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Impact of Climate Change on Hydroelectric Generation in Newfoundland

CCAF Project A283

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- Newfoundland Power: allowed use of operational models of their hydroelectric systems prepared for previous studies, and provided some financial and technical assistance.

- Newfoundland and Labrador Hydro: provided some financial and technical assistance.

- SGE Acres: contributed by foregoing profit from researchers' time spent on this project.

A stakeholder committee was formed to provide guidance to the technical team at SGE-Acres. Participating in the committee were Newfoundland Power (Ian Kerr, then Tony Chislett), Newfoundland and Labrador Hydro (David Harris), Government of Newfoundland Water Resources Division (Martin Goebel), and Donmec Consulting Inc (Desmond O'Neill).

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1 Introduction

1.1 Climate Change

It is widely accepted that climate change has been occurring for the past two hundred years as a result of the continuing industrialization of the global society. The phenomenon is believed to be due to the accumulation of greenhouse gases (primarily water vapour, carbon dioxide, methane, and nitrous oxide) in the atmosphere, which has the effect of reducing the radiation of heat into space. Some level of greenhouse gas is necessary since temperatures would be too low to sustain life on Earth without their effects; however, the concentration of these heat-trapping gases has increased such that the temperature in the atmosphere is reaching levels unprecedented in human history.

Although the effects of climate change are extremely difficult to quantify, some possible repercussions of global warming include more severe and frequent extreme weather events resulting in more frequent droughts and floods, water loss due to changed evaporation and precipitation patterns, a loss of coastal land due to an increase in mean sea level, a loss of habitat for species in the southern Arctic, and an increased risk of forest fires, to name a few. The environmental, social, and economic consequences cannot yet be fully quantified; however, it is clear that climate change is one of the largest environmental issues facing society today.

A change in climate will affect many different sectors of society. In Canada, water resources, fisheries, agriculture, forestry, transportation, infrastructure, and health are some of the sectors affected. Numerous investigations have been completed, and many others are currently ongoing, which endeavor to predict the climate of the future, to project the effects of this change in climate on any one of the affected sectors, and to measure the effectiveness of adaptation measures.

1.2 Effect of Climate Change on Hydroelectric Generation

The changes in temperature and precipitation associated with climate change will affect the quantity and distribution of runoff to streams and rivers. Since runoff is the “fuel” of hydroelectric generating plants, a change in climate could affect the quantity and timing of electricity produced at each plant.

Climate change will also affect the demand for hydroelectricity; warmer summer weather could increase energy needs for air conditioning, warmer winter weather would reduce the need for heating energy.

The focus of the current study is on the change in “normal” weather and its impact on day-to-day hydroelectric generation. It predicts future hydroelectric generation at various locations on the island of Newfoundland under five climate change scenarios derived by the Canadian Climate Impacts Scenarios (CCIS) project.

1.3 Objectives of Current Study

The objectives of the research were as follows

- to assess the sensitivity of Newfoundland Power’s (NP’s) hydroelectric generation to climate variability and climate change
- to assess the effect of factors such as location and volume of storage on the vulnerability of hydroelectric systems to climate change
- to consider how the presence of other water users in the system modify the impact of climate variability on generation. Examples of other users are municipalities or industries using the systems for water supply, or requirements for riparian releases for fisheries
- to investigate whether operational or physical changes at hydroelectric facilities would be effective adaptation strategies.

1.4 Approach

The approach taken to assessing the impact of climate change on hydroelectric generation in Newfoundland can be summarized into a number of steps.

- A brief literature review was undertaken to determine what other research had been done in this area.

- Four NP generating systems were chosen to study based on their size, location, the presence of other water users in the system, and the availability of stream flow and climate data representative of the drainage basin.

- For each chosen NP system, monthly climate data were obtained from the Meteorological Service of Canada (part of Environment Canada (EC)) for nearby climate gauges and monthly flow data were obtained from the Water Survey of Canada's (WSC's, also part of Environment Canada) hydrometric database.

- The EC climate and hydrometric data were used to develop monthly empirical climate-flow models to relate flow to temperature and precipitation at each location.

- Five climate change scenarios were chosen from the CCIS project to represent the range of global climate model (GCM) predictions for Newfoundland. The scenarios are presented as changes to temperature, in degrees Celsius, and percentage changes to precipitation, on a monthly basis.

- The temperature and precipitation changes were applied to the historic 30-year climate data, to generate climate sequences under climate change conditions. The empirical equations were then used to generate flow sequences under climate change conditions, based on the revised temperatures and precipitation. Daily flow sequences were derived from the monthly flow sequences based on historic variation of daily flows.

- The flow sequences under climate change conditions were run through an operation model of each generating system to determine reservoir inflows, water levels, reservoir releases and hydroelectric generation for each day in the 30-year period.

- The difference between generation using the climate change sequences and the base case was calculated to provide a measure of the impact of climate change.

- Various operational and physical modifications were made to the representation of the systems in the reservoir models to examine how the changes would affect the impact of climate change, and whether adaptation measures, for instance raising dams, would have positive affects on future energy generation.

1.5 Report Organization

This report describes each of the steps listed above in further detail, and provides a discussion of the results.

- Section 2 provides a summary of literature concerning research into the impact of climate change on hydroelectric generation.
- Sections 3 and 4 describe the NP systems and the climate and flow data used to represent conditions at each system.
- Section 5 describes in detail the methodology used to generate the baseline flow sequences and the flow sequences under climate change conditions. Included is a discussion of the climate change scenarios selected.
- Section 6 describes the operational modelling undertaken to predict hydroelectric generation under the various inflow condition.
- Section 7 discusses the impact of climate variability on hydroelectric generation, i.e. the variation in generation due to normal climate variation rather than climate change.
- Section 8 describes and discusses the results of the simulations, and Section 9 provides the study conclusions.
- Several appendices included at the end of the report provide additional information on methodology and more detailed results.

2 Literature Review

Descriptions of climate change and its potential impacts on temperature, precipitation and runoff are widely available in print and on-line. This literature review is focused only on research into the impact of climate change on hydroelectric generation.

A web-workshop, titled *Climate Scenarios for the Canadian Energy Sector*, was held in December 2001. It was organized by the Adaptation and Impacts Research Group of Environment Canada and funded by the Program on Energy Research and Development. Relevant conclusions from the synthesis report (Street et al 2002) are listed below.

- The utility of using downscaling techniques was questioned, due to the lack of observed data necessary in downscaling, and the inability to downscale to the level of small scale atmospheric events.

- Researchers should examine a range of climate scenarios, rather than a single best-estimate or mid-range scenario. This assists in risk management activities.

- Researchers should investigate socio-economic scenarios, such as changed generation or changed demand, as well as climate change scenarios.

- The challenge of constructing climate change scenarios that include extreme weather events has yet to be fully overcome.

- Energy researchers are focused more on long term than short term changes. In the short term, market prices have a far larger impact than climate change.

- Adaptation to the impacts of climate change involves planning energy systems to reduce the sensitivity of key assets, designing resilience and flexibility into the infrastructure and managing energy systems and institutions in a climate-resilient manner.

Filon (2000) reviews four studies, done in the 1980s and 1990s, that used general circulation models and hydrological models to predict hydrological changes in

Canada's major watersheds. The paper lists both the potential impacts of climate change on hydroelectric generation (including changes to runoff volume increasing or decreasing generation capacity, increased frequency of flooding leading to increased spill and spillway requirements, and decreased generation) and provides suggestions for adaptation. These generally relate to revised operation and to the design of spillways and plants.

