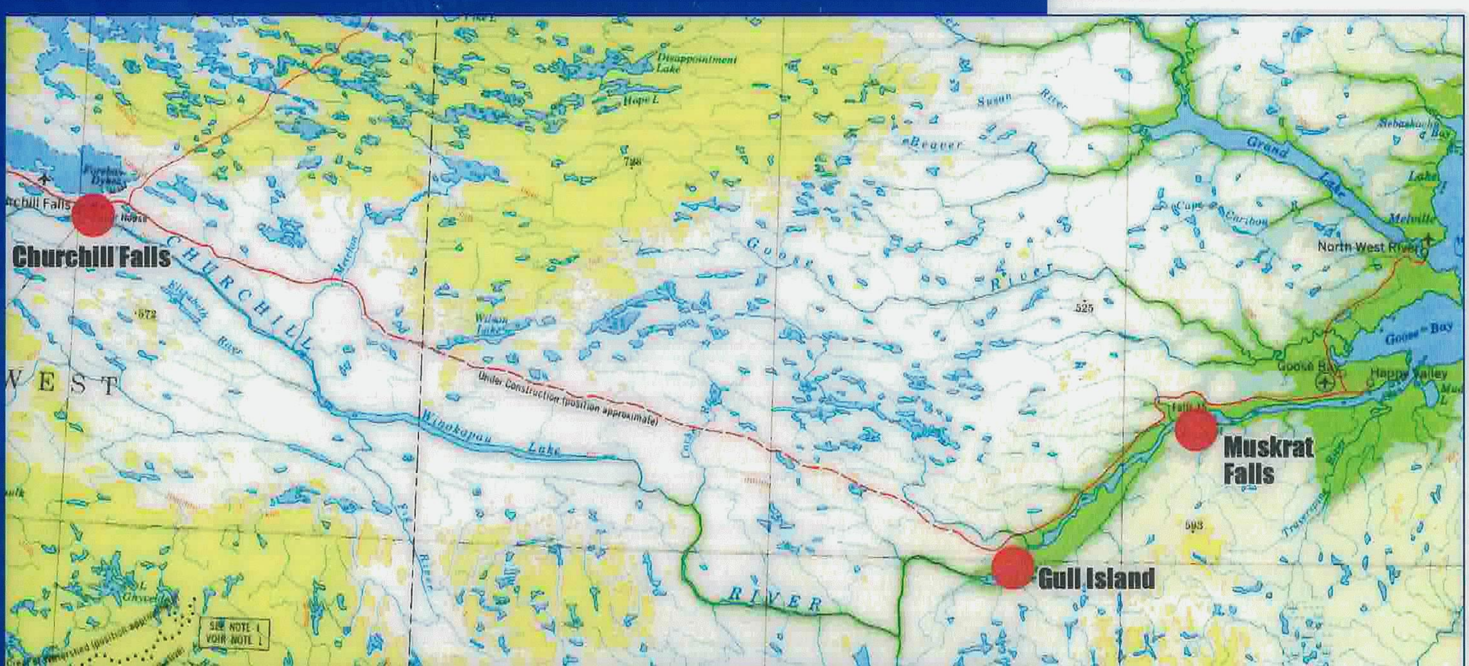
NEWFOUNDLAND AND LABRADOR HYDRO

Churchill River Complex

Optimization Study



Volume 1 - Main Report

January 1999

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February 19, 1999
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Newfoundland and Labrador Hydro
Hydro Place, Columbus Drive
P.O. Box 12400
St. John's, Newfoundland A1B 4K7

Attention: Mr. G. Piercy, P.Eng.

Dear ~~Sir~~ Gerard:

Churchill River Complex Optimization Study

We are pleased to submit the final report of the Churchill River Complex Optimization Study. We are providing 24 copies of Volume 1 and 12 copies of Volume 2, as well as a binder of detailed model output for your files. The first copy of Volume 1 contains a CD-ROM with electronic versions of the model setups and the report (excluding Appendices).

It has been a pleasure to work with you and your staff on this project and we look forward to continuing involvement with the Churchill River Complex studies.

Yours very truly,

S.H. Richter, P.Eng.
Senior Hydrotechnical Engineer
Project Manager

RW:smb

Encl.

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Executive Summary

Executive Summary

Acres International Limited carried out an optimization study for Newfoundland and Labrador Hydro to determine the optimal installed capacities for each of the proposed developments in the Churchill River Complex. These developments included an extension to the existing Churchill Falls station, referred to as CF2, and new stations on the Lower Churchill River at Gull Island and Muskrat Falls.

The operation of the reservoirs and hydroelectric generating stations and resulting energy output vary according to which developments are assumed to be in place. One of the principal tasks of the optimization study was to estimate the power and energy benefits from the total Churchill River Complex for the many possible combinations of installed capacity at the three developments.

Preliminary cost estimates were provided by the consultants studying the feasibility (feasibility consultants) of the three developments. Based on these estimates and the results of the power and energy simulations, preliminary installed capacities were provided to the feasibility consultants, to allow them to carry out more detailed design and costing.

The detailed cost estimates provided by the feasibility consultants were used along with the power and energy results to produce cost and energy curves, which were then used to finalize the optimization. The results showed that the preliminary combination was optimal within the accuracy of the cost estimates. The recommended installed capacities at each development are summarized in the following table.

Development	Installed Capacity (MW)
CF2	1100
Gull Island	2264
Muskrat Falls	824

Additional capacity may be installed at CF2, up to the transmission limit of 4300 MW, if the additional flow can be handled by the channels in the existing system.

The estimated average annual energy output from the Churchill River Complex is 57.1 TWh. This results in about 23.2 TWh annually of additional energy above average existing generation. The energy benefit of water from the proposed diversion of two rivers in Québec (St-Jean and Romaine) passing through the existing and new developments is included in this estimate.

The results of this study are based on several external assumptions relating to such factors as transmission limits and hydraulic capacity of channels in the existing Churchill Falls hydroelectric development, as well as the anticipated benefits of the power and energy on the market. The optimal installed capacity at CF2 is the most sensitive to these assumptions. The value of capacity would have to drop from the assumed rate of $0.55 million/MW to close to the incremental cost of capacity at CF2 (presently estimated at about $0.33 million/MW) before the results of the optimization would be substantially affected. If these factors change, the results of the optimization, particularly the selected installed capacity of CF2, should be reviewed.

In addition, the power and energy simulations were based on a monthly time step, as appropriate for this level of study. A simulation with a daily time step, as well as some consideration for within-day water management, is recommended to test the assumptions and fine-tune the results.

The following table shows the simulated energy production at each development, as well as the incremental firm and average annual energy that can be attributed to each development as it is added to the Complex.

Final Firm and Average Annual Energy Results (TWh/yr)

Component	CF1	CF1 + Divs.	CF1 + CF2 + Divs.	CF1 + CF2 + GI + Divs.	CF1 + CF2 + GI + MF + Divs.
CF1	33.87	-	-	-	-
CF1 + Divs.	-	37.74	29.65	29.49	29.49
CF2	-	-	9.05	9.05	9.05
GI	-	-	-	13.30	13.05
MF	-	-	-	-	5.46
Total Average Annual Energy	33.87	37.74	38.70	51.84	57.05
Incremental Average Annual Energy	-	3.87	0.96	13.14	5.21
Firm Energy	31.09	34.89	35.11	47.15	52.04
Incremental Firm Energy	-	3.80	0.22	12.04	4.89

CF1 - *existing Churchill Falls hydroelectric development*
CF2 - *proposed extension to the existing Churchill Falls hydroelectric development*
GI - *proposed hydroelectric development at Gull Island*
MF - *proposed hydroelectric development at Muskrat Falls*
Divs. - *diversion of additional waters into Ossokmanuan Reservoir from St-Jean and Romaine River basins.*

The above results may be slightly different from those appearing in the feasibility studies for the CF2, Gull Island and Muskrat Falls developments due to minor revisions in hydrology and power plant characteristics after the final feasibility reports were issued.

Introduction

1 Introduction

In June, 1998, Newfoundland and Labrador Hydro (NLH) engaged Acres International Limited to carry out an optimization study of the Churchill River Complex. The purpose of the optimization was to ensure that appropriate capacities are selected for the proposed hydroelectric developments at Churchill Falls (CF2), Gull Island, and Muskrat Falls. This report documents the optimization process and the results of the study.

The feasibility studies of the proposed hydroelectric developments at CF2, Gull Island, and Muskrat Falls were conducted concurrently with this study. The consultants conducting these studies are referred to in this report as the feasibility consultants. These consultants were as follows.

- RSW/EDM JV — Churchill Falls 2 Final Feasibility Study
- SNC/AGRA JV — Gull Island Development (Optimization)
- SNC/AGRA JV — Muskrat Falls Final Feasibility Study

1.1 Background

The Churchill Falls hydroelectric development was designed during the late 1960s and constructed between 1969 and 1974. It consists of an 11-unit underground powerhouse with a rated installed capacity of 5428.5 MW, two large storage reservoirs, two forebays and several control structures.

Proposed developments on the Lower Churchill represent some of the largest untapped hydro power resources in North America. Possible sites of energy generation under consideration on the Churchill River include Gull Island and Muskrat Falls. The proposed new developments also include additional capacity at the existing Churchill Falls hydroelectric development, using diverted water from St-Jean and Romaine Rivers in the province of Québec.

The proposed components making up the Churchill River Complex are

- addition of installed capacity at the existing Churchill Falls hydroelectric development (CF2);
- construction of a power development on the Lower Churchill River at Gull Island;

- construction of a power development on the Lower Churchill River at Muskrat Falls downstream of the Gull Island site;
- diversion of additional waters into Ossokmanuan Reservoir from the St-Jean and Romaine River basins;
- construction of new transmission lines within Labrador and to the Québec border;
- construction of a transmission link to the island of Newfoundland; and
- construction of new transmission lines, or upgrading of the existing transmission system, within Québec.

1.2 Previous Power and Energy Studies

In February, 1998, NLH engaged Acres to develop a comprehensive power and energy model of the Churchill River Complex using Acres Reservoir Simulation Package (ARSP). This model, with updates for this optimization study, was used to evaluate the energy production for each of the candidate development combinations. Studies carried out in 1991 and 1997 were also reviewed as part of the previous work.

1.3 Study Activities

The activities undertaken in this study were as follows.

- Meet with NLH and representatives of the feasibility consultants to agree on the candidate development combinations.
- Update ARSP power and energy model.
- Review and summarize power plant characteristics for each proposed development alternative provided by the feasibility consultants.
- Calculate power and energy, and resulting benefits.
- Meet with NLH to discuss results.
- Select preliminary optimum configuration.

- Present recommended configuration to NLH and feasibility consultants.
- Provide additional information to feasibility consultants as required for the feasibility studies.
- Carry out more detailed optimization analysis using various economic and financial indicators.
- Prepare interim report.
- Confirm final configuration.
- Prepare draft report.
- Present final results to NLH and Hydro-Québec (HQ).
- Prepare final report.

Optimization Methodology

2 Optimization Methodology

The objective of this study was to determine the optimum project configuration for the three proposed developments on the Churchill River; that is, CF2, Gull Island, and Muskrat Falls. For the purposes of the optimization study, the other proposed components listed in Section 1.1 were assumed to be in place (i.e., transmission lines and diversions).

The principal objective was to select the installed capacity at each development that would provide the optimum benefits to the overall Complex. A secondary objective was to optimize the dam height at Gull Island, since the backwater effects from the headpond can affect the tailwater level at the Upper Churchill hydroelectric developments. The Muskrat Falls headpond level was set at 39 m by NLH based on previous Muskrat Falls engineering studies, so no similar analysis was required at this site.

2.1 Assumptions

The optimization was based on the following externally fixed assumptions.

- The total new capacity is limited to 4300 MW, due to transmission constraints.[1]
- The variable component within each development were different installed capacities and the headpond level at Gull Island.
- Tariffs as provided by NLH and HQ for the power and energy sales are at the bus-bar.
- The water diverted from Québec rivers (St-Jean and Romaine) is included in the optimization study. The development scheme for the diversions is being studied separately by HQ and the cost is not included in the optimization analysis.

[1]A transmission limit of 4200 MW was used for the preliminary optimization analysis. Analysis by Trans Enérgie increased this limit to 4300 MW during the final optimization analysis. [2-1]

The basic issue thus left for the optimization study to address was the optimal allocation of 4300 MW among the three developments, CF2, Gull Island, and Muskrat Falls, and, for comparison, between CF2 and Gull Island only.

The range of installed capacities, and the values for which energy and cost data were required, were agreed upon in discussions with NLH, HQ, and the feasibility consultants early in the study.

2.2 Optimization Process

The optimization process required

- estimation of power and energy benefits;
- preparation of cost data;
- development of objective functions to describe the relationships between energy and cost to installed capacity;
- development of an optimization model to calculate optimum installed capacities as required for the analysis, using various measures for the objective function (for example, total benefits, net benefits, profitability);
- testing of sensitivities; and
- recommendation of the installed capacities at each development, based on the results of the optimization model and other constraints.

The power and energy benefits were obtained from the results of system simulations, with various development alternatives (various values of installed capacities) as provided by the feasibility consultants. The costs were also obtained from the feasibility consultants, who provided base costs for the agreed-upon development alternatives.

Churchill River Complex Power and Energy Model

3 Churchill River Complex Power and Energy Model

This section of the report provides a summary of the power and energy model setup of the Churchill River Complex and the simulated energy for each of the candidate development combinations. A detailed description of the power and energy model of the Churchill River Complex, including existing and proposed hydroelectric developments, is provided in the report "***Churchill River Complex: Power and Energy Modeling Study***" completed by Acres for NLH in July, 1998. This power and energy model, with updates for the optimization study, was used to evaluate the energy production for each of the candidate development combinations in the current study.

3.1 Model Setup

The ARSP model was used to evaluate the existing and proposed energy generation of the Churchill River Complex. ARSP uses a simplified network of channels, reservoirs, nodes (connecting points for channels), structures, and power stations to represent a water system. A detailed description of the ARSP model is provided in Appendix A.

In general, the model takes monthly inflows and uses the water to first satisfy environmental demands (where required) and then to generate energy, based on various physical and operational constraints. The portion of the inflow not used for energy generation is either stored or spilled.

The input data required to set up the model include

- representative hydrologic sequences;
- reservoir characteristics;
- power plant characteristics;
- structure data; and
- operational data.

A model schematic of the Churchill River Complex, including both existing and proposed hydroelectric developments and diversions, is presented in Figure 3.1. The sources of the input data used for the model setups of existing and proposed energy generation are described in the following sections.

3.1.1 Representative Hydrologic Sequences

Representative hydrologic sequences based on 41 years of historic records (October, 1956 to September, 1997) for each of the subbasins in the system were used to evaluate power and energy from the Churchill River Complex. Hydrologic sequences were required for the following subbasins.

(a) Upper Churchill Basin

- Lac Joseph local inflows.
- Ossokmanuan Reservoir local inflows (including Atikonak Lake).
- Smallwood Reservoir local inflows.
- West Forebay local inflows.
- East Forebay local inflows.

(b) Lower Churchill Basin

- Gull Island local inflows.
- Muskrat Falls local inflows.

(c) Diversions

- St-Jean River local inflows (from the portion of the basin being diverted).
- Romaine River local inflows (from the portion of the basin being diverted).

The long term hydrologic sequences used in the present simulations were developed in previous studies. The sources of the hydrologic sequences are described below. Monthly hydrologic sequences used in this study are provided in Appendix B.

Figures 3.2, 3.3, and 3.4 show the long term hydrologic sequences for the major basins in the Churchill River Complex, and for the proposed diversions from Québec. As these figures show, all the rivers have basically the same seasonal pattern. Natural inflows into Ossokmanuan Reservoir, for example, average about 500 m^3/s (including Lac Joseph local inflows), but in the spring the monthly average can be four times as high. In the late winter, by contrast, the average monthly flow can approach zero. An important feature of all the hydrologic sequences is the presence of an extended dry period from the late 1980s to the mid 1990s.

Upper Churchill River

Upper Churchill River hydrologic sequences were provided by HQ, and are summarized in the HQ Harmonization Report (April, 1998)[3-1] for the period October, 1975 to December, 1997. The Harmonization Report is so called because its purpose was to determine the reason for differences in Churchill Falls (Labrador) Corporation Limited (CF(L)Co) and HQ hydrometric data bases since 1975, harmonize the two data sets, and develop a procedure to ensure that the two data sets are consistent in the future. In the course of this work, hydrologic sequences were reconstituted for this period by HQ by backrouting techniques.

For the preceding period, October, 1956 to September, 1975, the flows in the Upper Churchill basin were also provided by HQ.[3-2] The flows for this period are almost entirely based on recorded flows from various locations, with the exception of the filling period of the Smallwood Reservoir.

The total inflows to Ossokmanuan Reservoir were divided into flows from Lac Joseph and from the remainder of the basin in case there is a future requirement to investigate the effect of Lac Joseph. For the present work, the flows were simply prorated and there is no difference in the results.

Lower Churchill River

The hydrologic sequences for the Lower Churchill River were taken from the Gull Island Power Development Report (October, 1997) [3-3] and Environment Canada Surface Water Data (May to September, 1997).[3-4] These were agreed upon with HQ. [3-5]

In general, the flows were obtained as the difference between the observed values at the Churchill River above Upper Muskrat Falls Environment Canada hydrometric station (Station Number 03OE001) and the flows at the Churchill River at Churchill Falls Powerhouse Environment Canada hydrometric station (Station Number 03OD005, including both power flows and spill contributed from CF(L)Co). The hydrologic sequence was extended in the present study to include May to September 1997, using Environment Canada Surface Water Data for the same two stations. Local inflows to the Gull Island and Muskrat Falls developments were determined by prorating the total local inflow by the ratio of drainage areas (Lower Churchill River flows were updated for the final power and energy runs based on revised data from Environment Canada for 1990 as discussed in Section 6).

Comment on Lower Churchill basin flows

The estimates of mean annual runoff in the Lower Churchill basin, based on the hydrologic sequences developed from data from the stations on the Churchill River as described above, are lower than expected when compared with estimates from other stations in and adjacent to the basin. This finding is consistent for the periods both before and after constructing the existing Churchill Falls hydroelectric development. A review of the data and discussions with Environment Canada staff and climatologists familiar with the area provided no explanation for this discrepancy. NLH has since reactivated hydrometric stations on two rivers, Minipi River in the Lower Churchill basin and Naskaupi River to the north, and installed a new station on the Metchin River, in the Lower Churchill basin. Data from these gauges should help to resolve this issue.

For the purposes of the optimization study, the hydrologic sequences previously developed have not been changed, since they provide conservative results. Sensitivity analysis shows that the increase in energy production at Gull Island and Muskrat Falls could be approximately three percent.

Diversions

The diversion hydrologic sequences were provided by HQ.[3-6] The hydrologic sequences were developed using the network of hydrometric stations in the St-Jean and Romaine basins, including a long term hydrometric station at the mouth of the Romaine River (Station Number 073801) with a flow record dating back to the mid-1950s, and other gauges of shorter record located in the vicinity of the proposed dam sites on the St-Jean and Romaine Rivers. Comparing non-winter flows for overlapping periods of record, proration factors were derived based on average flows. The recorded flows from the long term Romaine River hydrometric station were transposed to provide hydrologic sequences for the parts of the St-Jean and Romaine Rivers contributing to the diversion.

3.1.2 Reservoir Characteristics

The existing Churchill River hydroelectric development consists of two storage reservoirs and two forebays. These are Ossokmanuan and Smallwood

Reservoirs, and West and East Forebays. CF(L)Co has developed and updated storage curves for the reservoirs and forebays; the most recent curves are presented in Appendix C. These curves were used to represent the storage in the model. Key reservoir elevations, such as full supply level, dead storage level, and surcharge level, were taken from both CF(L)Co data [3-7] and the Flood Handling Study Report (March, 1989).[3-8]

Smallwood Reservoir consists of three smaller reservoirs - Hook Bay, Orma Lake, and Lobstick - which at low levels are distinct and are connected by channels. For the purpose of modelling, the Smallwood Reservoir was modelled as one reservoir, but the storage curve accounted for reduced storage at low levels. The difference in levels due to the hydraulic connections was not modelled. It would be possible to model the three reservoirs separately if the channel characteristics were known for the channels connecting the reservoirs.

For the run-of-the-river developments at Gull Island and Muskrat Falls, it was assumed that the headponds remain at a constant level. On a monthly time step, the live storage would not make any difference to the results if modelled. The live storage is equivalent to a few days of energy generation at Gull Island. At Muskrat Falls, within-day pondage is available. For the purpose of this study, the information on storage curves and reservoir levels were taken from the Gull Island Power Development Report (October, 1997).[3-3] Additional information was provided by HQ.[3-9]

Information on storage curves and reservoir levels for the diversions were provided by HQ.[3-6],[3-9] Storage is provided at the Romaine River diversion only.

Key reservoir features, storage curves, and reservoir levels are presented in Tables 3.1 and 3.2 for the Churchill River Complex (including the diversions).

3.1.3 Power Plant Characteristics

Power plant characteristics were required for the following.

- Churchill Falls existing hydroelectric development (CF1).
- Proposed additional capacity at Churchill Falls (CF2).
- Gull Island proposed hydroelectric development.
- Muskrat Falls proposed hydroelectric development.

Power plant characteristics were provided or derived from information provided by the feasibility consultants, as presented in Appendix D, E, and F for CF1 and CF2, Gull Island, and Muskrat Falls, respectively. Power plant characteristics for each of the development alternatives, including the existing Churchill Falls hydroelectric development, are presented in Tables 3.3 to 3.6. As can be seen in Table 3.5, Gull Island installed capacities are higher when the Muskrat Falls development is not in place due to the lower tailwater levels. For development combinations of CF1, CF2 and Gull Island the power plant characteristics in Table 3.5 were used.

Table 3.7 presents the tailwater curves for each development. As shown in this table, the tailwater curves for Churchill Falls (and CF2) and Gull Island differ depending on the development of downstream power plants. Churchill Falls tailwater is affected by the development of Gull Island, and Gull Island tailwater is affected by the development of Muskrat Falls. (At the time of the preliminary analysis, the datum correction had not been determined).

In addition to these plant characteristics, the model also requires the available capacity of the developments (availability curve) and the demand pattern for the Churchill River Complex.

These two items are discussed below.

Availability Curve

The power availability curve used in the Churchill River Complex power and energy model was provided by HQ.[3-9] Values for monthly availability are close to those of the La Grande 2 powerhouse which is the largest of the La Grande Complex and whose capacity is very similar to the capacity of CF1. The power availability curve assumes a reduction in available capacity to account for scheduled (maintenance) and unscheduled outages. Unit availability is higher in the winter than in the summer due to the maintenance program which concentrates all the maintenance works in the summer.

This same pattern of availability was used for each of the proposed developments in the preliminary analysis and is presented in Figure 3.5. Separate curves were developed for each station for the final analysis.

Demand Pattern

Energy loads on the existing and potential Churchill River Complex originate from four points. These include

- Labrador loads;
- station site services and Twin Falls loads;
- HQ loads; and
- HVDC infeed to the island of Newfoundland.

Monthly demand patterns were provided by HQ [3-10] and NLH [3-11] and are presented in Table 3.8. The demand pattern is expressed as a monthly fraction of the average annual firm energy. Monthly demand patterns provided by HQ were compared with those provided by NLH for Labrador and HVDC infeed to the island of Newfoundland. This comparison indicated that the shape provided by HQ is similar to those provided by NLH. The demand pattern provided by HQ takes into consideration the internal demands of Québec and Newfoundland and Labrador, as well as the external markets. The demand pattern provided by HQ was therefore used in the preliminary analysis.

3.1.4 Structure Data

Structure curves (stage/discharge curves) were required for the following water control structures.

Upper Churchill
- Ossokmanuan Control Structure (Spillway)
- Gabbro Control Structure
- Lobstick Control Structure
- Whitefish Control Structure
- Jacopie Control Structure (Spillway)
- East Forebay Spillway

Diversions from Québec
- Atikonak Control Structure

For the Upper Churchill Falls hydroelectric development, structure curves and tables were provided by CF(L)Co [3-7] for the main water control structures at Gabbro, Lobstick, and Whitefish (Appendix G). For the remaining structures in the existing development, curves were taken from the Flood Handling Study Report (March, 1989). [3-8]

For the Lower Churchill developments, this study did not incorporate spillway curves because the spillway will be adequately designed to pass any flows above the maximum power flow. A large arbitrary spillway capacity was given for Gull Island and Muskrat Falls in the model to ensure that spillway capacity would not be limiting.

For the diversions, the data were provided by HQ.[3-9] As with the Lower Churchill developments, it was assumed that the spillway capacity would be adequately designed to pass any required spill flows. A control structure located at Atikonak Lake will regulate the flow from the diversions to Ossokmanuan Reservoir.

Table 3.9 summarizes the structure curves used in the model for all the structures in the Churchill River Complex.

3.1.5 System Operation

The model is driven by the requirement to produce energy according to the demand pattern described above. When environmental demands are imposed on the system, as at the diversion locations, these demands are met before energy generation.

The definition of the energy requirement used for this study is the maximum average energy that can be produced during the most severe dry sequence of the hydrological record. The dry sequence begins after the last period when secondary energy was generated and ends when the reservoirs are just empty.

After environmental and power generation demands are satisfied, the remaining water in the system is either stored in the reservoirs, depending on operational target curves, or spilled if all reservoirs are at maximum operating level and the plants are at maximum output.

The target curve for Smallwood Reservoir was taken from the Gull Island Power Development Report (October, 1997). [3-3] For Ossokmanuan Reservoir and the forebays, target curves were developed from actual water levels provided by CF(L)Co.[3-7] The target curves for each of the reservoirs are described below.

- **Ossokmanuan Reservoir**
  Reservoir drawdown begins in mid-February to allow for spring runoff. During spring runoff, the reservoir is allowed to fill. Excess water in Ossokmanuan Reservoir is passed to Smallwood Reservoir.

- **Smallwood Reservoir**
  Smallwood Reservoir is operated to meet firm demand. If the reservoir is at the target curve, excess water is used to generate secondary energy, up to the maximum plant output. Any additional water is spilled at Jacopie.

- **West Forebay**
  During winter, the levels in West Forebay are kept high and constant to maintain ice cover; otherwise, ice jamming could occur upstream of Whitefish Falls control structure. During summer, the levels fluctuate to meet load demand, and may be kept low to allow for storage of excess flow.

- **East Forebay**
  East Forebay level is allowed to fluctuate in winter depending on energy demands. In summer it is kept high to maximize head. There are no specific operational constraints on East Forebay, except that full supply level is not exceeded. Levels at East and West Forebay may vary considerably on a daily basis to satisfy HQ generation demands.

Since the Lower Churchill developments are run-of-the-river, reservoir management is more straightforward than at the Upper Churchill developments. Gull Island and Muskrat Falls headpond levels are kept constant (on a monthly time step) and any flow above maximum power flow is spilled.

The Romaine Reservoir is assumed to be operated to provide water for energy generation. If the Upper Churchill reservoirs are below their target curves, water is released to bring them to their target curves. Water will also be released to generate secondary energy only. If water levels in the Romaine Reservoir are above the maximum allowable levels, and the Upper Churchill reservoirs are at or above their target curves, and the plants are generating at maximum output, excess flows from the Romaine Reservoir will be spilled.

All water from the St-Jean River except that required to satisfy environmental demands was assumed to be passed to the Romaine Reservoir. Ten percent of the mean monthly local inflow to St-Jean and Romaine Rivers above the diversions was the requirement provided by HQ for instream flow needs. This demand must be met before any system demands or constraints are imposed. Table 3.10 summarizes the monthly environmental releases assumed for the diversion.

3.2 Results of Preliminary Power and Energy Modelling

The feasibility consultants provided information on the physical characteristics for a range of installed capacities at each development (CF2, Gull Island, and Muskrat Falls) considered reasonable. The average annual energy for selected candidate development combinations was determined by system simulation.

The results for selected candidate development combinations investigated in this study, are presented in Table 3.11. Many additional runs were also required, for example to calculate the energy attributable to a particular development.

Table 3.1

Key Reservoir Features

Basin	Reservoir/ Forebay	Full Supply Level (m)	Low Supply Level (m)	Live Storage Volume ($*10^6$ m^3)
Diversions from the Province of Québec	Romaine River Diversion Headpond	497.00	494.00	3100
Upper Churchill (see Note 1)	Ossokmanuan Reservoir	479.15	475.03	2835
	Smallwood Reservoir	472.74	464.05	28941
	West Forebay	452.93	450.50	167
	East Forebay	448.51	447.60	121
Lower Churchill	Gull Island Reservoir	125.00	122.00	580
	Muskrat Falls Reservoir	39.00	39.00	0

Note:

1) During the course of the feasibility studies a discrepancy in the datum at the existing Churchill Falls hydroelectric development was discovered. The levels used in this study for the Upper Churchill development are to the old Upper Churchill Local Datum. The conversion for the Upper Churchill reservoirs is Geodetic Datum = Upper Churchill Local Datum - 1.85 m. The Diversions, Gull Island and Muskrat Falls are referenced to Geodetic Datum.

Table 3.2

Reservoir Storage Curves

Ossokmanuan Reservoir

Elevation (m)	Storage ($*10^6$ m^3)
475.03	0
476.00	586
478.00	1923
478.75	2490
479.00	2701
479.15	2835
479.50	3176
479.99	3734

Smallwood Reservoir

Elevation (m)	Storage ($*10^6$ m^3)
464.05	0
467.10	2618
469.00	10375
470.50	17185
471.50	22135
472.50	27551
472.74	28941
473.04	30756

West Forebay

Elevation (m)	Storage ($*10^6$ m^3)
445.00	0
445.50	7
446.00	13
447.00	31
448.00	54
449.00	83
450.00	120
451.00	167
452.00	231
452.93	309
452.99	315

East Forebay

Elevation (m)	Storage ($*10^6$ m^3)
443.80	0
445.00	124
447.10	370
448.70	580
448.99	621

Romaine Headpond

Elevation (m)	Storage ($*10^6$ m^3)
430.00	273
447.00	1217
467.00	3819
472.00	4926
487.00	13224
494.00	19235
497.00	22335
504.00	30870

Note:

1) During the course of the feasibility studies a discrepancy in the datum at the existing Churchill Falls hydroelectric development was discovered. The levels used in this study for the Upper Churchill development are to the old Upper Churchill Local Datum. The conversion for the Upper Churchill reservoirs is Geodetic Datum = Upper Churchill Local Datum - 1.85 m. The Diversions, Gull Island and Muskrat Falls are referenced to Geodetic Datum

Table 3.3

Power Plant Characteristics CF1 and CF2: Preliminary Runs

Power Plant Characteristics	CF1	CF2			
		Option 1	Option 2	Option 3	Option 4
Installed Capacity (MW)	5650.0	500.0	1000.0	1300.0	1500.0
Nominal Headpond Level (m)	448.0	448.0	448.0	448.0	448.0
Net Head (m)	312.2	317.0	317.0	317.0	317.0
Head Loss (m)	8.1	4.4	3.9	3.5	3.6
Maximum Flow (m^3/s)	2018.4	185.1	370.2	481.3	555.4
Best Efficiency Flow (m^3/s)	2018.4	185.1	370.2	481.3	555.4
Efficiency at Max Flow (%)	91.4	93.8	93.8	93.8	93.8
Efficiency at Best Flow (%)	91.4	93.8	93.8	93.8	93.8

Note:

1) A single value of efficiency was provided by the feasibility consultant for CF1 and CF2 to represent the units operating as a group on a monthly basis.

Table 3.4

Power Plant Characteristics Gull Island with Muskrat Falls: Preliminary Runs

Power Plant Characteristics	Gull Island with Muskrat Falls							
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Installed Capacity (MW)	1698.0	2264.0	2830.0	3396.0	1578.0	2184.0	2932.0	3641.0
Nominal Headpond Level (m)	125.0	125.0	125.0	125.0	121.0	123.0	127.0	129.0
Net Head (m)	84.0	84.0	84.0	84.0	80.0	82.0	86.0	88.0
Head Loss (m)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Maximum Flow (m^3/s)	2456.3	3275.1	4093.9	4912.6	2396.9	3236.4	4142.8	5027.6
Best Efficiency Flow (m^3/s)	2210.7	2947.6	3684.5	4421.4	2157.2	2912.8	3728.5	4524.9
Efficiency at Max Flow (%)	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6
Efficiency at Best Flow (%)	92.4	92.4	92.4	92.4	92.4	92.4	92.4	92.4

Note:

1) Efficiency at Best Flow (%) for Gull Island and Muskrat Falls was adjusted to account for the decrease in head loss at best efficiency flow.

Table 3.5

Power Plant Characteristics Gull Island without Muskrat Falls: Preliminary Runs

Power Plant Characteristics	Gull Island without Muskrat Falls							
	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
Installed Capacity (MW)	1728.6	2304.8	2881.0	3457.2	1607.4	2224.0	2983.0	3703.2
Nominal Headpond Level (m)	125.0	125.0	125.0	125.0	121.0	123.0	127.0	129.0
Net Head (m)	85.0	85.0	85.0	85.0	81.0	83.0	87.0	89.0
Head Loss (m)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Maximum Flow (m^3/s)	2471.2	3294.9	4118.6	4942.3	2411.4	3256.0	4166.4	5056.1
Best Efficiency Flow (m^3/s)	2224.1	2965.4	3706.8	4448.1	2170.2	2930.4	3749.8	4550.5
Efficiency at Max Flow (%)	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6
Efficiency at Best Flow (%)	92.4	92.4	92.4	92.4	92.4	92.4	92.4	92.4

Note:

1) Efficiency at Best Flow (%) for Gull Island and Muskrat Falls was adjusted to account for the decrease in head loss at best efficiency flow.

Table 3.6

Power Plant Characteristics Muskrat Falls: Preliminary Runs

Power Plant Characteristics	Muskrat Falls				
	Option 1	Option 2	Option 3	Option 4	Option 5
Installed Capacity (MW)	No Muskrat Falls	618.0	824.0	1030.0	1236.0
Nominal Headpond Level (m)		39.0	39.0	39.0	39.0
Net Head (m)		34.4	34.4	34.4	34.4
Head Loss (m)		1.2	1.2	1.2	1.2
Maximum Flow (m^3/s)		2232.3	2976.4	3720.5	4464.6
Best Efficiency Flow (m^3/s)		2076.0	2768.0	3460.1	4152.1
Efficiency at Max Flow (%)		88.6	88.6	88.6	88.6
Efficiency at Best Flow (%)		91.2	91.2	91.2	91.2

Note:

1) Efficiency at Best Flow (%) for Gull Island and Muskrat Falls was adjusted to account for the decrease in head loss at best efficiency flow.

Table 3.7

Tailwater Curves

Tailwater Curve CF1 without GI		Tailwater Curve CF1 GI Headpond = 121 m		Tailwater Curve CF1 GI Headpond = 123 m	
Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)
0	122.20	0	122.20	0	123.00
400	124.30	400	124.30	400	124.50
600	124.70	600	124.70	600	124.95
800	125.20	800	125.20	800	125.35
1000	125.60	1000	125.60	1000	125.75
1200	126.00	1200	126.00	1200	126.15
1600	126.90	1600	126.90	1600	126.90
2000	127.60	2000	127.60	2000	127.65
2800	129.00	2800	129.00	2800	129.14

Tailwater Curve CF1 GI Headpond = 125 m		Tailwater Curve CF1 GI Headpond = 127 m		Tailwater Curve CF1 GI Headpond = 129 m	
Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)
0	125.00	0	127.00	0	129.00
400	125.45	400	127.01	400	129.01
600	125.70	600	127.04	600	129.03
800	126.00	800	127.10	800	129.07
1000	126.25	1000	127.20	1000	129.12
1200	126.55	1200	127.33	1200	129.20
1600	127.15	1600	127.68	1600	129.32
2000	127.80	2000	128.18	2000	129.55
2800	129.20	2800	129.38	2800	130.00

Tailwater Curve GI without MF		Tailwater Curve GI with MF Headpond = 39 m		Tailwater Curve MF	
Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)
0	33.20	0	39.00	0	1.90
500	36.30	283	39.01	566	1.98
1000	37.00	566	39.03	2515	3.44
1500	37.40	850	39.07	3000	3.80
2000	37.70	1133	39.09		
2500	38.10	1699	39.19		
3000	38.30	2265	39.32		
3500	38.60	2832	39.48		
4000	38.80	5663	40.37		
4500	39.10				
5000	39.30				
6000	39.80				

<u>Note:</u> Tailwater curve for CF2 is the same as CF1.

Table 3.8

Monthly Demand Patterns: Preliminary Runs

Month	Monthly Demand Fraction		
	HQ	HVDC	Labrador
October	0.9396	0.7061	0.9767
November	1.0211	1.0701	1.0701
December	1.2405	1.3651	1.0709
January	1.2806	1.3886	1.1062
February	1.1472	1.5367	1.2397
March	1.1114	1.2238	1.0120
April	0.9083	1.0336	1.0214
May	0.8527	0.8708	0.9414
June	0.8523	0.7782	0.8998
July	0.8921	0.7531	0.8590
August	0.9151	0.7767	0.8708
September	0.8391	0.5229	0.9363

Note:

1) HQ monthly demand pattern used for optimization analysis

Table 3.9

Structure Discharge Curves

Gabbro Control Structure		Lobstick Control Structure		Whitefish Control Structure	
Elevation (m)	Discharge (m^3/s)	Elevation (m)	Discharge (m^3/s)	Elevation (m)	Discharge (m^3/s)
472.90	0.00	457.20	0.00	448.00	0.00
473.35	169.90	463.30	2124.00	448.50	1077.00
473.96	339.80	466.34	3330.00	449.00	1518.00
474.88	566.30	469.39	4604.00	449.60	1905.00
476.40	1076.00	470.92	5326.00	451.10	2601.00
477.32	1415.80	472.44	6133.00	451.40	2718.00
478.54	1868.90	472.74	6329.00	451.70	2826.00
479.76	2491.90	473.96	7127.00	452.00	2937.00
				452.30	3045.00
				452.60	3153.00
				452.90	3258.00
				453.50	3459.00

Table 3.9 (con't)

Structure Discharge Curves

Flow Over Gabbro Control Structure		Ossokmanuan Control Structure		Jacopie Spillway	
Elevation (m)	Discharge (m^3/s)	Elevation (m)	Discharge (m^3/s)	Elevation (m)	Discharge (m^3/s)
472.90	0.0	474.20	0.0	440.90	0.0
479.76	0.0	475.50	311.0	445.00	1764.0
479.91	5.9	476.30	623.0	446.50	2307.0
480.06	16.8	477.00	962.0	448.10	2904.0
480.36	47.5	477.80	1472.0	449.60	3557.0
480.67	87.3	478.50	2066.0	451.10	4269.0
480.97	134.5	479.15	2348.0	452.63	5045.0
481.28	160.5	480.50	3679.0	454.15	5888.0
				455.00	6359.4

East Forebay Spillway		Atikonak Control Structure	
Elevation (m)	Discharge (m^3/s)	Elevation (m)	Discharge (m^3/s)
436.47	0.0	491.00	0.0
438.90	169.9	492.70	114.0
440.40	396.4	494.17	305.0
441.96	736.2	495.49	541.0
443.50	1189.3	497.00	866.0
445.00	1699.0	498.45	1193.0
446.50	2265.4		
448.06	2718.4		
448.67	2973.3		
449.28	3199.8		

Note:

1) During the course of the feasibility studies a discrepancy in the datum at the existing Churchill Falls hydroelectric development was discovered. The levels used in this study for the Upper Churchill development are to the old Upper Churchill Local Datum. The conversion for the Upper Churchill reservoirs is Geodetic Datum = Upper Churchill Local Datum - 1.85 m. The Diversions, Gull Island and Muskrat Falls are referenced to Geodetic Datum.

Table 3.10

Quebec Diversion Monthly Environmental Releases

Month	Environmental Releases (m^3/s)
October	22.5
November	17.3
December	10.7
January	6.5
February	5.4
March	5.0
April	8.2
May	49.4
June	56.7
July	25.2
August	19.4
September	18.2
Average	20.4

Note:

1) Environmental releases are equal to 10 percent of the mean monthly flow.

