REPORT

Lower Churchill Development Corporation

Cost Effectiveness of Delivering Power From The Lower Churchill River in Labrador to The Island of Newfoundland

Summary Report

Report SMR-33-80
December 1980

SHAWMONT NEWFOUNDLAND

REPORT

LOWER CHURCHILL DEVELOPMENT CORPORATION

COST EFFECTIVENESS OF DELIVERING POWER FROM THE LOWER CHURCHILL RIVER IN LABRADOR TO THE ISLAND OF NEWFOUNDLAND

SUMMARY REPORT

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1980
LICENCE TO PRACTICE

REPORT SMR-33-80
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1 AUTHORIZATION

The government of Newfoundland together with the government of Canada are studying the viability of constructing hydroelectric plants on the Lower Churchill River in Labrador and transporting the power to the Island of Newfoundland. The executing agency is the Lower Churchill Development Corporation (LCDC). In April 1980, LCDC retained ShawMont Newfoundland Limited (ShawMont) to study the cost effectiveness of supplying the forecast electricity needs of the Island of Newfoundland utilizing hydroelectric power generated at the Muskrat Falls Site and/or the Gull Island Site on the Lower Churchill River transmitted to the Island, relative to on-island sources of power. The findings are contained in ShawMont Report:

SMR-12-80
"Cost Effectiveness of Delivering Power
From
The Lower Churchill River in Labrador
To
The Island of Newfoundland"
Dated June 1980.

Subsequent to a review by the shareholders of LCDC, ShawMont was further requested in August and September to examine the cost effectiveness with changes in the parameters of load growth, timing of the project, cost estimates of the LCDC project(s) and real escalation in the cost of coal. The results of these analyses are contained in four addendums to Report SMR-12-80 issued in September and November.

In November, LCDC requested that the analyses be summarized.

2 THE LOWER CHURCHILL PROJECT

The Lower Churchill River basin is defined as the watershed between the Churchill Falls power development and Muskrat Falls, located 280 km east of the Churchill Falls. From Muskrat Falls, the Churchill River runs its last 44 km into Lake Melville which is a large inlet of the Atlantic Ocean.

Two potential hydroelectric sites have been identified on the Lower Churchill: one at Muskrat Falls and the other 58 km further upstream at Gull Island. With the development of these two sites, the total hydroelectric potential of the powerful Churchill River will have been harnessed.

2.1 Muskrat Falls

At the Muskrat Falls site, the river drops 15 m in two sets of rapids. Upon completion of the project, the upstream water level will be raised to the tailwater level of Gull Island and develop a gross head of 37 m.

The river valley between Gull Island and Muskrat Falls is narrow and cannot provide any significant storage; consequently, the development at Muskrat Falls will be a run-of-river hydroelectric plant.

The total installed capacity at Muskrat Falls will be 618 MW which will be provided by three 206 MW units. The average annual energy generated at the plant has been estimated at 4730 GWh.

2.2 Gull Island

Gull Island is located upstream of Gull Lake near Gull Island Rapids, 225 km east of Churchill Falls. The project will utilize the 87 m head between the Churchill Falls tailrace and Gull Lake.

The total installed capacity for Gull Island is 1698 MW. For this capacity, the powerhouse would contain six units rated at 283 MW. The average annual energy generated at the plant has been estimated at 11,290 GWh.

2.3 Transmission System

The proposed transmission system to transmit the power from Labrador to the Island of Newfoundland has three components:

- an AC intertie between Churchill Falls and Gull Island converter station
- an AC intertie between Muskrat Falls and Gull Island converter station
- DC transmission line(s) between the Gull Island converter station and the Island of Newfoundland

The transmission intertie between Churchill Falls and Gull Island will be a single 735 kV circuit if Gull Island is built. If Muskrat Falls is built, the intertie will be a 345 kV circuit. Two 345 kV circuits will be built between Muskrat Falls and Gull Island. These interties provide sufficient intertie capacity to ensure effective water management of the Churchill River.

The transmission line(s) from the Gull Island converter station to the Island will be +400 kV HVDC and will cross the Strait of Belle Isle separating Newfoundland and Labrador via submarine cable(s). In the case of Muskrat Falls a single transmission line would be built providing a capability (delivered) of 5600 GWh (annual energy). This exceeds the capability of Muskrat Falls and the additional capacity and energy would be drawn from Churchill Falls under the recall power entitlement. For Gull Island, two transmission lines would be built giving 11,200 GWh delivered capability. A small amount of recall energy would be used.

2.4 Delivered Power

In summary the estimated generated and delivered power would be as follows:

LCDC with Muskrat Falls

Generated	3 x 206 MW	Capacity
	4730 GWh	Energy
Recall	1290 GWh	Energy
Delivered	800 MW	Capacity
	5600 GWh	Energy

LCDC with Gull Island

Generated	6 x 283 MW	Capacity
	11,290 GWh	Energy
Recall	760 GWh	Energy
Delivered	1,600 MW	Capacity
	11,200 GWh	Energy

3 APPROACH

The technique of comparing expansion sequences was used. This technique permits an examination of the effect of a project, particularly of a large project such as LCDC, on the plant that presently exists and plant that will likely follow (Figure 2). The effect of over supply is assessed and the system expansion technique can be used to test various staged development scenarios.

The procedure requires:

- The selection of a load growth. For this assignment, three possible load growths were examined (section 4).

- The selection of a time horizon or load horizon. For this assignment, the system expansions were extended far enough into the future to completely utilize the energy capability of the LCDC power projects. In other words, a load horizon was selected for comparing alternatives. This results in different simulation times for each load growth.

- The selection of a period of time over which to compare alternatives as to operating cost. A period of 60 years from 1986 was used. This is considered long enough to measure the difference between thermal plants, whose operating life is considered to be 30 years, and hydro plants, whose operating life is considered to exceed 60 years.

- The development of alternative expansion sequences. Equivalence in each scheme was achieved by:

  - adjusting each scheme at its termination to have equivalent energy capability. Part thermal plants were used.

  - adjusting the load carrying capability (LCC) of each scheme to give an LOLP of 0.2 days per year or better. Gas turbines were used to provide the necessary capacity capability.

- The present worthing of the cost streams for each alternative. Investment cash flows, operating costs and production costs were present worthed to the beginning of 1981. All production costing and cost

computations were performed by Shawinigan's computer program SYPCO which uses probabilistic procedures for computing production costs.

All the studies assumed that energy not required to service the Newfoundland load would be spilled. In other words, it was assumed that there would be no sales west.

4 LOAD GROWTH

Three load growth scenarios were examined:

NLH Load Forecast (Nominal on-Island) - this load was developed by Newfoundland and Labrador Hydro (NLH) in the spring of 1980. It is based on a continuing but reduced rate of growth in the domestic and commercial sectors with a constant addition to the industrial load.

Low Load Forecast - this load was prepared by the Federal Department of Energy, Mines and Resources.

High Load Forecast - this load was provided by LCDC for testing the infeed from Labrador.

The three load growths are tabulated on Table 1 and are compared to each other and the historic consumption on Figure 1.

5 SCHEDULING CRITERIA

Power consists of two components - capacity and energy - and it is necessary to plan a system so that the production of both components have a given reliability. The criteria used are as follows:

Energy - This is the basic component used for scheduling. Plants were scheduled based on the following:-

hydro	- firm, defined as the production under the lowest recorded flow
oil thermal	- 75% capacity factor of 95% of nameplate
coal thermal	- 75% capacity factor of 92% of nameplate
nuclear	- 80% capacity factor of rated capacity
gas turbines	- 0% capacity factor
reserve	- equal to three months output of the largest unit using average hydro energy in calculating capability.

Capacity -

hydro	- based on nameplate adjusted for head if necessary
oil	- 95% nameplate
coal	- 92% nameplate
nuclear	- rated capability
gas turbines	- nameplate rating
reserve	- adequate capacity for the system to have a reliability index equal to a loss of load probability (LOLP) of 0.2 days per year. Shawinigan's program SYPCO was used to establish reliability.

It was not possible to analyse the internal transmission grid; however, experience in previous work has shown that internal transmission costs should not significantly affect the cost-effectiveness comparisons.

6 ALTERNATIVES EXAMINED

Six sequences were used to examine the cost effectiveness of the LCDC projects.

Alternative 1 - was the on-island or base sequence. It consisted of Cat Arm Hydro + Island Pond Hydro + 150 MW Coal units + 300 MW Coal units + Gas Turbines.

Alternative 2 - was the Muskrat Falls + Coal sequence. It consisted of Muskrat Falls + Cat Arm Hydro + Island Pond Hydro + 150 MW Coal units + 300 MW Coal units + Gas Turbines. Gas turbines were required for reliability and early energy capability. For the delayed sequences, Cat Arm Hydro, Island Pond Hydro and 150 MW Coal units were built prior to Muskrat Falls.

Alternative 3 - was the Gull Island + Coal sequence. It consisted of Gull Island + 300 MW Coal units + Gas Turbines. Gas turbines were required for reliability and early energy capability. For the delayed sequences, Cat Arm Hydro + Island Pond Hydro + 150 MW Coal units were built prior to Gull Island.

Alternative 4 - was an iteration of the Gull Island + Coal sequence. Early studies showed only marginal differences with Sequence 3 in the staging of the transmission. It was not considered for the NLH load forecast or the low load forecast. It was substituted for Sequence 3 in the high load forecast studies.

Alternative 5 - was the Gull Island + Muskrat Falls sequence. No on-island hydro or coal fired plants were included. Gas turbines were required for reliability and early energy capability.

Alternative 6 - was the Muskrat Falls + Gull Island sequence. As with Sequence 5, no on-island hydro or coal fired plants were included. Gas turbines were required for reliability and early energy capability.

In alternatives using coal fired plants, the timing of the coal fired plants was adjusted to minimize the use of base load oil fired plants.

For the NLH load forecast, the order of development of the Lower Churchill was examined by comparing Sequence 5 to Sequence 6. The details of the plant required to meet the scheduling criteria are given on Table 5.

For the NLH load forecast, the low load forecast and the high load forecast, sequences were developed to examine:

- Muskrat + Coal (Sequence 2) vs On-Island (Sequence 1)
- Gull Island + Coal(Sequence 3) vs On-Island(Sequence 1)
- The timing of Muskrat and Gull Island (Sequences 2 and 3 were modified for a 4 year and 8 year delay)

The details of plant installation required to meet the scheduling criteria are found in Tables 6, 7 and 8.

An increase of 15% in the cost of the LCDC projects was tested as well as a 1% per year differential escalation in the cost of coal.

7 COSTING CRITERIA

The criteria tabulated in Table 4 were developed in cooperation with NLH and used for evaluating the alternatives. For details, see ShawMont Report:

SMR-3-80
"On-Island Methods of Meeting
The Projected Electrical Load Growth"
Dated July 1980.

The basic criteria that require elaboration are:

Escalation - The study was based on constant dollars. Sensitivity studies regarding differential escalation were undertaken for coal.

Discount Rate - The analysis was computed for a range of discount rates varying from 4% to 12.5%. The analysis used 7% and 10% for examining the results. Because of the use of constant dollars, the discount rates are effectively "real" rates net of escalation.