Filon refers to studies that have suggested increase in annual runoff and therefore energy production in northern Canada and decreased runoff and energy in the south. Changes in the seasonal precipitation distribution have the potential to increase generation in spring, if storage is available for the additional flows. Higher temperatures could increase evapotranspiration and therefore reduce summer generation.

Robinson (1997) describes modelling studies on two hydroelectric systems in the south-eastern USA which examined both supply (hydrology) and demand impacts of climate change in the same simulations. The models used the maximum annual reservoir drawdown as an indicator of dam size required to maintain continuous demand; the systems are used to meet peak energy demands. The climate change scenario modelled was a uniform 2 degree Celsius increase in temperature and a 10 percent decrease in precipitation. The timing and duration of dry spells and their correspondence to temperatures had the most significant impact on generation capability. The required drawdown increased on average 10 to 15 percent but with extremes up to 50 percent. The conclusion was that climate change could lead to reduced or less reliable hydroelectric generation.

A similar study was undertaken by Garr and Fitzharris (1994) for hydroelectric stations in mountainous regions of New Zealand. Their climate change scenarios considered an increase in precipitation of 10 percent and both a 2 and 3 degree Celsius increase in temperature. Both supply and demand implications of two climate change scenarios on hydroelectric generation were considered. For this region, the conclusion was that the system was made less vulnerable to climate variability because runoff increased and demand decreased.

A study of one glacial fed hydroelectric system in Switzerland lead to the tentative conclusion that increased temperatures would increase generation, but only if additional storage capacity could be provided (Westaway 2000).

Mimihou and Baltas (1997) examine the impact of several climate change scenarios on annual production from a hydroelectric station in northern Greece. Their conclusions suggest that climate change will lead to reduced reliability of hydroelectric generation from stations designed and operated based on current climate conditions. Their model suggests that, depending on the scenario examined, increases in storage of 12 to 50 percent would be required to maintain energy yields at the current risk levels.

Chapter seven of the Canada Country Study, Climate Impacts and Adaptation in the Energy Sector (Mercier 1998) indicates that 56 percent of Canada's generation is from hydroelectricity. Generation and changes in demand are the key impacts of climate change in the energy sector. The study suggests that generation may increase in Northern Quebec and Labrador, but could decrease in southern Ontario, the Prairies and south-eastern British Columbia. Demand changes from heating and cooling could increase or decrease.

There is general agreement among the various authors that climate change will have an impact on generation. The conclusions of the studies varied, however, suggesting perhaps, that direction and magnitude of the impacts will vary by system and by location.

3 Newfoundland Power Systems

There are two electrical utilities in the province of Newfoundland and Labrador: Newfoundland Power (NP) and Newfoundland and Labrador Hydro (NLH). Most generation is provided by NLH which also distributes to customers in Labrador and many of the more remote communities on the Island. NLH supplies 90 percent of the energy distributed by NP to consumers on the Island. NP generates the balance from 23 small hydroelectric generation stations (in 19 systems), five diesel-generating stations, and three gas turbine facilities. The location of each Newfoundland Power system is shown in Figure 3.1.

SGE Acres (then Acres International) conducted a *Water Management Study* for NP in 2000 to estimate the long-term production of each of the 19 hydroelectric systems. Reservoir simulation models set up for that study synthesized generation at each station over a time period of 15 years based on input characteristics of the systems and NP's operating rules. NP made these models available for this study to estimate hydroelectric production under the various climate scenarios.

Four of NP's systems were examined in this study. The selection of which of the 19 NP systems to use was based on factors such as the number of stations in the system and the installed capacity of each, the geographical location (whether coastal or inland), the amount of storage in the system, and the presence of other water users in the basin. Also critical in the selection was the availability of good quality, overlapping hydrological and meteorological records for the development of empirical flow models. A more detailed description of each of the four selected systems is included in the following sections.

3.1 Rose Blanche Brook System

The Rose Blanche Brook System is located on the south coast of Newfoundland near the community of Rose Blanche. It is NP's newest generating system, commissioned in 1998. Rose Blanche Brook station has two units with nameplate capacities of 3.0 MW each. The two units share a single generator. The rated net head is 114.2 m. The total drainage area above the intake to the penstock to Rose Blanche Brook station is 53 km^2. The only controlled storage in the system is the forebay, which is relatively small; Rose Blanche is essentially a run-of-river station.

A schematic of the Rose Blanche Brook system is shown in Figure 3.2. There is one overflow spillway on the Rose Blanche Brook Forebay. The spill re-enters Rose Blanche Brook downstream of the station.

The average annual precipitation recorded at the Port aux Basques meteorological station, located approximately 10 km west of Rose Blanche, is 1533 mm. Further description of the climate at this station is included in Section 4.0.

3.2 Lookout Brook System

The Lookout Brook system is located on the West Coast of Newfoundland near the community of St. George's. The Lookout Brook generating station contains two generating units with nameplate capacities of 2.95 MW and 3.25 MW with a rated net head of 154.5 m. The drainage area above the intake is approximately 82 km^2. The station was commissioned in 1945. Storage is provided by structures at Cross Pond and Joe Dennis Pond with Lookout Brook Forebay acting as the headpond for the Lookout Brook station. A schematic of the system is shown in Figure 3.3.

All major storage reservoirs are in series, with Cross Pond being the most upstream reservoir in the system. There is an overflow spillway located on Cross Pond, which when overtopped, would lead to spill out of the system. Water is released from Cross Pond to Joe Dennis Pond using the control structure located at its outlet. Water entering Joe Dennis Pond is stored, spilled within the system or released downstream to Lookout Brook Forebay using the control structure located at its outlet. Water from upstream reservoirs entering Lookout Brook Forebay is either spilled out of the system or used for generation.

The structures in the system are as follows

- Cross Pond gated outlet
- Cross Pond overflow spillway
- Joe Dennis Pond gated outlet
- Joe Dennis Pond overflow spillway
- Lookout Brook Forebay overflow spillway.

The average annual precipitation recorded at Stephenville, located approximately 30 km northwest of the generating station is 1279 mm. Further description of the climate at this station is included in Section 4.0.

3.3 Pierres Brook System

The Pierres Brook system is located on the southern shore of the Avalon Peninsula in eastern Newfoundland. The Pierres Brook generating station was commissioned in 1931 and has a nameplate capacity of 4.3 MW and a rated net head of 76.0 m. Storage is provided by structures at Gull Pond, Big Country Pond, and Witless Bay Country Pond. The total drainage area above the intake of the Pierres Brook station is approximately 116 km^2.

Figure 3.4 is a schematic of the Pierres Brook system. Controlled releases and spill from Big Country Pond, and controlled releases from Witless Bay Country Pond, are discharged into Gull Pond. Spill from Witless Bay Country Pond is discharged out of the system. Gull Pond is the forebay for the generating station. Spill from Gull Pond is discharged out of the system.

The structures in the system are as follows

- Witless Bay Country Pond gated outlet
- Witless Bay Country Pond overflow spillway
- Big Country Pond gated outlet
- Big Country Pond overflow spillway
- Gull Pond overflow spillway.

The Witless Bay Country Pond and Gull Pond spillways discharge out of the system; the Big Country Pond spillway discharges within the system.

A fish processing plant withdraws water for industrial use intermittently from the penstock. This demand is not metered; information from other fish plants suggests a maximum of 2000 m^3/day (about 0.023 m^3/s). Over a single year, this amount would be less than one-half percent of the estimated mean annual flow through the generating station.