Table 3.11

Summary of Selected Power and Energy Results

Installed Capacity (MW)				Energy	Capacity Factor
CF1	CF2	Gull Island	Muskrat Falls	(TWh/yr)	(%)
5428.5	-	-	-	33.96	71
5428.5	-	-	-	37.82	80
5428.5	500	-	-	38.32	74
5428.5	1000	-	-	38.71	69
5428.5	1300	-	-	38.89	66
5428.5	1500	-	-	38.98	64
5428.5	1950	-	-	39.15	61
5428.5	500	1729	-	50.82	76
5428.5	1000	1729	-	51.31	72
5428.5	1300	1729	-	51.43	69
5428.5	1000	2305	-	51.77	68
5428.5	1300	2305	-	51.97	66
5428.5	1500	2305	-	52.07	64
5428.5	1950	2305	-	52.27	62
5428.5	1000	2881	-	51.94	64
5428.5	1300	2881	-	52.13	62
5428.5	500	1698	618	55.13	76
5428.5	1000	1698	618	55.48	72
5428.5	1300	1698	618	55.68	70
5428.5	1000	2264	618	56.10	69
5428.5	1300	2264	618	56.33	67
5428.5	1500	2264	618	56.46	66
5428.5	1000	1698	824	56.24	72
5428.5	1300	1698	824	56.40	70
5428.5	1500	1698	824	56.49	68
5428.5	1000	2264	824	56.82	68
5428.5	1300	2264	824	57.02	66
5428.5	1500	2264	824	57.13	65
5428.5	1000	1698	1030	56.44	70
5428.5	1300	1698	1030	56.64	68
5428.5	1500	1698	1030	56.76	67
5428.5	1000	2264	1030	57.00	67

Note:

1) All runs except CF1 (33.96 TWh/yr) include diversion flows

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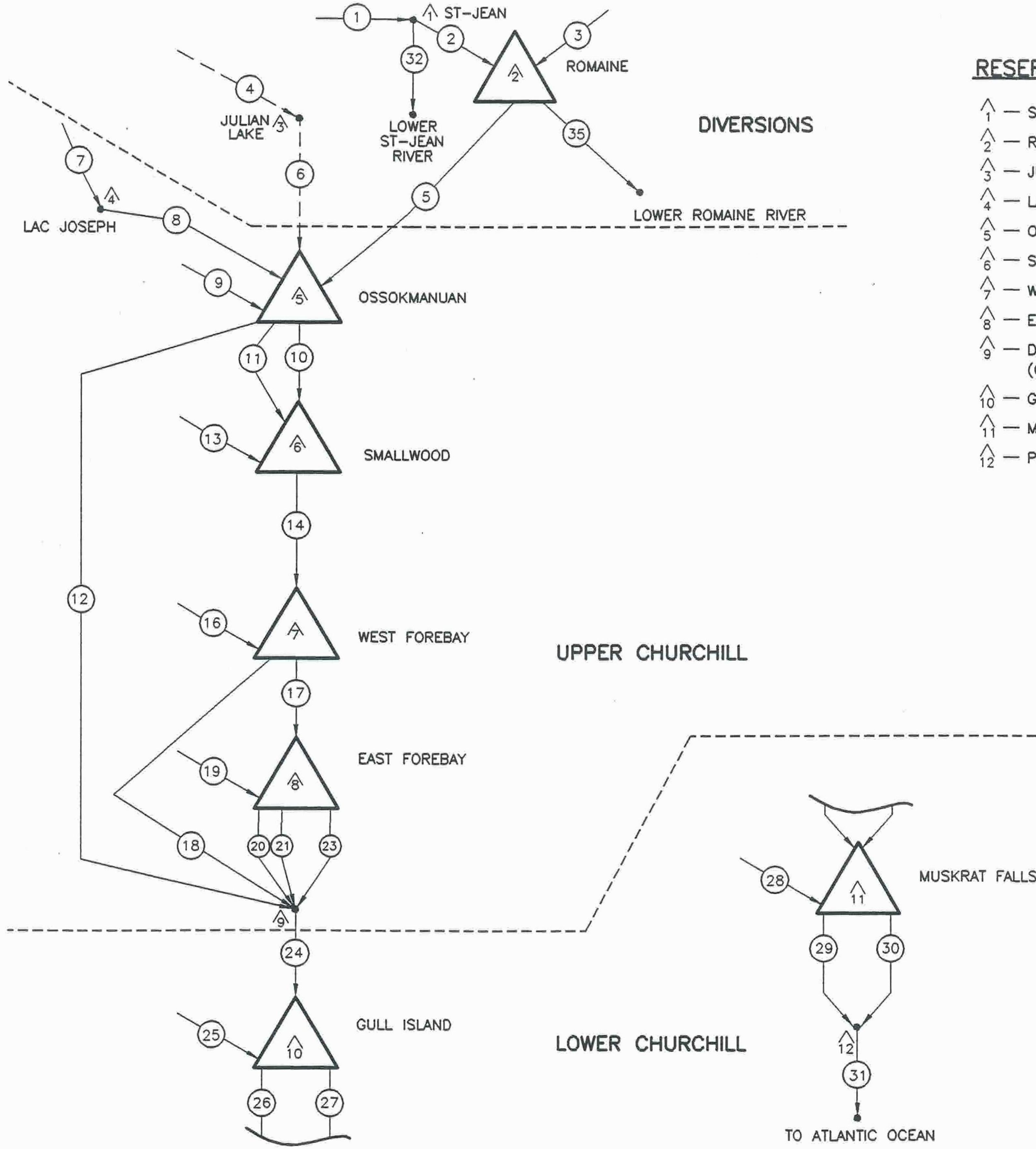


RESERVOIRS/NODES

- 1 — ST-JEAN
- 2 — ROMAINE
- 3 — JULIAN LAKE
- 4 — LAC JOSEPH
- 5 — OSSOKMANUAN
- 6 — SMALLWOOD
- 7 — WEST FOREBAY
- 8 — EAST FOREBAY
- 9 — DOWNSTREAM OF CHURCHILL FALLS STATION (CONTRIBUTING TO TAILWATER LEVELS)
- 10 — GULL ISLAND
- 11 — MUSKRAT FALLS
- 12 — POWER CONTROL NODE

CHANNELS

- (1) — ST-JEAN LOCAL INFLOW
- (2) — DIVERSION CHANNEL ST-JEAN TO ROMAINE
- (3) — ROMAINE LOCAL INFLOW
- (4) — JULIAN LOCAL INFLOW
- (5) — DIVERTED FLOW ROMAINE TO OSSOKMANUAN
- (6) — GENERAL FLOW JULIAN TO OSSOKMANUAN
- (7) — LAC JOSEPH LOCAL INFLOW
- (8) — GENERAL FLOW LAC JOSEPH TO OSSOKMANUAN
- (9) — OSSOKMANUAN LOCAL INFLOW
- (10) — GABBRO CONTROL STRUCTURE
- (11) — FLOW OVER GABBRO CONTROL STRUCTURE
- (12) — OSSKMANUAN CONTROL STRUCTURE
- (13) — SMALLWOOD LOCAL INFLOW
- (14) — LOBSTICK CONTROL STRUCTURE
- (16) — WEST FOREBAY LOCAL INFLOW
- (17) — WHITEFISH FALLS CONTROL STRUCTURE
- (18) — JACOPIE SPILLWAY
- (19) — EAST FOREBAY LOCAL INFLOW
- (20) — CHURCHILL FALLS POWER FLOW
- (21) — CF2 STATION POWER FLOW
- (23) — EAST FOREBAY SPILL
- (24) — GENERAL FLOW CF STATION TO GULL ISLAND
- (25) — GULL ISLAND LOCAL INFLOW
- (26) — GULL ISLAND POWER FLOW
- (27) — GULL ISLAND SPILL
- (28) — MUSKRAT FALLS LOCAL INFLOW
- (29) — MUSKRAT FALLS POWER FLOW
- (30) — MUSKRAT FALLS SPILL
- (31) — POWER CONTROL CHANNEL
- (32) — ST-JEAN ENVIRONMENTAL RELEASES
- (35) — ROMAINE ENVIRONMENTAL RELEASES

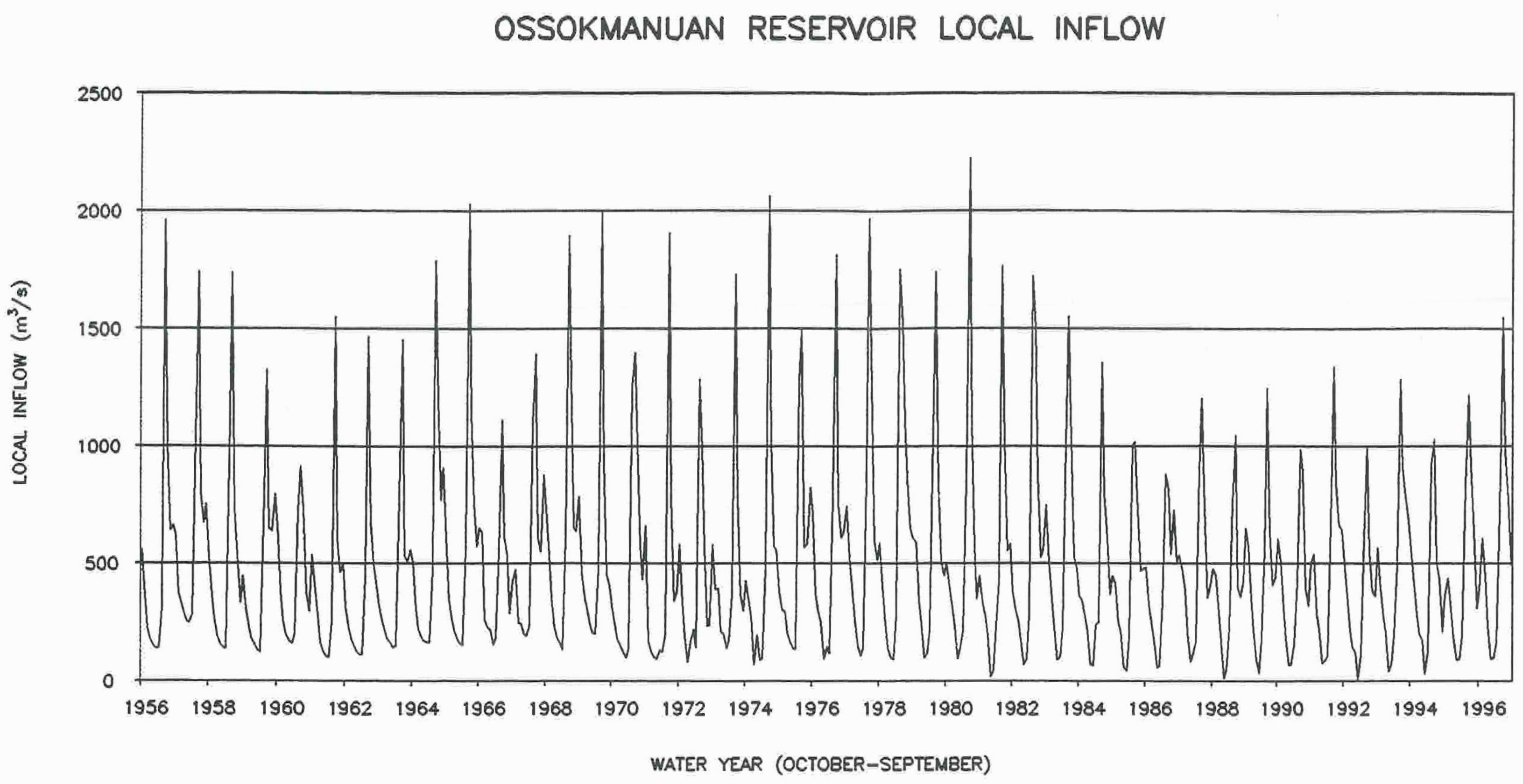
NOTE: JULIAN LAKE INCLUDED IN MODEL SETUP, NOT USED IN CURRENT MODEL SIMULATIONS.

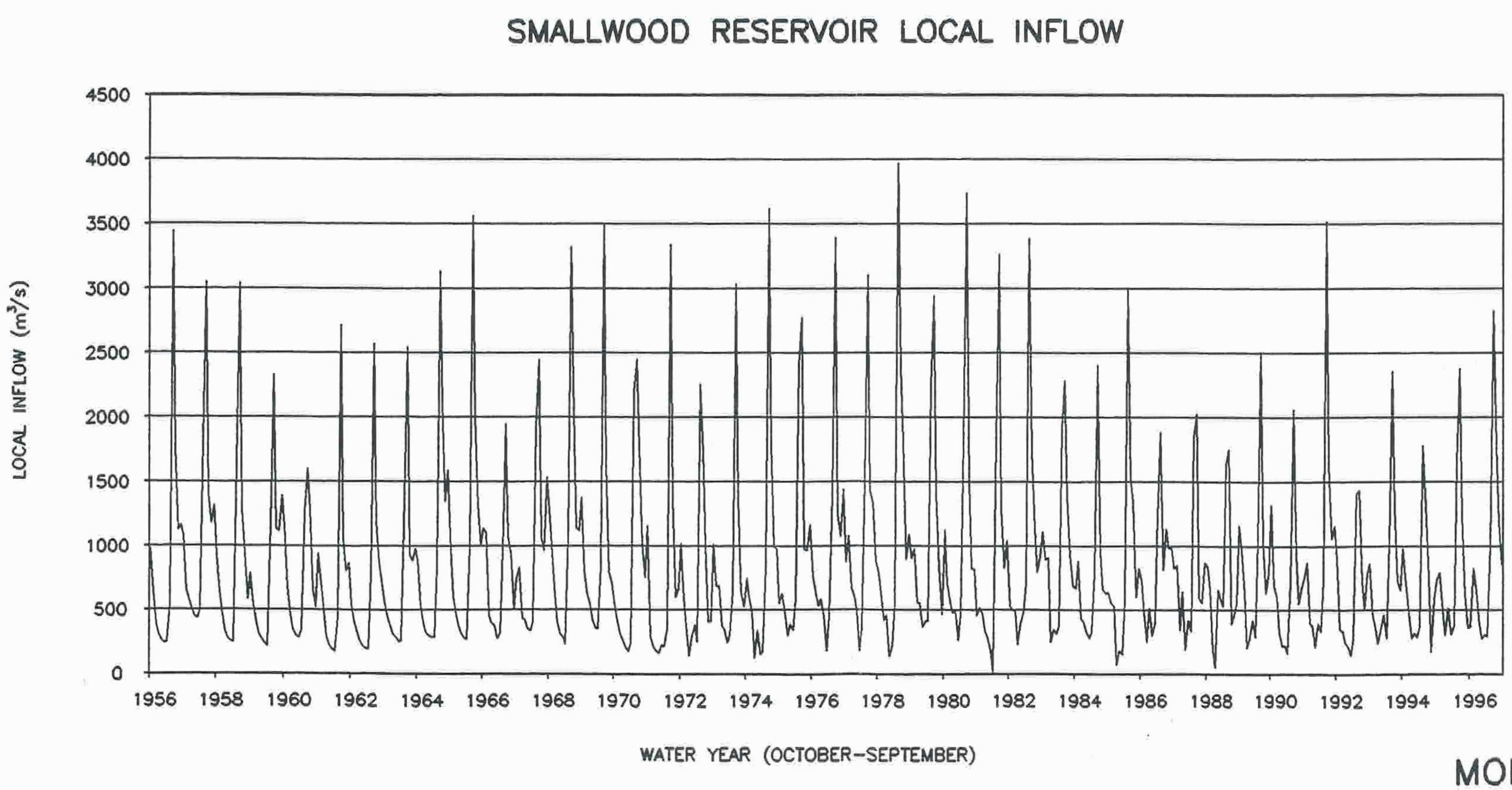
FIG 3.1

NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

MODEL SCHEMATIC — CHURCHILL RIVER COMPLEX

ACRES



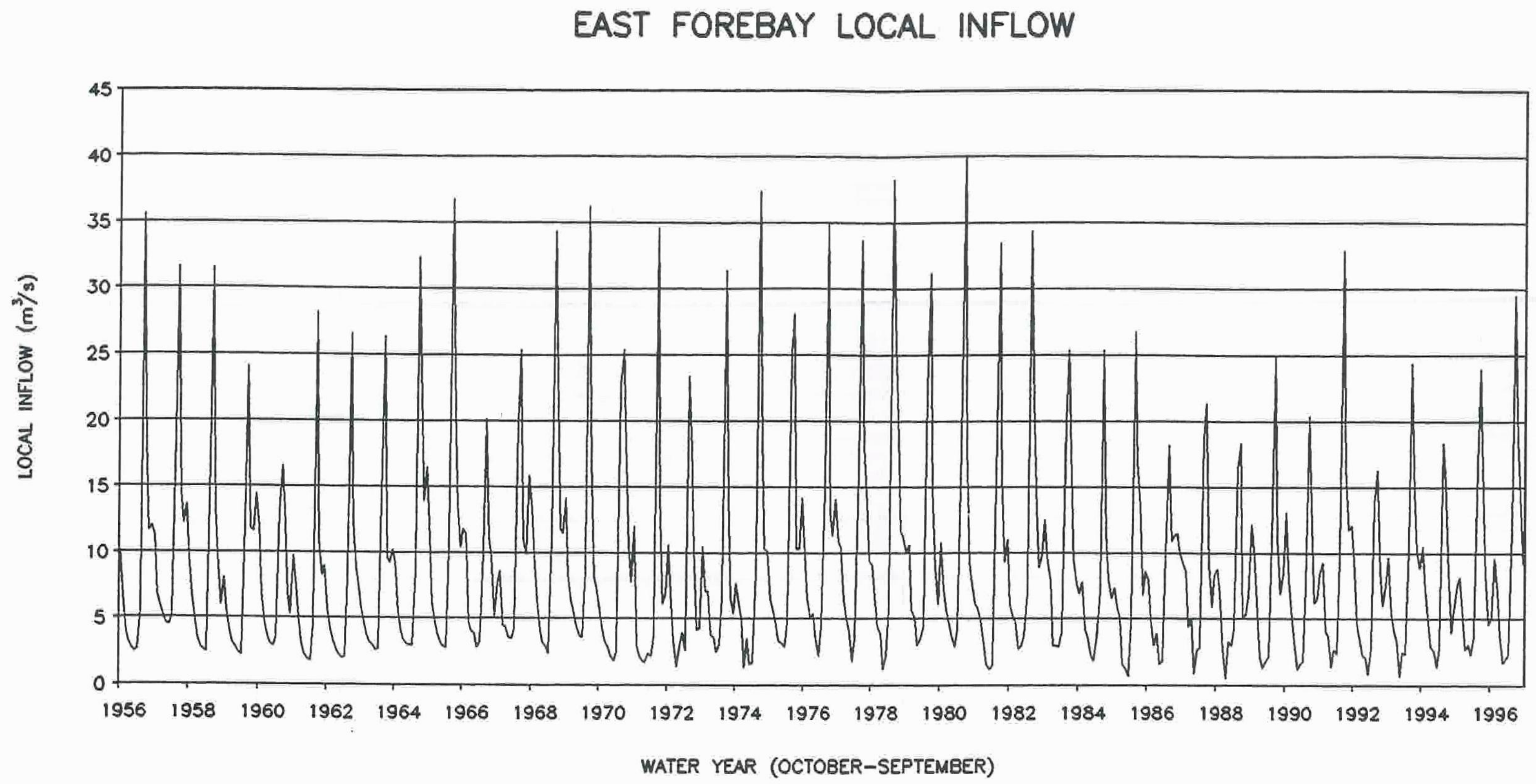


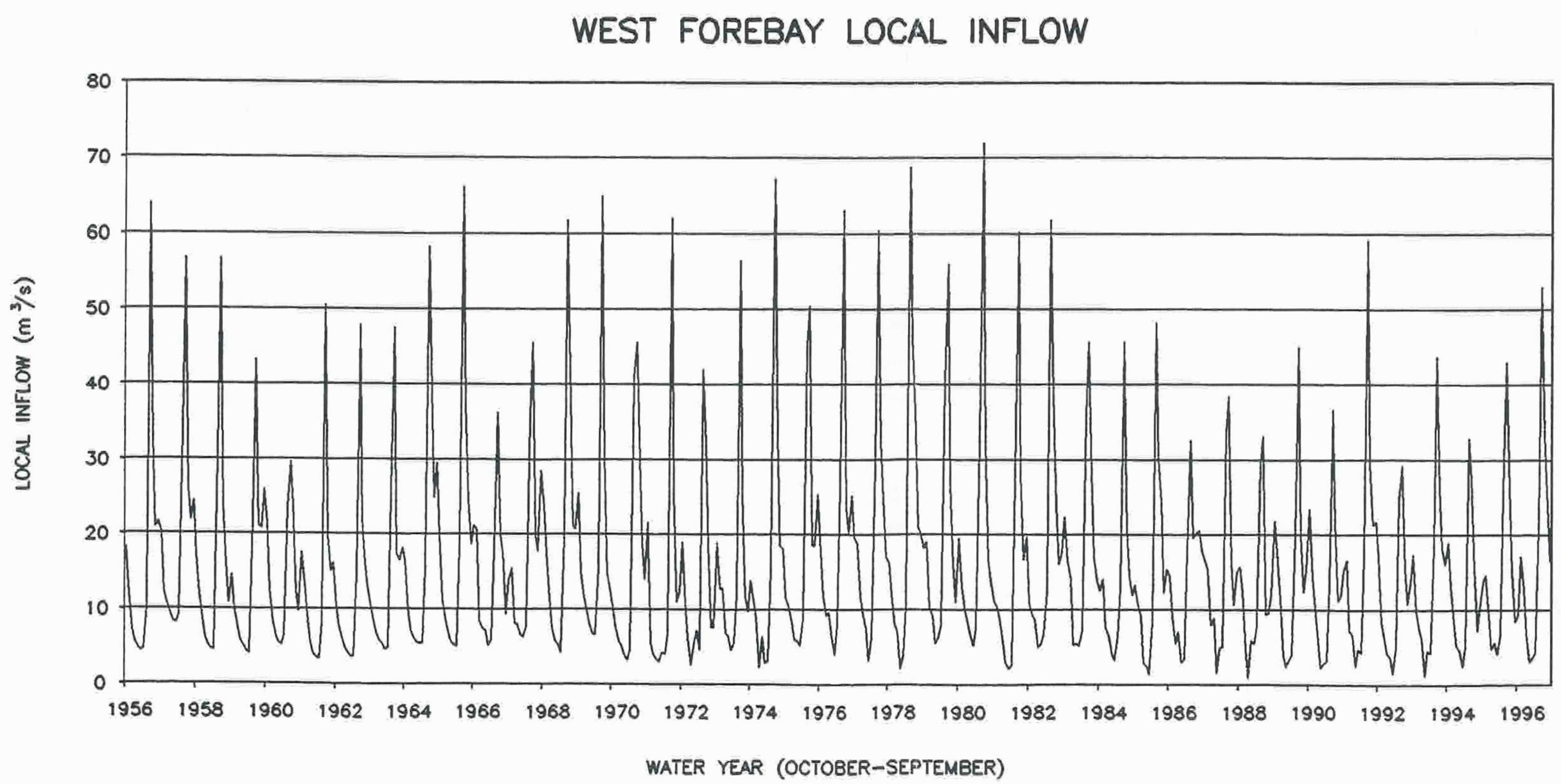
NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 3.2

MONTHLY HYDROLOGIC SEQUENCE
OSSOKMANUAN AND SMALLWOOD RESERVOIRS

ACRES





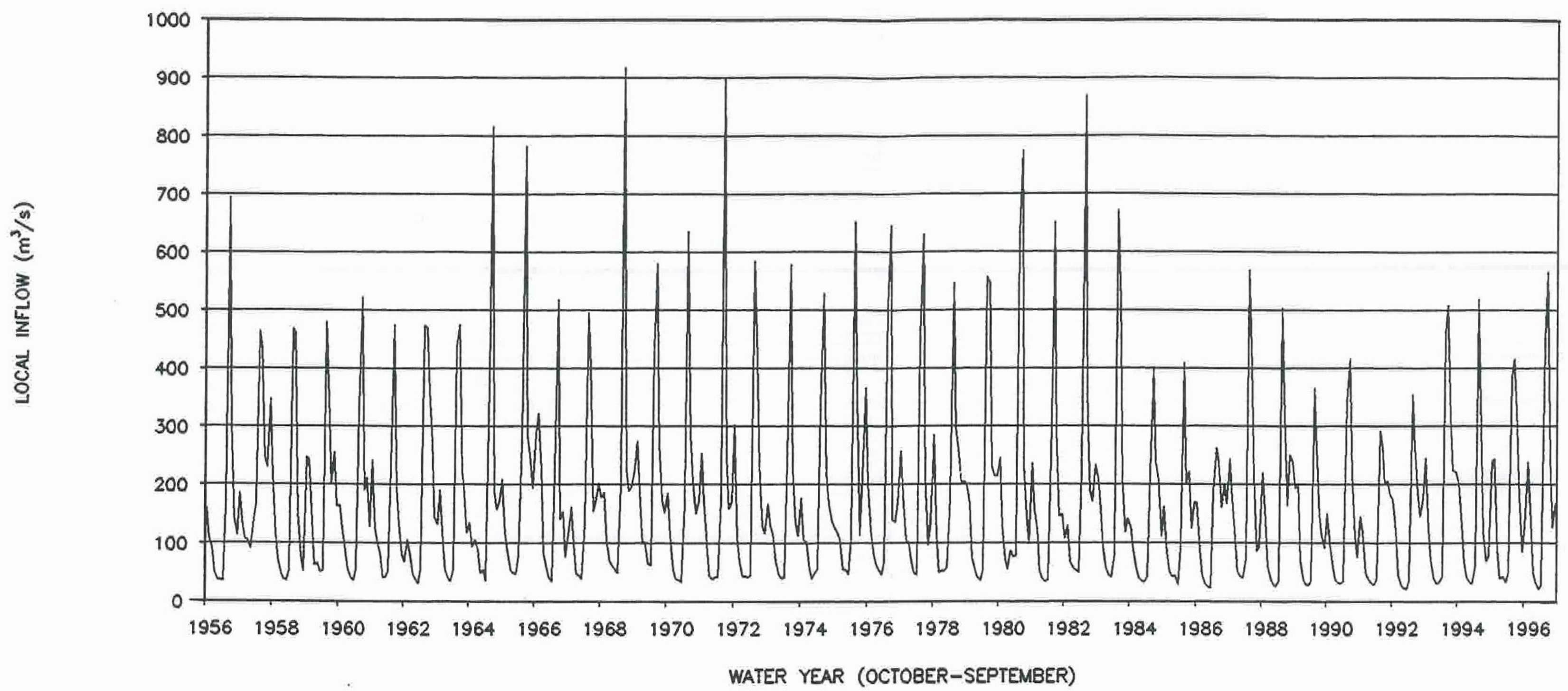
NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

MONTHLY HYDROLOGIC SEQUENCE
EAST AND WEST FOREBAYS

FIG 3.3

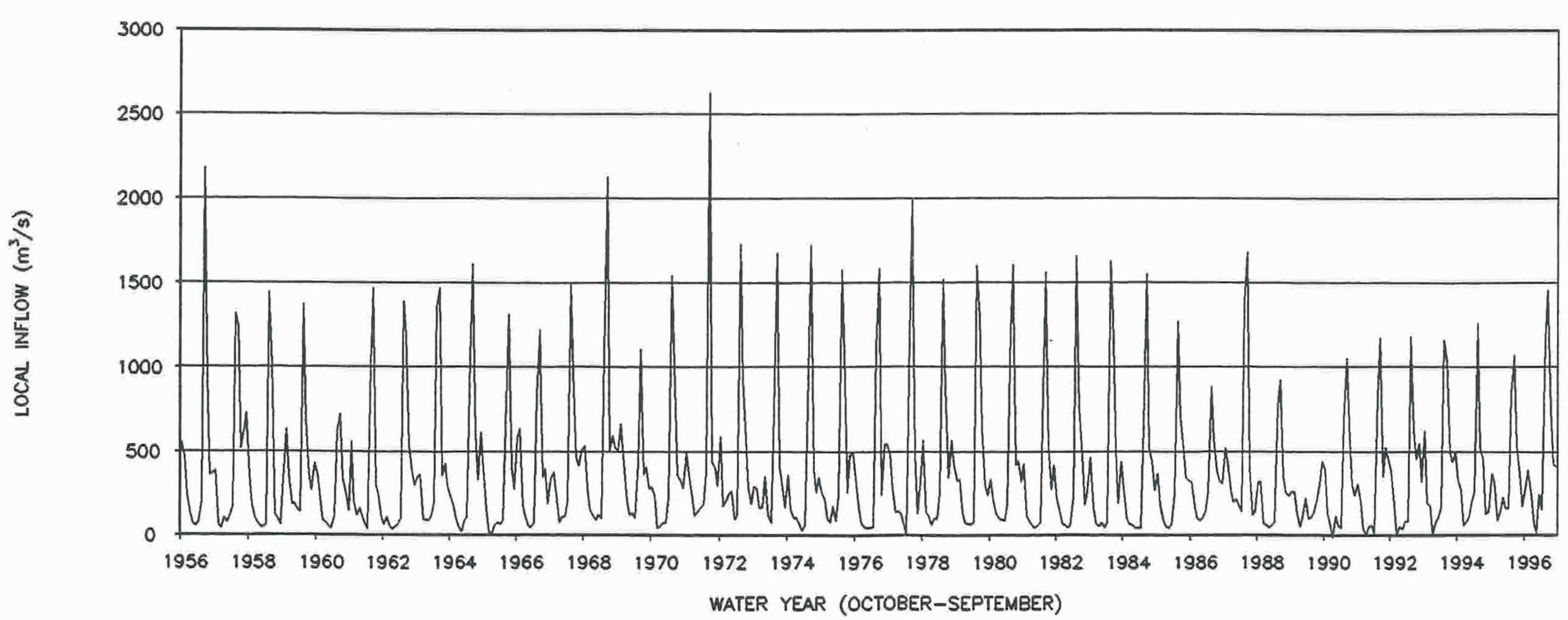
ACRES

ROMAINE RIVER LOCAL INFLOW (ABOVE DIVERSION)



NOTE:
ST–JEAN RIVER LOCAL INFLOW (ABOVE THE DIVERSION) FOLLOW THE SAME PATTERN AS ROMAINE RIVER LOCAL INFLOW (ABOVE THE DIVERSION), PRORATED BY AVERAGE FLOW.

GULL ISLAND LOCAL INFLOW



NOTE:
MUSKRAT FALLS LOCAL INFLOW FOLLOW THE SAME PATTERN AS GULL ISLAND LOCAL INFLOW, PRORATED BY DRAINAGE AREA.

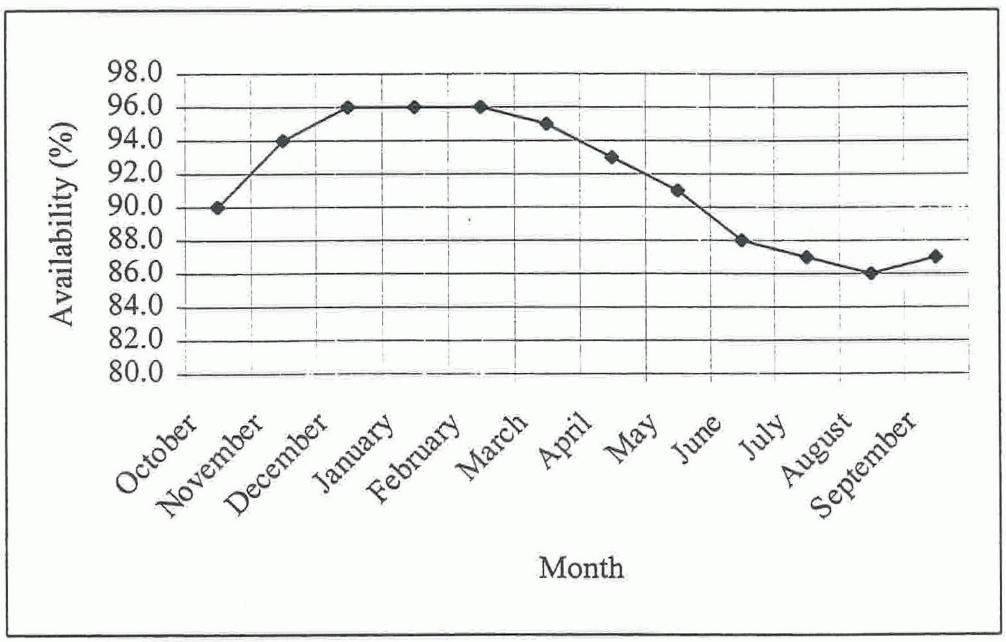
NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 3.4

MONTHLY HYDROLOGIC SEQUENCE
ROMAINE AND GULL ISLAND RESERVOIRS

ACRES

Month	Station Availability (%)
October	90.0
November	94.0
December	96.0
January	96.0
February	96.0
March	95.0
April	93.0
May	91.0
June	88.0
July	87.0
August	86.0
September	87.0



NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

AVAILABILITY CURVE

FIG 3.5

ACRES

Project Costs

4 Project Costs

Each feasibility consultant provided costs for the agreed-upon development alternatives. These are summarized in the following table as base costs, i.e., capital costs prior to owner's costs, owner's contingency and interest during construction (IDC). These were used in the preliminary sorting to determine the most promising combinations.

Station	Installed Capacity (MW)	Base Cost ($1000's)
CF2	500	278,840
	1000	415,140
	1300	485,180
	1500	566,360
	1950	654,620
Gull Island	1698	1,893,390
	2264	2,164,880
	2830	2,436,760
	3396	2,706,800
Muskrat Falls	618	1,175,000
	824	1,347,000
	1030	1,510,000
	1236	1,673,000

The base costs as summarized above were multiplied by an adjustment factor to obtain total development cost. The base cost for CF2 at 1100 MW was estimated by interpolation. Table 4.1 shows the adjusted costs. The adjustment factor included revised station costs, owner's costs, owner's contingency and IDC. Owner's costs and contingency were each taken as 5 percent of base cost. The annual rate for IDC was taken as 7.5 percent. The adjustment factors were 1.256 for CF2, 1.342 for Gull Island and 0.977 for Muskrat Falls. As Table 4.1 shows, Muskrat Falls adjustment factor is less than one because the updated cost, including IDC and interest during construction, is less than the base cost.

Table 4.1

Cost Adjustment

Installed Capacity (MW)	Base Cost ($1000's) (Aug 1998)	Revised Base Cost ($1000's) (Dec 1998)	Multiplier for Owner's Costs, Contingency & IDC	Total Development Cost ($1000's) (Dec 1998)	Adjustment Factor (Total/Base)
		CF2			
500	278,840	236,320		350,291	
1000	415,140	351,836		521,517	
1100	440,470	373,303	1.482	553,338	1.256
1300	485,180	411,196		609,505	
1500	566,360	479,997		711,487	
1950	654,620	554,798		822,363	
		Gull Island			
1698	1,893,390	1,604,223		2,540,138	
2264	2,164,880	1,834,250	1.583	2,904,364	1.342
2830	2,436,760	2,064,607		3,269,113	
		Muskrat Falls			
618	1,175,000	747,105		1,148,064	
824	1,347,000	856,468	1.537	1,316,121	0.977
1030	1,510,000	960,109		1,475,385	

Analysis

5 Analysis

This section of the report first summarizes the preliminary analysis carried out in order to provide installed capacities for use in the feasibility studies. It then describes the theoretical analysis carried out to define the optimum Churchill River Complex.

5.1 Preliminary Analysis

The results of the power and energy simulations described in Section 3 and the base costs from Section 4 were used to prepare preliminary recommended installed capacities at each development, considering various economic indicators such as total benefits, net benefits and incremental benefit/cost ratios. At that time, using the base costs provided, the value of capacity at both CF2 and Gull Island exceeded the unit cost of capacity, so the optimization results were dominated by the value of capacity rather than energy. A limit of 4200 MW in new installed capacity was imposed due to transmission constraints, later revised to 4300 MW.

Recognizing the technical and operational limitations on high flows at the Upper Churchill River developments, as well as the risk associated with relying on capacity benefits, the preferred solution at the preliminary stage was CF2 at 1100 MW, Gull Island at 2264 MW, and Muskrat Falls at 824 MW. These values were chosen from the development alternatives provided by the feasibility consultants for each development. Feasibility consultants were asked at that time to provide estimates of costs for plus or minus a unit to an improved level of accuracy over the base costs presented in Section 4, but due to schedule and budget constraints, this was not possible. Simulated results of energy and flows for this case, as provided to the feasibility consultants, are presented in Appendix H.

A separate analysis showed that a high headpond level at Gull Island is optimal; the level was therefore fixed at the maximum allowable of 125 m. Any level above this would cause flooding in the surge chamber of the existing Churchill Falls hydroelectric development.

5.2 Approach

The optimization process required the development of an optimization model to calculate optimum installed capacities, using various measures for the objective function (for example, total benefits, net benefits, or profitability).

The power and energy benefits were obtained from the results of system simulations, with various values of installed capacities and various candidate development combinations. Energy curves were developed by tabulating the incremental energy attributable to each development for each installed capacity of interest. The energy attributable to each development is defined as the increment in total energy when that development is added, rather than the energy produced at that station. Cost curves were also prepared, based on the cost data provided in Section 4.

Figures 5.1 to 5.3 show the relationships of energy and cost to installed capacity for each of the developments.

The optimization model was set up to determine the values of installed capacity at each development required to maximize or minimize the value of the economic or financial indicator of interest. The model employed the relationships of energy and cost to installed capacity as described above.

The principal economic and financial indicators used included

- total benefits;
- net benefits;
- benefit/cost (B/C) ratio; and
- cost of energy (without capacity credit).

These are defined as follows.

Total benefits
Total benefits attributable to each development were computed as the respective annual incremental energy yield multiplied by the value of energy ($225 million/TWh), plus the new installed capacity multiplied by the value of capacity ($0.55 million/MW).

Net benefits
Net benefits attributable to each development were computed as the total benefits minus the total development costs. The net benefits of the new developments were equal to the total benefits from the new developments minus the total costs of the new developments.

B/C Ratio
The ratio of benefits to costs (B/C) of each candidate development combination and of the new developments were computed as the respective total benefits divided by the total costs.

Cost of Energy (without Capacity Credit)
For this indicator, the cost of energy was calculated in dollars per TWh by dividing the total new development cost by the incremental energy yield, discounted at a rate of 9.93 percent for 50 years. This measure of the cost of energy has been commonly used in hydroelectric engineering; the present value of cost is divided by the average annual energy and the result, in mills (tenths of a cent per kilowatt hour), is derived essentially by assuming an interest rate of 10 percent for an infinite period.

The analysis required consideration of the benefits of both capacity and energy, since benefits accrue from both. While the benefits from an increment of capacity are the same regardless of the development at which it is located, the energy realized from the same increment of capacity will vary significantly. Separate values (expressed as net present values) were provided for energy and capacity benefits for the calculation of revenues; the economics of each is considered in the following sections.

5.3 Capacity Considerations

Since a unit of installed capacity has the same capacity benefit regardless of which development it is located, to realize the greatest net capacity benefit, it should be located at the development where it has the least cost. In general, this will be the site with the highest head for the Churchill River Complex; this site is CF2.

The following table, based on the adjusted costs, gives the incremental cost of capacity for each development. As expected, the development at which the capacity should be located for the sake of realizing capacity benefits is CF2. Since the net present value of the capacity benefit is $0.55 million/MW, the only development at which it is economic to install capacity for capacity benefits alone is CF2.

Development	Incremental Cost of Capacity ($/kW)
CF2	$331
Gull Island	$632
Muskrat Falls	$796

Thus the selection of the optimal installed capacities for Gull Island and Muskrat Falls must be based on energy economics. It is clear that it is not economic to install more capacity at these developments than is needed to provide the most economic energy, without other constraints.

5.4 Energy Considerations

The basis for establishing the minimum installed capacity is the cost of an additional increment of capacity relative to the value of the energy revenue that it realizes. On this basis, the cost of the last increment of capacity will equal the last increment of revenue that it generates. The corresponding capacities for Gull Island and Muskrat Falls developments are shown in the table below. Since the value of energy attributable to CF2 is always less than the cost of capacity, there is no capacity at which incremental energy revenue equals incremental cost.

Development	Capacity at which Incremental Energy Revenue = Incremental Cost
Gull Island	1818 MW
Muskrat Falls	677 MW

While these are the minimum installed capacities that should be considered, based on incremental costs of capacity (that is, excluding common fixed costs), additional capacity will in fact generate additional energy revenue. This revenue will help offset the fixed costs of civil works.

The installed capacity that minimizes the cost of energy at each development was therefore computed, with the following results. Note that all values of economic indicators presented in this section have been calculated using the assumptions and exclusions described previously.

Development	Energy cost	Capacity which Minimizes Unit Energy Cost
CF2	$0.058/kWh	1224 MW
Gull Island	$0.021/kWh	1763 MW
Muskrat Falls	$0.026/kWh	731 MW

The total new additional installed capacity of the Churchill River Complex would be 3718 MW if these capacities, based on energy economics, were selected. An additional 582 MW could be installed to realize economic capacity benefit to bring the capacity up to the transmission limit of 4300 MW. This capacity should logically be installed at CF2, since this is the only development where the capacity benefit exceeds the cost of capacity. The installed capacity of CF2 in that case would increase within the 4300 MW constraint from 1224 MW to 1806 MW. The flow required to generate an additional 1806 MW above the capacity of the existing station, however, exceeds the hydraulic capacity of the East Forebay channel in winter conditions.

The total benefits and net benefits for the above combination, together with the cost of energy and benefit-cost ratio, is shown in the following table.

Case 1: Based on Minimizing Cost of Energy	**Total 3718 MW** **CF2 1224 MW** **Gull Island 1763 MW** **Muskrat Falls 731 MW**
Economic Indicator	
Cost of energy ($/kWh)	$0.020
B/C Ratio	1.59
Total Benefits ($M)	$6994
Net Benefits ($M)	$2598

Note: The cost of energy is less than the weighted average of the costs in the previous table because the value of the diversion water to CF1 is taken into account when the Complex total is calculated.

5.5 Results

The high value of capacity relative to the low unit cost of capacity at CF2 assumed for this study leads to the conclusion that the installed capacity at CF2 should be increased significantly. The maximum economic capacity that might be installed at CF2 is limited by certain features, however, including transmission capacity and the hydraulic capacity of flow channels (specifically the East Forebay channel).

Installation of a capacity at CF2 which triggers the need for significant modifications at existing facilities would precipitate additional capital investment which may well render the installation of generating capacity over this limit uneconomic.

The Churchill River Complex can still take advantage of the full 4300 MW available, by installing the available capacity at either or both of the other two developments, albeit at an economic cost to the Complex as a whole. Since more energy benefits would be realized at the other developments than at CF2, the overall effect on the total Churchill River Complex could be relatively small.

To investigate other arrangements, the net Complex benefits were optimized, considering either 1100 MW or 1200 MW at CF2, and considering a project with only CF2 and Gull Island. The net benefits as well as performance on other economic indicators of these combinations is tabulated below. Case 1 is the same as Case 1 in the preceding table; Case 5 is the case agreed upon and provided to the feasibility consultants in September, 1998.

Station	*Case 1*	*Case 2*	*Case 3*	*Case 4*	*Case 5*
CF2 (MW)	1224	1200	1100	1100	1100
Gull Island (MW)	1763	2226	2294	2361	2264
Muskrat Falls (MW)	731	874	906	0	824
Total (MW)	3718	4300	4300	3461	4188
Economic Indicator					
Total Benefits ($ M)	6994	7597	7607	6004	7508
Total Cost ($M)	4396	4794	4829	3493	4746
Energy Cost (no capacity benefit) ($/kWh)	0.0200	0.0206	0.0208	0.0192	0.0205
B/C Ratio	1.59	1.59	1.58	1.72	1.58
Net Benefits ($M)	**2598**	**2803**	**2778**	**2511**	**2762**

Note: Costs are obtained from Figures 5.1, 5.2, and 5.3 .

As the table shows, the maximum net benefits to the project are obtained with Cases 2 and 3. Case 5 consists of the installed capacities selected from the preliminary analysis. The benefits for this case are similar to Cases 2 and 3, but the total capacity of the new developments does not take full advantage of the available transmission limit of 4300 MW. The selected combination (Case 5) was developed at a time when the transmission limit was given as 4200 MW. If the channels in the Churchill River Complex can handle the additional flow, the installed capacity should theoretically be increased at CF2 up to the transmission limit. The differences in net benefits among the three best cases are in fact small and within the accuracy of the cost estimates.

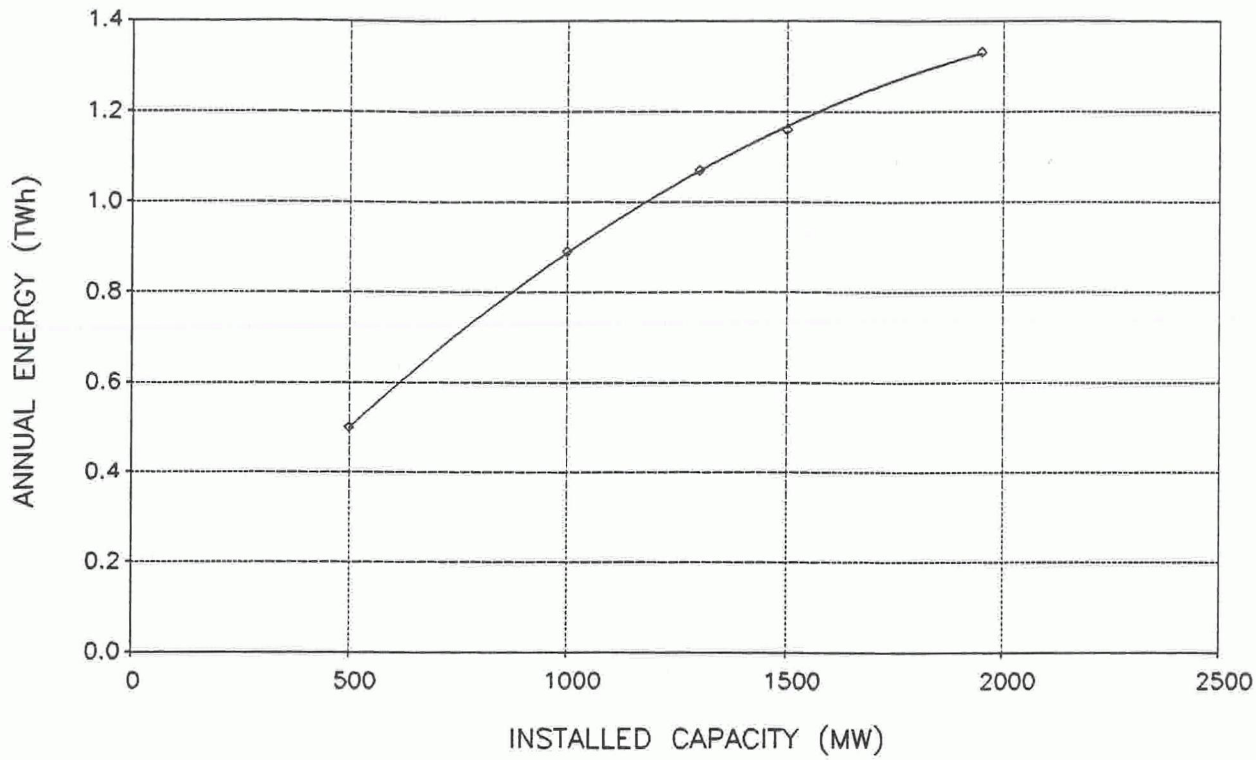
Figures 5.4 and 5.5 show the relationship of the economic indicators to investment for the cases presented above, along with the results for the highest ranking candidate development combinations simulated, as summarized in Section 3.

A check on the sensitivity of the net benefits for the five cases to changes in the values of capacity and energy in the range suggested by NLH and HQ ($0.5 to $0.6 million/MW for capacity and $200 to $250 million/TWh for energy) showed that the ranking of the cases by net benefits was not sensitive to changes in this range. As shown in Section 5.3, any value of capacity above the estimated incremental cost of capacity at CF2 ($0.33 million/MW) will not affect the results of the optimization study.