Fuel costs - World prices for fuel were used rather than subsidized prices. These are:

No. 6 Oil	0.95 x crude price, equal to $4.98 per 10^6 BTU
No. 2 Diesel	1.25 x crude price, equal to $7.12 per 10^6 BTU
Coal	$55 per tonne which at 11,700 BTU/lb coal is equal to $2.14 per 10^6 BTU

Churchill Falls Recall - 4.29 Mills/kWh

The investment costs for the various types of potential generation projects located on the Island of Labrador are summarized in Table 3, namely:

- Cat Arm Hydro Project
- Island Falls Hydro Project

- Coal/Oil Fired Thermal Plants (150 & 300 MW)
- Nuclear Power Plant (630 MW)
- Gas Turbines

Investment costs for the LCDC Projects are given in cash flow format in Table 2.

8 RESULTS

The results of the present worth computations are given in Tables 9 to 17 which tabulate the results by load growth, cost assumption, and fuel escalation assumption.

Table 18 summarizes the results for the two discount rates used by the federal government for examining the cost effectiveness of projects. The 7% rate is generally used by the Federal Department of Energy, Mines and Resources. The 10% rate is generally used by the Federal Treasury Department. On this table, the expansion sequence yielding the lowest discounted cost is outlined for each scenario.

The LCDC Schemes vs The On-Island Scheme

Figure 3 plots the cumulative present worth of incremental capital investments and operating costs over the comparison period versus discount rate for the basic alternatives. The comparison is for the NLH load growth and constant price scenario. The raw data is given on Table 9.

This figure shows that both LCDC schemes are lower cost than the on-island alternative up to a discount rate of 8.5% and that the Gull Island scheme is the lowest cost of the two LCDC schemes.

Subsequent studies on the effect of increases in the cost of the LCDC scheme and escalation in the cost of coal gave the following results as shown in the tables and as discussed in the addendums to Report SMR-12-80:

- an increase of 15% in the cost of the LCDC schemes reduces the breakeven discount rate of the LCDC schemes versus on-island by 1%

- escalation of 1% per year in the cost of coal increases the breakeven discount rate of the LCDC schemes versus on-island by 1%.

Order of Development for LCDC Schemes

For a discount rate of 7.5%, the least cost LCDC schemes include Gull Island only or Gull Island ahead of Muskrat (Table 18).

The LCDC Scheme with Muskrat

Reference to the NLH load forecast results given in Table 18, it is seen that for a 7.5% discount rate:

- Muskrat + Coal is less costly than on-island. Supplementary calculation showed that for a discount rate of 7.5%, the LCDC scheme with Muskrat only would have a unit cost of power equal to the cost of power from a coal fired thermal station located on the island. The inclusion of a significant amount of recall energy at a low cost makes the scheme cost effective.

- Muskrat + Coal is more costly than Gull + Coal.

Table 18 shows the effect of differential escalation in coal. There is a continuing reduction in the present worth cost from on-island to Muskrat + coal to Gull + coal to Gull + Muskrat from which it can be inferred that with a 1% 'real' escalation in coal, Muskrat, as an isolated project, is cost effective at a discount rate of 7.5%.

The LCDC Scheme with Gull Island

Providing that load growth equals or exceeds that forecast by NLH in the spring of 1980, that all costs remain relative and that the decision discount rate is 7%, the LCDC scenarios that include Gull Island first are the most cost effective (Table 18 and Figure 3).

Sensitivity to Key Parameters

Figures 5 and 6 summarize the analysis undertaken for differences in load growth, cost variations and delay to the project.

Effect of Capital Cost Changes

Table 18 and Figures 5 & 6 show that if the overall LCDC projects increase in cost by 15%, the least cost scenarios result from a delay in the LCDC projects. The cost effectiveness of the LCDC project with Muskrat becomes questionable (Figure 5).

Effect of Escalation in Coal Cost

A 'real' escalation of 1% per year in the cost of coal was tested. This enhanced the LCDC scenarios. See Table 18 and Figures 5 & 6.

Effect of Load Growth

Table 18 and Figures 5 & 6 show the effect of load growth. The higher the load growth the more cost effective the LCDC projects. It is evident that should the load growth be less than forecast by NLH in the spring of 1980, and that the decision discount rate is 7%, the lowest cost scenarios result from a delay to the LCDC projects.

Effect of a Delay

Essentially the analysis showed that the faster the absorption of the energy capability of the Lower Churchill plants, the better the return on investment; nevertheless for a desired discount rate of 7%, the immediate construction of the LCDC project was the least cost for the NLH load forecast or higher.

Figures 5 and 6 show the combined effect of load growth and delay to the in-service of LCDC.

For the low load growth, a 7% return requires that both LCDC scenarios be delayed.

For load growths equal to the NLH forecast or higher, both LCDC scenarios are lower cost than on-island generation for a 7% discount rate. There is an apparent benefit from delaying Gull Island + Coal when related to itself, but when compared to other development sequences Gull Island + Coal without delay is least cost (Figure 3). The cost penalty from delaying the Gull project for "as estimated costs" is:

Low load forecast	-	($ 114 Million)
NLH load forecast	-	$ 14 Million
High load forecast	-	$ 106 Million

The Effect of the Price of Recall Power

Figure 4 examines the effect of the cost of recall power on the cost-effectiveness of Muskrat + Coal and Gull Island + Coal. Since recall is not significant in the Gull Island sequences, the cost of recall has little effect as shown by the curve of breakeven discount rate between Gull + Coal and on-island. However, recall is significant in the Muskrat sequences and the cost of recall does effect the cost effectiveness of the Muskrat alternatives. As the cost of recall increases, the discount rate at which Muskrat + Coal is less costly than on-island decreases. For the breakeven discount rate to exceed 7%, the cost of recall should not exceed 24 mills per kWh.

Short Term Planning

The analysis of the effect of delays has been based on the building of on-island hydro (Cat Arm + Island Pond) ahead of the LCDC project. Upon completion of the assignment, a review of the analysis indicates that for a short delay (4 years say) the construction of on-island hydro may not be the least cost alternative. If the decision is to delay the LCDC schemes, a review of the on-island alternatives is warranted.

Effect of Sales West

The analysis has assigned no value to sales West. Table 19 gives the discounted value of the energy production of Gull not required on the island of Newfoundland. From Table 18 and Table 19, the price for power sold West that would make Gull + Coal equivalent to the on-island alternative for a discount rate of 10% and the presently planned in-service date of January 1986 is:

$$\frac{(2041.2 - 1777.6)}{25261 \text{ GWh}} \ 10^6\$ = 10.4 \text{ mills/kWh}$$

9 CONCLUSIONS

The cost effective studies carried out by ShawMont for LCDC may be summarized as follows:

(1) An LCDC project with the Gull Island hydroelectric plant built first followed by the Muskrat hydroelectric plant is more cost effective than the reverse, i.e. Muskrat first followed by Gull Island.

(2) The LCDC project that incorporates the Gull Island hydroelectric plant (1986 in-service date) is cost effective for discount rates greater than 7% provided that:

- the cost estimate is not exceeded;
- the load growth is equal to or greater than that estimated by NLH in the spring of 1980.

(3) The LCDC project that incorporates the Muskrat hydroelectric plant and recall power from Churchill Falls (1986 in-service date) is cost effective for discount rates greater than 7% provided that:

- the project includes a significant amount of recall power costing no more than 24 mills per kWh
- the cost estimate is not exceeded
- the load growth is not materially less than that forecast by NLH in the spring of 1980.

(4) A 15% increase in the cost of the LCDC projects without corresponding cost increases in the on-island alternative makes the LCDC project with Muskrat not cost effective and implies that the LCDC project with Gull Island be deferred.

(5) 'Real' or differential escalation on coal costs enhances the cost effectiveness of both LCDC projects. Escalation on coal also makes the Muskrat plant cost effective on its own without recall power.

(6) For load growth rates less than forecast by NLH in the spring of 1980, a delay in the implementation of both LCDC projects is cost effective.

(7) A delay of 8 years in the construction of the LCDC scheme with Gull Island incurs the following cost penalty at a discount rate of 7% and constant cost:

Low load growth	-	($ 114 Million)
NLH load growth	-	$ 14 Million
High load growth	-	$ 106 Million

(8) If the decision is to delay LCDC, a review of the short term options to supplying power to the Island of Newfoundland is suggested.

(9) If the surplus power available from Gull Island can be sold West at 10.5 Mills per kWh, the LCDC project incorporating Gull Island (1986 in-service date) will breakeven with on-island for a discount rate of 10% (NLH load growth, all costs as estimated).

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LOWER CHURCHILL DEVELOPMENT CORPORATION

FORECAST TOTAL ISLAND LOAD

YEAR	NLH FORECAST		LOW LOAD FORECAST		HIGH LOAD FORECAST	
	CAPACITY MW	ENERGY GWh	CAPACITY MW	ENERGY GWh	CAPACITY MW	ENERGY GWh
1980			1196.0	5977.0	1188.0	5914.0
1981	1244.0	6574.0	1248.0	6237.0	1251.0	6613.0
1982	1312.0	6919.0	1303.0	6510.0	1336.0	7048.0
1983	1357.0	7108.0	3159.0	6793.0	1396.0	7311.0
1984	1427.0	7448.0	1419.0	7090.0	1482.0	7734.0
1985	1516.0	7908.0	1480.0	7399.0	1589.0	8289.0
1986	1591.0	8272.0	1532.0	7658.0	1684.0	8753.0
1987	1668.0	8634.0	1586.0	7926.0	1782.0	9224.0
1988	1751.0	9029.0	1641.0	8203.0	1888.0	9738.0
1989	1828.0	9395.0	1698.0	8491.0	1990.0	10230.0
1990	1898.0	9730.0	1758.0	8788.0	2087.0	10698.0
1991	1973.0	10078.0	1812.0	9094.0	2190.0	11188.0
1992	2048.0	10429.0	1882.0	9410.0	2295.0	11689.0
1993	2125.0	10789.0	1948.0	9737.0	2405.0	12209.0
1994	2204.0	11159.0	2016.0	10037.0	2518.0	12750.0
1995	2285.0	11536.0	2086.0	10427.0	2636.0	13308.0
1996	2370.0	11925.0	2158.0	10785.0	2761.0	13898.0
1997	2457.0	12330.0	2232.0	11154.0	2890.0	14501.0
1998	2548.0	12750.0	2308.0	11537.0	3026.0	15141.0
1999	2642.0	13182.0	2387.0	11933.0	3159.0	15807.0
2000	2739.0	13529.0	2469.0	12342.0	3298.0	16503.0
2001	2840.0	14091.0	2554.0	12766.0	3443.0	17229.0
2002	2945.0	14569.0	2641.0	13203.0	3595.0	17987.0
2003	3054.0	15063.0	2732.0	13656.0	3735.0	18779.0
2004	3166.0	15573.0	2826.0	14125.0	3918.0	19605.0
2005	3282.0	16100.0	2923.0	14609.0	4090.0	20468.0
2006	3402.0	16645.0	3023.0	15110.0	4270.0	21368.0
2007	3526.0	17208.0	3127.0	15629.0	4458.0	22308.0
2008	3655.0	17791.0	3234.0	16165.0	4488.0	22460.0
2009	3789.0	18393.0	3345.0	16719.0		
2010	3928.0	19016.0	3460.0	17292.0		
2011	4071.0	19660.0	3577.0	17886.0		
2012	4220.0	20323.0	3700.0	18499.0		
2013	4337.0	21013.0	3827.0	19134.0		
2014	4534.0	21724.0	3958.0	19796.0		
2015	4700.0	22460.0	4094.0	20469.0		
2016			4243.0	21171.0		
2017			4380.0	21897.0		
2018			4492.0	22460.0		

