two eliminated alternatives were:

(i) All road route: minesite to Skagway via Ross River, Johnsons Crossing and Carcross. (p. 109)

(ii) Road-rail route to Skagway: road, minesite to Carcross via Ross River; rail, Carcross to Skagway. (p. 110)

Two other alternatives, extension of the narrow gauge rail line from Whitehorse to plantsite, and the all road route to Haines also appeared inferior but were included in the analysis because they had been suggested in the Parsons' feasibility study and elsewhere.

The five transportation alternatives finally considered were:

(i) New standard gauge rail line; minesite to tidewater (Dyea)

(ii) Extension of existing narrow gauge line (Skagway to Whitehorse) to the minesite.

(iii) All road route, minesite to Skagway, via Carmacks and Carcross.

(iv) All road route, minesite to Haines, via Carmacks and Aishihik.

(v) Existing road-rail route; by existing* road minesite to Whitehorse via Carmacks, thence by existing rail Whitehorse to Skagway.

---

*estimated completion date for the Carmacks - Ross River road, presently under construction: December, 1968.

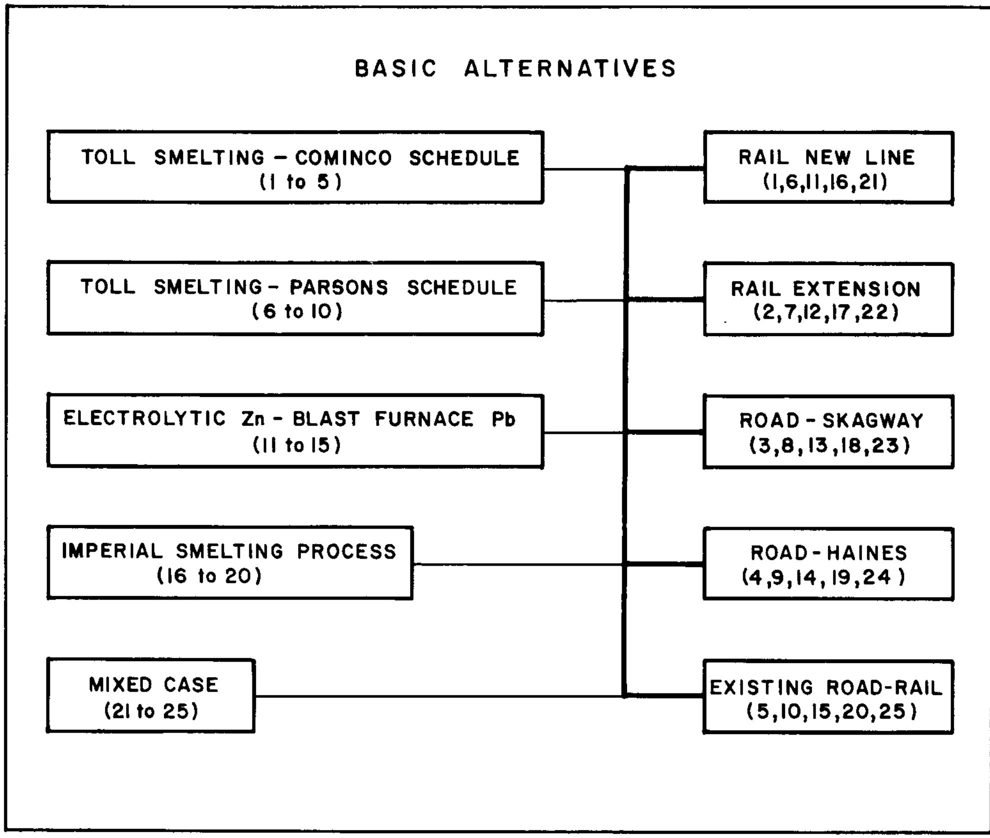
Capital cost and operating cost estimates for all seven original alternatives are derived in the appendix (pp. 93-110) and will be considered further in Section 7. Operating cost figures are abstracted from the Parsons' feasibility study. The capital cost estimates were provided by E. Weick; Head, Transportation Section, Resource and Economic Development Group, Dept. of Northern Affairs and National Resources and are based on limited information resulting from informal discussion with the Engineering Division, Northern Administration Branch of the same Department.

A flowsheet, showing the numbering of the basic alternatives, is set out on page 19 .

FLOWSHEET OF BASIC ALTERNATIVES AND VARIATIONS

Basic Alternative Numbers in Brackets

Base Case Variation Boxed



VARIATIONS

MARKET PRICE [1]		CAPITAL ALLOCATION [2]	POWER COST mils [3]				ROYALTY RATES [4]			
Pb	Zn	%	1-10	11-15	16-20	21-25	1	2	3	4
11.9	12.4	0	10	[8]	8	10	[3]	[5]	[6]	[1]
12.9	13.4	[25]	[12]	10	[10]	[12]	4	5	6	1
13.5	14.0	50	14	12	12	14	4	5	6	1
[14.0]	[14.5]	75	16	14	14	16	8	9	10	1
14.5	15.0	100					3	5	7	2
							3	6	9	3

1: In Canadian ¢/lb ; Pb - New York Producers Price, Zn - East St. Louis Producers Price
2: % of Transportation Facility + Townsite Capital Allocated to Anvil
3: Alternative Numbers
4: 1 - % Rate of Profits Between \$ 10,000 and \$ 1,000,000
   2 - % Rate of Profits Between \$ 1,000,000 and \$ 5,000,000
   3 - % Rate of Profits Between \$ 5,000,000 and \$ 10,000,000
   4 - Incremental % Increase in Rate for Each Additional \$ 5,000,000 in Profits Over \$ 10,000,000

6. VARIATIONS ON THE BASIC ALTERNATIVES

For each of the basic alternatives, variations were considered in each of four input variables: market price, per cent capital allocation of transportation facility and townsite cost to the firm, power cost, and royalty rate. The input variables changed were those that were considered critical to a government evaluation of the project. The flowsheet on page 19 shows the variations considered.

Market Price

Lead and zinc prices are most uncertain variables but their estimate is critical to the evaluation. Section 4 outlines the difficulty. A brief survey of references was made and informal talks were held with Mr. D.B. Fraser, Non-Ferrous Metals Unit, Mineral Resources Division, Department of Mines and Technical Surveys.

It was decided to assume a most probably base price of 14.0 ¢/lb.* for lead and 14.5 ¢/lb. for zinc. Because of the uncertainties attending such an estimate, a range of prices was considered bounding this estimate, within which one could feel somewhat confident of remaining over the productive life of the project. These variations, incidentally, include the 2 price estimates assumed in the Parsons' feasibility study. The following 5 price combinations were considered, lead based on the New York producers price, zinc based on the East St. Louis producers price:

---

* all monetary figures in Canadian units.

Lead: ¢/lb	Zinc: ¢/lb
11.9	12.4
12.9	13.4
13.5	14.0
14.0	14.5
14.5	15.0

Capital Allocation of Transportation Facility and Townsite

Exclusive of the tidewater handling and storage facilities, trucks and auxiliaries, no capital cost was included in the feasibility study for the basic transportation facility, road or rail as the case may be.(e.g. PFS: 10-6 Table 13-3) Also, no capital for the construction of a townsite was considered.(PFS: 12-6 and 13-3) It was decided that the effect of adding a portion or all of these capital costs on the project economics would be important to the evaluation of the project. The transport facility and townsite capital costs are unique for each basic alternative and are derived in the appendix. (pp. 99-102) For the base case it was assumed that 25 per cent of these capital costs would be carried by the firm. Variations are considered by which 0 per cent (the firm's assumption), 50 per cent, 75 per cent and 100 per cent of the capital costs are allocated to the firm. In this manner the variation in rate of return with per cent allocation can be determined over the full range of possible allocations for each basic alternative.

Power Cost

It is anticipated that power costs will be relatively high for this project and it was decided, therefore, to test the sensitivity of the project economics to variations in power cost.

Parsons' feasibility study assumed 8 mil power for the electrolytic zinc alternative and 10 mil power for all other processing alternatives. (PFS: 8-1) These operating costs include amortization of the capital cost of the power facility over 10 years.

A memo from E.W. Humphries, Chairman of the Northern Canada Power Commission summarizes the results of a study made of power alternatives for the Anvil Project by his staff. (pp.114-116) Although processes were considered sequentially rather than independently, the main points remain valid for this study and are outlined below:

(i) Milling and concentrating power requirements (Alternatives 1-10) can best be met by expanding the existing Whitehorse Rapids hydro development. The estimated cost of such power, delivered to Anvil, is about 13 mils.

(ii) Although no distinction has been made between smelting and refining alternatives, the most attractive power site appears to be at Five Fingers Rapids on the Yukon River, just below Carmacks. The average cost of power would be about 6.5 mils, but international considerations may prevent development.

(iii) If development of the Five Fingers site is precluded then the Granite site on the Pelly River, 15 miles east of the Pelly Crossing, could be developed. Estimated power cost is 8.5 mils.

Consider the following differences in unit power demand between the basic processing alternatives, placed on a common per ton of metal basis:

Toll Smelting	: 335kwh (PFS: 8-3)
Electrolytic Zinc-Blast Furnace Lead	: 2385kwh (PFS: 8-3, 8-7, 8-9)
Imperial Smelting Process	: 565kwh (PFS: 8-6, 8-13, 8-14)
Mixed Alternative	: 450kwh (average)

Taking into account both the recommendations contained in the memo and differences in power demand for the processing to metal alternatives outlined above, the base case power costs assumed in the analysis were:

Toll Smelting (Alternatives 1-10)	:	12 mils
Electrolytic Zn-Blast Furnace Pb (Alternatives 11-15)	:	8 mils
Imperial Smelting Process (Alternatives 16-20)	:	10 mils
Mixed Alternative (Alternatives 21-25)	:	12 mils

The following variations were also considered:

Toll Smelting	: 10, 14, 16 mils
Electrolytic Zn-Blast Furnace Pb	: 10, 12, 14 mils
Imperial Smelting Process	: 8, 12, 14 mils
Mixed Case	: 10, 14, 16 mils

Royalty Rates:

The effect of changes in royalty rate on both project economics and government revenue were analyzed. The existing schedule of rates was assumed most probable to prevail, and five variations were considered.

	Royalty Schedules: % Rates					
Annual Profit Increments	Base Case	Variation 1	Variation 2	Variation 3	Variation 4	Variation 5
$10,00 - 1,000,000	3	4	6	8	3	3
$1,000,000 - 5,000,000	5	5	7	9	5	6
$5,000,000 - 10,000,000	6	6	8	10	7	9
increase in rate for each $5,000,000 increment above $10,000,000	1	1	1	1	2	3

The first variation considers increasing the lowest profit interval rate only and thus narrows the rate differential between low profit and high profit producers. With the second and third variations all profit classes are increased by the same rate differential, i.e. 2 per cent and 4 per cent respectively. This increases the royalty burden uniformly over the range of profitable producers. With the fourth and fifth variations the lowest profit interval rate is fixed at the existing level, the rate differential increasing with increasing profit levels. Such a schedule has the effect of shifting the royalty burden from the low profit to the high profit producers, and therefore encourages the mining of marginal ores.

7. PREPARATION OF INPUT DATA

The methods of evaluation are a cash flow analysis for the determination of rate of return, royalty and tax payments and a Monte Carlo analysis of the input variables to determine upper and lower confidence limits for the estimated rate of return. For each basic alternative estimates of capital cost, revenue and operating cost are required. Some of the estimates have been abstracted from the Parsons' feasibility study, others have been independently generated. All monetary values are in Canadian units.

REVENUE

Ore Reserves

Anvil's most recent estimates of tonnage and grade (PFS: Table 5C-4) were accepted:

Ore Reserves, tons:	40,000,000
Lead, % :	4.16
Zinc, % :	6.43
Silver, ounces/ton:	1.19

Life

Parsons' estimate of a 20 year productive life was accepted as reasonable in relation to the ore reserves, although it was not shown that this life optimized the firm's project objectives. (PFS: Table 3-21)

Mining Rate

The grade of ore declines with depth. In order to maintain a constant metal recovery, the following ore production rates and grades were assumed(PFS: 4-3):

	Years 1-5	Years 6-20
Mining rate, tpy	1,610,000	2,129,000
Lead, %	5.29	3.85
Zinc, %	7.83	6.07
Silver, ounces/ton	1.58	1.08

Toll Smelting: Concentrate Production

For the toll smelting processing alternatives (Alternatives 1-10), the following output rates, recoveries, and grades were assumed(PFS: 4-3 and Table 3-21):

	Years 1-5	Years 6-20
Lead Concentrate		
Milling rate, tpy	138,460	133,488
Lead, %	55.00	55.00
Zinc, %	7.00	7.50
Silver, ounces/ton	9.42	8.84
Recovery of lead, %	89.50	89.50
Zinc Concentrate		
Milling rate, tpy	213,969	219,074
Zinc, %	52.00	52.00
Lead, %	1.20	1.17
Silver, ounces/ton	2.82	2.49
Recovery of zinc, %	88.30	88.30

Smelting and Refining: Metal Production(PFS: Table 3-21)

		Years 1-5	Years 6-20
(1)*	Pig Lead, tpy	78,335	75,626
	Slab Zinc, tpy	117,163	120,067
	Silver, ounces/year	1,812,000	1,638,000

	Years 1-5	Years 6-20
(2)* Pig Lead, tpy	74,793	72,206
Slab Zinc, tpy	112,447	115,234
Silver, ounces/year	1,812,000	1,638,000

*(1) electrolytic zinc-blast furnace lead (alternatives 11-15)

(2) imperial smelting process (alternatives 16-20)

Mixed Case: Concentrate and Metal Production

Production rates for the mixed case (alternatives 21-25) are taken at 50 per cent of the toll smelting process and 50 per cent of the imperial smelting process.

		Years 1-5	Years 6-20
Concentrates:	Lead, tpy	69,230	66,744
	Zinc, tpy	106,985	109,537
	Silver, avg. ounces/ton	5.41	4.89
Metal:	Pig Lead, tpy	37,397	36,103
	Slab Zinc, tpy	56,224	57,617
	Silver, ounces/year	906,000	819,000

Market Price

For the computer program it was necessary to express the base case market price on a per ton of ore basis and the price variations as percentage changes from that price. Silver is priced at $1.40 per ounce for all cases. By-product recovery of copper and cadmium is neglected. Reference may be made to the appendix for:

COMINCO Smelter Schedule (alternatives 1-5): pp. 79-81
Parsons Assumed Smelter Schedule (alternatives 6-10): p. 83
Parsons Smelter Schedule: p. 85
ASARCO Smelter Schedule: p. 86
Ataka Smelter Schedule: p. 87
Calculation of Market Price/ton ore and % Variations from Base Case: pp. 88-90

The following table summerizes the market prices per ton of ore:

	Lead	Zinc	Market Price: $/ton ore				
	NYPP ¢/lb.	ESLPP ¢/lb.	Alter-natives 1-5	Alter-natives 6-10	Alter-natives 11-15	Alter-natives 16-20	Alter-natives 21-25
Years 1-5 Years 6-20	11.9	12.4	14.72 10.99	16.10 11.11	28.82 21.72	27.67 20.85	21.19 15.92
Years 1-5 Years 6-20	12.9	13.4	16.80 12.55	18.05 13.05	31.25 23.56	30.00 22.61	23.40 17.58
Years 1-5 Years 6-20	13.5	14.0	18.04 13.50	19.19 14.27	32.71 24.66	31.40 23.67	24.72 18.59
Years 1-5 Years 6-20	14.0*	14.5*	19.10 14.35	20.18 15.15	33.92 25.58	32.56 24.55	25.83 19.45
Years 1-5 Years 6-20	14.5	15.0	20.15 15.10	21.10 16.15	35.14 26.50	33.72 25.43	26.94 20.27

*Base Case

OPERATING COST

Mining

Pre-production stripping expenses of $1,080,000 were assumed (PFS: 5-18), incurred in equal increments over the pre-production years. These expenses can be written-off for tax purposes as soon as taxable income is available, i.e. in the fourth production year.

Mining costs of $1.05 per ton of ore for years 1-5 and $0.732 per ton of ore for years 6-20 were assumed (PFS: Tables 5G-2, 5G-3), applying to all atlernatives.

Beneficiation and Metallurgical

The Parsons' beneficiation and metallurgical charges were used at their assumed power cost. From the power cost component of these charges, the power cost variations were calculated and worked back into the total beneficiation and metallurgical operating costs. The following table shows the base case beneficiation and metallurgical costs and the variations due to power cost.

For Parsons' beneficiation and metallurgical charges refer to: PFS: 8-2 to 8-9 and 8-12 to 8-15.

For derivation base case beneficiation and metallurgical costs and variations refer to appendix: pp. 91-92

Values for Alternatives 21-25 are averages of charges and variations for Alternatives 1-10 and Alternatives 16-20.

		Base Case			Variations: $/ton ore				
		Power Cost mils	$/ton ore Benef. Cost	$/ton ore Metal Cost	8 mils	10 mils	12 mils	14 mils	16 mils
Cases 1-10	Yrs. 1-5 Yrs. 6-20	12	2.273 2.120	--- ---	---	-.055	BC	+ .055	+.110
Cases 11-15	Yrs. 1-5 Yrs. 6-20	8	2.150 1.993	9.610 7.280	BC	+.927	+1.854	+2.781	---
Cases 16-20	Yrs. 1-5 Yrs. 6-20	10	1.905 1.770	7.340 5.600	-.226	BC	+ .226	+ .452	---
Cases 21-25	Yrs. 1-5 Yrs. 6-20	12	2.062 1.917	3.830 2.940	---	-.141	BC	+ .141	+.282

<u>Transportation by Land</u>

Transportation costs from minesite to tidewater are derived from figures presented in the Parsons' feasibility study (PFS: 10-2 to 10-7). The derivation is shown in the appendix. (pp. 93-95) Land transportation costs per ton of ore are summerized in the following table. They include a tidewater handling charge. (PFS: 10-6)

Basic Alternative Number	Land Transportation Costs: $/Ton of Ore	
	Years 1-5	Years 6-20
1 and 6	2.19	1.66
2 and 7	3.51	2.65
3 and 8	2.85	2.16
4 and 9	3.62	2.74
5 and 10	3.79	2.87
11	1.29	0.98
12	2.02	1.53
13	1.58	1.20
14	2.01	1.52
15	2.10	1.59
16	1.24	0.94
17	1.93	1.46
18	1.52	1.15
19	1.92	1.45
20	2.02	1.53
21	1.73	1.31
22	2.74	2.07
23	2.18	1.65t
24	2.77	2.10
25	2.90	2.20

Transportation by Water

Marine rates are derived from the figures assumed in the Parsons' feasibility study (PFS: Table 1-1) and include an unloading cost. The derivation is shown in the Appendix: pp. 96-97

Basic Alternative Number	Water Transportation Costs: $/ton ore	
	Years 1-5	Years 6-20
1-10	1.62	1.22
11-15	1.24	0.94
16-20	1.18	0.89
21-25	1.40	1.06

Marine Insurance

Marine insurance costs were assumed at 1 per cent of the market price: (PFS: 10-8, 10-9)

Basic Alternative Number	Marine Insurance Cost: $/ton ore	
	Years 1-5	Years 6-20
1-5	.19	.14
6-10	.20	.15
11-15	.34	.26
16-20	.33	.25
21-25	.26	.19

Selling Expense

Selling expenses were assumed at 1½ per cent of the market price (this figure was assumed by Anvil. Although not included in feasibility study, this figure was verified in a telephone conversation with Mr. Walter Shaw of Parsons-Jurden on June 17, 1966).

Basic Alternative Number	Selling Expense: $/ton ore	
	Years 1-5	Years 6-20
1-5	.29	.22
6-10	.30	.23
11-15	.51	.38
16-20	.49	.37
21-25	.39	.29

Tariffs

The destinations for processed products are (PFS: 4-4):

Concentrates:	30% to U.S.A.	70% to Japan
Metal :	50% to U.S.A.	50% to West Germany

The following tariff rates are assumed:

U.S.A. - in U.S. ¢/lb.

Pb metal	1-1/16 ¢/lb.
Zn metal	0.7 ¢/lb.
Pb concentrate	3/4 ¢/lb. contained
Zn concentrate	0.67 ¢/lb. contained

West Germany - in U.S. ¢/lb.

Pb metal (EEC ultimate)	0.6 ¢/lb.
Zn metal (EEC ultimate)	0.6 ¢/lb.

See Appendix (p. 98) for derivation of the following table of tariff costs:

Basic Alternative Number	Tariff Costs: $/ton ore	
	Years 1-5	Years 6-20
1-10	.54	.41
11-15	1.89	1.42
16-20	1.81	1.36
21-25	1.17	0.89

CAPITAL COSTS

The Parsons' estimates of capital cost for mine plant, processing installation, trucks, etc. were accepted. (PFS: Section 13) The Anvil Project will initially be a 4,400tpd operation rising to 5,800tpd in the 6th year of production. (7-day week) Allowing for location and capacity differences the capital cost estimates appear to be in line with those of recently installed similar installations at Pine Point, Brunswick and Mattagami.

The following capital cost estimates are generated in the Appendix:

transportation facility: pp. 91-101

townsite: p. 102

The distributions of total capital cost by asset category and over time are also tabled, and a composite depreciation rate is derived, for each basic alternative. (pp.103-108) Per centage variations for the allocation of transportation facility and townsite capital are also calculated. The following tables summerize the capital cost estimates.