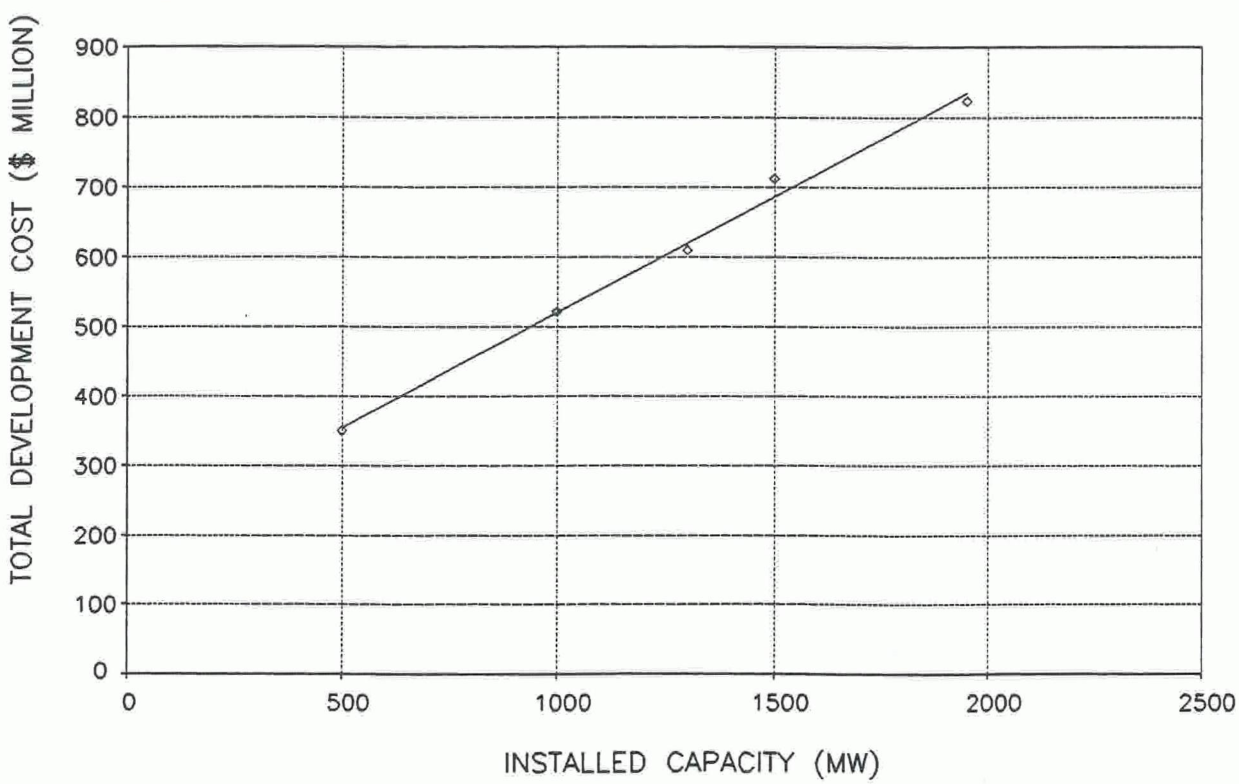
The table above and Figure 5.4 show that the selected case is near-optimal for maximizing net benefits. Minor adjustments to the allocation of the total allowable installed capacity may be made, depending on final hydraulic and transmission limits.

The installed capacities in Case 5 were therefore used to make the final estimates of power and energy described in Section 6.

(A) ANNUAL ENERGY AS A FUNCTION OF INSTALLED CAPACITY



(B) TOTAL DEVELOPMENT COST AS A FUNCTION OF INSTALLED CAPACITY



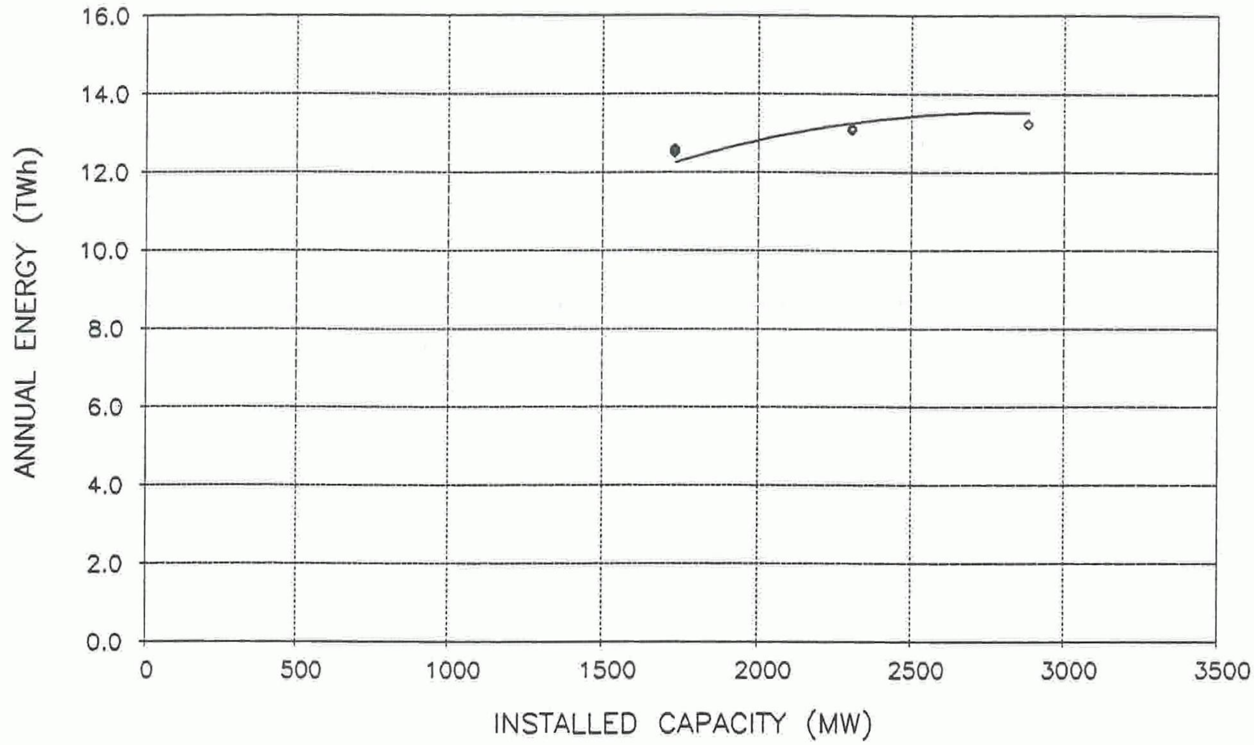
NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 5.1

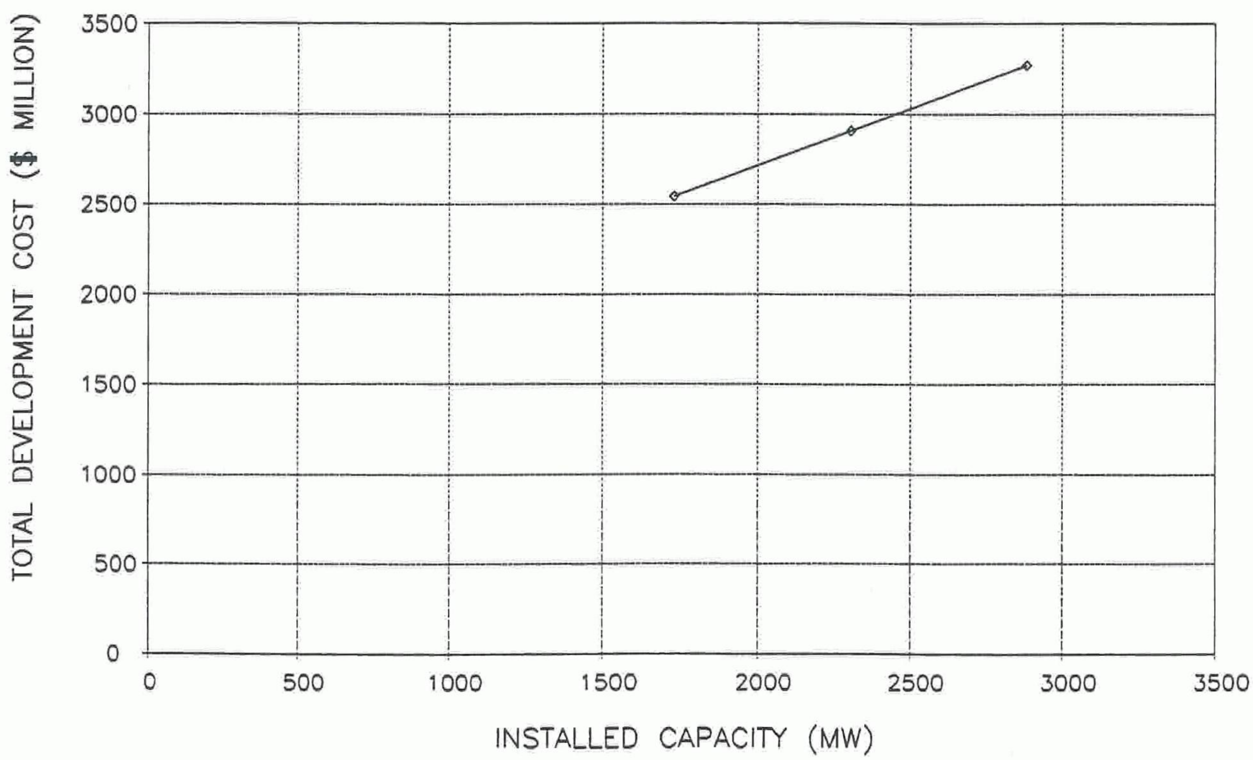
ACRES

ENERGY AND COST FUNCTIONS – CF2

(A) ANNUAL ENERGY AS A FUNCTION OF INSTALLED CAPACITY



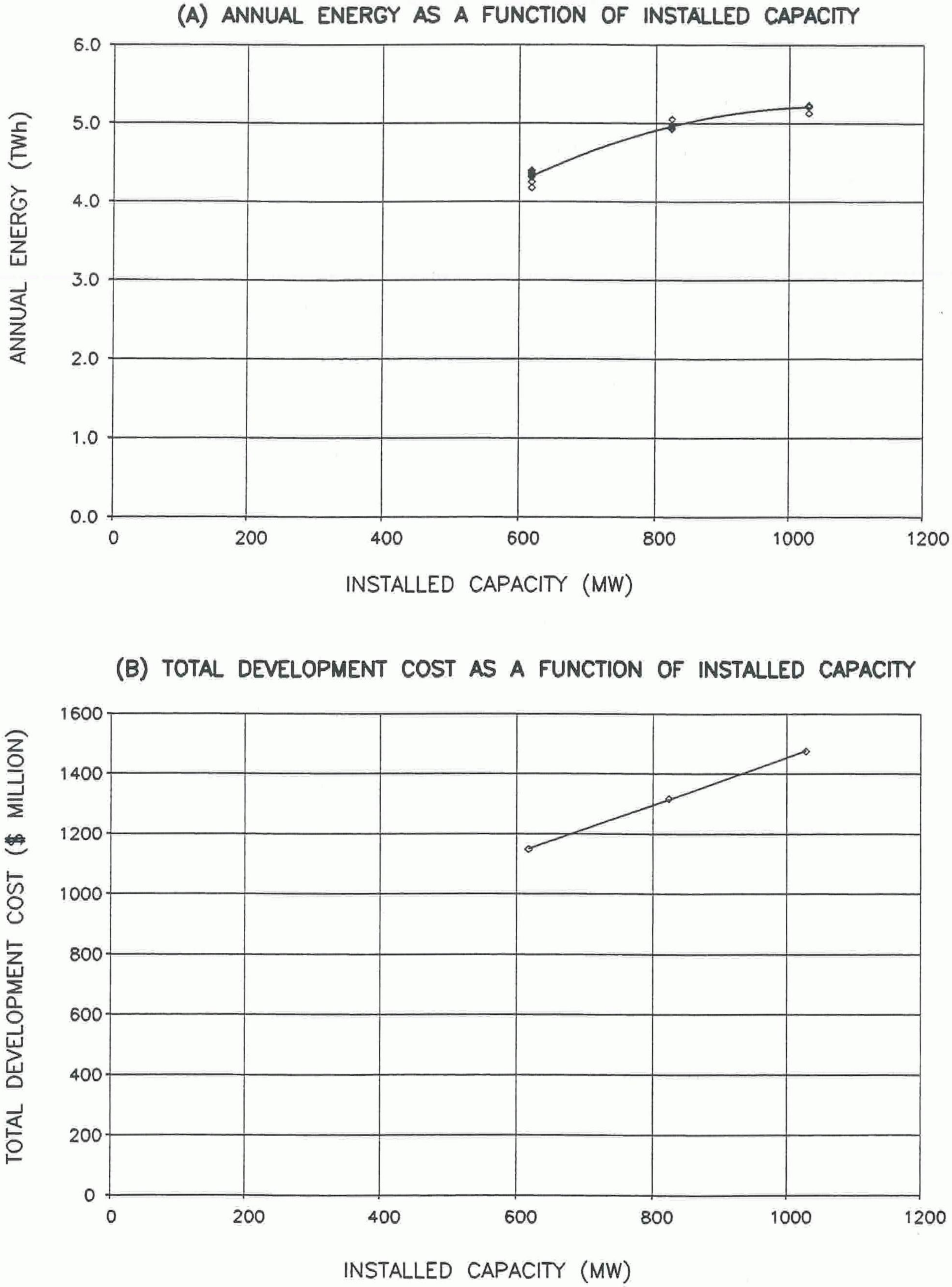
(B) TOTAL DEVELOPMENT COST AS A FUNCTION OF INSTALLED CAPACITY



NEWFOUNDLAND AND LABRADOR HYDRO FIG 5.2
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

ENERGY AND COST FUNCTIONS – GULL ISLAND

ACRES

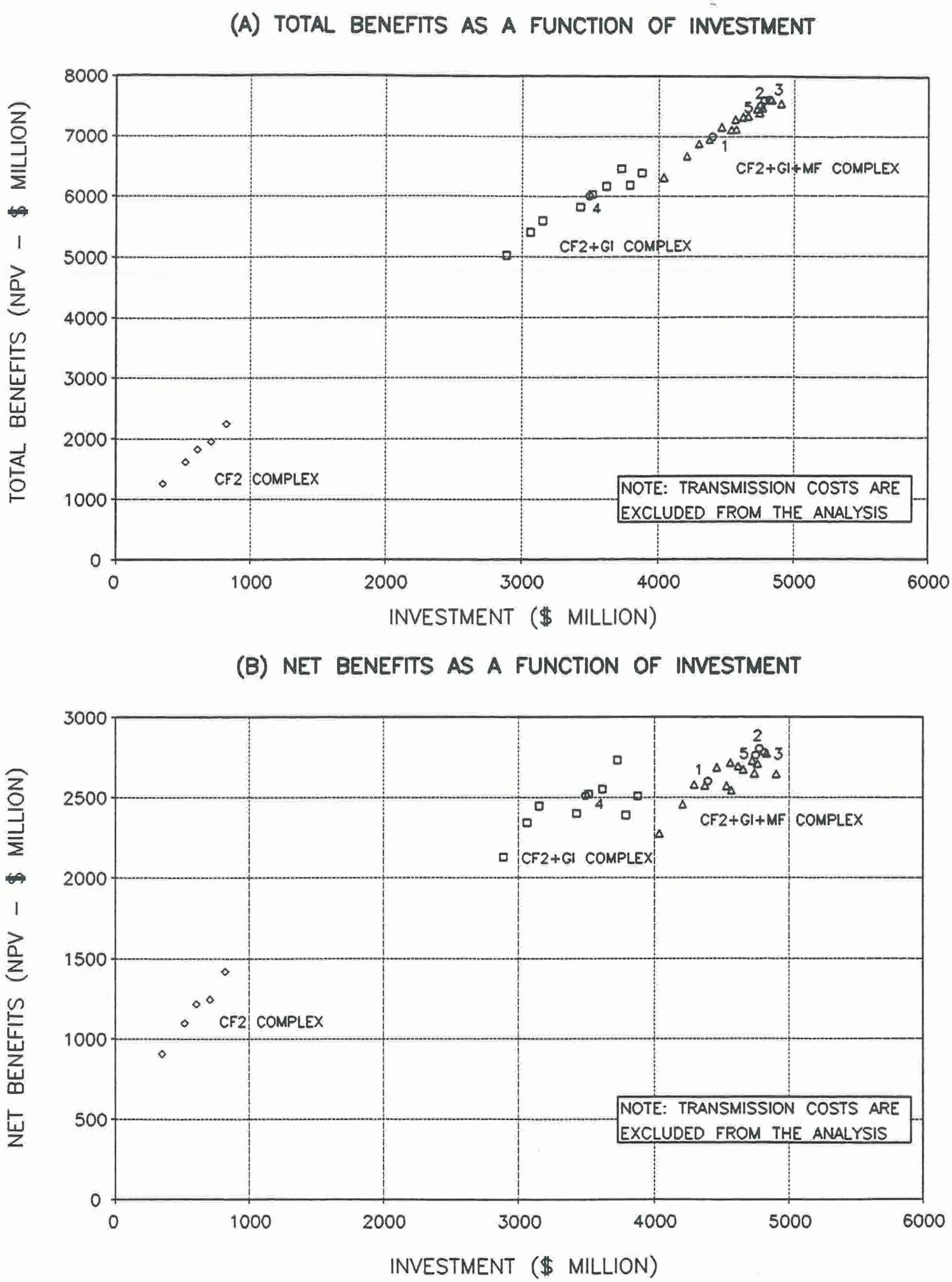


NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 5.3

ACRES

ENERGY AND COST FUNCTIONS – MUSKRAT FALLS

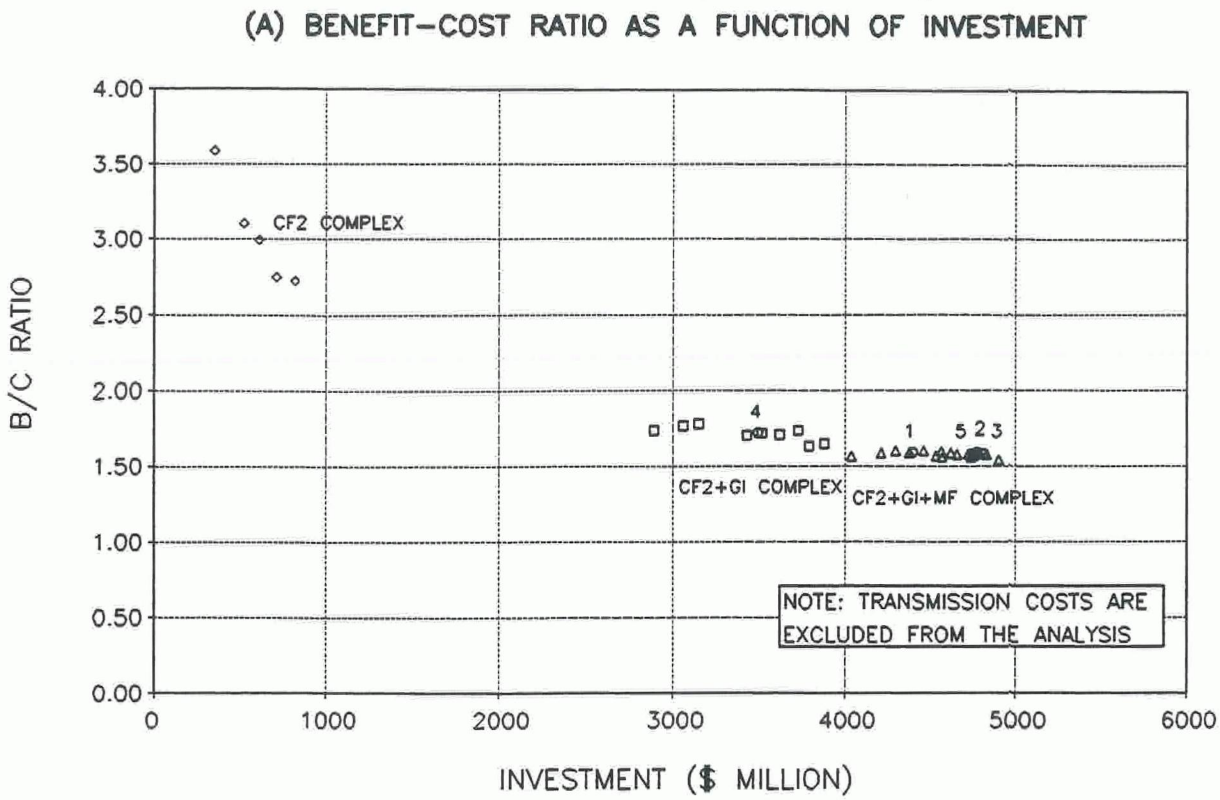


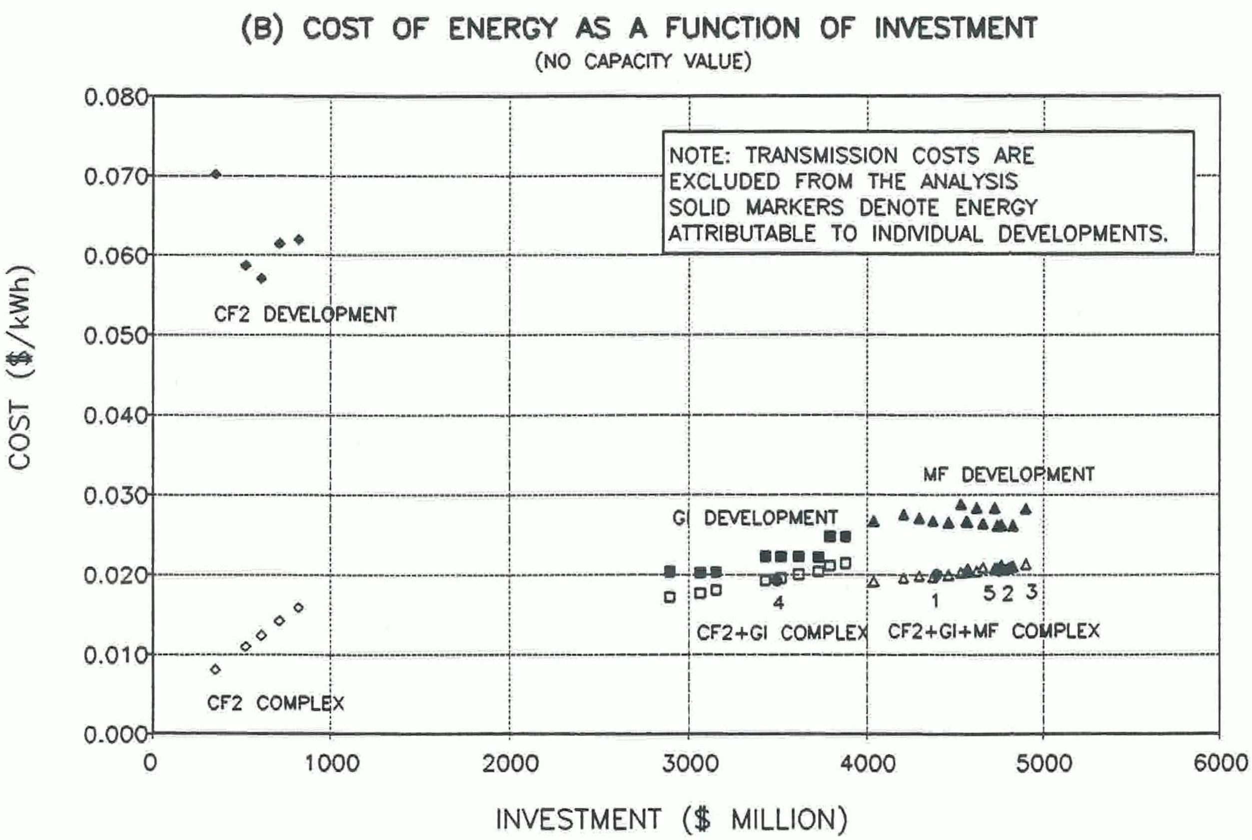
NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 5.4

TOTAL AND NET BENEFITS
AS A FUNCTION OF INVESTMENT

ACRES





NEWFOUNDLAND AND LABRADOR HYDRO
CHURCHILL RIVER COMPLEX
OPTIMIZATION STUDY

FIG 5.5

B/C RATIO AND COST OF ENERGY AS A FUNCTION OF INVESTMENT

ACRES

Final Power and Energy Results

6 Final Power and Energy Results

This section of the report presents the final power and energy results based on installed capacities selected from the optimization analysis. The final optimization of the Churchill River Complex as presented in Section 5 confirmed the preliminary selection of installed capacities for each of the developments in the Complex, that is CF2 - 1100 MW; Gull Island - 2264 MW; and Muskrat Falls - 824 MW. The rated installed capacities of 5428.5 MW for CF1 and 1100 MW for CF2 are at the low voltage side of the transformer. Rated installed capacities of 2264 MW for Gull Island and 824 MW for Muskrat Falls are at the high voltage side of the transformer. This slight difference has been accounted for in the availability curves.

The feasibility consultants revised the power plant characteristics for each of the developments as part of the feasibility studies. Revised power plant characteristics, as provided by the feasibility consultants, are presented in Appendix I and summarized in Table 6.1. As can be seen, revised power plant characteristics were also provided for CF1. Along with the changes to the power plant characteristics, other changes to the model that were incorporated to determine the final power and energy results included

- availability curves for CF1, CF2, Gull Island, and Muskrat Falls;
- tailwater curves;
- monthly demand pattern; and
- Lower Churchill inflow sequence.

Availability Curves

Adjustments were made to CF1 and CF2 availability to account for the increase in rated capacity in the winter and output at the high voltage side of the transformer. For CF2, during April it was assumed that the units would be shut down for two weeks for maintenance, therefore only being available 50 percent of the time (before adjustments). Availability curves used for final power and energy simulations are presented in Table 6.2 for all developments. Average capacity potential for each development is shown in Table 6.3.

As discussed in Section 3.1.3, the power availability curve assumes a reduction in available capacity to account for scheduled (maintenance) and unscheduled outages. Unit availability is higher in the winter than in the summer due to the maintenance program which concentrates all the maintenance works in the summer. For Gull Island and Muskrat Falls, the rated capacities are the same for winter and summer. In the case of CF2, however, provisions were made for an increase in rated capacity in the winter due to lower water temperature.

Tailwater Curves
Along with revised power plant characteristics, the feasibility consultants provided revised tailwater curves to be used for the final power and energy simulations. The curves used for final power and energy simulations are presented in Table 6.4.

Monthly Demand Pattern
HQ provided a revised monthly demand pattern to be used for the final power and energy simulations (November, 1998). This curve is presented in Appendix J. Table 6.5 presents the revised monthly demand pattern and the monthly demand pattern used for the optimization analysis. Also provided in Table 6.5 is the monthly demand pattern for Labrador and the HVDC infeed to the island of Newfoundland. The demand pattern provided by HQ takes into consideration the internal demands of Québec and Newfoundland and Labrador, as well as the external markets.

Lower Churchill Inflow Sequence

Revised data for May, June and July of 1990 from Environment Canada for the hydrometric station 03OE001, Churchill River above Upper Muskrat Falls, led to revisions in the local inflow sequences to Gull Island and Muskrat Falls in those months.

Final power and energy simulations were conducted for the following cases based on installed capacities selected from the optimization analysis.

1) CF1 (Existing)
2) CF1 + Diversions
3) CF1 + Diversions + CF2
4) CF1 + Diversions + CF2 + Gull Island
5) CF1 + Diversions + CF2 + Gull Island + Muskrat Falls (proposed Churchill River Complex)

Table 6.6 presents the simulated energy produced at each development, as well as the incremental firm and average annual energy that can be attributed to each development as it is added to the Complex. Table 6.7 summarizes the average annual energy, attributable development energy, spill, power flow and capacity factor for the cases listed in Table 6.6.

Detailed model information for the existing case and proposed Churchill River Complex are provided in Volume 2 of this report.

Table 6.1

Final Power Plant Characteristics

Final Power Plant Characteristics	CF1	CF2	GI with MF	GI without MF	MF
Installed Capacity (MW)	5428.5	1100.0	2264.0	2311.0	824.0
Nominal Headpond Level (m)	448.5	448.5	125.0	125.0	39.0
Net Head (m)	311.8	315.0	84.0	85.8	35.0
Head Loss (m)	4.4	3.8	2.0	2.0	0.5
Maximum Flow (m^3/s)	2008	412	3030	3030	2667
Best Efficiency Flow (m^3/s)	2008	412	2670	2670	2437
Efficiency at Max Flow (%)	90.3	92.0	91.1	91.1	90.0
Efficiency at Best Flow (%)	90.3	92.0	93.6	93.6	91.8

Notes:

1) Efficiency at Best Flow (%) for Gull Island and Muskrat Falls was adjusted to account for the decrease in head loss at best efficiency flow.

2) Head loss for CF1 without CF2 is 5.12 m.

3) A single value of efficiency was provided by the feasibility consultant for CF1 and CF2 to represent the units operating as a group on a monthly basis.

4) Installed capacity for CF1 and CF2 are at the low voltage side of the transformer, while Gull Island and Muskrat Falls are at the high voltage side of the transformer. Adjustments for CF1 and CF2 installed capacities are accounted for in the availability curves.

Table 6.2

Final Availability Curves

Month	Availability (%)			
	CF1	CF2	GI	MF
October	91.96	95.94	90.00	90.00
November	96.05	100.20	94.00	94.00
December	98.09	102.33	96.00	96.00
January	98.09	102.33	96.00	96.00
February	98.09	102.33	96.00	96.00
March	97.07	102.33	95.00	95.00
April	95.03	53.30	93.00	93.00
May	92.99	97.00	91.00	91.00
June	89.92	93.80	88.00	88.00
July	88.90	92.74	87.00	87.00
August	87.88	91.67	86.00	86.00
September	88.90	92.74	87.00	87.00

Table 6.3

Average Capacity Potential (MW) CF1, CF2, Gull Island, and Muskrat Falls for 5428.5/1100/2264/824

Month	Average Capacity Potential (MW)			
	CF1	CF2	GI	MF
October	4992	1055	2038	742
November	5214	1102	2128	775
December	5325	1126	2173	791
January	5325	1126	2173	791
February	5325	1126	2173	791
March	5269	1126	2151	783
April	5159	586	2106	766
May	5048	1067	2060	750
June	4881	1032	1992	725
July	4826	1020	1970	717
August	4771	1008	1947	709
September	4826	1020	1970	717
Average	5080	1033	2073	755

Table 6.4

Final Tailwater Curves

Tailwater Curve CF1 without GI		Tailwater Curve CF1 GI Headpond = 125 m		Tailwater Curve GI without MF	
Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)
0	122.20	0	126.85	0	35.92
400	124.30	400	126.90	500	36.53
600	124.70	1000	127.16	1000	36.94
800	125.20	1600	127.90	1500	37.30
1000	125.60	2800	129.41	2000	37.64
1200	126.00			2500	37.95
1600	126.90			3000	38.24
2000	127.60			3500	38.52
2800	129.00			4000	38.80
				4500	39.06
				5000	39.32
				6000	39.81

Tailwater Curve GI with MF Headpond = 39 m		Tailwater Curve MF	
Discharge (m^3/s)	Tailwater (m)	Discharge (m^3/s)	Tailwater (m)
0	38.98	1000	2.00
283	39.00	1500	2.60
566	39.03	2000	2.90
850	39.06	2500	3.40
1133	39.09	3000	3.80
1699	39.18	4000	4.60
2265	39.29		
2832	39.41		
5663	40.33		

Note:

1) Tailwater curve for CF2 is the same as CF1. During the course of the feasibility studies a discrepancy in the datum at the existing Churchill Falls hydroelectric development was discovered. The levels used in this study for the Upper Churchill development are to the old Upper Churchill Local Datum. The conversion for the Upper Churchill reservoirs is Geodetic Datum = Upper Churchill Local Datum - 1.85 m. The Diversions, Gull Island and Muskrat Falls are referenced to Geodetic Datum.

Table 6.5

Monthly Demand Patterns

Month	Monthly Demand Fraction			
	*HQ	HVDC	Labrador	**HQ
October	0.9396	0.7061	0.9767	0.8101
November	1.0211	1.0701	1.0701	1.1023
December	1.2405	1.3651	1.0709	1.2799
January	1.2806	1.3886	1.1062	1.3564
February	1.1472	1.5367	1.2397	1.3349
March	1.1114	1.2238	1.0120	1.1798
April	0.9083	1.0336	1.0214	0.8590
May	0.8527	0.8708	0.9414	0.8195
June	0.8523	0.7782	0.8998	0.8152
July	0.8921	0.7531	0.8590	0.8784
August	0.9151	0.7767	0.8708	0.8430
September	0.8391	0.5229	0.9363	0.7385

* Monthly demand pattern used for optimization analysis.
** Monthly demand pattern used for final energy results.

Table 6.6

Final Firm and Average Annual Energy Results (TWh/yr)

Component	CF1	CF1 + Diversions	CF1 + CF2 + Diversions	CF1 + CF2 + Gull Island + Diversions	CF1 + CF2 + Gull Island + Muskrat Falls + Diversions
CF1	33.87	-	-	-	-
CF1 + Diversion	-	37.74	29.65	29.49	29.49
CF2	-	-	9.05	9.05	9.05
Gull Island	-	-	-	13.30	13.05
Muskrat Falls	-	-	-	-	5.46
Total Average Annual Energy	**33.87**	**37.74**	**38.70**	**51.84**	**57.05**
Incremental Average Annual Energy	-	**3.87**	**0.96**	**13.14**	**5.21**
Firm Energy	**31.09**	**34.89**	**35.11**	**47.15**	**52.04**
Incremental Firm Energy	-	**3.80**	**0.22**	**12.04**	**4.89**

Note:

1) The above results may be slightly different from those appearing in the feasibility studies for the CF2, Gull Island and Muskrat Falls developments due to minor revisions in hydrology and power plant characteristics after the final feasibility reports were issued.

Table 6.7

Detailed Model Results

Model Setup	Installed Capacity (MW)	Average Energy (TWh/yr)	Attrib. Energy (TWh/yr)	Spill (m^3/s)	Power Flow (m^3/s)	Capacity Factor (%)
CF1						
- CF1	5428.5	33.87	-	12.58	1380	76
CF1+Diversions						
- CF1	5428.5	37.74	3.87	37.58	1539	85
CF1+Diversions+CF2						
- CF1	5428.5	29.65	-	8.96	1207	67
- CF2	1100	9.05	-	-	361	100
- Total	6528.5	38.70	0.96	-	-	72
CF1+Diversions+CF2+GI						
- CF1	5428.5	29.49	-	10.21	1204	66
- CF2	1100	9.05	-	-	362	100
- GI	2264	13.30	-	28.15	1938	72
- Total	8792.5	51.84	13.14	-	-	72
CF1+Diversions+CF2+GI+MF						
- CF1	5428.5	29.49	-	10.29	1204	66
- CF2	1100	9.05	-	-	362	100
- GI	2264	13.05	-	28.94	1937	72
- MF	824	5.46	-	78.20	1952	83
- Total	9616.5	57.05	5.21	-	-	73

1) The above results may be slightly different from those appearing in the feasibility studies for the CF2, Gull Island and Muskrat Falls developments due to minor revisions in hydrology and power plant characteristics after the final feasibility reports were issued.

Conclusions and Recommendations

7 Conclusions and Recommendations

7.1 Conclusions

The installed capacities used in the feasibility studies are optimal for the Churchill River Complex, within the level of accuracy of the cost estimates. The installed capacities are as follows.

Development	Installed Capacity (MW)
CF2	1100
Gull Island	2264
Muskrat Falls	824

The following table shows the simulated energy production at each development, as well as the incremental firm and average annual energy that can be attributed to each development as it is added to the Complex.

Component	CF1	CF1 + Divs.	CF1 + CF2 + Divs.	CF1 + CF2 + GI + Divs.	CF1 + CF2 + GI + MF + Divs.
CF1	33.87	-	-	-	-
CF1 + Divs.	-	37.74	29.65	29.49	29.49
CF2	-	-	9.05	9.05	9.05
GI	-	-	-	13.30	13.05
MF	-	-	-	-	5.46
Total Average Annual Energy	33.87	37.74	38.70	51.84	57.05
Incremental Average Annual Energy	-	3.87	0.96	13.14	5.21
Firm Energy	31.09	34.89	35.11	47.15	52.04
Incremental Firm Energy	-	3.80	0.22	12.04	4.89

CF1 - *existing Churchill Falls hydroelectric development*
CF2 - *proposed extension to the existing Churchill Falls hydroelectric development*
GI - *proposed hydroelectric development at Gull Island*
MF - *proposed hydroelectric development at Muskrat Falls*
Divs. - *diversion of additional waters into Ossokmanuan Reservoir from St-Jean and Romaine River basins.*

The above table shows that estimated average annual energy output from the Churchill River Complex is 57.1 TWh. This results in about 23.2 TWh annually of additional energy above average existing generation. The energy benefits of water from the proposed diversion of two rivers in Québec (St-Jean and Romaine) passing through the existing and new developments are included in this estimate.

The above results may be slightly different from those appearing in the feasibility studies for the CF2, Gull Island and Muskrat Falls developments due to minor revisions in hydrology and power plant characteristics after the final feasibility reports were issued.

The results of this study are based on several external assumptions relating to such factors as

- a limit on new capacity of 4300 MW due to transmission constraints;
- a limit on the total flow at the existing and proposed new developments at Churchill Falls due to the hydraulic capacity of channels in the existing Churchill Falls Complex;
- volume and rate of water being diverted into the system from rivers in Québec; and
- anticipated rates for the power and energy sales on the market.

The optimal installed capacities at all developments are sensitive to these factors. The optimal installed capacity at CF2 is the most sensitive, since almost all of its benefit derives from capacity rather than energy. The value of capacity would have to drop from the assumed rate of $0.55 million/MW to close to the incremental cost of capacity at CF2 (presently estimated at about $0.33 million/MW) before the results of the optimization would be substantially affected.

7.2 Recommendations

The new developments in Churchill River should have installed capacities similar to those determined in this study.

Additional capacity may be installed at CF2, up to the transmission limit, if the additional flow can be handled by the channels in the existing system.

If any of the external assumptions listed in the conclusions change before the final design stage, the results of the optimization, particularly the selected installed capacity of CF2, should be reviewed.

The power and energy simulations were done using a monthly time step, as appropriate for this level of study. A simulation with a daily time step, as well as some consideration for within-day water management, is recommended to test the assumptions and fine-tune the results.

List of References

List of References

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3-7 Churchill Falls (Labrador) Corporation Limited. *Storage Curves (November, 1996), Structure Curves, and recorded site data (May, 1995 to April, 1997).* Provided by Churchill Falls (Labrador) Corporation Limited.

3-8 Churchill Falls (Labrador) Corporation Limited (March, 1989). *Flood Handling Study of the Churchill Falls System Main Report.* Prepared by Acres International Limited.

3-9 Letter from J. Levay, Société d'énergie de la Baie James, to M. Rana, Newfoundland and Labrador Hydro, July 2, 1998. *Churchill River Complex Data for energy simulation.*

3-10 Letter from J. Levay, Société d'énergie de la Baie James, to M. Rana, Newfoundland and Labrador Hydro, July 17, 1998. *Churchill River Complex Data for energy simulation - monthly demand factors.*

3-11 Fax from G. Piercy, Newfoundland and Labrador Hydro, to S. Richter, Acres International Limited, July 24, 1998.

Appendix A
Description of ARSP Model

ACRES RESERVOIR SIMULATION PROGRAM (ARSP) COMPUTER MODELING PROGRAM

ARSP is a general reservoir simulation program that is capable of simulating a wide range of operating policies in multipurpose, multi reservoir systems. Water resource allocation problems involving energy production, flood control, water supply, irrigation, low-flow augmentation, diversion, navigation, environmental, and many other requirements can be modeled. The model takes natural inflows, precipitation, evaporation and evapotranspiration data as input.

A major advantage of ARSP is its flexibility in allowing the user to make structural or operating policy changes by modifying the input data rather than by changing the computer program itself. Furthermore, the operating policies are modeled separately from the physical system. In this way, a unique and powerful division in representation of a water resource network is realized and is responsible, in large part, for the flexibility and general applicability of the model. This approach allows alternative water resource policies to be investigated by superimposing new penalty structures on the existing network. The penalty structure defines the relative priorities of conflicting water uses under various hydrologic conditions, and at various times of the year. The priorities are specified by the user, and are not dependent on the system configuration.

Operational features that can be represented include storage and release of water by reservoirs, physical discharge controls at reservoir outlets, water flow in channels (e.g., streams, power channels, diversion or irrigation canals), consumptive demands (e.g., agricultural, industrial or municipal), hydropower releases, head losses in channels, water losses in channels, hydraulic routing through channels and reservoirs, and inflow forecasts. Flow and water level constraints may be absolute, or they may be relative to the flow or level in a previous time step.

ARSP is based on the premise that a water resource system can be represented by a flow network and that an optimal operating decision for the upcoming time period can be made given the initial state of the system and estimates of net inflows during the period. It is a steady-state model since the system configuration and the penalty structure do not change with time. It is not an "optimization model", but it does use a solution algorithm that is based on optimization principles. It is known as the "out of kilter" algorithm.

In the model, a physical water resource system is described as a network consisting of discrete components, each of which is defined separately. Junctions and control points, such as reservoirs, are represented as nodes, while natural or man-made flow paths that connect junctions are referred to as channels. The network solution technique allocates water in such a way that the total penalties for demand and reservoir storage are minimized for a given time step, e.g., the model might determine if it is preferable to draw a reservoir down to maintain a minimum flow in a channel or to keep the water in storage and allow the channel flow to fall below the desired value.