The average annual precipitation recorded at St. John's Airport, located approximately 25 km north of Pierres Brook is 1499 mm. Further description of the climate at this station is included in Section 4.0.

3.4 Petty Harbour System

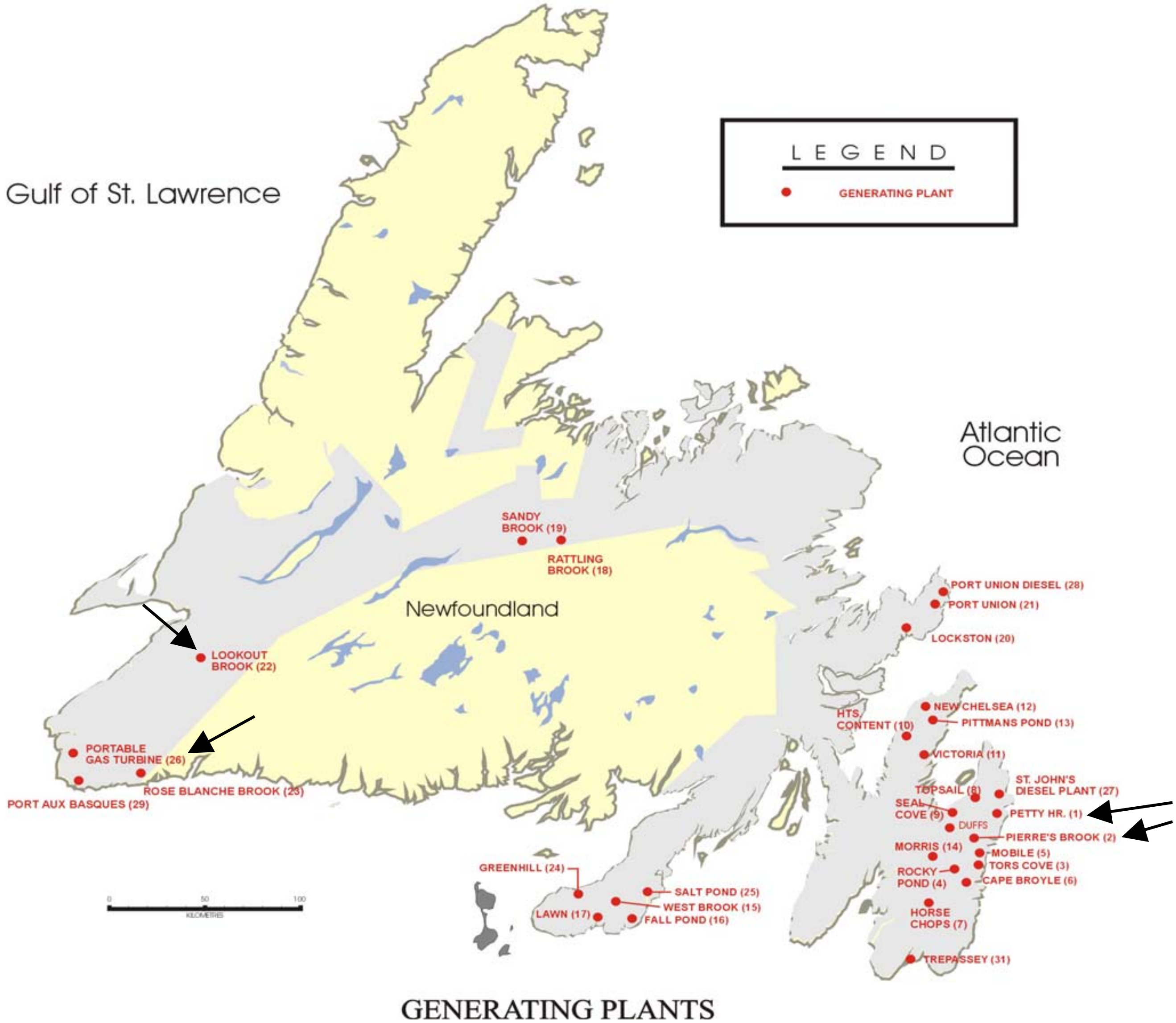
The Petty Harbour system is located on the east coast of the Avalon Peninsula of Newfoundland. The system was commissioned in 1900 and has a nameplate capacity of 5.3 MW and a rated head of 57.9 m. Storage is provided by structures at Bay Bulls Big Pond, Cochrane Pond, and Petty Harbour Forebay. The total drainage area above the intake of the Petty Harbour generating station is approximately 136 km^2.

A schematic of the system is shown in Figure 3.5. The drainage area falls largely within the municipal boundary of the City of St. John's. Bay Bulls Big Pond is the largest storage reservoir and is primarily used as a municipal water supply for the Regional Water System, serving the City of St. John's, the City of Mount Pearl, the Town of Conception Bay South, and the Town of Paradise. Spill and controlled releases from Bay Bulls Big Pond are discharged into Raymond Brook, which flows into the forebay. Controlled releases from Cochrane Pond are discharged into Paddy's Pond, part of the adjacent Topsail Hydroelectric System. The forebay, comprised of First Pond and Second Pond, is located near the community of Goulds. The generating station is located in the community of Petty Harbour and draws flow from the forebay through a single penstock. Spill from the forebay is discharged around the station and out of the system.

The structures in the system are as follows

- Bay Bulls Big Pond overflow spillway
- Bay Bulls Big Pond gated outlet
- Cochrane Pond overflow spillway
- Cochrane Pond gated outlet
- Petty Harbour Forebay overflow spillway.

The data from St. John's Airport climate station, located approximately 10 km north of Petty Harbour, was used for this system as well as for Pierres Brook. The average annual precipitation at is 1499 mm. Further description of the climate at this station is included in Section 4.0.



Notes:

Arrows show locations of systems examined in this study

Numbers in brackets following plant name are not significant for this study

Figure 3.1

Location of Newfoundland Power Generating Systems

Impact of Climate Change on Hydroelectric Generation in Newfoundland

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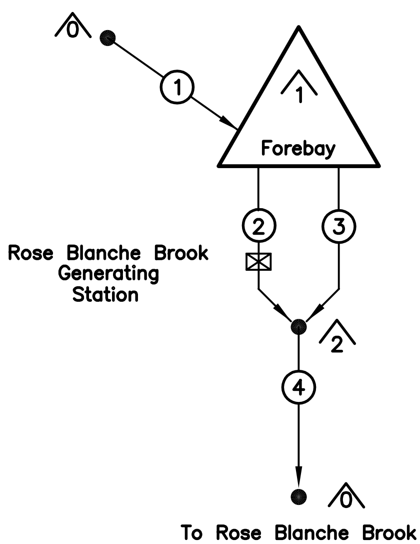