Transportation Facility (pp. 99-101)

	Basic Alternative No.	Capital Cost - $
New Rail	1, 6, 11, 16 and 21	120,000,000
Ext'n. of Exist. Rail	2, 7, 12, 17 and 22	60,000,000
Road: to Skagway	3, 8, 13, 18 and 23	12,000,000
Road: to Haines	4, 9, 14, 19 and 24	12,000,000
Existing Road - Rail	5, 10, 15, 20 and 25	3,800,000

Townsite (p. 102)

	Basic Alternative No.	Capital Cost - $
Toll Smelting	1 - 10	6,000,000
Processing to Metal	11 - 20	9,000,000
Mixed Case	21 - 25	7,500,000

Total (pp.103-108)

Alternative Number	Base Case			% Variations in Capital Allocation Transportation Facility and Townsite			
	TCC* mil. $	DR %	PPCC mil. $	0%	50%	75%	100%
1, 6	79.405	17.00	73.249	-39.67	+39.67	+79.34	+119.01
2, 7	64.405	20.03	58.249	-25.62	+25.62	+51.24	+ 76.86
3, 4, 2, 9	52.405	23.70	46.249	- 8.59	+ 8.59	+17.18	+ 25.77
5, 10	50.355	24.50	44.199	- 4.87	+ 4.87	+ 9.74	+ 14.61
11	126.236	23.08	121.738	-25.55	+25.55	+51.10	+ 76.65
12	111.236	25.66	106.738	-15.51	+15.51	+31.02	+ 46.53
13, 14	99.236	28.28	94.738	- 5.29	+ 5.29	+10.58	+ 15.87
15	97.186	28.79	92.688	- 3.29	+ 3.29	+ 6.58	+ 9.87
16	133.953	23.50	129.521	-24.08	+24.08	+48.16	+ 72.24
17	118.953	25.96	114.521	-14.50	+14.50	+29.00	+ 43.50
18, 19	106.953	28.42	102.521	- 4.91	+ 4.91	+ 9.82	+ 14.73
20	104.903	28.90	100.471	- 3.05	+ 3.05	+ 6.10	+ 9.15
21	106.679	21.06	101.385	-29.88	+29.88	+59.76	+ 89.64
22	91.679	23.85	86.385	-18.41	+18.41	+36.82	+ 55.23
23, 24	79.679	26.84	74.385	- 6.12	+ 6.12	+12.24	+ 18.36
25	77.629	27.44	72.335	- 3.64	+ 3.64	+ 7.28	+ 10.92

Working Capital

Working capital is not included in the total capital cost estimates. The Parsons' feasibility study included working costs in the rate of return evaluations but not as part of the invested capital. Presumeably, these funds are to be secured by short term loans, repaid as quickly as possible from internal sources. In the present evaluation it is assumed that working capital is raised by 8 per cent loans at the beginning of the first production year and

* TCC: total capital cost
DR : composite depreciation rate
PPCC: pre-production capital cost

are repaid in the second year. Working capital requirements, of the same order as the Parsons' estimates, are shown below.

Alternative No.	Working Capital - $
1 - 10	8,000,000
11 - 15	10,000,000
16 - 20	9,000,000
21 - 25	8,500,000

CONFIDENCE LIMITS

In the cash flow evaluation for the basic alternatives and their variations, use is made of the input values outlined above under revenue, operating cost and capital cost. These values may be regarded as most probable estimates.

In order to express the overall results in terms of a confident range of values, use is made of the Monte Carlo technique. To use this method each estimated 'most probable' value must be assigned an upper and a lower limit, within which one has confidence of achieving. If one is, say, 90 per cent confident that each of the parameters will lie within the stated limits, then the calculated limits for rate of return will span a similar confidence interval. It was decided to impute a 90 per cent confidence level into the input parameter limits. Therefore, for each input variable, one estimates upper and lower limiting values within which one feels 90 per cent confident that actual results will fall. The estimating of such limits is extremely subjective in nature, and the meaningfullness of results, except as rough guidelines, must be discounted accordingly. A Monte Carlo sampling of 30 was taken in each case.

The following factors were considered in estimating the confidence limits:

(i) market uncertainties, expressed in terms of production of tons of ore, and reflecting the relative uncertainties of metal and concentrate markets show wider limits for alternatives 11-20 than for alternatives 21-25 which in turn reflect wider limits than alternatives 1-10.

(ii) price uncertainties are kept in approximately the same proportion for all basic alternatives. Greater uncertainty concerning prices farther in the future was reflected by showing wider price limits in years 6-20 than in years 1-5.

(iii) for operating costs in general, wider confidence limits were shown with increasing time. Probable inflation is shown by the upper limit increasing at a more rapid rate than the rate of decrease of the lower limit.

(iv) confidence limits for transportation by water reflect the growing and potential scale economies in ocean freight.

(v) tariff limits reflect advancing depletion in industrialized nations and, consequently, a probable easing in trade barriers i.e. a probable lowering of tariffs.

(vi) difficulties in marketing metals compared to concentrates are shown in wider limits and a higher upper limit for the processing of metal alternatives.

8. RESULTS

Table 1

Basic Alternatives ★

Alternative Number	Rate of Return %	Government Revenue: mil $	
		Royalty	Tax
1	17.8	12	69
2	19.9	11	61
3	27.0	12	71
4	24.9	11	64
5	25.6	11	63
6	19.7	14	78
7	22.2	13	70
8	29.8	14	80
9	27.7	13	73
10	28.5	13	72
11	14.5	23	95
12	15.8	22	94
13	18.3	23	101
14	17.8	23	98
15	18.1	23	97
16	14.8	25	105
17	16.1	24	104
18	18.4	26	111
19	18.0	25	108
20	18.3	25	107
21	15.2	18	85
22	16.6	17	81
23	20.0	18	90
24	19.2	17	84
25	19.5	17	84

★ Price: Lead: 14.0 ¢/lb.
Zinc: 14.5 ¢/lb.
% Capital Allocation of Transportation Facility and Townsite: 25%
Power Cost: Alternatives 1-10 and 21-25 mils; Alternatives 11-15 at 8 mils; Alternatives 16-20 at 10 mils.
Royalty: Existing Schedule.

Table 2

Price Variations

% Rate of Return

	Prices: ¢/lb				
Pb: NYPP Zn: ESLPP	11.9 12.4	12.9 13.4	13.5 14.0	14.0 14.5	14.5 15.0
1*	9.3	13.5	15.9	17.8	19.7
2	9.1	14.5	17.4	19.9	22.2
3	14.5	20.7	24.1	27.0	29.7
4	12.0	18.5	22.0	24.9	27.7
5	12.2	18.9	22.6	25.6	28.5
6	11.7	15.7	17.9	19.7	21.5
7	12.2	17.1	19.9	22.2	24.3
8	18.0	23.8	27.1	29.8	32.3
9	15.7	21.7	25.0	27.7	30.3
10	16.0	22.2	25.7	28.5	31.2
11	9.0	11.7	13.3	14.5	15.6
12	9.7	12.8	14.5	15.8	17.1
13	11.9	15.1	16.9	18.3	19.7
14	11.3	14.6	16.4	17.8	19.2
15	11.5	14.8	16.6	18.1	19.5
16	10.0	12.4	13.7	14.8	15.9
17	10.8	13.5	15.0	16.1	17.3
18	12.9	15.6	17.2	18.4	19.7
19	12.4	15.2	16.8	18.0	19.2
20	12.5	15.4	17.0	18.3	19.5
21	9.4	12.3	13.9	15.2	16.5
22	9.9	13.2	15.1	16.6	18.0
23	12.8	16.4	18.4	20.0	21.6
24	11.8	15.5	17.6	19.2	20.8
25	11.9	15.7	17.9	19.5	21.1

* Alternative Number

Table 3

Power Cost Variations

% Rate of Return

Alternative Number	Power Cost - mils				
	8	10	12	14	16
1		17.9	17.8	17.7	17.6
2		20.0	19.9	19.7	19.6
3		27.1	27.0	26.8	26.7
4		25.1	24.9	24.8	24.6
5		25.8	25.6	25.4	25.3
6		19.8	19.7	19.6	19.5
7		22.3	22.2	22.0	21.9
8		29.9	29.8	29.6	29.4
9		27.9	27.7	27.6	27.4
10		28.7	28.5	28.4	28.2
11		13.4	12.3	11.2	
12		14.6	13.4	12.2	
13		17.1	15.8	14.5	
14		16.6	15.3	14.0	
15		16.9	15.5	14.2	
16	15.0	14.8	14.6	14.3	
17	16.4	16.1	15.9	15.6	
18	18.7	18.4	18.2	17.9	
19	18.3	18.0	17.8	17.5	
20	18.5	18.3	18.0	17.7	
21		15.4	15.2	15.0	14.8
22		16.8	16.6	16.4	16.2
23		20.3	20.0	19.8	19.6
24		19.4	19.2	19.0	18.7
25		19.7	19.5	19.3	19.0

Table 4

Variation in Capital Allocation of
Transportation Facility and Townsite Capital
% Rate of Return

Alternative Number	% Capital Allocation				
	0%	25%	50%	75%	100%
1	30.0	17.8	12.1	8.6	6.1
2	26.9	19.9	15.5	12.4	10.1
3	29.5	27.0	24.8	23.0	21.4
4	27.3	24.9	22.9	21.2	19.7
5	26.9	25.6	24.4	23.3	22.3
6	32.8	19.7	13.6	9.9	7.3
7	29.9	22.2	17.4	14.1	11.6
8	32.5	29.8	27.4	25.4	23.7
9	30.3	27.7	25.5	23.7	22.0
10	30.0	28.5	27.2	26.0	24.9
11	19.4	14.5	11.2	8.9	7.0
12	18.7	15.8	13.6	11.8	10.3
13	19.3	18.3	17.4	16.6	15.8
14	18.8	17.8	17.0	16.1	15.4
15	18.7	18.1	17.6	17.0	16.5
16	19.4	14.8	11.7	9.4	7.6
17	18.8	16.1	14.0	12.3	10.8
18	19.4	18.4	17.6	16.8	16.1
19	18.9	18.0	17.2	16.4	15.7
20	18.8	18.3	17.7	17.2	16.8
21	21.5	15.2	11.4	8.7	6.7
22	20.2	16.6	13.9	11.8	10.1
23	21.3	20.0	18.9	17.9	17.0
24	20.4	19.2	18.1	17.1	16.2
25	20.2	19.5	18.9	18.2	17.6

Table 5

Variation in Royalty Schedule

RR: % rate of return

Roy: aggregate royalty in millions of dollars

Alternative Number	Royalty Schedule * 3-5-6-1 RR	Roy	4-5-6-1 RR	Roy	6-7-8-1 RR	Roy	8-9-10-1 RR	Roy	3-5-7-2 RR	Roy	3-6-9-3 RR	Roy
1	17.8	12	17.8	13	17.7	17	17.5	22	17.8	14	17.7	18
2	19.9	11	19.8	11	19.6	15	19.4	19	19.8	12	19.7	15
3	27.0	12	27.0	13	26.7	17	26.4	22	26.9	14	26.7	18
4	24.9	11	24.9	11	24.6	16	24.4	20	24.9	12	24.7	16
5	25.6	11	25.6	11	25.3	15	25.1	20	25.6	12	25.4	15
6	19.7	14	19.7	14	19.5	19	19.3	24	19.7	16	19.5	21
7	22.2	13	22.2	13	21.9	17	21.7	22	22.1	14	21.9	18
8	29.8	14	29.7	14	29.4	19	29.1	25	29.6	16	29.4	21
9	27.7	13	27.7	13	27.4	18	27.1	23	27.6	15	27.4	18
10	28.5	13	28.5	13	28.2	18	27.9	22	28.5	14	28.2	18
11	14.5	23	14.5	23	14.3	31	14.1	38	14.4	28	14.2	38
12	15.8	22	15.8	22	15.6	30	15.4	37	15.7	27	15.5	36
13	18.3	23	18.3	24	18.1	31	17.9	39	18.2	29	18.0	38
14	17.8	23	17.8	23	17.6	30	17.4	38	17.7	28	17.5	37
15	18.1	23	18.1	23	17.9	30	17.7	38	18.0	28	17.8	37
16	14.8	25	14.8	25	14.6	33	14.5	41	14.7	31	14.5	42
17	16.1	24	16.1	24	15.9	32	15.8	40	16.0	30	15.8	40
18	18.4	26	18.4	26	18.2	34	18.0	42	18.3	32	18.1	42
19	18.0	25	18.0	25	17.8	33	17.6	41	17.9	31	17.7	41
20	18.3	25	18.3	25	18.1	33	17.9	41	18.1	31	17.9	41
21	15.2	18	15.2	18	15.0	24	14.9	31	15.1	21	15.0	28
22	16.6	17	16.6	17	16.4	23	16.2	29	16.5	20	16.4	26
23	20.0	18	20.0	19	19.8	25	19.6	31	19.9	22	19.7	28
24	19.2	17	19.2	17	19.0	24	18.8	30	19.1	20	18.9	26
25	19.5	17	19.5	17	19.3	23	19.1	29	19.4	20	19.2	26

* A-B-C-D

A: % rate applied to annual profits from $10,000 - 1,000,000

B: % rate applied to annual profits from $1,000,000 - 5,000,000

C: % rate applied to annual profits from $5,000,000 - 10,000,000

D: % increase in royalty rate for each $5,000,000 above $10,000,000.

Table 6

Monte Carlo Limits *

% Rate of Return

Alternative Number	Calculated Value	Monte Carlo Values		
		Lower Limit	Mean	Upper Limit
1	17.8	12.5	16.8	21.2
2	19.9	13.3	18.7	24.1
3	27.0	19.0	25.9	32.8
4	24.9	15.9	23.0	30.1
5	25.6	16.0	23.5	31.1
6	19.7	14.4	18.8	23.2
7	22.2	15.7	21.1	26.5
8	29.8	20.3	27.9	35.4
9	27.7	18.5	25.8	33.2
10	28.5	18.7	26.5	34.3
11	14.5	7.3	12.0	16.6
12	15.8	7.9	13.1	18.3
13	18.3	8.3	14.9	21.5
14	17.8	7.9	14.4	21.0
15	18.1	9.4	15.2	21.0
16	14.8	8.2	12.7	17.1
17	16.1	8.8	13.8	18.8
18	18.4	10.5	16.0	21.5
19	18.0	10.2	15.6	21.1
20	18.3	10.3	15.9	21.5
21	15.2	8.8	13.4	18.0
22	16.6	9.3	14.5	19.7
23	20.0	12.3	18.0	23.7
24	19.2	11.4	17.1	22.8
25	19.5	11.3	17.3	23.3

* 90% confidence limits.

9. ANALYSIS OF RESULTS

Comparison with the Parsons' Feasibility Study Results

The rate of return results obtained in the present Government evaluation are more optimistic than those projected in the Parsons' feasibility study.

For example, compare results for base case assumptions (most probable variable values estimated for each evaluation), and the road to Skagway transportation alternative.

	Rate of Return: %	
	Parsons' Results	Government Results
Toll Smelting - Parsons' schedule	14.3-21.4	29.8
Electrolytic Zinc-Blast Furnace Lead	14.0-18.0	18.3
Imperial Smelting Process	13.3-17.6	18.4

There appear to be 3 important factors responsible for the rate of return differentials.

(i) Price

Parsons assumes: Pb: 11-12.5 U.S. ¢/lb.
Zn: 11.5-13.0 U.S. ¢/lb.

Government assumes: Pb: 13.0 U.S. ¢/lb.
Zn: 13.5 U.S. ¢/lb.

The prices used in each case must be estimates of the price or price range that will most probably prevail over the productive life of the project. It is erroneous to discount the price estimate to a 'safe' limit price that can be achieved with confidence. If this is done the resulting rate of return applies to a 'safe' investment, to the extent that marketing uncertainties have already been discounted. Such a rate of return cannot be rationally compared with the inherent project uncertainties because the marketing portion of that uncertainty has already been removed.

The relative price estimates favour higher rates of return in the Government evaluation.

(ii) Transportation Facility and Townsite Capital

The Parsons' evaluation implicitly assumes that the capital costs of the transportation facility (tidewater installation and vehicles excepted) and townsite are borne by the Government. The Government evaluation assumes in the base case that 25 per cent of these capital costs are carried by the firm. This factor favours a higher rate of return in the Parsons' evaluation.

(iii) Tax Allowances

This factor, although less important than price, has a significant effect on rate of return.

Parsons assumes that depreciation for tax purposes is at an annual straight line rate of 5 per cent, except for trucks which are depreciated on a straight line basis over three years. Depreciation allowance for the initial tax-free production years is deferred equally to the fourth and fifth years. Exploration and development expenses are depreciated as a capital cost.

The Government assumes a diminishing balance rate which varies for each alternative within the range 17-29 per cent. No deferred depreciation is allowed for the first three production years. Exploration and development expenses are written-off as soon as possible i.e. in the fourth year.

The more rapid depreciation allowed in the government analysis favours higher rates of return.

There are several other differences between the two evaluations which account for less significant differences in rate of return: interest charges on working capital, power costs, taxation rate, etc.

Comparison of Toll Smelting and Processing to Metal Alternatives

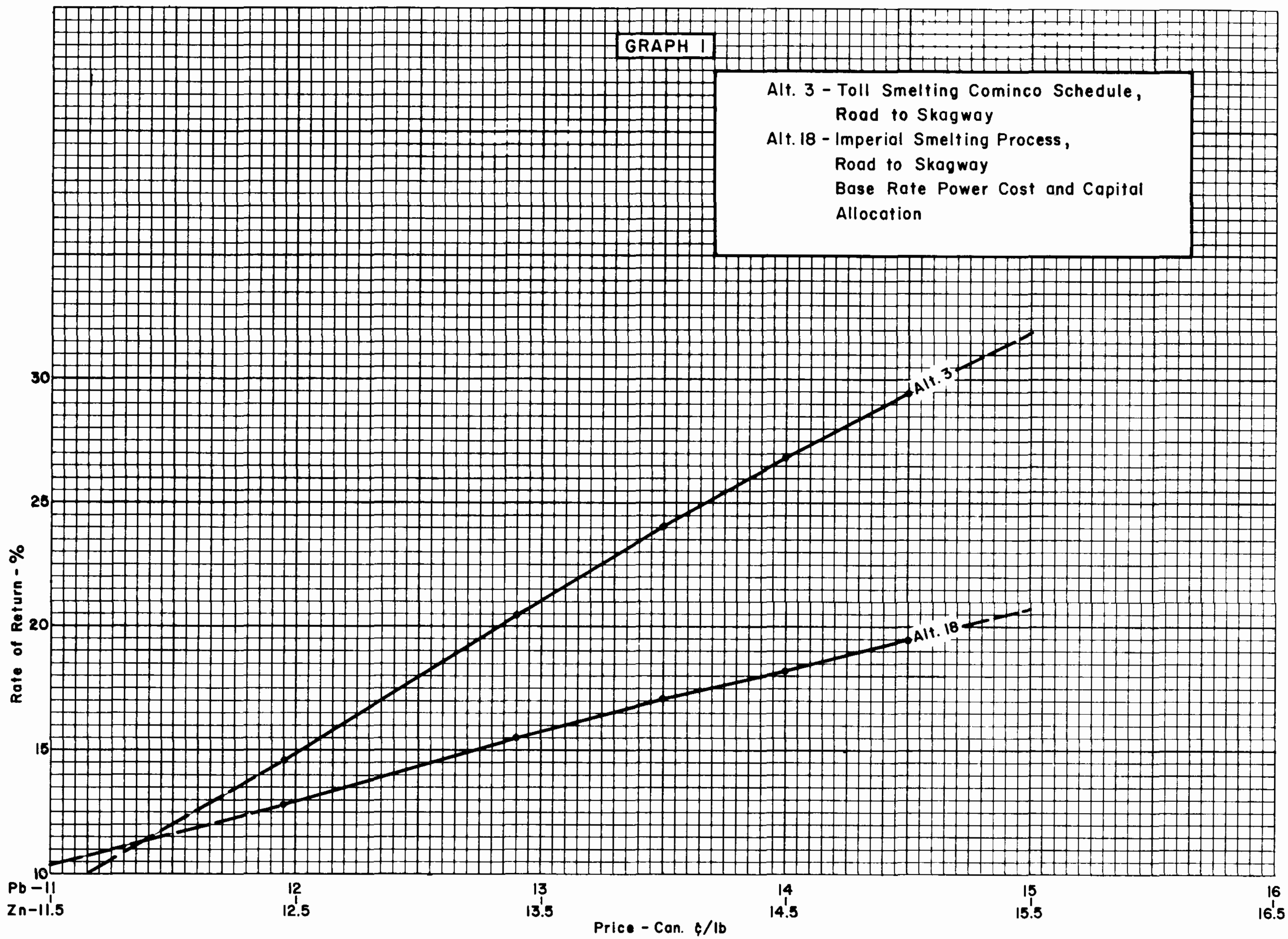
The shipment of selective concentrates for toll smelting realizes a considerably higher rate of return than processing to metal for the probable range of prices considered. The preference widens as price increases.

The complete set of results is shown in Tables 1 and 2. An example is illustrated in Graph 1. Rates of return for the least attractive smelter schedule, COMINCO, are compared with rates of return for the most attractive processing to metal alternative, the imperial smelting process, over the probable range of prices. The optimum transportation is assumed; the all road route to Skagway.

The greater rates of return for the toll smelting of concentrate alternatives can be understood when it is realized that for this project and the probable range of market prices, the mining and milling functions are considerably more profitable than the smelting and refining functions. Processing to metal by Anvil results in transportation cost savings and captures the profit margin of the toll smelter. However, these benefits are relatively small in relation to the aggregate investment required to effect them. For example, a rate or return analysis using cash flow and investment estimates from Parsons' preliminary feasibility study, subdivides the electrolytic zinc-blast furnace lead process into mining-milling and smelting-refining functions for lead at 12.5 U.S. ¢/lb. and zinc at 13 U.S. ¢/lb. (p. 111) The following rates of return result:

mining-milling -	21.4%
smelting-refining -	11.4%
combined return -	18.0%

The rate of return differential between concentrate and metal alternatives widens with increasing price because a fixed increase in aggregate revenue (resulting from the same increase in market price for both alternatives) has a greater impact on the rate of return of a smaller investment than the rate of return of a larger investment. Other things


GRAPH I
Alt. 3 - Toll Smelting Cominco Schedule, Road to Skagway
Alt. 18 - Imperial Smelting Process, Road to Skagway
Base Rate Power Cost and Capital Allocation
Alt. 3
Alt. 18
Rate of Return - %
10
15
20
25
30
Pb - 11
Zn - 11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
Price - Can. ¢/lb

being equal, as price increases the increase in returns (cash flow minus capital investment totalled over the life of the project i.e. undiscounted surplus or profit) per unit of investment is inversely proportional to the aggregate level of investment. For the Anvil Project the processing to metal alternatives necessitate an investment approximately twice as large as the investment required for the toll smelting of selective concentrates. A given increase in price does not realize a fixed increase in revenue for the two alternatives however. The revenue increase for the toll smelting of concentrates alternative would be somewhat less because net smelter returns are usually based on a fixed per cent of market price and the toll smelter, therefore, shares to some extent in price increase benefits. This revenue differential is much less significant than the investment differential.