Appendix B
Monthly Hydrologic Sequences

Upper Churchill River Hydrologic Sequences

CRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.10.19 14:35:14

PERIOD AVERAGE CHANNEL FLOW (cms) : 7 Lac Joseph Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	175.896	115.132	69.968	54.714	46.771	42.611	44.534	97.324	618.332	316.809	201.646	208.958	166.154
2	1957	1957	194.334	117.369	102.745	91.935	80.148	78.257	88.437	328.250	548.995	251.915	211.195	236.976	194.562
3	1958	1958	166.347	115.447	83.016	60.103	48.977	44.849	43.903	294.526	547.387	229.980	168.584	104.321	159.377
4	1959	1959	141.228	96.694	71.890	56.289	48.347	41.665	38.167	210.565	418.577	204.199	200.700	250.655	148.491
5	1960	1960	207.382	120.553	81.755	61.710	53.421	49.954	61.395	227.742	287.845	230.925	118.630	92.881	133.417
6	1961	1961	169.845	128.495	87.460	52.161	39.774	33.408	31.485	78.887	488.892	189.890	144.411	156.482	133.458
7	1962	1962	98.585	72.836	58.212	46.771	39.113	34.984	35.614	140.282	462.480	212.488	156.797	126.289	123.845
8	1963	1963	101.453	80.778	66.469	55.974	51.845	44.849	46.771	247.156	458.352	166.977	159.035	176.527	138.147
9	1964	1964	159.350	95.433	69.968	58.842	53.106	52.161	52.161	149.170	563.303	378.204	241.735	285.954	180.232
10	1965	1965	192.443	108.450	83.016	68.077	56.289	50.270	48.662	178.103	639.638	359.420	236.976	180.340	183.853
11	1966	1966	204.829	198.494	82.385	71.575	68.392	48.977	57.266	174.321	350.816	192.443	168.900	90.013	142.627
12	1967	1967	133.601	149.800	78.257	76.649	62.971	60.103	73.151	345.741	440.198	191.812	172.398	276.404	171.959
13	1968	1968	230.295	168.900	110.373	72.521	56.289	50.585	41.035	191.497	597.027	407.452	204.514	200.385	194.742
14	1969	1969	247.156	143.781	111.948	97.009	76.019	64.263	63.286	149.485	628.197	292.951	142.488	126.604	178.764
15	1970	1970	99.562	75.704	56.605	48.032	37.852	30.855	42.958	395.696	440.860	317.754	181.632	134.861	155.960
16	1971	1971	208.327	52.791	38.167	31.801	28.933	41.350	38.797	63.286	600.210	245.549	106.559	119.292	131.312
17	1972	1972	183.208	105.298	59.473	25.119	52.791	69.337	44.534	405.529	312.333	179.395	73.151	73.781	132.625
18	1973	1973	182.578	123.421	123.421	66.469	62.656	43.556	54.083	115.447	545.181	245.549	114.186	93.511	147.583
19	1974	1974	134.231	108.135	85.884	21.936	61.395	27.357	30.225	149.485	650.133	321.568	179.080	175.266	162.021
20	1975	1975	120.017	94.992	92.156	63.790	51.782	42.516	42.737	404.332	470.612	178.292	183.082	258.975	167.340
21	1976	1976	223.613	115.667	94.015	77.469	29.405	45.794	36.717	246.967	571.655	236.062	191.151	198.463	172.783
22	1977	1977	233.572	164.802	116.613	81.598	46.834	33.187	43.651	269.691	620.507	394.026	186.927	161.083	196.703
23	1978	1978	184.595	126.320	75.735	43.903	31.076	28.964	88.279	552.020	480.981	347.475	252.577	202.906	202.378
24	1979	1979	190.142	185.635	105.992	76.334	30.351	36.875	69.274	328.943	548.522	262.789	159.413	141.039	178.518
25	1980	1980	156.892	126.289	98.428	72.363	29.059	45.763	66.375	268.115	700.465	345.426	179.489	109.490	183.707
26	1981	1981	140.818	105.424	86.483	61.521	4.822	14.971	73.435	132.876	556.023	322.513	174.005	182.956	155.066
27	1982	1982	119.418	96.032	79.770	55.186	20.896	29.910	86.735	542.502	474.205	274.292	164.456	174.131	177.397
28	1983	1983	235.180	159.571	109.490	71.512	27.924	32.431	69.999	316.210	488.797	324.405	167.355	149.611	180.206
29	1984	1984	113.713	106.811	86.672	65.965	21.778	21.022	74.979	77.973	428.411	250.403	190.205	115.163	129.740
30	1985	1985	141.039	130.323	78.414	66.217	18.690	13.017	57.014	316.494	321.726	228.435	147.468	150.052	139.782
31	1986	1986	151.943	101.485	73.119	51.877	18.248	20.297	105.487	277.160	256.801	170.034	229.192	159.539	135.322
32	1987	1987	168.553	150.557	122.381	63.759	25.308	38.167	53.516	281.352	379.339	232.028	111.129	128.589	146.869
33	1988	1988	150.525	140.692	90.769	52.129	2.364	15.002	70.850	237.386	329.605	125.721	111.633	133.601	122.155
34	1989	1989	205.176	179.741	110.278	68.234	28.870	9.676	55.911	176.369	393.238	199.314	128.054	139.494	141.562
35	1990	1990	190.772	160.453	97.766	56.699	21.558	22.062	49.482	131.741	310.726	281.447	123.673	99.657	129.430
36	1991	1991	157.680	169.971	89.886	68.928	23.827	27.798	33.187	210.660	422.202	263.860	208.107	201.866	157.037
37	1992	1992	160.453	113.682	66.816	44.534	38.041	1.135	34.007	191.182	315.107	172.430	119.544	112.579	114.425
38	1993	1993	178.607	124.145	85.411	64.610	12.103	23.669	62.088	154.213	405.592	285.670	246.999	214.032	155.422
39	1994	1994	176.936	130.890	88.657	61.868	54.966	9.203	37.789	289.862	323.617	160.390	135.397	65.335	128.383
40	1995	1995	114.092	137.383	95.024	58.716	28.554	29.437	61.616	260.740	384.003	288.853	201.110	96.379	147.036
41	1996	1996	121.593	191.151	139.904	73.151	29.626	30.761	50.774	227.048	489.207	305.526	243.658	154.875	172.056
AVERAGE			167.463	126.574	87.922	61.416	39.541	36.123	55.131	239.910	470.002	258.163	171.640	157.544	156.401
MAXIMUM			247.156	198.494	139.904	97.009	80.148	78.257	105.487	552.020	700.465	407.452	252.577	285.954	202.378
MINIMUM			98.585	52.791	38.167	21.936	2.364	1.135	30.225	63.286	256.801	125.721	73.151	65.335	114.425

PERIOD AVERAGE CHANNEL FLOW (cms) : 9 Ossokmanuan Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	382.20	250.17	152.03	118.89	101.63	92.59	96.77	211.48	1343.57	688.39	438.15	454.04	361.03
2	1957	1957	422.27	255.03	223.25	199.76	174.15	170.04	192.16	713.25	1192.91	547.38	458.90	514.92	422.76
3	1958	1958	361.45	250.85	180.38	130.60	106.42	97.45	95.40	639.97	1189.41	499.72	366.32	226.68	346.31
4	1959	1959	306.87	210.11	156.21	122.31	105.05	90.53	82.93	457.53	909.52	443.70	436.10	544.65	322.65
5	1960	1960	450.62	261.95	177.64	134.09	116.08	108.55	133.40	494.86	625.46	501.77	257.77	201.82	289.90
6	1961	1961	369.05	279.21	190.04	113.34	86.43	72.59	68.41	171.41	1062.31	412.61	313.79	340.02	289.99
7	1962	1962	214.21	158.26	126.49	101.63	84.99	76.02	77.39	304.82	1004.92	461.71	340.70	274.41	269.10
8	1963	1963	220.45	175.52	144.43	121.63	112.65	97.45	101.63	537.04	995.95	362.82	345.57	383.57	300.18
9	1964	1964	346.25	207.37	152.03	127.86	115.39	113.34	113.34	324.13	1224.00	821.80	525.26	621.35	391.63
10	1965	1965	418.16	235.65	180.38	147.92	122.31	109.23	105.74	387.00	1389.86	780.98	514.92	391.86	399.49
11	1966	1966	445.07	431.31	179.01	155.52	148.61	106.42	124.43	378.78	762.28	418.16	367.00	195.59	309.91
12	1967	1967	290.30	325.50	170.04	166.55	136.83	130.60	158.95	751.26	956.50	416.79	374.60	600.60	373.65
13	1968	1968	500.41	367.00	239.83	157.58	122.31	109.92	89.16	416.10	1297.27	885.35	444.39	435.41	423.15
14	1969	1969	537.04	312.42	243.25	210.79	165.18	139.64	137.51	324.81	1365.00	636.55	309.61	275.10	388.43
15	1970	1970	216.34	164.50	123.00	104.37	82.25	67.04	93.34	859.80	957.94	690.45	394.67	293.04	338.89
16	1971	1971	452.67	114.71	82.93	69.10	62.87	89.85	84.30	137.51	1304.19	533.55	231.54	259.21	285.33
17	1972	1972	398.09	228.80	129.23	54.58	114.71	150.66	96.77	881.17	678.67	389.81	158.95	160.32	288.18
18	1973	1973	396.72	268.18	268.18	144.43	136.14	94.64	117.52	250.85	1184.62	533.55	248.11	203.19	320.68
19	1974	1974	291.67	234.97	186.62	47.66	133.40	59.44	65.68	324.81	1412.67	698.73	389.12	380.83	352.05
20	1975	1975	260.78	206.41	200.24	138.61	112.52	92.38	92.86	878.57	1022.59	387.41	397.82	562.72	363.61
21	1976	1976	485.89	251.33	204.28	168.33	63.89	99.51	79.78	536.63	1242.14	512.94	415.35	431.24	375.44
22	1977	1977	507.53	358.10	253.39	177.30	101.77	72.11	94.85	586.01	1348.29	856.17	406.17	350.02	427.41
23	1978	1978	401.10	274.48	164.56	95.40	67.52	62.94	191.82	1199.48	1045.12	755.03	548.82	440.89	439.75
24	1979	1979	413.16	403.36	230.31	165.87	65.95	80.13	150.53	714.76	1191.88	571.01	346.39	306.46	387.90
25	1980	1980	340.91	274.41	213.87	157.24	63.14	99.44	144.23	582.58	1522.03	750.57	390.01	237.91	399.17
26	1981	1981	305.98	229.08	187.92	133.68	10.48	32.53	159.57	288.72	1208.18	700.79	378.09	397.54	336.94
27	1982	1982	259.48	208.67	173.33	119.91	45.40	64.99	188.47	1178.80	1030.40	596.01	357.34	378.37	385.46
28	1983	1983	511.02	346.73	237.91	155.39	60.68	70.47	152.10	687.09	1062.10	704.90	363.64	325.09	391.57
29	1984	1984	247.09	232.09	188.33	143.33	47.32	45.68	162.92	169.43	930.89	544.10	413.29	250.24	281.91
30	1985	1985	306.46	283.18	170.39	143.88	40.61	28.28	123.89	687.71	699.07	496.36	320.43	326.05	303.73
31	1986	1986	330.16	220.52	158.88	112.72	39.65	44.10	229.21	602.24	558.00	369.47	498.01	346.66	294.04
32	1987	1987	366.25	327.14	265.92	138.54	54.99	82.93	116.28	611.35	824.26	504.17	241.47	279.41	319.13
33	1988	1988	327.07	305.71	197.23	113.27	5.14	32.60	153.95	515.81	716.20	273.18	242.57	290.30	265.43
34	1989	1989	445.82	390.56	239.62	148.27	62.73	21.02	121.49	383.23	854.46	433.09	278.25	303.11	307.60
35	1990	1990	414.53	348.65	212.43	123.20	46.84	47.94	107.52	286.26	675.17	611.55	268.73	216.54	281.24
36	1991	1991	342.62	369.33	195.31	149.77	51.77	60.40	72.11	457.74	917.40	573.34	452.19	438.63	341.22
37	1992	1992	348.65	247.02	145.18	96.77	82.66	2.47	73.89	415.42	684.69	374.67	259.76	244.62	248.63
38	1993	1993	388.09	269.75	185.59	140.39	26.30	51.43	134.91	335.09	881.31	620.73	536.70	465.07	337.72
39	1994	1994	384.46	284.41	192.64	134.43	119.43	20.00	82.11	629.84	703.18	348.51	294.20	141.97	278.96
40	1995	1995	247.91	298.52	206.48	127.58	62.05	63.96	133.88	566.56	834.40	627.65	436.99	209.42	319.49
41	1996	1996	264.21	415.35	304.00	158.95	64.37	66.84	110.33	493.35	1062.99	663.87	529.44	336.53	373.86
AVERAGE			363.88	275.03	191.04	133.45	85.92	78.49	119.79	521.30	1021.26	560.96	372.96	342.33	339.84
MAXIMUM			537.04	431.31	304.00	210.79	174.15	170.04	229.21	1199.48	1522.03	885.35	548.82	621.35	439.75
MINIMUM			214.21	114.71	82.93	47.66	5.14	2.47	65.68	137.51	558.00	273.18	158.95	141.97	248.63

PERIOD AVERAGE CHANNEL FLOW (cms) : 13 Smallwood Local Inflow

SIM	YEAR OF HYD	YEAR OF OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	979.50	641.20	389.70	304.60	260.40	237.30	247.90	542.00	3443.30	1764.20	1123.00	1163.70	925.27
2	1957	1957	1082.20	653.60	572.10	511.90	446.40	435.70	492.40	1827.90	3057.10	1402.80	1176.10	1319.60	1083.42
3	1958	1958	926.40	643.00	462.30	334.80	272.80	249.80	244.40	1640.10	3048.20	1280.60	938.80	581.00	887.54
4	1959	1959	786.40	538.40	400.30	313.50	269.20	232.00	212.50	1172.60	2330.90	1137.10	1117.60	1395.70	826.87
5	1960	1960	1154.90	671.30	455.20	343.60	297.60	278.10	341.80	1268.20	1603.00	1285.90	660.70	517.20	742.95
6	1961	1961	945.80	715.60	487.10	290.50	221.40	186.00	175.30	439.30	2722.40	1057.40	804.10	871.40	743.17
7	1962	1962	549.10	405.60	324.10	260.40	217.90	194.80	198.30	781.10	2575.40	1183.20	873.20	703.20	689.64
8	1963	1963	565.00	449.90	370.20	311.70	288.70	249.80	260.40	1376.20	2552.40	929.90	885.60	983.00	769.30
9	1964	1964	887.40	531.40	389.70	327.70	295.80	290.50	290.50	830.70	3136.80	2106.00	1346.10	1592.30	1003.65
10	1965	1965	1071.60	604.00	462.30	379.10	313.50	279.80	271.00	991.90	3561.90	2001.50	1319.60	1004.30	1023.82
11	1966	1966	1140.70	1105.30	458.70	398.50	380.80	272.80	318.80	970.70	1953.60	1071.60	940.50	501.30	794.22
12	1967	1967	743.90	834.20	435.70	426.80	350.70	334.80	407.40	1925.30	2451.30	1068.00	960.00	1539.20	957.57
13	1968	1968	1282.30	940.50	614.60	403.80	313.50	281.60	228.50	1066.30	3324.60	2268.90	1138.90	1115.90	1084.41
14	1969	1969	1376.20	800.60	623.40	540.20	423.30	357.80	352.50	832.50	3498.20	1631.30	793.50	704.90	995.45
15	1970	1970	554.40	421.50	315.30	267.50	210.80	171.80	239.10	2203.40	2454.90	1769.40	1011.40	751.00	868.46
16	1971	1971	1160.10	294.00	212.50	177.10	161.20	230.20	216.10	352.50	3342.30	1367.40	593.30	664.20	731.23
17	1972	1972	1020.20	586.30	331.20	139.90	294.00	386.10	247.90	2258.30	1739.30	999.00	407.40	410.90	738.55
18	1973	1973	1016.70	687.20	687.20	370.20	348.90	242.60	301.10	643.00	3035.90	1367.40	635.90	520.70	821.83
19	1974	1974	747.50	602.20	478.20	122.20	341.80	152.30	168.30	832.50	3620.30	1790.70	997.20	976.00	902.23
20	1975	1975	551.00	629.00	492.00	297.30	386.90	340.00	585.40	2415.00	2781.50	973.10	968.30	1167.90	966.81
21	1976	1976	764.30	651.10	528.30	583.80	452.90	180.00	445.70	1400.70	3401.10	1248.60	1077.60	1442.90	1014.21
22	1977	1977	873.90	1081.60	669.90	600.90	480.60	178.40	350.10	1516.10	3111.30	1435.30	1334.70	881.40	1044.04
23	1978	1978	789.60	632.60	415.90	455.60	136.70	215.90	545.40	3973.40	2384.90	1818.10	894.10	1088.60	1120.04
24	1979	1979	901.90	980.70	554.00	554.10	364.70	410.10	414.50	2244.50	2944.60	1404.90	832.50	463.80	1008.99
25	1980	1980	1125.90	711.90	564.80	473.80	496.50	258.80	460.00	1819.80	3736.40	1493.60	824.20	818.60	1066.02
26	1981	1981	450.40	519.40	464.50	340.80	274.20	172.90	10.40	1836.70	3266.90	1293.30	830.40	1045.00	876.68
27	1982	1982	527.70	504.60	489.50	230.80	389.90	487.80	705.10	3390.20	1747.00	1141.70	794.70	914.60	947.92
28	1983	1983	1111.20	891.70	906.50	247.10	348.70	313.70	375.00	1925.20	2288.40	1383.50	929.00	685.60	954.21
29	1984	1984	667.10	884.10	428.60	414.50	328.00	280.70	324.20	786.40	2410.20	954.80	657.80	632.60	730.42
30	1985	1985	635.50	551.40	533.70	70.10	184.20	150.00	576.80	3006.50	1534.70	1343.80	598.40	827.30	839.29
31	1986	1986	729.70	474.90	248.30	516.00	298.10	393.90	1232.90	1887.70	817.10	1137.70	982.40	982.30	811.86
32	1987	1987	824.50	852.60	337.30	644.40	188.20	421.30	331.30	1859.50	2033.70	594.20	554.70	873.70	795.40
33	1988	1988	838.00	665.00	182.70	51.50	661.00	574.50	526.80	1646.80	1758.40	391.10	448.60	551.10	689.52
34	1989	1989	1162.20	967.60	638.90	201.40	274.90	420.90	286.90	1042.80	2508.30	1023.90	632.70	792.80	830.61
35	1990	1990	1323.90	684.50	600.30	330.10	219.90	220.10	160.00	715.50	2066.00	930.30	548.10	675.50	708.09
36	1991	1991	745.50	875.60	396.00	380.00	212.10	392.50	328.10	730.90	3521.10	1633.10	1058.40	1161.30	953.29
37	1992	1992	902.70	346.20	332.90	242.50	215.90	141.90	277.00	1409.30	1436.70	721.40	500.10	787.90	611.65
38	1993	1993	867.20	466.40	354.50	238.50	341.90	459.90	273.20	1034.40	2366.00	1300.90	726.50	655.30	758.46
39	1994	1994	985.80	708.20	472.30	273.70	323.20	283.20	370.10	1785.50	1315.30	759.00	167.00	587.80	671.27
40	1995	1995	738.60	797.00	501.40	303.00	516.50	307.50	377.10	1662.50	2382.80	1235.10	621.20	359.20	817.52
41	1996	1996	365.10	827.00	647.80	385.30	275.80	308.70	292.20	1004.80	2829.70	1783.70	1189.90	856.60	898.99
AVERAGE			874.93	678.75	469.02	342.91	319.01	292.11	352.74	1488.99	2587.66	1304.47	851.08	867.50	870.85
MAXIMUM			1376.20	1105.30	906.50	644.40	661.00	574.50	1232.90	3973.40	3736.40	2268.90	1346.10	1592.30	1120.04
MINIMUM			365.10	294.00	182.70	51.50	136.70	141.90	10.40	352.50	817.10	391.10	167.00	359.20	611.65

PERIOD AVERAGE CHANNEL FLOW (cms) : 16 West Forebay Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	18.200	11.900	7.200	5.700	4.800	4.400	4.600	10.100	64.000	32.800	20.900	21.600	17.194
2	1957	1957	20.100	12.200	10.600	9.500	8.300	8.100	9.200	34.000	56.800	26.100	21.900	24.500	20.144
3	1958	1958	17.200	12.000	8.600	6.200	5.100	4.600	4.500	30.500	56.700	23.800	17.500	10.800	16.502
4	1959	1959	14.600	10.000	7.400	5.800	5.000	4.300	4.000	21.800	43.300	21.100	20.800	26.000	15.367
5	1960	1960	21.500	12.500	8.500	6.400	5.500	5.200	6.400	23.600	29.800	23.900	12.300	9.600	13.826
6	1961	1961	17.600	13.300	9.100	5.400	4.100	3.500	3.300	8.200	50.600	19.700	15.000	16.200	13.836
7	1962	1962	10.200	7.500	6.000	4.800	4.100	3.600	3.700	14.500	47.900	22.000	16.200	13.100	12.814
8	1963	1963	10.500	8.400	6.900	5.800	5.400	4.600	4.800	25.600	47.500	17.300	16.500	18.300	14.313
9	1964	1964	16.500	9.900	7.200	6.100	5.500	5.400	5.400	15.400	58.300	39.200	25.000	29.600	18.654
10	1965	1965	19.900	11.200	8.600	7.000	5.800	5.200	5.000	18.400	66.200	37.200	24.500	18.700	19.014
11	1966	1966	21.200	20.600	8.500	7.400	7.100	5.100	5.900	18.000	36.300	19.900	17.500	9.300	14.760
12	1967	1967	13.800	15.500	8.100	7.900	6.500	6.200	7.600	35.800	45.600	19.900	17.800	28.600	17.796
13	1968	1968	23.800	17.500	11.400	7.500	5.800	5.200	4.200	19.800	61.800	42.200	21.200	20.700	20.144
14	1969	1969	25.600	14.900	11.600	10.000	7.900	6.700	6.600	15.500	65.000	30.300	14.800	13.100	18.517
15	1970	1970	10.300	7.800	5.900	5.000	3.900	3.200	4.400	41.000	45.600	32.900	18.800	14.000	16.146
16	1971	1971	21.600	5.500	4.000	3.300	3.000	4.300	4.000	6.600	62.100	25.400	11.000	12.300	13.598
17	1972	1972	19.000	10.900	6.200	2.600	5.500	7.200	4.600	42.000	32.300	18.600	7.600	7.600	13.740
18	1973	1973	18.900	12.800	12.800	6.900	6.500	4.500	5.600	12.000	56.400	25.400	11.800	9.700	15.283
19	1974	1974	13.900	11.200	8.900	2.300	6.400	2.800	3.100	15.500	67.300	33.300	18.500	18.100	16.771
20	1975	1975	11.600	10.400	8.300	6.000	5.800	5.200	8.700	45.300	50.500	18.600	18.500	25.500	17.901
21	1976	1976	17.800	11.800	9.100	9.600	6.300	4.000	7.900	26.700	63.100	23.600	20.300	25.300	18.804
22	1977	1977	19.600	18.800	11.800	9.400	7.400	3.200	6.200	29.500	60.500	32.400	24.800	17.000	20.093
23	1978	1978	16.300	12.000	7.900	7.100	2.100	3.900	10.400	68.800	46.100	36.600	21.100	20.200	21.185
24	1979	1979	18.200	19.100	10.200	9.200	5.500	6.300	7.900	40.400	56.000	26.600	16.100	11.000	18.934
25	1980	1980	19.500	13.100	10.300	8.300	6.700	5.200	7.500	32.500	72.000	32.100	16.600	13.900	19.841
26	1981	1981	11.100	10.300	8.800	5.800	2.900	2.100	2.700	27.800	60.300	28.000	16.700	19.800	16.393
27	1982	1982	10.900	9.400	8.600	4.900	5.400	6.800	12.400	61.800	38.700	24.000	16.100	17.600	18.138
28	1983	1983	22.500	16.500	14.200	5.300	5.400	5.200	7.200	36.000	45.600	28.400	16.900	13.900	18.166
29	1984	1984	12.500	14.100	7.600	6.500	4.000	3.200	6.400	12.800	45.700	20.600	14.600	11.900	13.334
30	1985	1985	13.300	10.800	9.000	2.800	2.400	1.300	8.400	48.200	30.300	24.400	12.200	15.400	14.963
31	1986	1986	14.400	9.000	5.400	7.000	2.900	3.300	17.900	32.700	19.600	20.300	20.600	17.900	14.323
32	1987	1987	16.500	15.400	7.900	8.900	1.600	4.900	5.000	33.800	38.500	16.300	10.600	15.100	14.605
33	1988	1988	15.800	12.500	4.800	.900	5.900	5.400	7.800	29.700	33.200	9.400	9.500	12.100	12.257
34	1989	1989	21.900	17.700	11.400	3.900	2.400	3.300	4.000	19.800	45.000	19.900	12.400	15.300	14.788
35	1990	1990	23.500	14.400	10.300	5.900	2.200	2.800	3.200	13.500	36.700	21.700	11.200	11.900	13.160
36	1991	1991	15.300	16.700	7.300	6.700	2.500	4.800	4.300	17.200	59.200	29.500	21.300	21.800	17.247
37	1992	1992	17.100	8.400	6.500	4.200	3.700	1.500	5.000	24.800	29.300	15.500	10.800	13.600	11.740
38	1993	1993	17.400	9.800	7.400	6.100	1.200	4.500	4.300	18.400	43.800	26.300	18.300	16.100	14.532
39	1994	1994	19.000	13.200	8.500	5.200	4.600	2.400	5.000	33.000	27.700	15.500	7.200	10.300	12.684
40	1995	1995	13.700	14.700	9.200	4.800	5.600	4.100	6.600	30.000	43.100	26.300	15.100	8.400	15.178
41	1996	1996	9.400	17.200	12.800	6.800	3.000	3.700	4.300	21.200	53.000	33.400	23.900	16.500	17.154
AVERAGE			16.871	12.705	8.654	6.120	4.773	4.420	6.098	27.127	48.571	25.376	16.693	16.398	16.191
MAXIMUM			25.600	20.600	14.200	10.000	8.300	8.100	17.900	68.800	72.000	42.200	25.000	29.600	21.185
MINIMUM			9.400	5.500	4.000	.900	1.200	1.300	2.700	6.600	19.600	9.400	7.200	7.600	11.740

PERIOD AVERAGE CHANNEL FLOW (cms) : 19 East Forebay Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	10.100	6.600	4.000	3.200	2.700	2.500	2.600	5.600	35.600	18.200	11.600	12.000	9.564
2	1957	1957	11.200	6.800	5.900	5.300	4.600	4.500	5.100	18.900	31.600	14.500	12.200	13.600	11.204
3	1958	1958	9.600	6.700	4.800	3.500	2.800	2.600	2.500	17.000	31.500	13.200	9.700	6.000	9.183
4	1959	1959	8.100	5.600	4.100	3.200	2.800	2.400	2.200	12.100	24.100	11.800	11.600	14.400	8.547
5	1960	1960	11.900	6.900	4.700	3.600	3.100	2.900	3.500	13.100	16.600	13.300	6.800	5.300	7.674
6	1961	1961	9.800	7.400	5.000	3.000	2.300	1.900	1.800	4.500	28.200	10.900	8.300	9.000	7.676
7	1962	1962	5.700	4.200	3.400	2.700	2.300	2.000	2.100	8.100	26.600	12.200	9.000	7.300	7.141
8	1963	1963	5.800	4.700	3.800	3.200	3.000	2.600	2.700	14.200	26.400	9.600	9.200	10.200	7.957
9	1964	1964	9.200	5.500	4.000	3.400	3.100	3.000	3.000	8.600	32.400	21.800	13.900	16.500	10.383
10	1965	1965	11.100	6.200	4.800	3.900	3.200	2.900	2.800	10.300	36.800	20.700	13.600	10.400	10.581
11	1966	1966	11.800	11.400	4.700	4.100	3.900	2.800	3.300	10.000	20.200	11.100	9.700	5.200	8.198
12	1967	1967	7.700	8.600	4.500	4.400	3.600	3.500	4.200	19.900	25.400	11.000	9.900	15.900	9.895
13	1968	1968	13.300	9.700	6.400	4.200	3.200	2.900	2.400	11.000	34.400	23.500	11.800	11.500	11.221
14	1969	1969	14.200	8.300	6.400	5.600	4.400	3.700	3.600	8.600	36.200	16.900	8.200	7.300	10.293
15	1970	1970	5.700	4.400	3.300	2.800	2.200	1.800	2.500	22.800	25.400	18.300	10.500	7.800	9.002
16	1971	1971	12.000	3.000	2.200	1.800	1.700	2.400	2.200	3.600	34.600	14.100	6.100	6.900	7.553
17	1972	1972	10.600	6.100	3.400	1.400	3.000	4.000	2.600	23.400	18.000	10.300	4.200	4.300	7.645
18	1973	1973	10.500	7.100	7.100	3.800	3.600	2.500	3.100	6.700	31.400	14.100	6.600	5.400	8.496
19	1974	1974	7.700	6.200	4.900	1.300	3.500	1.600	1.700	8.600	37.400	18.500	10.300	10.100	9.315
20	1975	1975	6.500	5.800	4.600	3.400	3.200	2.900	4.800	25.200	28.100	10.300	10.300	14.200	9.961
21	1976	1976	9.900	6.600	5.100	5.400	3.500	2.200	4.400	14.900	35.100	13.100	11.300	14.100	10.474
22	1977	1977	10.900	10.400	6.500	5.200	4.100	1.800	3.500	16.400	33.700	18.000	13.800	9.400	11.165
23	1978	1978	9.100	6.700	4.400	3.900	1.200	2.200	5.800	38.300	25.600	20.300	11.700	11.200	11.779
24	1979	1979	10.100	10.600	5.700	5.100	3.000	3.500	4.400	22.500	31.200	14.800	8.900	6.100	10.525
25	1980	1980	10.800	7.300	5.700	4.600	3.700	2.900	4.200	18.100	40.100	17.900	9.200	7.700	11.035
26	1981	1981	6.200	5.700	4.900	3.200	1.600	1.200	1.500	15.500	33.500	15.600	9.300	11.000	9.120
27	1982	1982	6.100	5.200	4.800	2.700	3.000	3.800	6.900	34.400	21.500	13.300	8.900	9.800	10.082
28	1983	1983	12.500	9.200	7.900	3.000	3.000	2.900	4.000	20.000	25.400	15.800	9.400	7.700	10.108
29	1984	1984	6.900	7.800	4.200	3.600	2.200	1.800	3.600	7.100	25.400	11.500	8.100	6.600	7.405
30	1985	1985	7.400	6.000	5.000	1.600	1.300	.700	4.700	26.800	16.900	13.600	6.800	8.600	8.332
31	1986	1986	8.000	5.000	3.000	3.900	1.600	1.800	9.900	18.200	10.900	11.300	11.500	10.000	7.966
32	1987	1987	9.200	8.600	4.400	5.000	.900	2.700	2.800	18.800	21.400	9.100	5.900	8.400	8.135
33	1988	1988	8.800	6.900	2.700	.500	3.300	3.000	4.300	16.500	18.400	5.200	5.300	6.700	6.804
34	1989	1989	12.200	9.800	6.300	2.200	1.300	1.800	2.200	11.000	25.000	11.100	6.900	8.500	8.213
35	1990	1990	13.100	8.000	5.700	3.300	1.200	1.600	1.800	7.500	20.400	12.100	6.200	6.600	7.321
36	1991	1991	8.500	9.300	4.100	3.700	1.400	2.700	2.400	9.600	32.900	16.400	11.800	12.100	9.592
37	1992	1992	9.500	4.700	3.600	2.300	2.100	.800	2.800	13.800	16.300	8.600	6.000	7.600	6.530
38	1993	1993	9.700	5.500	4.100	3.400	.700	2.500	2.400	10.300	24.400	14.600	10.200	8.900	8.094
39	1994	1994	10.500	7.300	4.800	2.900	2.600	1.400	2.800	18.400	15.400	8.600	4.000	5.700	7.061
40	1995	1995	7.600	8.200	5.100	2.700	3.100	2.300	3.700	16.700	24.000	14.600	8.400	4.600	8.442
41	1996	1996	5.200	9.600	7.100	3.800	1.700	2.000	2.400	11.800	29.500	18.600	13.300	9.200	9.546
AVERAGE			9.383	7.063	4.807	3.410	2.651	2.463	3.395	15.093	27.022	14.107	9.278	9.117	9.005
MAXIMUM			14.200	11.400	7.900	5.600	4.600	4.500	9.900	38.300	40.100	23.500	13.900	16.500	11.779
MINIMUM			5.200	3.000	2.200	.500	.700	.700	1.500	3.600	10.900	5.200	4.000	4.300	6.530

Lower Churchill River Hydrologic Sequences

PERIOD AVERAGE CHANNEL FLOW (cms) : 25 Gull Island Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	559.00	469.40	243.20	126.70	70.70	52.70	74.90	199.30	2180.70	935.50	356.90	371.90	470.02
2	1957	1957	386.50	62.60	38.90	106.00	77.80	112.20	171.40	1319.20	1240.20	516.10	619.30	730.20	450.29
3	1958	1958	356.10	180.70	101.70	72.00	50.70	44.50	61.10	1446.90	1018.20	123.40	100.30	62.90	303.28
4	1959	1959	332.40	633.10	357.60	187.30	189.80	150.80	143.60	1375.50	684.10	362.80	268.40	432.90	427.96
5	1960	1960	362.10	218.50	86.20	77.70	51.50	39.10	117.30	623.50	726.00	341.90	253.20	147.00	254.80
6	1961	1961	559.60	202.80	114.30	159.10	111.40	67.40	35.20	1012.40	1469.80	294.00	242.80	106.60	365.72
7	1962	1962	62.20	108.40	57.00	33.20	50.30	63.50	102.70	1392.60	1188.20	539.80	373.10	294.00	357.18
8	1963	1963	352.50	362.00	95.10	92.10	87.10	109.00	192.80	1358.70	1469.70	354.30	428.10	287.20	433.63
9	1964	1964	231.30	175.20	97.70	41.50	17.70	86.50	106.60	1057.30	1613.10	603.70	330.20	615.60	415.63
10	1965	1965	397.40	153.70	16.70	9.20	58.10	77.80	64.10	88.50	794.70	1318.40	401.40	274.10	306.35
11	1966	1966	585.40	636.50	175.00	107.50	52.10	45.00	71.00	839.20	1220.90	344.30	395.50	187.80	389.57
12	1967	1967	336.50	375.30	242.60	72.00	103.50	111.70	199.00	1500.50	966.90	465.80	413.50	512.90	443.68
13	1968	1968	535.60	283.50	155.70	116.70	86.80	124.90	97.60	1081.40	2125.90	510.20	593.00	521.20	520.33
14	1969	1969	510.60	667.10	431.70	204.80	121.30	129.50	102.40	433.50	1105.40	361.40	409.50	279.30	397.08
15	1970	1970	290.10	235.00	37.30	54.50	73.10	78.10	227.20	1542.90	1016.70	357.30	324.60	281.10	378.29
16	1971	1971	490.20	367.30	234.40	116.00	144.00	165.30	186.70	372.30	2626.60	438.20	408.00	295.60	485.68
17	1972	1972	591.20	175.90	204.30	252.40	263.50	94.50	119.70	1731.30	926.20	579.70	283.60	185.40	453.26
18	1973	1973	293.30	279.20	164.60	167.80	352.10	115.20	72.20	736.50	1678.80	411.60	278.50	163.60	391.41
19	1974	1974	363.50	152.60	100.10	104.90	64.60	24.10	59.50	768.50	1725.50	392.30	256.00	348.20	363.49
20	1975	1975	256.90	213.10	102.30	75.10	173.40	87.70	241.10	1579.10	1069.50	255.10	485.30	492.20	420.33
21	1976	1976	302.20	168.20	74.00	50.20	41.00	47.30	48.20	1113.20	1584.40	241.20	546.20	545.30	397.63
22	1977	1977	482.80	277.90	138.40	142.90	132.20	68.60	.90	1176.80	1992.90	481.00	128.90	326.40	446.15
23	1978	1978	566.90	137.40	120.30	60.10	103.10	103.10	257.70	1520.40	882.20	343.60	566.90	420.90	426.17
24	1979	1979	326.40	335.00	137.40	77.30	68.70	68.70	77.30	1603.80	1297.10	635.70	300.60	240.50	433.06
25	1980	1980	335.00	214.80	128.90	103.10	94.50	85.90	189.00	1212.90	1606.30	420.90	446.70	322.10	431.09
26	1981	1981	429.50	120.30	85.90	60.10	41.20	57.60	74.70	850.40	1564.20	524.00	274.90	420.90	376.19
27	1982	1982	212.20	154.60	69.60	60.10	41.20	57.60	226.80	1657.00	755.90	481.00	180.40	257.70	348.65
28	1983	1983	463.90	163.20	69.60	51.50	77.30	43.00	77.30	1626.90	1297.10	506.80	189.00	438.10	418.92
29	1984	1984	249.10	103.10	68.70	60.10	43.00	43.00	43.00	661.40	1550.50	524.00	438.10	266.30	338.27
30	1985	1985	369.40	180.40	85.90	51.50	43.00	60.10	240.50	1271.30	699.20	519.70	343.60	326.40	351.63
31	1986	1986	317.80	171.80	103.10	85.90	103.10	146.00	257.70	884.80	576.40	384.80	326.40	309.20	306.99
32	1987	1987	524.00	429.50	266.30	197.60	214.80	180.40	137.40	1385.60	1683.60	403.70	121.10	137.40	474.22
33	1988	1988	317.80	317.80	68.70	60.10	41.20	57.60	74.70	772.20	924.30	352.20	255.10	234.50	290.65
34	1989	1989	258.60	258.60	130.60	51.00	109.40	222.00	96.50	103.70	126.00	196.70	308.50	443.00	192.30
35	1990	1990	396.40	134.90	52.70	-14.10	115.50	59.40	41.60	684.40	1050.50	568.70	303.40	237.60	303.42
36	1991	1991	309.40	205.70	43.30	-.20	54.20	59.50	8.30	828.90	1178.60	351.90	527.30	447.20	335.44
37	1992	1992	384.20	191.00	3.40	53.30	36.20	82.90	82.70	1185.20	630.40	453.40	550.70	320.20	333.83
38	1993	1993	622.90	194.00	173.80	1.20	75.20	100.40	164.70	1160.80	1040.70	495.60	439.30	493.80	415.66
39	1994	1994	331.20	271.10	58.90	80.10	103.80	205.60	257.70	1260.00	527.10	452.60	127.80	140.20	319.98
40	1995	1995	367.90	319.90	85.50	128.90	227.30	159.90	162.20	852.00	1069.80	535.80	364.00	171.70	370.92
41	1996	1996	280.40	390.80	263.60	69.10	8.20	246.80	155.00	1160.00	1458.00	751.00	429.00	412.00	470.96
AVERAGE			382.94	260.78	128.90	87.96	96.92	95.97	124.88	1059.29	1227.86	466.59	350.95	329.30	385.61
MAXIMUM			622.90	667.10	431.70	252.40	352.10	246.80	257.70	1731.30	2626.60	1318.40	619.30	730.20	520.33
MINIMUM			62.20	62.60	3.40	-14.10	8.20	24.10	.90	88.50	126.00	123.40	100.30	62.90	192.30

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.10.19 14:35:14

PERIOD AVERAGE CHANNEL FLOW (cms) : 28 Muskrat Falls Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	91.800	77.000	39.900	20.800	11.600	8.600	12.300	32.700	357.900	153.500	58.600	61.000	77.133
2	1957	1957	63.500	10.300	6.400	17.400	12.800	18.400	28.100	216.500	203.600	84.700	101.600	119.800	73.907
3	1958	1958	58.500	29.700	16.700	11.800	8.300	7.300	10.000	237.500	167.100	20.200	16.500	10.300	49.778
4	1959	1959	54.600	103.900	58.700	30.700	31.200	24.800	23.600	225.800	112.300	59.600	44.000	71.100	70.260
5	1960	1960	59.400	35.900	14.200	12.700	8.400	6.400	19.200	102.300	119.200	56.100	41.600	24.100	41.811
6	1961	1961	91.900	33.300	18.800	26.100	18.300	11.100	5.800	166.200	241.300	48.300	39.800	17.500	60.048
7	1962	1962	10.200	17.800	9.300	5.400	8.200	10.400	16.800	228.600	195.000	88.600	61.300	48.300	58.615
8	1963	1963	57.900	59.400	15.600	15.100	14.300	17.900	31.700	223.000	241.200	58.100	70.300	47.100	71.171
9	1964	1964	38.000	28.800	16.000	6.800	2.900	14.200	17.500	173.600	264.800	99.100	54.200	101.000	68.228
10	1965	1965	65.200	25.200	2.700	1.500	9.500	12.800	10.500	14.500	130.400	216.400	65.900	45.000	50.268
11	1966	1966	96.100	104.500	28.700	17.700	8.600	7.400	11.700	137.700	200.400	56.500	64.900	30.800	63.950
12	1967	1967	55.200	61.600	39.800	11.800	17.000	18.300	32.700	246.300	158.700	76.500	67.900	84.200	72.827
13	1968	1968	87.900	46.500	25.600	19.100	14.200	20.500	16.000	177.500	348.900	83.800	97.300	85.600	85.398
14	1969	1969	83.800	109.500	70.900	33.600	19.900	21.300	16.800	71.200	181.500	59.300	67.200	45.900	65.190
15	1970	1970	47.600	38.600	6.100	8.900	12.000	12.800	37.300	253.300	166.900	58.600	53.300	46.100	62.087
16	1971	1971	80.500	60.300	38.500	19.000	23.600	27.100	30.700	61.100	431.100	71.900	67.000	48.500	79.718
17	1972	1972	97.000	28.900	33.500	41.400	43.300	15.500	19.700	284.200	152.000	95.100	46.600	30.400	74.396
18	1973	1973	48.200	45.800	27.000	27.500	57.800	18.900	11.900	120.900	275.600	67.600	45.700	26.900	64.258
19	1974	1974	59.700	25.100	16.400	17.200	10.600	4.000	9.800	126.200	283.200	64.400	42.000	57.200	59.679
20	1975	1975	42.200	35.000	16.800	12.300	28.500	14.400	39.600	259.200	175.500	41.900	79.700	80.800	69.004
21	1976	1976	49.600	27.600	12.100	8.200	6.700	7.800	7.900	182.700	260.100	39.600	89.700	89.500	65.264
22	1977	1977	79.300	45.600	22.700	23.500	21.700	11.300	.100	193.200	327.100	79.000	21.100	53.600	73.240
23	1978	1978	93.100	22.600	19.700	9.900	16.900	16.900	42.300	249.600	144.800	56.400	93.100	69.100	69.964
24	1979	1979	53.600	55.000	22.600	12.700	11.300	11.300	12.700	263.200	212.900	104.300	49.300	39.500	71.086
25	1980	1980	55.000	35.200	21.100	16.900	15.500	14.100	31.000	199.100	263.700	69.100	73.300	52.900	70.752
26	1981	1981	70.500	19.700	14.100	9.900	6.800	9.400	12.300	139.600	256.800	86.000	45.100	69.100	61.753
27	1982	1982	34.800	25.400	11.400	9.900	6.800	9.400	37.200	272.000	124.100	79.000	29.600	42.300	57.232
28	1983	1983	76.100	26.800	11.400	8.500	12.700	7.100	12.700	267.100	212.900	83.200	31.000	71.900	68.770
29	1984	1984	40.900	16.900	11.300	9.900	7.100	7.100	7.100	108.600	254.500	86.000	71.900	43.700	55.538
30	1985	1985	60.600	29.600	14.100	8.500	7.100	9.900	39.500	208.700	114.800	85.300	56.400	53.600	57.732
31	1986	1986	52.200	28.200	16.900	14.100	16.900	24.000	42.300	145.200	94.600	63.200	53.600	50.800	50.398
32	1987	1987	86.000	70.500	43.700	32.400	35.200	29.600	22.600	227.400	276.400	66.300	19.900	22.600	77.844
33	1988	1988	52.200	52.200	11.300	9.900	6.800	9.400	12.300	126.800	151.700	57.800	41.900	38.500	47.725
34	1989	1989	42.400	42.400	21.400	8.400	17.900	36.400	15.800	17.000	20.700	32.300	50.600	72.700	31.542
35	1990	1990	65.100	22.100	8.700	-2.300	19.000	9.700	6.800	112.300	172.400	93.300	49.800	39.000	49.796
36	1991	1991	50.800	33.800	7.100	.000	8.900	9.800	1.400	136.100	193.500	57.800	86.600	73.400	55.086
37	1992	1992	63.100	31.300	.600	8.800	5.900	13.600	13.600	194.500	103.500	74.400	90.400	52.600	54.802
38	1993	1993	102.200	31.900	28.500	.200	12.400	16.500	27.000	190.500	170.800	81.400	72.100	81.000	68.224
39	1994	1994	54.400	44.500	9.700	13.200	17.000	33.700	42.300	206.800	86.500	74.300	21.000	23.000	52.524
40	1995	1995	60.400	52.500	14.000	21.100	37.300	26.300	26.600	139.800	175.600	87.900	59.800	28.200	60.876
41	1996	1996	46.000	64.100	43.300	11.400	1.300	40.500	25.400	190.000	239.000	123.000	71.000	68.000	77.295
AVERAGE			62.866	42.805	21.154	14.437	15.907	15.754	20.502	173.866	201.537	76.580	57.624	54.063	63.297
MAXIMUM			102.200	109.500	70.900	41.400	57.800	40.500	42.300	284.200	431.100	216.400	101.600	119.800	85.398
MINIMUM			10.200	10.300	.600	-2.300	1.300	4.000	.100	14.500	20.700	20.200	16.500	10.300	31.542

