NATURAL RESOURCE INSTITUTE
UNIVERSITY OF MANITOBA

PRACTICUM

AN EXAMINATION OF THE CONTRACTUAL ARRANGEMENTS GOVERNING THE SUPPLY OF HYDRO-ELECTRICITY TO THE MINING INDUSTRY IN NORTHERN MANITOBA

Submitted by

Alison Mary Hine

In Partial Fulfillment of Requirements for the Degree of
Master of Natural Resource Management

1975

AN EXAMINATION OF THE CONTRACTUAL ARRANGEMENTS GOVERNING THE SUPPLY OF HYDRO-ELECTRICITY TO THE MINING INDUSTRY IN NORTHERN MANITOBA

by

ALISON MARY HINE

A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF NATURAL RESOURCE MANAGEMENT

ABSTRACT

This Practicum examines the contractual arrangements between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited., governing the supply of hydro-electricity from the Kelsey Generating Station in northern Manitoba. One of the objectives of this Practicum is to quantify this relationship for the years 1961 to 1970. The main purpose of this Practicum is, however, to illustrate that objective discussion of this topic is contingent upon the resolution of certain theoretical questions.

In the preface, the confusing state of current recource management is commented upon. The suggestion is made that part of this confusion may be due to unresolved theoretical debate. In the introduction, the discussion of the contractual agreements is put into this broader perspective. The agreements between the contracting parties governing the sale of hydro-electricity and The Manitoba Hydro Act are discussed.

Chapter 2 provides a chronology of events and specific details of the agreements. The objective of Chapters 3 and 4 is to provide the methodological framework and to determine whether the analysis is sensitive to the use of different analytical approaches. The analysis is tested both by using different rates of return on the

capital invested at Kelsey and by making adjustments for inflation.

In the final chapter it is concluded that the analysis is indeed sensitive to these different analytical approaches. This issue is then discussed in a historical and current economic perspective with the aim of highlighting some of the differences in these two perspectives. Some of the policy issues behind these theoretical questions are touched upon.

PREFACE

It is not the author's intention to discuss the somewhat bewildering state of resource management. Rather, it is hoped that this Practicum might play a small role in an essential trend in demystifying resource management. The attempt is to remove ideology, to remove politics, to remove propaganda and to provide a rational, logical basis for objective discussion.

Such a logical response is far from simple. The analytical tools at hand are often subject to much contention and can be used to manipulate and confuse, rather than clarify. Nevertheless the attempt at objectivity is desperately needed.

ACKNOWLEDGEMENTS

I would like to thank Manitoba Hydro and The International Nickel Company of Canada Ltd., for permission to use data relevant to this Practicum. Without help and co-operation from Manitoba Hydro, in particular Mr. Chris Goodwin and Mr. Bruce Cameron, this study would have been impossible.

The help, encouragement and criticism from my Practicum committee was invaluable. I would like to express my gratitude for all the time that Mr. Jack Atchison (Manitoba Hydro) and Mr. David Young (Lombard North) spent on this study. Finally I would like to thank my committee chairman, Dr. Bob Fenton (InterGroup Consulting Economists) for all the time and energy that he devoted to this Practicum.

CONTENTS

LIST OF TABLES

INTRODUCTION

The Problem

This Practicum will examine the contractual arrangements between the Manitoba Hydro-Electric Board (Manitoba Hydro) and The International Nickel Company of Canada Ltd. (INCO), for the supply of electrical power to the Thompson area of northern Manitoba.

An agreement for the supply and sale of hydro-electric power to INCO was signed in 1961. It was agreed that Manitoba Hydro would construct the Kelsey Generating Station and associated transmission facilities and reserve for INCO 98.4 megawatts (MW) of power annually[1] for a twenty year period. In return, INCO agreed to pay:

> Such amounts as shall equal in the aggregate all the costs of the Board (Manitoba Hydro) in supplying such power during such a period, such costs being presently referred to in Section 40 of 'The Manitoba Hydro Act'.[2]

Provisions were made for the delivery of power over and above the 98.4 MW negotiated in the initial agreement of 1961. The terms were defined in two supplemental agreements in 1965 and 1967 respectively. The agreement in 1965 set a rate for surplus energy available from the Kelsey Generating Station. The 1967 agreement defined the

---

1. See Appendix 1.

2. The Original Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1961, p.19, Article 6.1.

terms for the purchase of energy from the interconnected system.[3]

The conditions for the sale of power by Manitoba Hydro to any customer are governed by The Manitoba Hydro Act.[4] The intent of this Act is to:

> Provide for the continuance of a supply of power adequate for the needs of the province, and to promote economy and efficiency in the generation, distribution, supply, and use of power.[5]

Within this framework, The Act stipulates that:

> The prices payable for power supplied by the corporation shall be such as to return to it in full the costs to the corporation, of supplying the power.[6]

These include operating expenses, all interest costs associated with the financing of construction, purchase and operation of the property and works of Manitoba Hydro and reserves or funds for depreciation, insurance and rate stabilization.[7]

The allocation of costs of supplying power set out in the agreements, between the two parties, should fall within the scope of The Act. An examination of this

---

3. Kelsey was interconnected with the general Manitoba transmission network in 1967.

4. The Manitoba Hydro Act, Revised Statutes of Manitoba, S.M., 1961 (1st Sess.), c.28, 1970 Vol. 2, ch. H190.

5. Ibid, Section 3, p.2.

6. Ibid, Section 39 (1), p.19.

7. Ibid, Section 40 (2), p.20.

problem should first establish whether the terms for the sale of hydro-electricity to INCO, lie within the terms of reference of Manitoba Hydro's mandate. Insofar as the period 1961/62 to 1970/71 is concerned, Manitoba Hydro's charges are set according to the agreement and within the scope of The Manitoba Hydro Act. Since this is the case, then it is The Manitoba Hydro Act, not the activities of Manitoba Hydro, per se, that should be discussed.

The discussion itself must, therefore, shift to examine whether the terms in The Manitoba Hydro Act, as reflected in the agreement between Manitoba Hydro and INCO, are in the public interest. The question for debate seems to lie in the interpretation of the word cost, whether investments made by a Crown Corporation, such as Manitoba Hydro, should be expected to earn a social rate of return[8] and what this rate should be.

Herein lies the crux of the problem. The Original Agreement between INCO and Manitoba Hydro was negotiated in 1956 and signed in 1961. Terms that may have been in the public interest at the time, may now, in hindsight, seem questionable, due to changing economic circumstances. To further complicate, the theoretical debate concerning the

---

8. See Appendix 1.

appropriate social rate of return and the definition of cost are far from resolved in the literature. The choice of one analytical approach over another will often dictate the outcome of the analysis. Thus, by its very nature, this type of analysis is often prone to partisan discussion.

This small problem is symptomatic of the much broader issue discussed in the preface. The analysis is far from simple and the methodology itself is not free from theoretical debate. These factors, combined with diverging political opinions can only lead to confusion and complexity. Far from moving toward a public understanding of the relationship between Manitoba Hydro and a private company, the issue can become obscured. If such a minute corner of resource management can create such confusion, then it is no wonder that broader and far more serious resource controversies exist.

The Objectives

The objectives of this Practicum are four fold:

1) To determine whether Manitoba Hydro is supplying INCO with power at less than cost. This will involve an evaluation of costs using different rates of return, a comparison of depreciation costs based on historical capital costs, with capital costs inflated to reflect increases in hydro-electric construction costs and a discussion of opportunity costs.

2) To analyse the data using different analytical tools, where theoretical debate prevails in the literature, with the aim of providing objective commentary on the results in the light of these different approaches.

3) To demonstrate that the interpretation of the data derives mainly from theoretical arguments, and that the choice of one approach over another will seriously bias the conclusions.

4) To discuss The Manitoba Hydro Act and the agreements between Manitoba Hydro and INCO, in the light of the above.