Alternatively, a break-even point in price may be reached below which the metal alternative projects a greater rate of return than the concentrate alternative (see Graph 1 as an illustration). This differential widens as price decreases. However, the break-even price for this project is sufficiently low to be considered outside the range of probable lead-zinc prices with some confidence. For the illustrated example the break-even prices are 11.4 ¢/lb. for lead and 11.9 ¢/lb. for zinc.

Besides the rate of return argument analyzed above there are five other factors which, from the firm's point of view, mitigate against the processing to metal alternative:

(i) The preference for the toll smelting of concentrate alternative becomes more pronounced than the rate of return differential if the marketing of metals is more uncertain than the marketing of concentrates. (See Sections 3 and 4 for the implications and general outline of this argument)

(ii) The processing to metal alternative requires an investment of $100-130 million while the toll smelting alternative requires $50-60 million. Apart from a decision on the basis of rate of return, the firm will have financial constraints which depending on their magnitude will result in some increase in preference for the lower investment toll smelting alternative.

(iii) The technical feasibility of processing Anvil concentrate products by the imperial smelting process or electrolytic zinc-blast furnace lead process have not at this stage been established by the company.

(iv) The concentrate content assumed in the calculations were those resulting from the initial flotation tests (55% lead, 52% zinc). As is mentioned in Parsons' preliminary feasibility study(PFS: 3-3) more recent tests have indicated the possibility of recovering higher quality selective concentrates (70% lead, 55% zinc). The realization of such qualities would increase the relative attractiveness of the toll smelting alternative both through decreased transportation costs and increased net smelter returns.

(v) The rate of returns calculated are not certain, they represent most probable estimates. The 90% lower confidence limit, calculated by Monte Carlo analysis, is another useful indicator of the relative attractiveness of alternatives. It should be cautioned that the basis for these estimates is largely subjective and that the results are, therefore, only indicators. For the base case, assuming the most attractive transportation alternative (all road route to Skagway), the lower confidence limit for concentrate alternatives ranges from 19 to 21%, and for the metal alternatives the range is 8 to 11%. (See Table 6) The lower limits are proportionally lower for the metal alternative. This reflects the greater market uncertainties for metal compared to concentrates, an argument that was set forward in (i). Comparing for example, the toll smelting alternative using the COMINCO smelter schedule (alternative 3) with the imperial smelting process (alternative 18), for base case conditions and the all road route to Skagway:

	Alternative 3	Alternative 18
calculated value - rate of return: %	27.0	18.4
90% lower confidence limit: %	19.0	10.5
percentage decrease	-30 %	-43 %

While the lower confidence limit still affords the concentrate alternative with a fair return, the lower confidence limit rate of return for the metal alternative is unattractive for a mineral development opportunity.

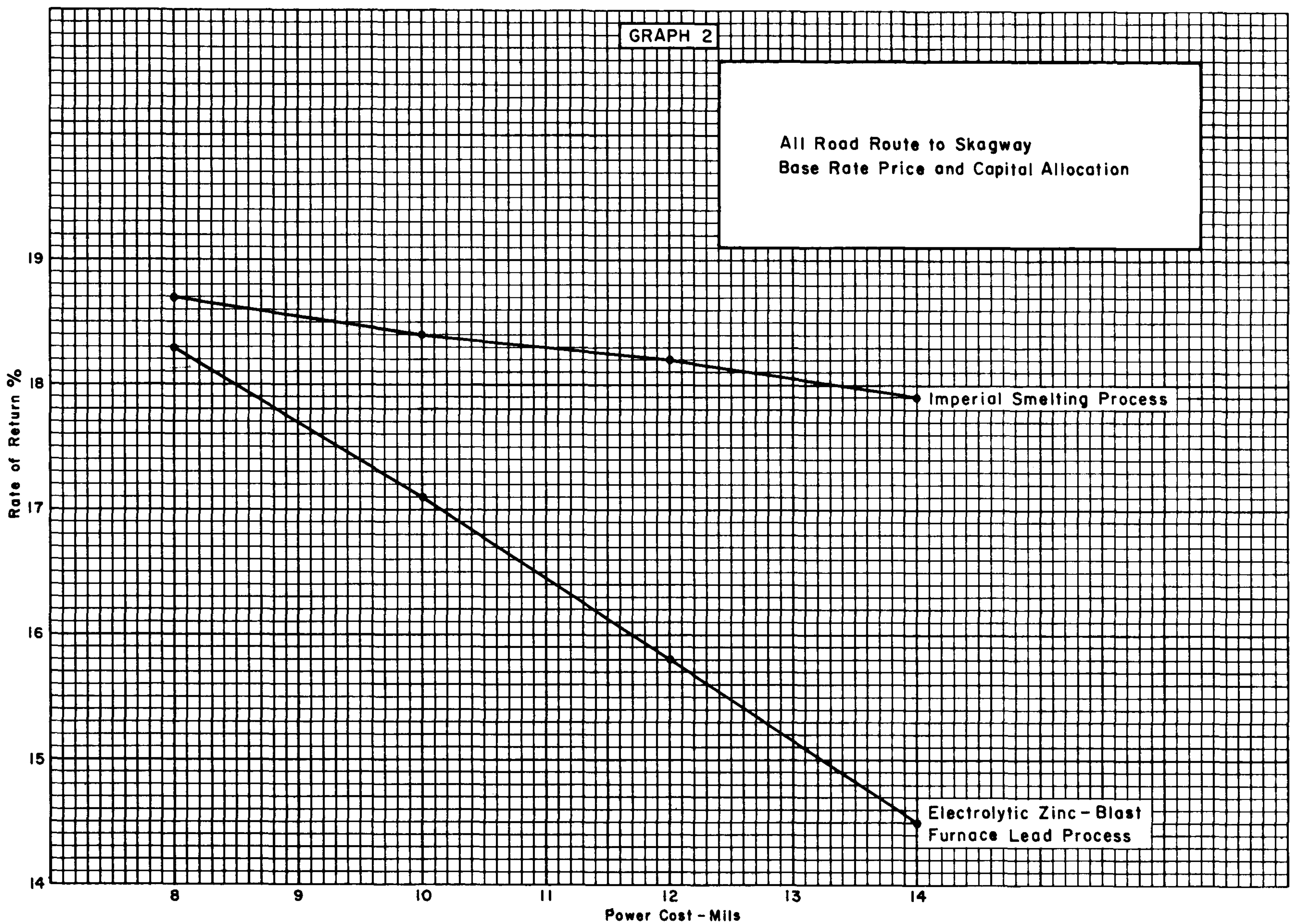
From the firms point of view there is one argument in favour of the processing to metal alternative. If market conditions became depressed, the more forward integrated the firm, the better are its chances of retaining markets.

Since the cumulative effect of these other factors also weigh heavily in favour of the toll smelting of concentrate alternative, it would appear that the firm could make a decision solely on the basis of rate of return, as this factor alone offers large investment benefits compared to the processing to metal alternative.

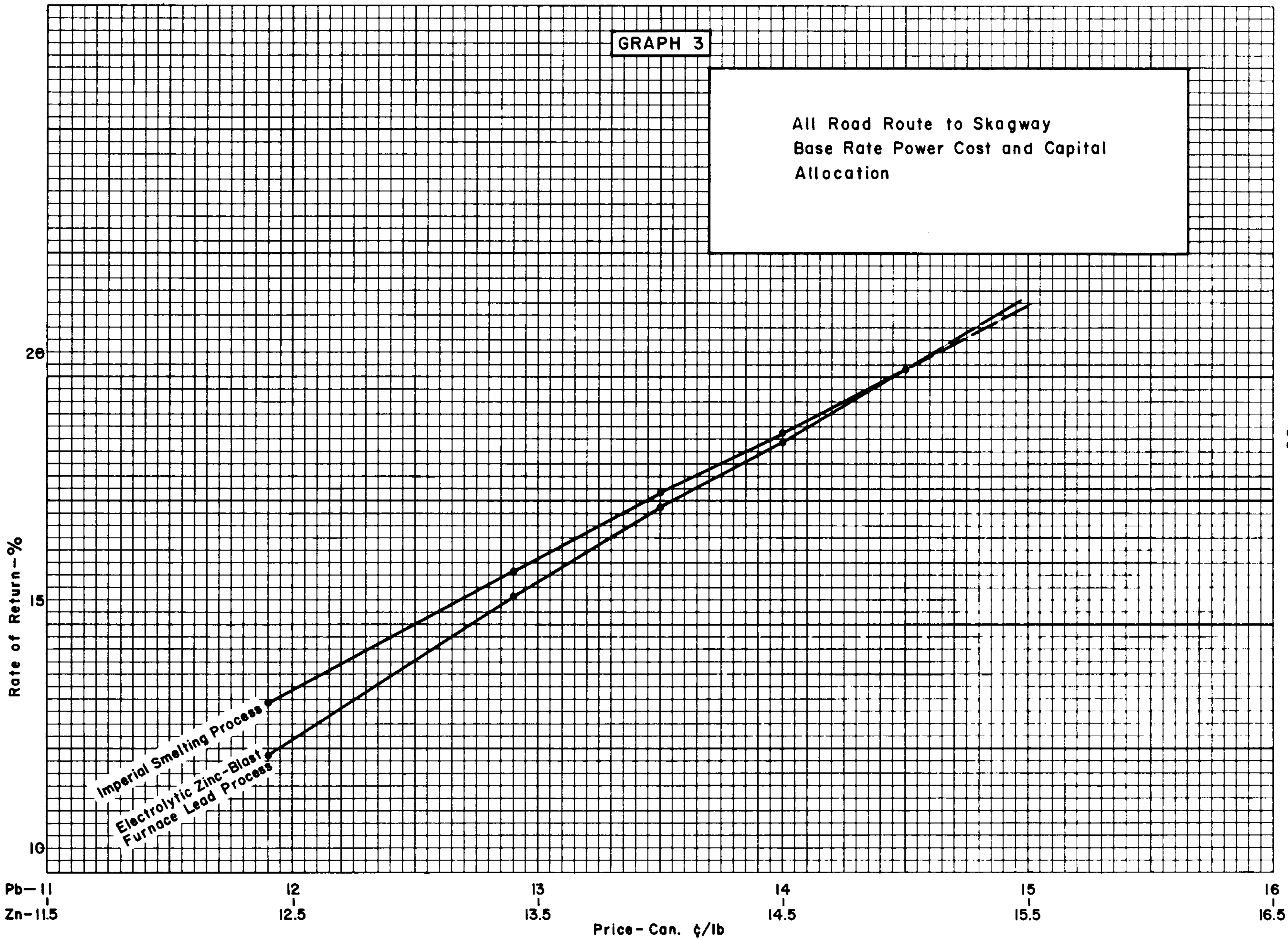
Processing to Metal Alternatives

In the base case and for most of the variations considered, the imperial smelting process projects a slightly higher rate of return than the electrolytic zinc-blast furnace lead alternative. (see Tables 1-6)

As power costs represent a higher proportion of total operating cost in the electrolytic zinc-blast furnace lead alternative, the rate of return differential between the two alternatives widens in favour of the imperial smelting process as power costs increase. The example shown in Graph 2 plots rate of return for the two processing to metal alternatives against power cost for the optimum transportation alternative, the all road route to Skagway, at the base rate price and capital allocation. It is evident from the relative slopes of the curves that the electrolytic zinc-



GRAPH 2
All Road Route to Skagway
Base Rate Price and Capital Allocation
Imperial Smelting Process
Electrolytic Zinc - Blast Furnace Lead Process
Rate of Return %
19
18
17
16
15
14
8
9
10
11
12
13
14
Power Cost - Mils


GRAPH 3
All Road Route to Skagway
Base Rate Power Cost and Capital
Allocation
Imperial Smelting Process
Electrolytic Zinc-Blast Furnace Lead Process
Rate of Return-%
20
15
10
Pb-11
Zn-11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
Price-Can. ¢/lb

blast furnace lead rate of return is more sensitive to changes in power cost than that of the imperial smelting process. In this area of the Yukon power costs are expected to be relatively high, but are expected to be less expensive for the electrolytic zinc-blast furnace lead alternative because of the economies of scale attending its greater demand. In the rate of return calculations 8 mil power has been assumed as most probable for the electrolytic zinc-blast furnace lead process and 10 mil power most probable for the imperial smelting process.

The rate of return premium for the imperial smelting process decreases as price increases and above a break-even price the electrolytic zinc-blast furnace lead alternative is preferred. The example shown in Graph 3 plots rate of return for the two processing to metal alternatives against price for the all road route to Skagway, at base rate prices and capital allocations. The break-even prices, 14.5 Can. ¢/lb. for lead and 15.0 Can. ¢/lb. for zinc, lie at the upper bound of the probable range of market prices. Within this range therefore, the imperial smelting process is preferred. The diminishing attractiveness of the imperial smelting process with increasing price is largely due to the relatively smaller quantities of marketable metal recovered. For instance, the estimated recoveries from the two processes, from an identical ore input, for the first five years of production are:

	Pig Lead tpy	Slab Zinc tpy
Electrolytic Zinc - Blast Furnace Lead	78,335	117,163
Imperial Smelting	74,793	112,447

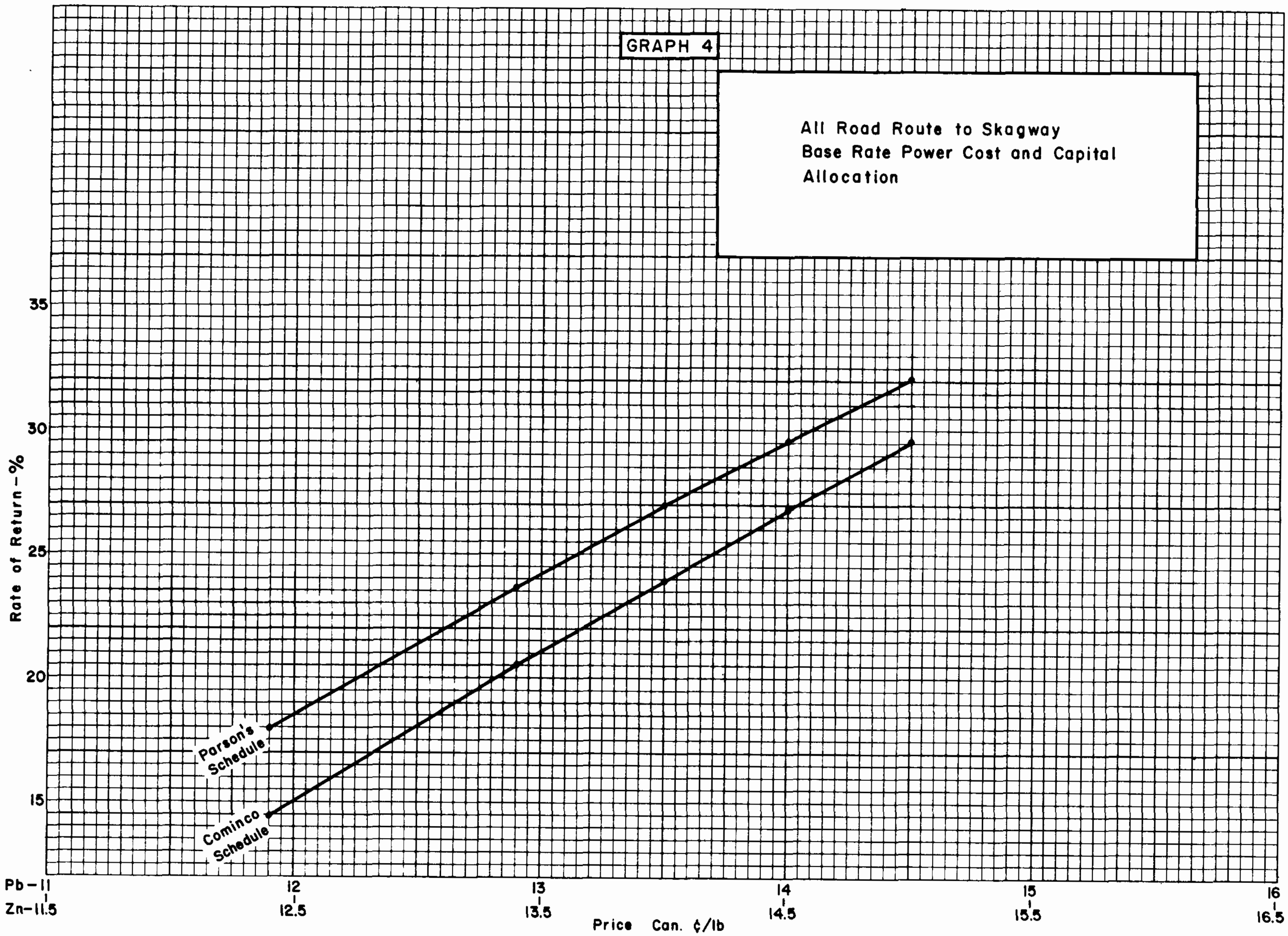
The differences in recovery became more valuable as prices increase.

Toll Smelting Alternatives

The Parsons' synthesized toll smelter schedule yields significantly higher rates of return than the COMINCO smelter schedule; 2 to 4 per centage points on an absolute rate of return basis. (see Tables 1-6)

The example shown in Graph 4 plots rate of return against price for the two smelter schedules assuming the optimum transportation alternative, the all road route to Skagway, and the base rate power cost and capital allocation. As price increases, the rate of return differential narrows.

The comparison made is hypothetical. It assumes that the COMINCO schedule is operative at those same points in the U.S. and Japan where the Parsons' schedule is assumed to apply. The comparison illustrates therefore, that other things being equal, net smelter returns from the Parsons' schedule are significantly higher than those realized from the COMINCO schedule. A more realistic comparison would consider other factors than the smelter schedules per se. COMINCO returns would be realized at Trail, B.C., the Parsons' schedule would be operative at the assumed smelting points in the U.S. and Japan. For the Anvil project, the Parsons' schedule would still realize higher net smelter returns but against these one would have to charge higher transportation costs and the tariff charges resulting from the import of lead and zinc concentrates into the U.S. These costs would certainly reduce the attractiveness of the Parsons' schedule to Anvil and might render the COMINCO schedule preferable.

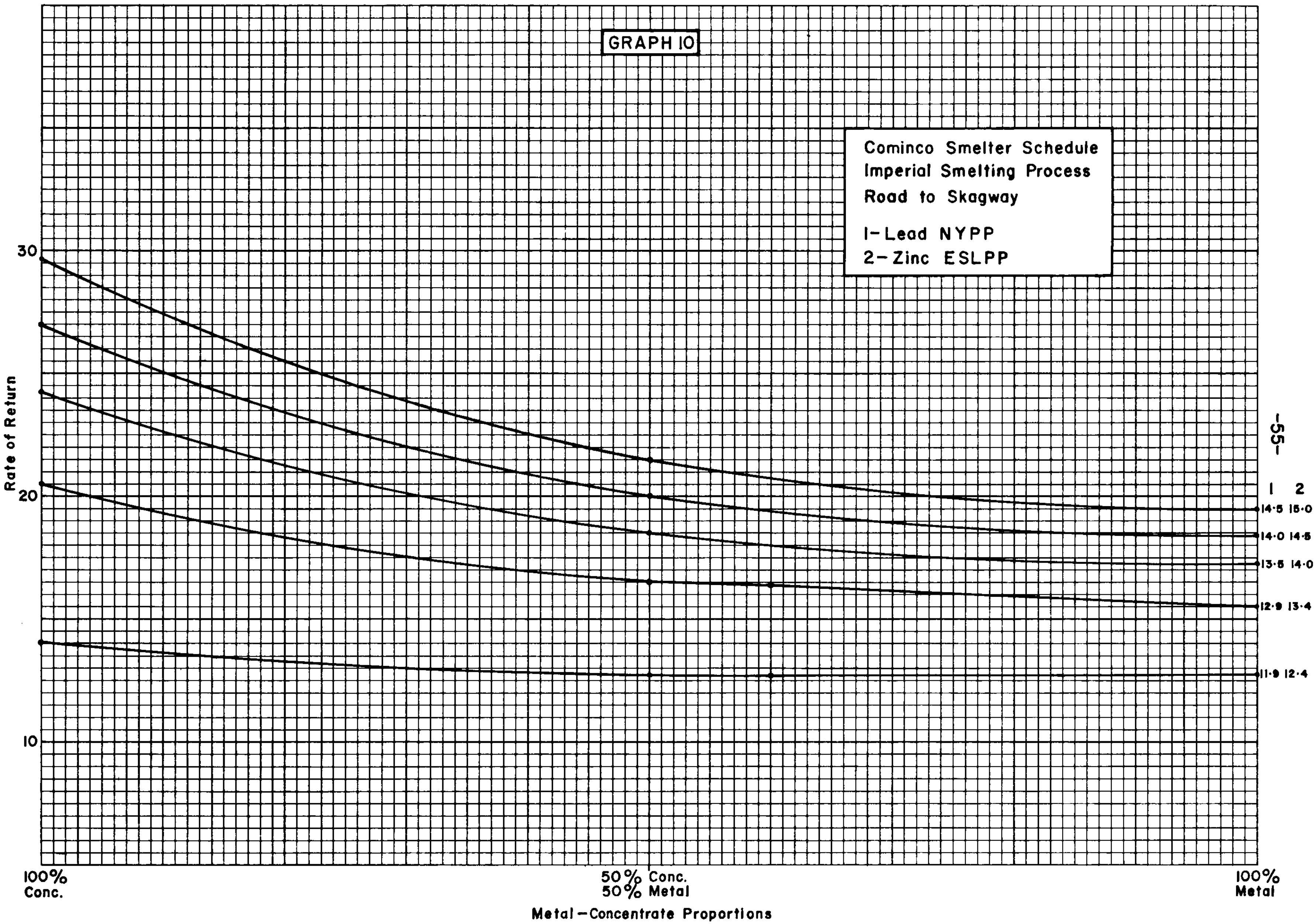

GRAPH 4
All Road Route to Skagway
Base Rate Power Cost and Capital
Allocation
Rate of Return-%
35
30
25
20
15
Parson's Schedule
Cominco Schedule
Pb-11
Zn-11.5
12
12.5
13
13.5
14
14.5
15
15.5
16
16.5
Price Can. ¢/lb