Diversions
Hydrologic Sequences

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.10.19 14:35:14

PERIOD AVERAGE CHANNEL FLOW (cms) : 1 St. Jean Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	25.934	17.710	14.936	8.195	6.125	6.067	5.759	26.463	112.690	49.383	22.948	18.422	26.248
2	1957	1957	30.306	20.820	17.209	17.209	14.792	22.602	27.291	75.181	70.232	39.887	37.384	56.441	35.865
3	1958	1958	34.957	18.624	11.749	8.099	6.221	5.894	8.860	75.865	74.652	24.470	12.519	8.484	24.309
4	1959	1959	40.186	39.165	25.346	10.092	10.641	8.378	8.715	77.810	56.605	32.492	41.313	26.569	31.599
5	1960	1960	26.771	20.435	14.156	9.110	6.693	5.807	8.975	53.947	84.571	30.845	34.254	20.772	26.443
6	1961	1961	39.262	20.290	16.150	13.174	6.722	6.808	8.455	44.885	77.040	31.432	21.552	13.000	24.994
7	1962	1962	10.959	17.190	13.472	7.646	6.086	4.921	8.879	76.799	76.096	58.406	44.308	23.516	29.185
8	1963	1963	21.388	30.941	16.775	8.860	6.635	5.653	8.946	71.012	77.088	36.170	30.094	19.087	27.825
9	1964	1964	22.033	15.235	17.209	14.339	8.022	9.004	5.759	60.871	132.152	30.440	25.577	27.975	30.745
10	1965	1965	34.042	19.135	13.992	9.014	7.954	7.791	12.702	44.471	126.808	46.051	40.822	31.375	32.890
11	1966	1966	46.821	52.387	36.825	13.761	9.466	6.741	5.508	36.161	83.954	22.794	25.048	12.548	29.396
12	1967	1967	18.586	26.434	16.015	7.820	7.309	6.279	21.687	80.391	65.397	24.913	27.619	33.021	28.030
13	1968	1968	28.938	30.267	17.016	11.363	10.160	8.898	8.012	32.511	148.552	36.450	30.566	32.039	32.845
14	1969	1969	37.278	44.674	30.363	16.034	16.679	10.699	10.131	70.376	94.162	43.528	28.206	24.730	35.641
15	1970	1970	30.065	18.355	8.946	6.462	6.038	5.479	27.060	103.002	46.330	33.223	24.528	28.033	28.288
16	1971	1971	41.284	28.062	16.082	7.357	6.308	6.953	6.905	28.177	145.606	39.974	25.635	27.696	31.655
17	1972	1972	49.132	17.748	11.257	7.097	7.145	6.770	7.290	94.769	74.372	37.750	20.945	18.971	29.619
18	1973	1973	27.147	21.205	18.923	11.383	7.608	6.510	6.731	39.444	93.815	36.690	21.956	18.278	25.856
19	1974	1974	28.765	17.238	16.515	9.043	6.385	8.003	8.917	54.438	85.736	35.410	27.137	22.611	26.774
20	1975	1975	20.868	19.559	17.373	9.023	9.033	7.588	17.267	105.689	56.335	18.326	34.755	59.485	31.382
21	1976	1976	32.578	19.838	12.750	10.294	8.397	7.540	10.901	82.491	104.707	22.582	22.207	27.282	30.194
22	1977	1977	41.968	29.372	17.007	16.535	10.920	7.983	7.454	73.843	102.145	34.206	15.803	21.928	31.672
23	1978	1978	46.224	18.480	8.195	8.619	8.677	9.428	28.697	88.452	48.054	40.716	32.877	33.301	31.147
24	1979	1979	32.328	27.118	12.307	8.840	6.818	5.730	8.811	90.185	88.461	37.682	34.764	34.851	32.452
25	1980	1980	39.830	20.984	11.749	8.898	14.185	12.452	12.615	102.261	125.450	37.615	23.738	16.072	35.572
26	1981	1981	38.587	25.625	20.059	8.523	6.308	5.547	6.154	49.286	105.622	47.476	23.632	24.219	30.169
27	1982	1982	17.334	21.138	11.171	9.312	8.888	7.983	35.660	141.099	57.559	30.344	27.657	37.856	33.992
28	1983	1983	33.888	25.587	15.389	9.235	7.222	6.693	12.750	108.819	83.694	34.360	19.270	22.929	31.804
29	1984	1984	20.849	14.146	9.486	6.558	5.701	5.335	6.857	35.689	65.051	38.944	33.657	18.114	21.783
30	1985	1985	26.444	15.129	8.253	6.866	7.309	4.661	14.917	66.360	32.819	36.007	20.358	27.571	22.343
31	1986	1986	27.436	14.368	7.222	4.921	4.073	3.958	30.508	42.719	38.770	26.020	32.771	27.128	21.736
32	1987	1987	39.608	28.351	17.623	8.340	6.934	6.625	11.806	92.304	65.388	34.398	13.809	15.456	28.543
33	1988	1988	35.727	25.712	9.842	6.202	4.796	4.256	5.662	81.778	51.636	26.752	40.677	38.761	27.807
34	1989	1989	31.452	32.742	11.421	6.327	4.757	4.574	5.951	59.321	42.536	24.114	18.076	14.965	21.460
35	1990	1990	24.508	15.812	9.678	6.028	5.297	5.056	5.576	55.719	67.468	35.381	18.230	12.326	21.853
36	1991	1991	23.709	19.366	8.080	6.260	5.297	4.603	6.279	47.457	43.152	32.790	33.455	29.776	21.787
37	1992	1992	28.254	19.597	7.396	4.651	3.727	3.496	5.826	57.491	43.133	30.190	23.690	28.380	21.432
38	1993	1993	39.810	20.002	11.517	6.404	5.036	5.489	7.078	75.018	82.365	51.386	36.286	36.016	31.529
39	1994	1994	32.713	23.728	10.786	6.693	5.422	4.998	9.794	84.089	48.121	19.530	11.219	12.683	22.609
40	1995	1995	39.030	39.560	14.320	6.491	7.011	5.489	8.147	62.576	67.352	52.878	28.919	13.867	28.945
41	1996	1996	21.032	38.780	25.760	8.012	5.354	3.380	4.680	72.437	91.678	39.926	20.695	27.195	29.996
AVERAGE			31.415	24.168	14.886	9.002	7.516	6.881	11.463	68.821	78.960	35.169	27.048	25.457	28.498
MAXIMUM			49.132	52.387	36.825	17.209	16.679	22.602	35.660	141.099	148.552	58.406	44.308	59.485	35.865
MINIMUM			10.959	14.146	7.222	4.651	3.727	3.380	4.680	26.463	32.819	18.326	11.219	8.484	21.432

PERIOD AVERAGE CHANNEL FLOW (cms) : 3 Romaine Local Inflow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	160.190	109.391	92.260	50.621	37.832	37.475	35.571	163.462	696.082	305.034	141.750	113.793	162.134
2	1957	1957	187.196	128.604	106.298	106.298	91.367	139.609	168.578	464.392	433.817	246.383	230.917	348.636	221.537
3	1958	1958	215.927	115.042	72.570	50.026	38.427	36.404	54.725	468.615	461.120	151.149	77.329	52.405	150.157
4	1959	1959	248.227	241.921	156.562	62.339	65.730	51.751	53.833	480.631	349.647	200.699	255.186	164.116	195.187
5	1960	1960	165.366	126.225	87.441	56.272	41.341	35.869	55.439	333.229	522.388	190.527	211.585	128.307	163.335
6	1961	1961	242.516	125.333	99.755	81.374	41.520	42.055	52.227	277.255	475.872	194.156	133.125	80.303	154.389
7	1962	1962	67.693	106.179	83.218	47.230	37.594	30.396	54.844	474.385	470.043	360.770	273.686	145.260	180.277
8	1963	1963	132.114	191.122	103.621	54.725	40.984	34.917	55.261	438.635	476.169	223.422	185.887	117.897	171.874
9	1964	1964	136.099	94.104	106.298	88.572	49.550	55.618	35.571	375.998	816.299	188.029	157.990	172.801	189.911
10	1965	1965	210.276	118.195	86.430	55.677	49.134	48.123	78.459	274.697	783.285	284.452	252.153	193.799	203.161
11	1966	1966	289.211	323.593	227.467	85.003	58.473	41.639	34.025	223.362	518.581	140.799	154.718	77.508	181.580
12	1967	1967	114.804	163.284	98.922	48.301	45.148	38.784	133.958	496.572	403.956	153.885	170.600	203.971	173.143
13	1968	1968	178.749	186.958	105.108	70.191	62.756	54.963	49.491	200.818	917.600	225.147	188.802	197.903	202.885
14	1969	1969	230.263	275.946	187.553	99.041	103.026	66.087	62.577	434.709	581.635	268.868	174.229	152.755	220.152
15	1970	1970	185.709	113.377	55.261	39.914	37.296	33.846	167.150	636.241	286.178	205.220	151.506	173.158	174.736
16	1971	1971	255.008	173.336	99.338	45.446	38.962	42.947	42.650	174.050	899.398	246.918	158.346	171.076	195.530
17	1972	1972	303.487	109.629	69.537	43.840	44.137	41.817	45.029	585.382	459.395	233.177	129.378	117.183	182.954
18	1973	1973	167.685	130.984	116.886	70.310	46.992	40.211	41.579	243.646	579.493	226.634	135.624	112.901	159.713
19	1974	1974	177.679	106.476	102.015	55.855	39.438	49.431	55.082	336.263	529.586	218.723	167.626	139.668	165.381
20	1975	1975	128.902	120.812	107.309	55.737	55.796	46.873	106.655	652.837	347.981	113.198	214.678	367.433	193.847
21	1976	1976	201.234	122.537	78.757	63.588	51.870	46.576	67.336	509.540	646.770	139.490	137.170	168.518	186.505
22	1977	1977	259.231	181.426	105.049	102.134	67.455	49.312	46.041	456.123	630.947	211.287	97.613	135.445	195.638
23	1978	1978	285.523	114.150	50.621	53.238	53.595	58.235	177.262	546.361	296.825	251.498	203.078	205.696	192.394
24	1979	1979	199.688	167.507	76.021	54.606	42.115	35.393	54.428	557.068	546.420	232.761	214.737	215.273	200.456
25	1980	1980	246.026	129.616	72.570	54.963	87.620	76.913	77.924	631.661	774.898	232.345	146.628	99.279	219.724
26	1981	1981	238.352	158.287	123.905	52.643	38.962	34.263	38.010	304.439	652.421	293.256	145.974	149.602	186.352
27	1982	1982	107.071	130.567	69.001	57.521	54.904	49.312	220.269	871.560	355.536	187.434	170.838	233.832	209.968
28	1983	1983	209.324	158.049	95.055	57.045	44.613	41.341	78.757	672.169	516.975	212.239	119.027	141.631	196.449
29	1984	1984	128.783	87.382	58.592	40.509	35.215	32.954	42.353	220.448	401.814	240.553	207.897	111.889	134.551
30	1985	1985	163.343	93.449	50.978	42.412	45.148	28.790	92.141	409.904	202.721	222.411	125.749	170.303	138.010
31	1986	1986	169.470	88.750	44.613	30.396	25.162	24.448	188.445	263.871	239.483	160.726	202.424	167.566	134.264
32	1987	1987	244.658	175.121	108.856	51.513	42.828	40.925	72.927	570.154	403.896	212.477	85.300	95.472	176.307
33	1988	1988	220.686	158.822	60.793	38.308	29.623	26.292	34.977	505.138	318.953	165.247	251.260	239.423	171.765
34	1989	1989	194.275	202.246	70.548	39.081	29.385	28.255	36.761	366.421	262.741	148.948	111.651	92.438	132.556
35	1990	1990	151.387	97.673	59.781	37.237	32.716	31.229	34.441	344.174	416.745	218.544	112.603	76.140	134.985
36	1991	1991	146.450	119.622	49.907	38.665	32.716	28.433	38.784	293.137	266.548	202.543	206.647	183.925	134.580
37	1992	1992	174.526	121.050	45.684	28.731	23.020	21.593	35.988	355.119	266.429	186.482	146.331	175.299	132.384
38	1993	1993	245.907	123.548	71.143	39.557	31.110	33.906	43.721	463.380	508.767	317.407	224.136	222.470	194.753
39	1994	1994	202.067	146.569	66.622	41.341	33.489	30.872	60.495	519.414	297.242	120.634	69.299	78.340	139.657
40	1995	1995	241.089	244.360	88.453	40.092	43.304	33.906	50.323	386.527	416.031	326.627	178.630	85.657	178.791
41	1996	1996	129.913	239.542	159.120	49.491	33.073	20.879	28.909	447.439	566.288	246.621	127.831	167.983	185.282
AVERAGE			194.051	149.287	91.949	55.606	46.425	42.503	70.805	425.103	487.731	217.237	167.072	157.245	176.031
MAXIMUM			303.487	323.593	227.467	106.298	103.026	139.609	220.269	871.560	917.600	360.770	273.686	367.433	221.537
MINIMUM			67.693	87.382	44.613	28.731	23.020	20.879	28.909	163.462	202.721	113.198	69.299	52.405	132.384

Appendix C
Storage Curves

E M M A G A S I N E M E N T   A   O s s o k m a n u a n

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
471.8				0.00	0.00	0.00	0.00	0.00	0.00	0.00
471.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
472.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
473.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
474.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
475.0	0.00	0.00	0.00	0.00	2.34	7.89	13.45	19.02	24.61	30.22
475.1	35.84	41.48	47.13	52.80	58.48	64.18	69.89	75.61	81.35	87.10
475.2	92.87	98.65	104.44	110.24	116.06	121.89	127.60	133.45	139.32	145.20
475.3	151.10	157.00	162.92	168.85	174.79	180.74	186.70	192.68	198.66	204.66
475.4	210.67	216.68	222.71	228.75	234.80	240.86	246.93	253.00	259.09	265.19
475.5	271.30	277.26	283.39	289.52	295.67	301.82	307.98	314.15	320.32	326.51
475.6	332.70	338.91	345.12	351.34	357.56	363.80	370.04	376.28	382.54	388.80
475.7	395.07	401.35	407.63	413.93	420.22	426.53	432.68	439.00	445.32	451.65
475.8	457.99	464.33	470.68	477.03	483.39	489.75	496.12	502.50	508.88	515.26
475.9	521.66	528.05	534.45	540.86	547.27	553.69	560.11	566.53	572.96	579.39

E M M A G A S I N E M E N T   A   O s s o k m a n u a n

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
476.0	585.83	592.12	598.56	605.02	611.47	617.93	624.39	630.86	637.33	643.80
476.1	650.28	656.76	663.25	669.73	676.23	682.72	689.22	695.72	702.23	708.73
476.2	715.24	721.76	728.27	734.79	741.32	747.84	754.21	760.74	767.27	773.81
476.3	780.35	786.89	793.43	799.97	806.52	813.07	819.62	826.18	832.73	839.29
476.4	845.85	852.41	858.98	865.55	872.11	878.68	885.26	891.83	898.41	904.98
476.5	911.56	917.98	924.57	931.15	937.74	944.33	950.92	957.51	964.10	970.69
476.6	977.29	983.89	990.49	997.09	1003.69	1010.29	1016.90	1023.50	1030.11	1036.72
476.7	1043.33	1049.94	1056.55	1063.17	1069.78	1076.40	1082.86	1089.48	1096.10	1102.72
476.8	1109.35	1115.97	1122.60	1129.23	1135.86	1142.49	1149.12	1155.76	1162.39	1169.03
476.9	1175.67	1182.31	1188.95	1195.59	1202.23	1208.88	1215.53	1222.18	1228.83	1235.48
477.0	1242.13	1248.63	1255.29	1261.94	1268.60	1275.27	1281.93	1288.60	1295.27	1301.93
477.1	1308.61	1315.28	1321.95	1328.63	1335.31	1341.99	1348.68	1355.36	1362.05	1368.74
477.2	1375.43	1382.13	1388.82	1395.52	1402.23	1408.93	1415.47	1422.18	1428.89	1435.61
477.3	1442.33	1449.05	1455.77	1462.50	1469.23	1475.96	1482.69	1489.43	1496.17	1502.92
477.4	1509.67	1516.42	1523.17	1529.93	1536.69	1543.46	1550.22	1557.00	1563.78	1570.56
477.5	1577.34	1583.96	1590.76	1597.55	1604.35	1611.16	1617.97	1624.78	1631.60	1638.42
477.6	1645.25	1652.09	1658.92	1665.76	1672.61	1679.47	1686.32	1693.19	1700.06	1706.93
477.7	1713.81	1720.70	1727.59	1734.49	1741.39	1748.30	1755.05	1761.97	1768.89	1775.83
477.8	1782.77	1789.72	1796.67	1803.63	1810.60	1817.58	1824.56	1831.55	1838.55	1845.55
477.9	1852.56	1859.58	1866.61	1873.65	1880.69	1887.74	1894.80	1901.87	1908.95	1916.03
478.0	1923.13	1930.06	1937.17	1944.29	1951.42	1958.56	1965.71	1972.87	1980.04	1987.22
478.1	1994.40	2001.60	2008.81	2016.03	2023.26	2030.50	2037.75	2045.02	2052.29	2059.57
478.2	2066.87	2074.18	2081.50	2088.83	2096.17	2103.53	2110.71	2118.09	2125.49	2132.89
478.3	2140.31	2147.74	2155.18	2162.64	2170.11	2177.59	2185.09	2192.60	2200.13	2207.67
478.4	2215.22	2222.79	2230.37	2237.97	2245.59	2253.21	2260.86	2268.52	2276.19	2283.88
478.5	2291.59	2299.13	2306.86	2314.62	2322.39	2330.18	2337.99	2345.81	2353.65	2361.51
478.6	2369.39	2377.28	2385.19	2393.12	2401.07	2409.04	2417.03	2425.03	2433.06	2441.10
478.7	2449.17	2457.25	2465.35	2473.48	2481.62	2489.79	2497.77	2505.98	2514.21	2522.46
478.8	2530.73	2539.02	2547.33	2555.67	2564.03	2572.41	2580.81	2589.24	2597.69	2606.16
478.9	2614.66	2623.18	2631.73	2640.30	2648.89	2657.51	2666.15	2674.82	2683.51	2692.23
479.0	2700.98	2709.54	2718.33	2727.15	2736.00	2744.88	2753.78	2762.72	2771.67	2780.66
479.1	2789.67	2798.72	2807.79	2816.89	2826.01	2835.17	2844.36	2853.57	2862.82	2872.10
479.2	2881.41	2890.74	2900.11	2909.51	2918.94	2928.40	2937.66	2947.19	2956.75	2966.34
479.3	2975.96	2985.62	2995.30	3005.03	3014.78	3024.58	3034.40	3044.26	3054.15	3064.08
479.4	3074.05	3084.05	3094.08	3104.16	3114.26	3124.41	3134.59	3144.81	3155.06	3165.36
479.5	3175.69	3185.81	3196.21	3206.66	3217.15	3227.67	3238.24	3248.84	3259.48	3270.17
479.6	3280.89	3291.66	3302.47	3313.32	3324.21	3335.14	3346.12	3357.13	3368.19	3379.30
479.7	3390.45	3401.64	3412.87	3424.15	3435.48	3446.85	3457.98	3469.44	3480.95	3492.50
479.8	3504.10	3515.74	3527.44	3539.17	3550.96	3562.79	3574.68	3586.61	3598.59	3610.62
479.9	3622.70	3634.83	3647.01	3659.23	3671.52	3683.85	3696.23	3708.66	3721.15	3733.69

E M M A G A S I N E M E N T A S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
463.9	-98.51	-92.38	-86.24	-80.08	-73.91	-67.72	-61.52	-55.30	-49.07	-42.82
464.0	-36.56	-30.44	-24.15	-17.84	-11.52	-5.19	1.15	7.52	13.90	20.29
464.1	26.70	33.12	39.56	46.02	52.48	58.97	65.46	71.98	78.50	85.05
464.2	91.60	98.17	104.76	111.36	117.98	124.61	131.09	137.75	144.43	151.12
464.3	157.82	164.54	171.27	178.02	184.79	191.56	198.36	205.16	211.99	218.82
464.4	225.60	232.54	239.43	246.32	253.23	260.16	267.10	274.06	281.03	288.01
464.5	295.01	301.85	308.88	315.93	322.99	330.06	337.15	344.25	351.37	358.50
464.6	365.65	372.81	379.99	387.10	394.39	401.61	408.84	416.10	423.36	430.64
464.7	437.94	445.25	452.57	459.91	467.27	474.63	481.04	489.24	496.65	504.08
464.8	511.52	518.98	526.45	533.94	541.44	548.95	556.48	564.03	571.59	579.17
464.9	586.76	594.36	601.98	609.62	617.27	624.93	632.61	640.30	648.01	655.73
465.0	663.47	671.03	678.80	686.58	694.38	702.19	710.02	717.86	725.71	733.58
465.1	741.47	749.37	757.28	765.21	773.16	781.12	789.09	797.08	805.08	813.10
465.2	821.13	829.18	837.24	845.32	853.41	861.52	869.44	877.58	885.73	893.89
465.3	902.07	910.27	918.48	926.70	934.94	943.19	951.46	959.75	968.04	976.36
465.4	984.68	993.03	1001.38	1009.75	1018.14	1026.54	1034.96	1043.39	1051.83	1060.29
465.5	1068.77	1077.05	1085.55	1094.08	1102.61	1111.16	1119.72	1128.30	1136.89	1145.50
465.6	1154.12	1162.76	1171.41	1180.07	1188.76	1197.45	1206.16	1214.89	1223.63	1232.38
465.7	1241.15	1249.93	1258.73	1267.55	1276.38	1285.22	1293.86	1302.73	1311.62	1320.52
465.8	1329.44	1338.37	1347.32	1356.28	1365.25	1374.24	1383.25	1392.27	1401.30	1410.35
465.9	1419.42	1428.49	1437.59	1446.70	1455.82	1464.96	1474.11	1483.28	1492.46	1501.65
466.0	1510.87	1519.87	1529.11	1538.36	1547.63	1556.92	1566.22	1575.53	1584.86	1594.20
466.1	1603.56	1612.93	1622.32	1631.72	1641.14	1650.57	1660.02	1669.48	1678.96	1688.45
466.2	1697.95	1707.47	1717.01	1726.56	1736.12	1745.70	1755.06	1764.67	1774.29	1783.93
466.3	1793.58	1803.25	1812.93	1822.63	1832.34	1842.07	1851.81	1861.56	1871.33	1881.12
466.4	1890.92	1900.73	1910.56	1920.40	1930.26	1940.13	1950.02	1959.93	1969.84	1979.77
466.5	1989.72	1999.44	2009.42	2019.41	2029.41	2039.43	2049.47	2059.52	2069.58	2079.66
466.6	2089.75	2099.86	2109.98	2120.12	2130.27	2140.44	2150.62	2160.82	2171.03	2181.26
466.7	2191.50	2201.75	2212.02	2222.31	2232.61	2242.92	2253.00	2263.34	2273.70	2284.07
466.8	2294.46	2304.86	2315.28	2325.71	2336.15	2346.62	2357.09	2367.58	2378.09	2388.61
466.9	2399.14	2409.69	2420.25	2430.83	2441.43	2452.03	2462.66	2473.29	2483.95	2494.61
467.0	2505.29	2515.73	2526.44	2537.17	2547.91	2558.66	2569.43	2580.21	2591.01	2601.83
467.1	2612.65	2633.78	2670.59	2707.46	2744.37	2781.35	2818.38	2855.47	2892.61	2929.80
467.2	2967.05	3004.35	3041.71	3079.12	3116.58	3154.10	3190.75	3228.38	3266.05	3303.78
467.3	3341.56	3379.39	3417.28	3455.22	3493.21	3531.25	3569.34	3607.48	3645.68	3683.92
467.4	3722.22	3760.56	3798.96	3837.41	3875.90	3914.45	3953.05	3991.69	4030.39	4069.13
467.5	4107.92	4145.82	4184.71	4223.64	4262.63	4301.66	4340.74	4379.87	4419.05	4458.27
467.6	4497.54	4536.86	4576.22	4615.64	4655.09	4694.59	4734.14	4773.74	4813.38	4853.06
467.7	4892.80	4932.57	4972.39	5012.26	5052.17	5092.12	5131.14	5171.19	5211.27	5251.40
467.8	5291.57	5331.79	5372.05	5412.35	5452.69	5493.08	5533.51	5573.98	5614.50	5655.05
467.9	5695.64	5736.28	5776.96	5817.68	5858.44	5899.25	5940.09	5980.97	6021.89	6062.86

E M M A G A S I N E M E N T   A   S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
468.0	6103.86	6143.90	6184.98	6226.10	6267.26	6308.46	6349.69	6390.97	6432.29	6473.64
468.1	6515.03	6556.46	6597.92	6639.42	6680.96	6722.54	6764.15	6805.80	6847.49	6889.21
468.2	6930.97	6972.77	7014.60	7056.46	7098.37	7140.30	7181.25	7223.26	7265.30	7307.37
468.3	7349.49	7391.63	7433.81	7476.02	7518.27	7560.55	7602.86	7645.20	7687.58	7729.99
468.4	7772.44	7814.91	7857.42	7899.96	7942.53	7985.13	8027.77	8070.43	8113.13	8155.86
468.5	8198.62	8240.36	8283.18	8326.03	8368.91	8411.82	8454.75	8497.72	8540.72	8583.75
468.6	8626.80	8669.88	8712.99	8756.14	8799.40	8842.50	8885.72	8928.98	8972.25	9015.56
468.7	9058.89	9102.25	9145.64	9189.05	9232.50	9275.96	9318.39	9361.91	9405.45	9449.02
468.8	9492.61	9536.23	9579.87	9623.54	9667.23	9710.95	9754.69	9798.46	9842.25	9886.06
468.9	9929.89	9973.75	10017.64	10061.54	10105.47	10149.42	10193.39	10237.39	10281.40	10325.44
469.0	10369.50	10412.51	10456.61	10500.73	10544.88	10589.04	10633.23	10677.43	10721.66	10765.91
469.1	10810.17	10854.46	10898.76	10943.08	10987.42	11031.79	11076.17	11120.57	11164.98	11209.42
469.2	11253.87	11298.34	11342.83	11387.34	11431.86	11476.41	11519.87	11564.45	11609.04	11653.64
469.3	11698.27	11742.91	11787.56	11832.23	11876.92	11921.62	11966.33	12011.07	12055.81	12100.57
469.4	12145.34	12190.13	12234.93	12279.75	12324.58	12369.42	12414.28	12459.15	12504.03	12548.92
469.5	12593.83	12637.66	12682.59	12727.53	12772.49	12817.46	12862.43	12907.42	12952.42	12997.44
469.6	13042.46	13087.49	13132.53	13177.58	13222.65	13267.72	13312.80	13357.90	13403.00	13448.11
469.7	13493.23	13538.36	13583.50	13628.64	13673.79	13718.95	·13763.02	13808.19	13853.38	13898.57
469.8	13943.76	13988.97	14034.18	14079.40	14124.62	14169.85	14215.09	14260.33	14305,58	14350.83
469.9	14396.09	14441.36	14486.62	14531.90	14577.17	14622.46	14667.75	14713.03	14758.33	14803.62
470.0	14848.92	14897.14	14942.77	14988.44	15034.14	15079.90	15125.69	15171.53	15217.41	15263.33
470.1	15309.30	15355.31	15401.35	15447.45	15493.58	15539.75	15585.97	15632.23	15678.53	15724.87
470.2	15771.25	15817.67	15864.13	15910.63	15957.18	16003.74	16049.22	16095.88	16142.59	16189.31
470.3	16236.11	16282.96	16329.80	16376.71	16423.66	16470.64	16517.65	16564.73	16611.83	16658.96
470.4	16706.14	16753.37	16800.64	16847.93	16895.28	16942.66	16990.07	17037.52	17084.99	17132.55
470.5	17180.13	17226.56	17274.23	17321.90	17369.63	17417.37	17465.21	17513.04	17560.91	17608.84
470.6	17656.78	17704.77	17752.82	17800.87	17849.00	17897.14	17945.32	17993.56	18041.82	18090.12
470.7	18138.46	18186.83	18235.26	18283.72	18332.19	18380.73	18428.13	18476.73	18525.37	18574.06
470.8	18622.78	18671.54	18720.33	18769.18	18818.07	18866.97	18915.94	18964.92	19013.94	19063.00
470.9	19112.10	19161.27	19210.48	19259.67	19308.94	19358.26	19407.59	19456.97	19506.39	19555.84
471.0	19605.34	19653.67	19703.26	19752.87	19802.52	19852.20	19901.96	19951.72	20001.52	20051.37
471.1	20101.28	20151.21	20201.18	20251.20	20301.25	20351.36	20401.47	20451.67	20501.87	20552.12
471.2	20602.41	20652.78	20703.14	20753.55	20804.01	20854.53	20903.83	20954.42	21005.05	21055.72
471.3	21106.43	21157.18	21207.98	21258.82	21309.69	21360.61	21411.57	21462.58	21513.62	21564.73
471.4	21615.87	21667.05	21718.27	21769.53	21820.86	21872.21	21923.60	21975.03	22026.53	22078.06
471.5	22129.65	22180.02	22231.69	22283.38	22335.16	22386.94	22438.81	22490.71	22542.64	22594.63
471.6	22646.68	22698.74	22750.87	22803.07	22855.27	22907.53	22959.85	23012.23	23064.65	23117.12
471.7	23169.63	23222.18	23274.81	23327.45	23380.16	23432.92	23484.43	23537.29	23590.21	23643.17
471.8	23696.16	23749.22	23802.35	23855.50	23908.70	23961.99	24015.29	24068.60	24122.08	24175.58
471.9	24229.09	24282.67	24336.30	24390.01	24443.75	24497.54	24551.39	24605.31	24659.27	24713.28
472.0	24767.33	24820.16	24874.34	24928.58	24982.91	25037.25	25091.66	25146.13	25200.65	25255.25
472.1	25309.89	25364.59	25419.37	25474.18	25529.05	25584.00	25639.00	25694.06	25749.17	25804.36
472.2	25859.63	25914.93	25970.30	26025.71	26081.22	26136.79	26191.04	26246.75	26302.49	26358.30
472.3	26414.17	26470.12	26526.12	26582.19	26638.32	26694.55	26750.82	26807.16	26863.55	26920.04
472.4	26976.59	27033.19	27089.89	27146.62	27203.44	27260.33	27317.29	27374.34	27431.42	27488.60
472.5	27545.87	27601.77	27659.16	27716.61	27774.15	27831.75	27889.43	27947.20	28005.05	28062.94
472.6	28120.91	28178.98	28237.12	28295.32	28353.62	28411.98	28470.44	28528.94	28587.54	28646.24
472.7	28705.00	28763.83	28822.75	28881.77	28940.84	29000.00	29057.83	29117.14	29176.56	29236.05
472.8	29295.62	29355.30	29415.04	29474.88	29534.79	29594.78	29654.89	29715.07	29775.34	29835.69
472.9	29896.13	29956.66	30017.30	30078.00	30138.81	30199.67	30260.68	30321.76	30382.92	30444.17

E M M A G A S I N E M E N T   A   S m a l l w o o d

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
473.0	30505.53	30565.47	30627.01	30688.64	30750.38					

E M M A G A S I N E M E N T A B i e f a m o n t o u e s t

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
445.0		1.34	1.43	1.52	1.61	1.70	1.80	1.89	1.98	2.08
445.1	2.17	2.27	2.36	2.46	2.56	2.66	2.76	2.86	2.96	3.06
445.2	3.16	3.26	3.37	3.47	3.57	3.68	3.78	3.89	4.00	4.10
445.3	4.21	4.32	4.43	4.54	4.65	4.77	4.88	4.99	5.11	5.22
445.4	5.34	5.45	5.57	5.69	5.80	5.92	6.04	6.16	6.28	6.40
445.5	6.52	6.64	6.76	6.89	7.01	7.14	7.26	7.39	7.51	7.64
445.6	7.77	7.90	8.03	8.16	8.29	8.42	8.55	8.68	8.81	8.95
445.7	9.08	9.21	9.35	9.48	9.62	9.76	9.89	10.03	10.17	10.31
445.8	10.45	10.59	10.73	10.87	11.01	11.15	11.30	11.44	11.58	11.73
445.9	11.87	12.02	12.17	12.31	12.46	12.61	12.76	12.91	13.06	13.21
446.0	13.36	13.51	13.66	13.81	13.96	14.12	14.27	14.43	14.58	14.74
446.1	14.89	15.05	15.21	15.37	15.53	15.69	15.85	16.01	16.17	16.33
446.2	16.49	16.65	16.81	16.98	17.14	17.31	17.47	17.63	17.80	17.97
446.3	18.13	18.30	18.47	18.64	18.81	18.98	19.15	19.32	19.49	19.66
446.4	19.83	20.01	20.18	20.35	20.53	20.70	20.88	21.06	21.23	21.41
446.5	21.59	21.76	21.94	22.12	22.30	22.48	22.66	22.84	23.02	23.20
446.6	23.39	23.57	23.75	23.94	24.12	24.31	24.49	24.68	24.87	25.06
446.7	25.24	25.43	25.62	25.81	26.00	26.19	26.38	26.57	26.76	26.95
446.8	27.15	27.34	27.53	27.73	27.92	28.12	28.31	28.51	28.71	28.90
446.9	29.10	29.30	29.50	29.70	29.90	30.10	30.30	30.50	30.70	30.91
447.0	31.11	31.31	31.51	31.72	31.92	32.13	32.33	32.54	32.75	32.96
447.1	33.16	33.37	33.58	33.79	34.00	34.21	34.42	34.63	34.85	35.06
447.2	35.27	35.49	35.70	35.92	36.13	36.35	36.56	36.77	36.99	37.21
447.3	37.43	37.65	37.87	38.09	38.31	38.53	38.75	38.97	39.19	39.42
447.4	39.64	39.86	40.09	40.31	40.54	40.77	40.99	41.22	41.45	41.68
447.5	41.90	42.13	42.36	42.59	42.82	43.05	43.28	43.51	43.75	43.98
447.6	44.22	44.45	44.69	44.92	45.16	45.39	45.63	45.87	46.11	46.35
447.7	46.59	46.83	47.07	47.31	47.55	47.79	48.03	48.27	48.52	48.76
447.8	49.01	49.25	49.50	49.74	49.99	50.24	50.49	50.74	50.99	51.24
447.9	51.49	51.74	51.99	52.24	52.49	52.75	53.00	53.26	53.51	53.77
448.0	54.02	54.27	54.53	54.79	55.05	55.31	55.57	55.83	56.09	56.35
448.1	56.61	56.88	57.14	57.40	57.67	57.93	58.20	58.47	58.73	59.00
448.2	59.27	59.54	59.81	60.08	60.35	60.62	60.89	61.16	61.43	61.70
448.3	61.98	62.25	62.53	62.81	63.08	63.36	63.64	63.92	64.20	64.48
448.4	64.76	65.04	65.32	65.61	65.89	66.17	66.46	66.74	67.03	67.32
448.5	67.60	67.88	68.17	68.46	68.75	69.04	69.33	69.63	69.92	70.21
448.6	70.51	70.80	71.10	71.39	71.69	71.99	72.29	72.58	72.88	73.18
448.7	73.49	73.79	74.09	74.39	74.70	75.00	75.30	75.61	75.91	76.22
448.8	76.53	76.84	77.15	77.46	77.77	78.08	78.39	78.71	79.02	79.34
448.9	79.65	79.97	80.28	80.60	80.92	81.24	81.56	81.88	82.20	82.53
449.0	82.85	83.17	83.49	83.82	84.14	84.47	84.80	85.13	85.46	85.79
449.1	86.12	86.45	86.78	87.12	87.45	87.79	88.12	88.46	88.80	89.14
449.2	89.48	89.82	90.16	90.50	90.84	91.18	91.52	91.87	92.21	92.56
449.3	92.91	93.26	93.61	93.96	94.31	94.66	95.01	95.37	95.72	96.08
449.4	96.43	96.79	97.15	97.51	97.87	98.23	98.59	98.96	99.32	99.69
449.5	100.05	100.41	100.78	101.14	101.51	101.88	102.26	102.63	103.00	103.38
449.6	103.75	104.13	104.50	104.88	105.26	105.64	106.02	106.40	106.79	107.17
449.7	107.56	107.94	108.33	108.72	109.11	109.50	109.88	110.27	110.66	111.06
449.8	111.45	111.85	112.24	112.64	113.04	113.44	113.84	114.24	114.65	115.05
449.9	115.46	115.86	116.27	116.68	117.09	117.50	117.91	118.33	118.74	119.15

E M M A G A S I N E M E N T A B i e f a m o n t o u e s t

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
450.0	119.57	119.98	120.40	120.82	121.24	121.66	122.08	122.51	122.93	123.36
450.1	123.78	124.21	124.64	125.07	125.51	125.94	126.37	126.81	127.24	127.68
450.2	128.12	128.56	129.00	129.45	129.89	130.33	130.77	131.22	131.67	132.12
450.3	132.57	133.02	133.47	133.93	134.38	134.84	135.30	135.76	136.22	136.68
450.4	137.14	137.61	138.08	138.54	139.01	139.48	139.95	140.42	140.90	141.37
450.5	141.85	142.32	142.79	143.27	143.76	144.24	144.72	145.21	145.70	146.18
450.6	146.67	147.16	147.66	148.15	148.65	149.14	149.64	150.14	150.64	151.14
450.7	151.64	152.15	152.66	153.16	153.67	154.18	154.68	155.20	155.71	156.23
450.8	156.74	157.26	157.78	158.31	158.83	159.35	159.88	160.41	160.94	161.47
450.9	162.00	162.53	163.07	163.61	164.14	164.68	165.23	165.77	166.31	166.86
451.0	167.41	167.94	168.49	169.04	169.60	170.15	170.71	171.27	171.83	172.39
451.1	172.95	173.52	174.09	174.65	175.22	175.79	176.37	176.94	177.52	178.10
451.2	178.67	179.26	179.84	180.42	181.01	181.60	182.17	182.76	183.36	183.95
451.3	184.55	185.14	185.74	186.35	186.95	187.55	188.16	188.77	189.38	189.99
451.4	190.60	191.22	191.84	192.45	193.07	193.70	194.32	194.95	195.58	196.20
451.5	196.84	197.45	198.09	198.73	199.36	200.00	200.65	201.29	201.94	202.59
451.6	203.24	203.89	204.54	205.20	205.85	206.51	207.17	207.84	208.50	209.17
451.7	209.84	210.51	211.18	211.86	212.53	213.21	213.87	214.56	215.24	215.93
451.8	216.62	217.31	218.00	218.69	219.39	220.09	220.79	221.49	222.20	222.90
451.9	223.61	224.32	225.03	225.75	226.47	227.19	227.91	228.63	229.35	230.08
452.0	230.81	231.53	232.26	233.00	233.73	234.47	235.22	235.96	236.71	237.46
452.1	238.21	238.96	239.71	240.47	241.23	241.99	242.76	243.52	244.29	245.06
452.2	245.84	246.61	247.39	248.17	248.95	249.74	250.50	251.29	252.08	252.88
452.3	253.67	254.47	255.27	256.07	256.88	257.69	258.50	259.31	260.12	260.94
452.4	261.76	262.58	263.40	264.23	265.06	265.89	266.72	267.56	268.40	269.24
452.5	270.08	270.91	271.76	272.61	273.46	274.32	275.17	276.03	276.90	277.76
452.6	278.63	279.50	280.37	281.25	282.13	283.01	283.89	284.78	285.67	286.56
452.7	287.45	288.35	289.25	290.15	291.05	291.96	292.85	293.76	294.67	295.59
452.8	296.51	297.43	298.36	299.29	300.22	301.15	302.09	303.02	303.97	304.91
452.9	305.86	306.81	307.76	308.71	309.67	310.63	311.60	312.56	313.53	314.50

E M M A G A S I N E M E N T A B . - e s t , C h u r c h . F a l l s

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
443.7									-1.34	-0.35
443.8	0.63	1.62	2.61	3.60	4.60	5.59	6.59	7.58	8.58	9.57
443.9	10.57	11.57	12.57	13.57	14.57	15.57	16.58	17.58	18.59	19.59
444.0	20.60	21.58	22.59	23.60	24.60	25.61	26.63	27.64	28.65	29.66
444.1	30.68	31.69	32.71	33.72	34.74	35.76	36.78	37.80	38.82	39.84
444.2	40.86	41.88	42.91	43.93	44.96	45.98	46.98	48.01	49.04	50.07
444.3	51.10	52.13	53.16	54.19	55.23	56.26	57.29	58.33	59.37	60.40
444.4	61.44	62.48	63.52	64.56	65.60	66.64	67.68	68.73	69.77	70.82
444.5	71.86	72.88	73.93	74.98	76.03	77.08	78.13	79.18	80.23	81.28
444.6	82.34	83.39	84.45	85.50	86.56	87.62	88.68	89.74	90.80	91.86
444.7	92.92	93.98	95.04	96.11	97.17	98.24	99.28	100.35	101.41	102.48
444.8	103.55	104.62	105.69	106.77	107.84	108.91	109.99	111.06	112.14	113.22
444.9	114.29	115.37	116.45	117.53	118.61	119.69	120.77	121.86	122.94	124.03
445.0	125.11	126.17	127.26	128.35	129.44	130.53	131.62	132.71	133.80	134.89
445.1	135.98	137.08	138.17	139.27	140.37	141.46	142.56	143.66	144.76	145.86
445.2	146.96	148.06	149.17	150.27	151.38	152.48	153.56	154.67	155.78	156.88
445.3	157.99	159.10	160.21	161.33	162.44	163.55	164.67	165.78	166.90	168.01
445.4	169.13	170.25	171.37	172.49	173.61	174.73	175.85	176.97	178.10	179.22
445.5	180.35	181.45	182.57	183.70	184.83	185.96	187.09	188.22	189.35	190.48
445.6	191.62	192.75	193.89	195.02	196.16	197.29	198.43	199.57	200.71	201.85
445.7	202.99	204.13	205.28	206.42	207.56	208.71	209.83	210.97	212.12	213.27
445.8	214.42	215.57	216.72	217.87	219.02	220.18	221.33	222.49	223.64	224.80
445.9	225.95	227.11	228.27	229.43	230.59	231.75	232.91	234.08	235.24	236.40
446.0	237.57	238.71	239.87	241.04	242.21	243.38	244.55	245.72	246.89	248.06
446.1	249.23	250.41	251.58	252.76	253.93	255.11	256.29	257.47	258.65	259.83
446.2	261.01	262.19	263.37	264.55	265.74	266.92	268.08	269.27	270.45	271.64
446.3	272.83	274.02	275.21	276.40	277.59	278.79	279.98	281.17	282.37	283.57
446.4	284.76	285.96	287.16	288.36	289.56	290.76	291.96	293.16	294.37	295.57
446.5	296.77	297.95	299.16	300.36	301.57	302.78	303.99	305.20	306.41	307.62
446.6	308.84	310.05	311.26	312.48	313.69	314.91	316.13	317.35	318.57	319.79
446.7	321.01	322.23	323.45	324.67	325.90	327.12	328.32	329.54	330.77	332.00
446.8	333.23	334.46	335.69	336.92	338.15	339.38	340.62	341.85	343.08	344.32
446.9	345.56	346.79	348.03	349.27	350.51	351.75	352.99	354.23	355.48	356.72
447.0	357.97	359.18	360.43	361.67	362.92	364.17	365.42	366.67	367.92	369.17
447.1	370.42	371.68	372.93	374.19	375.44	376.70	377.96	379.21	380.47	381.73
447.2	382.99	384.25	385.52	386.78	388.04	389.31	390.54	391.81	393.07	394.34
447.3	395.61	396.88	398.15	399.42	400.69	401.96	403.24	404.51	405.78	407.06
447.4	408.34	409.61	410.89	412.17	413.45	414.73	416.01	417.29	418.57	419.86
447.5	421.14	422.40	423.68	424.97	426.26	427.54	428.83	430.12	431.41	432.70
447.6	434.00	435.29	436.58	437.88	439.17	440.47	441.77	443.06	444.36	445.66
447.7	446.96	448.26	449.57	450.87	452.17	453.48	454.75	456.05	457.36	458.67
447.8	459.98	461.28	462.59	463.90	465.22	466.53	467.84	469.15	470.47	471.78
447.9	473.10	474.42	475.73	477.05	478.37	479.69	481.01	482.33	483.66	484.98

E M M A G A S I N E M E N T A B . - e s t , C h u r c h . F a l l s

VOLUME EN MILLIONS DE METRES CUBES EN FONCTION DU NIVEAU EN METRES

NIVEAU	0	1	2	3	4	5	6	7	8	9
448.0	486.30	487.60	488.92	490.25	491.58	492.90	494.23	495.56	496.89	498.22
448.1	499.56	500.89	502.22	503.56	504.89	506.23	507.56	508.90	510.24	511.58
448.2	512.92	514.26	515.60	516.94	518.29	519.63	520.94	522.29	523.63	524.98
448.3	526.33	527.68	529.03	530.38	531.73	533.08	534.43	535.79	537.14	538.49
448.4	539.85	541.21	542.56	543.92	545.28	546.64	548.00	549.36	550.72	552.09
448.5	553.45	554.78	556.15	557.51	558.88	560.25	561.62	562.99	564.36	565.73
448.6	567.10	568.47	569.84	571.22	572.59	573.97	575.35	576.72	578.10	579.48
448.7	580.86	582.24	583.62	585.00	586.39	587.77	589.12	590.51	591.89	593.28
448.8	594.67	596.05	597.44	598.83	600.22	601.62	603.01	604.40	605.79	607.19
448.9	608.59	609.98	611.38	612.78	614.18	615.57	616.97	618.38	619.78	621.18

Appendix D
Power Plant Characteristics CF1 and CF2
(Preliminary Characteristics)

Refer to Table 6.1 and Appendix I for final characteristics.

RSW - EDM Joint Venture

500 René-Lévesque Blvd. West, Suite 600, Montréal, Québec, Canada H2Z 1W7

Fax Transmittal

To:	R. Besaw. P. Eng.	**Date:**	July 30, 1998
Co.:	CF(L)Co	**Fax No.:**	(709) 737-1800
From:	D.M. Coulson, Eng.	**O/Ref.:**	P16 1569.E29
Project:	Churchill Falls Powerplant Extension (CF2)		
Subject:	Head Losses and Unit Characteristics for Energy Studies		
N^br of Pages:	(8) (including this one)	**Copy:**	J. Levay (H-Q) B. Chaulk (RSW-EDM) Thach Tran Van (H-Q) S. Richter (Acres) C. P. Tran (RSW-EDM) C. Chartrand (RSW-EDM) A. Leroux (RSW-EDM)

Message :

Dear Bob,

We present, herein, preliminary data on head losses and unit characteristics for each of the agreed alternatives. The values given are preliminary, but should be sufficiently precise to give a meaningful comparison and a well founded selection of number and size of units for CF2.