CHAPTER 2

BACKGROUND INFORMATION

Chronology

1956. Manitoba Hydro and INCO entered into negotiations for the delivery of power to the mining development at Thompson. The negotiations resulted in the decision to build a generating station on the Nelson River with an initial maximum capacity of 125 MW. The Kelsey Generating Station would operate under a 50 foot head of water and with design potential to double the initial capacity.[9]

1960 On the 22nd June 1960, power was transmitted to INCO's mining operation and to the townsite of Thompson[10]. INCO's mining exploration activities continued at both Thompson and Pipe Lake.[11]

1961 Installation of a 5th generating unit, brought the capacity of Kelsey up to about 160 MW.[12] On April 1st 1961, The Original Agreement between Manitoba Hydro and INCO was signed, defining the conditions for the reservation and or supply of 98.4 MW of power.[13]

---

9. Manitoba Hydro-Electric Board, 6th Annual Report, 1957, p.5.
10. Manitoba Hydro-Electric Board, 10th Annual Report, 1961, p.4.
11. The International Nickel Company of Canada Ltd., Annual Report, 1960.
12. Manitoba Hydro-Electric Board, op.cit., 1961, p.4.
13. The Original Agreement, op.cit., 1961.

INCO's mining development in Thompson produced 75,000,000 lbs. of nickel in their first year of operations. Exploration at Pipe Lake continued.[14]

1962. Thompson's nickel output rose to 90,000,000 lbs. Preparations were made to the Thompson site for the sinking of a second and third production shaft.[15]

1963. Nickel output from Thompson remained at a constant level. Preparations continued for further expansion at Thompson.[16]

1965. The First Supplementary Agreement was signed, setting the terms for the supply of surplus power available from Kelsey, over and above the 98.4 MW contract.[17] Two exploration shafts were sunk at the Soab mine, some 40 miles southwest of Thompson.[18]

1967. The construction of a transmission line between Kelsey and the Grand Rapids Generating Station was completed in 1967, linking Kelsey to the southern system. The Second Supplementary Agreement defined the conditions for the supply and purchase of power

---

14. The International Nickel Company of Canada Ltd., Annual Report, 1961.
15. The International Nickel Company of Canada Ltd., Annual Report, 1962.
16. The International Nickel Company of Canada Ltd., Annual Report, 1963.
17. The First Supplementary Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1965.
18. The International Nickel Company of Canada Ltd., Annual Report, 1965.

from the interconnected system. The agreement also made provisions for the financing of additional capacity at Kelsey.[19] To meet future output from the New Pipe Mine and the Soab Mine, INCO started to expand the mill, smelter and refinery at Thompson. The Birchtree mine started operations in 1967.[20]

1969. The 6th generating unit was completed and started producing power in 1969, increasing Kelsey's capacity to 198 MW. The expansion of the mill, smelter and refinery was completed in 1969. The New Pipe and Soab mines were expected to be producing nickel by 1971.[21]

---

19. The Second Supplementary Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1967.

20. The International Nickel Company of Canada Ltd., Annual Report, 1967.

21. The International Nickel Company of Canada Ltd., Annual Report, 1969.

The Agreements Between Manitoba Hydro and INCO

This background is not intended to be comprehensive, but rather to provide a summary of the essential features of the three agreements. Those aspects, such as engineering details, that are not relevant to the discussion in this Practicum, are excluded.

The Original Agreement (1961)[22]

Article 3 defined the financial assistance that Manitoba Hydro received from INCO, for the construction of the Kelsey Generating Station plus transmission line. INCO agreed to lend the corporation a sum of twenty million dollars bearing interest at 2% and maturing on January 1st 1965.[23] It was agreed that, as far as possible, the billing for power should be adjusted to account for INCO's low interest loan to Manitoba Hydro.[24]

The conditions for the reservation of power were set out in Article 5. Manitoba Hydro could supply power from other units at the generating station. However, for the purposes of billing this power would be considered to have been supplied from generating units 1 to 4.[25] If INCO's power requirements exceeded that available or potentially available capacity from Kelsey, then Manitoba

---

22. The Original Agreement, op.cit., 1961.
23. Ibid, p.9, Article 3.2.
24. Ibid, p.10, Article 3.6.
25. Ibid, p.15, Article 5.1.

Hydro would examine how such requirements could best be satisified, subject to future agreement.[26] Article 5 also states that the interconnection of Kelsey with any other generating station will affect neither the reservation, nor the characteristics of the 98.4 MW of power.[27]

The provisions for the allocation of the costs of power are defined in Article 6. Article 6.1 states that INCO shall pay all the costs of supplying 98.4 MW of power for the 20 years of the agreement. The costs being defined in Section 40 of The Manitoba Hydro Act.

Depreciation was computed on a straight line basis. The parties agreed that for the duration of the agreement, depreciation, would not exceed 50% of the initial capital costs (excluding the initial transmission line costs), 100% of the initial transmission line costs, 100% of the accounting adjustments referred to in Article 3, (concerning the interest on INCO's loan) and an appropriate depreciation on all capital additions.[28]

Interest was calculated on the 20 million dollars loaned by INCO at the agreed rate,[29] on any moneys borrowed in excess of the 20 million, plus appropriate adjustments

---

26. Ibid, p.16, Article 5.3.
27. Ibid, p.18, Article 5.4.
28. Ibid, p.19, Article 6.3.1
29. Ibid, p.21, Article 6.3.3.1.

for interest on reserves for depreciation. The interest rate used for the initial capital investment (in excess of the $20 million loan) was set at 5.53% per annum.[30] The interest rate used for moneys borrowed or used from depreciation reserves, for capital additions, would reflect the cost of capital.[31] Administrative costs were fixed at $75,000 per annum.[32]

Manitoba Hydro agreed not to charge as contingency or general reserves (excluding depreciation and insurance reserves) an amount which would increase the cost per kilowatt hour to more than 4.5 mills in the power year. (This figure of 4.5 mills/KWH would, however, be adjusted to reflect increasing capital and operating costs). Provided that this amount was not less than $200,000, an agreed minimum for contingency reserves.[33]

Should INCO suspend its mining operations before 1981 then the company would be liable for the full cost of the hydro-electric development as defined in Article 9.[34]

Article 15 provides for the delivery of power for the period 1981 to 2001. Manitoba Hydro will reserve

---

30. Ibid, p.22, Article 6.3.3.2.
31. Ibid, p.22, Article 6.3.3.4.
32. Ibid, p.22, Article 6.3.3.5.
33. Ibid, p.24, Article 6.3.7.
34. Ibid, p.31, Article 9.1.

and or supply, for the 20 year period, that amount of power required by INCO during the year 1980 to 1981, the last year of the Original Agreement.[35] Should INCO discontinue its operations, 2 years prior notice must be given. All provisions in the agreement would then cease, subject to INCO's obligation to pay for reserved or supplied power to date.[36]

The First Supplementary Agreement (1965)[37]

The First Supplementary Agreement provides for the purchase of power in excess of the 98.4 MW contract:

> The first 98,400 kilowatts of demand shall be deemed to be supplied by Manitoba Hydro from the Primary Development as the same is defined in the Original Agreement.[38]

Manitoba Hydro agreed to construct a 230 KV electric transmission line between Grand Rapids Generating Station and Kelsey and to supply firm power, over an above the 98.4 MW, from the interconnected system at $32.50 per kilowatt per year up to 85% load factor.[39] Article 19 states that the cost of this interconnection shall not be included in INCO's billing for power provided that neither party waives the provisions set out in the Original Agreement for any future interconnections. (Namely that INCO will pay an equitable portion of the costs of any future

---

35. Ibid, p.48, Article 15.1.
36. Ibid, p.48, Article 15.1.1.
37. The First Supplementary Agreement, op.cit., 1965.
38. Ibid, p.10, Article 10.
39. Ibid, Schedule B.

interconnection). Until the completion of the transmission line, Manitoba Hydro agreed to supply firm and interruptible power, that it might have available from the Kelsey Generating Station. For firm and interruptible energy, INCO would be billed for 5 mills per kilowatt hour and 1.25 mills per kilowatt hour respectively.[40]

The Second Supplementary Agreement (1967)[41]

The obligations under the 1965 agreement ceased with the signing of the Second Supplementary Agreement. Manitoba Hydro agreed to supply power from the interconnected system according to the schedules set out in Article 9, at $32.50 per kilowatt per year between 98.4 MW and 133.6 MW and $35.00 per kilowatt per year for power over 133.6 MW up to 85% load factor, for firm energy and 1.25 mills per kilowatt hour for interruptible energy.[42]

The provisions for financing the 6th generating unit at Kelsey were described in Article 7. INCO agreed to advance to Manitoba Hydro a total of $5,000,000, in five yearly installments of $1,000,000; each bearing interest of 5 1/2% per annum and each maturing in five years, from the time of their issue.[43]

---

40. Ibid, Schedule A and Schedule C.
41. The Second Supplementary Agreement, op.cit., 1967.
42. Ibid, Schedule B and Schedule C.
43. Ibid, p.6, Article 7.