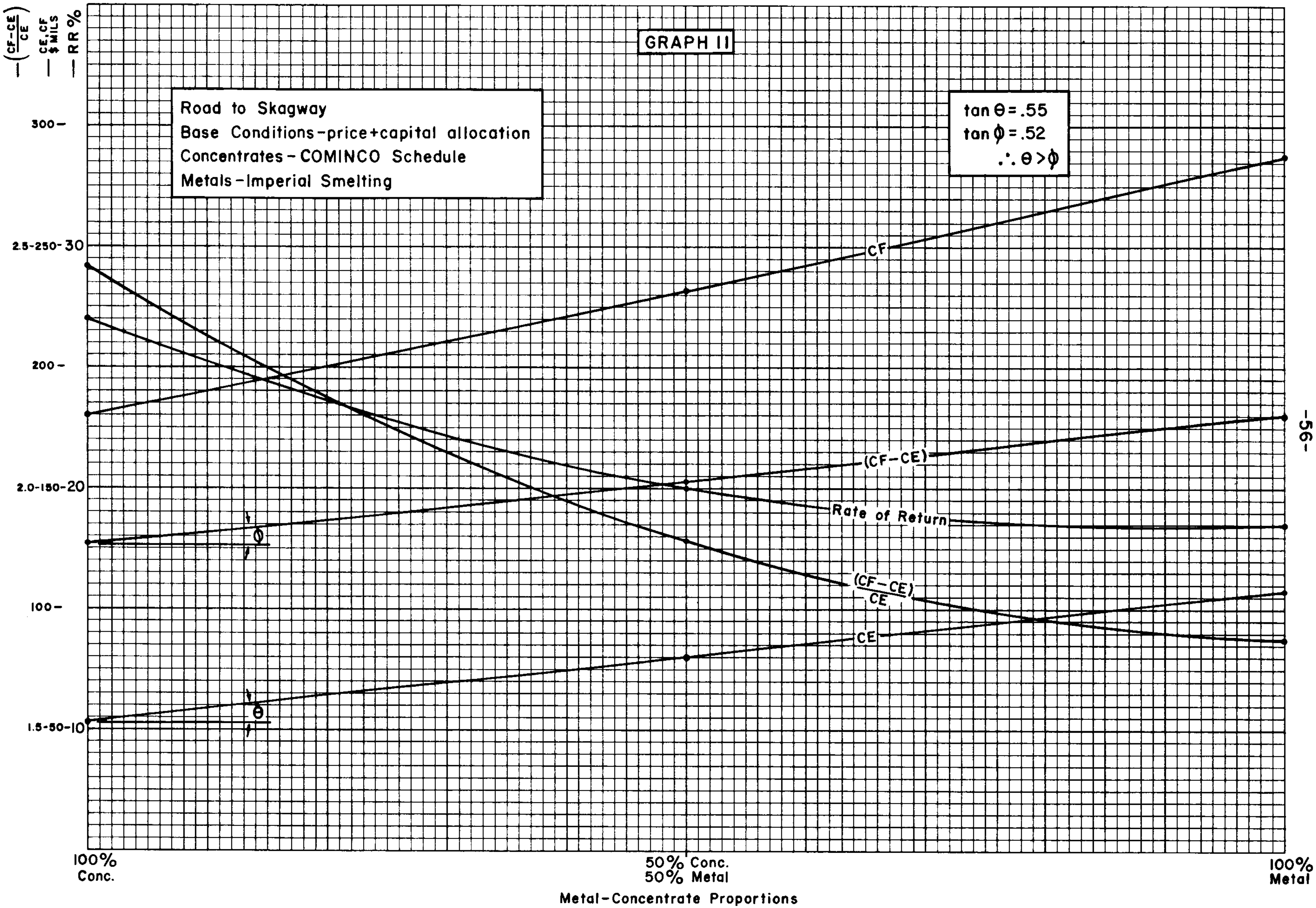
The Mixed Case

The mixed case was designed to balance the high rates of return of the toll smelting alternatives against the development advantages that might accrue from smelting and refining installations in a remote region that showed good potential for the creation and development of other mineral opportunities; a balance between firm and national objectives. The results are disappointing because the rates of return for the mixed case are much closer to the processing to metal rates of return than to the toll smelting rates of return. (see Table 1)

Graph 10 for example, plots rate of return against metal-concentrate proportion. The COMINCO schedule is assumed for the toll smelting of concentrates and the imperial smelting process for the production of metal. The road to Skagway is the assumed transportation alternative and curves are plotted for the different price structures. The rate of return decreases at a decreasing rate from the 100% concentrate to the 100% metal alternative.

In determining the input figures for the mixed case it was assumed that both capital costs and operating costs increased linearly from the 100% concentrate alternative and the 100% metal alternative. Following from this, cash flow and returns (cash flow minus capital cost) also increase linearly. One might expect then that rate of return would respond linearly, increasing or decreasing depending on the relationship between the rate of increase of returns and the rate of increase of capital cost. This is not so, as is illustrated in Graph 11 for the base price, other variables fixed as in Graph 10. Rate of return decreases at a decreasing rate.


GRAPH 10
Cominco Smelter Schedule
Imperial Smelting Process
Road to Skagway
1-Lead NYPP
2-Zinc ESLPP
Rate of Return
30
20
10
1 2
14·5 15·0
14·0 14·5
13·5 14·0
12·9 13·4
11·9 12·4
100% Conc.
50% Conc. 50% Metal
100% Metal
Metal-Concentrate Proportions

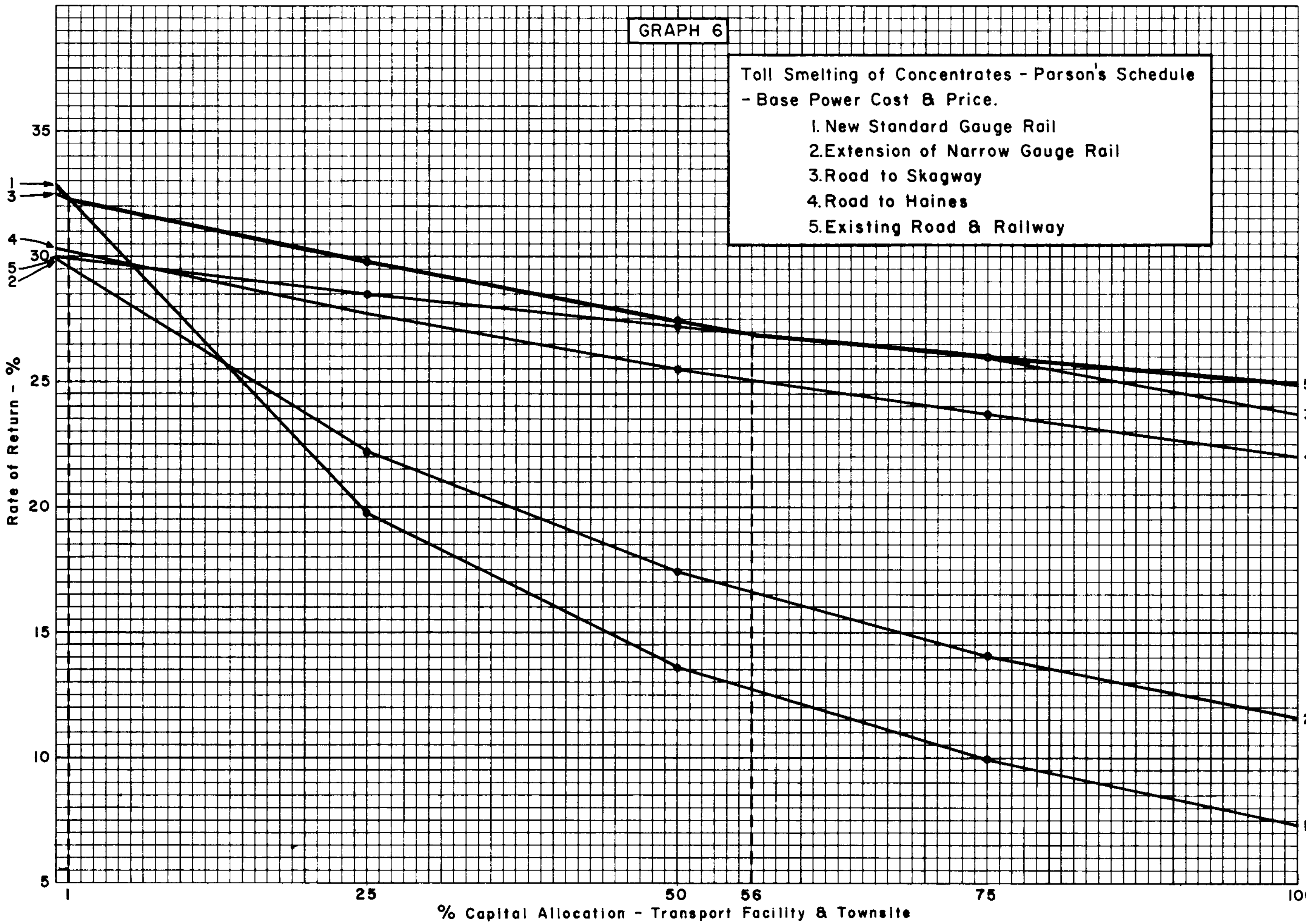

GRAPH II
Road to Skagway
Base Conditions-price+capital allocation
Concentrates-COMINCO Schedule
Metals-Imperial Smelting
tan Θ=.55
tan ϕ=.52
∴ Θ>ϕ
(CF-CE)/CE
CE, CF $ MILS
RR %
300-
2.5-250-30
200-
2.0-150-20
100-
1.5-50-10
CF
(CF-CE)
Rate of Return
(CF-CE)/CE
CE
ϕ
Θ
100% Conc.
50% Conc. 50% Metal
100% Metal
Metal-Concentrate Proportions

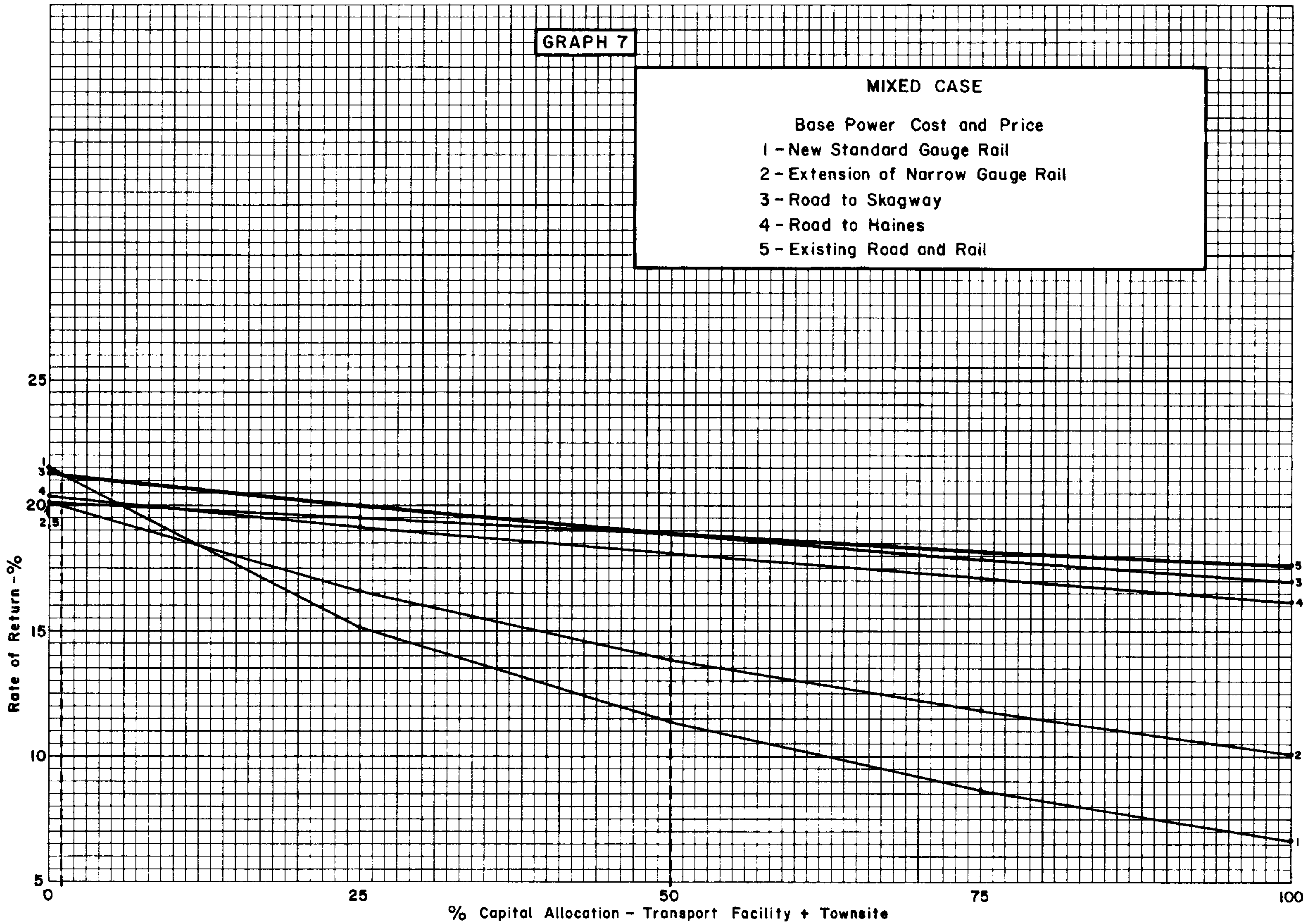
Rate of return is a time dimensioned measure of returns per unit of capital expenditure. In this case the rate of increase in returns is less than the rate of increase in capital expenditure (i.e. $\theta > \phi$ in Graph 11) and therefore CF-CE/CD and rate of return both decrease and at a decreasing rate. A general proof has been worked for this phenomena. In the example rate of return does not decrease as rapidly as the CF-CE/CE ratio because cash flow is not distributed evenly through the time interval: higher cash flows are realized in early years than in later years due to tax incentives and production scheduling. The mixed case does not offer a much higher rate of return than the 100% metal alternative. In Graph 11, the mixed case returns 20.0% compared to the 100% metal's 18.4%, and the 100% concentrate's 27.0%. If Anvil is to process its concentrates then there is no great rate of return incentive for processing less than the entire production. Such a strategy would give the firm greater marketing flexibility however. To process less than 50% of the concentrate production in an attempt to realize a larger rate of return would probably violate the minimum scale of plant constraint for lead-zinc smelting and refining.

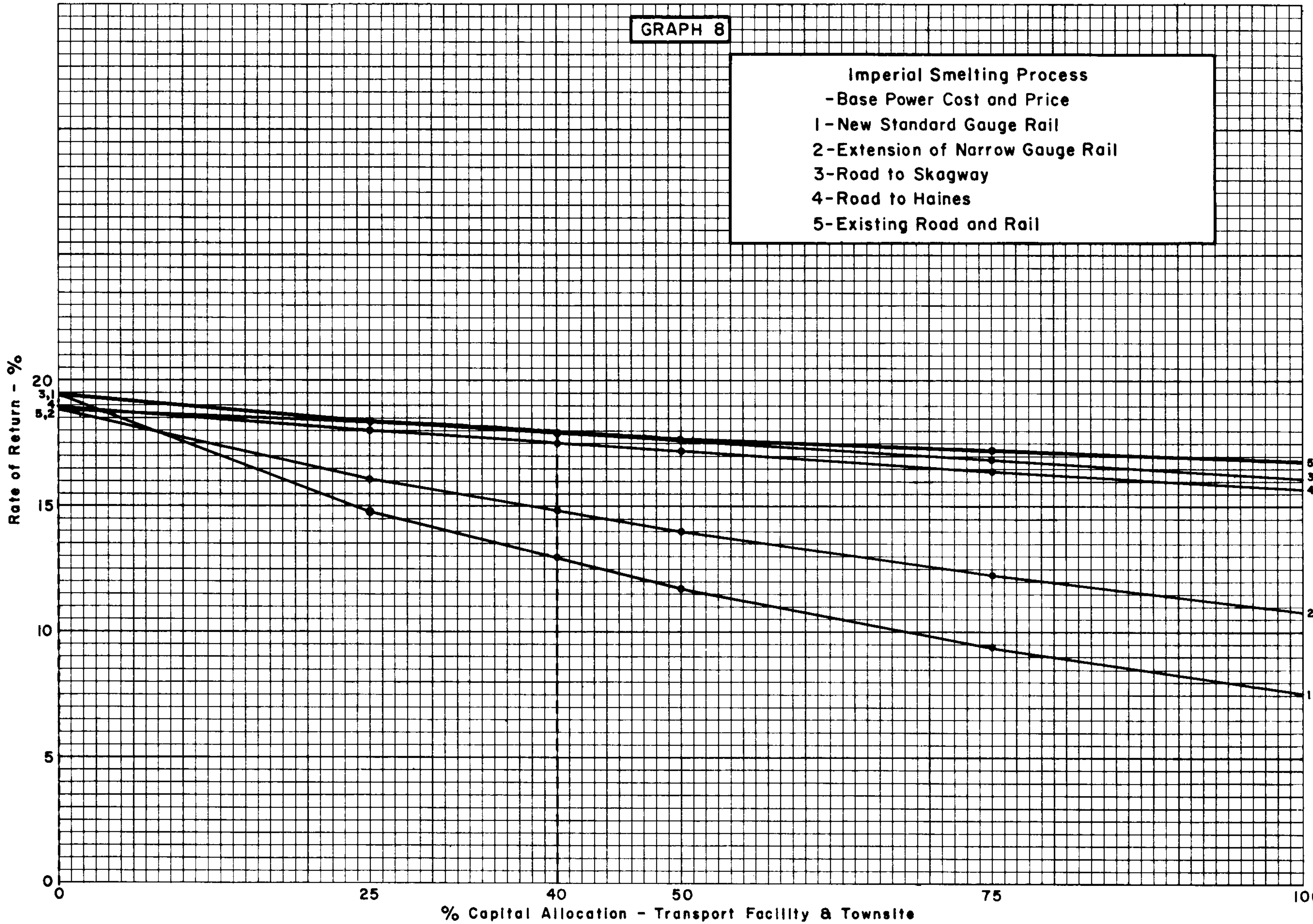
Transportation Alternatives

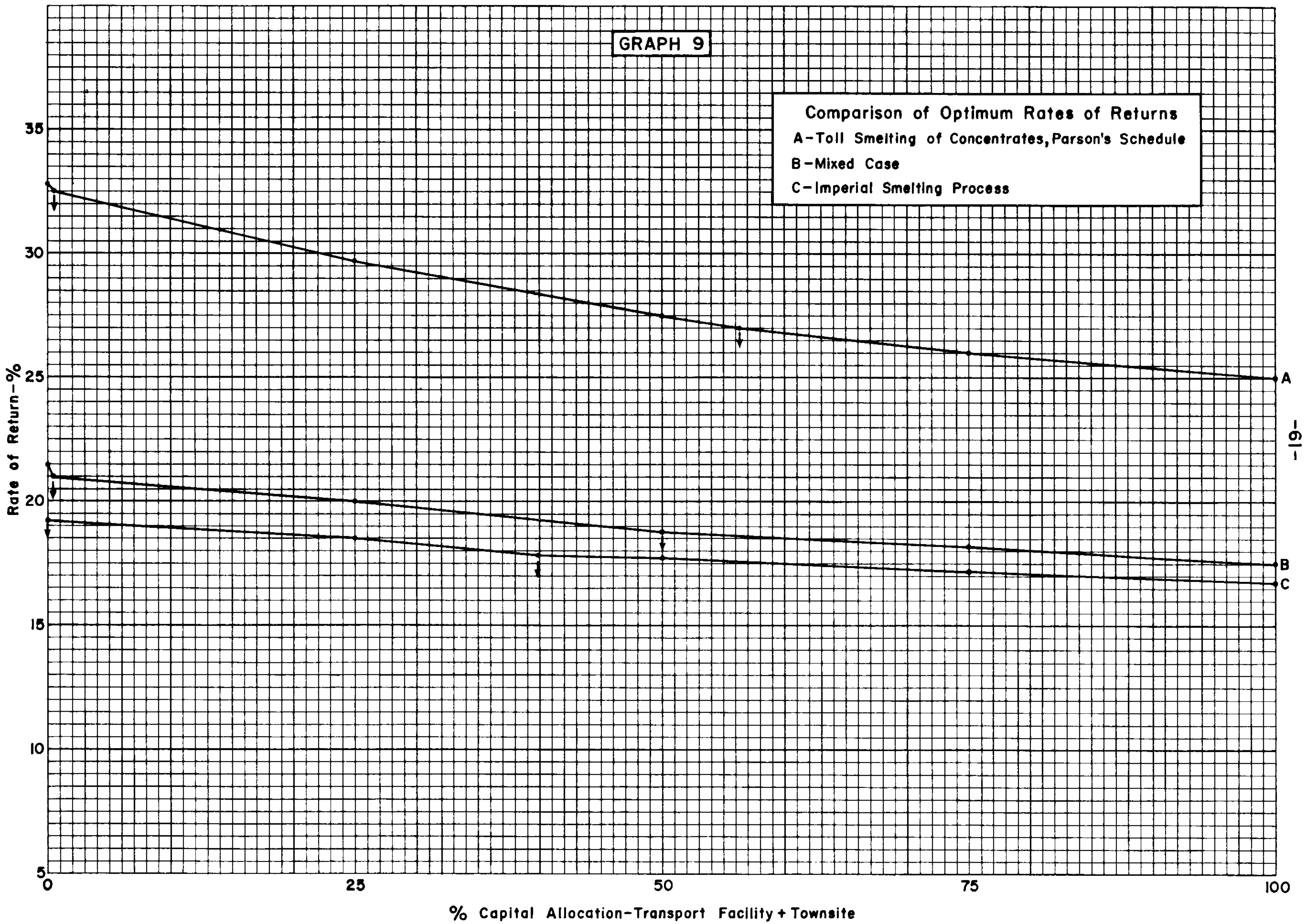
From the firm's point of view there are three critical transportation alternatives; a new rail line from tidewater, the all road route to Skagway, and the existing road-rail route. The optimum from among these is dependent on both the process selected and the percentage allocation of the basic transportation facility and townsite capital costs to the firm. (see Table 4)

Graphs 6 to 8 plot rate of return against percentage capital allocation for the five transportation alternatives, for three processing


GRAPH 6
Toll Smelting of Concentrates - Parson's Schedule
- Base Power Cost & Price.
1. New Standard Gauge Rail
2. Extension of Narrow Gauge Rail
3. Road to Skagway
4. Road to Haines
5. Existing Road & Railway
Rate of Return - %
35
30
25
20
15
10
5
1
25
50
56
75
100
% Capital Allocation - Transport Facility & Townsite
1
3
4
5
2
5
3
4
2
1


GRAPH 7
MIXED CASE
Base Power Cost and Price
1 - New Standard Gauge Rail
2 - Extension of Narrow Gauge Rail
3 - Road to Skagway
4 - Road to Haines
5 - Existing Road and Rail
Rate of Return - %
% Capital Allocation - Transport Facility + Townsite
5
10
15
20
25
0
25
50
75
100


GRAPH 8
Imperial Smelting Process
-Base Power Cost and Price
1-New Standard Gauge Rail
2-Extension of Narrow Gauge Rail
3-Road to Skagway
4-Road to Haines
5-Existing Road and Rail
Rate of Return - %
20
15
10
5
0
3,1
4
5,2
5
3
4
2
1
0
25
40
50
75
100
% Capital Allocation - Transport Facility & Townsite


GRAPH 9
Comparison of Optimum Rates of Returns
A-Toll Smelting of Concentrates, Parson's Schedule
B-Mixed Case
C-Imperial Smelting Process
Rate of Return-%
35
30
25
20
15
10
5
0
25
50
75
100
A
B
C
% Capital Allocation-Transport Facility + Townsite

alternatives; toll smelting using the Parsons' schedule, the imperial smelting process and the mixed case. For very low capital allocations, the new standard gauge rail line offers the highest rate of return; in the middle range of capital allocations, the road to Skagway is optimum; and for high capital allocations, the existing road and rail route offers the highest rate of return. In no instance are either the extension of the existing narrow gauge rail line or the road to Haines critical transportation alternatives.