1.0 HEAD LOSSES

a) Head losses are calculated for 4 alternatives :

- one unit at 500 MW ;
- two units at 500 MW ;
- two units at 550 MW ;
- three units at 500 MW ;

b) It is assumed that the water passage dimensions will give the same flow velocities in the penstock and in the tailrace tunnels of each alternative. For the head loss calculations, the nominal discharges of the units are taken from Hydro-Québec's memo dated 98-07-20. (These are slightly high as outlined below);

c) The water passage dimensions for the base alternative of 2 units at 550 MW are identical to those from alternative B-1 of the RSW 1988-89 report ;

...2

Mr. R. Besaw, P. Eng. *July 30, 1998*
CF(L)Co

d) The water passage dimensions and head losses for CF2 at the above mentioned nominal discharges are given in the following table :

		ALTERNATIVES			
		1 X 500 MW	2 X 500 MW	2 x 550 MW	3 x 500 MW
Nominal Discharge	(m^3/s)	1 x 177	2 x 177	2 x 194,5	3 x 177
Concrete Lined Penstock Dia.	(m)	6,20	6,20	6,50	6,20
Steel Lined Penstock Dia.	(m)	5,06	5,06	5,30	5,06
Tailrace Tunnel Height	(m)	12,1	17,0	18,0	21,0
Tailrace Tunnel Width	(m)	9,2	13,0	13,7	16,0
Tailrace Tunnel Sect.	(m^2)	103,4	205,2	229,0	312,0
Units Upstream Losses	(m)	2,60	2,60	2,51	2,60
Units Downstream Losses	(m)	1,78	1,25	1,13	0,97
Total Losses	(m)	4,38	3,85	3,64	3,57

e) The losses upstream of the turbines include intake losses, penstock friction losses, bend losses and the convergence loss between the concrete lined and steel lined sections of the penstock ;

f) The losses downstream of the units include the surge chamber loss, tailrace tunnel friction loss and tailrace tunnel inlet and outlet losses.

Note that the upstream losses vary as the square of the discharge in an individual unit, while the downstream losses vary as square of the total discharge in the plant (1 or 2 or 3 units).

The head losses upstream and downstream of the units in CF1 may be taken from articles 4.7.1 and 4.7.2 of our 1988-89 report (copies attached).

2.0 UNIT CHARACTERISTICS

The existing powerplant houses 5 GE Hydro units and 6 GEC Alsthom units. The GEC Alsthom units have an average maximum output of approximately 500 MW (6 units). The 5 GE Hydro units have an average maximum output of 530 MW. When these units were new, and the turbine efficiencies were measured by the thermodynamic method in the period 1972 to 1974, the range of efficiencies in the normal operating power range were as follows :

CF1	EFFICIENCY IN PERCENT	
POWER (MW)	5 x GEH	6 x GECA
80 % (400)	93,66	94,52
Peak	93,88 (435 MW)	94,74 (431 MW)
100 % (500)	93,67	93,91
106 % (530)	93,62	N/A

...3

Mr. R. Besaw, P. Eng.
CF(L)Co

July 30, 1998

The units will have undergone deterioration of the water passage surfaces between the spiral case inlet and the draft tube outlet, such that today we estimate that the efficiency will have dropped approximately 1 %. This would give rise to the following turbine efficiencies :

CF1	EFFICIENCY IN PERCENT	
POWER (MW)	5 x GEH	6 x GECA
80 % (400)	92,66	93,52
Peak	92,88 (435,4 MW)	93,74 (431,5 MW)
100 % (500)	92,67	92,91
106 % (530) Est.	92,62	N/A

Based on recent discussions with GE Hydro and GEC Alsthom, we conclude that an appropriate efficiency difference between new and average life would be about 0,5 %, as shown on the following table.

CF2	EFFICIENCY IN PERCENT	
POWER	New	Average Life
80 %	95,6	95,1
Peak	95,9	95,4
100 %	95,4	94,9

Based on the above, the total maximum plant output today of CF1 calculates to 5650 MW and a discharge is 2006 m^3/s. The new plant CF2 equipped with two 500 MW units with the head losses described above would operate under a net head of approximately 317 m and would have a total discharge of approximately 344 m^3/s.

The total power discharge from CF1 and CF2 would, therefore, be approximately 2350 m^3/s without discharge from the Jacopie or Ossokmanuan spillways.

3.0 MODE OF PLANT OPERATION

Given the information presented above, we believe it would be worthwhile representing CF1 as 2 generating stations, one with 5 GE Hydro units and the other with 6 GEC Alsthom units. The new plant, CF2, would then be equipped with 1 or 2 or 3 units whose efficiency characteristics under average life conditions are given above. Given the number of units in the combined CF1 and CF2 plants all units will be capable of being operated exclusively between 80 % load and full load, it would, therefore, be possible to assume constant efficiency in each of the plants. We would suggest a constant turbine efficiency of 95,1 % for the new plant, 92,7 % for the existing plant with 5 GE Hydro units and 93,4 % for the 6 GEC Alsthom existing units.

...4

Keep in mind that the above suggested efficiencies are for the turbine. In the high load range, one can assume a generator efficiency of 98,6 % also constant and for both the existing and new plants.

The head losses quoted above for CF2 plant extension are based on a fairly optimized penstock arrangement and what may be a generously sized tailrace tunnel, which gives relatively low downstream losses in the CF2 plant. However, the result of the comparison of alternatives would not be affected, since the costs which will be provided for these alternatives on August 14th, 1998 will be based on the dimensions used to establish these losses.

Given the relationship between the efficiencies in the existing plant and the efficiency of the units in the new plant, whether 1 or 2 or 3 units, it is evident that the mode of operation should involve first loading up to near full output the unit or units in CF2, then bringing on units in the existing plant. The same logic would suggest bringing on GEC Asthom units in the existing plant before GE Hydro units, but we do not believe this to be a sane overall long term operating mode, since CF(L)Co will have an interest in having relatively uniform numbers of operating hours on each of the units in the plant. Therefore, we suggest that the loading of CF1 be done first with a GEC Alsthom unit, followed by a GE unit and so forth. A sensitivity analysis could then be done to determine the potential gain of first loading all 6 GEC Alsthom units before GE Hydro units are brought on line.

4.0 UNPLANNED OUTAGES

Susan Richter of Acres International requested our opinions on the manner of treating unplanned outages in the simulation. Hydro-Québec's practice has been to apply a reduction in available capacity of 3 %. In the case of a hydraulic system with significant storage, discharge which is not turbined by virtue of non-availability of the units, is stored and turbined at a later date when the total demand is within the available capacity.

With the « power discharge » capacity of 2350 m^3/s in CF1 and CF2 combined, we see from Fig. 1 that it would cover up to 98 % of the system discharge. Therefore, an assumption of 3 % unplanned outage will have limited impact.

In a conversation with Susan Richter of Acres International today, we agreed that the 3 % reduction of available plant capacity should be used for the « Base Case » and that a Sensitivity Study should be done, assuming 100 % availability to indicate the potential gains in long term energy generation benefits of investing toward the reduction of unplanned outages (improved reliability of control and protection systems, etc.).

...5

RSW - EDM Joint Venture

Mr. R. Besaw, P. Eng.
CF(L)Co

July 30, 1998

Susan Richter of Acres International indicated in recent correspondence that the availability of units in CF2 would be adjusted during the month of April having each unit out of service for 2 weeks for the annual inspection. This consideration must be made for all units in CF1 also and represents a non-availability which is planned, such that it does not affect the requirement for available capacity.

Long term total outage rates for a large hydro system vary between 10 % and 12 %, including unplanned outages and planned outages including ultimately major overhauls. We should be aware that the CF1 plant, after 27 years of operation will enter, within the next 15 years, the period of major overhauls. These may result in runner replacement in the existing units, which will work in favour of increased energy generation with the same discharge. We believe that it is acceptable for CF(L)Co to make the projections on potential revenue of the optimization of number and size of units in the 4 Churchill River plants, CF1, CF2, Gull Island and Muskrat Falls, assuming that the existing units retain their present characteristics. Any subsequent modifications to those units will be made on the basis of justifiable economic analyses. It is conceivable that the increase in energy generation attributable to runner replacement could form a part of the commercial contract relating to CF2 energy and power rates.

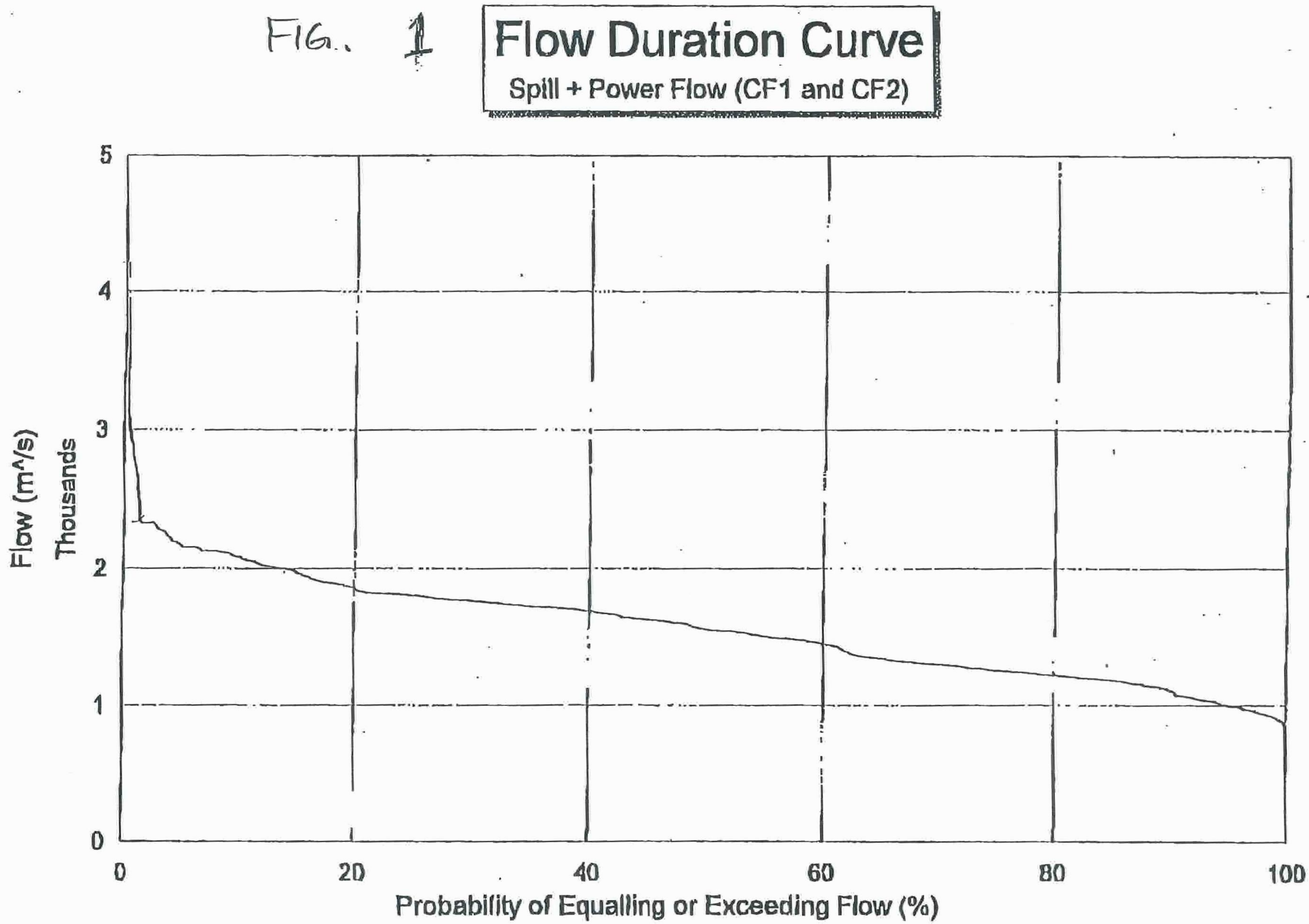
We trust that the above fulfills the immediate requirements concerning unit characteristics and we remain at your disposal to discuss this subject further.

Best regards,

DMC/mr

D.M. Coulson, Eng.
Project Manager

FIG. 1



07/09/98

CF2_FD.WK4

4.7 Hydraulic and Electrical Losses

4.7.1 Upstream Hydraulic Losses (CF 1)

Measurements made by Professor Alming during the field efficiency tests on the Churchill Falls turbines along with certain measurements of upstream head losses made subsequently by CF(L)Co have permitted establishing the following formula for calculation of upstream head losses:

$dH = 8{,}14 \times 10^{-5} q^2$, where q = penstock flow in m^3/s and dH = head loss in m.

4.7.2 Downstream Hydaulic Losses (CF 1)

Measurements taken by CL(F)Co in October 1988 have allowed calculation of the losses in the tailrace tunnels. For all plant flows in excess of about 1050 m^3/sec the tailrace tunnel head losses respect the following formula:

$$dH = 1,31 \times 10^{-6} Q^2, \text{ where } Q = \text{total plant discharge in } m^3/s \text{ and } dH = \text{head loss in m.}$$

At lower flows the apparent measured tailrace tunnel losses were substantially greater than those indicated by the above formula. However since low plant flows are not relevant in this study, no attempt was made to determine why this is so.

4.7.3 Plant Capacity

During full load testing at the Churchill Falls plant, the eleven units have actually produced over 5700 MW, i.e. close to 520 MW per unit average output. This condition involved having all turbines with the guide vanes set at 100% full opening, against the stops; not a condition which CF(L)Co considers as normal plant full load.

RSW - EDM Joint Venture

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Fax Transmittal

To:	R. Besaw, P. Eng.	**Date:**	August 10, 1998
Co.:	Churchill Falls Corporation	**Fax No.:**	(709) 737-1800
From:	D.M. Coulson, Eng.	**O/Ref.:**	P16 1569.E46
Project:	Churchill Falls Powerplant Extension (CF2)		
Subject:	Unit Characteristics and Head Losses Option 4 - Two Units at 650 MW		
Nbr of Pages:	(4) (including this one)	Copy:	C. Chartrand (RSW-EDM) B. Chaulk (RSW-EDM) J. Levay (H-Q) Thach Tran Van (H-Q) S. Richter (Acres) C. P. Tran (RSW-EDM) A. Leroux (RSW-EDM)

Message :

Dear Bob,

We present herein the preliminary data on Head Losses and Unit Characteristics for option 4 of the CF2 Generating Station. We intend to follow the option identifications provided by Susan Richter in the table entitled Summary.WK4 attached to her memo dated August 3rd, 1998. The alternatives are :

- Option 1 — 2 units at 500 MW
- Option 2 — 3 units at 500 MW
- Option 3 — 1 unit at 500 MW
- Option 4 — 2 units at 650 MW

...2

RSW - EDM Joint Venture

Mr. R. Besaw, P. Eng.
CF(L)Co

August 10th, 1998

The information presented herein follows the same format as that presented in our fax transmittal of July 30th, 1998.

As agreed during Progress Meeting N° 2 on August 7th, 1998, the option involving 2 units at 550 MW as been eliminated.

1.0 HEAD LOSSES

a) It is assumed that the water passage dimensions will give the same flow velocities in the penstock and in the tailrace tunnels as for the other alternatives. For the head loss calculations, the normal discharge is ratioed from those taken from Hydro-Québec's memo dated 98-07-20. This discharge is slightly different from the nominal discharge of the unit under winter rating conditions. In any event, the head losses are proportional to the square of the discharge per unit in the penstock and proportional as the square of the plant discharge for the tailrace tunnel ;

b) The water passage dimensions and head losses for option 4 of CF2 are as follows :

		ALTERNATIVES
		2 x 650 MW
Nominal Discharge	(m^3/s)	2 x 230
Concrete Lined Penstock Dia.	(m)	7,05
Steel Lined Penstock Dia.	(m)	5,75
Tailrace Tunnel Height	(m)	19,4
Tailrace Tunnel Width	(m)	14,9
Tailrace Tunnel Sect.	(m^2)	268,3
Units Upstream Losses	(m)	2,40
Units Downstream Losses	(m)	1,06
Total Losses	(m)	3,46

Mr. R. Besaw, P. Eng.
CF(L)Co

August 10th, 1998

c) The losses upstream of the turbines include intake losses, penstock friction losses, bend losses and conversion loss between the concrete line and steel line sections of the penstock ;

d) The losses downstream of the units include the surge chamber loss, tailrace tunnel friction loss and tailrace tunnel inlet and outlet losses.

2.0 UNIT CHARACTERISTICS

« Option 4 » under study involves the following unit characteristics :

- Number of units : 2
- Rated capacity (cooling water at 15° C) 650 MW
- Rated net head (full pool level in East Forebay) 317 m
- Rated discharge per unit : 223,6 m^3/s
- Discharge with 8 % overload in winter 241,5 m^3/s

Based on the same reasoning as presented in our July 30th, 1998 facsimile transmission, the turbine efficiencies will be as follows :

CF2	EFFICIENCY IN PERCENT	
POWER	New	Average Life
80 %	95,6	95,1
Peak	95,9	95,4
100 %	95,4	94,9

...4

RSW - EDM Joint Venture

Mr. R. Besaw, P. Eng.
CF(L)Co

August 10th, 1998

We, therefore, recommend for « Option 4 » of CF2 a constant turbine efficiency of 95,1 % and a constant generator efficiency of 98,6 % giving a constant unit efficiency of 93,7 %

We believe that this completes the data for Unit Characteristics for the 4 options being studied.

Best regards

D.M. Coulson, Eng.
Project Manager

DMC/mr
enc.

Appendix E
Power Plant Characteristics Gull Island
(Preliminary Characteristics)

Refer to Table 6.1 and Appendix I for final characteristics.

GULL ISLAND PROJECT

Basic Data for the Energy Study

- Full Supply Levels: El. 121 to 129 m (See table below)

- Trailrace curve:

Flow (m^3/s)	0	283	566	850	1133	1699	2265	2832	5663
Elevation(m)	39.00	39.01	39.03	39.07	39.09	39.19	39.32	39.48	40.37

- Head losses:

  - At maximum turbine flow: 1.60 m
  - At maximum efficiency flow: 1.40 m

- Turbine characteristics:

HWL (m)	Nominal Capacity (MW)	Maximum Turbine Flow (m^3/s)	Design Head (m)
121	263.0	369.9	80
123	273.0	374.5	82
125	283.0	379.1	84
127	293.2	383.5	86
129	303.5	388.0	88

- Unit efficiency at 100% capacity: 90.6%
- Maximum efficiency: 92.2 % (Turbine flow = 90% Q_{max})
  (Unit efficiency includes turbine, generator and transformer efficiencies)

GULL ISLAND PROJECT (WITHOUT MUSKRAT FALLS)

Basic Data for the Energy Study

- **Full Supply Levels:** El. 121 to 129 m (See table below)

- **Trailrace curve:**

Flow (m^3/s)	0	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	60
Elevation(m)	33.2	36.3	37.0	37.4	37.7	38.1	38.3	38.6	38.8	39.1	39.3	39.

- **Head losses:**
  - At maximum turbine flow: 1.60 m
  - At maximum efficiency flow: 1.40 m

- **Turbine characteristics:**

HWL (m)	Nominal Capacity (MW)	Maximum Turbine Flow (m^3/s)	Design Head (m)
121	~~263.0~~ 267.9	~~369.5~~ 372.2	~~80~~ 81.0
123	~~273.0~~ 278.0	~~374.5~~ 376.8	~~82~~ 83.0
125	~~283.0~~ 288.1	~~379.1~~ 381.3	~~84~~ 85.0
127	~~295.2~~ 298.8	~~383.5~~ 385.7	~~86~~ 87.0
129	~~303.5~~ 308.6	~~388.0~~ 390.2	~~88~~ 89.0

- Unit efficiency at 100% capacity: 90.6%
- Maximum efficiency: 92.2 % (Turbine flow = 90% Q)
  (Unit efficiency includes turbine, generator and transformer efficiencies)

- Cases to be Studied, Gull Island

Case Number	HWL (m)	No. of Units	Installed Capacity (MW)
1	121	6	1578
2	121	8	2104
3	121	10	2630
4	121	12	3156
5	123	6	1638
6	123	8	2184
7	123	10	2730
8	123	12	3275
9	125	6	1698
10	125	8	2264
11	125	10	2830
12	125	12	3396
13	127	6	1759
14	127	8	2345
15	127	10	2932
16	127	12	3518
17	129	6	1821
18	129	8	2428
19	129	10	3035
20	129	12	3641

Appendix F
Power Plant Characteristics Muskrat Falls
(Preliminary Characteristics)

Refer to Table 6.1 and Appendix I for final characteristics.

MUSKRAT FALLS PROJECT

Basic Data for the Energy Study

- Full Supply Level: El. 39.0 m

- Trailrace curve:

Flow (m^3/s)	0	566	2515	3000
Elevation (m)	1.90	1.98	3.44	3.80

(Note: This curve is being updated. The new curve will be transmitted as soon as it is available).

- Head losses:

  - At maximum turbine flow: 1.20 m
  - At maximum efficiency flow: 1.10 m

- Turbine characteristics:

  - Capacity 206 MW
  - Nominal Head: 34.4 m
  - Unit efficiency at 100% capacity: 88.6%
  - Maximum efficiency: 90.9% (turbine flow = 93% x Q_{max})
  (Unit efficiency includes: turbine, generator and transformer efficiencies)

- Cases to be studied, Muskrat Falls

Case Number	No. of Units	Installed Capacity (MW)
1	3	618
2	4	824
3	5	1030
4	6	1236

Appendix G
Structure Curves and Tables

LOBSTICK CONTROL STRUCTURE

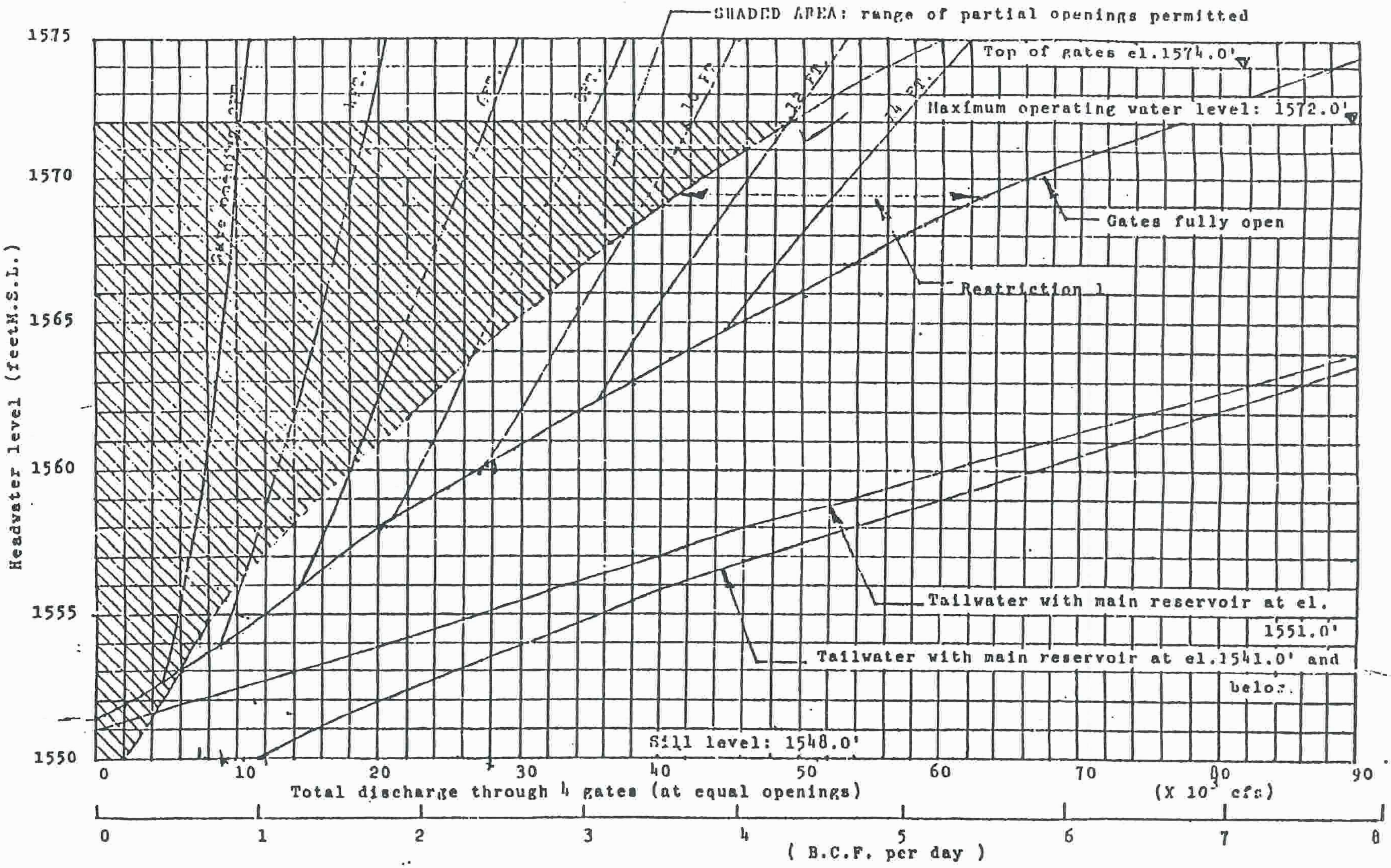
Page

Rating table for one gate fully open ,

H: Main reservoir level upstream of the structure   Q: discharge in cfs

H	Q	H	Q	H	Q	H	Q
1515.0	17,400	1525.5	32,900	1535.5	47,200	1545.5	63,600
1515.5	18,300	1526.0	33,600	1536.0	47,900	1546.0	64,500
1516.0	19,000	1526.5	34,300	1536.5	48,700	1546.5	65,400
1516.5	19,800	1527.0	35,000	1537.0	49,500	1547.0	66,400
1517.0	20,600	1527.5	35,700	1537.5	50,200	1547.5	67,300
1517.5	21,300	1528.0	36,400	1538.0	51,000	1548.0	68,200
1518.0	22,100	1528.5	37,100	1538.5	51,800	1548.5	69,200
1518.5	22,800	1529.0	37,800	1539.0	52,600	1549.0	70,100
1519.0	23,600	1529.5	38,500	1539.5	53,400	1549.5	71,100
1519.5	24,300	1530.0	39,200	1540.0	54,200	1550.0	72,200
1520.0	25,000	1530.5	39,900	1540.5	55,000	1550.5	73,300
1520.5	25,800	1531.0	40,600	1541.0	55,800	1551.0	74,500
1521.0	26,500	1531.5	41,300	1541.5	56,700	1551.5	75,600
1521.5	27,200	1532.0	42,000	1542.0	57,500	1552.0	76,700
1522.0	27,900	1532.5	42,700	1542.5	58,400	1552.5	77,900
1522.5	28,700	1533.0	43,400	1543.0	59,200	1553.0	79,100
1523.0	29,400	1533.5	44,200	1543.5	60,100	1553.5	80,300
1523.5	30,100	1534.0	44,900	1544.0	60,900	1554.0	81,500
1524.0	30,800	1534.5	45,600	1544.5	61,800	1554.5	82,700
1524.5	31,500	1535.0	46,400	1545.0	62,700	1555.0	83,900
1525.0	32,200						

Gabbro control structure rating curves.



Gabbro Control Structure...........Rating table for one gate fully open.

H: Ossokmanuan reservoir level, upstream of the structure. Q: Discharge in CFS.

H	Q	H	Q	H	Q	H	Q	H	Q	H	Q
1555.0	2850	1558.4	5370	1561.8	8270	1565.2	11500	1568.6	14900	1572.0	18500
.1	2925	.5	5450	.9	8360	.3	11600	.7	15000	.1	18610
.2	3000	.6	5530	1562.0	8450	.4	11700	.8	15100	.2	18720
.3	3075	.7	5610	.1	8545	.5	11800	.9	15200	.3	18830
.4	3150	.8	5690	.2	8640	.6	11900	1569.0	15300	.4	18940
.5	3225	.9	5770	.3	8735	.7	12000	.1	15405	.5	19050
.6	3300	1559.0	5850	.4	8830	.8	12100	.2	15510	.6	19160
.7	3375	.1	5930	.5	8925	.9	12200	.3	15615	.7	19270
.8	3450	.2	6010	.6	9020	1566.0	12300	.4	15720	.8	19380
.9	3525	.3	6090	.7	9115	.1	12400	.5	15825	.9	19490
1556.0	3600	.4	6170	.8	9210	.2	12500	.6	15930	1573.0	19600
.1	3670	.5	6250	.9	9305	.3	12600	.7	16035	.1	19715
.2	3740	.6	6330	1563.0	9400	.4	12700	.8	16140	.2	19830
.3	3810	.7	6410	.1	9495	.5	12800	.9	16245	.3	19945
.4	3880	.8	6490	.2	9590	.6	12900	1570.0	16350	.4	20060
.5	3950	.9	6570	.3	9685	.7	13000	.1	16455	.5	20175
.6	4020	1560.0	6650	.4	9780	.8	13100	.2	16560	.6	20290
.7	4090	.1	6740	.5	9875	.9	13200	.3	16665	.7	20405
.8	4160	.2	6830	.6	9970	1567.0	13300	.4	16770	.8	20520
.9	4230	.3	6920	.7	10065	.1	13400	.5	16875	.9	20635
1557.0	4300	.4	7010	.8	10160	.2	13500	.6	16980	1574.0	20750
.1	4375	.5	7100	.9	10255	.3	13600	.7	17085	.1	20860
.2	4450	.6	7190	1564.0	10350	.4	13700	.8	17190	.2	20970
.3	4525	.7	7280	.1	10445	.5	13800	.9	17295	.3	21080
.4	4600	.8	7370	.2	10540	.6	13900	1571.0	17400	.4	21190
.5	4675	.9	7460	.3	10635	.7	14000	.1	17510	.5	21300
.6	4750	1561.0	7550	.4	10730	.8	14100	.2	17620	.6	21410
.7	4825	.1	7640	.5	10825	.9	14200	.3	17730	.7	21520
.8	4900	.2	7730	.6	10920	1568.0	14300	.4	17840	.8	21630
.9	4975	.3	7820	.7	11015	.1	14400	.5	17950	.9	21740
1558.0	5050	.4	7910	.8	11110	.2	14500	.6	18060	1575.0	21850
.1	5130	.5	8000	.9	11205	.3	14600	.7	18170		
.2	5210	.6	8090	1565.0	11300	.4	14700	.8	18280		
.3	5290	.7	8180	.1	11400	.5	14800	.9	18390		

WHEN USING THIS CHART. ADD. (0.2) TO GET TRUE FLOW

Ossokmanuan Reservoir Storage

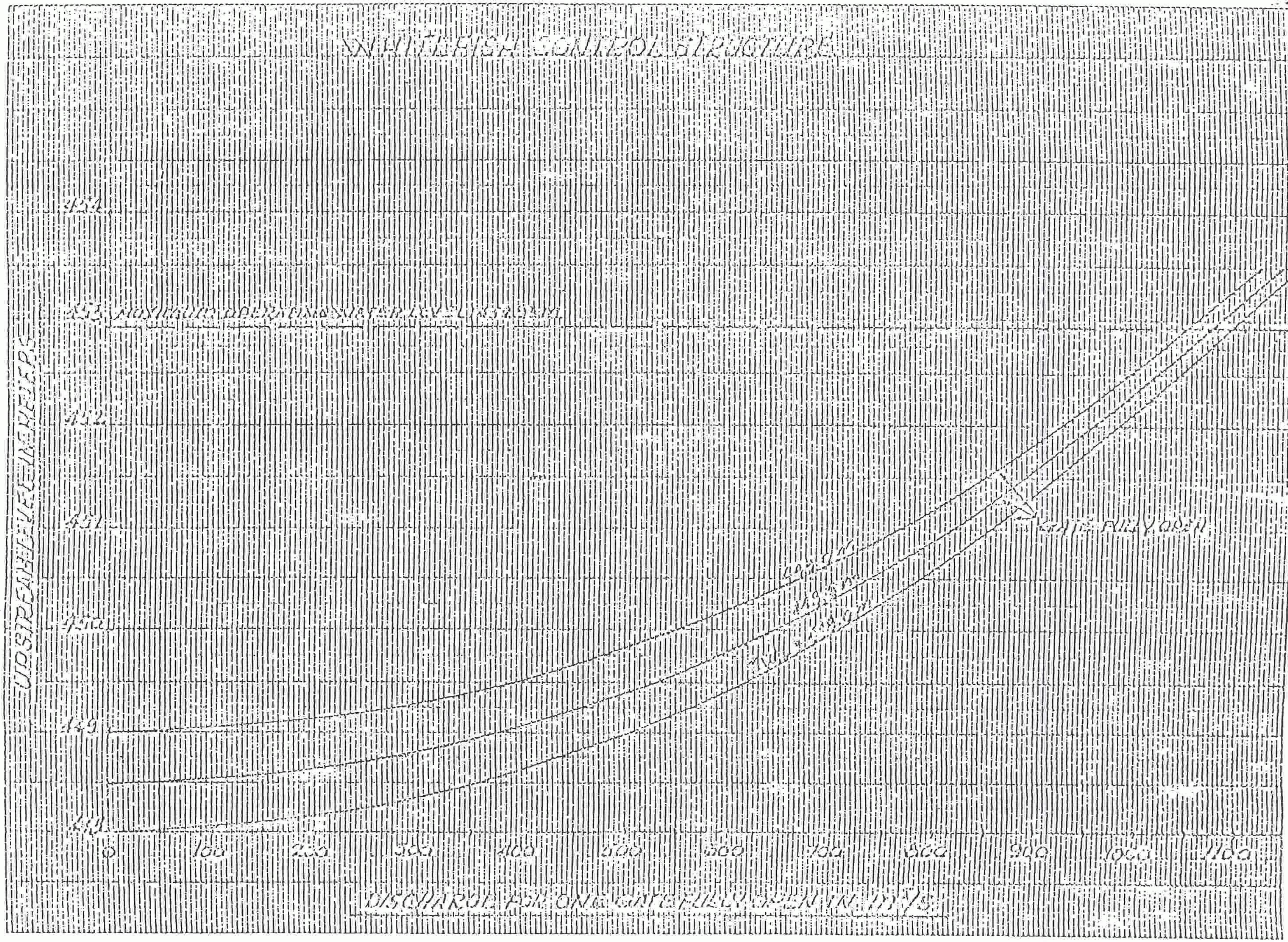
H: Upstream elevation at Gabbro structure Q: CFS/days S: Billion cubic feet (BCF)

H	Q	S
1565.0	510,000	44.064
.1	519,357	44.872
.2	528,714	45.681
.3	538,071	46.490
.4	547,428	47.298
.5	556,785	48.106
.6	566,142	48.915
.7	575,499	49.718
.8	584,856	50.526
.9	594,213	51.334
1566.0	603,570	52.142
.1	612,927	52.950
.2	622,284	53.758
.3	631,641	54.566
.4	640,998	55.374
.5	650,355	56.182
.6	659,712	56.990
.7	669,069	57.798
.8	678,426	58.606
.9	687,783	59.414
1567.0	697,140	60.222
.1	706,497	61.030
.2	715,854	61.838
.3	725,211	62.646
.4	734,568	63.454
.5	743,925	64.262
.6	753,282	65.070
.7	762,639	65.878
.8	771,996	66.686
.9	781,353	67.494

H	Q	S
1568.0	790,710	68.302
.1	800,067	69.110
.2	809,424	69.918
.3	818,781	70.726
.4	828,138	71.534
.5	837,495	72.342
.6	846,852	73.150
.7	856,209	73.958
.8	865,566	74.766
.9	874,923	75.574
1569.0	884,280	76.382
.1	893,637	77.190
.2	902,994	77.998
.3	912,351	78.806
.4	921,708	79.614
.5	931,065	80.422
.6	940,422	81.230
.7	949,779	82.038
.8	959,136	82.846
.9	968,493	83.654
1570.0	977,850	84.462
.1	987,207	85.270
.2	996,564	86.078
.3	1,005,921	86.886
.4	1,015,278	87.694
.5	1,024,635	88.502
.6	1,033,992	89.310
.7	1,043,349	90.118
.8	1,052,706	90.926
.9	1,062,063	91.734

H	Q	S
1571.0	1,071,420	92.542
.1	1,080,777	93.350
.2	1,090,134	94.158
.3	1,099,491	94.966
.4	1,108,848	95.774
.5	1,118,205	96.582
.6	1,127,562	97.390
.7	1,136,919	98.198
.8	1,146,276	99.006
.9	1,155,633	99.814
1572.0	1,164,990	100.622
.1	1,174,347	101.464
.2	1,183,704	102.272
.3	1,193,061	103.081

K+E 16 X 10 TO THE CENTIMETER



WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTUR							
	447,8	447,9	448,0	448,1	448,2	448,3	448,4	448,5
448,0	224	160	0	0	0	0	0	0
448,1	274	226	161	0	0	0	0	0
448,2	316	276	228	163	0	0	0	0
448,3	353	319	279	230	164	0	0	0
448,4	386	356	322	281	232	166	0	0
448,5	417	390	359	325	284	234	167	0
448,6	445	421	393	363	328	286	236	169
448,7	472	449	424	397	366	330	289	238
448,8	497	476	453	428	400	369	333	292
448,9	520	501	480	457	432	404	372	336
449,0	543	525	506	485	461	436	407	376
449,1	565	548	530	510	489	465	440	411
449,2	585	570	553	534	515	493	469	443
449,3	605	590	575	558	539	519	497	474
449,4	624	610	596	580	562	544	524	502
449,5	643	630	616	601	585	567	548	528
449,6	661	648	635	621	606	590	572	553
449,7	678	666	654	641	626	611	595	577
449,8	695	684	672	659	646	632	616	600
449,9	711	701	689	678	665	651	637	621
450,0	727	717	706	695	683	671	657	642
450,1	742	733	723	712	701	689	676	662
450,2	757	748	739	729	718	707	695	682
450,3	772	764	755	745	735	724	713	700
450,4	786	778	770	761	751	741	730	718
450,5	800	793	785	776	767	757	747	736
450,6	814	807	799	791	782	773	763	753
450,7	828	821	813	806	797	789	779	770
450,8	841	834	827	820	812	804	795	786
450,9	854	848	841	834	827	819	810	801
451,0	867	861	854	848	841	833	825	817
451,1	879	874	867	861	854	847	840	832
451,2	892	886	880	874	868	861	854	846
451,3	904	899	893	887	881	875	868	860
451,4	916	911	906	900	894	888	881	874
451,5	928	923	918	913	907	901	895	888
451,6	940	935	930	925	920	914	908	902
451,7	952	947	942	937	932	927	921	915
451,8	964	959	954	950	945	939	934	928
451,9	976	971	966	962	957	952	946	941

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE							
	447.8	447.9	448.0	448.1	448.2	448.3	448.4	448.5	44
452.0	988	984	979	974	969	964	959	954	9
452.1	1000	996	991	956	961	976	971	966	9
452.2	1012	1008	1003	998	993	988	983	978	9
452.3	1024	1020	1015	1011	1006	1001	996	991	9
452.4	1035	1031	1027	1023	1018	1013	1008	1003	9
452.5	1047	1043	1039	1035	1030	1026	1021	1016	10
452.6	1059	1055	1051	1047	1042	1038	1033	1028	10
452.7	1070	1066	1062	1059	1054	1050	1045	1041	10
452.8	1081	1078	1074	1070	1066	1062	1058	1053	10
452.9	1093	1089	1086	1082	1078	1074	1070	1065	10
453.0	1104	1100	1097	1093	1090	1086	1082	1077	10
453.1	1115	1112	1108	1105	1101	1097	1093	1089	10
453.2	1126	1123	1120	1116	1113	1109	1105	1101	10
453.3	1137	1134	1131	1128	1124	1121	1117	1113	11
453.4	1148	1145	1142	1139	1135	1132	1128	1125	11
453.5	1159	1156	1153	1150	1147	1143	1140	1136	11

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE			
	448.7	448.8	448.9	449.0
448.0	0	0	0	0
448.1	0	0	0	0
448.2	0	0	0	0
448.3	0	0	0	0
448.4	0	0	0	0
448.5	0	0	0	0
448.6	0	0	0	0
448.7	0	0	0	0
448.8	171	0	0	0
448.9	242	172	0	0
449.0	296	244	174	0
449.1	342	299	246	175
449.2	382	345	301	248
449.3	418	385	348	304
449.4	451	421	388	351
449.5	481	455	425	392
449.6	510	485	458	428
449.7	537	514	489	462
449.8	562	541	518	493
449.9	586	567	546	523
450.0	609	591	571	550
450.1	631	614	596	576
450.2	653	637	619	601
450.3	673	658	642	624
450.4	693	678	663	647
450.5	712	698	684	668
450.6	730	717	704	689
450.7	748	736	723	709
450.8	765	754	741	729
450.9	782	771	759	747
451.0	798	788	777	765
451.1	814	804	794	783
451.2	829	820	810	800
451.3	844	836	826	817
451.4	859	851	842	833
451.5	874	866	857	848
451.6	888	880	872	864
451.7	902	894	887	879
451.8	915	908	901	893
451.9	929	922	915	908

WHITEFISH CONTROL STRUCTURE

RATING TABLE OF DISCHARGES (IN CMS) FOR ONE GATE FULLY OPEN

UPSTREAM LEVEL METERS	EAST FOREBAY LEVEL (IN METERS) DOWNSTREAM OF THE STRUCTURE			
	448.7	448.8	448.9	449.0
452.0	942	936	929	922
452.1	955	949	942	936
452.2	968	962	956	949
452.3	980	975	969	963
452.4	993	987	982	976
452.5	1005	1000	995	989
452.6	1017	1012	1007	1002
452.7	1030	1025	1020	1014
452.8	1043	1038	1032	1027
452.9	1055	1050	1045	1039
453.0	1068	1063	1058	1052
453.1	1080	1075	1070	1065
453.2	1092	1088	1083	1078
453.3	1104	1100	1095	1090
453.4	1116	1112	1108	1103
453.5	1128	1124	1120	1115

Appendix H
Simulated Energy and Flows Provided to Feasibility Consultants from Preliminary Analysis

Results of final analysis (January 1999) are provided in Volume 2.