CHAPTER 3

METHODOLOGY

The purpose of this chapter is to provide the broad methodological framework for the analysis and to discuss the rationale for the choice of different approaches.

The Original Agreement tied the reservation and supply of 98.4 MW of power to the cost of generating that power as defined by The Manitoba Hydro Act. The later agreements set the provisions for the supply of power, either surplus from Kelsey (in excess of 98.4 MW) or available from the interconnected system. From 1967 onwards, it became significantly more difficult to maintain the original, specific relationship between INCO and the Kelsey Generating Station.

For the purposes of this Practicum, the costs of reserving 98.4 MW of power were calculated for the period, 1961 to 1970. In the interests of completeness, the costs of supplying all INCO's power requirements were also calculated, for the same time period. This second approach took into consideration the costs of additional capacity to Kelsey in 1967.

An evaluation of the cost of hydro-electric generation from the interconnected would be extremely complex. It was, therefore, assumed that once the interconnection was established Kelsey operated at capacity, providing INCO

with all the available power.[44] Given this assumption, the effect of the interconnection could then be ignored and the sale of hydro-electricity to INCO could be related to the cost of generating all the available power at Kelsey.

The 98.4 MW contract and the supply of total, available power from Kelsey were both analysed in three ways. It is hoped that these three different analytical approaches will be sufficient to demonstrate the nature of the problem. The problem being one of choice of methodology rather than fact. This chapter will consider these three approaches in turn.

a) Average cost per kilowatt hour as defined by the three agreements.

The average cost per kilowatt hour for a given year was calculated by dividing INCO's total billing for power in that year, by its annual consumption of energy (KWH). INCO's annual billing was the sum of the operating costs, the administrative costs, the interest costs, depreciation and an amount for the contingency reserve, all defined in the Original Agreement.

---

44. Some adjustments were made to the data, to account for the fact that from 1968 onwards, INCO's power consumption was greater than the total capacity available at Kelsey. The details are discussed in Chapter 4.

b) Average cost per kilowatt hour at different social rates of return.

It is generally agreed that the interest rate, in theory at least:

> Serves as a price in the capital market bringing the savings preferences of consumers into consistency with the investment plans of business enterprises.[45]

In other words, in the private sector, the market interest rate, in some way, usually reflects the investors opportunity cost of capital. The dispute arises when government investment activities are considered. Since decisions are often made in a political and social context, considerations other than economic, will often govern the nature of public investment and expenditures.

> Whenever the ballot box and the political process replace market choice, investment decisions will not be made by comparing the rate of return of investments with the market rate of interest.[46]

Not only is there an aspect of market failure, but it is also argued that public investments should be expected to earn a social rate of return, reflecting the opportunity cost of the employed resources.

In the case at hand, it could be argued that Manitoba Hydro, a Crown Corporation, should earn a social

---

45. J.V. Krutilla, O. Eckstein, Multiple Purpose River Development, Studies in Applied Economics. John Hopkins, 1958, p.78.

46. Ibid, p.78.

rate of return on their investment at Kelsey. In turn INCO's payments should reflect this opportunity cost. It must be emphasised that it is not the intent of this Practicum to argue for or against a particular rate of return. In order to circumvent this problem, the calculation of the average cost per kilowatt hour was undertaken at different rates of return. Three rates were chosen, 5%, 10% and 15%. This range was considered reasonable in the light of historical and current economic conditions. The low rate of 5% was chosen, since it was close to the interest rate defined in Article 6.3.3.2 of the Original Agreement. (5.53%) The question of the appropriate rates of return will be discussed in greater detail in Chapter 5.

The initial construction costs were capitalised to give their present value in 1961 at 5%, 10% and 15%. In order to annualise the initial capital costs, the capital recovery method was used. This combines both ammortisation and a rate of return on capital invested, to give an equal annual capital charge over the 50 year life of the installation. When Manitoba Hydro does its costing, the annual capital costs are not equal due to declining interest payments.

Both insurance and interim replacement costs were included in the annual operations costs. Annual interim re-

placement costs were escalated by the general wholesale price index,[47] to reflect inflation. Labour costs also included adjustments for annual wage increases.

Both the annual capital charges and the operations costs were calculated per kilowatt installed. In other words both figures were divided by the capacity. (KW)[48] The total annual cost per kilowatt was then computed.[49] The average cost per kilowatt hour was calculated assuming an 85% load factor (ie. 7446 hours of hydro-electric generation in one year), at the three rates of return.[50]

c) Average cost per kilowatt hour escalated to reflect inflationary changes.

The period 1961 - 1970 has been characterised by rising interest rates and increased prices of capital

---

47. Statistics Canada. Canadian Statistical Reviews, Catalogue 11-003E.

48. For the analysis of the Original Agreement, an annual capacity of 98.4 MW was used for the years 1963-70. For the first two years, the cost per kilowatt was calculated on INCO's power requirements. The analysis of the total supply of hydro-electricity from Kelsey, considered the cost per kilowatt on the basis of INCO's power consumption in a given year. When INCO's power demand exceeded Kelsey's capacity in 1968, the cost per kilowatt was calculated for the total capacity available at Kelsey.

49. Total annual cost/KW = Annual capital charges/KW + operating costs/KW.

50. Average cost/KWH = $\frac{\text{Total annual cost/KW}}{\text{7446 Hours}}$

goods, in part due to inflationary pressures. It has been argued that the annual capital charges should reflect these upward inflationary changes. In other words, the true opportunity cost of generation should include an adjustment for inflation.

The annual capital charges per kilowatt were, therefore, escalated by the price index for hydro-electric construction for the period 1961 to 1970.[51] Apart from this adjustment, the analysis was identical to that described in 3(b).

---

51. Statistics Canada, Construction Price Indexes for Hydro-Electric Generating Station. 1961-1970, Catalogue 62-533.

CHAPTER 4

ANALYSIS

The first section of this chapter will consider only the 98.4 MW contract, as defined in the Original Agreement between Manitoba Hydro and INCO. The second section will deal with the total supply of hydro-electric power from Kelsey to INCO. This analysis must, therefore, consider the cost of capital additions. With the interconnection of Kelsey to the southern transmission system, in 1967, INCO's billing for power, and the cost evaluation became significantly more complex. As of 1967, INCO could no longer be considered the sole customer of power from Kelsey and INCO may indeed have purchased hydro-electric power from the interconnected system. These factors make the analysis in the second section of this chapter somewhat more involved.

For the sake of clarity, the details of the calculations were included in the appendices at the end of this Practicum.

Section (i)

Analysis of the 98.4 MW Contract

(a) INCO's payments for 98.4 MW of power as defined in the Original Agreement.

In order to determine the billed average cost per kilowatt hour, it was necessary to calculate INCO's annual energy consumption from the 98.4 MW contract. Given the

rates for firm and interruptible energy in the supplementary agreements, and data concerning INCO's billing for load in excess of 98.4 MW, it was possible to estimate INCO's consumption of energy supplied from the 98.4 MW of reserved power, for the years 1965 to 1971.[52] Using this information the following billed cost of energy was calculated.

Table 1: Average cost per Kilowatt hour (mills) as defined in the Original Agreement

Year	Mills
1961/62	5.4
1962/63	4.9
1963/64	3.9
1964/65	4.4
1965/66	4.6
1966/67	4.7
1967/68	5.4
1968/69	6.6
1969/70	6.8
1970/71	7.4

b) Evaluation of the average cost of generation at different rates of return.

The Annual capital charges were calculated for the initial construction costs. These include all the costs of constructing the transmission line and the Kelsey Generating Station, with its five generating units. The costs of the 6th generating unit were excluded since the provisions for additional capacity were set out in later agreements between the two parties. Total annual costs per kilowatt installed

52. By request from INCO, data concerning their annual energy consumption for the period 1961 to 1970 are not included in this Practicum, for reasons of confidentiality.

were calculated for the 98.4 MW of reserved capacity. An 85% load factor was used to convert these costs per kilowatt to the average cost per kilowatt hour. (Appendix 2) As discussed in Chapter 3, three rates of return (5%, 10% and 15%) were used to calculate the annual capital charges.

Table 2: Average cost per kilowatt hour (mills) at 5%, 10% and 15% return on capital invested.