For each process, the slope of the rate of return curve for a given transportation alternative is dependent on the capital cost of that facility, townsite capital representing a fixed cost for each processing alternative. Rate of return is inversely proportional to capital investment. Therefore, other costs being equal, the transportation alternative with the largest capital cost will yield a rate of return which is most sensitive to the percentage capital allocation. Sensitivity, measured by the slope of the rate of return curve, is a function of the capital cost of the transportation facility. This explains why the new standard gauge rail can be both the most preferred alternative at 0% capital allocation and the least preferred at 100% capital allocation. It is preferred initially because of lower operating costs but these benefits are rapidly cancelled by the greater investment burden, relative to other transportation alternatives, which is levied with increasing percentage capital allocation. Above 1% capital allocation, the road to Skagway is the preferred alternative; operating costs are higher but this additional cost is less than the difference in capital cost between this lower cost alternative and the higher capital cost rail alternative, on a time value rate of return basis. For similar reasons as capital allocation increases in the range 40 to 56% the existing road-rail route becomes preferred over the road to Skagway alternative. At break even points, the higher investment from one transportation alternative just balances the higher operating costs of another on a rate of return basis. Operating costs are fixed for each transportation alternative and when percentage capital allocation increases beyond the operating cost differential, the alternative with the high operating cost is preferred.

Between processing alternatives, for any given transportation alternative, the sensitivity of rate of return to changes in the percentage capital allocation is dependent on the total estimated investment for that process. Slopes, therefore, steepen from the imperial smelting process to the toll smelting of concentrates alternative, as the total investment approximately halves. This phenomena is shown in Graph 9 which plots the optimum rates of return against percentage capital allocation for each process. The graph also shows a shift to the left in break even points from toll smelting to the mixed case to the imperial smelting process. This shift is due to differences in tonnage moved between the three alternatives. Toll smelting accounts for the largest tonnage and, therefore, a higher investment differential (i.e. higher % capital allocation) will be required for a transportation alternative with lower operating costs to balance with an alternative having higher operating costs, because the aggregate operating cost differential is higher due to the larger tonnage. As transported tonnage declines from toll smelting to the mixed case to the imperial smelting process, the break even points shift to the left.

It can be seen from Graphs 6-8 that in most instances the optimum transportation alternative does not offer a significantly higher rate of return compared to other alternatives. For low percentage capital allocations (0-1%) the road to Skagway gives only slightly lower rates of return than the new standard gauge rail line. In the middle and upper ranges of percentage capital allocation there is not a great deal of difference between the road to Skagway facility and the existing road-rail alternative. It should be borne in mind that the transportation alternatives compared involve estimated capital expenditures of $120,000,000; $12,000,000; and $3,800,000 respectively. Even if the firm bears none of the cost of a $120,000,000 rail line, the lower operating costs will constitute a paltry incentive in terms of rate of return because of the relatively small tonnages moved. Between low and high capital cost transportation alternatives one is considering savings in the order of $3/ton transported on at most 350,000 tons per year - an increase in net cash flow of about - $700,000 per year compared to total cash flows in the range of $8,000,000 - $25,000,000. The benefit of this increased cash flow in terms of rate of return is, therefore, small.

Rail lines offer scale economies, but for the Anvil Project the tonnages will not be forthcoming to realize these benefits and, therefore, for this project alone the rail line is not justified in that it does not provide a significant development incentive. A lower capital cost transfortation alternative, either the road to Skagway or the existing road-rail route, would be more in balance with the estimated tonnages.

Apart from the Anvil project other national benefits may be derived from a high capital cost transportation facility, in terms of increasing economic development and employment in this remote area. A detailed benefit-cost analysis of other development potential in the region would be required as the rational basis for such a decision.

It has been assumed that under any given set of conditions Anvil will select that transportation alternative which offers the greatest rate of return. Graphs 6-8 show that government provision of transportation facility and townsite, either all or in part, influences, but is not critical to, the development potential of this project. As the firm assumes a greater proportion of the capital cost of transportation facility and townsite, optimum transportation alternatives change and rate of return is reduced, but not critically. The following table shows rates of return for graphed processes, optimum transportation alternatives and extreme capital allocations:

	0%	100%
Toll Smelting	32.8	24.9
Mixed Case	21.5	17.6
Imperial Smelting	19.4	16.8

It does not appear that the provision of transportation facility and a townsite by the Government would be a critical factor in the development of this project to production, although, undoubtedly, such provisions would render the opportunity even more attractive to investors.

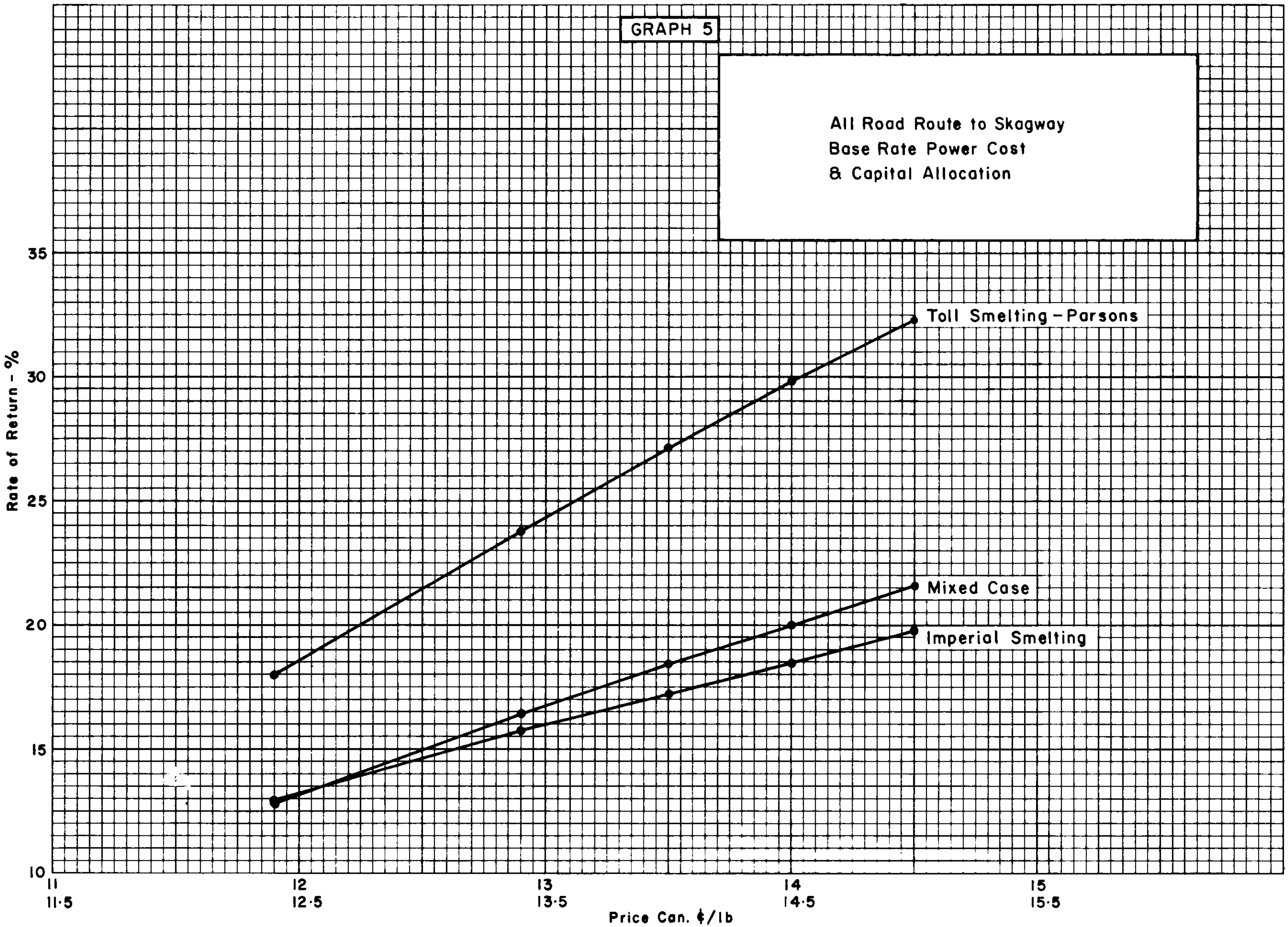
Price Variations

Rate of return is very sensitive to price changes which have a pronounced multiplier effect. A given percentage increase in price will raise rate of return much more than that proportion. (see Table 2, Since rate of return is so sensitive to price changes, a good price estimate is critical to the analysis. Unfortunately the forecasting of lead-zinc prices is fraught with uncertainties.

An example shown in Graph 5 plots rate of return against price for three alternatives: toll smelting using the Parsons' schedule, the imperial smelting process, and the mixed case. The optimum transportation alternative, the all road route to Skagway, is assumed and the base rate power costs and capital allocations apply. Within the probable range of prices there are wide variations in the rate of return. Depending on the price assumed within this range, the attractiveness of the investment opportunity varies from fair to excellent. The multiplier effect accounts for the fact that increasing the market price of lead from 12 to 14.5 Can. ¢/lb. and zinc from 12.5 to 15 Can. ¢/lb., through the range of probable prices, or in other words by about 20 per cent, increases rate of return by the following percentages:

Toll Smelting:	79%
Mixed Case:	69%
Imperial Smelting Process:	53%

Any change of variable that increases cash flow increases the rate of return, assuming no additional investment is required. Any change of variable that increases the ratio of cash flow to the estimated value of that variable, produces a multiplier effect not only on cash flow but also on rate of return. Rate of return is directly related to cash flow if investment is assumed constant, i.e. rate of return varies as (cash flow-investment) /investment, with a time value dimension effecting the equality. To show the presence of a multiplier effect one must therefore show that increasing price increases the ratio of cash flow to revenue. Consider the incremental values of a price increase. The resulting incremental revenue must bear none of the normal operating charges, it must only bear tax and royalty payments. Neglecting royalty payments, and assuming depletion allowance at $33\frac{1}{3}$ per cent and federal tax at 50 per cent of net income after depletion, an increase in price that


GRAPH 5
All Road Route to Skagway
Base Rate Power Cost
& Capital Allocation
Toll Smelting – Parsons
Mixed Case
Imperial Smelting
Rate of Return – %
35
30
25
20
15
10
11
11·5
12
12·5
13
13·5
14
14·5
15
15·5
Price Can. ¢/lb

realizes an incremental revenue of 100 would increase cash flow by 66-2/3 as follows:

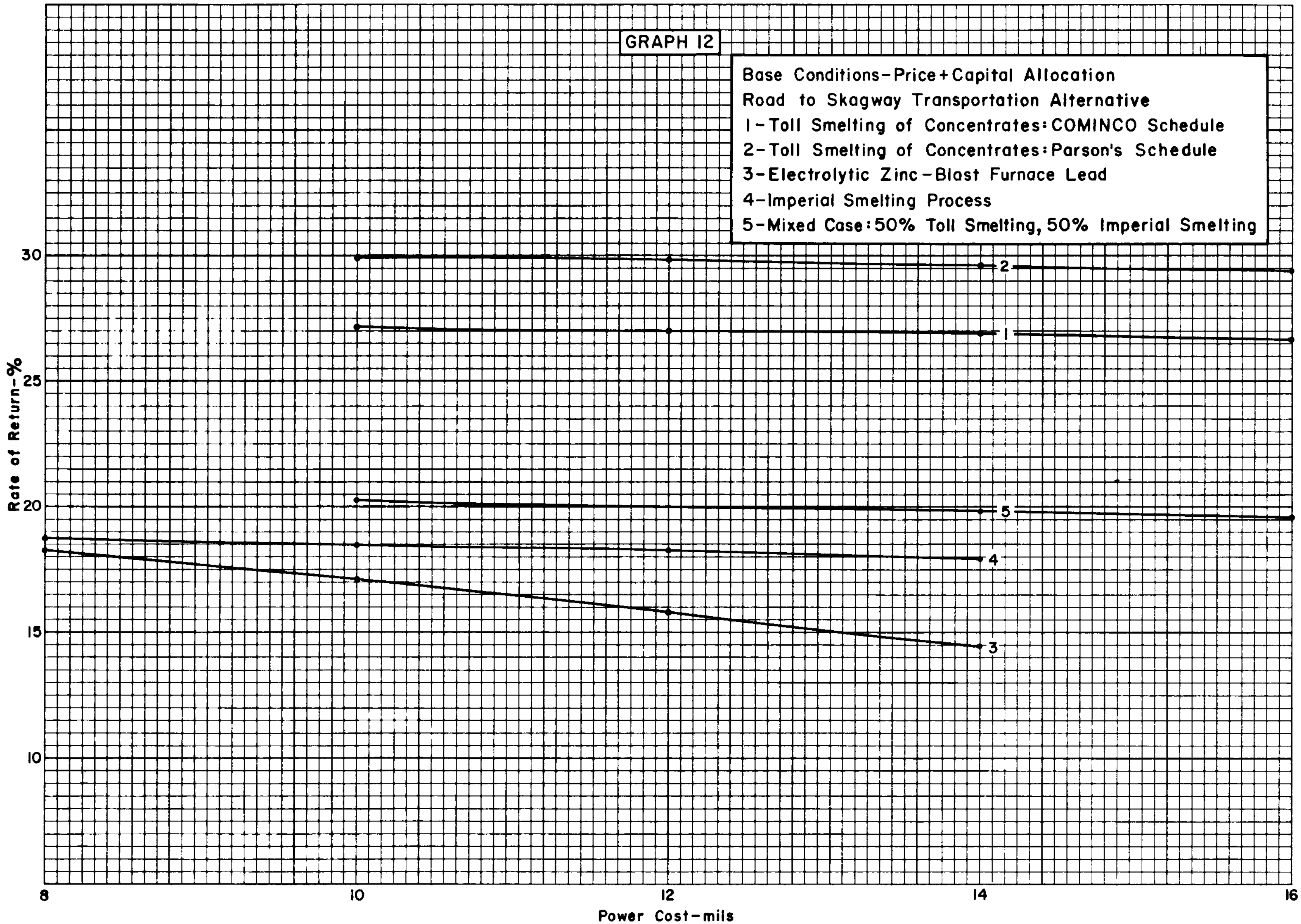
Revenue	100
Depletion	33-1/3
Taxable Income	66-2/3
Tax	33-1/3
Cash Flow	66-2/3

The incremental ratio of cash flow to revenue is, therefore, about .67. The normal ratio for this project, charging operating costs, is in the range .30 to .40. Therefore, the incremental increase in cash flow will increase the ratio of cash flow to revenue and exert a multiplier effect on rate of return.

It can also be seen from the example that the size of the multiplier effect is proportional to the aggregate level of investment. Toll smelting has a higher multiplier than the imperial smelting process, for example. The increase in cash flow resulting from a given increase in price is the same for the three alternatives if one ignores the small increase in smelter charges for the toll smelting alternative. Between alternatives, therefore, the increase in rate of return resulting from a given increase in price is inversely proportional to capital invested. The rate of return will increase more for the low capital alternative than for the high capital alternative, and consequently, its multiplier will be larger.

Power Cost Variations

Electrolytic zinc-blast furnace lead is the only processing alternative that shows a significant sensitivity to power cost variations. (see Table 3) The results are plotted in Graph 12 for all five processing alternatives, the all road route to Skagway and base conditions of price and capital allocation applying.


GRAPH 12
Base Conditions-Price+Capital Allocation
Road to Skagway Transportation Alternative
1-Toll Smelting of Concentrates: COMINCO Schedule
2-Toll Smelting of Concentrates: Parson's Schedule
3-Electrolytic Zinc-Blast Furnace Lead
4-Imperial Smelting Process
5-Mixed Case: 50% Toll Smelting, 50% Imperial Smelting
Rate of Return-%
30
25
20
15
10
8
10
12
14
16
Power Cost-mils
2
1
5
4
3

Although the mine is located in a region where relatively high power costs can be expected, this would not appear to significantly alter the project economics except for the electrolytic zinc alternative. This is the only alternative where important economies could result from the location of smelting and refining facilities in a low power cost area, removed from the minesite.

Royalty Schedule Variations

Significant increases in royalty revenues could be obtained by increasing the schedule rates, without materially changing the firm's rate of return. (see Table 5) Two examples are illustrated.

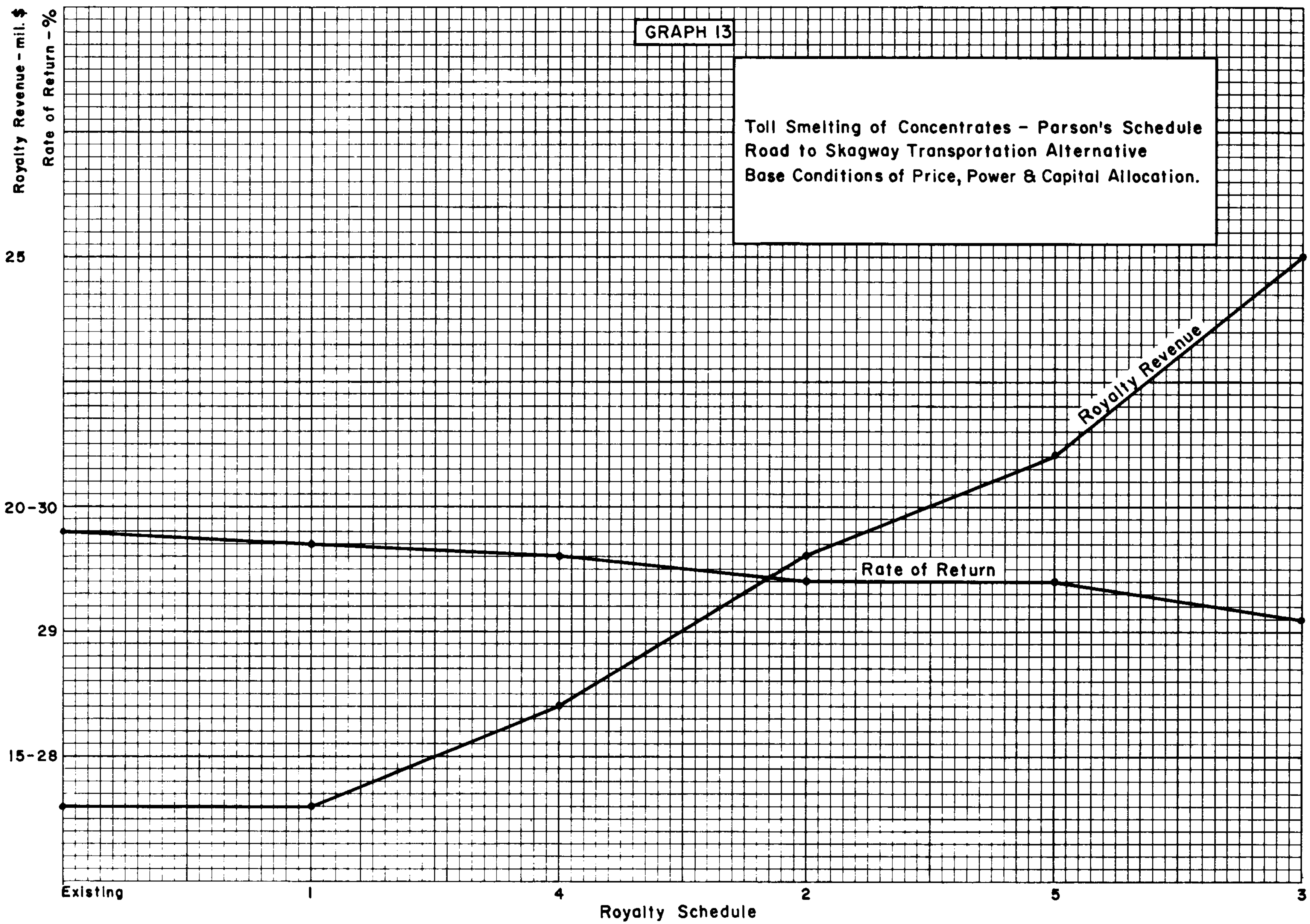
Graph 13 plots rate of return and royalty revenue against the various assumed royalty schedules for the toll smelting of concentrates using the Parsons' schedule, the base conditions of price, power and capital allocation, and the road to Skagway transportation alternative. Between the existing schedule and the most punitive schedule, royalty revenues are increased $11 million (79%)* while rate of return is only decreased absolutely by .7% (3%)*.