* Energy adjusted to the NLH Load Scenario

LOWER CHURCHILL DEVELOPMENT CORPORATION

PROJECT CAPITAL COSTS

CASH FLOWS (IN 1980 MILLION DOLLARS)

MUSKRAT FALLS + 1 BIPOLE

Year	Muskrat Falls	1 Line (including Straits Crossing)	Total
1981	130	63	193
1982	174	172	346
1983	179	257	436
1984	177	244	421
1985	114	100	214
1986	18	12	30

GULL ISLAND + 1 BIPOLE + 2ND BIPOLE STAGED

Year	Gull Island	1 Line + 1 Line (incl. Straits Crossing)		Total
1981	110		63	173
1982	230		172	402
1983	255		257	512
1984	300		244	544
1985	270		100	370
1986	100		12	112
1987				
1988				
1989				
1990				
1991		2nd line & third valve group	56	56
1992			131	131
1993			130	130
1994			59	59
1995				
1996		fourth valve group	12	12
1997			32	32
1998			33	33
1999			15	15

LOWER CHURCHILL DEVELOPMENT CORPORATION

PROJECT CAPITAL COSTS

CASH FLOWS (IN 1980 MILLION DOLLARS)

GULL ISLAND + 2 BIPOLES INITIALLY

Year	Gull Island	2 Lines (incl. Straits Crossing)	Total
1981	110	80	190
1982	230	161	391
1983	255	254	509
1984	300	266	566
1985	270	168	438
1986	100	61	161
1987			7
1988			
1989		third valve group 24	24
1990		56	56
1991		56	56
1992		29	29
1993			
1994			
1995			
1996		fourth valve group 12	12
1997		32	32
1998		33	33
1999		15	15

LOWER CHURCHILL DEVELOPMENT CORPORATION

SUMMARY CAPITAL COST ESTIMATES - 'ON-ISLAND' GENERATION

(January 1980 Prices, $ x 10^6, Excluding IDC & EDC)

Project	Cat Arm	Island Pond	150 MW Coal/Oil	300 MW Coal/Oil	630 MW Nuclear	54 MW GT
Total Capital Cost	172.9	51.2	103.0	178.8	816.7	14.1
Annual Cash Flow %:						
Year 1	11	6	10	6	2	40
2	35	22	25	16	6	60
3	30	43	37	30	13	-
4	23	27	23	28	17	-
5	1	2	5	17	27	-
6	-	-	-	3	17	-
7	-	-	-	-	13	-
8	-	-	-	-	5	-

Notes:
1. Plants generally go into service at the beginning of the last cash flow year.
2. Cost for Cat Arm & Island Pond includes transmission facilities.
3. Cost for coal/oil (dual-fired) units & gas turbines are for a typical unit, there are minor variations depending on specific site & unit number.
4. Nuclear cost is for the first unit at a site.
5. Costs are summarized from report SMR-3-80 which gives more details.

LOWER CHURCHILL DEVELOPMENT CORPORATION

Cost Factors for Economic Comparisons

Real Discount Rates: 4% - 5% - 6% - 7% - 7.5% - 10% - 12.5%

Service Lives for New Plant	Years
Hydro	60
Thermal and Gas Turbines	30
Nuclear	30
Transmission Associated with Hydro	60

Period of Comparison	
Simulation Period	various
Evaluation Period	65 (1981-2045)

Insurance	
Hydro (on-island)	0.10% of investment
Thermal	0.25% of investment
Nuclear	0.40% of investment
Gas Turbines	0.25% of investment

Operation and Maintenance

		Fixed ($/kW/yr)	Variable (mills/kWh)
Existing Hydro		none	none
Future Hydro	- Cat Arm	5.00	none
	- Island Pond	6.50	none
Existing Thermal	- NLH	none	0.260
	- others	none	0.518
Future Thermal	- 150MW - oil fired	5.42	0.260
	- 150MW - coal fired	5.88	0.339
	- 300MW - oil fired	3.83	0.220
	- 300MW - coal fired	4.79	0.288
Gas Turbines (existing & future)		none	7.400
Nuclear - 630 MW	- Unit 1	23.00	none
	Unit 2	14.00	none
Muskrat Falls (including transmission)		$10 million per year (all inc. cost)	
Gull Island (" ")		$13 million per year (" " ") (at full development)	

Overhead	
Generation	35% of Fixed and Variable Costs

Fuel Costs	
Oil	498 cents/10^6 BTU
Coal	214 " "
Diesel	712 " "
Nuclear	4.2 mills/kWh (includes spent fuel disposal)

Recall Energy from Churchill Falls	4.0 mills / kWh at the plant, equivalent to 4.29 mills/kWh delivere

LOWER CHURCHILL DEVELOPMENT CORPORATION

ALTERNATIVE GENERATION EXPANSION PROGRAMS

NLH LOAD FORECAST

Gull + Muskrat vs Muskrat + Gull

Year	Alternative 5	Alternative 6
	Gull + Muskrat	Muskrat + Gull
1984	2 x 54 MW G.T.	2 x 54 MW G.T.
1985	-	-
1986	5600GWh Gull	4310GWh Muskrat
		1290GWh Recall
1987	-	-
1988	-	-
1989	-	-
1990	-	-
1991	-	-
1992	-	-
1993	-	-
1994	-	-
1995	2800GWh Gull	1 x 54 MW G.T.
1996	-	2 x 54 MW G.T.
1997	-	2 x 54 MW G.T.
1998	-	-
1999	-	5600GWh Gull
2000	2109GWh Gull	-
	688GWh Recall	-
2001	-	-
2002	-	-
2003	-	-
2004	1 x 54 MW G.T.	-
2005	2 x 54 MW G.T.	-
2006	3 x 54 MW G.T.	2800GWh Gull
2007	3 x 54 MW G.T.	-
2008	-	-
2009	4310GWh Muskrat	1 x 54 MW G.T.
	1290GWh Recall	-
2010	-	-
2011	-	2109GWh Gull
		688GWh Recall
2012	-	-
2013	1 x 54 MW G.T.	4 x 54 MW G.T.
2014	3 x 54 MW G.T.	3 x 54 MW G.T.
2015	4 x 54 MW G.T.	4 x 54 MW G.T.
Total Capacity Added - 1984 to 2015		
Oil	-	-
Coal	-	-
G.T.s	1026 MW	1026 MW
Hydro	2400 MW	2400 MW
Total	3426 MW	3426 MW

LOWER CHURCHILL DEVELOPMENT CORPORATION
ALTERNATIVE GENERATION EXPANSION PROGRAMS

NLH Load Forecast

Year	Alternative 1D On-Island	Alternative 2D Muskrat	Alternative 2D4 Muskrat Delayed by 4 years	Alternative 2D8 Muskrat Delayed by 8 years	Alternative 3D Gull Island	Alternative 3D4 Gull Delayed by 4 years	Alternative 3D8 Gull Delayed by 8 years
1984		2 x 54 MW G.T.			2 x 54 MW G.T.		
1985	2x63.5MW Cat Arm 27MW Island Pond		2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond		2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond
1986	150 MW Coal	4310gWh Muskrat 1290gWh Recall	150 MW Coal	150 MW Coal	5600gWh Gull	150 MW Coal	150 MW Coal
1987	150 MW Coal		150 MW Coal	150 MW Coal		1 x 54 MW G.T.	150 MW Coal
1988	150 MW Coal		1 x 54 MW G.T.	150 MW Coal		2 x 54 MW G.T.	150 MW Coal
1989	150 MW Coal			150 MW Coal			150 MW Coal
1990			4310gWh Muskrat 1290gWh Recall			5600gWh Gull	
1991							
1992	150 MW Coal			2 x 54 MW G.T.			2 x 54 MW G.T.
1993							
1994	150 MW Coal	2x63.5MW Cat Arm 27MW Island Pond		4310GWh Muskrat 1290GWh Recall			5600GWh Gull
1995					2800gWh Gull	2800gWh Gull	2800GWh Gull
1996	150 MW Coal 1 x 54 MW G.T.	150 MW Coal					
1997							
1998	150 MW Coal 2 x 54 MW G.T.	150 MW Coal					
1999							
2000	150 MW Coal 1 x 54 MW G.T.	150 MW Coal	150 MW Coal 1 x 54 MW G.T.		2112gWh Gull 688gWh Recall	2112gWh Gull 688gWh Recall	2112GWh Gull 688GWh Recall
2001	2x54 MW G.T.	3 x 54 MW G.T.	3 x 54 MW G.T.				
2002				2 x 54 MW G.T.			
2003	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	2 x 54 MW G.T.			
2004	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.		1 x 54 MW G.T.		
2005	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	300MW coal + 54MW G.T.	2 x 54 MW G.T.		
2006				3 x 54 MW G.T.			
2007	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	2 x 54 MW Coal	
2008	3 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.		3 x 54 MW G.T.	3 x 54 MW G.T.	
2009							
2010	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 3 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	4 x 54 MW G.T.
2011	3 x 54 MW G.T.	3 x 54 MW G.T.	3 x 54 MW G.T.		3 x 54 MW G.T.	3 x 54 MW G.T.	3 x 54 MW G.T.
2012				300MW Coal + 2x54MW G.T.			3 x 54 MW G.T.
2013	300 MW Coal 2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.		300 MW Coal 2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	182 MW Coal 54 MW G.T.
2014	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	208MW Coal + 3x54MW G.T.	3 x 54 MW G.T.	3 x 54 MW G.T.	3 x 54 MW G.T.
2015	84 MW Coal 3 x 54 MW G.T.	58 MW Coal 4 x 54 MW G.T.	58 MW Coal 4 x 54 MW G.T.	3 x 54 MW G.T.	26 MW Coal 3 x 54 MW G.T.	32 MW Coal 3 x 54 MW G.T.	4 x 54 MW G.T.
TOTAL CAPACITY ADDED - 1984 to 2015							
Oil	-	-	-	-	-	-	-
Coal	2634 MW	1708 MW	1708 MW	1708 MW	1708 MW	1708 MW	1708 MW
G.T.s	1404 MW	1404 MW	1404 MW	1296 MW	1188 MW	1134 MW	1080 MW
Hydro	154 MW	954 MW	954 MW	954 MW	1600 MW	1754 MW	1754 MW
Total	4192 MW	4066 MW	4066 MW	3958 MW	3714 MW	3670 MW	3616 MW