CF2

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ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD CAPACITY POTENTIAL (MW) : 2 Churchill Falls Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	5085.00	5311.00	5424.00	5424.00	5424.00	5367.48	5254.49	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
2	1957	1957	5085.00	5311.00	5423.98	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
3	1958	1958	5085.00	5311.00	5423.98	5423.99	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
4	1959	1959	5085.00	5310.99	5423.98	5423.99	5424.00	5367.50	5254.50	5141.50	4971.99	4915.49	4859.00	4915.50	5173.07
5	1960	1960	5085.00	5311.00	5423.98	5423.99	5424.00	5367.50	5254.50	5141.49	4971.99	4915.50	4859.00	4915.50	5173.07
6	1961	1961	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.08
7	1962	1962	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.49	4859.00	4915.49	5173.08
8	1963	1963	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.49	5173.08
9	1964	1964	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.49	4858.99	4915.50	5173.08
10	1965	1965	5085.00	5310.99	5423.98	5423.99	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
11	1966	1966	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4858.99	4915.49	5173.07
12	1967	1967	5085.00	5311.00	5424.00	5424.00	5423.98	5367.49	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
13	1968	1968	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.08
14	1969	1969	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.08
15	1970	1970	5084.99	5310.99	5424.00	5423.98	5423.98	5367.49	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
16	1971	1971	5085.00	5310.99	5424.00	5423.98	5423.99	5367.49	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.07
17	1972	1972	5085.00	5310.99	5423.98	5423.98	5423.99	5367.50	5254.50	5141.50	4972.00	4915.50	4858.99	4915.49	5173.07
18	1973	1973	5084.99	5310.99	5423.98	5423.98	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.07
19	1974	1974	5084.99	5310.99	5424.00	5424.00	5424.00	5367.48	5254.49	5141.49	4972.00	4915.50	4859.00	4915.50	5173.07
20	1975	1975	5084.99	5310.99	5423.98	5423.98	5423.99	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
21	1976	1976	5085.00	5311.00	5423.98	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.08
22	1977	1977	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.08
23	1978	1978	5085.00	5311.00	5423.98	5423.99	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
24	1979	1979	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
25	1980	1980	5085.00	5311.00	5423.98	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
26	1981	1981	5084.99	5310.99	5423.98	5423.99	5423.99	5367.50	5254.50	5141.49	4972.00	4915.50	4859.00	4915.50	5173.07
27	1982	1982	5084.99	5310.99	5423.98	5423.98	5423.99	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
28	1983	1983	5085.00	5311.00	5423.99	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
29	1984	1984	5084.99	5311.00	5423.98	5423.99	5424.00	5367.50	5254.50	5141.49	4972.00	4915.49	4859.00	4915.49	5173.07
30	1985	1985	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.50	4971.99	4915.49	4858.99	4915.49	5173.07
31	1986	1986	5085.00	5310.98	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4971.99	4915.50	4859.00	4915.49	5173.07
32	1987	1987	5085.00	5310.99	5424.00	5423.98	5423.98	5367.49	5254.50	5141.50	4972.00	4915.50	4858.99	4915.50	5173.07
33	1988	1988	5084.99	5310.99	5424.00	5424.00	5423.98	5367.49	5254.50	5141.49	4971.99	4915.50	4859.00	4915.49	5173.07
34	1989	1989	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.49	5141.50	4972.00	4915.50	4859.00	4915.49	5173.08
35	1990	1990	5085.00	5310.98	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4971.99	4915.49	4859.00	4915.49	5173.07
36	1991	1991	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.49	4859.00	4915.49	5173.08
37	1992	1992	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4971.99	4915.50	4859.00	4915.49	5173.08
38	1993	1993	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4971.99	4915.49	4859.00	4915.49	5173.08
39	1994	1994	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.50	4971.99	4915.50	4859.00	4915.50	5173.08
40	1995	1995	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.49	4859.00	4915.50	5173.08
41	1996	1996	5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.49	4972.00	4915.49	4859.00	4915.49	5173.08
AVERAGE			5085.00	5311.00	5423.99	5423.99	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.07
MAXIMUM			5085.00	5311.00	5424.00	5424.00	5424.00	5367.50	5254.50	5141.50	4972.00	4915.50	4859.00	4915.50	5173.08
MINIMUM			5084.99	5310.98	5423.98	5423.98	5423.98	5367.48	5254.49	5141.49	4971.99	4915.49	4858.99	4915.49	5173.07

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD AVERAGE ENERGY (MW CONTINUOUS) : 2 Churchill Falls Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	2531.98	2907.44	4010.27	4276.42	3746.35	3618.38	2749.22	2433.37	1085.50	3041.47	3923.61	3822.84	3180.13
2	1957	1957	2728.83	3234.88	4173.93	4353.56	5424.00	5367.50	5254.50	1533.54	3014.09	4915.50	4859.00	4915.50	4137.89
3	1958	1958	3907.97	3139.63	4123.60	4320.23	4872.81	4374.99	4311.68	1431.74	2842.67	4912.28	2887.21	2534.34	3632.84
4	1959	1959	2714.42	2776.12	3918.83	4227.98	3650.75	3954.86	4169.75	1488.63	2077.05	2520.22	2874.16	4680.65	3249.32
5	1960	1960	3230.69	3109.18	4136.03	4315.66	3971.23	4501.50	4745.45	2091.07	2043.36	2537.07	2719.64	2466.17	3319.45
6	1961	1961	2531.50	3121.82	4113.46	4250.49	3713.66	3606.51	2781.31	1778.79	1454.93	2575.76	2728.06	2498.90	2928.25
7	1962	1962	2932.64	3197.92	4159.38	4351.29	3762.73	3609.66	2726.71	1475.00	1672.68	2377.52	2622.88	2347.18	2934.44
8	1963	1963	2698.21	2993.72	4128.85	4304.12	3733.18	3573.07	2653.93	1502.01	1454.99	2527.07	2578.54	2352.68	2873.58
9	1964	1964	2795.97	3144.04	4126.77	4344.64	3788.95	3591.16	2723.57	1742.82	1369.71	2326.08	2657.49	4085.97	3054.58
10	1965	1965	3302.18	3161.41	4191.75	4370.55	3756.50	3987.16	4430.15	2523.04	2247.82	4776.19	4859.00	4915.50	3879.82
11	1966	1966	4330.45	4793.71	4066.94	4291.79	5424.00	4594.38	4643.14	1917.69	1646.56	2535.13	2604.83	2433.14	3594.37
12	1967	1967	2711.10	2983.03	4010.75	4320.21	3719.99	3570.94	2648.90	1389.07	2884.80	2608.89	2982.24	4420.24	3182.62
13	1968	1968	5085.00	3928.48	4080.33	4532.65	5254.18	4516.83	4240.86	1723.51	1085.47	4915.50	4710.04	4628.52	4055.06
14	1969	1969	5085.00	3592.33	3859.65	5424.00	5424.00	5172.29	4792.70	2244.16	2557.38	4912.64	4333.26	2359.08	4144.87
15	1970	1970	2748.54	3095.91	4175.19	4334.26	3744.45	3597.95	2626.15	1356.18	2847.72	4915.50	4859.00	2357.63	3392.47
16	1971	1971	3542.66	2989.48	4017.30	4285.03	3687.52	3527.86	3085.61	2293.55	1085.42	2459.38	2594.75	2345.90	2993.92
17	1972	1972	2506.09	3143.50	4041.43	4175.93	3591.65	3589.71	4327.57	1244.18	1882.56	2345.41	2695.13	2435.09	2993.87
18	1973	1973	2745.96	3060.35	4073.21	4243.58	3520.63	3882.25	4564.44	2000.17	1330.61	2480.83	2699.23	2452.75	3086.86
19	1974	1974	2689.34	3162.31	4124.85	4293.87	3751.25	3641.35	2761.67	1974.47	1302.82	4812.27	3571.63	2980.79	3259.19
20	1975	1975	2775.32	3113.55	4123.11	4317.77	3663.90	3590.20	5254.50	1334.66	2674.89	4875.46	3749.62	4487.62	3660.98
21	1976	1976	3604.93	3149.71	4145.81	4337.67	5406.46	4185.96	4823.26	1698.06	1440.73	4915.50	4248.62	4915.50	3897.23
22	1977	1977	4508.88	4155.98	4094.19	5364.19	5424.00	4264.01	4611.44	1647.22	1692.07	4915.50	4859.00	4638.75	4175.51
23	1978	1978	2672.15	3174.55	4108.70	4329.75	4312.74	4136.88	5254.50	1418.37	4972.00	4915.50	4498.00	4719.42	4035.15
24	1979	1979	3883.91	4014.97	4095.01	4744.24	5166.50	4757.92	5023.55	1319.96	3319.08	4915.50	4859.00	2390.47	4035.47
25	1980	1980	3040.88	3112.18	4101.80	4295.31	5424.00	4503.22	5122.66	1618.39	4972.00	4915.50	4561.63	2761.98	4024.86
26	1981	1981	2636.18	3188.36	4136.26	4329.77	3770.06	3614.40	3525.78	1908.69	1398.80	4384.17	4585.57	3687.31	3432.92
27	1982	1982	2811.43	3160.68	4149.32	4329.77	3770.07	3614.40	5254.50	1288.37	4829.86	4915.50	4859.00	3609.26	3879.98
28	1983	1983	3804.23	3492.89	4149.32	4561.12	5100.45	4445.78	4917.17	1306.22	1929.03	4915.50	4859.00	2675.57	3842.54
29	1984	1984	2781.62	3202.21	4150.04	4329.76	3768.60	4244.24	4816.59	2060.57	1406.92	2390.24	2570.49	2369.58	3171.82
30	1985	1985	2684.58	3139.87	4136.22	4336.61	3768.60	3612.38	2615.40	1571.75	2064.91	2393.72	2646.67	2320.98	2938.62
31	1986	1986	2726.16	3146.78	4122.44	4309.08	3720.33	3543.33	2601.52	1881.09	2163.75	2502.45	2660.54	2334.89	2974.45
32	1987	1987	2560.12	2939.48	3991.79	4219.74	3630.71	3515.73	2979.63	1480.57	1327.75	2487.21	2826.43	2473.96	2867.98
33	1988	1988	2726.17	3029.28	4150.00	4329.73	3770.05	3614.42	3137.45	1971.50	1884.06	2528.75	2718.10	2395.31	3019.57
34	1989	1989	2773.95	3076.90	4100.41	4337.02	3715.26	3482.31	2731.77	2510.73	2527.60	2654.38	2675.00	2226.74	3067.03
35	1990	1990	2662.84	3176.54	4162.85	4389.18	3710.36	3612.97	2776.14	2042.07	1782.88	2354.26	2679.11	2392.81	2977.38
36	1991	1991	2732.94	3119.48	4170.37	4378.04	3759.61	3612.87	2803.07	1925.96	1680.36	2528.99	2498.68	2223.35	2951.62
37	1992	1992	2672.66	3131.34	4202.36	4335.19	3774.08	3594.06	2742.89	1640.50	2120.28	2447.13	2479.83	2325.99	2952.91
38	1993	1993	2480.62	3128.92	4065.81	4376.92	3742.75	3579.98	2676.62	1660.00	1790.73	2413.12	2569.52	2185.73	2887.07
39	1994	1994	2715.38	3066.83	4157.86	4313.73	3719.77	3495.48	2601.52	1580.76	2203.48	2447.77	2820.99	2471.68	2964.25
40	1995	1995	2685.78	3027.57	4136.55	4274.65	3620.65	3532.19	2678.64	1907.41	1767.41	2380.75	2630.22	2446.16	2923.14
41	1996	1996	2756.35	2970.58	3993.94	4322.54	3796.59	3462.40	2684.46	1660.71	1461.95	2207.70	2577.69	2251.70	2843.25
AVERAGE			3061.36	3225.71	4101.87	4387.27	4123.74	3909.60	3704.16	1745.77	2129.19	3412.18	3394.94	3057.02	3351.64
MAXIMUM			5085.00	4793.71	4202.36	5424.00	5424.00	5367.50	5254.50	2523.04	4972.00	4915.50	4859.00	4915.50	4175.51
MINIMUM			2480.62	2776.12	3859.65	4175.93	3520.63	3462.40	2601.52	1244.18	1085.42	2207.70	2479.83	2185.73	2843.25

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD CAPACITY POTENTIAL (MW) : 3 CF2 Station

SIM	YEAR OF HYD	YEAR OF OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1069.20	1116.72	1140.48	1140.48	1140.48	1128.59	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
2	1957	1957	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
3	1958	1958	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
4	1959	1959	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
5	1960	1960	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
6	1961	1961	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
7	1962	1962	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.54	1087.71
8	1963	1963	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.54	1087.72
9	1964	1964	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.56	1087.72
10	1965	1965	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
11	1966	1966	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
12	1967	1967	1069.20	1116.72	1140.48	1140.48	1140.44	1128.59	1104.84	1081.07	1045.44	1033.56	1021.68	1033.56	1087.72
13	1968	1968	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
14	1969	1969	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
15	1970	1970	1069.20	1116.72	1140.48	1140.46	1140.47	1128.59	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
16	1971	1971	1069.20	1116.72	1140.48	1140.46	1140.47	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
17	1972	1972	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.55	1087.72
18	1973	1973	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
19	1974	1974	1069.20	1116.71	1140.48	1140.48	1140.48	1128.57	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.71
20	1975	1975	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
21	1976	1976	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
22	1977	1977	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
23	1978	1978	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
24	1979	1979	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
25	1980	1980	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.07	1045.44	1033.56	1021.68	1033.56	1087.72
26	1981	1981	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
27	1982	1982	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
28	1983	1983	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
29	1984	1984	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.54	1087.71
30	1985	1985	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.55	1021.66	1033.55	1087.71
31	1986	1986	1069.20	1116.69	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
32	1987	1987	1069.20	1116.70	1140.48	1140.46	1140.47	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.71
33	1988	1988	1069.20	1116.72	1140.48	1140.48	1140.45	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
34	1989	1989	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.54	1087.72
35	1990	1990	1069.20	1116.69	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.54	1021.68	1033.54	1087.71
36	1991	1991	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.53	1021.68	1033.54	1087.71
37	1992	1992	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.72
38	1993	1993	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.54	1087.71
39	1994	1994	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
40	1995	1995	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.56	1087.72
41	1996	1996	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.54	1087.72
AVERAGE			1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.07	1045.43	1033.56	1021.68	1033.55	1087.72
MAXIMUM			1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
MINIMUM			1069.20	1116.69	1140.46	1140.46	1140.44	1128.57	1104.84	1081.06	1045.42	1033.53	1021.66	1033.54	1087.71

PERIOD AVERAGE ENERGY (MW CONTINUOUS) : 3 CF2 Station

SIM	YEAR OF HYD	YEAR OF OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1069.20	1116.72	1140.48	1140.48	1140.48	1128.59	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
2	1957	1957	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
3	1958	1958	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.55	1021.68	1033.56	1087.72
4	1959	1959	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
5	1960	1960	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
6	1961	1961	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
7	1962	1962	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.54	1087.71
8	1963	1963	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.54	1087.72
9	1964	1964	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.56	1087.72
10	1965	1965	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
11	1966	1966	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
12	1967	1967	1069.20	1116.72	1140.48	1140.48	1140.44	1128.59	1104.84	1081.07	1045.44	1033.56	1021.68	1033.56	1087.72
13	1968	1968	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
14	1969	1969	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.55	1021.68	1033.56	1087.72
15	1970	1970	1069.20	1116.72	1140.48	1140.46	1140.47	1128.59	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
16	1971	1971	1069.20	1116.72	1140.48	1140.46	1140.47	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
17	1972	1972	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.55	1087.72
18	1973	1973	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
19	1974	1974	1069.20	1116.71	1140.48	1140.48	1140.48	1128.57	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.71
20	1975	1975	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
21	1976	1976	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
22	1977	1977	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
23	1978	1978	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
24	1979	1979	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
25	1980	1980	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.07	1045.44	1033.56	1021.68	1033.56	1087.72
26	1981	1981	1069.20	1116.72	1140.47	1140.47	1140.48	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.72
27	1982	1982	1069.20	1116.72	1140.46	1140.47	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
28	1983	1983	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
29	1984	1984	1069.20	1116.72	1140.47	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.54	1087.71
30	1985	1985	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.55	1021.66	1033.55	1087.71
31	1986	1986	1069.20	1116.69	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
32	1987	1987	1069.20	1116.70	1140.48	1140.46	1140.47	1128.60	1104.84	1081.06	1045.44	1033.56	1021.68	1033.56	1087.71
33	1988	1988	1069.20	1116.72	1140.48	1140.48	1140.45	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.71
34	1989	1989	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.54	1087.72
35	1990	1990	1069.20	1116.69	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.54	1021.68	1033.54	1087.71
36	1991	1991	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.53	1021.68	1033.54	1087.71
37	1992	1992	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.54	1087.72
38	1993	1993	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.54	1087.71
39	1994	1994	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.42	1033.56	1021.68	1033.56	1087.72
40	1995	1995	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.43	1033.54	1021.68	1033.56	1087.72
41	1996	1996	1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.06	1045.44	1033.54	1021.68	1033.54	1087.72
AVERAGE			1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.07	1045.43	1033.56	1021.68	1033.55	1087.72
MAXIMUM			1069.20	1116.72	1140.48	1140.48	1140.48	1128.60	1104.84	1081.08	1045.44	1033.56	1021.68	1033.56	1087.72
MINIMUM			1069.20	1116.69	1140.46	1140.46	1140.44	1128.57	1104.84	1081.06	1045.42	1033.53	1021.66	1033.54	1087.71

PERIOD AVERAGE CHANNEL FLOW (cms) : 20 Churchill Falls Power Flow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	896.48	1031.37	1426.72	1521.99	1332.31	1286.54	976.49	863.36	384.20	1077.42	1391.41	1355.50	1129.08
2	1957	1957	966.38	1147.94	1485.30	1549.63	1934.17	1913.80	1873.06	543.71	1068.47	1747.06	1725.57	1745.93	1471.49
3	1958	1958	1385.92	1114.02	1467.28	1537.69	1735.94	1557.27	1534.55	507.59	1007.52	1744.69	1022.59	897.28	1290.74
4	1959	1959	961.26	984.65	1394.00	1504.65	1298.13	1406.87	1483.72	527.78	735.62	892.27	1017.95	1661.75	1153.88
5	1960	1960	1144.72	1103.18	1471.73	1536.05	1412.75	1602.60	1690.09	741.69	723.67	898.25	963.06	873.08	1179.07
6	1961	1961	896.30	1107.68	1463.65	1512.71	1320.62	1282.30	987.92	630.77	515.06	911.99	966.06	884.70	1039.49
7	1962	1962	1038.78	1134.77	1480.09	1548.81	1338.17	1283.42	968.47	522.94	592.23	841.62	928.70	830.86	1041.74
8	1963	1963	955.50	1062.08	1469.16	1531.91	1327.60	1270.35	942.54	532.52	515.08	894.70	912.96	832.81	1020.08
9	1964	1964	990.22	1115.59	1468.41	1546.43	1347.54	1276.81	967.35	618.00	484.86	823.38	941.00	1449.35	1084.49
10	1965	1965	1170.14	1121.77	1491.68	1555.71	1335.94	1418.43	1576.98	895.26	796.21	1695.95	1725.86	1745.84	1378.56
11	1966	1966	1536.69	1702.46	1444.88	1527.50	1934.17	1635.92	1653.36	680.10	582.97	897.56	922.30	861.36	1277.14
12	1967	1967	960.08	1058.27	1426.89	1537.68	1322.89	1269.58	940.76	492.44	1022.50	923.75	1056.35	1568.68	1129.91
13	1968	1968	1806.68	1395.37	1451.79	1613.80	1873.06	1608.09	1509.19	611.15	384.18	1756.94	1672.23	1643.09	1442.58
14	1969	1969	1806.93	1275.34	1372.83	1934.17	1934.17	1843.56	1707.06	796.09	906.13	1744.81	1537.59	835.08	1473.92
15	1970	1970	973.38	1098.46	1485.75	1542.71	1331.63	1279.24	932.65	480.77	1009.32	1745.84	1725.57	834.57	1204.84
16	1971	1971	1255.71	1060.57	1429.23	1525.08	1311.28	1254.19	1096.37	813.64	384.17	870.67	918.72	830.41	1062.86
17	1972	1972	887.28	1115.40	1437.87	1486.01	1277.01	1276.29	1540.24	441.03	666.64	830.23	954.36	862.05	1062.99
18	1973	1973	972.46	1085.79	1449.24	1510.23	1251.63	1380.89	1625.11	709.40	471.01	878.29	955.82	868.32	1096.16
19	1974	1974	952.35	1122.09	1467.73	1528.24	1334.06	1294.75	980.92	700.27	461.16	1708.87	1265.94	1055.85	1157.31
20	1975	1975	982.89	1104.73	1467.10	1536.80	1302.83	1276.47	1873.06	473.14	947.88	1731.50	1329.37	1592.75	1300.68
21	1976	1976	1277.89	1117.61	1475.23	1543.93	1927.86	1489.58	1718.04	602.11	510.02	1746.45	1507.38	1745.95	1385.34
22	1977	1977	1600.43	1476.66	1456.75	1912.65	1934.17	1517.52	1641.98	584.06	599.10	1751.26	1725.57	1646.75	1485.17
23	1978	1978	946.25	1126.45	1461.95	1541.10	1535.00	1472.01	1873.06	502.84	1773.42	1753.32	1596.43	1675.62	1435.42
24	1979	1979	1377.35	1426.27	1457.04	1689.76	1841.52	1694.63	1790.01	467.92	1176.98	1747.38	1725.57	846.21	1434.78
25	1980	1980	1077.25	1104.24	1459.47	1528.76	1934.17	1603.22	1825.64	573.83	1767.75	1750.44	1619.17	978.12	1431.25
26	1981	1981	933.47	1131.37	1471.81	1541.10	1340.79	1285.12	1253.41	676.90	495.17	1555.80	1627.72	1307.19	1219.19
27	1982	1982	995.72	1121.51	1476.49	1541.10	1340.79	1285.12	1873.06	456.71	1716.45	1745.84	1725.57	1279.37	1378.84
28	1983	1983	1348.93	1239.86	1476.48	1624.02	1817.76	1582.63	1751.78	463.05	683.12	1746.45	1725.57	947.43	1365.87
29	1984	1984	985.13	1136.30	1476.74	1541.10	1340.27	1510.45	1715.64	730.86	498.04	846.13	910.10	838.81	1126.59
30	1985	1985	950.66	1114.10	1471.80	1543.55	1340.27	1284.40	928.82	557.28	731.32	847.37	937.15	821.57	1043.18
31	1986	1986	965.43	1116.57	1466.86	1533.69	1323.01	1259.72	923.88	667.10	766.38	885.96	942.08	826.50	1055.86
32	1987	1987	906.47	1042.78	1420.10	1501.70	1290.97	1249.86	1058.59	524.92	469.99	880.55	1001.00	875.85	1018.04
33	1988	1988	965.43	1074.74	1476.73	1541.09	1340.79	1285.12	1114.85	699.21	667.17	895.30	962.52	847.93	1071.97
34	1989	1989	982.40	1091.69	1458.98	1543.70	1321.19	1237.92	970.27	890.88	895.55	939.90	947.21	788.15	1088.75
35	1990	1990	942.94	1127.16	1481.33	1562.38	1319.44	1284.60	986.08	724.28	631.29	833.37	948.67	847.04	1056.98
36	1991	1991	967.84	1106.84	1484.02	1558.39	1337.05	1284.57	995.67	683.04	594.95	895.38	884.61	786.95	1047.84
37	1992	1992	946.43	1111.07	1495.48	1543.04	1342.23	1277.85	974.23	581.68	750.96	866.32	877.92	823.35	1048.28
38	1993	1993	878.24	1110.21	1446.59	1557.99	1331.02	1272.82	950.63	588.60	634.08	854.25	909.76	773.61	1024.88
39	1994	1994	961.60	1088.10	1479.54	1535.36	1322.81	1242.62	923.88	560.47	780.48	866.55	999.07	875.04	1052.23
40	1995	1995	951.09	1074.13	1471.91	1521.36	1287.37	1255.74	951.35	676.45	625.81	842.77	931.31	865.98	1037.63
41	1996	1996	976.15	1053.84	1420.87	1538.51	1350.28	1230.80	953.42	588.85	517.55	781.40	912.66	797.00	1009.28
AVERAGE			1084.81	1144.71	1459.45	1561.76	1467.68	1390.82	1317.91	619.09	754.74	1210.93	1203.67	1083.51	1190.59
MAXIMUM			1806.93	1702.46	1495.48	1934.17	1934.17	1913.80	1873.06	895.26	1773.42	1756.94	1725.86	1745.95	1485.17
MINIMUM			878.24	984.65	1372.83	1486.01	1251.63	1230.80	923.88	441.03	384.17	781.40	877.92	773.61	1009.28

PERIOD AVERAGE CHANNEL FLOW (cms) : 21 CF2 Station Power Flow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	363.759	380.641	389.852	390.001	389.704	385.564	377.063	368.558	355.549	351.812	348.140	352.143	370.964
2	1957	1957	363.836	380.773	389.941	390.047	390.749	386.633	378.404	368.300	356.104	352.964	348.625	352.739	371.486
3	1958	1958	364.348	380.734	389.912	390.025	390.379	385.990	377.816	368.269	356.039	352.715	347.707	351.622	371.192
4	1959	1959	363.829	380.587	389.796	389.972	389.651	385.756	377.739	368.283	355.775	351.616	347.702	352.580	371.004
5	1960	1960	364.029	380.722	389.919	390.022	389.832	386.060	378.074	368.443	355.765	351.623	347.645	351.597	371.041
6	1961	1961	363.759	380.727	389.910	389.987	389.686	385.561	377.077	368.354	355.623	351.638	347.648	351.609	370.863
7	1962	1962	363.914	380.758	389.936	390.043	389.713	385.563	377.055	368.280	355.670	351.559	347.609	351.551	370.868
8	1963	1963	363.823	380.676	389.918	390.017	389.697	385.543	377.026	368.286	355.623	351.620	347.593	351.552	370.845
9	1964	1964	363.861	380.736	389.917	390.040	389.728	385.553	377.054	368.345	355.603	351.546	347.621	352.275	370.920
10	1965	1965	364.057	380.743	389.949	390.052	389.710	385.774	377.881	368.593	355.828	352.635	348.684	352.720	371.285
11	1966	1966	364.568	381.072	389.320	390.010	390.749	386.119	378.007	368.393	355.663	351.623	347.601	351.579	371.116
12	1967	1967	363.828	380.671	389.852	390.026	389.677	385.539	377.024	368.262	356.055	351.651	347.742	352.444	370.961
13	1968	1968	365.010	381.126	389.890	390.149	390.638	386.068	377.778	368.341	355.549	354.931	348.536	352.547	371.612
14	1969	1969	365.060	380.942	389.767	390.749	390.749	386.506	378.105	368.487	355.932	352.715	348.344	351.561	371.473
15	1970	1970	363.842	380.715	389.944	390.027	389.699	385.554	377.014	368.256	356.041	352.720	348.625	351.560	371.067
16	1971	1971	364.158	380.673	389.856	390.001	389.670	385.517	377.200	368.500	355.549	351.594	347.598	351.557	370.888
17	1972	1972	363.749	380.736	389.864	389.941	389.617	385.553	377.825	368.229	355.727	351.557	347.635	351.583	370.898
18	1973	1973	363.841	380.702	389.883	389.980	389.578	385.716	377.956	368.416	355.594	351.602	347.637	351.592	370.939
19	1974	1974	363.819	380.742	389.916	390.011	389.707	385.572	377.067	368.409	355.587	352.660	347.965	351.789	371.003
20	1975	1975	363.852	380.723	389.909	390.021	389.657	385.552	378.404	368.251	355.976	352.698	348.053	352.478	371.195
21	1976	1976	364.190	380.739	389.925	390.036	390.737	385.884	378.125	368.335	355.620	352.843	348.302	352.743	371.349
22	1977	1977	364.662	381.250	389.898	390.712	390.749	385.928	377.986	368.322	355.679	353.800	348.625	352.555	371.576
23	1978	1978	363.814	380.749	389.903	390.031	390.024	385.857	378.404	368.272	358.272	354.211	348.424	352.604	371.609
24	1979	1979	364.335	381.173	389.897	390.292	390.578	386.228	378.256	368.247	356.219	353.027	348.625	351.569	371.433
25	1980	1980	363.956	380.723	389.901	390.012	390.749	386.061	378.321	368.316	357.142	353.636	348.458	351.708	371.475
26	1981	1981	363.799	380.754	389.918	390.030	389.717	385.565	377.389	368.391	355.610	352.426	348.470	352.075	371.078
27	1982	1982	363.866	380.742	389.924	390.027	389.716	385.565	378.404	368.240	356.986	352.720	348.625	352.035	371.302
28	1983	1983	364.294	380.888	389.929	390.169	390.533	386.029	378.186	368.244	355.740	352.842	348.625	351.675	371.325
29	1984	1984	363.855	380.760	389.926	390.030	389.717	385.917	378.121	368.434	355.612	351.563	347.590	351.557	370.987
30	1985	1985	363.818	380.735	389.923	390.035	389.717	385.564	377.010	368.304	355.771	351.566	347.612	351.546	370.864
31	1986	1986	363.834	380.726	389.915	390.020	389.690	385.526	377.005	368.383	355.798	351.610	347.623	351.547	370.871
32	1987	1987	363.770	380.646	389.842	389.963	389.635	385.510	377.157	368.281	355.593	351.605	347.683	351.600	370.838
33	1988	1988	363.834	380.689	389.930	390.031	389.708	385.564	377.221	368.409	355.721	351.620	347.644	351.564	370.892
34	1989	1989	363.853	380.709	389.902	390.035	389.687	385.492	377.056	368.588	355.920	351.667	347.628	351.518	370.903
35	1990	1990	363.810	380.738	389.938	390.065	389.684	385.565	377.075	368.429	355.696	351.553	347.630	351.563	370.876
36	1991	1991	363.837	380.726	389.942	390.058	389.712	385.565	377.085	368.395	355.672	351.612	347.563	351.517	370.871
37	1992	1992	363.814	380.731	389.960	390.034	389.720	385.554	377.061	368.320	355.786	351.590	347.556	351.545	370.870
38	1993	1993	363.740	380.730	389.883	390.058	389.702	385.546	377.035	368.325	355.698	351.569	347.589	351.507	370.846
39	1994	1994	363.830	380.705	389.935	390.022	389.689	385.500	377.005	368.306	355.809	351.590	347.682	351.599	370.870
40	1995	1995	363.819	380.689	389.923	390.000	389.634	385.520	377.036	368.390	355.692	351.560	347.612	351.589	370.853
41	1996	1996	363.846	380.666	389.843	390.027	389.732	385.481	377.038	368.325	355.625	351.513	347.592	351.525	370.832
AVERAGE			363.988	380.768	389.888	390.069	389.937	385.734	377.550	368.354	355.876	352.185	347.948	351.859	371.077
MAXIMUM			365.060	381.250	389.960	390.749	390.749	386.633	378.404	368.593	358.272	354.931	348.684	352.743	371.612
MINIMUM			363.740	380.587	389.320	389.941	389.578	385.481	377.005	368.229	355.549	351.513	347.556	351.507	370.832

Gull Island

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD CAPACITY POTENTIAL (MW) : 5 Gull Island Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.70	2127.25	2102.80	2127.25	2238.73
2	1957	1957	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
3	1958	1958	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
4	1959	1959	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
5	1960	1960	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
6	1961	1961	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
7	1962	1962	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
8	1963	1963	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
9	1964	1964	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
10	1965	1965	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
11	1966	1966	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
12	1967	1967	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
13	1968	1968	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
14	1969	1969	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
15	1970	1970	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
16	1971	1971	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.70	2127.25	2102.80	2127.25	2238.73
17	1972	1972	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
18	1973	1973	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
19	1974	1974	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
20	1975	1975	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
21	1976	1976	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
22	1977	1977	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
23	1978	1978	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
24	1979	1979	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
25	1980	1980	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
26	1981	1981	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
27	1982	1982	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
28	1983	1983	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
29	1984	1984	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
30	1985	1985	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
31	1986	1986	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
32	1987	1987	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
33	1988	1988	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
34	1989	1989	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
35	1990	1990	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
36	1991	1991	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
37	1992	1992	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
38	1993	1993	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
39	1994	1994	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
40	1995	1995	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
41	1996	1996	2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
AVERAGE			2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
MAXIMUM			2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.71	2127.25	2102.80	2127.25	2238.73
MINIMUM			2200.61	2298.41	2347.32	2347.32	2347.32	2322.86	2273.96	2225.06	2151.70	2127.25	2102.80	2127.25	2238.73

PERIOD AVERAGE ENERGY (MW CONTINUOUS) : 5 Gull Island Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1388.13	1435.39	1570.86	1554.96	1368.30	1316.72	1091.17	1093.23	2151.70	1801.08	1598.59	1585.76	1496.61
2	1957	1957	1310.37	1215.17	1460.51	1560.26	1830.66	1838.11	1845.78	1699.80	2027.20	2098.92	2049.58	2127.25	1754.15
3	1958	1958	1606.11	1279.14	1494.43	1525.42	1659.89	1516.38	1505.52	1768.87	1813.87	1693.01	1123.26	1002.32	1498.78
4	1959	1959	1265.40	1524.00	1632.66	1587.70	1632.66	1482.66	1529.43	1730.24	1354.84	1226.74	1247.61	1863.92	1489.44
5	1960	1960	1427.44	1299.60	1486.06	1528.50	1414.91	1546.73	1666.24	1323.09	1377.55	1215.40	1194.24	1047.91	1377.32
6	1961	1961	1388.46	1291.10	1501.23	1572.45	1390.29	1324.65	1069.67	1533.74	1782.24	1189.43	1188.60	1026.00	1355.22
7	1962	1962	1118.93	1239.97	1470.27	1504.47	1357.27	1322.55	1106.22	1739.49	1627.97	1322.64	1259.24	1127.61	1350.47
8	1963	1963	1276.28	1377.26	1490.86	1536.27	1377.16	1347.14	1155.03	1721.15	1782.18	1222.13	1289.03	1123.92	1392.00
9	1964	1964	1210.59	1276.16	1492.26	1508.95	1339.66	1334.98	1108.34	1558.06	1867.49	1357.27	1235.99	1841.07	1427.24
10	1965	1965	1473.52	1264.52	1448.52	1491.51	1361.49	1436.09	1540.03	1033.20	1484.75	2127.25	1912.12	1807.73	1533.21
11	1966	1966	1893.54	2069.57	1532.55	1544.59	1811.26	1576.51	1603.28	1439.92	1645.68	1216.71	1271.38	1070.02	1553.71
12	1967	1967	1267.62	1384.46	1570.53	1525.42	1386.01	1348.60	1158.38	1797.86	1786.49	1328.93	1386.98	1853.87	1483.04
13	1968	1968	2060.08	1571.00	1523.60	1617.11	1791.17	1615.90	1513.91	1571.11	2151.71	2127.25	1989.48	1916.40	1787.35
14	1969	1969	2062.75	1770.10	1672.70	1926.46	1863.48	1797.98	1667.84	1220.16	1802.98	1872.83	1749.22	1119.65	1710.58
15	1970	1970	1242.48	1308.53	1459.64	1515.97	1369.60	1330.44	1173.66	1821.03	1814.10	1870.52	1827.43	1120.62	1490.27
16	1971	1971	1608.82	1380.13	1566.10	1549.19	1407.91	1377.57	1267.59	1186.98	2151.70	1267.60	1278.14	1128.49	1430.48
17	1972	1972	1405.57	1276.54	1549.85	1622.85	1472.49	1340.66	1554.25	1933.02	1486.05	1344.27	1210.73	1068.73	1439.49
18	1973	1973	1244.21	1332.45	1528.40	1577.16	1520.37	1435.92	1582.73	1384.29	1906.54	1253.20	1207.96	1056.91	1417.79
19	1974	1974	1282.24	1263.93	1493.56	1543.18	1365.00	1301.24	1082.83	1401.62	1934.29	1868.95	1426.79	1340.12	1443.02
20	1975	1975	1224.47	1296.68	1494.75	1527.10	1423.80	1335.62	1898.36	1842.56	1807.47	1782.53	1648.74	1856.46	1594.97
21	1976	1976	1483.21	1272.37	1479.47	1513.65	1798.09	1467.05	1635.14	1588.34	1864.86	1837.78	1829.54	2022.37	1647.56
22	1977	1977	1864.37	1628.49	1514.25	1863.49	1871.70	1504.44	1541.52	1622.75	2151.71	2127.25	1679.59	1772.19	1760.78
23	1978	1978	1431.95	1255.69	1504.48	1518.99	1546.96	1496.00	1910.88	1820.73	2151.71	2127.25	1912.51	1865.37	1712.31
24	1979	1979	1577.10	1633.47	1513.72	1644.96	1753.61	1639.06	1711.81	1857.24	2151.71	2127.25	1809.32	1098.60	1710.13
25	1980	1980	1355.59	1297.60	1509.12	1542.21	1843.26	1582.65	1823.17	1642.29	2151.71	2127.25	1839.05	1261.18	1663.46
26	1981	1981	1317.99	1246.43	1485.89	1519.00	1352.36	1319.36	1302.03	1445.98	1838.41	1852.50	1715.81	1586.20	1499.75
27	1982	1982	1200.24	1265.01	1477.09	1519.00	1352.36	1319.35	1887.58	1888.87	2151.71	1963.78	1718.55	1441.37	1599.81
28	1983	1983	1659.66	1361.58	1477.09	1575.48	1742.10	1534.51	1682.79	1870.97	1778.99	2037.63	1725.05	1325.91	1648.08
29	1984	1984	1220.25	1237.11	1476.60	1518.99	1353.32	1479.65	1629.38	1343.61	1830.25	1314.08	1294.45	1112.59	1400.68
30	1985	1985	1285.44	1278.98	1485.89	1514.34	1353.32	1320.71	1180.86	1673.88	1363.03	1311.75	1243.25	1145.19	1347.47
31	1986	1986	1257.48	1274.31	1495.18	1532.92	1385.80	1367.13	1190.18	1464.62	1296.49	1238.67	1233.92	1135.86	1323.27
32	1987	1987	1369.17	1413.79	1583.33	1593.25	1446.17	1385.73	1201.32	1735.71	1909.40	1248.92	1122.63	1042.70	1421.12
33	1988	1988	1257.49	1353.34	1476.60	1518.99	1352.35	1319.36	1196.49	1403.63	1485.01	1220.99	1195.27	1095.34	1323.10
34	1989	1989	1225.39	1321.30	1510.03	1514.07	1389.20	1408.21	1102.88	1041.44	1052.32	1136.68	1224.22	1208.44	1261.12
35	1990	1990	1300.06	1254.32	1467.96	1478.92	1392.50	1320.33	1073.14	1356.07	1553.40	1338.30	1221.45	1097.02	1321.38
36	1991	1991	1252.93	1292.67	1462.88	1486.42	1359.38	1320.38	1055.10	1434.34	1622.78	1220.82	1342.77	1210.71	1338.73
37	1992	1992	1293.45	1284.72	1441.32	1515.32	1349.66	1333.03	1095.39	1627.30	1325.75	1275.84	1355.44	1141.82	1337.85
38	1993	1993	1422.74	1286.34	1533.37	1487.18	1370.73	1342.49	1139.81	1614.09	1548.09	1298.69	1295.10	1236.00	1382.17
39	1994	1994	1264.75	1328.06	1471.30	1529.79	1386.18	1399.35	1190.18	1667.76	1269.77	1275.40	1126.26	1044.22	1330.28
40	1995	1995	1284.62	1354.47	1485.67	1556.14	1452.92	1374.65	1138.45	1446.85	1563.86	1320.47	1254.31	1061.29	1357.89
41	1996	1996	1237.21	1392.85	1581.87	1523.85	1334.53	1421.62	1134.55	1613.68	1775.22	1437.11	1289.48	1191.60	1412.17
AVERAGE			1398.00	1363.14	1509.08	1555.77	1490.97	1428.82	1388.85	1559.99	1746.17	1561.59	1451.78	1345.87	1483.52
MAXIMUM			2062.75	2069.57	1672.70	1926.46	1871.70	1838.11	1910.88	1933.02	2151.71	2127.25	2049.58	2127.25	1787.35
MINIMUM			1118.93	1215.17	1441.32	1478.92	1334.53	1301.24	1055.10	1033.20	1052.32	1136.68	1122.63	1002.32	1261.12

PERIOD AVERAGE CHANNEL FLOW (cms) : 26 Gull Island Power Flow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1819.23	1881.41	2059.77	2038.69	1792.72	1724.80	1428.45	1431.22	2832.79	2364.73	2096.45	2079.54	1962.86
2	1957	1957	1716.71	1591.31	1914.14	2045.67	2402.72	2412.63	2422.86	2231.21	2664.78	2758.80	2693.49	2797.26	2302.78
3	1958	1958	2106.37	1675.45	1958.89	1999.71	2177.02	1987.76	1973.46	2322.75	2381.76	2220.80	1470.60	1311.80	1965.22
4	1959	1959	1657.49	1998.34	2141.40	2081.92	1877.58	1943.42	2005.06	2271.56	1775.50	1606.68	1634.06	2447.23	1952.84
5	1960	1960	1870.85	1702.40	1947.85	2003.77	1854.08	2027.76	2185.46	1733.63	1805.44	1591.77	1563.91	1371.68	1804.90
6	1961	1961	1819.66	1691.20	1967.86	2061.80	1821.71	1735.26	1400.20	2011.53	2340.48	1557.62	1556.50	1342.91	1776.08
7	1962	1962	1464.90	1623.93	1927.02	1972.06	1778.18	1732.49	1448.23	2283.82	2136.10	1732.98	1649.41	1476.41	1769.79
8	1963	1963	1671.82	1804.76	1954.18	2014.03	1804.40	1764.89	1512.37	2259.51	2340.40	1600.62	1688.65	1471.57	1824.55
9	1964	1964	1585.39	1671.53	1956.03	1977.97	1754.97	1748.86	1451.00	2043.64	2453.56	1778.62	1618.82	2417.23	1871.04
10	1965	1965	1931.60	1656.22	1898.33	1954.96	1783.75	1882.00	2018.96	1352.35	1946.74	2803.81	2511.00	2372.66	2011.34
11	1966	1966	2486.66	2720.03	2009.20	2025.01	2377.02	2067.04	2102.36	1887.69	2159.53	1593.48	1665.40	1400.74	2037.82
12	1967	1967	1660.41	1814.24	2059.34	1999.70	1816.06	1766.82	1516.78	2361.20	2345.46	1741.20	1817.60	2434.03	1944.55
13	1968	1968	2707.29	2059.99	1997.38	2120.65	2350.50	2119.06	1984.56	2060.89	2832.11	2808.14	2613.77	2516.84	2347.57
14	1969	1969	2710.80	2323.39	2194.30	2529.72	2446.22	2359.57	2187.56	1598.07	2367.46	2458.93	2295.44	1465.94	2244.87
15	1970	1970	1627.32	1714.17	1912.99	1987.24	1794.43	1742.89	1536.87	2391.93	2382.06	2455.86	2398.79	1467.23	1954.20
16	1971	1971	2110.07	1808.54	2053.49	2031.08	1844.95	1805.01	1660.27	1554.44	2838.32	1660.47	1674.31	1477.56	1876.04
17	1972	1972	1842.23	1672.03	2032.03	2128.35	1930.12	1756.35	2037.76	2540.56	1948.57	1761.49	1585.59	1399.03	1887.15
18	1973	1973	1629.60	1745.70	2003.73	2068.01	1993.30	1881.81	2075.26	1814.32	2505.40	1641.49	1581.95	1383.51	1858.51
19	1974	1974	1679.67	1655.44	1957.74	2023.15	1788.37	1704.42	1417.49	1837.18	2542.25	2453.83	1869.91	1755.84	1891.80
20	1975	1975	1603.64	1698.56	1959.31	2001.92	1865.89	1749.72	2492.56	2420.49	2373.36	2339.29	2162.73	2437.43	2092.20
21	1976	1976	1944.28	1666.55	1939.15	1984.17	2359.60	1922.76	2144.36	2083.64	2450.04	2412.37	2401.88	2657.30	2161.51
22	1977	1977	2447.89	2135.81	1985.05	2446.26	2457.12	1972.05	2020.86	2129.19	2832.75	2800.78	2203.09	2325.71	2311.69
23	1978	1978	1876.96	1644.60	1972.15	1991.23	2028.13	1960.96	2509.16	2391.51	2838.87	2801.64	2511.76	2449.13	2248.58
24	1979	1979	2068.08	2142.44	1984.34	2157.35	2300.80	2149.56	2245.56	2439.97	2830.29	2797.89	2374.79	1438.28	2244.52
25	1980	1980	1776.20	1699.77	1978.27	2021.87	2419.42	2075.18	2392.96	2155.05	2840.85	2799.04	2414.32	1651.92	2183.91
26	1981	1981	1726.77	1632.42	1947.63	1991.23	1771.71	1728.28	1705.50	1895.69	2414.98	2432.23	2251.09	2080.16	1966.47
27	1982	1982	1571.78	1656.86	1936.01	1991.23	1771.71	1728.28	2478.26	2481.95	2829.34	2579.56	2254.59	1889.11	2098.80
28	1983	1983	2177.12	1783.95	1936.01	2065.68	2285.60	2011.66	2207.26	2458.19	2335.96	2677.48	2263.19	1737.20	2162.19
29	1984	1984	1598.08	1620.16	1935.37	1991.23	1772.98	1939.36	2136.76	1760.69	2404.16	1721.70	1695.79	1456.66	1835.85
30	1985	1985	1683.88	1675.24	1947.62	1985.09	1772.98	1730.06	1546.33	2196.88	1786.29	1718.63	1628.36	1499.52	1765.67
31	1986	1986	1647.06	1669.09	1959.88	2009.61	1815.80	1791.25	1558.59	1920.28	1698.58	1622.37	1616.10	1487.25	1733.73
32	1987	1987	1794.24	1852.92	2076.24	2089.26	1895.40	1815.77	1573.15	2278.80	2509.19	1635.85	1469.78	1364.85	1863.10
33	1988	1988	1647.07	1773.22	1935.36	1991.22	1771.69	1728.29	1566.77	1839.82	1947.19	1599.12	1565.26	1434.00	1733.52
34	1989	1989	1604.85	1731.00	1979.48	1984.73	1820.28	1845.41	1443.83	1363.17	1377.47	1488.27	1603.34	1582.67	1651.96
35	1990	1990	1703.15	1642.80	1923.97	1938.35	1824.63	1729.57	1404.75	1777.11	2037.49	1753.62	1599.70	1436.21	1731.28
36	1991	1991	1641.07	1693.27	1917.26	1948.25	1780.96	1729.63	1381.06	1880.33	2129.22	1598.89	1759.47	1585.67	1754.15
37	1992	1992	1694.44	1682.80	1888.84	1986.38	1768.15	1746.30	1433.99	2135.20	1737.15	1671.31	1776.18	1495.09	1752.98
38	1993	1993	1864.88	1684.94	2010.28	1949.25	1795.92	1758.76	1492.36	2117.72	2030.48	1701.42	1696.65	1618.92	1811.38
39	1994	1994	1656.63	1739.91	1928.38	2005.48	1816.30	1833.72	1558.58	2188.78	1663.39	1670.74	1474.55	1366.84	1743.08
40	1995	1995	1682.81	1774.72	1947.34	2040.26	1904.31	1801.15	1490.58	1896.84	2051.30	1730.13	1642.92	1389.27	1779.40
41	1996	1996	1620.40	1825.31	2074.31	1997.64	1748.21	1863.08	1485.46	2117.18	2331.17	1883.92	1689.25	1560.53	1851.08
AVERAGE			1832.42	1786.25	1978.24	2039.79	1954.53	1872.53	1820.33	2046.73	2293.86	2049.45	1903.43	1764.21	1945.39
MAXIMUM			2710.80	2720.03	2194.30	2529.72	2457.12	2412.63	2509.16	2540.56	2840.85	2808.14	2693.49	2797.26	2347.57
MINIMUM			1464.90	1591.31	1888.84	1938.35	1748.21	1704.42	1381.06	1352.35	1377.47	1488.27	1469.78	1311.80	1651.96