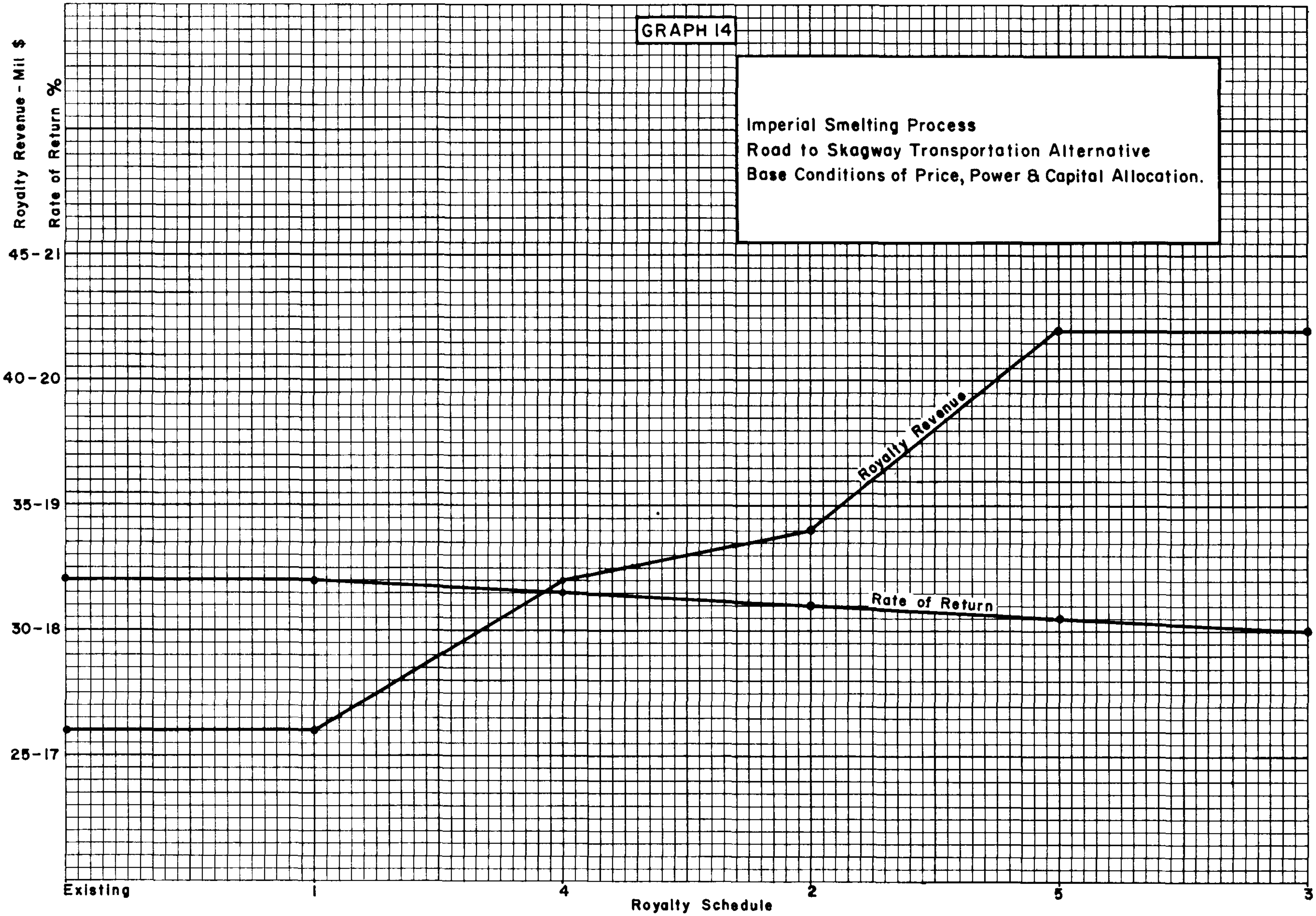
Graph 14 plots identical curves for the imperial smelting process. Between the existing schedule and the most punitive schedule royalty revenues are increased $16 million (62%) while rate of return is decreased absolutely by .4% (2%)

In both examples the change in rate of return is not significant but the increase in revenue is considerable. Schedule #1 produces only negligible changes, increasing revenue by $10,000 per year for 20 years. While schedule #3 results in considerably higher revenues than schedule #5 in the toll smelting case, revenues are identical for the imperial smelting alternative. This shows that an increase in aggregate profits produces a

---

*percentage change from original value.


GRAPH 13
Toll Smelting of Concentrates - Parson's Schedule
Road to Skagway Transportation Alternative
Base Conditions of Price, Power & Capital Allocation.
Royalty Revenue - mil. $
Rate of Return - %
25
20-30
29
15-28
Royalty Revenue
Rate of Return
Existing
1
4
2
5
3
Royalty Schedule


GRAPH 14
Imperial Smelting Process
Road to Skagway Transportation Alternative
Base Conditions of Price, Power & Capital Allocation.
Royalty Revenue - Mil $
Rate of Return %
45-21
40-20
35-19
30-18
25-17
Royalty Revenue
Rate of Return
Existing
1
4
2
5
3
Royalty Schedule

larger increase in revenue when a rate schedule is used which levies a relatively high royalty rate on high profit increments.

The processing alternative gives a greater increase in royalties than the concentrate alternative because the aggregate profit level is higher. However, the percentage increase is not as great because a larger proportion of processing revenues are absorbed in operation costs and are thus unavailable for royalty payment.

A Smelting and Refining Installation in National Perspective

From Anvil's point of view a smelting and refining installation does not appear to be economically justifiable. The question remains as to whether or not it is in the national interest to force the issue. The rate of return differential between the toll smelting of concentrates and the processing to metal alternatives is large and it would require a large direct subsidy to swing the balance in favour of the installation of smelting and refining facilities.

It is not within the scope of this report to carry out a cost-benefit analysis of a processing installation although such a study would be required as the rational basis for such a decision. Of the many factors to be taken into account the following would certainly merit detailed consideration:

(i) Increased employment and the population and economic stabilization of a remote area. However, smelters and refineries are capital intensive and do not employ large numbers.

(ii) Increased export value and attending increases to the national account. Lead-zinc smelting and refining accounts for about one-third of the end product value, the remainder being already in the concentrate product.

(iii) Stimulation of existing and potential lead-zinc developments in the Territory. Although information is inconclusive, there would appear to be good potential for additional lead-zinc mine developments in the Vangorda district which might only be realized by the construction of smelting and refining facilities.

If justification were forthcoming then the question of location would remain. Generally, mineral processing installations extend beyond the life of any individual raw material source. The location of the Anvil processing installation should therefore, take into account potential raw material sources external to the Faro No. 1 orebody. Modern basemetal smelters and refineries are almost always located on international shipping routes but the unusual political boundaries of this area of the Canadian north mitigate against such a location from a purely national perspective. The power generation problem in the mine vicinity is another factor to consider.

If the national benefits to be derived from a processing to metal alternative justified the Government inducement of such an installation then there would appear to be possibilities for a trade-off. All or a portion of the government revenue differential between the Anvil concentrate and metal alternatives could be used to lever the firms rate of return on the metal alternative to the point where it would become the firm's optimum alternative on a rate of return basis. As can be seen in Table 1 this revenue differential is in the order of $50 million. Government revenue from the Anvil Project which would not otherwise be realized, could be used to encourage a smelting and refining installation. This differential could be particularly effective if in government evaluation of revenue time value is ignored or discounting is done at a minimal "safe" rate. Greater leverage can be exerted on the firm's rate of return then, by applying government revenues that would have been obtained from later stages of production to reduce the firm's capital investment in its pre-production years.

The final decision would be to determine the method of subsidy to render the processing to metal alternative most attractive to the firm. The

Government could offer to completely subsidize the transport facility and townsite for the processing to metal alternative while offering no assistance for the toll smelting alternative. However, the latter alternative would remain the preferred investment. For example, compare the toll smelting alternative using the Parsons' schedule with the imperial smelting process for base conditions of price and power. At 100% capital allocation the most favourable processing alternative yields 19.4% while at 0% capital allocation the most favourable toll smelting alternative still yields 24.9%. Such a strategy, however, narrows the gap. At the base case capital allocation the comparable returns would be 18.4% and 29.8% respectively. A method of subsidy, having a more direct impact on rate of return would be required.

These four factors: justification, location, source of funds, and method of subsidy will have to be evaluated sequentially. A negative decision at any stage would preclude encouragement of a smelting and refining installation and terminate the analysis.

10. RECOMMENDATIONS AND CONCLUSIONS

1. Assuming that the firm is able to select its optimum alternative, it does not appear that the development of this project is contingent on the provision of transportation and townsite facilities by the Government. Taking into account the remote area, the uncertainties inherent in mineral development opportunities and the market conditions for lead and zinc, this opportunity appears attractive even if the investors provide the above mentioned facilities.

2. The relatively small transported tonnages do not offer sufficient justification for a high capital cost transportation alternative. Even if the Government provided such a facility only small economic benefits would accrue to Anvil. A lower capital cost transportation facility, either the road to Skagway or the existing road-rail route, would be more in balance with the estimated tonnages.

   To more completely evaluate the transportation alternatives it is recommended that a cost-benefit analysis be pursued, comparing the relative effects of the various transportation alternatives on other economic opportunities in the region, in relation to their respective capital costs.

3. From Anvil's viewpoint, a smelting and refining installation does not appear to be economically justified. Rate of return and several other factors mitigate against such a facility. To induce Anvil to pursue the processing to metal alternative, the Government

would have to provide some form of large direct subsidy and perhaps market support.

If it was decided that such intervention could be permitted, then justification would depend largely on an evaluation of the benefits that could be realized from furthering the development of lead-zinc-silver mines in the Territory. Increased Government revenues realized from the processing to metal alternative could also be considered as a rationale. If sufficient justification for a smelting and refining installation was shown to exist then problems of location, sources of Government funds and method of subsidy would remain to be resolved.

APPENDIX

COMINCO SMELTER SCHEDULE

This schedule applies to the purchase of concentrates f.o.b. Tadanac, effective September 1, 1962. It only includes payments and charges relevant to the Anvil Project.

Lead Concentrates:

Silver: 95% of the silver will be paid for at the Engineering and Mining Journal New York quotation for silver less 2.00¢ per ounce of silver paid for.

Minimum Deduction one troy ounce per dry ton.

Lead: 92-½% of the contained lead (wet lead assay), with a minimum deduction of 20 pounds per ton (1.0%), will be paid for at the "Net Tadanac Realized Price", less 0.6¢ per pound.

Zinc: Will be paid for to the extent shown in the following table at the "Net Tadanac Realized Price" less 5.5¢ per pound.

If the ore or concentrates contain Zinc to the extent of:	The following percentages of Zinc will be paid for:
Less than 5%	Minimum deduction of 50 pounds per dry ton (2.5%)
5% and over but less than 6%	47%
6% " " " " " 7%	44%
7% " " " " " 8%	41%
8% " " " " " 9%	38%
9% " " " " " 10%	35%

Base Charge: $15.00 per dry ton.

Credit the base charge for lead in excess of 30% at 10¢ per unit per dry ton.

Debit the base charge for the deficiency in lead below 30% at 10¢ per unit per dry ton.

COMINCO SMELTER SCHEDULE

Zinc Concentrates

Silver: 80% of the silver will be paid for at the Engineering and Mining Journal New York quotation for silver less 2.00¢ per ounce of silver paid for.

Minimum deduction one troy ounce per dry ton.

Lead: 80% of the contained lead (wet lead assay), with a minimum deduction of 20 pounds per ton (1.0%), will be paid for at the Net Tadanac Realized Price, less 3.35¢ per pound.

Zinc: Will be paid for to the extent shown in the following table at the Net Tadanac Realized Price, less 2.6¢ per pound.

If the concentrates contain zinc to the extent of:	The following percentages of zinc will be paid for:	And the following treatment charge per dry ton of concentrates will apply:
60% and over	86%	$12.00
58% and over but less than 60%	85%	13.00
56% " " " " " 58%	84%	13.00
54% " " " " " 56%	83%	13.00
52% " " " " " 54%	82%	13.00
50% " " " " " 52%	81%	13.00
48% " " " " " 50%	80%	14.00
46% " " " " " 48%	79%	14.00
44% " " " " " 46%	78%	15.00
42% " " " " " 44%	76%	15.00
40% " " " " " 42%	74%	16.00

Treatment Charges: $12.00 per dry ton up to $16.00 per dry ton depending upon zinc grade of concentrates, as set out in the foregoing table, under heading ZINC.

COMINCO SMELTER SCHEDULE

A comparison between Net Tadanac Realized Price and U.S. Producer Price for lead and zinc as provided by COMINCO.

<u>Lead</u>

	NTRP	NYPP	Difference
1960	8.3	11.6	3.3
1961	7.7	11.0	3.3
1962	7.3	10.3	3.0
1963	8.1	12.0	3.9
1964	11.5	14.7	3.2
1965	13.9	17.2	3.3
Jan. - May '66	13.4	17.0	3.6
AVERAGE	10.0	13.5	3.5

<u>Zinc</u>

	NTRP	ESLPP	Difference
1960	10.7	12.6	1.9
1961	9.5	11.7	2.2
1962	9.1	12.4	3.3
1963	10.0	12.9	2.9
1964	13.3	14.6	1.3
1965	14.1	15.6	1.5
Jan. - May '66	14.0	15.6	1.6
AVERAGE	11.5	13.5	2.0

<u>Notes:</u>

(i) All Prices in Canadian ¢/lb.
(ii) NTRP: Net Tadanac Realized Price
NYPP: New York Producers Price
ESLPP: East St. Louis Producers Price.
(iii) The NTR price reflects the delivered price for metal on all markets less freight, selling expense, discounts (in certain cases) from quoted price, duty, brokerage charges, etc.

COMINCO SMELTER SCHEDULE

NSR/ton of ore for Anvil Project

Ag: ounces contained in concentrate
Pb: tons contained in concentrate
Zn: tons contained in concentrate
T: tons of concentrate processed

NSR: Lead Concentrates: Can. $

Silver: .95 (Ag) 1.38
Lead: .925 (Pb) (NYPP - .035) 2000 - .925 (Pb) (12)
Zinc: .41 (Zn) (ESLPP - .02) 2000 - .41 (Zn) (110)
Tonnage Charge: - (15 - 2.5) T lead

NSR: Zinc Concentrates: Can. $

Silver: .80 (Ag) 1.38
Lead: .80 (Pb) (NYPP - .035) 2000 - .80 (Pb)67
Zinc: .82 (Zn) (ESLPP - .02) 2000 - .82 (Zn)52
Tonnage Charge: -(13) T zinc

Pb (NYPP): 11.9 Can. ¢/lb.
Zn (ESLPP): 12.4 Can. ¢/lb.

	Years 1 - 5	Years 6 - 20
Net Smelter Return: $	23,696,000	23,406,000
Net Smelter Return/ton of ore	14.72	10.99

Pb (NYPP): 13.5 Can. ¢/lb.
Zn (ESLPP): 14.0 Can. ¢/lb.

	Years 1 - 5	Years 6 - 20
Net Smelter Return: $	29,045,000	28,744,000
Net Smelter Return/ton of ore	18.04	13.50

See Graph 16

PARSONS ASSUMED SMELTER SCHEDULE

Synthensized from Preliminary Feasibility Study

PFS: TABLE 3 - 8

Pb: 11.0 U.S. ¢/lb. = 11.9 Can. ¢/lb.
Zn: 11.5 U.S. ¢/lb. = 12.4 Can. ¢/lb.

	Yrs. 1 - 5	Yrs. 6 - 20
Total Sales: U.S. $	39,449,000	39,198,000
Smelting and Refining Costs: U.S. $	15,329,000	15,540,000
Net Smelter Return: U.S. $	24,120,000	23,658,000
Tons of Ore Mined	1,610,000	2,129,000
NSR: Can. $/ton of ore	16.10	11.11*

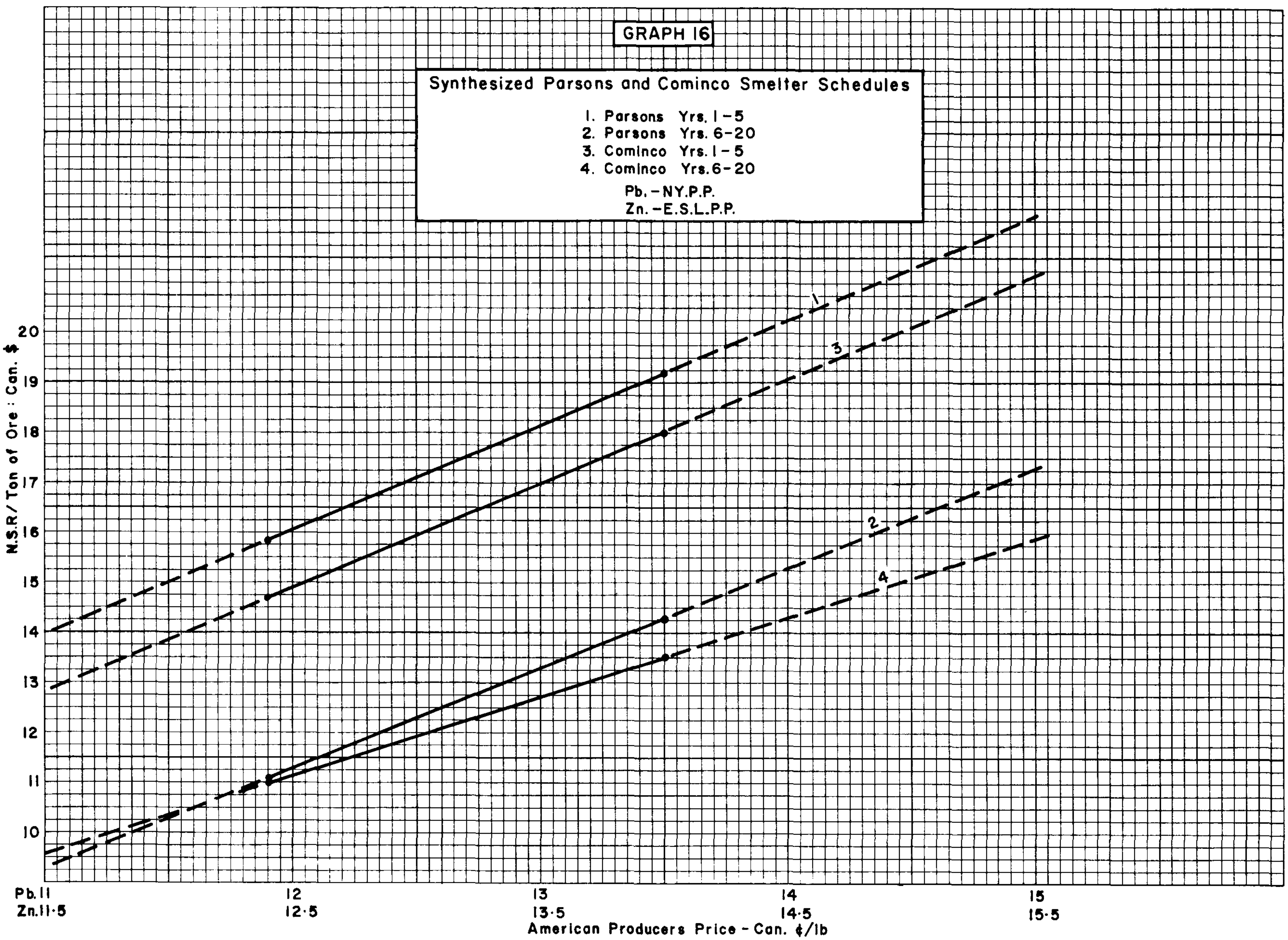
PFS: TABLE 3 - 9

Pb: 12.5 U.S. ¢/lb. = 13.5 Can. ¢/lb.
Zn: 13.0 U.S. ¢/lb. = 14.0 Can. ¢/lb.

	Yrs. 1 - 5	Yrs. 6 - 20
Total Sales: U.S. $	44,394,000	44,135,000
Smelting and Refining Cost: U.S. $	15,650,000	15,869,000
Net Smelter Return: U.S. $	28,744,000	28,266,000
NSR: Can. $/ton of ore	19.19	14.27

See Graph 16

* mistake - should be 11.95, this will widen the preference for toll smelting using the Parson's schedule. This error was noticed too late to be taken into account.



GRAPH 16
Synthesized Parsons and Cominco Smelter Schedules
1. Parsons Yrs. 1 - 5
2. Parsons Yrs. 6-20
3. Cominco Yrs. 1 - 5
4. Cominco Yrs. 6-20
Pb. - NY.P.P.
Zn. - E.S.L.P.P.
N.S.R / Ton of Ore : Can. $
20
19
18
17
16
15
14
13
12
11
10
1
2
3
4
Pb. 11
Zn. 11·5
12
12·5
13
13·5
14
14·5
15
15·5
American Producers Price - Can. ¢/lb

PARSONS SMELTER SCHEDULE

This schedule, used by Parsons - Jurden in the Preliminary Feasibility Report, was provided by Walter R. Shaw, Project Manager for the Ralph M. Parsons Construction Co., of Canada, Ltd., in a letter dated June 27, 1966. It is a toll smelter schedule based on the ASARCO custom smelter schedule.