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Table 6

LOWER CHURCHILL DEVELOPMENT CORPORATION
ALTERNATIVE GENERATION EXPANSION PROGRAMS
LOW LOAD FORECAST

Year	Alternative 1L On-Island	Alternative 2L Muskrat	Alternative 2L4 Muskrat delayed by 4 years	Alternative 2L8 Muskrat delayed by 8 years	Alternative 3L Gull Island ✓	Alternative 3L4 Gull delayed by 4 years ✓	Alternative 3L8 Gull delayed by 8 years ✓
1984	-	1 x 54 MW G.T.	-	-	1 x 54 MW G.T.	-	-
1985	2x63.5MW Cat Arm 27MW Island Pond	-	2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond	-	2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond
1986	-	4310GWh Muskrat 1290GWh Gull	150 MW Coal	150 MW Coal	5600 GWh Gull	150 MW Coal	150 MW Coal
1987	-	-	150 MW Coal	150 MW Coal	-	-	150 MW Coal
1988	150 MW Coal	-	-	150 MW Coal	-	-	150 MW Coal
1989	150 MW Coal	-	-	-	-	-	-
1990	150 MW Coal	-	4310 GWh Muskrat 1286 GWh Recall	-	-	5600 GWh Gull	150 MW Coal
1991	-	-	-	150 MW Coal	-	-	-
1992	-	-	-	-	-	-	-
1993	150 MW Coal	-	-	-	-	-	-
1994	150 MW Coal	-	-	4310 GWh Muskrat 1296 GWh Recall	-	-	5600 GWh Gull
1995	-	-	-	-	-	-	-
1996	-	-	-	-	-	-	-
1997		2x63.5MW Cat Arm 27MW Island Pond	-	-	-	-	-
1998	-	-	-	-	2800 GWh Gull	2800 GWh Gull	2800 GWh Gull
1999	150 MW Coal 1 x 54 MW G.T.	-	-	-	-	-	-
2000	-	150 MW Coal	-	-	-	-	-
2001	150 MW Coal 1 x 54 MW G.T.	-	-	-	-	-	-
2002	1 x 54 MW G.T.	150 MW Coal 1 x 54 MW G.T.	1 x 54 MW G.T.	-	-	-	-
2003	-	-	-	-	-	-	-
2004	150 MW Coal 2 x 54 MW G.T.	150 MW Coal 1 x 54 MW G.T.	150 MW Coal 2 x 54 MW G.T.	-	2112 GWh Gull 688 GWh Recall	2112 GWh Gull 688 GWh Recall	2118 GWh Gull 688 GWh Recall
2005	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	-	-	-
2006	-	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	-	-	-
2007	300 MW Coal	-	-	-	-	-	-
2008	3 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	-	-	-
2009	-	2 x 54 MW G.T.	2 x 54 MW G.T.	-	-	-	-
2010	300 MW Coal	-	-	2 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	2 x 54 MW G.T.	-
2011	2 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	2 x 54 MW G.T.	3 x 54 MW G.T.	-
2012	-	2 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.	-	-	-
2013	300 MW Coal 1 x 54 MW G.T.	-	-	-	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 2 x 54 MW G.T.	2 x 54 MW G.T.
2014	3 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T. 3 x 54 MW G.T.	3 x 54 MW G.T. 2 x 54 MW G.T.	2 x 54 MW G.T.	3 x 54 MW G.T.
2015	-	-	-	-	-	-	-
2016	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	300 MW Coal 1 x 54 MW G.T.	3 x 54 WM G.T.	300 MW G.T. 1 x 54 MW G.T.	300 MW G.T. 2 x 54 MW G.T.	3 x 54 MW G.T.
2017	1 x 54 MW G.T.	2 x 54 MW G.T.	2 x 54 MW G.T.		3 x 54 MW G.T.	2 x 54 MW G.T.	3 x 54 MW G.T.
2018	84 MW Coal 2 x 54 MW G.T.	58 MW Coal 2 x 54 MW G.T.	58 MW Coal 2 x 54 MW G.T.	208 MW Coal 2 x 54 WM G.T.	26 MW Coal 2 x 54 MW G.T.	32 MW Coal 2 x 54 MW G.T.	182 MW Coal 3 x 54 MW G.T.

TOTAL CAPACITY ADDED - 1984 to 2018

Oil	-	-	-	-	-	-	-
Coal	2634 MW	1708 MW	1708 MW	1708 MW	926 MW	782 MW	782 MW
G.T.s	1080 MW	972 MW	972 MW	972 MW	918 MW	810 MW	756 MW
Hydro	154 MW	954 MW	954 MW	954 MW	1600 MW	1754 MW	1754 MW
Total	3868 MW	3634 MW	3634 MW	3634 MW	3444 MW	3346 MW	3292 MW

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Table 7

LOWER CHURCHILL DEVELOPMENT CORPORATION

ALTERNATIVE GENERATION EXPANSION PROGRAMS

HIGH LOAD FORECAST

Year	Alternative 1H On-Island	Alternative 2H Muskrat	Alternative 2H4 Muskrat delayed by 4 years	Alternative 2H8 Muskrat delayed by 8 years	Alternative 3H Gull Island	Alternative 3H4 Gull delayed by 4 years	Alternative 3H8 Gull delayed by 8 years
1984		2x54MW G.T.			2x54MW G.T.		
1985	2x63.5MW Cat Arm 27MW Island Pond 150MW Coal		2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond		2x63.5MW Cat Arm 27MW Island Pond	2x63.5MW Cat Arm 27MW Island Pond
1986	150MW Coal	4316GWh Muskrat 1290GWh Recall	150MW Coal	150MW Coal	5600GWh Gull	150MW Coal 1x54MW G.T.	150MW Coal
1987	150MW Coal		150MW Coal	150MW Coal		2x54MW G.T.	300MW Coal 2x54MW G.T.
1988	150MW Coal		150MW Coal	150MW Coal		2x54MW G.T.	
1989							300MW Coal
1990	150MW Coal		4310GWh Muskrat 1290GWh Recall	300MW Coal 1x54MW G.T.		5600GWh Gull	
1991		2x63.5MW Cat Arm 27MW Island Pond		2x54MW G.T.			2x54MW G.T.
1992	150MW Coal			2x54MW G.T.	2800GWh Gull	2800GWh Gull	2x54MW G.T.
1993	150MW Coal	150MW Coal					
1994	150MW Coal 1x54MW G.T.	150MW Coal		4310GWh Muskrat 1290GWh Recall			8400GWh Gull
1995							
1996	150MW Coal 3x54MW G.T.	150MW Coal	1x54MW G.T.		2112GWh Gull 688GWh Recall	2112GWh Gull 688GWh Recall	2112 GWh Gull 688GWh Recall
1997							
1998	300MW Coal 1x54MW G.T.	300MW Coal 1x54MW G.T.	300MW Coal 2x54MW G.T.				
1999			3x54MW G.T.	1x54MW G.T.			
2000	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.					
2001	2x54MW G.T.	3x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.		
2002							
2003	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 3x54MW G.T.	300MW Coal	
2004					3x54MW G.T.	3x54MW G.T.	
2005	300MW Coal 3x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.	300MW Coal 2x54MW G.T.			1x54MW G.T.
2006	2x54MW G.T.	4x54MW G.T.	3x54MW G.T.	3x54MW G.T.	300MW Coal 3x54MW G.T.	300MW Coal 3x54MW G.T.	4x54MW G.T.
2007	84MW Coal 4x54MW G.T.	58 MW Coal 2x54MW G.T.	3x54MW G.T. 58 MW Coal	3x54MW G.T. 58 MW Coal	3x54MW G.T.	4x54MW G.T.	4x54MW G.T.
2008		1x54MW G.T.	1x54MW G.T.	1x54MW G.T.	26MW Coal 54MW G.T.	32MW Coal	32 MW Coal
TOTAL CAPACITY ADDED - 1984 to 2008							
Oil	-	-	-	-	-	-	-
Coal	2634 MW	1708 MW	1708 MW	1708 MW	926 MW	782 MW	782 MW
G.T.s	1080 MW	1026 MW	1026 MW	1026 MW	918 MW	810 MW	810 MW
Hydro	154 MW	954 MW	954 MW	954 MW	1600 MW	1754 MW	1754 MW
Total	3868 MW	3688 MW	3688 MW	3688 MW	3444 MW	3346 MW	3346 MW

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Table 8

LOWER CHURCHILL DEVELOPMENT CORPORATION

NLH LOAD FORECAST

SIMULATION TO YEAR 2015

CUMULATIVE PRESENT WORTH

Costs as Estimated: No Escalation

Recall = 4.29 Mills/kWh

Discount Rate	Alt. # 1D On-Island	Alt. # 2D Muskrat	Alt. # 2D4 Muskrat Delayed by 4 years	Alt. # 2D8 Muskrat Delayed by 8 years	Alt. # 3D Gull	Alt. # 3D4 Gull Delayed by 4 years	Alt. # 3D8 Gull Delayed by 8 years	Alt. # 5D Gull + Muskrat	Alt. # 6D Muskrat + Gull
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	6077.7	4879.2	5050.5	5208.9	3851.7	3987.9	4175.2	3602.3	3821.0
5	4682.1	3934.4	4062.4	4162.0	3289.3	3402.2	3519.0	3175.5	3350.9
6	3699.6	3272.5	3359.9	3411.5	2886.6	2966.2	3025.4	2848.5	2981.5
7.5	2712.0	2608.9	2641.1	2636.5	2468.6	2490.5	2482.3	2483.3	2557.5
10	1777.6	1977.6	1931.5	1863.7	2041.2	1966.6	1882.8	2075.3	2069.5
12.5	1275.5	1628.7	1519.8	1414.2	1776.5	1618.1	1489.7	1805.2	1742.3

LOWER CHURCHILL DEVELOPMENT CORPORATION

NLH LOAD FORECAST

SIMULATION TO YEAR 2015

CUMULATIVE PRESENT WORTH

Recall = 4.29 Mills/kWh

Capital Investment of Gull Island and Muskrat Alternative

Is Increased by 15%

Discount Rate	Alt. # 1D On-Island	Alt. # 2D Muskrat	Alt. # 2D4 Muskrat Delayed by 4 years	Alt. # 2D8 Muskrat Delayed by 8 years	Alt. # 3D Gull	Alt. # 3D4 Gull Delayed by 4 years	Alt. # 3D8 Gull Delayed by 8 years	Alt. # 5D Gull + Muskrat	Alt. # 6D Muskrat + Gull
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	6077.7	5097.1	5236.8	5308.1	4170.8	4266.7	4420.9	4009.8	4232.5
5	4682.1	4146.0	4236.5	4305.2	3594.7	3659.9	3739.1	3549.8	3726.4
6	3699.6	3478.0	3522.8	3540.5	3179.4	3204.8	3222.7	3195.1	3326.2
7.5	2712.0	2806.0	2788.6	2747.0	2744.1	2703.5	2650.2	2796.1	2863.8
10	1777.6	2161.8	2057.2	1949.6	2291.7	2144.0	2011.8	2346.4	2327.3
12.5	1275.5	1800.8	1627.3	1481.3	2005.9	1766.8	1589.4	2046.0	1964.9

LOWER CHURCHILL DEVELOPMENT CORPORATION

NLH LOAD FORECAST

SIMULATION TO YEAR 2015

CUMULATIVE PRESENT WORTH

Recall = 4.29 Mills/kWh

Coal Escalation = 1%

Discount Rate	Alt. # 1D On-Island	Alt. # 2D Muskrat	Alt. # 2D4 Muskrat Delayed by 4 years	Alt. # 2D8 Muskrat Delayed by 8 years	Alt. # 3D Gull	Alt. # 3D4 Gull Delayed by 4 years	Alt. # 3D8 Gull Delayed by 8 years	Alt. # 5D Gull + Muskrat	Alt. # 6D Muskrat + Gull
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	7294.7	5549.3	5728.4	5915.0	4174.8	4262.9	4485.1	3602.3	3821.0
5	5522.7	4381.9	4517.2	4641.5	3499.0	3581.2	3728.1	3175.5	3350.9
6	4292.3	3576.1	3670.2	3743.8	3024.5	3084.4	3170.0	2848.5	2981.5
7.5	3076.4	2783.5	2821.6	2835.5	2543.8	2555.7	2569.4	2483.3	2557.5
10	1955.1	2052.1	2010.9	1957.2	2070.1	1992.8	1925.4	2075.3	2069.5
12.5	1371.2	1663.0	1558.3	1463.5	1788.4	1629.8	1514.0	1805.2	1742.3