	Mills		
Year	5%	10%	15%
1961/62	4.6	8.8	14.1
1962/63	4.7	8.9	14.1
1963/64	4.5	8.5	13.5
1964/65	4.6	8.6	13.6
1965/66	4.6	8.6	13.6
1966/67	4.6	8.6	13.6
1967/68	4.8	8.7	13.7
1968/69	4.9	8.9	13.9
1969/70	4.9	8.9	13.9
1970/71	4.8	8.8	13.8

Source: Appendix 2.

c) Evaluation of the average cost of generation, allowing the annual capital charges to reflect inflationary increases.

The methodology used was identical to the above analysis except that the annual capital charges were inflated using the construction price index for hydro-electric generating stations.[53] It was assumed that this index reflected a reasonable inflation rate for the hydro-electric installation in question (Appendix 3). To be consistent with previous results, the same three rates of return were used.

53. Statistics Canada, 1961-70, op.cit., Catalogue 62-533.

Table 3: Average cost per kilowatt hour (mills) increased to reflect annual inflationary changes.

	Mills		
Year	5%	10%	15%
1961/62	4.6	8.8	14.1
1962/63	4.8	9.1	14.4
1963/64	4.7	8.9	14.3
1964/65	5.0	9.3	14.8
1965/66	5.2	9.8	15.5
1966/67	5.6	10.3	16.4
1967/68	5.7	10.7	17.1
1968/69	6.1	11.3	18.2
1969/70	6.4	11.9	18.9
1970/71	6.6	12.4	19.8

Source: Appendix 3.

Section (ii)

Analysis of the Total Supply of Power from Kelsey

a) INCO's payments for total power as defined by the three agreements.

By 1965, INCO's power requirements were greater than 98.4 MW. Manitoba Hydro agreed to sell available surplus energy from Kelsey, as set out in the two supplementary agreements. From 1968 to 1970, INCO's power demand exceeded the available capacity. It was assumed that this additional energy was purchased from the interconnected system. INCO's total billing did not separate energy supplied from the Kelsey generating Station, from energy generated from the interconnected system. It was therefore assumed, that Kelsey operated at capacity, providing INCO with all the available energy. In order to obtain the average cost per kilowatt hour that pertained to Kelsey alone, the total bill-

ing was reduced by the following factor:[55]

$$\frac{\text{INCO's capacity requirements (MW)} - \text{Kelsey's total capacity (MW)}}{\text{Kelsey's total capacity (MW)}} \times 100$$

Table 4: Average cost per kilowatt hour (mills) for total power as defined in the three agreements.

Year	Mills
1961/62	5.4
1962/63	4.9
1963/64	3.9
1964/65	4.4
1965/66	4.3
1966/67	4.5
1967/68	4.4
1968/69	5.6
1969/70	5.7
1970/71	5.7

b) Evaluation of the average cost of generation at different rates of return for total available power from Kelsey.

In broad terms, the analysis was similar to that described in Section (i)b. The costs of the capital additions were annualised over the remaining life of the facilities with expected returns of 5%, 10% and 15%. These costs were added to the annual capital charges for the initial development for the last two years of the analysis. For the years 1961 to 1967 costs per kilowatt were computed on INCO's power requirements for each year. From 1968 onwards, when INCO's power requirements exceeded Kelsey's capacity, the annual costs per kilowatt installed were calculated for the available power at Kelsey. (Appendix 4)

55. For the years in question, this amounted to reducing INCO's total billing by 5.6% in 1968, 1.8% in 1969 and 7.5% in 1970.

Table 5: Average cost per kilowatt hour (mills) for total power available from Kelsey at 5%, 10% and 15% return on capital invested.

	Mills		
Year	5%	10%	15%
1961/62	4.6	8.8	14.1
1962/63	4.7	8.9	14.1
1963/64	4.5	8.5	13.5
1964/65	4.6	8.6	13.6
1965/66	4.2	7.7	12.2
1966/67	4.1	7.5	11.9
1967/68	3.6	6.6	10.5
1968/69	3.2	5.7	8.9
1969/70	3.2	5.8	9.0
1970/71	3.0	5.4	8.5

Source: Appendix 4.

c) Evaluation of the average cost of generation for total available power from Kelsey, allowing annual capital charges to reflect inflationary changes.

Annual capital charges were inflated by the construction price index for hydro-electric generating stations, as in Section (i)c. Since the annual capital charges for the 6th generating unit reflect actual costs, these were treated separately and only inflated for the last two years of the analysis. (Appendix 5)

Table 6: Average cost per kilowatt hour (mills) for total power from Kelsey increased to reflect annual inflationary changes.

	Mills		
Year	5%	10%	15%
1961/62	4.6	8.8	14.1
1962/63	4.8	9.1	14.4
1963/64	4.7	8.9	14.2
1964/65	5.0	9.3	14.8
1965/66	4.7	8.7	13.9
1966/67	4.8	9.0	14.3
1967/68	5.3	9.9	15.7
1968/69	4.3	8.8	13.8
1969/70	3.9	7.3	11.6
1970/71	3.9	7.3	11.6

Source: Appendix 5.

CHAPTER 5

DISCUSSION AND CONCLUDING REMARKS

For the purpose of comparison the calculations described in Chapter 4, presented an array of the average costs per kilowatt hour for energy delivered to INCO. The treatment of the data in this manner is for illustrative purposes alone. It is hoped, however, that the three average cost calculations can provide the comparitive basis for discussion. INCO's actual payments are however, not based on the average cost of generation. The Original Agreement provides that INCO shall cover all the costs of reserving and supplying hydro-electricity, regardless of whether INCO actually consumed the 98.4 MW of power.

The first objective of this practicum was to determine whether INCO was supplied with hydro-electricity at less than cost. The summary tables, included in this chapter, compare INCO's billed average cost with the average cost at different rates of return and the average cost escalated to reflect inflation, for the ten years in question. To determine whether INCO's payments covered the total opportunity costs of providing hydro-electricity from Kelsey, would require the choice of one approach over another. This assumes that the appropriate social rate of return can be determined and that Manitoba Hydro should expect to earn such a return on their investment.

TABLE 7: Summary 98.4 MW Contract

Year	Average Cost Mills/ KWH as defined in the Original Agreement[b]	Average Cost Mills/ KWH at different rates of return [a]			Average Costs Mills/ KWH increased to reflect inflation		
		5%	10%	15%	5%	10%	15%
1961/62	5.4	4.6	8.8	14.1	4.6	8.8	14.1
1962/63	4.9	4.7	8.9	14.1	4.8	9.1	14.4
1963/64	3.9	4.5	8.5	13.5	4.7	8.9	14.3
1964/65	4.4	4.6	8.6	13.6	5.0	9.3	14.8
1965/66	4.6	4.6	8.6	13.6	5.2	9.8	15.5
1966/67	4.7	4.6	8.6	13.6	5.6	10.3	16.4
1967/68	5.4	4.8	8.7	13.7	5.7	10.7	17.1
1968/69	6.6	4.9	8.9	13.9	6.1	11.3	18.2
1969/70	6.8	4.9	8.9	13.9	6.4	11.9	18.9
1970/71	7.4	4.8	8.8	13.8	6.6	12.4	19.8

Source: Chapter 4, Tables 1, 2 and 3.

a) It should be remembered that this data was derived assuming a constant 85% load factor.

b) The actual load factor varied from 65% - 85%, which accounts for the fluctuations, over the 10 years, in the average cost/KWH as defined in the Original Agreement.

TABLE 8: Summary: Total Power Available from Kelsey

Total	Average Cost Mills/ KWH as defined in all the agreements [b]	Average Cost Mills/ KWH at different rates of return [a]			Average Costs Mills/ KWH increased to reflect inflation		
		5%	10%	15%	5%	10%	15%
1961/62	5.4	4.6	8.8	14.1	4.6	8.8	14.1
1962/63	4.9	4.7	8.9	14.1	4.8	9.1	14.4
1963/64	3.9	4.5	8.5	13.5	4.7	8.9	14.2
1964/65	4.4	4.6	8.6	13.6	5.0	9.3	14.8
1965/66	4.3	4.2	7.7	12.2	4.7	8.7	13.9
1966/67	4.5	4.1	7.5	11.9	4.8	9.0	14.3
1967/68	4.4	3.6	6.6	10.5	5.3	9.9	15.7
1968/69	5.6	3.2	5.7	8.9	4.3	8.8	13.8
1969/70	5.7	3.2	5.8	9.0	3.9	7.3	11.6
1970/71	5.7	3.0	5.4	8.5	3.9	7.3	11.6

Source: Chapter 4, Tables 4, 5 and 6.

a) It should be remembered that this data was derived assuming a constant 85% load factor.

b) The actual load factor varied from 65% - 85%, which accounts for the fluctuations, over the 10 years, in the average cost/KWH as defined in all the agreements.