Lead Concentrates

1. Return of 95 per cent of contained lead metal after 1.5 unit deduction.
2. Return of 95 per cent of contained silver or gross content less one ounce.
3. In addition to the base charge add:

    a. 1.2 ¢/lb of lead returned
    b. 1.0 ¢/ounce of silver returned

Zinc Concentrates

1. Return of 85 per cent of contained zinc metal or gross content less 160 pounds per ton of concentrates.
2. Return of 80 per cent of contained silver.
3. In addition to the base charge add:

    a. 0.3 ¢/lb of zinc returned
    b. 1.5 ¢/ounce of silver returned

ASARCO SMELTER SCHEDULE

These are tentative smelter schedules forwarded to the Parsons-Jurden Corporation by A.J. Kroha of ASARCO in a letter dated December 30, 1965.

Lead Concentrates:

Delivery: In bond, f.o.b. wharf of Buyer's plant at Selby, California.

Silver: Pay for 95% at Handy & Harman unrefined basis less 1¢ per ounce. Minimum deduction one ounce.

Lead: Deduct 1.5 units and pay for 95% of remainder at New York quotation for common domestic lead less 1.7¢.

Base Charge: $23.35 per net ton of product based on Selby average hourly labor cost of $3.55. Adjust 6¢ per ton for each 1¢ change in labor cost.

Impurities: No charge for impurities subject to further study of product.

Duties: All United States Customs duties for Seller's account.

Zinc Concentrates:

Delivery: In bond, f.o.b. Buyer's plant, Corpus Christi, Texas.

Silver: Pay for 80% at Handy & Harman unrefined basis less 1.5¢ per ounce.

Zinc: Pay for 85% at East St. Louis zinc price less 0.69¢ per lb. Minimum deduction, 8 units.

Lead: Deduct 1.5 units and pay for 65% at New York price less 2¢ per lb.

Base Charge: $55.00 per net ton based on 14.5¢ Zn. Adjust $1.00 for each 1¢ that zinc quotation is below 14.5¢ to a minimum of 9.5¢ zinc quotation.

Duties: All United States Customs duties for Seller's account.

ATAKA SMELTER SCHEDULE

This schedule reflects the current terms of zinc and lead concentrates which the Japanese smelters are paying for. These terms change according to market conditions. This reference schedule was forwarded to Cyprus Mines Corporation by Y. Kato of Ataka, New York, Inc. in a letter dated April 28, 1966.

(1) Zinc Concentrates:

Zinc: 85-% of the full zinc contents (minimum deduction 8 units) shall be paid for at the average of so-called "Producers Price" (minimum price for "Producers Price" of £72-0-0 to be guaranteed by buyer)

Silver: Deduct from the silver content five troy ounce per metric ton and pay for 60-% of the remainder at the Handy & Harman unrefined price in the "E&MJ Metal & Mineral Markets".

Cadmium: Deduct 3 lbs. per metric ton and pay for the remainder at 70-% of U.K. and European price in the "Metal Bulletin"

Treatment Charges: For 1966, US$43.00; for 1967, US$43.50 per dry net metric ton of concentrates, CIF Japanese port, berth terms. The above treatment charges are based on a quotation for zinc of £80-0-0 and will be increased by 18.75¢ U.S. Currency for each £1-0-0 which the quotation applicable for the governing quotational period is above £80-0-0; fractions in proportion.

Iron Penalty: Up to 7-% free: any excess to be penalized at the rate of US$0.50 per metric ton net dry of concentrates for each 1-% over 7-%, fractions in proportion.

(2) Lead Concentrates:

Lead: Pay for 90-% of the lead content at the average of the four official London Metal Market quotations, plus a premium of £2-0-0.

Silver: Pay for 95-% of the silver content, if over one troy ounce, at the Handy & Harman unrefined silver price in the "E&MJ Metal & Mineral Markets".

Treatment Charge: US$20.00 per dry metric ton, CIF Japanese port, berth terms.

CALCULATION OF MARKET PRICE/TON ORE

Price Structure	1	2	3	4	5
Pb: NYPP	11.9	12.9	13.5	14.0	14.5
Zn: ESLPP	12.4	13.4	14.0	14.5	15.0

Cases 1-5

Price Structure	MP/ton ore* Yrs. 1-5 $	MP/ton ore* Yrs. 6-20 $	% Change From Base Case Yrs. 1-5	% Change From Base Case Yrs. 6-20	Average** % Change
1	14.72	10.99	-22.93	-23.41	-23.01
2	16.80	12.55	-12.04	-12.54	-12.13
3	18.04	13.50	- 5.55	- 5.92	- 5.61
4	19.10	14.35	—	—	—
5	20.15	15.10	+ 5.50	+ 5.23	+ 5.45

Cases 6-10

Price Structure	MP/ton ore* Yrs. 1-5 $	MP/ton ore* Yrs. 6-20 $	% Change From Base Case Yrs. 1-5	% Change From Base Case Yrs. 6-20	Average** % Change
1	16.10	11.11	-20.22	-26.67	-21.32
2	18.05	13.05	-10.56	-13.86	-11.12
3	19.19	14.27	- 4.91	- 5.81	- 5.06
4	20.18	15.15	—	—	—
5	21.10	16.15	+ 4.56	+ 6.60	+ 4.91

* See Graph 16

** weighted average due to time value considerations, estimated at 20% c.i.:

	Yrs. 1-5	Yrs. 6-20
PV of $1/annum	2.991	1.879
PV / annum	.598	.125

$$\text{Average \% Charge} = \text{Change 1-5} + \frac{.125}{.598}\,(\text{Change 6-20} - \text{Change 1-5})$$

CALCULATION OF MARKET PRICE/TON ORE

Metal Alternatives: 50% to West Germany
50% to U.S.A.

assume: Lead: European Producers Price = (NYPP - 2.2¢/lb)
Zinc: European Producers Price = (ESLPP - 1.8¢/lb)

Price Structure	1	2	3	4	5
Lead: Avg. Price Can.¢/lb	10.8	11.8	12.4	12.9	13.4
Zinc: Avg. Price Can.¢/lb	11.5	12.5	13.1	13.6	14.1

Cases 11-15

Price Structure	MP/ton ore* Yrs. 1-5 $	MP/ton ore* Yrs. 6-20 $	% Change From Base Case Yrs. 1-5	% Change From Base Case Yrs. 6-20	Average** % Change
1	28.82	21.72	-15.04	-15.09	-15.05
2	31.25	23.56	- 7.90	- 7.90	- 7.90
3	32.71	24.66	- 3.57	- 3.60	- 3.57
4	33.92	25.58	—	—	—
5	35.14	26.50	+ 3.60	+ 3.60	+ 3.60

Cases 16-20

Price Structure	MP/ton ore* Yrs. 1-5 $	MP/ton ore* Yrs. 6-20 $	% Change From Base Case Yrs. 1-5	% Change From Base Case Yrs. 6-20	Average** % Change
1	27.67	20.85	-15.02	-15.07	-15.03
2	30.00	22.61	- 7.86	- 7.90	- 7.87
3	31.40	23.67	- 3.56	- 3.58	- 3.56
4	32.56	24.55	—	—	—
5	33.72	25.43	+ 3.56	+ 3.58	+ 3.56

* includes lead, zinc and silver

** see note on preceeding page

CALCULATION OF MARKET PRICE/TON ORE

Cases 21 - 25

Average of Cases 1 - 5 and Cases 16 - 20

Price Structure	MP/ton ore Yrs. 1 - 5 $	MP/ton ore Yrs. 6 - 20 $	% Change from Base Case Yrs. 1 - 5	% Change from Base Case Yrs. 6 - 20	Average % Change
1	21.19	15.92	-17.96	-18.15	-17.99
2	23.40	17.58	- 9.41	- 9.61	- 9.44
3	24.72	18.59	- 4.22	- 4.42	- 4.25
4	25.83	19.45	---	---	---
5	26.94	20.27	+ 4.30	+ 4.42	+ 4.29

BENEFICIATION AND METALLURGICAL COSTS

Consider variations in power rates.

Alternative Number	Feasibility Study Rate	Base Case Rate-mils	Variations mils
1 - 10	10	12	10, 14, 16
11 - 15	8	8	10, 12, 14
16 - 20	10	10	8, 12, 14
21 - 25	10	12	10, 14, 16

Assume power variations Yrs. 1 - 5 as average over mine life.

<u>Cases 1 - 10</u>

power cost at 10 mils = $0.275/ton ore (PFS: 8 - 3)

Power Rate mils	Power Cost /ton of ore	Variation $/ton of ore
10	.275	- .055
12	.330	---
14	.385	+ .055
16	.440	+ .110

Base Case Beneficiation Cost:

Yrs. 1 - 5: 2.218 + .055 = $2.273 / ton ore
Yrs. 6 - 20: 2.065 + .055 = $2.120 / ton ore

<u>Cases 11 - 15</u>

power costs at 8 mils:
concentrates = $0.275 / ton ore
zinc metallurgical treatment: 31.75 (PFS: 8 - 7) x .0728 = $3.175/ton ore
lead metallurgical treatment: 5.30 (PFS: 8 - 8) x .0487 = $0.258/ton ore

Power Rate mils	Power Cost /ton of ore	Variation $/ton ore
8	3.708	---
10	4.635	+ .927
12	5.562	+1.854
14	6.489	+2.781

BENEFICIATION AND METALLURGICAL COSTS

Base Case:	Concentrating: $/ton ore	Met. Treatment: $/ton ore
Yrs. 1 - 5	2.150	9.610
Yrs. 6 - 20	1.993	7.280

Cases 16 - 20

Power costs at 10 mils
Concentrating: $0.324/ton ore (PFS: 8-6)
Metallurgical treatment: 5.00 (PFS: 8 - 13) x .1163 = $0.580/ton ore.

Power Rate mils	Power Cost /ton of ore	Variations $/ton of ore
8	.904	- .226
10	1.130	---
12	1.356	+ .226
14	1.582	+ .452

Base Case:	Concentrating: $/ton ore	Met. Treatment: $/ton ore
Yrs. 1 - 5	1.905	7.390
Yrs. 6 - 20	1.770	5.600

Cases 21 - 25: average of Cases 1 - 10 and 16 - 20

Power Rate mils	Power Cost /ton of ore	Variations $/ton of ore
10	.702	- .141
12	.843	---
14	.984	+ .141
16	1.125	+ .282

Base Case	Concentrating: $/ton ore	Met. Treatment: $/ton ore
Yrs. 1 - 5	2.062	3.83
Yrs. 6 - 20	1.917	2.94

TRANSPORTATION BY LAND

Operating Costs

New Rail Line: Mine - Dyea (Skagway Flats)

Operating costs based on $7-9/ton estimate (PFS: 10-7) and weighted for volume.

Cases 1, 6:	\$8.30/ton Transported	(400,000 tpy)
Cases 11, 16:	\$8.90/ton Transported	(250,000 tpy)
Case 21:	\$8.60/ton Transported	(325,000 tpy)

Extension of Existing Rail: Whitehorse - Mine

See PFS: 10-5 and Graph 17.

Cases 2, 7:	\$14.30/ton Transported	(400,000 tpy)
Cases 12, 17:	\$14.90/ton Transported	(250,000 tpy)
Case 22:	\$14.60/ton Transported	(325,000 tpy)

Road: Mine - Skagway

See PFS: 10-3 and average.

Cases: 3, 8, 13, 18, 23: \$11.30/ton transported

Road: Mine - Haines

See PFS: 10-4 and accept Can. \$.48*/vehicle mile (30 ton truck)

$$* \frac{10.50 \times 30}{650} = \$0.48$$

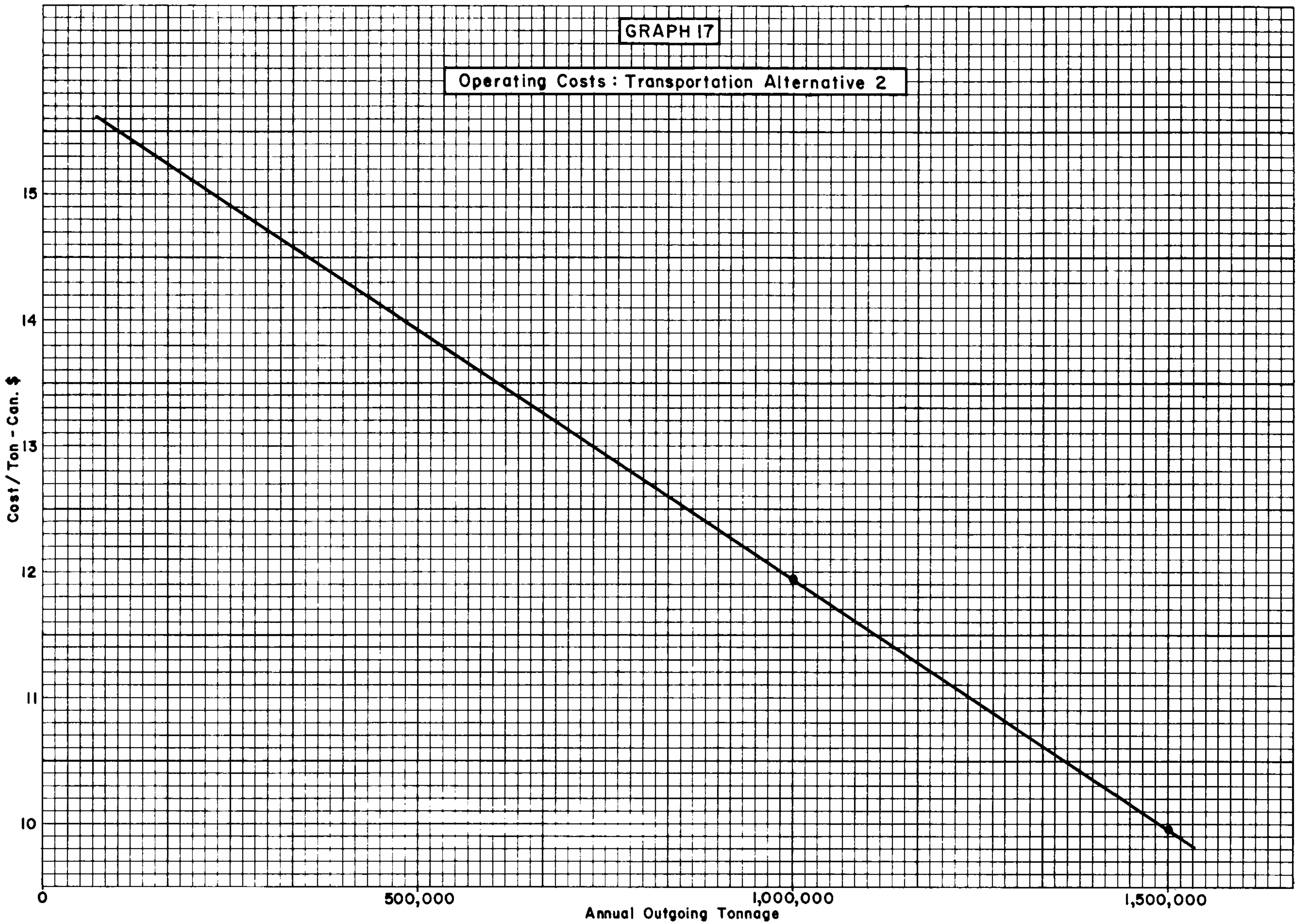
Mine - Haines: 925 miles round trip $= \frac{.48 \times 925}{30} = \$14.80$

Cases: 4, 9, 14, 19, 24: \$14.80/ton transported.

Existing Road - Rail:

See PFS: 10-4 and average.

Cases: 5, 10, 15, 20, 25: \$15.60/ton Transported.


GRAPH 17
Operating Costs : Transportation Alternative 2
Cost / Ton - Can. $
15
14
13
12
11
10
0
500,000
1,000,000
1,500,000
Annual Outgoing Tonnage

TRANSPORTATION BY LAND

Operation Cost/Ton Ore

Tide water Handling: $1.73/ton handled (PFS: 10-6)

Alternative Number	Years 1 - 5			Years 6 - 20		
	Ratio TT/TO*	Cost $/TT	Cost $/TO	Ratio TT/TO	Cost $/TT	Cost $/TO
1	.2189	10.03	2.19	.1656	10.03	1.66
2	.2189	16.03	3.51	.1656	16.03	2.65
3	.2189	13.03	2.85	.1656	13.03	2.16
4	.2189	16.53	3.62	.1656	16.53	2.74
5	.2189	17.33	3.79	.1656	17.33	2.87
6	.2189	10.03	2.19	.1656	10.03	1.66
7	.2189	16.03	3.51	.1656	16.03	2.65
8	.2189	13.03	2.85	.1656	13.03	2.16
9	.2189	16.53	3.62	.1656	16.53	2.74
10	.2189	17.33	3.79	.1656	17.33	2.87
11	.1214	10.63	1.29	.0919	10.63	0.98
12	.1214	16.63	2.02	.0919	16.63	1.53
13	.1214	13.03	1.58	.0919	13.03	1.20
14	.1214	16.53	2.01	.0919	16.53	1.52
15	.1214	17.33	2.10	.0919	17.33	1.59
16	.1163	10.63	1.24	.0880	10.63	0.94
17	.1163	16.63	1.93	.0880	16.63	1.46
18	.1163	13.03	1.52	.0880	13.03	1.15
19	.1163	16.53	1.92	.0880	16.53	1.45
20	.1163	17.33	2.02	.0880	17.33	1.53
21	.1676	10.33	1.73	.1268	10.33	1.31
22	.1676	16.33	2.74	.1268	16.33	2.07
23	.1676	13.03	2.18	.1268	13.03	1.65
24	.1676	16.53	2.77	.1268	16.53	2.10
25	.1676	17.33	2.90	.1268	17.33	2.20

* Tons Transported/Tons of Ore Produced.

TRANSPORTATION BY WATER

Operating Cost/Ton Ore

Cases 1-10

Yrs. 1-5:	Japan:	.7(352,500)(6.29)* =	1,552,000
	Selby:	.3(138,500)(9.03) =	375,000
	Corpus Christi:	.3(214,000)(10.54) =	677,000
		352,500	2,604,000

Avg. Cost/Ton Transported: $7.39
Avg. Cost/Ton of Ore: (7.39)(.2189)** = $1.62

Yrs. 6-20:	Japan:	.7(352,500)(6.29) =	1,552,000
	Selby:	.3(133,500)(9.03) =	362,000
	Corpus Christi:	.3(219,000)(10.54) =	692,000
		352,500	2,606,000

Avg. Cost/Ton Transported: $7.39
Avg. Cost/Ton of Ore: (7.39)(.1656) = $1.22

Cases 11-15

Avg. Cost/Ton Transported = (8.87 + 11.50)/2 = $10.18

Avg. Cost/Ton of Ore: Yrs. 1-5: (10.18)(.1214) = $1.24
Yrs. 6-20: (10.18)(.0919) = $0.94

Cases 16-20

Avg. Cost/Ton Transported: $10.18

Avg. Cost/Ton of Ore: Yrs. 1-5: (10.18)(.1163) = $1.18
Yrs. 6-20: (10.18)(.0880) = $0.89

---

* PFS: Table 1-1
** Ratio: Tons Transported/Tons of Ore Mined

TRANSPORTATION BY WATER

Operating Cost/Ton Ore

Cases 21-25

	Years 1-5	Years 6-20
Tons of Lead Concentrate	69,250	66,750
Tons of Zinc Concentrate	107,000	109,500
Tons of Metal	93,650	93,650
	269,900	269,900

Yrs. 1-5:	Japan:	.7(176,250)(6.29) =	776,000
	Selby:	.3(69,250)(9.03) =	188,000
	Corpus Christi:	.3(107,000)(10.54)=	338,000
	U.S.A.:	.5(93,650)(8.87) =	415,000
	W. Germany:	.5(93,650)(11.50)=	538,000
		269,900	2,255,000

Avg. Cost/Ton Transported: $8.35

Avg. Cost/Ton of Ore: (8.35)(.1676) = $1.40

Yrs. 6-20: Avg. Cost/Ton Transported: $8.35

Avg. Cost/Ton of Ore: (8.35)(.1268) = $1.06

T A R I F F S

$/Ton Ore

United States

Lead Metal: 1-1/16 U.S. ¢/lb = Can. $22.84/ton
Zinc Metal: .7 U.S. ¢/lb = Can. $15.05/ton
Lead Concentrate: 3/4 U.S. ¢/lb = Can. $16.12/ton
Zinc Concentrate: .67 U.S. ¢/lb = Can. $14.41/ton

Germany

Lead Metal (EEC Ultimate): .6 U.S. ¢/lb = Can. $12.90/ton
Zinc Metal (EEC Ultimate): .6 U.S. ¢/lb = Can. $12.90/ton

Cases 1-10

Yrs. 1-5: 41,500(.55)(16.12) +64,200(.52)(15.05) = 870,300/1,610,000 = $0.54/ton ore
Yrs. 6-20: 40,000(.55)(16.12) +65,700(.52)(15.05) = 868,800/2,129,000 = $0.41/ton ore

Cases 11-15

Yrs. 1-5: 894,200 +505,000 +881,700 +755,700 = 3,036,600/1,610,000 = $1.89/ton ore
Yrs. 6-20: 863,600 +487,700 +903,500 +774,400 = 3,029,200/2,129,000 = $1.42/ton ore

Cases 16-20

Yrs. 1-5: 854,200 +482,500 +845,800 +725,000 = 2,907,500/1,610,000 = $1.81/ton ore
Yrs. 6-20: 824,500 +465,700 +866,900 +743,000 = 2,900,100/2,129,000 = $1.36/ton ore

Cases 21-25: average Cases 1-10 and Cases 16-20

Yrs. 1-5: $1.17/ton ore
Yrs. 6-20: $0.89/ton ore

CAPITAL COST

Transportation Facility

Capital cost estimates were provided by E. Weick, Head, Transportation Section, Resource and Economic Development Group, Dept. of Northern Affairs and National Resources. They are based on limited information resulting from informal discussion with the Engineering Division of the same Department. The estimates do not include tidewater facilities, trucks and auxilaries, included in Parsons estimates.