LOWER CHURCHILL DEVELOPMENT CORPORATION

LOW LOAD FORECAST

SIMULATION TO YEAR 2018

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Cost as Estimated: No Escalation

Discount Rate	Alt. # 1L On-Island	Alt. # 2L Muskrat	Alt. # 2L4 Muskrat delayed by 4 years	Alt. # 2L8 Muskrat delayed by 8 years	Alt. # 3L Gull	Alt. # 3L4 Gull delayed by 4 years	Alt. # 3L8 Gull delayed by 8 years
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	5474.3	4393.3	4288.3	4514.0	3569.0	3597.5	3682.4
6	3277.0	2950.5	2837.7	2951.4	2696.8	2675.4	2655.4
7	2630.1	2529.3	2406.2	2475.9	2430.3	2375.0	2316.5
7.5	2375.7	2363.9	2234.6	2285.1	2322.6	2249.7	2174.8
10	1535.1	1814.1	1649.7	1626.2	1941.3	1783.0	1647.9
12.5	1086.5	1514.4	1313.9	1244.5	1704.6	1473.0	1304.6

Table 12

LOWER CHURCHILL DEVELOPMENT CORPORATION

LOW LOAD FORECAST

SIMULATION TO YEAR 2018

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Capital Investment of Muskrat, Gull, and Associated Transmission = 115% of Base Case Value

Discount Rate	Alt. # 1L On-Island	Alt. # 2L Muskrat	Alt. # 2L4 Muskrat delayed by 4 years	Alt. # 2L8 Muskrat delayed by 8 years	Alt. # 3L Gull	Alt. # 3L4 Gull delayed by 4 years	Alt. # 3L8 Gull delayed by 8 years
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	5474.3	4611.2	4474.5	4673.2	3883.4	3871.7	3922.1
6	3277.0	3156.1	3000.5	3080.4	2984.4	2908.9	2845.9
7	2630.1	2729.1	2558.6	2592.2	2706.1	2590.9	2486.7
7.5	2375.7	2561.0	2382.2	2395.6	2592.9	2457.5	2335.8
10	1535.1	1998.0	1775.2	1712.0	2187.0	1955.3	1770.4
12.5	1086.5	1686.5	1421.3	1311.6	1929.6	1617.3	1398.7

Table 13

LOWER CHURCHILL DEVELOPMENT CORPORATION

LOW LOAD FORECAST

SIMULATION TO YEAR 2018

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Coal Escalation = 1%

Discount Rate	Alt. # 1L On-Island	Alt. # 2L Muskrat	Alt. # 2L4 Muskrat delayed by 4 years	Alt. # 2L8 Muskrat delayed by 8 years	Alt. # 3L Gull	Alt. # 3L4 Gull delayed by 4 years	Alt. # 3L8 Gull delayed by 8 years
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	6618.8	5001.9	4929.8	5182.8	3863.1	3846.8	3963.5
6	3820.4	3215.9	3125.8	3255.6	2818.3	2779.4	2783.0
7	3015.6	2708.3	2604.3	2687.2	2509.7	2443.7	2405.8
7.5	2702.7	2511.7	2400.1	2462.5	2387.0	2305.8	2250.3
10	1686.6	1873.5	1721.4	1705.9	1964.9	1804.8	1684.2
12	1166.1	1540.0	1348.6	1285.1	1713.7	1482.5	1325.3

Table 14

LOWER CHURCHILL DEVELOPMENT CORPORATION

HIGH LOAD FORECAST

SIMULATION TO YEAR 2008

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Cost as Estimated: No Escalation

Discount Rate	Alt. # 1H On-Island	Alt. # 2H Muskrat	Alt. # 2H4 Muskrat delayed by 4 years	Alt. # 2H8 Muskrat delayed by 8 years	Alt. # 3H Gull	Alt. # 3H4 Gull delayed by 4 years	Alt # 3H8 Gull delayed by 8 years
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	6906.7	5657.7	5893.8	6102.7	4331.9	4562.2	4747.6
6	4326.9	3842.2	3976.7	4081.5	3236.3	3409.7	3459.3
7	3539.5	3288.0	3378.3	3441.3	2889.0	3023.5	3024.0
7.5	3224.4	3065.8	3135.6	3180.0	2746.6	2860.9	2840.9
10	2151.1	2302.2	2283.3	2254.4	2235.0	2249.1	2152.4
12.5	1556.5	1866.8	1778.8	1702.3	1915.9	1840.9	1700.5

Table 13

LOWER CHURCHILL DEVELOPMENT CORPORATION

HIGH LOAD FORECAST

SIMULATION TO YEAR 2008

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Capital Investment of Muskrat, Gull, and Associated Transmission = 115% of Base Case Value

Discount Rate %	Alt. # 1H On-Island $ 10^6	Alt. # 2H Muskrat $ 10^6	Alt. # 2H4 Muskrat delayed by 4 years $ 10^6	Alt. # 2H8 Muskrat delayed by 8 years $ 10^6	Alt. # 3H Gull $ 10^6	Alt. # 3H4 Gull delayed by 4 years $ 10^6	Alt. # 3H8 Gull delayed by 8 years $ 10^6
4	6906.7	5875.6	6080.0	6261.9	4655.3	4812.8	4961.8
6	4326.9	4047.8	4139.5	4210.5	3534.0	3622.7	3627.0
7	3539.5	3487.8	3530.8	3557.6	3175.1	3220.4	3172.7
7.5	3224.4	3262.8	3283.1	3290.5	3027.2	3050.2	2980.5
10	2151.1	2486.1	2408.9	2340.2	2490.4	2405.4	2255.7
12.5	1556.5	2038.9	1886.3	1769.4	2149.5	1970.8	1777.0

LOWER CHURCHILL DEVELOPMENT CORPORATION

HIGH LOAD FORECAST

SIMULATION TO YEAR 2008

CUMULATIVE PRESENT WORTH

Cost of Recall Energy = 4.29 Mills/kWh

Coal Escalation = 1%

Discount Rate	Alt. # 1H On-Island	Alt. # 2H Muskrat	Alt. # 2H4 Muskrat delayed by 4 years	Alt. # 2H8 Muskrat delayed by 8 years	Alt. # 3H Gull	Alt. # 3H4 Gull delayed by 4 years	Alt. # 3H8 Gull delayed by 8 years
%	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6	$ 10^6
4	8263.3	6452.3	6698.4	6934.6	4737.5	4888.1	5098.9
6	5007.7	4223.3	4366.4	4492.6	3422.8	3553.2	3618.9
7	4036.8	3558.8	3657.1	3739.2	3018.2	3120.1	3133.3
7.5	3652.5	3295.5	3372.9	3435.4	2854.8	2940.4	2931.1
10	2367.2	2408.6	2396.1	2381.0	2281.6	2279.3	2187.2
12.5	1676.5	1920.2	1837.6	1771.7	1937.4	1851.9	1712.1

LOWER CHURCHILL DEVELOPMENT CORPORATION

CUMULATIVE PRESENT WORTH TO 1981 OF CASH COSTS BETWEEN 1984 and 2045

PRICE OF RECALL = 4.29 MILLS/KWH

Load Forecast	NLH FORECAST - Simulation Period to 2015					
Discount Rate	7.5%			10.0%		
Cost Condition	All Costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year	All Costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year
On-Island	2712.0	2712.0	3076.4	1777.6	1777.6	1955.1
Muskrat in 1986 + Coal	2608.9	2806.0	2783.5	1977.6	2161.8	2052.1
Muskrat in 1990 + Coal	2641.1	2788.6	2821.6	1931.5	2057.2	2010.9
Muskrat in 1994 + Coal	2636.5	2747.0	2835.5	1863.7	1949.6	1957.2
Gull in 1986 + coal	2468.6	2744.1	2543.8	2041.2	2291.7	2070.1
Gull in 1990 + Coal	2490.5	2703.5	2555.7	1966.6	2144.0	1992.8
Gull in 1994 + Coal	2482.3	2650.2	2569.4	1882.8	2011.8	1925.4
Gull in 1986 + Muskrat	2483.3	2796.1	2483.3	2075.3	2346.4	2075.3
Muskrat in 1986 + Gull	2557.5	2863.8	2557.5	2069.5	2327.3	2069.5

Load Forecast	LOW LOAD FORECAST - Simulation Period to 2018					
Discount Rate	7.0%			10.0%		
Cost Condition	All costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year	All costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year
On-Island	2630.1	2630.1	3015.6	1535.1	1535.1	1686.6
Muskrat in 1986 + Coal	2529.3	2729.1	2708.3	1814.1	1998.0	1873.5
Muskrat in 1990 + Coal	2406.2	2558.6	2604.3	1649.7	1775.2	1721.4
Muskrat in 1994 + Coal	2475.9	2592.2	2687.2	1626.2	1712.0	1705.9
Gull in 1986 + Coal	2430.3	2706.1	2509.7	1941.3	2187.0	1964.9
Gull in 1990 + Coal	2375.0	2590.9	2443.7	1783.0	1955.3	1804.8
Gull in 1994 + Coal	2316.5	2486.7	2405.8	1647.9	1770.4	1684.2

Load Forecast	HIGH LOAD FORECAST - Simulation Period to 2008					
Discount Rate	7.0%			10.0%		
Cost Condition	All costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year	All costs as estimated	LCDC @ 1.15 estimate	Coal escalating @ 1% per year
On-Island	3539.5	3539.5	4036.8	2151.1	2151.1	2367.2
Muskrat in 1986 + Coal	3288.0	3487.8	3558.8	2302.2	2486.1	2408.6
Muskrat in 1990 + Coal	3378.3	3530.8	3657.1	2283.3	2408.9	2396.0
Muskrat in 1994 + Coal	3441.3	3557.6	3739.2	2254.4	2340.2	2381.0
Gull in 1986 + Coal	2889.0	3175.1	3018.2	2235.0	2490.4	2281.6
Gull in 1990 + Coal	3008.6	3220.4	3120.1	2238.1	2405.4	2279.3
Gull in 1994 + Coal	2994.9	3172.7	3133.3	2126.1	2255.7	2187.2