Several observations emerge from the analysis. At a rate of return of 5%, payments by INCO exceeded the costs of reserving 98.4 MW of power, in seven out of the ten years in question. In addition, payments by INCO exceeded the costs of supplying all the total energy, available from Kelsey, in eight of the ten years. At both a return 10% and 15%, INCO's payments do not account for the opportunity costs of generation. If the opportunity cost of Kelsey includes an adjustment for inflation similar observations can be made. At 5%, INCO's payments exceeded both the costs of reserving 98.4 MW and of supplying total energy available form Kelsey in five out of the 10 years. On the other hand, at 10% and 15%, INCO's annual payments cover neither the opportunity cost of reserving nor the costs of supplying hydro-electricity from Kelsey.

It therefore appears that interpretation of the data is sensitive both to the choice of the required rate of return on capital invested and to the method of accounting for inflation. This Practicum has, therefore, met the main objectives set out in Chapter 1. Namely that objective discussion of the contractual agreements between Manitoba Hydro and INCO requires first the resolution of certain theoretical problems.

The final objective of this Practicum entails a discussion of the three agreements and The Manitoba Hydro

Act in the light of the preceeding analysis. It is, therefore, important to focus the discussion onto the major areas of concern, so that commentary may be made on both The Act and the contractual agreements.

A breakdown of INCO's hydro-electric bills reveals that the most significant items are interest and depreciation. Combined, they amount to about 70% of the total payment.[56]

This in itself should be sufficient to narrow the discussion. There are two further factors that reinforce this conclusion. First, the other components of INCO's power bills, besides comprising a small percentage of the total billing, seem to be adequately provided for in the agreements. In the case of operating costs, interim replacement costs are escalated each year to reflect inflation and labour costs include all effective wage increases. Contingency reserves seem to protect both the interests of Manitoba Hydro and INCO. Administrative costs were fixed at $75,000 and may have increased. However, since they form such a small portion of the total costs, they can, in all probability, be ignored.

The second factor emerges as a general observation from the analysis. The analysis, in Chapter 4, indicates

---

56.

Year	Interest (% of total billing)	Depreciation (% of total billing)
1961/62	46%	34%
1965/66	47%	29%
1970/71	42%	26%

that the interpretation of the data is sensitive to the social rate of return adopted. Adjustments for inflation also change the interpretation of the results. This suggests that the discussion should indeed focus on the social rate of return (the interest item of INCO's billing) and the problems of accounting for inflation (the depreciation and interest components of INCO's billing).

Social Rate of Return

Manitoba Hydro is a public enterprise, utilizing scarce capital resources and thus it can be argued that it should earn a rate of return on its investments.

This social rate of return would be identical to the market interest rate assuming perfect capital markets, no risk and perfect knowledge.[57] However, this assumption is far from realistic. What social rate of return would reflect the economic conditions of the late fifties?

Two studies were undertaken, at about the time of the construction of Kelsey, to determine the social cost of

---

57. See Appendix 1.

capital used in the development of water resources. Krutilla and Eckstein[58] derived a measure of the social cost of capital assuming that public funds were obtained through taxation in the United States. Reuber and Wonnacott[59] estimated the opportunity cost of borrowed funds, from Canadian and United States sources, in 1959.

The Krutilla and Eckstein study postulates the following:

> When government imposes taxes in order to finance public investments, it levies a compulsory loan or forced saving on the community, which releases the resources for the undertaking. The taxes lead to a reduction of consumption by households, to a decline in investments or both... The social cost, therefore, is equal to the foregone rate of return on private investment.[60]

They developed two different tax cut models; one stimulating consumption, the other stimulating investment and estimated the social cost of capital to be 5.79% and 5.44% respectively.

Funds were obtained through borrowing not taxation, for the financing of Kelsey. For this reason, the measure obtained by Krutilla and Eckstein may not be accurate.

Reuber and Wonnacott applied weights to different sources of borrowed capital and combined them to give a

---

58. J.V. Krutilla, O. Eckstein, op. cit., 1958.

59. G.L. Reuber, R.J. Wonnacott, The Cost of Capital in Canada- with special reference to public development of the Columbia River, Resources for the Future, Inc., 1961.

60. J.V. Krutilla, O. Eckstein, op. cit., pp.84-85.

social cost of capital. They observed that if borrowing was done in Canada, the social cost of capital was about 5 1/2% and 5%, if borrowing was done by the Canadian Government in the United States.[61]

Despite the fact that the estimates, in both these studies, are based on different types of funding and derived for two countries, Canada and the United States, they are quite similar. If these estimates are accepted as a reasonable approximation of the social cost of capital in the late fifties, then Manitoba Hydro could expect to earn a social rate of between 5% and 5 1/2%, on their investment at Kelsey. This assumes that Manitoba Hydro borrowed all the funds from the capital markets and obtained no financial assistance from INCO. INCO, however, agreed to lend Manitoba Hydro $20 million at 2%, maturing in 1965, which is at least one percentage point less (and in some cases as much as 1 3/4% less) than government bonds maturing at the same time.[62] Reuber and Wonnacott's estimate is based on the weighting of capital derived from different sources and it is unlikely that it took account of a loan similar to INCO's. It is, therefore, possible that the social cost of capital for Kelsey is somewhat less than 5% to 5 1/2%. It is beyond

---

61. G.L. Reuber, R.J. Wonnacott, op. cit., p.84.

62. The Manitoba Power Commission, Annual Report, March 31, 1957, p.16.

the scope of this Practicum to quantify precisely the necessary adjustment to Reuber and Wonnacott's estimate. Suffice it to say that a downward adjustment should probably be made.[63]

Comparing the billed average cost per kilowatt hour with the average cost per kilowatt hour at 5%, (an approximation of the social cost of capital as estimated by Reuber and Wonnacott) indicates that payments by INCO exceeded the costs of reserving 98.4 MW of power in seven out of the ten years. In addition, payments by INCO exceeded the costs of supplying total energy available from Kelsey, in eight of the ten years.[64] If 5% is accepted a reasonable social rate of return, from a historical perspective then in most years revenues from INCO exceeded the opportunity cost of generation.

---

63. It can also be argued that since INCO loaned $20 million for the sole purpose of constructing Kelsey, the true social opportunity cost of this capital was zero. Since this capital would not have been invested in Manitoba if Kelsey were not built, the Province and in turn Manitoba Hydro, could expect to earn nothing on the loan. The social cost of capital for the entire project would therefore, be a weighted average of Reuber and Wonnacott's estimate and the social cost of capital of zero on the funds derived from INCO.

64. INCO's billed cost/KWH exceeded the average cost/KWH, at 5%, on the 98.4 MW by 1.7 mills/KWH in 1968, 1.9 mills/KWH in 1969 and 2.6 mills/KWH in 1970. Similarly on the costs of supplying total energy from Kelsey, the margin grew to 2.4 mills/KWH in 1968, 2.5 mills/KWH in 1969 and 2.7 mills/KWH in 1970.

In the light of current inflation rates and the recent discussion in Manitoba sparked off by Prof. Kierans' Report on Natural Resources Policy in Manitoba, it is now suggested that the social rate of return should be as high as 15%.[65] It must be conceeded that these rates are usually cited in conjunction with risky investments, such as mining developments. The major financial risk associated with Kelsey, is that INCO might cease its operations after 1981, when the contract comes up for re-negotiation. However, since the interconnection in 1967, power can now be supplied to southern markets. Manitoba Hydro will, therefore, not be left with a generating system and no customer. In addition it should be remembered that by 1981, almost two thirds of the costs will have been recovered. This is due to the clauses in the Original Agreement, which provide that the initial construction costs and the transmission costs shall be depreciated over 40 years and 20 years, respectively.