CHANNELS

1 — Rose Blanche Brook Inflow

2 — Rose Blanche Brook Power Flow Units #1 and #2

3 — Rose Blanche Brook Spill

4 — Rose Blanche Brook Total Outflow

RESERVOIRS / NODES

0 — Source / Sink

1 — Rose Blanche Brook Forebay

2 — Rose Blanche Brook Total Outflow

FIG 3.2

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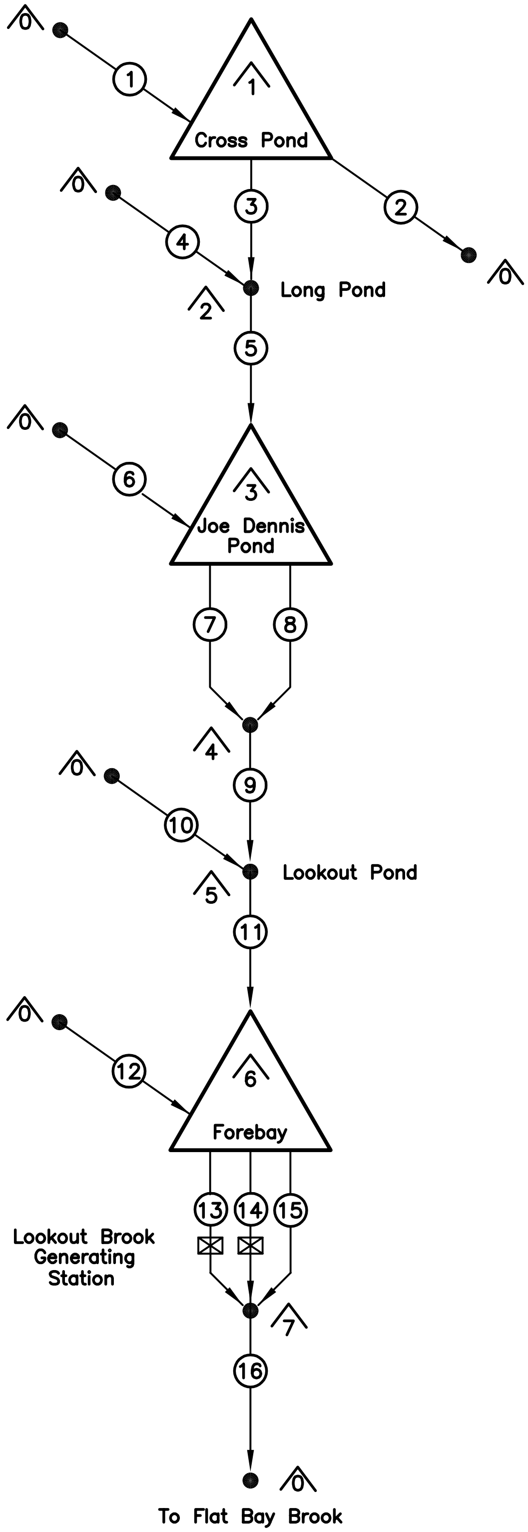
CLIMATE CHANGE IMPACTS AND ADAPTATION DIRECTORATE

IMPACT OF CLIMATE CHANGE ON HYDROELECTRIC GENERATION IN NEWFOUNDLAND

ARSP MODEL SCHEMATIC – ROSE BLANCHE BROOK SYSTEM



CHANNELS

- (1) — Cross Pond Local Inflow
- (2) — Cross Pond Spill
- (3) — Cross Pond Canal
- (4) — Long Pond Local Inflow
- (5) — Long Pond to Joe Dennis Pond General Flow
- (6) — Joe Dennis Pond Local Inflow
- (7) — Joe Dennis Pond Spill
- (8) — Joe Dennis Pond Outlet Gate
- (9) — Joe Dennis Pond To Lookout Pond General Flow
- (10) — Lookout Pond Local Inflow
- (11) — Lookout Pond To Forebay General Flow
- (12) — Lookout Brook Forebay Local Inflow
- (13) — Power Flow (LBK–G3)
- (14) — Power Flow (LBK–G4)
- (15) — Lookout Brook Spill
- (16) — Lookout Brook General Outflow

RESERVOIRS / NODES

- 0 — Source / Sink
- 1 — Cross Pond
- 2 — Long Pond
- 3 — Joe Dennis Pond
- 4 — Joe Dennis Pond Total Outflow
- 5 — Lookout Pond
- 6 — Lookout Brook Forebay
- 7 — Lookout Brook Total Outflow

FIG 3.3

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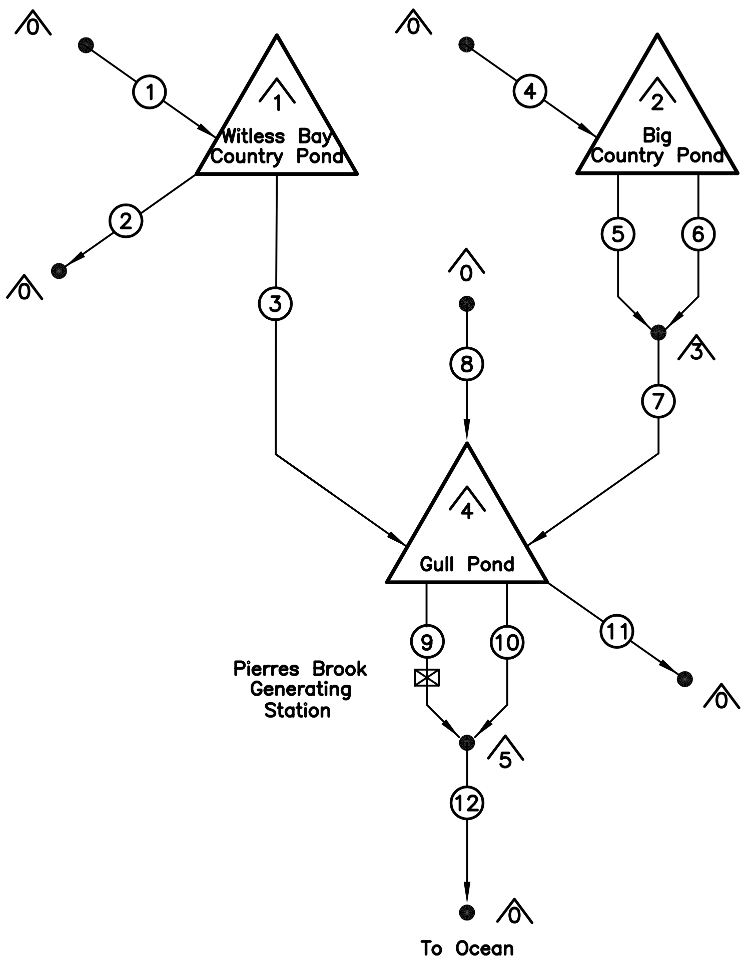
CLIMATE CHANGE IMPACTS AND ADAPTATION DIRECTORATE

IMPACT OF CLIMATE CHANGE ON HYDROELECTRIC GENERATION IN NEWFOUNDLAND

ARSP MODEL SCHEMATIC – LOOKOUT BROOK HYDROELECTRIC SYSTEM



CHANNELS

(1) — Witless Bay Country Pond Local Inflow
(2) — Witless Bay Country Pond Spill
(3) — Witless Bay Country Pond Outlet Gate
(4) — Big Country Pond Local Inflow
(5) — Big Country Pond Outlet Gate
(6) — Big Country Pond Spill
(7) — Big Country Pond Total Outflow
(8) — Gull Pond Local Inflow
(9) — Pierres Brook Power Flow
(10) — Pierres Brook Spill
(11) — Fish Plant Demand
(12) — Pierres Brook Total Outflow

RESERVOIRS / NODES

0 — Source / Sink
1 — Witless Bay Country Pond
2 — Big Country Pond
3 — Big Country Pond Total Outflow
4 — Gull Pond (Forebay)
5 — Pierres Brook Total Outflow