LOWER CHURCHILL DEVELOPMENT CORPORATION

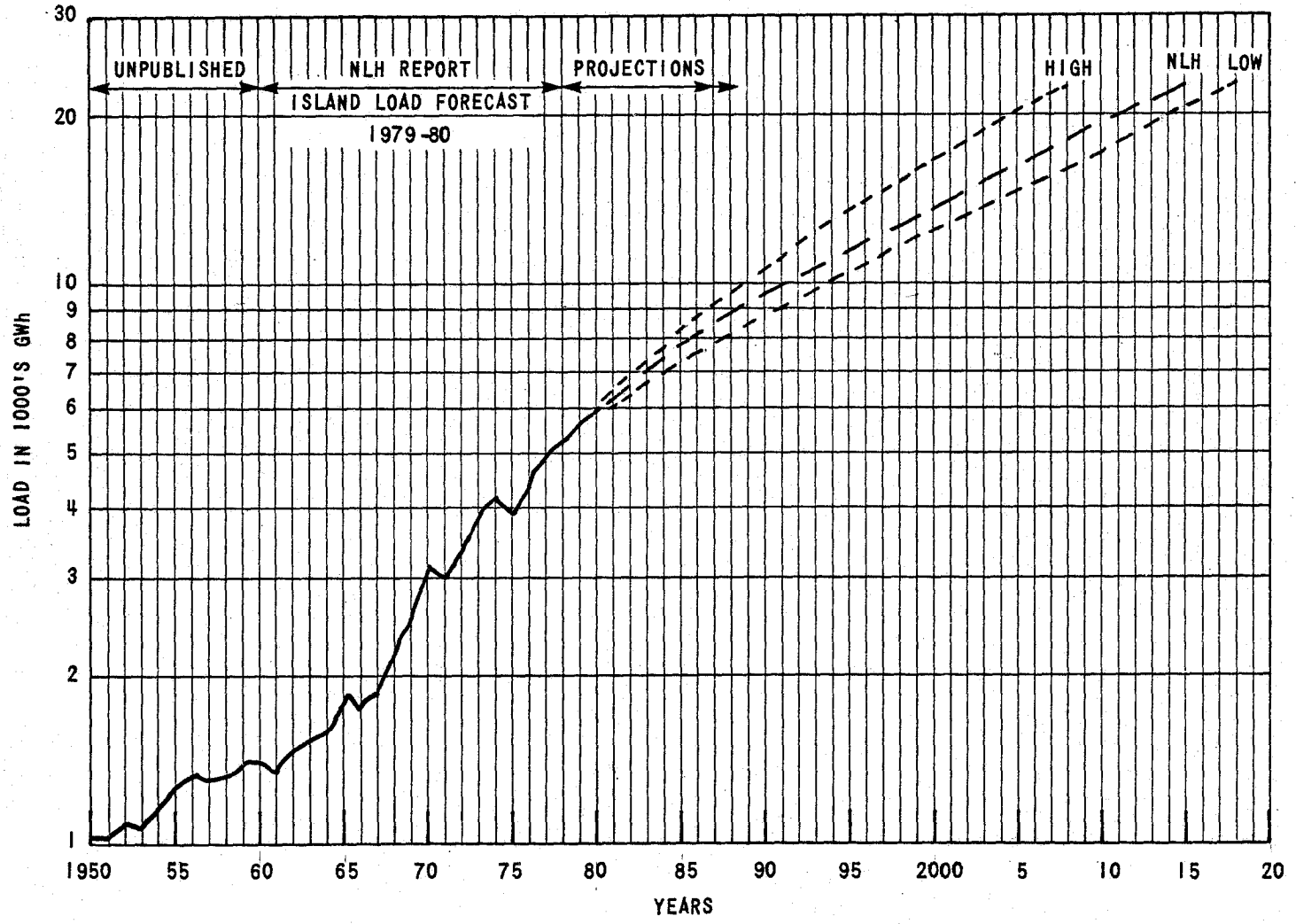
Present Worth of Energy Available

for Sales West

Alternative # 3 (Gull)

Year	Gull Energy Available (GWh)	Gull Energy Absorbed (GWh)	Gull Energy for sale (GWh)	Present Worth of Gull Energy for sale to January 1981 at 10% discount rate	
				Annual	Cumulative
1986	10,512	3353	7159	4041	4041
1987	10,512	3707	6805	3492	7533
1988	10,512	4104	6408	2988.4	10522.4
1989	10,512	4469	6043	2562.8	13085.2
1990	10,512	4807	5705	2199.5	15284.7
1991	10,512	5153	5359	1878.3	17163.0
1992	10,512	5494	5018	1598.9	18761.9
1993	10,512	5600	4912	1422.8	20184.7
1994	10,512	5600	4912	1294.5	21478.2
1995	10,512	6611	3901	933.9	22412.1
1996	10,512	7001	3511	764.1	23176.2
1997	10,512	7394	3118	616.9	23793.1
1998	10,512	7807	2705	486.5	24279.6
1999	10,512	8209	2303	376.6	24656.2
2000	10,512	8700	1812	269.3	24925.5
2001	10,512	9167	1345	181.8	25107.3
2002	10,512	9627	885	108.7	25216.0
2003	10,512	10108	404	45.1	25261.1
2004	10,512	10512	0	0	25261.1