New Rail Line: Mine - Tidewater: Alternatives: 1, 6, 11, 16 and 21

Mileage: Mine - Carmacks: 125

Carmacks - Tidewater (Dyea): 212 (Charles Report)
337 miles

Route includes an 11 mile tunnel.

Crest Study:	Dyea - Crest	$194,000,000*
	Less: 11 mile tunnel	$ 21,300,000
		$172,700,000

Distance: (578-11) = 567 miles

Assume: $300,000/mile

Anvil:	11 mile tunnel :	21,000,000
	326 miles at 300,000/mile :	97,800,000
		$118,800,000

Use: $120,000,000

---

* only clearing, grubbing, grading, tunnels, bridges, slide protection and track.

not included: right of way costs, legal surveys, cost of communications and signals, shops and rolling stock.

CAPITAL COST

Transportation Facility

Extension of Existing Rail: Whitehorse-Mine: Alternatives: 2, 7, 12, 17 and 22.

Assumptions: (i) narrow gauge (36") beyond Whitehorse
(ii) cost of building narrow gauge line at 85% of standard gauge line.

Cost/mile =.85(300,000)= $255,000

Distance: Whitehorse-Carmacks-Mine: 235 miles

Capital Cost: 235 (255,000) = $59,925,000

Use: $60,000,000

Road: Mine-Carmacks-Carcross-Skagway: Alternatives: 3, 8, 13, 18 and 23

Distance: 325 miles

Mine-Carmacks	:	3,800,000*
Carcross-Skagway: 66 miles** @ 120,000/mile	:	7,920,000
		$11,720,000

Use: $12,000,000

Road: Mine-Carmacks-Aishihik-Haines: Alternatives: 4, 9, 14, 19 and 24

Distance: 462 miles (PFS: 10-1)

Mine-Carmacks	:	3,800,000*
Carmacks-Aishihik: 50 miles at 50,000/mile	:	2,500,000
Aishihik-Alaska Highway: 84 miles at 35,000/mile	:	2,940,000(reconstruction)
Haines Road	:	2,000,000(reconstruction)
		11,240,000

Use: $12,000,000

* road: Ross River-Carmacks under construction; estimated completion: December, 1968.
** mileage in Canada (subject to revision); total mileage: 78 miles.

CAPITAL COST

Transportation Facility

Existing Road-Rail: Alternatives: 5, 10, 15, 20, 25.

Road: Mine - Carmacks - Whitehorse

Rail: Whitehorse - Skagway

Road: Mine - Carmacks: $3,800,000

Use: $3,800,000

CAPITAL COST

Townsite

The Parsons' Preliminary Feasibility Study includes no estimate of townsite cost or of the number of employees required for the operation. Rough estimates were made of the bases of townsite costs at Kitimat, Elsa and Thompsons and projected townsite costs for Crest and Baffinland Iron Mines.

Alternative Number	Employees	Townsite Population
1 - 10	200	800
11 - 20	300	1200
21 - 25	250	1000

Townsite Facilities at $30,000 per employee

Alternative Number	Capital Cost of Townsite
1 - 10	$6,000,000
11 - 20	$9,000,000
21 - 25	$7,500,000

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternatives 1 and 6:

Parsons Transportation Capital:	9,884,000	@ 4% =	395,000
Plant and Machinery:	38,021,000	@ 30% =	11,406,000
Transportation Facility:	30,000,000	@ 4% =	1,200,000
Townsite:	1,500,000	@ 30% =	500,000
	79,405,000	17.00%**	13,501,000

% Variations: -39.67, +39.67, +79.34, +119.01

Capital/Pre-Production Year:	36,625,000 (2)*
Year 5 :	3,024,000
Year 10 :	3,132,000

Alternatives 2 and 7

Parsons Transportation Capital:	9,884,000	@ 4% =	395,000
Plant and Machinery:	38,021,000	@ 30% =	11,406,000
Transportation Facility:	15,000,000	@ 4% =	600,000
Townsite:	1,500,000	@ 30% =	500,000
	64,405,000	20.03%	12,901,000

% Variations: -25.62, +25.62, +51.24, +76.86

Capital/Pre-Production Year:	29,125,000 (2)
Year 5 :	3,024,000
Year 10 :	3,132,000

---

* number of pre-production years.

** composite diminishing balance depreciation rate for Federal income tax.

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternatives 3,4,8 and 9

Parsons Tranportation Capital:	9,884,000 @	4% =	395,000
Plant and Machinery:	38,021,000 @	30% =	11,406,000
Transportation Facility:	3,000,000 @	4% =	120,000
Townsite:	1,500,000 @	30% =	500,000
	52,405,000	23.70%	12,421,000

% Variations: -8.59, +8.59, +17.18, +25.77

Capital/Pre-Production Year:	23,125,000	(2)
Year 5 :	3,024,000	
Year 10 :	3,132,000	

Alternatives 5 and 10

Parsons Transportation Capital:	9,884,000 @	4% =	395,000
Plant and Machinery:	38,021,000 @	30% =	11,406,000
Transportation Facility:	950,000 @	4% =	38,000
Townsite:	1,500,000 @	30% =	500,000
	50,355,000	24.50%	12,339,000

% Variations: -4.87, +4.87, +9.74, +14.61

Capital/Pre-Production Year:	22,100,000	(2)
Year 5 :	3,024,000	
Year 10 :	3,132,000	

Alternative 11

Parsons Transportation Capital:	3,580,000 @	4% =	143,000
Plant and Machinery:	90,406,000 @	30% =	27,122,000
Transportation Facility:	30,000,000 @	4% =	1,200,000
Townsite:	2,250,000 @	30% =	675,000
	126,236,000	23.08%	29,140,000

% Variations: -25.55, +25.55, +51.10, +76.65

Capital/Pre-Production Year:	40,580,000	(3)
Year 5 :	2,767,000	
Year 10 :	1,731,000	

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternative 12

Parsons Transportation Capital:	3,580,000	@ 4% =	143,000
Plant and Machinery:	90,406,000	@ 30% =	27,122,000
Transportation Facility:	15,000,000	@ 4% =	600,000
Townsite:	2,250,000	@ 30% =	675,000
	111,236,000	25.66%	28,540,000

% Variations: -15.51, +15.51, +31.02, +46.53

Capital/Pre-Production Year:	35,580,000	(3)
Year 5 :	2,767,000	
Year 10 :	1,731,000	

Alternatives 13 and 14

Parsons Transportation Capital:	3,580,000	@ 4% =	143,000
Plant and Machinery:	90,406,000	@ 30% =	27,122,000
Transportation Facility:	3,000,000	@ 4% =	120,000
Townsite:	2,250,000	@ 30% =	675,000
	99,236,000	28.28%	28,060,000

% Variations: -5.29, +5.29, +10.58, +15.87

Capital/Pre-Production Year:	31,579,000	(3)
Year 5 :	2,767,000	
Year 10 :	1,731,000	

Alternative 15

Parsons Transportation Capital:	3,580,000	@ 4% =	143,000
Plant and Machinery:	90,406,000	@ 30% =	27,122,000
Transportation Facility:	950,000	@ 4% =	38,000
Townsite:	2,250,000	@ 30% =	675,000
	97,186,000	28.79%	27,978,000

% Variations: -3.29, +3.29, +6.58, +9.87

Capital/Pre-Production Year:	30,896,000	(3)
Year 5 :	2,767,000	
Year 10 :	1,731,000	

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternative 16

Parsns Transportation Capital:	3,505,000 @	4% =		140,000
Plant and Machinery:	98,198,000 @	30% =		29,459,000
Transportation Facility:	30,000,000 @	4% =		1,200,000
Townsite:	2,250,000 @	30% =		675,000
	133,953,000	23.50%		31,474,000

% Variations: -24.08, +24.08, +48.16, +72.24

Capital/Pre-Production Year: 43,173,000 (3)
Year 5 : 2,766,000
Year 10 : 1,666,000

Alternative 17

Parsons Transportation Capital:	3,505,000 @	4% =		140,000
Plant and Machinery:	98,198,000 @	30% =		29,459,000
Transportation Facility:	15,000,000 @	4% =		600,000
Townsite:	2,250,000 @	30% =		675,000
	118,953,000	25.96%		30,874,000

% Variations: -14.50, +14.50, +29,00, +43.50

Capital/Pre-Production Year: 38,173,000 (3)
Year 5 : 2,766,000
Year 10 : 1,666,000

Alternatives 18 and 19

Parsons Transportation Capital:	3,505,000 @	4% =		140,000
Plant and Machinery:	98,198,000 @	30% =		29,459,000
Transportation Facility:	3,000,000 @	4% =		120,000
Townsite:	2,250,000 @	30% =		675,000
	106,953,000	28.42%		30,394,000

% Variations: -4.91, +4.91, +9.82, +14.73

Capital/Pre-Production Year: 34,173,000 (3)
Year 5 : 2,766,000
Year 10 : 1,666,000

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternative 20

Parsons Transportation Capital:	3,505,000 @	4% =	140,000
Plant and Machinery:	98,198,000 @	30% =	29,459,000
Transportation Facility:	950,000 @	4% =	38,000
Townsite:	2,250,000 @	30% =	675,000
	104,903,000	28.90%	30,312,000

% Variations: -3.05, +3.05, +6.10, +9.15

Capital/Pre-Production Year:	33,490,000 (3)
Year 5 :	2,766,000
Year 10 :	1,666,000

Alternative 21

Parsons Transportation Capital:	6,695,000 @	4% =	268,000
Plant and Machinery:	68,109,000 @	30% =	20,433,000
Transportation Facility:	30,000,000 @	4% =	1,200,000
Townsite:	1,875,000 @	30% =	563,000
	106,679,000	21.06%	22,464,000

% Variations: -29.88, +29.88, +59.76, +89.64

Capital/Pre-Production Year:	33,793,000 (3)
Year 5 :	2,895,000
Year 10 :	2,399,000

Alternative 22

Parsons Transportation Capital:	6,695,000 @	4% =	268,000
Plant and Machinery:	68,109,000 @	30% =	20,433,000
Transportation Facility:	15,000,000 @	4% =	600,000
Townsite:	1,875,000 @	30% =	563,000
	91,679,000	23.85%	21,864,000

% Variations: -18.41, +18.41, +36.82, +55.23

Capital/Pre-Production Year:	28,795,000 (3)
Year 5 :	2,895,000
Year 10 :	2,399,000

CAPITAL COSTS

ASSET AND TIME DISTRIBUTION

Composite Depreciation Rate

Alternatives 23 and 24

Parsons Transportation Capital:	6,695,000	@ 4%	=	268,000
Plant and Machinery:	68,109,000	@ 30%	=	20,433,000
Transportation Facility:	3,000,000	@ 4%	=	120,000
Townsite:	1,875,000	@ 30%	=	563,000
	79,679,000	26.84%		21,384,000

% Variations: -6.12, +6.12, +12.24, +18.36

Capital/Pre-Production Year:	24,795,000	(3)
Year 5 :	2,895,000	
Year 10 :	2,399,000	

Alternative 25

Parsons Transportation Capital:	6,695,000	@ 4%	=	268,000
Plant and Machinery:	68,109,000	@ 30%	=	20,433,000
Transportation Facility:	950,000	@ 4%	=	38,000
Townsite:	1,875,000	@ 30%	=	563,000
	77,629,000	27.44%		21,302,000

% Variations: -3.64, +3.64, +7.28, +10.92

Capital/Pre-Production Year:	24,112,000	(3)
Year 5 :	2,895,000	
Year 10 :	2,399,000	

REJECTED TRANSPORTATION ALTERNATIVES

Road: Mine-Ross River-Johnsons Crossing-Jakes Corner-Carcross-Skagway

Distance:	Mine-Ross River	:	34
	Ross River-Johnsons Corner	:	138
	Johnsons Corner-Carcross	:	55
	Carcross-Skagway	:	78
			305 miles

Capital Cost:

Mine-Ross River: (3,800,000)(28)/142	:	750,000
Ross River-Johnsons Corner: 138 mi. at $85,000/mile*	:	11,730,000
Carcross-Skagway: 66mi. at $120,000/mile	:	7,920,000
		$20,400,000

Operating Cost:

30 ton payload at U.S. $0.48/vehicle mile (PFS: 10-4)

Cost/ton transported: (610)(.48)/30 = U.S. $9.80 = Can. $10.60

Rejection Decision:

Compare with the road to Skagway via Carmacks alternative:

Capital Cost: $12,000,000

Operating Cost: Can. $11.30/ton transported

Break Even Tonnage = 8,400,000/.70 = 12,000,000 tons.

Neglect Time Value

Maximum tonnage over mine life (toll smelting alternatives):
20(350,000) = 7,000,000 tons.

Therefore, the road to Skagway via Carmacks transportation alternative is preferred.

---

* Canol Road is in bad condition and traverses rough terrain. Restoration cost for a road comparable in quality with other road alternatives estimated at $80-90,000/mile by J.M. Jacobsen, Engineering Division.

REJECTED TRANSPORTATION ALTERNATIVES

Road: Mine-Ross River-Carcross
Rail: Carcross-Skagway

Distance: 305 miles

Capital Cost: $12,480,000 (see preceding rejected alternative)

Operating Cost:

road portion: 227 miles
rail portion: 78 miles
305 miles

Road: 454(.48)/30 = U.S. $7.30/ton = Can. $7.80/ton transported
Rail: 14.60(78)(2)/337 = Can. $6.80/ton transported*

Total Operating Cost: $14.60/ton transported

Rejection Decision:

Compare with the existing road (via Carmacks) -rail alternative:

Capital Cost: $3,800,000
Operating Cost: $15.60/ton transported

Break Even Tonnage = 8,680,000/1.00 = 8,680,000 tons

Maximum tonnage over mine life = 7,000,000

Therefore, the existing road (via Carmacks) -rail alternative is preferred.

---

* based on operating cost estimate for the extension of existing narrow gauge line: Whitehorse-Mine (337 miles at $14.60/ton). Contains an assumed factor of 2 for short haul diseconomies.

COMPARISON OF MINING-MILLING AND SMELTING-REFINING RATES OF RETURN

Using Parsons' Preliminary Feasibility Study compare:

Case A: Toll smelting of concentrates (PFS: Table 3-9)

Case B: Electrolytic zinc-blast furnace lead processing (PFS: Table 3-11)

All figures in U.S. currency.

Lead at 12-1/2 ¢/lb

Zinc at 13 ¢/lb

Year	Cash Flow - mil. $		
	Case A	Case B	Case (B-A)
-3		-25.275	-25.275
-2	-19.829	-29.487	- 9.658
-1	-19.829	-29.487	- 9.658
1	+ 5.949	+11.088	+ 5.139
2	+14.711	+22.495	+ 7.784
3	+16.487	+24.591	+ 8.104
4	+13.143	+20.271	+ 7.128
5	+10.316	+17.698	+ 7.382
6	+11.088	+17.498	+ 6.410
7	+11.038	+17.380	+ 6.342
8	+10.919	+17.114	+ 6.195
9	+10.926	+17.134	+ 6.208
10	+ 8.016	+15.524	+ 7.508
11-13	+11.250	+17.313	+ 6.063
14-20	+10.927	+17.134	+ 6.207
21	+11.141	+14.527	+ 3.386
Rate of Return	21.4% (PFS: Table 3-1)	18.0% (PFS: Table 3-2)	11.4%

C O P Y

ANVIL MINING CORPORATION LIMITED
523 West Sixth Street
Los Angeles, California 90014
Telephone 629-5771

JUNE 27, 1966

KENNETH LIEBER
President
ROBERT H. COLLINS III
Administrative Assistant

Cable Address
ANVLZING

The Honorable Arthur Laing,
Minister of Northern Affairs and
National Resources,
Parliament Buildings,
Ottawa, Ontario, Canada.

My dear Mr. Minister:

Anvil Mining Corporation Limited is completing its feasibility analysis of bringing its property in the Yukon Territory of Canada into production. To this end, we have delivered to your staff a copy of the preliminary feasibility study analyzing numerous alternates for producing the property. It is obvious from study of this work that the initial phase of development of the Anvil property should be the opening of the mine, the building of a concentrator for production of high-grade lead and zinc concentrates, and the construction of the necessary off-site facilities for such an operation. We fully recognize your desire, as well as our own, for a complete smelting facility in the Yukon, and are willing to express our intent to continue with further studies of a smelter.

However, to initially bring the property into production, we need assistance from you and your department in the following areas:

1. Construction and operation of a power facility capable of delivering 14,000 kw to our plant in the Vangorda Creek area.

2. All-weather road transportation from the Anvil property to tidewater, preferably the Haines area of Alaska.

3. The development and construction of a townsite to house the people necessary for the operation of the facility.

Anvil has spent $4 million since July, 1965, in its exploration and development program of the Vangorda Creek area of the Yukon Territory. The Board of Directors of Anvil last week approved a budget calling for another $1.5 million expenditure for the second half of 1966. By late 1966, we will have sufficient detailed analysis completed so that the Board of Directors can act on the resolution to appropriate the necessary funds to bring the property into production. During the next few months, we would like to meet with you and your advisors to discuss the possibilities of government financial assistance in the fields of transportation, power and townsite. We would hope that the government, like Anvil, could proceed with its engineering analysis and feasibility studies so that specific costs (both capital and operating) as well as specific routes, locations, rates and taxes might be discussed and agreed upon between us.

We recognize that final authorization of the funds to complete this work rests with your Parliament, as it does with our Board of Directors. However, if we both complete the necessary pre-engineering and analysis, we believe it will be an easier matter when it comes to the finalization of the program.

We will look forward to your reply, and to meeting with you very soon.

Respectfully submitted,

(sgd.) Kenneth Lieber
by Robert H. Collins

Kenneth Lieber.

NORTHERN CANADA POWER COMMISSION

Memorandum No. 7381

Date July 26, 1966

To Chairman

From E.W. Humphrys

Subject

Your File No.

Our File No.

The Minister enquired (in a note on the letter of Transmittal re the Auditor General's report and financial statements for 1965/66) regarding surveys etc. for power supply for Van Gorda Creek Mining area. This situation is:

Anvil Mining have given us their projected power requirements based on a 3 stage development as follows:

Step 1 - Milling and concentrating	only	12,600 KW
Step 2 - " " "	& Smelting	71,000 KW
Step 3 - " " "	" & Iron & Sulphur Recovery	95,000 KW

Anvil have indicated that there is likely to be a lapse of 5 years - between steps 1 and 2, and while step 2 is highly probable step 3 is problematical. Anvil have quoted 8 mils as a maximum tolerable power cost for steps 2 and 3 but they recognize that an appreciably higher cost would likely be unavoidable (and could be accepted) for step 1.

We first checked with the Water Resources Branch to obtain data in respect to possible power sites in the Yukon within economic transmission distance of Van Gorda Creek area, following which we asked Montreal Engineering to review this data and prepare preliminary cost estimates of the more attractive looking sites. A quick field reconnaisance of the more attractive sites was carried out by J. Long of our staff and a senior member of Montreal Engineering Company staff in early May.

Included in the above study has been expansion of the existing Whitehorse Rapids hydro development since it appeared that this might be the best way meeting the step 1 requirement. These studies also included an estimate of the cost of a thermal power development at Carmacks (using Carmacks coal) and thermal (gas turbine) plants at Carmacks, Van Gorda Creek and Whitehorse, using gas from the Eagle Plain or from the Beaver River Valley area.

The results to date may be summarized as follows:

(a) Stage 1 requirements can best be met by adding 2 - 8000 KW units to the existing Whitehorse Rapids development and constructing a storage dam at the outlet of Marsh Lake. This would constitute ultimate development of the Whitehorse site (27,000 KW). In addition to Anvil's step 1 requirements it would supply the increased demand of the Whitehorse area (which would probably evantually require installation of No. 3 unit even if the Anvil project were not involved).

Est. Cost	2 - 8000 KW Unit addition	$ 5,040,000
	Marsh Lake Storage Dam	2,430,000
	Transmission Lines	
	Whitehorse to Carmacks	2,400,000
	Carmacks to Van Gorda Creek	2,500,000
		$12,370,000

Est. Cost of power - (Basis Anvil Mining consuming 72,000,000 KWHrs)

Whitehorse - Bus Bar Cost -	8.6 mils/KWHr
Anvil Mining-Van Gorda Creek -	13.1 mils/KWHr

(b) Step 2 - Additional 58,400 KW (say 60 MW).

The Five Fingers Rapids site on the Yukon River just below Carmacks appears to be the most attractive site to supply this increment.

Est. Cost	3-22.5 HW Units (90,000 HP) including transmission to Carmacks	$34,300,000

Average Cost of power at Van Gorda Creek, assuming 71 MW Load (12.0 MW supplied from Whitehorse; 59 MW from 5 Fingers)- 6.5 mils/KWHr.

(c) The additional 24 MW required for step 3 (total 95 MW) could be supplied by the Five Fingers Rapids site. The ultimate cost of power at Van Gorda would likely remain in the 6 to 6.5 mil range.

(d) If because of International considerations it is not practicable to develop the Five Fingers Rapids site (due to it being a main stem-Yukon River - site) the step 2 requirements could be met by developing the Granite site on the Pelly River some 15 miles to the east of the Pelly Crossing. This site would involve greater capital expense, viz. $49,300,000, and the delivered cost of power would approach 8.5 mils (.5 mil above the top limit set by Anvil).

...3

Due to lack of storage the Granite site could not be expanded to supply stage 3, hence another site would have to be developed to meet that requirement.

(e) Sites on the Francis and Highland rivers in the south east Yukon have been considered and appear to have possibilities; but have not been appraised in detail. These sites might prove preferable to Granite as an alternative to Five Fingers, even though they would not co-ordinate with the expanded Whitehorse development as well as Five Fingers or Granite.

(f) Since Five Fingers Rapids is so obviously the most attractive site, the next step is to determine whether or not the international considerations that militate against developing this site can be satisfied, before any further site studies (including field work) are carried out. A separate paper is being prepared to initiate action looking towards a solution to this problem.

E.W. Humphrys.