FIG 3.4

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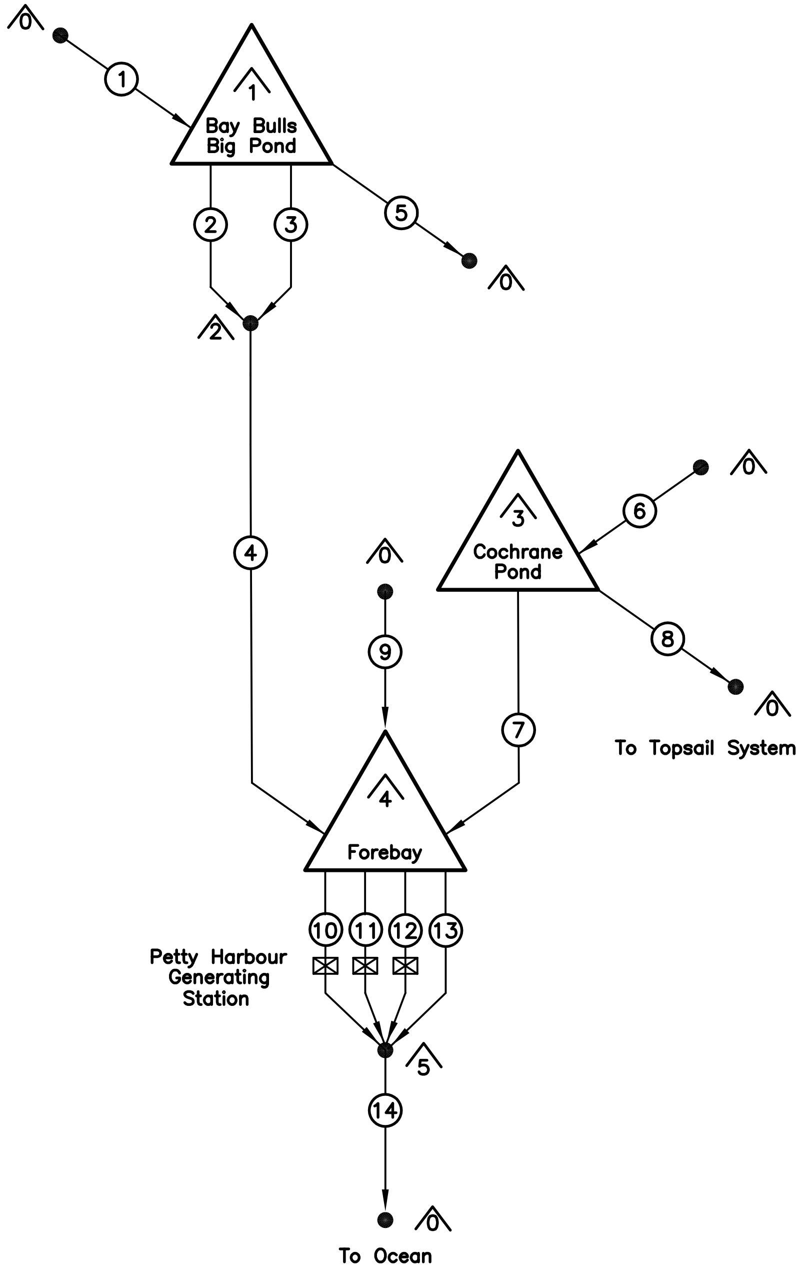
CLIMATE CHANGE IMPACTS AND ADAPTATION DIRECTORATE
IMPACT OF CLIMATE CHANGE ON HYDROELECTRIC GENERATION IN NEWFOUNDLAND

ARSP MODEL SCHEMATIC – PIERRES BROOK HYDROELECTRIC SYSTEM



CHANNELS

- (1) — Bay Bulls Big Pond Local Inflow
- (2) — Bay Bulls Big Pond Outlet Gate
- (3) — Bay Bulls Big Pond Spill
- (4) — Bay Bulls Big Pond Total Outflow
- (5) — Regional Water Supply Demand
- (6) — Cochrane Pond Local Inflow
- (7) — Cochrane Pond Outlet Gate
- (8) — Cochrane Pond Spill
- (9) — Forebay Local Inflow
- (10) — Petty Harbour Unit 1
- (11) — Petty Harbour Unit 2
- (12) — Petty Harbour Unit 3
- (13) — Petty Harbour Spill
- (14) — Petty Harbour Total Outflow

RESERVOIRS / NODES

- 0 — Source / Sink
- 1 — Bay Bulls Big Pond
- 2 — Bay Bulls Big Pond Total Outflow
- 3 — Cochrane Pond
- 4 — Forebay (First Pond and Second Pond)
- 5 — Petty Harbour Total Outflow

FIG 3.5

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CLIMATE CHANGE IMPACTS AND ADAPTATION DIRECTORATE

IMPACT OF CLIMATE CHANGE ON HYDROELECTRIC GENERATION IN NEWFOUNDLAND

ARSP MODEL SCHEMATIC – PETTY HARBOUR HYDROELECTRIC SYSTEM

4 Environment Canada Climate and Hydrological Data

There are no inflow or climate records in the basins at the NP systems examined in this study. For the purpose of this analysis, climate and hydrometric records from nearby Environment Canada (EC) meteorological and hydrometric stations were used. Table 4.1 summarizes the meteorological and hydrometric stations used in the study; the selections were based on previous work for NP during the *Water Management Study*.

Table 4.1
Hydrological and Meteorological Data Sources

System	Hydrometric Station		Meteorological Station		Period of Record Used
Rose Blanche	NF02ZB001 Isle aux Morts River below highway bridge	Oct 1962 to present	8402975 Port aux Basques	1909 to Apr 1997	Nov 1962 to Apr 1997 (414 months)
Lookout Brook	NF02ZA001 Little Barachois Brook near St. George's	Nov 1978 to May 1997	8403800 Stephenville	1942 to present	Nov 1978 to May 1997 (223 months)
Pierres Brook, and Petty Harbour	NF02ZM008 Waterford River at Kilbride	Jan 1974 to present	8403506 St. John's	1942 to present	Jan 1974 to Dec 1997 (288 months)

In the development of the monthly flow models for each system, historic data were used for every month where both flow and climate data were available. The periods of record for each station are also listed in Table 4.1. It is likely that orographic effects and relative proximities of the climate stations and hydroelectric systems to the ocean would result in differences in volume of precipitation between the two locations. These differences, however, would be indirectly taken into account by the regression analyses to estimate the parameters of the climate-flow models.