LIST OF FIGURES

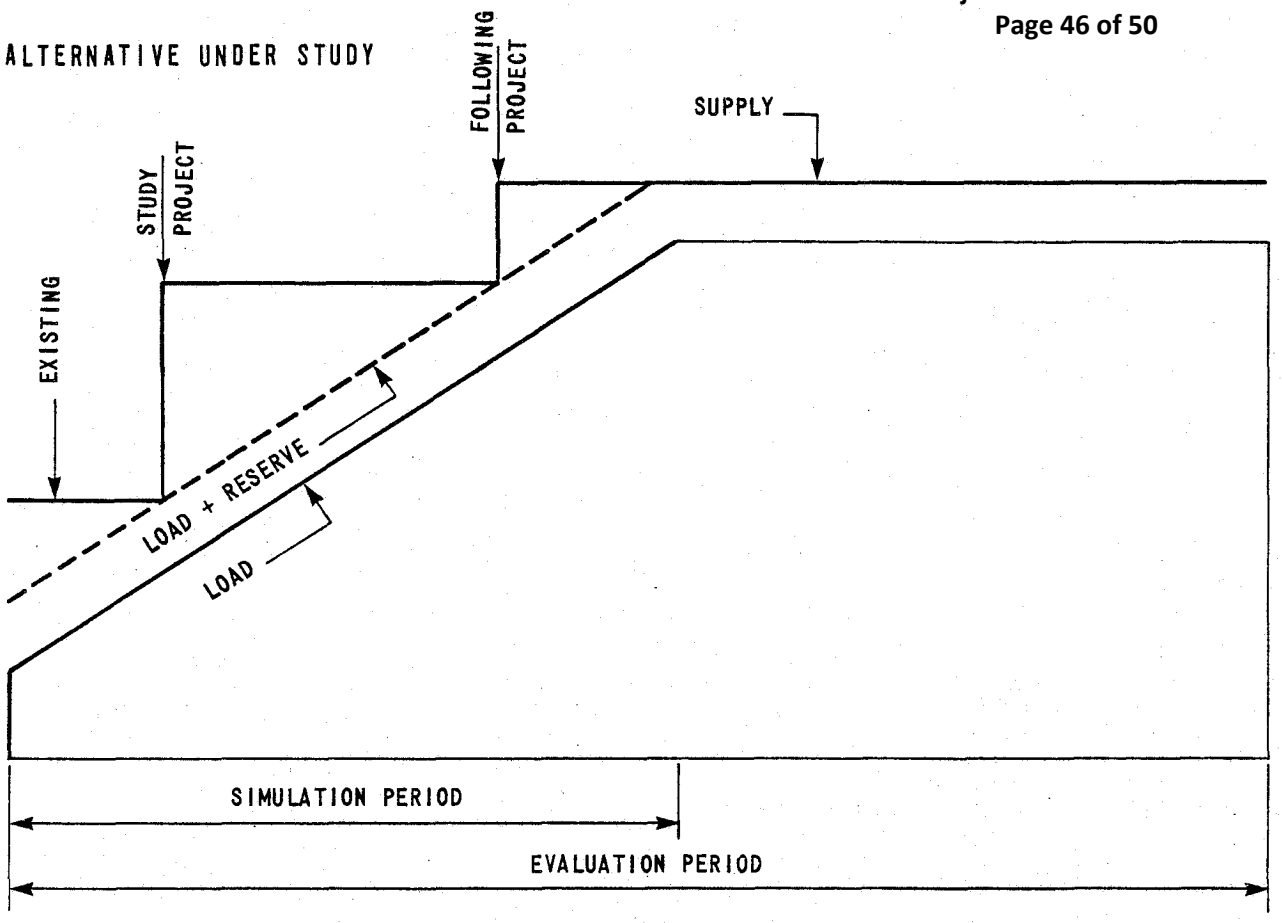


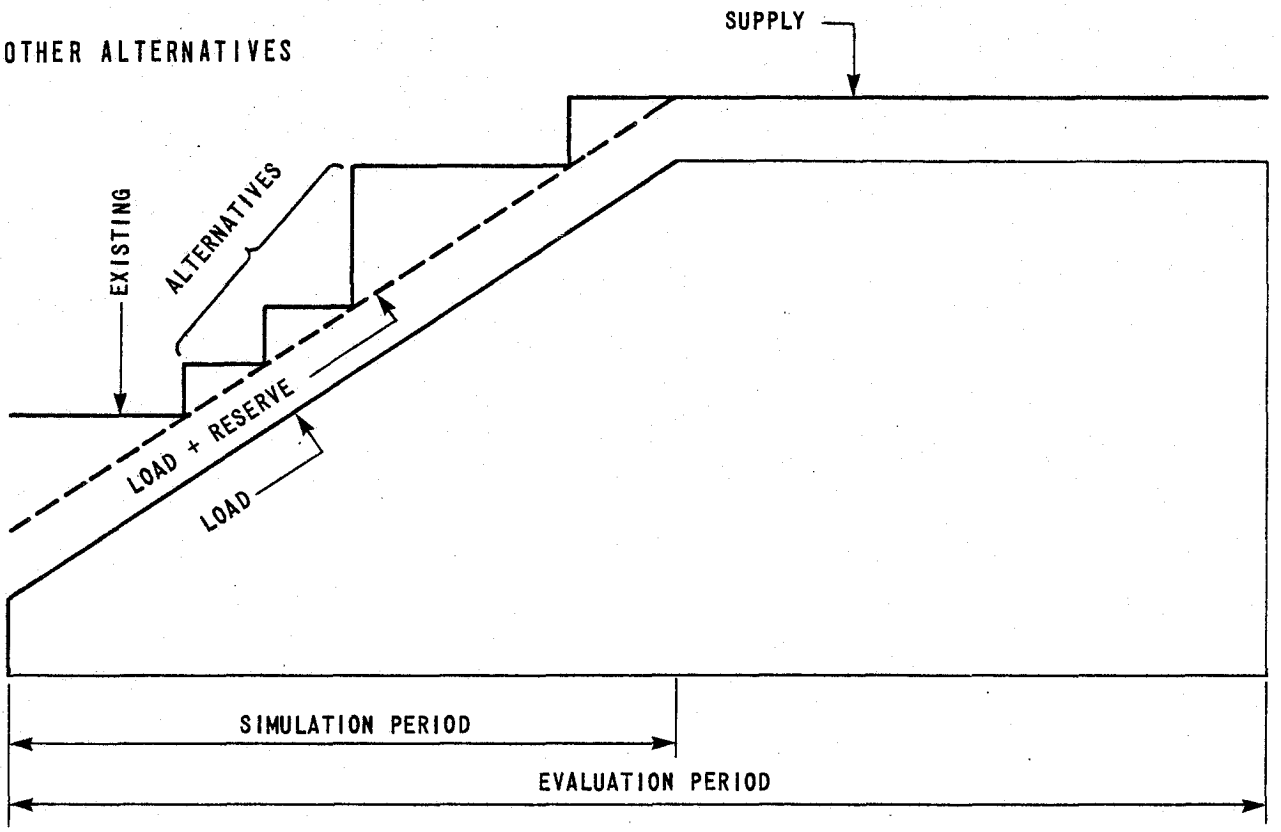
LOWER CHURCHILL DEVELOPMENT CORPORATION

ENERGY CONSUMPTION

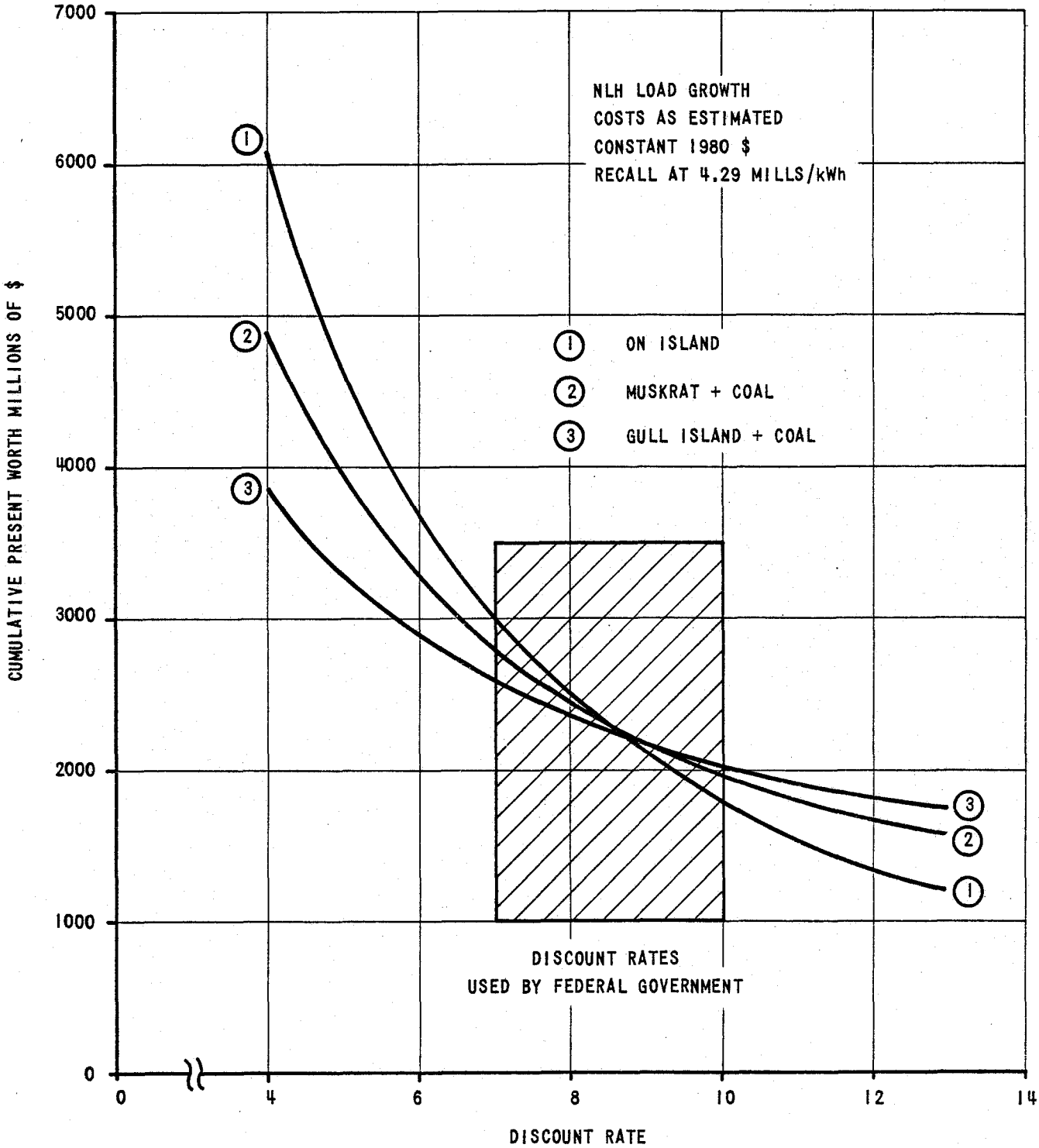
HISTORIC & PROJECTED

ISLAND OF NEWFOUNDLAND



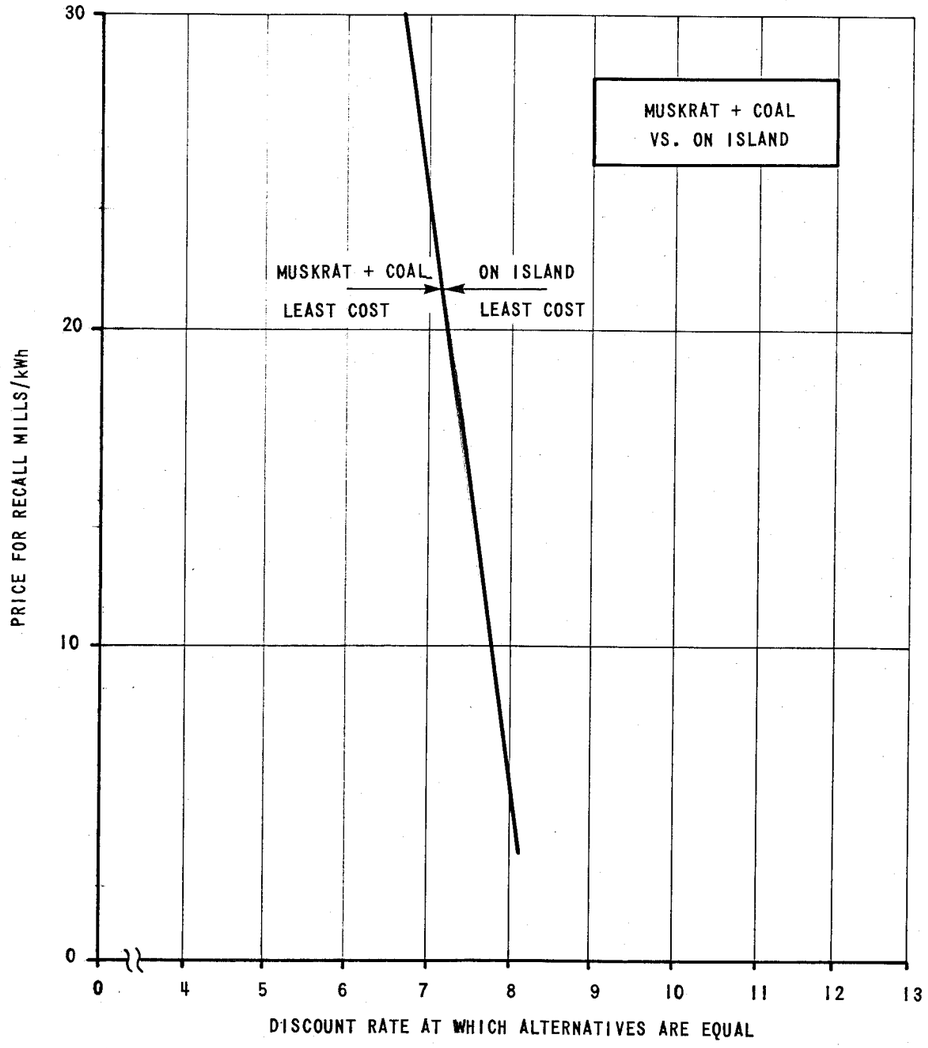


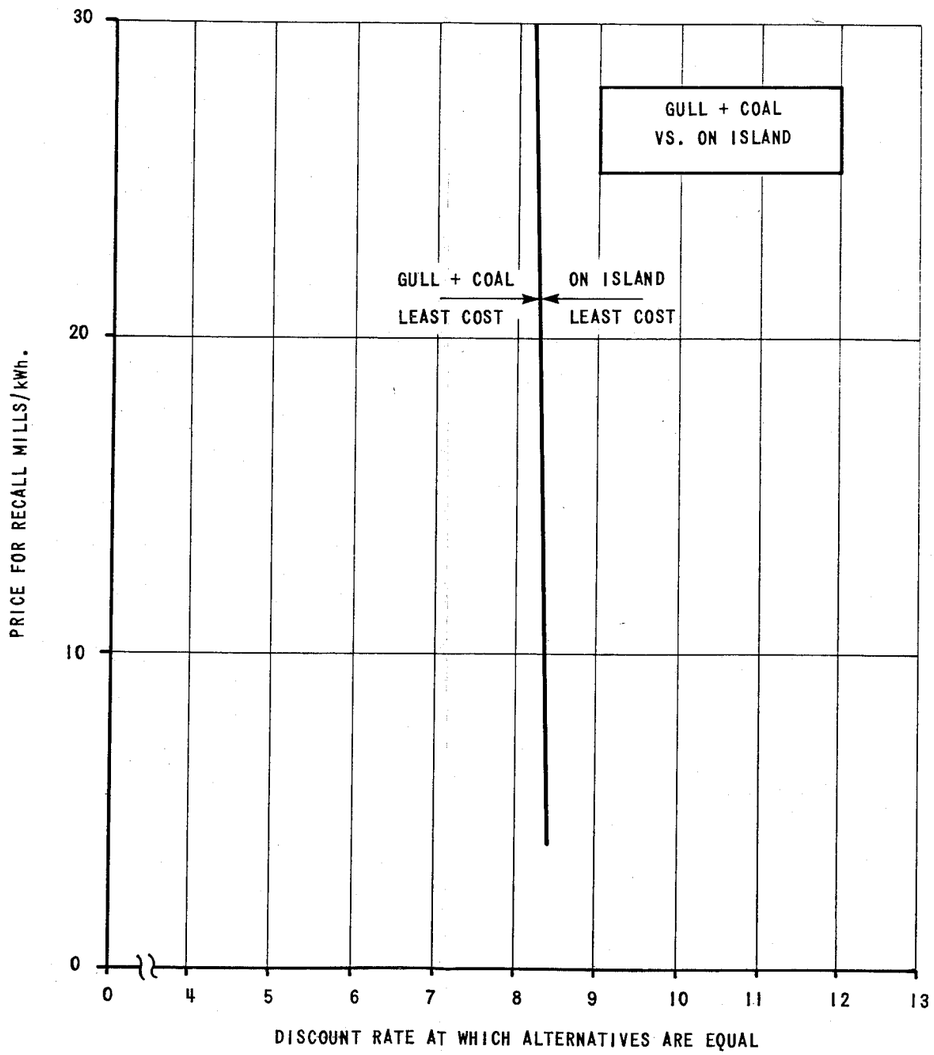
COMPARISON METHOD



LOWER CHURCHILL DEVELOPMENT CORPORATIO

COST EFFECTIVENESS





LOWER CHURCHILL DEVELOPMENT CORPORATION
EFFECT OF VALUE OF RECALL ENERGY
NLH LOAD GROWTH-SIMULATION TO 2006

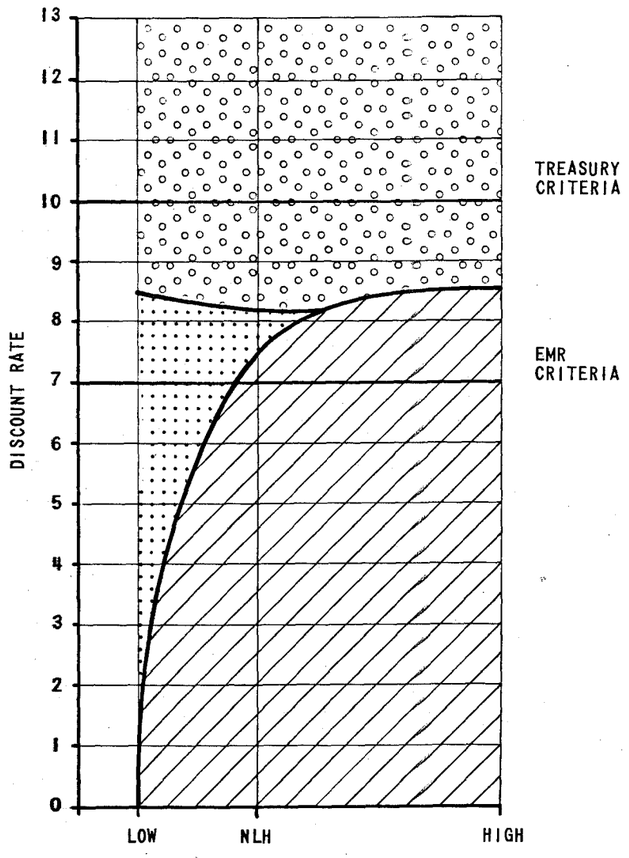
MUSKRAT FALLS + COAL

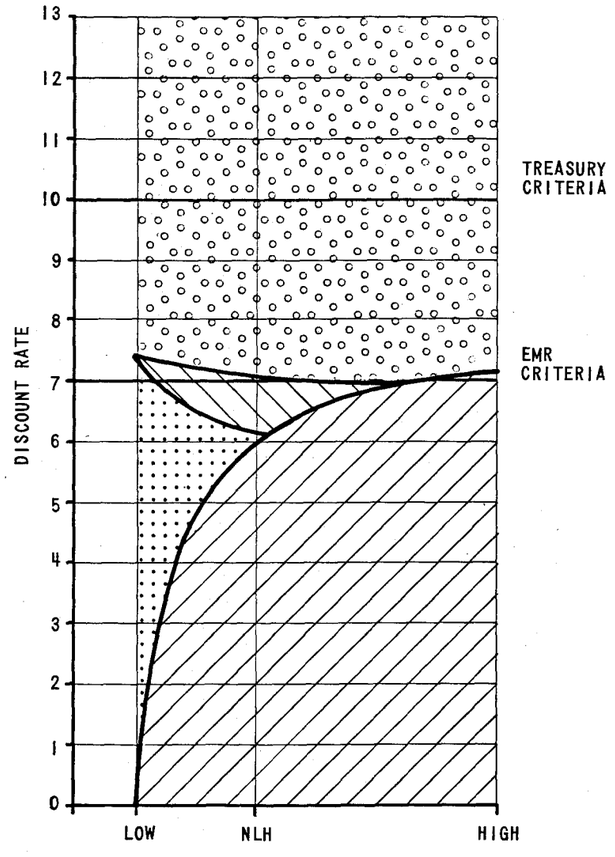
1986 IN SERVICE (NO DELAY)

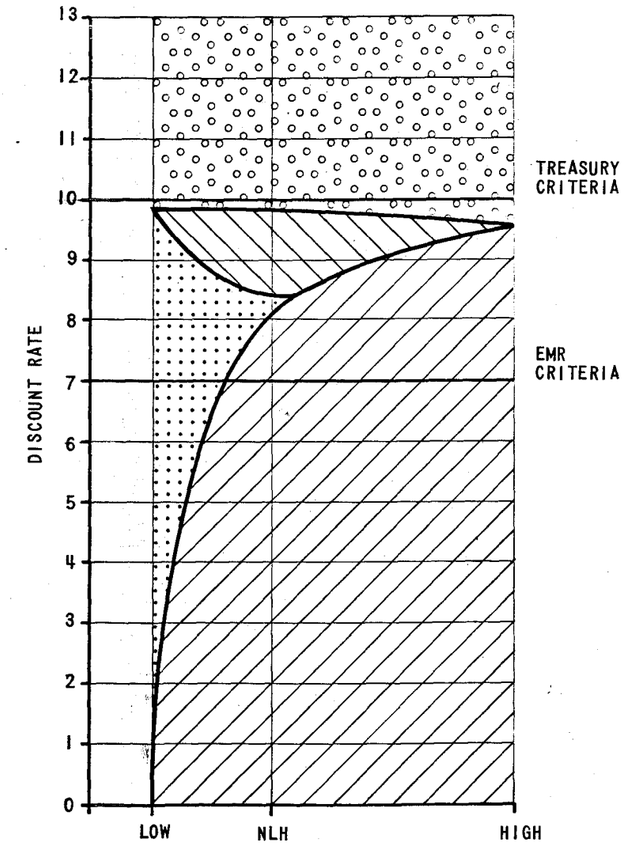