If Manitoba Hydro expects to earn 10% to 15% on their investment, this puts INCO's actual payments in quite a different light. Even at a rate of return of 10%, INCO's payments did not cover the opportunity cost of generation. However the intent of The Manitoba Hydro Act is that the Corporation should recover in full the costs of

---

65. E. Kierans, Report on Natural Resources in Manitoba, 1973, p.42.

supplying power. The Manitoba Hydro Act does not define cost. Manitoba Hydro at present seems to interpret the intent of The Act as excluding the need to earn a social rate of return on hydro-electric investments.

Two further observations should be made. First, to argue for a 10% to 15% return on investment in the late fifties would probably have met with stiff opposition from INCO, putting the Kelsey development into jeopardy. INCO might have resorted to generating its own electricity. In turn, Manitoba Hydro would have lost all the advantages of generating hydro-electricity at Kelsey, once the interconnection became effective in 1967.

Second, it is far from resolved whether the long term social rate of return should be as high as 15%. Economists seem hesitant to predict the changes in economic conditions over the next decade. Consequently a discussion of the appropriate social rate of return is hampered by much uncertainty. The implications of different rates of return on investment decisions, consumption and pricing policies are still unclear, making policy discussion almost impossible.

Inflation

The current accounting and economic literature[66] indicates that there is a concern for inflation. The problem appears to be twofold. The first centers around the question of the advisability of accounting for inflation, particularly if the investment is made in the name of public. Secondly there is the related technical problem of the accounting procedure to adopt. It is not the intent of this Practicum to resolve either of these questions. Nevertheless, it is still important to draw attention to the impact of the inflation question.

The annual capital charges were escalated to reflect upward changes in the costs of hydro-electric construction, as described in Chapter 3. INCO's billed average cost can be compared with the "inflated" average cost at a rate of return of 5%. There is, however, a problem associated with this comparison. INCO's total payments consists of a mixture of inflated and uninflated dollars; while "inflated" average costs are in constant dollars. The comparison is, therefore, somewhat tenuous.[67] To

---

66. W.T. Baxter, "Inflation and Accounts", Modern Financial Management, ed. B.V. Carsberg, H.C. Edey, Penguin Modern Management Series, 1969, p.50.

67. It is the depreciation item of the billing that poses the most problem. The initial capital construction costs are in historical dollars, while revenues are in current dollars, making the comparison impossible. Since, the funding is through debt, not equity, interest costs are depreciating at the same rate as revenues. The interest item of the billing does not, therefore, pose the same problem.

convert all the components of the billing to constant dollars would require a detailed breakdown of INCO's billing. The necessary calculations are considered beyond the scope of this Practicum.

A second best approach can, however, be adopted. Both The Manitoba Hydro Act[68] and the Original Agreement provide for the formation of reserves for rate stabilisation and contingencies and as such also protect Manitoba Hydro against any increases in "capital and operating costs."[69] There is, therefore, an attempt to account for increases in interest rates and the prices of capital goods. The comparison between the billed average cost and the "inflated" average cost can give an indication whether the provision of The Act adquately protects Manitoba Hydro against inflation. At 5%, INCO's payments exceeded the total opportunity cost of generation in five out of the ten years in question.[70]

Any long term contract is risky given the serious problems associated with forcasting long term economic changes. The Manitoba Hydro Act, may, require some changes in this regard, so that Manitoba Hydro is able to build

---

68. The Manitoba Hydro Act, op.cit., Sections 40(1), 40(2).
69. The Original Agreement, op.cit., p.24, Article 6.3.7.
70. See Tables 7 and 8.

more flexibility into their contracts.

Since economic conditions can change significantly, one could question the wisdom of a long term agreement. Several factors necessitate such a long term contract. It must be remembered that the agreements were drawn up in the light of INCO's mining development in a remote area of northern Manitoba. It was not just a simple matter of providing INCO with hydro-electric power from an existing network, since none existed. INCO could not, therefore, be considered a regular industrial customer, being charged a rate that reflected the average cost of hydro-electric generation from the Manitoba network.

A complete hydro-electric generating installation was required to meet INCO's power requirements. Covering the costs for power from a development, such as Kelsey, required a contractual agreement to protect the interests of both parties. On the one hand, Manitoba Hydro required a guarantee that INCO would pay all the costs of constructing and operating Kelsey, even if the mining company ceased its operations at Thompson, within the 20 years of the Original Agreement. INCO, on the other hand, had to be assured of power no more costly than the cost of power from generating facilities of their own. Since Manitoba Hydro had to build a completely new hydro-electric installation, not only did they require the guarantee of a market, in

this case INCO; they also had to be assured that the customer would cover all the costs associated with Kelsey. Hydro-electric facilities are generally assumed to have a long economic life, consequently the capital invested is recovered over all, or some portion of the life of the installation. Only a long term contractual arrangement on the basis of reserved power and payments to account for the total costs of generation and transmission, would provide Manitoba Hydro with sufficient protection.

A contract between Manitoba Hydro and INCO legally binds the two parties to a set of conditions for a given time period. Clearly it must satisfy both parties. The Original Agreement necessarily involves an element of trade off and compromise between the two parties. As with any long term agreement, both parties accept a certain loss of flexibility, unless the agreement specifically stipulates the possibility of changes. The provisions of the Original Agreement are further constrained since they must lie within the scope of The Manitoba Hydro Act. The Act specifies the conditions for the sale of hydro-electric power and unless The Act itself is amended, the substance of the Original Agreement cannot be altered.

Interestingly, it is unlikely that the Kelsey Generating Station would have been built without a long

term industrial contract, like INCO's.[71] Kelsey was not considered the best site on the Nelson River and without the guarantee of a market it was deemed to be uneconomic. It was uneconomic since it was located in a remote area of northern Manitoba and Grand Rapids, situated on the Saskatchewan River, was considered better suited to the needs of the overall network at that time. INCO, however, provided this guarantee with its signature on the Original Agreement. Particularly since they agreed to cover all the costs. Kelsey, therefore, became an economic proposition despite its shortcomings.

Other power users derived benefits from Kelsey, once the interconnection was established in 1967. Adding the Kelsey Generating Station to the southern system, provided greater flexibility and efficiency in the delivery of power to other users. It meant that Kelsey could operate nearer the 100% load factor, and, therefore, generate hydroelectricity more efficiently. Energy is supplied from the least cost sources, so within reason, more generating sites will give the system greater potential for the generation of cheaper power. Kelsey could make a contribution to the economics of minimising costs for the whole system, assuming that demand for power existed. With the interconnection,

---

71. Personal Communication, J. Atchison, Production Division, Manitoba Hydro, 1974.

surplus power from Kelsey was not only available to Manitoba customers, but could also be exported to obtain additional revenues.

An examination of the summary tables in this chapter, reveal that at a rate of return of 5%, from 1967 onwards, INCO's payments exceeded the opportunity cost of reserving 98.4 MW of power. The average cost calculation at 5% includes the costs of the five generating units, bringing Kelsey's capacity to about 157 MW. So in fact INCO's payments actually covered 85% of the costs of 157 MW (equivalent to 133 MW of capacity) not 98.4 MW, as specified in the agreements. Nevertheless, Manitoba Hydro only reserved 98.4 MW specifically for INCO. This extra capacity of 35 MW was available to permit generation maintenance at Kelsey to be carried out without reduction to the contracted capacity to INCO. When not being used for this purpose, this represented free or subsidised capacity for Manitoba power users.[72]

Despite some of the inherent restrictions of a long term agreement, the INCO contract turned Kelsey into an economic proposition insofar as the delivery of power to INCO was concerned. In addition, without the INCO contract, Kelsey would in all probability, never have been built. The loss of this contract would have deprived

---

72. Kelsey's capacity surplus from the INCO contract with 5 generating units (0.85 x 157 MW) - 98.4 MW = 34.6 MW.

Manitoba power users, the benefits from the interconnection of Kelsey to the southern transmission system.

Concluding Remarks

This Practicum illustrates that the interpretation of the preceeding analysis is indeed sensitive to the choice of the social rate of return and to adjustments for inflation. The determination of the appropriate rate of return is still unresolved. It is unclear whether Manitoba Hydro should expect to earn such a social rate of return. Nor is it clear, given the need for a long term agreement, whether the social rate should reflect historical or current economic conditions.

Adopting a social rate of return would entail a change in the intent of The Manitoba Hydro Act. Manitoba Hydro's objective would no longer be to provide least cost power. This would entail a fundamental change in the Board's policy which has been in existence since about 1950. There is, therefore, a policy trade off between these differing objectives, which policy makers should address.