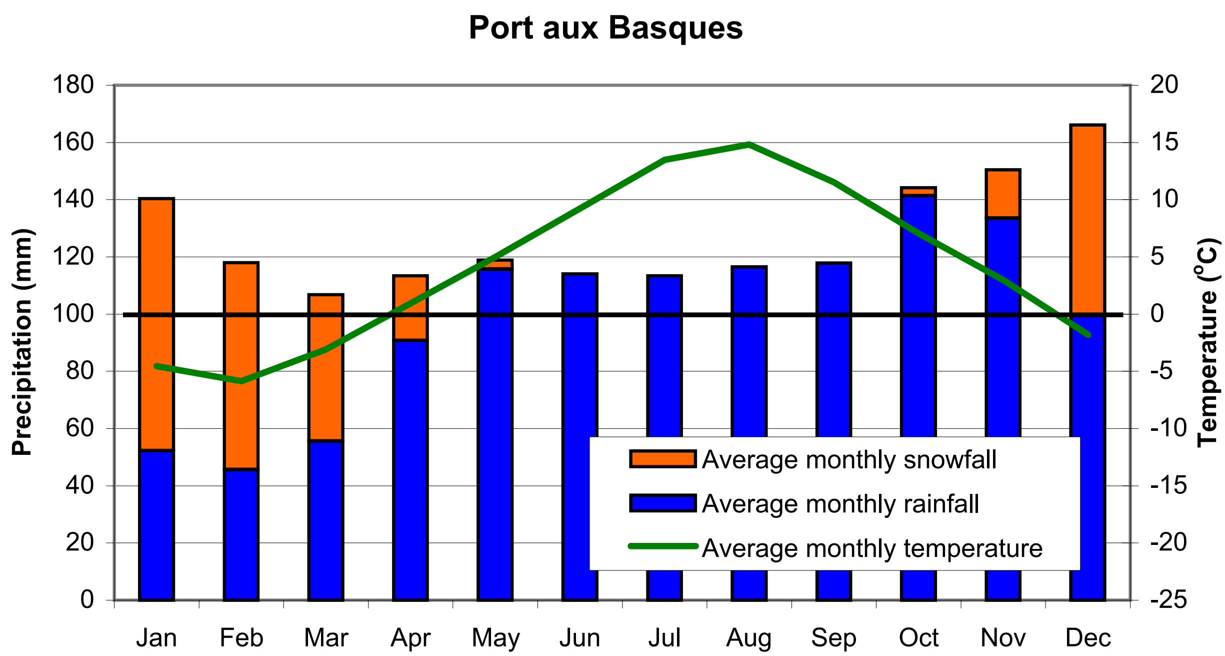
For the Rose Blanche System, a gauge on Isle aux Morts River (Isle aux Morts River Below Highway Bridge, 02ZB001) was used to synthesize project inflows and the climate station at Port aux Basques was used to estimate temperature and precipitation in the basin. In the modelling, the inflow to the Rose Blanche is modelled as 0.2540 times the Isle aux Morts flow. The proration factors for each station were calculated during the *Water Management Study* based on differences in drainage area and mean annual runoff.

For the Lookout Brook System, a gauge on Little Barachois Brook (Little Barachois Brook near St. Georges, 02ZA001) was used to synthesize project inflows and the climate station at Stephenville was used to estimate temperature and precipitation in the basin. In the modelling, the total inflow to Lookout Brook is modelled as 0.6282 times the Little Barachois Brook flow.

The same hydrometric and climate gauges were used for both Pierres Brook and Petty Harbour Systems. The Waterford River gauge (Waterford River at Kilbride, 02ZM008) was used to synthesize project inflows and the climate station at St. John's Airport was used to estimate temperature and precipitation in the basins. In the modelling, the inflow to the Pierres Brook is modelled as 2.2201 times the Waterford River flow, and the inflow to Petty Harbour is modelled as 2.602 times the Waterford River flow.

The time period chosen for modeling corresponds to the 30-year climate normal period of 1961 to 1990, which is described further in Section 5.1.2. This time period includes a range of representative wet and dry years. All of the selected climate stations have data for the full 30-year simulation period (with occasional missing periods, but no long gaps). The periods of record for the hydrometric stations are shorter, but sufficient data were available for the purposes of this study, as described in Section 6.

Figures 4.1 to 4.3 illustrate the monthly average rain, snow, and temperature at each of the three meteorological stations that were used in the research and monthly average hydrographs developed from all available flow data at each of the hydrometric stations used. The temperature patterns, especially the cycling between temperatures above and below freezing, explain the distribution of precipitation into rain and snow and the changes in runoff over the year.



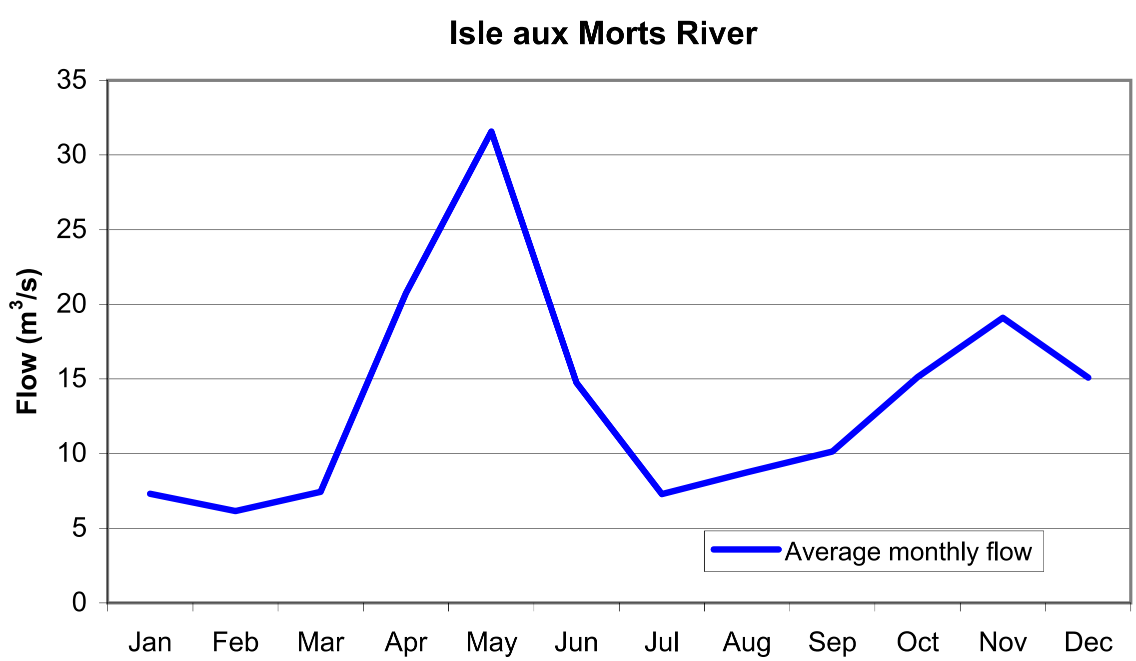


Figure 4.1
Rose Blanche Brook Area Climate and Hydrometric Data

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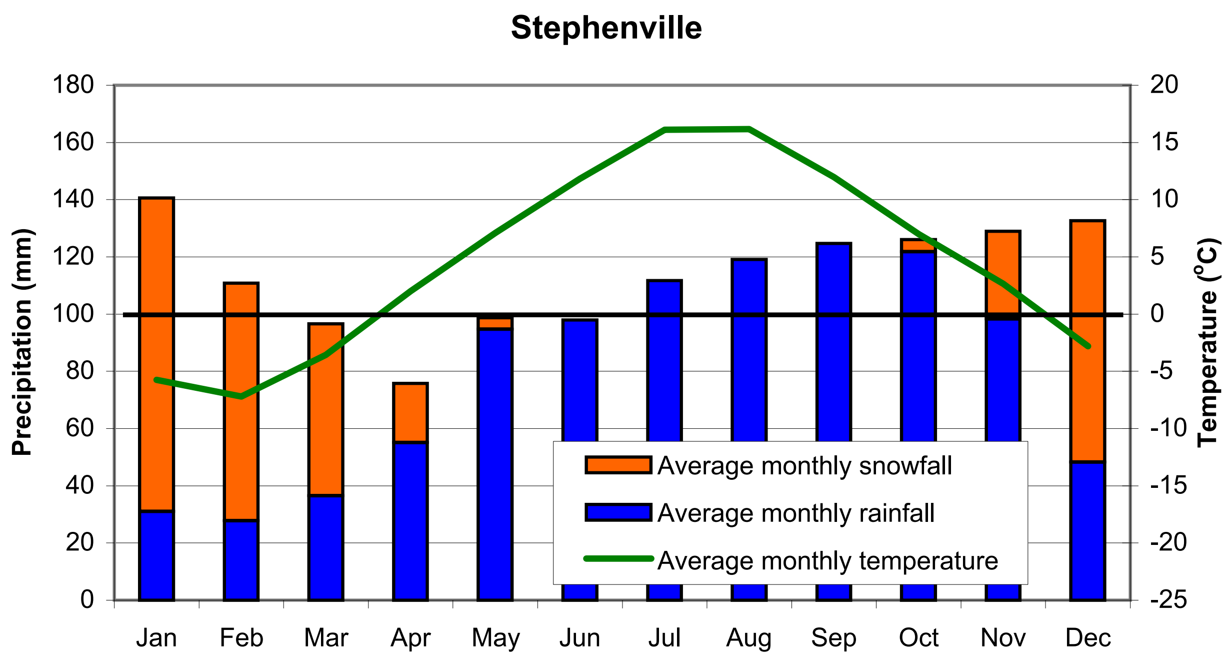