PERIOD AVERAGE CHANNEL FLOW (cms) : 27 Gull Island Spill

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	.00	.00	.00	.00	.00	.00	.00	.00	87.65	.00	.00	.00	7.20
2	1957	1957	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	42.54	3.50
3	1958	1958	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	1959	1959	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5	1960	1960	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	1961	1961	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7	1962	1962	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	1963	1963	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
9	1964	1964	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
10	1965	1965	.00	.00	.00	.00	.00	.00	.00	.00	.00	563.18	.00	.00	47.83
11	1966	1966	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
12	1967	1967	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	1968	1968	.00	.00	.00	.00	.00	.00	.00	.00	33.52	1101.50	.00	.00	96.31
14	1969	1969	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
15	1970	1970	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
16	1971	1971	.00	.00	.00	.00	.00	.00	.00	.00	528.00	.00	.00	.00	43.40
17	1972	1972	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
18	1973	1973	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
19	1974	1974	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
20	1975	1975	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
21	1976	1976	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
22	1977	1977	.00	.00	.00	.00	.00	.00	.00	.00	114.93	416.12	.00	.00	44.79
23	1978	1978	.00	.00	.00	.00	.00	.00	.00	.00	865.47	519.46	.00	.00	115.25
24	1979	1979	.00	.00	.00	.00	.00	.00	.00	.00	.00	117.91	.00	.00	10.01
25	1980	1980	.00	.00	.00	.00	.00	.00	.00	.00	930.08	261.46	.00	.00	98.65
26	1981	1981	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
27	1982	1982	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
28	1983	1983	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
29	1984	1984	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
30	1985	1985	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
31	1986	1986	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
32	1987	1987	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
33	1988	1988	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
34	1989	1989	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
35	1990	1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
36	1991	1991	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	1992	1992	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
38	1993	1993	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
39	1994	1994	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
40	1995	1995	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
41	1996	1996	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
AVERAGE			.00	.00	.00	.00	.00	.00	.00	.00	62.43	72.67	.00	1.04	11.39
MAXIMUM			.00	.00	.00	.00	.00	.00	.00	.00	930.08	1101.50	.00	42.54	115.25
MINIMUM			.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Muskrat Falls

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD CAPACITY POTENTIAL (MW) : 6 Muskrat Falls Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.129	774.230	765.331	774.230	814.801
2	1957	1957	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
3	1958	1958	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
4	1959	1959	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
5	1960	1960	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
6	1961	1961	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
7	1962	1962	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
8	1963	1963	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
9	1964	1964	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
10	1965	1965	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
11	1966	1966	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
12	1967	1967	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
13	1968	1968	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
14	1969	1969	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
15	1970	1970	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
16	1971	1971	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.126	774.230	765.331	774.230	814.801
17	1972	1972	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
18	1973	1973	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.129	774.230	765.331	774.230	814.801
19	1974	1974	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
20	1975	1975	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.828	783.130	774.230	765.331	774.230	814.801
21	1976	1976	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
22	1977	1977	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
23	1978	1978	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
24	1979	1979	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
25	1980	1980	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
26	1981	1981	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.131	774.230	765.331	774.230	814.801
27	1982	1982	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.829	783.130	774.230	765.331	774.230	814.801
28	1983	1983	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
29	1984	1984	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
30	1985	1985	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
31	1986	1986	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
32	1987	1987	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
33	1988	1988	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
34	1989	1989	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
35	1990	1990	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
36	1991	1991	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
37	1992	1992	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
38	1993	1993	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
39	1994	1994	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
40	1995	1995	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
41	1996	1996	800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
AVERAGE			800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.130	774.230	765.331	774.230	814.801
MAXIMUM			800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.829	783.131	774.230	765.331	774.230	814.801
MINIMUM			800.928	836.525	854.323	854.323	854.323	845.424	827.626	809.827	783.126	774.230	765.331	774.230	814.801

PERIOD AVERAGE ENERGY (MW CONTINUOUS) : 6 Muskrat Falls Station

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	595.297	609.464	651.435	639.525	563.372	542.055	453.366	460.428	783.129	774.230	667.818	663.529	617.297
2	1957	1957	556.104	502.256	598.165	640.587	744.316	748.842	754.655	753.707	783.130	774.230	765.331	774.230	699.219
3	1958	1958	670.689	533.543	614.582	625.272	676.754	620.379	616.927	786.408	783.130	693.161	467.487	417.081	625.443
4	1959	1959	535.604	652.196	681.112	655.270	594.624	612.357	630.371	768.134	588.382	521.785	525.370	774.230	628.201
5	1960	1960	601.063	543.530	610.517	626.777	580.837	632.005	682.458	572.855	599.359	516.253	503.437	439.635	575.789
6	1961	1961	595.455	539.375	617.877	647.948	574.076	545.955	442.757	674.484	783.130	503.533	500.649	428.816	571.396
7	1962	1962	463.833	514.397	602.906	615.138	558.018	544.910	460.796	772.512	719.621	568.552	535.190	478.898	569.945
8	1963	1963	540.917	581.309	612.850	630.510	567.687	556.908	484.778	763.843	783.130	519.530	549.743	477.090	589.282
9	1964	1964	508.848	532.088	613.522	617.315	549.418	550.980	461.826	686.137	783.130	585.369	523.849	774.230	598.873
10	1965	1965	620.896	526.384	592.336	608.883	560.050	590.475	630.608	430.789	644.759	774.230	765.326	744.940	624.529
11	1966	1966	792.964	836.518	633.116	634.514	735.552	643.958	655.697	629.399	728.037	516.891	541.120	450.554	648.960
12	1967	1967	536.694	584.807	651.278	625.270	571.995	557.610	486.450	800.103	770.140	567.358	587.693	774.230	626.276
13	1968	1968	800.921	653.455	628.681	663.324	729.461	663.240	622.016	692.391	783.130	774.230	765.331	774.226	712.442
14	1969	1969	800.928	749.383	700.248	787.327	759.072	734.191	682.370	522.688	783.130	774.230	728.858	474.986	708.090
15	1970	1970	524.423	547.884	597.733	620.700	564.007	548.762	493.940	809.827	783.130	773.134	754.983	475.467	625.538
16	1971	1971	678.272	582.712	649.160	636.731	582.623	571.708	529.236	506.475	783.126	541.743	544.436	479.339	590.493
17	1972	1972	603.745	532.271	641.317	672.160	613.907	553.620	638.893	809.827	651.701	579.044	511.483	449.913	605.150
18	1973	1973	525.263	559.523	630.984	650.205	637.035	592.241	647.700	602.546	783.129	534.700	510.140	444.074	592.598
19	1974	1974	543.852	526.088	614.151	633.844	561.768	534.528	449.259	610.914	783.130	774.230	595.588	565.961	599.953
20	1975	1975	515.640	542.101	614.738	626.079	590.353	551.297	778.281	809.828	783.130	734.286	693.552	774.230	667.863
21	1976	1976	620.029	530.224	607.329	619.578	729.929	601.157	666.994	700.615	783.130	754.949	765.331	774.230	678.942
22	1977	1977	776.806	675.601	624.154	760.102	762.770	616.894	628.082	717.038	783.130	774.230	688.242	733.735	711.385
23	1978	1978	612.905	522.062	619.423	622.183	635.231	615.259	783.886	809.827	783.130	774.230	765.325	774.230	693.368
24	1979	1979	657.951	680.329	623.883	672.247	714.050	669.535	698.239	809.827	783.130	774.230	746.817	464.652	691.433
25	1980	1980	571.437	542.526	621.692	633.374	749.978	648.357	746.780	726.343	783.130	774.230	765.331	533.444	674.355
26	1981	1981	561.258	517.537	610.452	622.185	555.622	543.373	537.354	632.341	783.131	774.230	709.383	666.107	626.661
27	1982	1982	503.762	526.637	606.184	622.184	555.623	543.373	773.427	809.829	783.130	774.227	705.859	601.409	651.023
28	1983	1983	696.757	565.303	606.185	643.883	710.001	627.428	686.967	809.827	783.130	774.230	708.795	564.809	681.552
29	1984	1984	513.566	512.985	605.963	622.184	556.095	605.901	664.511	582.816	783.130	564.387	552.371	471.525	586.296
30	1985	1985	545.389	533.448	610.449	619.941	556.095	544.029	497.476	741.384	592.325	563.258	527.394	487.554	568.772
31	1986	1986	531.767	531.173	614.936	628.899	571.885	566.652	502.037	641.302	560.029	527.607	522.847	482.950	557.131
32	1987	1987	586.120	599.026	657.438	657.945	601.170	575.682	500.451	770.733	783.130	532.609	468.273	437.058	597.632
33	1988	1988	531.769	569.705	605.960	622.181	555.618	543.375	495.427	611.881	651.205	518.986	503.939	463.042	556.218
34	1989	1989	516.066	554.086	622.111	619.805	573.559	586.590	459.121	434.862	440.365	477.669	518.087	518.519	526.721
35	1990	1990	552.509	521.398	601.755	602.795	575.160	543.821	444.454	588.864	683.999	576.149	516.746	463.867	556.104
36	1991	1991	529.539	540.148	599.307	606.434	559.033	543.870	435.563	626.706	717.137	518.889	575.864	519.636	564.510
37	1992	1992	549.289	536.239	588.872	620.384	554.281	550.028	455.453	719.211	574.238	545.760	582.034	485.878	564.101
38	1993	1993	612.047	537.034	633.375	606.792	564.545	554.647	477.302	712.914	681.460	556.888	552.689	531.966	585.617
39	1994	1994	535.284	557.395	603.399	627.374	572.065	582.286	502.037	738.491	547.016	545.557	470.059	437.818	560.334
40	1995	1995	545.006	570.243	610.335	640.108	604.452	570.284	476.639	632.741	689.011	567.486	532.780	446.260	573.836
41	1996	1996	521.849	588.864	656.748	624.507	546.902	593.100	474.717	712.607	783.130	623.905	550.134	510.404	599.439
AVERAGE			587.378	569.787	621.626	637.865	612.658	588.333	573.398	682.767	722.778	636.450	604.041	561.092	616.653
MAXIMUM			800.928	836.518	700.248	787.327	762.770	748.842	783.886	809.829	783.131	774.230	765.331	774.230	712.442
MINIMUM			463.833	502.256	588.872	602.795	546.902	534.528	435.563	430.789	440.365	477.669	467.487	417.081	526.721

PERIOD AVERAGE CHANNEL FLOW (cms) : 29 Muskrat Falls Power FLow

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1910.93	1958.41	2099.67	2059.49	1804.32	1733.40	1440.75	1463.92	2589.70	2518.23	2155.05	2140.54	1990.59
2	1957	1957	1780.11	1601.61	1920.54	2063.07	2415.52	2431.03	2450.96	2447.71	2566.59	2536.05	2504.26	2542.48	2270.27
3	1958	1958	2164.77	1705.15	1975.59	2011.51	2185.32	1995.06	1983.46	2560.15	2548.86	2241.00	1487.10	1322.10	2014.98
4	1959	1959	1711.99	2102.24	2200.10	2112.62	1908.68	1968.12	2028.66	2497.26	1887.80	1666.18	1678.06	2518.23	2023.05
5	1960	1960	1930.25	1738.30	1961.95	2016.57	1862.58	2034.16	2204.66	1835.93	1924.54	1647.87	1605.51	1395.78	1846.71
6	1961	1961	1911.46	1724.50	1986.66	2087.90	1840.01	1746.36	1406.00	2177.63	2550.67	1605.82	1596.30	1360.41	1833.54
7	1962	1962	1475.10	1641.73	1936.42	1977.46	1786.48	1742.89	1465.13	2512.32	2331.10	1821.58	1710.61	1524.61	1828.40
8	1963	1963	1729.62	1864.16	1969.78	2029.13	1818.70	1782.79	1543.97	2482.51	2550.67	1658.72	1758.95	1518.67	1893.16
9	1964	1964	1623.39	1700.33	1972.03	1984.77	1757.87	1763.06	1468.50	2217.14	2558.23	1877.72	1673.02	2518.23	1926.09
10	1965	1965	1996.80	1681.42	1901.03	1956.46	1793.25	1894.80	2029.46	1366.85	2077.14	2577.55	2492.43	2417.66	2016.83
11	1966	1966	2582.76	2738.94	2037.90	2042.61	2385.52	2074.44	2114.06	2025.39	2359.83	1649.98	1730.30	1431.54	2094.72
12	1967	1967	1715.61	1875.84	2099.14	2011.50	1833.06	1785.12	1549.48	2607.40	2504.16	1817.60	1885.50	2518.23	2017.36
13	1968	1968	2620.72	2106.49	2022.98	2139.85	2364.70	2139.56	2000.56	2238.39	2586.08	2601.14	2499.70	2522.80	2320.06
14	1969	1969	2620.71	2432.89	2265.10	2563.32	2466.12	2380.87	2204.36	1669.17	2548.86	2518.23	2362.64	1511.74	2295.26
15	1970	1970	1674.92	1752.77	1919.09	1996.14	1806.43	1755.69	1574.17	2641.25	2548.86	2514.46	2452.09	1513.33	2015.94
16	1971	1971	2190.47	1868.84	2091.99	2050.08	1868.55	1832.11	1690.87	1615.54	2619.55	1732.37	1741.31	1526.06	1902.33
17	1972	1972	1939.23	1700.93	2065.53	2169.75	1973.32	1771.85	2057.36	2651.56	2100.57	1856.59	1632.09	1429.43	1946.81
18	1973	1973	1677.70	1791.50	2030.73	2095.51	2051.10	1900.71	2087.06	1935.22	2561.71	1708.99	1627.65	1410.31	1904.71
19	1974	1974	1739.37	1680.44	1974.14	2040.35	1798.97	1708.42	1427.29	1963.28	2564.19	2518.23	1911.91	1812.94	1929.98
20	1975	1975	1645.84	1733.56	1976.11	2014.22	1894.39	1764.12	2532.16	2643.22	2548.86	2381.19	2242.33	2518.23	2158.10
21	1976	1976	1993.88	1694.15	1951.25	1992.37	2366.30	1930.56	2152.26	2266.34	2557.77	2451.97	2487.84	2530.73	2196.18
22	1977	1977	2527.09	2181.41	2007.75	2469.66	2478.82	1983.35	2020.96	2322.29	2589.50	2561.26	2224.29	2379.31	2310.98
23	1978	1978	1969.96	1667.10	1991.85	2001.13	2045.03	1977.86	2551.46	2641.01	2622.60	2565.87	2493.92	2518.23	2254.61
24	1979	1979	2121.68	2197.44	2006.84	2170.05	2312.10	2160.86	2258.26	2644.57	2576.40	2545.84	2424.09	1477.78	2241.99
25	1980	1980	1831.20	1734.97	1999.47	2038.77	2434.92	2089.28	2423.96	2354.05	2633.46	2551.94	2487.62	1704.82	2189.09
26	1981	1981	1797.27	1652.12	1961.73	2001.13	1778.51	1737.78	1717.80	2035.29	2555.65	2518.23	2296.19	2149.26	2018.68
27	1982	1982	1606.58	1682.26	1947.41	2001.13	1778.51	1737.78	2515.46	2647.49	2571.35	2525.87	2284.19	1931.41	2104.32
28	1983	1983	2253.22	1810.75	1947.41	2074.18	2298.30	2018.76	2219.96	2645.84	2548.86	2531.49	2294.19	1809.10	2204.74
29	1984	1984	1638.98	1637.06	1946.67	2001.13	1780.08	1946.46	2143.86	1869.19	2554.92	1807.70	1767.69	1500.36	1882.85
30	1985	1985	1744.48	1704.84	1961.72	1993.59	1780.08	1739.96	1585.83	2405.48	1900.99	1803.93	1684.76	1553.12	1823.39
31	1986	1986	1699.26	1697.29	1976.78	2023.71	1832.70	1815.25	1600.89	2065.48	1793.18	1685.47	1669.70	1537.95	1784.11
32	1987	1987	1880.24	1923.42	2119.94	2121.66	1930.60	1845.37	1595.65	2506.20	2561.97	1702.05	1489.68	1387.35	1922.54
33	1988	1988	1699.27	1825.42	1946.66	2001.12	1778.49	1737.79	1579.07	1966.52	2098.89	1656.92	1607.16	1472.50	1781.24
34	1989	1989	1647.25	1773.40	2000.88	1993.13	1838.28	1881.81	1459.63	1380.17	1398.17	1520.57	1653.94	1655.37	1683.50
35	1990	1990	1768.15	1664.90	1932.57	1936.05	1843.63	1739.27	1411.55	1889.41	2209.89	1846.92	1649.50	1475.21	1781.06
36	1991	1991	1691.87	1727.07	1924.36	1948.25	1789.86	1739.43	1382.46	2016.33	2322.62	1656.59	1845.97	1659.07	1809.21
37	1992	1992	1757.44	1714.10	1889.44	1995.08	1774.05	1759.90	1447.59	2329.70	1840.55	1745.71	1866.58	1547.59	1807.75
38	1993	1993	1967.08	1716.74	2038.78	1949.45	1808.22	1775.26	1519.36	2308.22	2201.28	1782.72	1768.75	1699.92	1879.58
39	1994	1994	1710.93	1784.41	1938.08	2018.58	1833.30	1867.42	1600.88	2395.58	1749.89	1745.04	1495.55	1389.84	1795.59
40	1995	1995	1743.21	1827.22	1961.34	2061.46	1941.60	1827.35	1517.18	2036.64	2226.90	1818.03	1702.62	1417.47	1840.27
41	1996	1996	1666.40	1889.41	2117.61	2008.94	1749.51	1903.58	1510.86	2307.18	2550.04	2006.92	1760.25	1628.53	1926.71
AVERAGE			1886.76	1826.96	1999.39	2054.22	1970.43	1888.28	1840.83	2209.39	2355.92	2060.50	1943.93	1801.91	1987.01
MAXIMUM			2620.72	2738.94	2265.10	2563.32	2478.82	2431.03	2551.46	2651.56	2633.46	2601.14	2504.26	2542.48	2320.06
MINIMUM			1475.10	1601.61	1889.44	1936.05	1749.51	1708.42	1382.46	1366.85	1398.17	1520.57	1487.10	1322.10	1683.50

ACRES INTERTEL LIMITED ACRES WATER RESOURCES SIMULATION PROGRAM (# A01000_3.10) 1998.09.23 09:57:27

PERIOD AVERAGE CHANNEL FLOW (cms) : 30 Muskrat Falls Spill

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	.00	.00	.00	.00	.00	.00	.00	.00	688.65	.00	.00	.00	56.60
2	1957	1957	.00	.00	.00	.00	.00	.00	.00	.00	301.69	307.45	290.83	417.12	109.89
3	1958	1958	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
4	1959	1959	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5	1960	1960	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6	1961	1961	.00	.00	.00	.00	.00	.00	.00	.00	31.01	.00	.00	.00	2.55
7	1962	1962	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8	1963	1963	.00	.00	.00	.00	.00	.00	.00	.00	30.94	.00	.00	.00	2.54
9	1964	1964	.00	.00	.00	.00	.00	.00	.00	.00	160.04	.00	.00	.00	13.15
10	1965	1965	.00	.00	.00	.00	.00	.00	.00	.00	.00	1005.74	84.47	.00	92.59
11	1966	1966	.00	85.49	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	7.03
12	1967	1967	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
13	1968	1968	174.47	.00	.00	.00	.00	.00	.00	.00	628.46	1392.19	211.37	79.55	209.20
14	1969	1969	173.89	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	14.77
15	1970	1970	.00	.00	.00	.00	.00	.00	.00	3.88	.00	.00	.00	.00	.33
16	1971	1971	.00	.00	.00	.00	.00	.00	.00	.00	1177.77	.00	.00	.00	96.80
17	1972	1972	.00	.00	.00	.00	.00	.00	.00	173.10	.00	.00	.00	.00	14.70
18	1973	1973	.00	.00	.00	.00	.00	.00	.00	.00	219.19	.00	.00	.00	18.02
19	1974	1974	.00	.00	.00	.00	.00	.00	.00	.00	261.26	.00	.00	.00	21.47
20	1975	1975	.00	.00	.00	.00	.00	.00	.00	36.36	.00	.00	.00	.00	3.09
21	1976	1976	.00	.00	.00	.00	.00	.00	.00	.00	152.27	.00	3.63	216.07	30.58
22	1977	1977	.00	.00	.00	.00	.00	.00	.00	.00	685.18	734.54	.00	.00	118.70
23	1978	1978	.00	.00	.00	.00	.00	.00	.00	.00	1226.54	811.63	110.83	.00	179.16
24	1979	1979	.00	.00	.00	.00	.00	.00	.00	58.59	466.80	474.26	.00	.00	83.62
25	1980	1980	.00	.00	.00	.00	.00	.00	.00	.00	1401.07	577.66	.00	.00	164.22
26	1981	1981	.00	.00	.00	.00	.00	.00	.00	.00	116.03	.00	.00	.00	9.54
27	1982	1982	.00	.00	.00	.00	.00	.00	.00	106.36	381.99	132.59	.00	.00	51.69
28	1983	1983	.00	.00	.00	.00	.00	.00	.00	79.35	.00	229.19	.00	.00	26.20
29	1984	1984	.00	.00	.00	.00	.00	.00	.00	.00	103.64	.00	.00	.00	8.52
30	1985	1985	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
31	1986	1986	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
32	1987	1987	.00	.00	.00	.00	.00	.00	.00	.00	223.52	.00	.00	.00	18.37
33	1988	1988	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
34	1989	1989	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
35	1990	1990	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
36	1991	1991	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	1992	1992	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
38	1993	1993	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
39	1994	1994	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
40	1995	1995	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
41	1996	1996	.00	.00	.00	.00	.00	.00	.00	.00	20.13	.00	.00	.00	1.65
AVERAGE			8.50	2.09	.00	.00	.00	.00	.00	11.16	201.86	138.18	17.10	17.38	33.05
MAXIMUM			174.47	85.49	.00	.00	.00	.00	.00	173.10	1401.07	1392.19	290.83	417.12	209.20
MINIMUM			.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

PERIOD AVERAGE CHANNEL FLOW (cms) : 31 Power Control Channel

SIM	YEAR OF HYD	OTH	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	AVE
1	1956	1956	1910.93	1958.41	2099.67	2059.49	1804.32	1733.40	1440.75	1463.92	3278.34	2518.23	2155.05	2140.54	2047.19
2	1957	1957	1780.11	1601.61	1920.54	2063.07	2415.52	2431.03	2450.96	2447.71	2868.28	2843.50	2795.09	2959.60	2380.17
3	1958	1958	2164.77	1705.15	1975.59	2011.51	2185.32	1995.06	1983.46	2560.15	2548.86	2241.00	1487.10	1322.10	2014.98
4	1959	1959	1711.99	2102.24	2200.10	2112.62	1908.68	1968.12	2028.66	2497.26	1887.80	1666.18	1678.06	2518.23	2023.05
5	1960	1960	1930.25	1738.30	1961.95	2016.57	1862.58	2034.16	2204.66	1835.93	1924.54	1647.87	1605.51	1395.78	1846.71
6	1961	1961	1911.46	1724.50	1986.66	2087.90	1840.01	1746.36	1406.00	2177.63	2581.68	1605.82	1596.30	1360.41	1836.09
7	1962	1962	1475.10	1641.73	1936.42	1977.46	1786.48	1742.89	1465.13	2512.32	2331.10	1821.58	1710.61	1524.61	1828.40
8	1963	1963	1729.62	1864.16	1969.78	2029.13	1818.70	1782.79	1543.97	2482.51	2581.60	1658.72	1758.95	1518.67	1895.70
9	1964	1964	1623.39	1700.33	1972.03	1984.77	1757.87	1763.06	1468.50	2217.14	2718.26	1877.72	1673.02	2518.23	1939.25
10	1965	1965	1996.80	1681.42	1901.03	1956.46	1793.25	1894.80	2029.46	1366.85	2077.14	3583.28	2576.90	2417.66	2109.43
11	1966	1966	2582.76	2824.43	2037.90	2042.61	2385.52	2074.44	2114.06	2025.39	2359.83	1649.98	1730.30	1431.54	2101.74
12	1967	1967	1715.61	1875.84	2099.14	2011.50	1833.06	1785.12	1549.48	2607.40	2504.16	1817.60	1885.50	2518.23	2017.36
13	1968	1968	2795.19	2106.49	2022.98	2139.85	2364.70	2139.56	2000.56	2238.39	3214.53	3993.33	2711.07	2602.34	2529.26
14	1969	1969	2794.60	2432.89	2265.10	2563.32	2466.12	2380.87	2204.36	1669.17	2548.86	2518.23	2362.64	1511.74	2310.02
15	1970	1970	1674.92	1752.77	1919.09	1996.14	1806.43	1755.69	1574.17	2645.13	2548.86	2514.46	2452.09	1513.33	2016.27
16	1971	1971	2190.47	1868.84	2091.99	2050.08	1868.55	1832.11	1690.87	1615.54	3797.32	1732.37	1741.31	1526.06	1999.13
17	1972	1972	1939.23	1700.93	2065.53	2169.75	1973.32	1771.85	2057.36	2824.66	2100.57	1856.59	1632.09	1429.43	1961.52
18	1973	1973	1677.70	1791.50	2030.73	2095.51	2051.10	1900.71	2087.06	1935.22	2780.90	1708.99	1627.65	1410.31	1922.73
19	1974	1974	1739.37	1680.44	1974.14	2040.35	1798.97	1708.42	1427.29	1963.28	2825.45	2518.23	1911.91	1812.94	1951.46
20	1975	1975	1645.84	1733.56	1976.11	2014.22	1894.39	1764.12	2532.16	2679.59	2548.86	2381.19	2242.33	2518.23	2161.19
21	1976	1976	1993.88	1694.15	1951.25	1992.37	2366.30	1930.56	2152.26	2266.34	2710.04	2451.97	2491.48	2746.80	2226.76
22	1977	1977	2527.09	2181.41	2007.75	2469.66	2478.82	1983.35	2020.96	2322.29	3274.68	3295.80	2224.29	2379.31	2429.68
23	1978	1978	1969.96	1667.10	1991.85	2001.13	2045.03	1977.86	2551.46	2641.01	3849.14	3377.50	2604.76	2518.23	2433.77
24	1979	1979	2121.68	2197.44	2006.84	2170.05	2312.10	2160.86	2258.26	2703.17	3043.19	3020.10	2424.09	1477.78	2325.62
25	1980	1980	1831.20	1734.97	1999.47	2038.77	2434.92	2089.28	2423.96	2354.05	4034.54	3129.60	2487.62	1704.82	2353.31
26	1981	1981	1797.27	1652.12	1961.73	2001.13	1778.51	1737.78	1717.80	2035.29	2671.68	2518.23	2296.19	2149.26	2028.22
27	1982	1982	1606.58	1682.26	1947.41	2001.13	1778.51	1737.78	2515.46	2753.85	2953.34	2658.46	2284.19	1931.41	2156.01
28	1983	1983	2253.22	1810.75	1947.41	2074.18	2298.30	2018.76	2219.96	2725.19	2548.86	2760.68	2294.19	1809.10	2230.95
29	1984	1984	1638.98	1637.06	1946.67	2001.13	1780.08	1946.46	2143.86	1869.19	2658.56	1807.70	1767.69	1500.36	1891.37
30	1985	1985	1744.48	1704.84	1961.72	1993.59	1780.08	1739.96	1585.83	2405.48	1900.99	1803.93	1684.76	1553.12	1823.39
31	1986	1986	1699.26	1697.29	1976.78	2023.71	1832.70	1815.25	1600.89	2065.48	1793.18	1685.47	1669.70	1537.95	1784.11
32	1987	1987	1880.24	1923.42	2119.94	2121.66	1930.60	1845.37	1595.65	2506.20	2785.49	1702.05	1489.68	1387.35	1940.91
33	1988	1988	1699.27	1825.42	1946.66	2001.12	1778.49	1737.79	1579.07	1966.52	2098.89	1656.92	1607.16	1472.50	1781.24
34	1989	1989	1647.25	1773.40	2000.88	1993.13	1838.28	1881.81	1459.63	1380.17	1398.17	1520.57	1653.94	1655.37	1683.50
35	1990	1990	1768.15	1664.90	1932.57	1936.05	1843.63	1739.27	1411.55	1889.41	2209.89	1846.92	1649.50	1475.21	1781.06
36	1991	1991	1691.87	1727.07	1924.36	1948.25	1789.86	1739.43	1382.46	2016.33	2322.62	1656.59	1845.97	1659.07	1809.21
37	1992	1992	1757.44	1714.10	1889.44	1995.08	1774.05	1759.90	1447.59	2329.70	1840.55	1745.71	1866.58	1547.59	1807.75
38	1993	1993	1967.08	1716.74	2038.78	1949.45	1808.22	1775.26	1519.36	2308.22	2201.28	1782.72	1768.75	1699.92	1879.58
39	1994	1994	1710.93	1784.41	1938.08	2018.58	1833.30	1867.42	1600.88	2395.58	1749.89	1745.04	1495.55	1389.84	1795.59
40	1995	1995	1743.21	1827.22	1961.34	2061.46	1941.60	1827.35	1517.18	2036.64	2226.90	1818.03	1702.62	1417.47	1840.27
41	1996	1996	1666.40	1889.41	2117.61	2008.94	1749.51	1903.58	1510.86	2307.18	2570.17	2006.92	1760.25	1628.53	1928.36
AVERAGE			1895.26	1829.05	1999.39	2054.22	1970.43	1888.28	1840.83	2220.55	2557.78	2198.68	1961.04	1819.29	2020.06
MAXIMUM			2795.19	2824.43	2265.10	2563.32	2478.82	2431.03	2551.46	2824.66	4034.54	3993.33	2795.09	2959.60	2529.26
MINIMUM			1475.10	1601.61	1889.44	1936.05	1749.51	1708.42	1382.46	1366.85	1398.17	1520.57	1487.10	1322.10	1683.50

Appendix I
Final Power Plant Characteristics CF1, CF2, Gull Island and Muskrat Falls

RSW - EDM Joint Venture

500 René-Lévesque Blvd. West, Suite 600, Montréal, Québec, Canada H2Z 1W7

Fax Transmittal

To:	S. Richter	**Date:**	November 18, 1998
Co.:	Acres International Ltd	**Fax No.:**	(709) 754-2717
From:	D.M. Coulson, Eng.	**O/Ref.:**	P16 1569.E166
Project:	Churchill Falls Powerplant Extension (CF2)		
Subject:	Updated Performance Characteristics		
N^br of Pages:	(2) (including this one)	**Copy:**	R. Besaw (CF(L)Co) C. Chartrand (RSW-EDM) C. P. Tran (RSW-EDM)

Message :

Dear Susan,

This is in response to Bob Besaw's facsimile dated November 16th, 1998. Please find attached a Table of the updated Performance Characteristics of the existing CF-1 and the new CF-2 Generating Stations. The attached table confirms our telephone conversation this morning.

Please note that we are in the process of evaluating the losses between the generator terminals and the 735 kV line connections and will advise you within the next few days if there is a change to the efficiency coefficient given in the attached table (98,7 %).

A question was raised in the third paragraph of the attachment to Bob Besaw's facsimile of November 16th, 1998 requesting an opinion as to whether or not non-availability of the machines for planned maintenance should be incorporated in the overall machine availability. We believe that this should be done consistently for all plants. By definition in a plant with a number of identical machines, planned maintenance can be done in periods of low discharge, sufficiently low that the absence of a machine for generation will have no effect on the annual energy produced from the available discharge. At this stage of evaluation, it would represent only a minor difference at CF-1 and CF-2 to take into account the two weeks per year per machine that the CF2 units would be down for inspection and calculate the reduced energy production by virtue of their replacement with a slightly less efficient CF-1 unit. Whether you incorporate this nuance at this time depends upon whether you want to be sure to have taken into account any known occurrence which will have the effect of reducing potential generation. The difference is approximately 1,7 % for one machine/month each year. RSW-EDM recommends that it be taken into account.

RSW - EDM Joint Venture

We give in the Table "weighted" unit efficiencies because we have not fixed during the "Final Feasibility Study" the definitive location of the best efficiency point. Because of the 8 % difference between the "Summer" and "Winter" thermal capacity of the CF-2 generators, we expect the optimal peak efficiency of the turbines will be at about 530 MW (523 MW at generator terminals).

We trust that the above fulfills your requirements at this time.

Best regards

DMC/mr

D.M. Coulson, Eng.
Project Manager

CHURCHILL FALLS POWER PROJECT

Plant Extension – CF2
Performance Characterisitics

Item N°	Characteristics	Value			
		CF-1 GE Canada (5 units)	CF-1 Alstom (6 units)	CF-2 (2 units)	Total (13 units)
1.	Installed Capacity (MW)	5428.5		1100	6528.5
2.	Maximum Output (MW)	5620		1188	6808
3.	Full Supply Level (m)	446.7		446.7	
4.	Weighted Unit Efficiency at Generator Terminals %	91.32	91.61	93.18	
5.	Efficiency Coefficient * Gen. Ter. To 735 kV Line connections %	98.7	98.7	98.7	
6.	Tailwater Level in Churchill River (m)	See RSW-EDM Report – Fig. 3.2.6.A & B			
7.	Gross Head f(Q) (m)	Function of Items 3. and 6.			
8.	Upstream Head Losses (m) (q = Penstock Discharge m^3/s)	$8.0 \times 10^{-5} q^2$		$4.9 \times 10^{-5} q^2$	
9.	Downstream Head Losses (m) (Q = Discharge in one T.R. tunnel in m^3/s)	$5.0 \times 10^{-6} Q^2$		$1.0 \times 10^{-5} Q^2$	
10.	Rated Net Head (at Rated Power) (m)	311.8	311.8	315.0	

*** Being recalculated 98-11-18 (to be confirmed)**

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 5
To S. RICHTER	From G. PILERCY
Co. ACRES	Co. NFLD HYDRO
Dept.	Phone # 737-1714
Fax # 754-2717	Fax # 737-1972

AGRA Monenco
ENGINEERING GLOBAL SOLUTIONS

Canada H3A 2V4
Tel.: (514) 499-3300
Fax.: (514) 499-3194
amql@monenco.agra.com

FAX

#053

To: Robert Barnes **Company:** NLH **Fax No.:** (709) 737-1972

From: Dave Robinson / (514) 499 3342

Date: November 20, 1998 **W.O.** SAJ 110244 **Total Pages:**

Subject: Gull Island Hydroelectric Development

As requested in your fax of November 16, 1998, we attach a data sheet with power station characteristics for the cases:

- With Muskrat Falls reservoir at elevation 39 m
- Without Muskrat Falls reservoir
- Without Muskrat Falls reservoir, and with 2 m of additional head from tailrace improvements.

As each succeeding case involves a larger net head, for comparative purposes, either the power or the rated flow is held constant. The table below shows the three cases for each.

Description	Units	With Muskrat Falls	Without Muskrat Falls	Without M.F. plus low TW
Constant Power alternatives				
Installed Capacity	MW	2264	2264	2264
Rated Flow	m^3/s	505	495	482
Average annual power	MW	1407	1433	1457
Annual Generation	GWh	12,917	13,153	13,373
Constant Rated Flow				
Installed Capacity	MW	2264	2311	2363
Rated Flow	m^3/s	505	505	505
Average annual power	MW	1407	1454	1458
Annual Generation	GWh	12,917	13,160	13,468

We trust this provides the information required. Please advise if anything further is needed.

[signature]

.99 → Transformer η
George Sturge

GULL ISLAND HYDROELECTRIC DEVELOPMENT

Power Station Characteristics

Power station characteristics are detailed below for three alternatives:

- With Muskrat Falls reservoir at elevation 39 m, constant rated flow,
- Without Muskrat Falls, constant rated flow,
- Without Muskrat Falls, plus tailrace improvements, constant rated flow.

The possible tailrace improvements would involve excavating the tailrace channel such that the tailwater level is lowered to the same level as Gull Lake. As no studies have been done to support this case, it is assumed to result in a 2 m lowering of the tailwater level.

The following characteristics are applicable for the three identified alternatives:

Characteristics	Units	With M.F.	Without M.F.	Without M.F., lowered TW.
Installed Capacity (HV side of transformer)	MW	2264	2311	2363
Full supply Level	m	125	125	125
Turbine Rated Capacity	MW	389	397	406
Turbine Efficiency at rated load	%	.934	.934	.934
Peak Turbine Efficiency	%	.955	.955	.955
Turbine/Generator Efficiency at rated flow	%	.92	.92	.92
Peak Turbine/Generator Efficiency	%	.94	.94	.94
Rated Head	m	84	85.8	87.8
Rated Turbine Flow	m^3/s	505	505	505
Turbine flow at peak efficiency	m^3/s	445	445	445
Head loss at rated flow	m	2	2	2
Head loss at peak efficiency flow	m	1.5	1.5	1.5
Tailwater at rated flow	m	39.5	38.2	36.3
Tailwater at peak efficiency flow	m	39.4	38.0	36.0
Net Head at rated flow	m	83.5	84.3	86.7
Net Head at peak efficiency flow	m	84.1	85.5	87.4

The tailwater rating curves are approximated by the following relationships:

- With Muskrat Falls reservoir at elevation 39 m,

$$Tw = 3.044x10^{-8} Q^2 + 6.597 \times 10^{-5} Q + 38.98$$

- Without Muskrat Falls,

$$Tw = \left(\frac{Q}{970}\right)^{0.746} + 35.92$$

- Without Muskrat Falls, and with tailrace lowered 2 m,

$$Tw = \left(\frac{Q}{970}\right)^{0.746} + 33.92$$

GULL ISLAND HYDROELECTRIC DEVELOPMENT

Power Station Characteristics

Power station characteristics are detailed below for three alternatives:

- With Muskrat Falls reservoir at elevation 39 m, constant rated capacity,
- Without Muskrat Falls, constant rated capacity
- Without Muskrat Falls, plus tailrace improvements, constant rated capacity.

The possible tailrace improvements would involve excavating the tailrace channel such that the tailwater level is lowered to the same level as Gull Lake. As no studies have been done to support this case, it is assumed to result in a 2 m lowering of the tailwater level.

The following characteristics are applicable for the three identified alternatives:

Characteristics	Units	With M.F.	Without M.F.	Without M.F., lowered TW.
Installed Capacity (HV side of transformer)	MW	2264	2264	2264
Full supply Level	m	125	125	125
Turbine Rated Capacity	MW	389	389	389
Turbine Efficiency at rated load	%	.934	.934	.934
Peak Turbine Efficiency	%	.955	.955	.955
Turbine/Generator Efficiency at rated flow	%	.92	.92	.92
Peak Turbine/Generator Efficiency	%	.94	.94	.94
Rated Head	m	84	85.8	88
Rated Turbine Flow	m^3/s	505	495	482
Turbine flow at peak efficiency	m^3/s	445	435	425
Head loss at rated flow	m	2	1.9	1.8
Head loss at peak efficiency flow	m	1.5	1.45	1.4
Tailwater at rated flow	m	39.5	38.2	36.2
Tailwater at peak efficiency flow	m	39.4	38.0	36.0
Net Head at rated flow	m	83.5	84.9	87
Net Head at peak efficiency flow	m	84.1	85.5	87.6

The tailwater rating curves are approximated by the following relationships:

- With Muskrat Falls reservoir at elevation 39 m.

$$Tw = 3.044 \times 10^{-8} Q^2 + 6.597 \times 10^{-5} Q + 38.98$$

- Without Muskrat Falls,

$$Tw = \left(\frac{Q}{970}\right)^{0.746} + 35.92$$

- Without Muskrat Falls, and with tailrace lowered 2 m,

$$Tw = \left(\frac{Q}{970}\right)^{0.746} + 33.92$$

Post-it™ brand fax transmittal memo 7671	# of pages ▸ [redacted] 1
To S. RICKER	From G. PIERCY
Co. ACRES	Co. NFLD HYDRO
Dept.	Phone # 737-1714
Fax # 754-2717	Fax # 737-1972

Bob Barnes 11/19/98 08:25 AM

To: Gerard Piercy/NLHydro@NLHydro
cc:
Subject: Muskrat Falls Plant Characteristics

Subject: Muskrat Falls Plant Characteristics

There were a couple of errors in our reply yesterday on plant characteristics. Therefore I am resending the data as below:

Characteristic		Value
Normal operating level = 39.0m		
Installed capacity at HV side Main Power Transform.	=	824 MW
" " " Generator terminals	=	832 MW
Weighted efficiency (turbine/generator)	=	92.5 %
Flow at best efficiency	=	2437 cms
Efficiency at max. plant flow(turbine/generator)	=	90.9 %
Max. plant flow	=	2667 cms
Hydraulic losses : at best effy. flow	=	0.43 m
" " : at max. flow	=	0.50 m
T.W.L. at best effy.	=	3.3 m
T.W.L. at max. flow	=	3.5 m
T.W.L. at mean flow	=	3.0 m
Net head at best effy.	=	35.27 m
Net head at max. flow	=	35.0 m

TAILRACE H-Q CURVE

Flow (cms)	1000	1500	2000	2500	3000	4000
T.W.L.(m)	2.0	2.6	2.9	3.4	3.8	4.6

To convert power and energy from generator terminals to HV side of main power transformers we have assumed a transform. effy = 99.0%.

We trust these changes will not cause you any problems.

Regards
P. Helwig/ M. Dessureault

Appendix J
Monthly Demand Pattern Used for Final Energy Simulations

Hydro Québec

November 4, 1998

Mr Madan S. Rana, P. Eng.
Director - Generating Engineering
& Telecontrol/EMS
Newfoundland and Labrador Hydro
Head Office, St.John's, Newfoundland
P.O.Box 12400
A1B 4K7

Ref: Churchill River Complex
Monthly demand factors and capacity curve
of the Atikonak control structure

Dear Madan,

To finalize the energy simulation for the Churchill Complex, we are sending you the revised demand factors. These factors take into consideration the internal demand of Quebec and Newfoundland-Labrador and also the external markets.

Month	Demand factor	Month	Demand factor	Month	Demand factor
Oct	0,8101	Feb	1,3349	June	0,8152
Nov	1,1023	Mar	1,1798	July	0,8784
Dec	1,2799	Apr	0,8590	Aug	0,8430
Jan	1,3564	May	0,8195	Sep	0,7385

Also, folowing the optimization study of the Romaine-St-Jean Diversion, a new control structure equipped with 4 gates (12,6m wide by 5,6m high) has been adopted. The capacity curve of the control structure is attached to this letter for use by ACRES to finalize the energy simulation.

Best regards,

Jerry Levay

c.c.
Fred Martin
Pierre Fortin
Christine Brunelle
Thach Tran-Van