Finally it should be stressed that if objective commentary is to be made on the contractual arrangements between Manitoba Hydro and INCO, theoretical questions such as these should first be addressed. The policy implications should be analysed. If new policy objectives emerge, through the legislative process, these new directives should be incorporated into The Manitoba Hydro Act.

APPENDIX 1

A TECHNICAL DIGRESSION

Certain engineering and economic concepts are used throughout this Practicum. For the purposes of clarity they are defined here.

Engineering Concepts

Hydro-electric pricing is based on two concepts, power and energy. Power is the maximum rate which the turbines can convert the energy of moving water into hydro-electric energy.[73]

In terms of the generation of hydro-electricity, power is a function of the head of water (i.e. the energy of the stored water behind the dam) and the flow of water through the turbines. Power is, therefore, the physical limit of the generating capacity. Capacity can be increased by adding more generators or by raising the head. They can be operated in different combinations, to meet the specific power requirements of power users.

Energy[74] is the electrical work produced by the flow of water through the generators over a period of time. Energy output can be increased if generators are run for a greater length of time which in turn requires a greater volume of water.

---

73. Power is measured in watts. 1 Megawatt (MW) = 10^6 Watts.

74. Energy is measured in Kilowatt hours (KWH)
1 Kilowatt hour = 1000 watt hours.

In the case of the INCO agreement, Manitoba Hydro agreed to reserve 98.4 MW of power at peak load. However, INCO's power requirements will fluctuate during the day. The daily load factor (85%) is a measure of the average power demand in a given day to account for these fluctuations. The billing for energy is, therefore, calculated on the basis of this load factor.

Economic Concepts

A firm would expect to earn a return on their investment equal or greater to the opportunity cost of this capital. Suppose that the firm could lend this capital and earn X%. If the firm is to invest this capital in some project, such as a hydro-electric development, they must be assured of at least X% on their investment. Otherwise it is more profitable for the firm to lend this capital. The opportunity cost of this capital is, therefore, the total revenue that the firm could earn if the resources were allocated differently. If the capital markets operated perfectly, borrowers and investers were all knowledgeable and there was no risk involved in any investment, then the market interest rate would reflect the true opportunity cost of capital. In a perfect economic world a firm, public or private, would expect to earn a return at least equivalent to the market interest rate.

Capital markets, however, do not function perflectly. Investors view the risks of public and private investments differently and knowledge is far from perfect. A private firm might still consider the market interest rate a reasonable indicator of the opportunity cost of capital. Expenditures made in the name of the public pose a serious problem. Economic theory suggests that the market failure is sufficiently important that public investments should earn a social rate of return. This social rate of return may be different from the market interest rate.

There is some controversy over what the social rate of return should actually represent. Some suggest that it should represent "the pretax rate of return forgone on physical investments in the private sector when funds are transferred to the public sector to finance public activities."[75] Others argue that the social rate of return should reflect "society's feelings about providing for the future as opposed to current consumption".[76] In order to circumvent this controversy, a sensitivity analysis can be undertaken. The data is analysed using different rates of return and it is to be hoped that the range encompasses both schools of thought.

---

75. C.W. Howe, Benefit-Cost Analysis for Water System Planning, Water Resources Monograph 2, American Geophysical Union, 1971, p.66.

76. Ibid., p.67.

APPENDIX 2

Evaluation of the average cost of generation at different rates of return.

The initial capital costs were capitalised for the period 1956 to 1961, to give the present value of the total costs in 1961 at 5%, 10% and 15%.

Year	0%($)	5%($)	10%($)	15%($)
56/57	677,280	864,428	1,090,803	1,362,188
57/58	3,915,403	4,759,211	5,732,654	6,847,504
58/59	12,289,231	14,226,940	16,357,288	18,690,845
59/60	18,083,589	19,937,804	21,882,368	23,916,927
60/61	9,117,911	9,573,615	10,029,960	10,485,178
61/62	790,860	790,860	790,860	790,860
Present value of Total costs in 1961		$50,152,858	$55,883,933	$62,093,502

Source: Column 2: Manitoba Hydro.

The capital costs were annualised by calculating the capital recovery factors (CRF) over 50 years at 5%, 10% and 15% respectively.

CRF at 5% = $2,748,376 per annum

CRF at 10% = $5,638,688 per annum

CRF at 15% = $9,320,234 per annum.

The annual capital charges per kilowatt were obtained by dividing the CRF by the capacity (MW).

	Capacity	Annual Capital Charges $/KW		
Year	(MW)	5%($)	10%(%)	15%($)
61/62	93.3	29.5	60.4	99.9
62/63	94.5	29.1	59.7	98.6
63/64	98.4	27.9	57.3	94.7
64/65	98.4	27.9	57.3	94.7
65/66	98.4	27.9	57.3	94.7
66/67	98.4	27.9	57.3	94.7
67/68	98.4	27.9	57.3	94.7
68/69	98.4	27.9	57.3	94.7
69/70	98.4	27.9	57.3	94.7
70/71	98.4	27.9	57.3	94.7

Source: Column 2; Manitoba Hydro

Operational costs were similarly calculated on a kilowatt installed basis.

Year	Operations & Maintenance Costs ($)	Capacity (MW)	Operations & Maintenance Costs $/KW
1961/62	461,169	93.3	4.9
1962/63	583,028	94.5	6.2
1963/64	572,850	98.4	5.8
1964/65	671,278	98.4	6.8
1965/66	669,898	98.4	6.8
1966/67	645,072	98.4	6.6
1967/68	740,441	98.4	7.5
1968/69	904,521	98.4	9.2
1969/70	857,518	98.4	8.7
1970/71	777,974	98.4	7.9

Source: Column 2: Manitoba Hydro
Column 3: Manitoba Hydro

Operations costs/KW plus annual capital charges/KW were added to give the total annual costs/KW. Using a load factor of 85% (i.e. 7446 hours of generation per year), total annual costs/KW were converted to average cost/KWH.

	Total Annual Costs $/KW			Average Cost (mills)/KWH		
Year	5%($)	10%($)	15%($)	5%	10%	15%
61/62	34.4	65.3	104.8	4.6	8.8	14.1
62/63	35.3	65.9	104.8	4.7	8.9	14.1
63/64	33.7	63.1	100.3	4.5	8.5	13.5
64/65	34.7	64.1	101.5	4.6	8.6	13.6
65/66	34.7	64.1	101.5	4.6	8.6	13.6
66/67	34.5	63.9	101.3	4.6	8.6	13.6
67/68	35.4	64.8	102.2	4.8	8.7	13.7
68/69	37.1	66.5	103.9	4.9	8.9	13.9
69/70	36.6	66.0	103.4	4.9	8.9	13.9
70/71	35.8	65.2	102.6	4.8	8.8	13.8

APPENDIX 3

Evaluation of the average cost of generation, allowing the annual capital charges to reflect inflationary increases.

The annual capital charges/KW in Appendix 2, were inflated using the price index, calculated by Statistics Canada, for hydro-electric generating stations.

Year	Price Index	"Inflated" Annual Capital Charges $/KW 5%($)	10%($)	15%($)
61/62	100	29.5	60.4	99.9
62/63	102.7	29.9	61.3	101.3
63/64	106.0	29.6	60.8	100.4
64/65	109.5	30.6	62.7	103.7
65/66	114.8	32.0	65.8	108.7
66/67	121.8	34.0	69.8	115.3
67/68	126.2	35.2	72.3	119.5
68/69	131.3	36.6	75.2	124.3
69/70	139.2	38.8	79.8	131.8
70/71	147.4	41.1	84.5	139.6

Source: Column 2: Catalogue 62-533, Statistics Canada.

These "inflated" annual capital charges/KW were then added to the operations costs/KW to give total annual costs/KW. These costs/KW were converted using an 85% load factor, to "inflated" average cost/KWH.