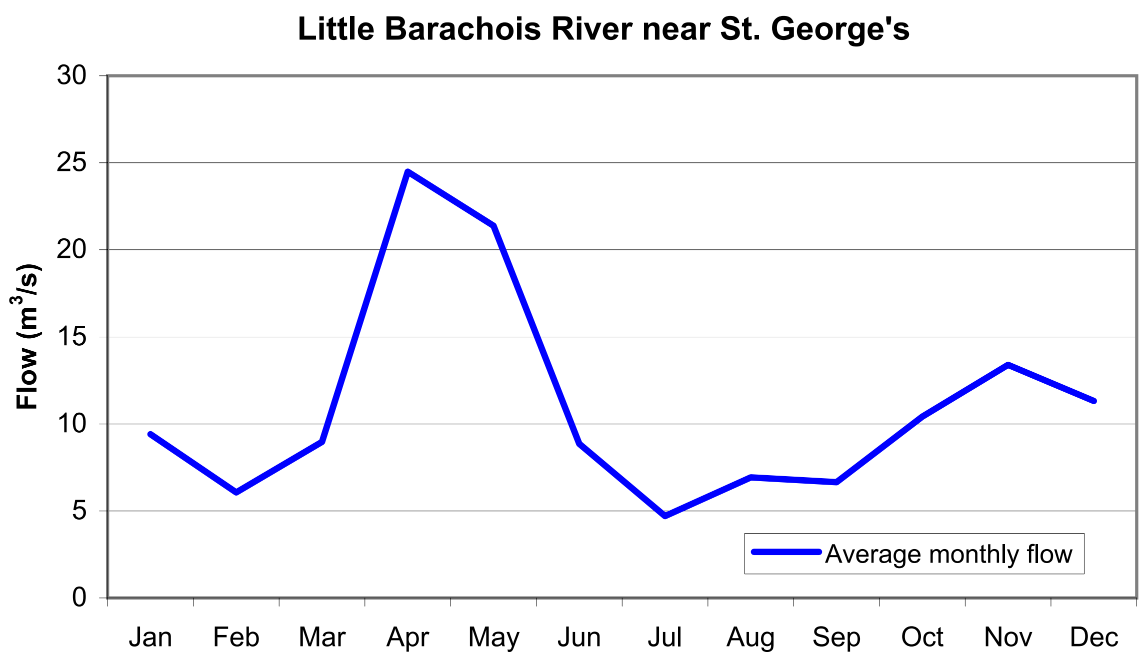

Figure 4.2

Lookout Brook Area Climate and Hydrometric Data

Impact of Climate Change on Hydroelectric Generation in Newfoundland

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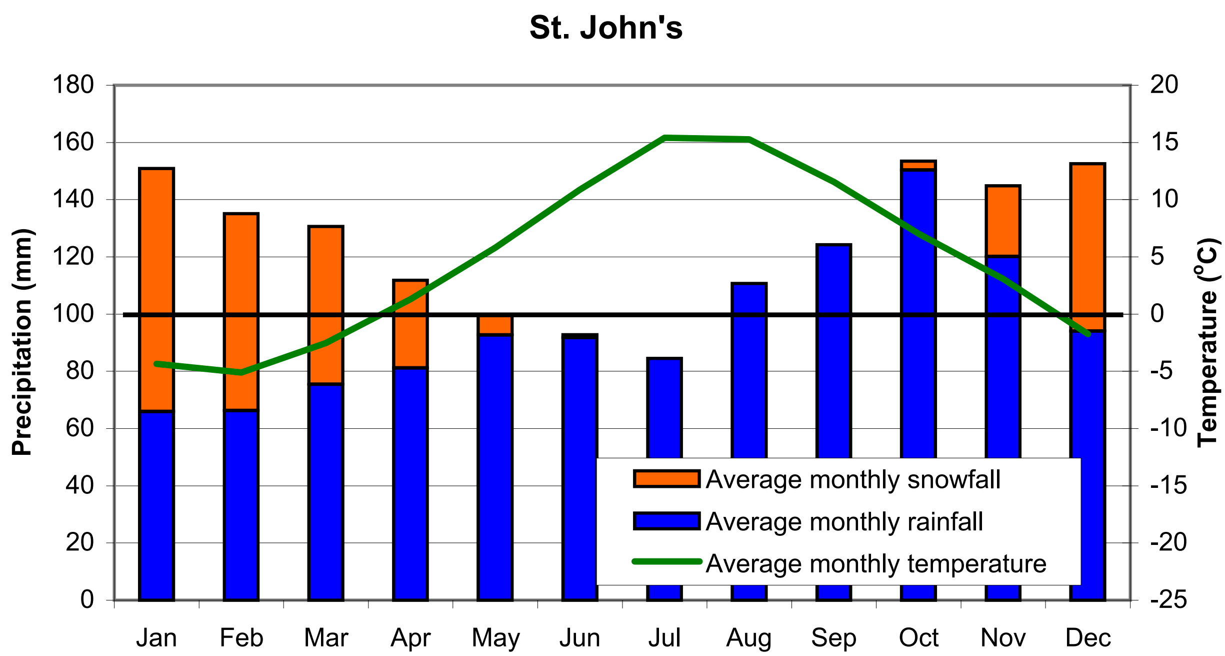