1994 IN SERVICE (8 YEARS DELAY)

1990 IN SERVICE (4 YEARS DELAY)

ON ISLAND







LOWER CHURCHILL DEVELOPMENT CORPORATION
COST EFFECTIVENESS
EFFECT OF COST ASSUMPTIONS,
LOAD GROWTH & DELAY
RECALL @ 4.29 MILLS/kWh

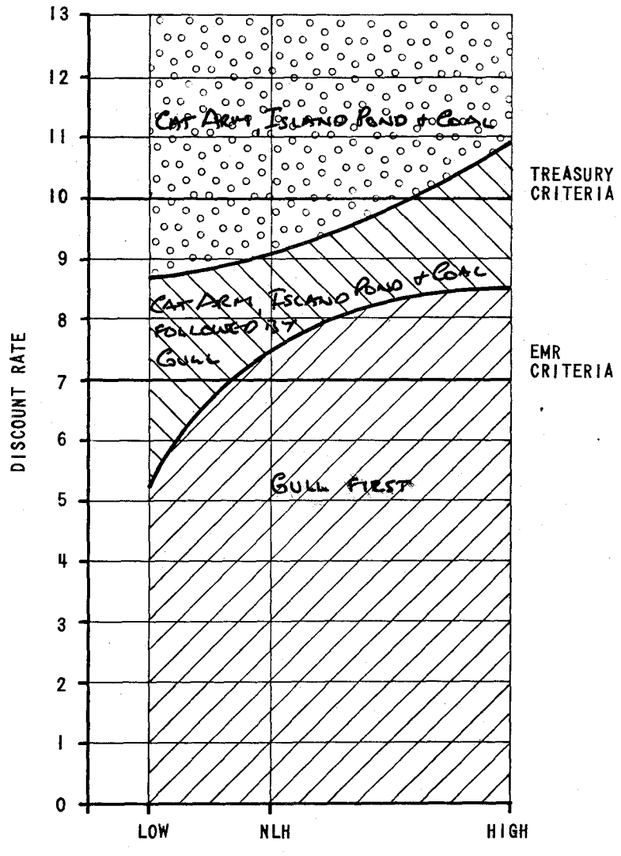
GULL ISLAND + COAL

1986 IN SERVICE (NO DELAY)

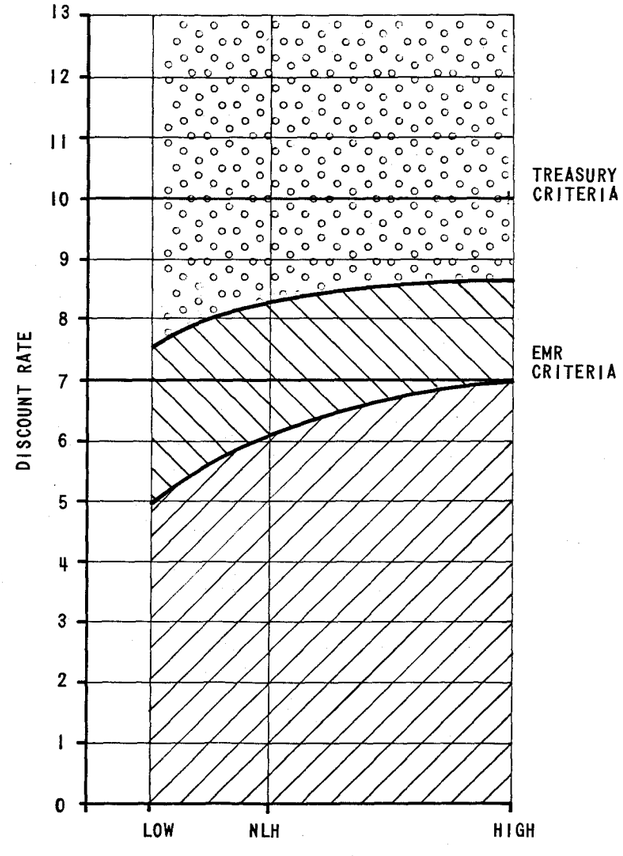
1994 IN SERVICE (8 YEARS DELAY)

1990 IN SERVICE (4 YEARS DELAY)

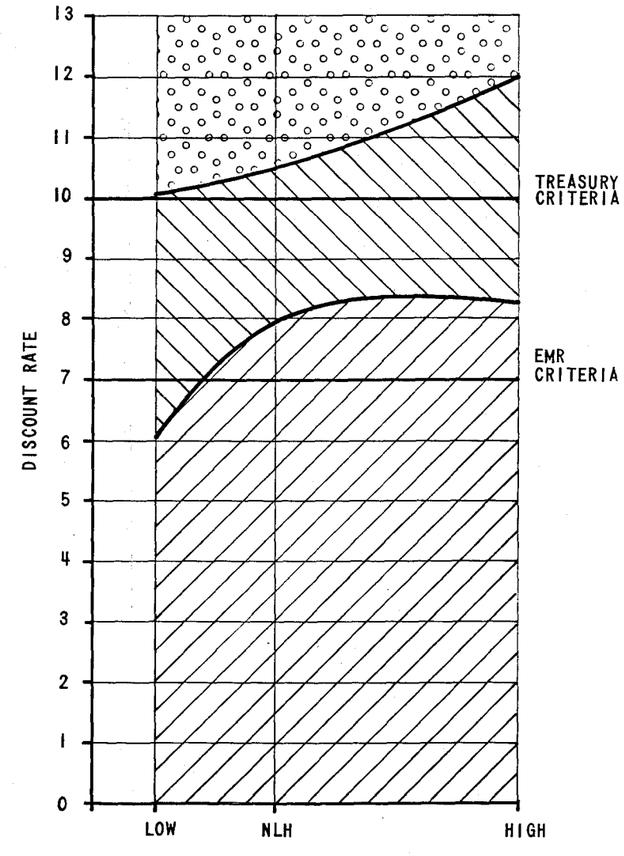
ON ISLAND



LOAD GROWTH
ALL COSTS CONSTANT



LOAD GROWTH
LCDC COSTS INCREASED 15%



LOAD GROWTH
ESCALATION ON COAL = 1% PER YEAR

LOWER CHURCHILL DEVELOPMENT CORPORATION
COST EFFECTIVENESS
EFFECT OF COST ASSUMPTIONS,
LOAD GROWTH & DELAY