Year	"Inflated" Total Annual Costs $/KW 5%($)	10%($)	15%($)	"Inflated" Average Cost (mills)/KWH 5%	10%	15%
61/62	34.4	65.3	104.8	4.6	8.8	14.1
62/63	36.1	67.5	107.5	4.8	9.1	14.4
63/64	35.4	66.6	106.2	4.8	8.9	14.3
64/65	37.4	69.5	110.5	5.0	9.3	14.8
65/66	38.8	72.6	115.5	5.2	9.8	15.5
66/67	41.8	76.4	121.9	5.6	10.3	16.4
67/68	42.7	79.8	127.0	5.7	10.7	17.1
68/69	45.8	84.4	135.5	6.1	11.3	18.2
69/70	47.5	88.5	140.5	6.4	11.9	18.9
70/71	49.0	92.4	147.5	6.6	12.4	19.8

APPENDIX 4

Evaluation of the average cost of generation at different rates of return for total power available at Kelsey.

The costs of the 6th generating unit were capitalised to give the present value of the capital additions in 1969 at 5%, 10% and 15%.

Year	0%($)	5%($)	10%($)	15%($)
67/68	3,617,030	3,987,905	4,376,851	4,783,798
68/69	9,149,983	9,607,290	10,064,880	10,522,059
69/70	2,073,156	2,073,156	2,073,156	2,073,156
Present value of capital additions in 1969.		$15,668,351	$16,514,887	$17,379,013

Source: Column 2: Manitoba Hydro.

The capital costs were annualised by calculating the capital recovery factors over 41 years, the remaining life of the hydro-electric plant, at 5%, 10% and 15% respectively.

CRF at 5% = $905,631 per annum

CRF at 10% = $1,686,169 per annum

CRF at 15% = $2,615,541 per annum

Further expenditures, of $1,442,774, were made on the 6th generating unit in 1970. For simplicity, these costs were kept separate from the above calculation and capital recovery factors were obtained over 40 years at 5%, 10% and 15% respectively.

CRF at 5% = $84,113 per annum

CRF at 10% = $147,595 per annum

CRF at 15% = $217,281 per annum

The annual capital charges were calculated as described in the previous appendices. (Note, 1970 expenditures were included in the annual capital charges/KW for 1970.)

Year	Capacity (MW)	Annual Capital Charges $/KW 5%	10%	15%
1969/70	190.2	4.8	8.9	13.6
1970/71	200.7	4.9	9.1	14.1

Source: Column 2: Manitoba Hydro

Annual capital charges for the 10 years were then calculated, on the total capacity allocated or available for INCO. The additional charges for the capital additions were included, in the 1969, 1970 figures.

Year	Capacity (MW)	Annual Capital Charges $/KW 5%($)	10%($)	15%($)
1961/62	93.3	29.5	60.4	99.9
1962/63	94.5	29.1	59.7	98.6
1963/64	98.4	27.9	57.3	94.7
1964/65	98.4	27.9	57.3	94.7
1965/66	110.0	25.0	51.3	84.7
1966/67	112.0	24.5	50.3	83.2
1967/68	129.0	21.3	43.7	72.2
1968/69	154.0	17.8	36.6	60.5
1969/70	190.2	19.3	38.5	62.6
1970/71	200.7	18.6	37.2	60.5

Source: Column 2: Manitoba Hydro

Operating costs were similarly computed.

Year	Operating Costs ($)	Capacity (MW)	Operating Costs $/KW
1961/62	$461,169	93.3	4.9
1962/63	583,028	94.5	6.2
1963/64	572,850	98.4	5.8
1964/65	671,278	98.4	6.8
1965/66	669,898	110.0	6.1
1966/67	645,072	112.0	5.8
1967/68	740,441	129.0	5.7
1968/69	904,521	154.0	5.8
1969/70	857,518	190.2	4.5
1970/71	777,974	200.7	3.9

Source: Column 2: Manitoba Hydro
Column 3: Manitoba Hydro

Annual capital charges/KW and operating costs/KW were added to give total annual costs/KW. These costs/KW were converted to average cost/KWH using an 85% load factor.

Year	Total Annual Costs $/KW			Average Cost mills/KWH		
	5%($)	10%($)	15%($)	5%	10%	15%
1961/62	34.4	65.3	104.8	4.6	8.8	14.1
1962/63	35.3	65.9	104.8	4.7	8.9	14.1
1963/64	33.7	63.1	100.5	4.5	8.5	13.5
1964/65	34.7	64.1	101.5	4.6	8.6	13.6
1965/66	31.1	57.4	90.8	4.2	7.7	12.2
1966/67	30.3	56.1	89.0	4.1	7.5	11.9
1967/68	27.0	49.4	77.9	3.6	6.6	10.5
1968/69	23.6	42.4	66.3	3.2	5.7	8.9
1969/60	23.8	43.0	67.1	3.2	5.8	9.0
1970/71	22.5	41.1	64.4	3.0	5.5	8.6

APPENDIX 5

Evaluation of the average cost of generation for total available power from Kelsey, allowing annual capital charges to reflect inflationary charges.

The methodology used was essentially identical to that described in Appendix 2. The annual capital charges/KW for the total power from Kelsey were inflated using the price index for hydro-electric generating stations.

Year	Price Index	"Inflated" Annual Capital Charges $/KW 5%($)	10%($)	15%($)
1961/62	100	29.5	60.4	99.9
1962/63	102.7	29.9	61.3	101.3
1963/64	106.0	29.5	60.7	100.4
1964/65	109.5	30.6	62.7	103.7
1965/66	114.8	28.7	58.9	97.2
1966/67	121.8	29.8	61.3	101.3
1967/68	126.2	26.9	55.1	91.1
1968/69	131.3	23.4	48.0	79.4
1969/70	139.2	24.9	50.1	81.8
1970/71	147.4	25.1	50.5	82.5

Source: Column 2: Catalogue 62-533, Statistics Canada.

These "inflated" annual capital charges/KW were then added to the operations costs/KW to give total annual costs/KW, which in turn were converted to "inflated" average cost/KWH.

Year	"Inflated" Total Annual Costs $/KW 5%($)	10%($)	15%($)	"Inflated" Average Cost (mills)/KWH 5%	10%	15%
61/62	34.4	65.3	104.8	4.6	8.8	14.1
62/63	36.1	67.5	107.6	4.8	9.1	14.4
63/64	35.3	66.5	106.2	4.7	8.9	14.2
64/65	37.4	69.5	110.5	5.0	9.3	14.8
65/66	34.8	65.0	103.3	4.7	8.7	13.9
66/67	35.6	67.1	107.1	4.8	9.0	14.3
67/68	32.6	60.8	96.8	4.4	8.2	13.0
68/69	29.2	53.8	85.2	3.9	7.2	11.4
69/70	29.9	54.6	86.3	3.9	7.3	11.6
70/71	29.0	54.5	86.4	3.9	7.3	11.6

LITERATURE CITED

Books

Baxter, W.T., "Inflation and Accounts", Modern Financial Management, ed. Carsberg, B.V., Edey, H.C., Penguin Modern Management Series, 1969.

Howe, C.W., Benefit-Cost Analysis for Water System Planning, Water Resources Monograph 2, American Geophysical Union, 1971, p.66.

Krutilla, J.V., Ecstein, O., Multiple Purpose River Development, Studies in Applied Economics, John Hopkins, 1958.

Reuber, G.L., Wonnacott, R.J., The Cost of Capital in Canada - with special reference to public development of the Columbia River, Resources for the Future, Inc., 1961.

Legal

The First Supplementary Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1965.

The Original Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1961.

The Second Supplementary Agreement between the Manitoba Hydro-Electric Board and The International Nickel Company of Canada Limited, 1967.

Government Documents

The Manitoba Hydro Act, Revised Statutes of Manitoba, S.M., 1961 (1st Sess.), c.28, 1970 Vol.2, ch. H190.

Statistics Canada, Canadian Statistical Review, Catalogue 11-003E.

Statistics Canada, Construction Price Indexes for Hydro-Electric Generating Station 1961-1970, Catalogue 62-533.

Reports

The International Nickel Company of Canada Limited, Annual Report, 1960.

The International Nickel Company of Canada Limited, Annual Report, 1961.

The International Nickel Company of Canada Limited, Annual Report, 1962.

The International Nickel Company of Canada Limited, Annual Report, 1963.

The International Nickel Company of Canada Limited, Annual Report, 1965.

The International Nickel Company of Canada Limited, Annual Report, 1967.

The International Nickel Company of Canada Limited, Annual Report, 1969.

Kierans, E., Report on Natural Resources in Manitoba, 1973.

The Manitoba Hydro-Electric Board, Annual Report, 1957.

The Manitoba Hydro-Electric Board, Annual Report, 1961.

The Manitoba Power Commission, Annual Report, 1957.