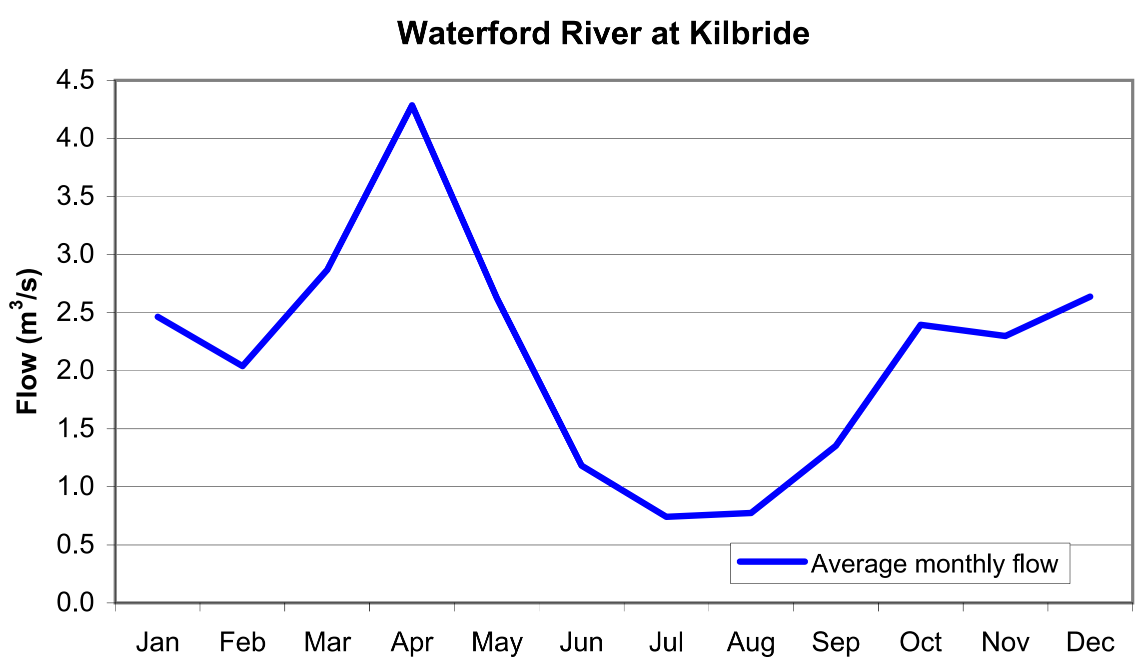

Figure 4.3

Pierres Brook and Petty Harbour Area Climate and Hydrometric Data

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5 Methodology

5.1 Climate Change Quantification

This section summarizes the approach taken to the selection of the climate change scenarios used in this research. Desmond O'Neill of Donmec Consulting Inc. undertook the meteorological tasks for this study and prepared this section of the report.

All change scenarios have been obtained from the Canadian Climate Impacts Scenarios (CCIS) project (Canadian Institute for Climate Studies 2003). Funded by the CCAF, the main role of the CCIS is to provide climate scenario information and scenario construction advice to impacts researchers in Canada. This is intended to ensure a nationally consistent framework so that the resulting studies can be used to provide Canadians with a meaningful national assessment of the impacts of climate change and contribute to international assessments such as those undertaken by the Intergovernmental Panel on Climate Change (IPCC).

5.1.1 Global Climate Modelling and Scenario Development

Global Climate Models (GCMs) are the most credible tools available for simulating the response of the global climate system to increasing greenhouse gas concentrations. The most recent transient GCM experiments are "warm start", i.e. the GCM simulation begins by modeling the historic forcing due to greenhouse gases and aerosols since the nineteenth century. This permits comparison of modelled and observed climate during the historic period. Simulations then continue into the future with the GCM being "forced" by specified future greenhouse gas emissions.

A "climate change scenario" is constructed by calculating the difference (or ratio) between GCM-derived values at a particular time period in the future and those for the model-simulated baseline period. Direct GCM output itself is not generally of sufficient resolution or reliability to be used directly to represent present-day or future climate. Instead "change fields" are calculated. Change fields are the model-simulated changes in climate between some future time period and the model-simulated baseline period. The values are then applied to observed baseline climate data to project future climate conditions. It is important that the observed climate data represent the same time period as has been used to calculate the change fields.

Greenhouse gases such as water vapour, carbon dioxide, methane and nitrous oxide absorb long-wave radiation emitted from the Earth's surface and re-emit this energy, warming the earth's surface. Human activities since the beginning of the industrial revolution have resulted in large increases in atmospheric concentrations of greenhouse gas.

As noted above, it is necessary to specify how the concentrations of atmospheric components which affect the Earth's energy balance may change in order to simulate future climate by means of GCM experiments. The projection of future atmospheric concentrations of greenhouse gases, however, requires that assumptions be made regarding future emissions of these gases. This, in turn, necessitates projecting population growth, economic activity, energy use, land use changes, and other factors. To address this requirement, the IPCC commissioned the development of an updated set of emission scenarios for its IPCC Third Assessment Report, Special Report on Emission Scenarios (SRES) (Nakicenovic 2000). Appendix A provides a brief overview of the SRES scenarios. All GCM model simulations used in the present project are based on SRES emissions.

Most GCMs exhibit substantial inter-decadal climate variability often making it difficult to distinguish a climate change signal from this background noise. In line with IPCC recommendations, the CCIS project has addressed this issue by employing a 30-year period for averaging GCM outputs. The averaging process dampens the effects of inter-decadal variability and concentrates the climate change signal. In the CCIS project, the three time slices for which change fields relative to the 1961 to 1990 mean period have been calculated are the 2020s, the 2050s and the 2080s, corresponding to the 30-year mean periods 2010 to 2039, 2040 to 2069 and 2070 to 2099.

5.1.2 Application of Climate Scenarios in the Current Study

Any realistic assessment of the impacts of climate change must include an examination of the impact response to current or recent climate conditions, as this will provide a comparative basis for projecting the response to future conditions. Specification of the present-day or "baseline" climate is, in consequence, vitally important. The IPCC has recommended that, where possible, 1961 to 1990 (the most recent 30-year climate normal period) should be adopted as the climatological baseline period for impact and adaptation assessments. This period is considered to be both representative of recent average climate and of sufficient duration to encompass a range of climatic variations and weather anomalies. It is also a period for which observational data are, in general, readily available, adequately distributed over space, and of sufficiently high quality. Reflecting the IPCC's advice, the 1961 to 1990 climate normal period has been used as the baseline period throughout the present project. The scenarios available through the CCIS web pages represent the change fields calculated with respect to the model-simulated 1961 to 1990, 30-year mean period. Observational data for this period have been taken from official Meteorological Service of Canada records for Newfoundland stations located in or adjacent to the watersheds of interest, as described in Section 4.0.

The IPCC has also recommended that "users should design and apply multiple scenarios in impact assessments, where these scenarios span a range of possible future climates, rather than designing and applying a single ‘best guess’ scenario". In the present project, scatter plots of mean temperature change versus precipitation change, available on the CCIS web site, were used to select five scenarios that, broadly speaking, straddle the range of changes predicted for the Island by the GCMs represented on that web site. An example of the type of scatter plot examined in also included in Appendix A. These climate change scenarios are approximately representative of the warmest, coldest, wettest, driest and mid-range climate simulations for the Newfoundland region for the 2020s period. It should be noted that no single scenario is any more, or less, probable than others in the same scenario family.

- Wettest Scenario – Hadley model CM3, SRES emission scenario: B11
- Driest Scenario – Canadian model CGCM2, SRES emission scenario: A23
- Warmest Scenario – Canadian model CGCM2, SRES emission scenario: A21
- Coldest Scenario – Canadian model CGCM2, SRES emission scenario: A22

- Middle Scenario – Canadian model CGCM2, SRES emission scenario: A2X

Throughout this report, the scenarios as defined above have been referenced as: Warmest, Coldest, Wettest, Driest, and Middle.

In the present study, the analysis of the impacts of climate change on hydroelectric generation in Newfoundland has been restricted to the 30-year period centred on the 2020s. GCM-derived change values for temperature and precipitation, obtained from the CCIS project web site, were applied to 1961 to 1990 climate normal values for the selected observation stations to produce projected values of these parameters for the 2020s period. Application of the model-generated change fields to the observed baseline climatology is a simple and direct way of obtaining regional detail in the representation of simulated future climate.

Table 5.1 summarizes the temperature and precipitation changes for the five future climate scenarios selected for the present study. The data listings represent climate scenario fields for the 2020s period derived respectively from the Hadley and Canadian Coupled Models when run using the various SRES emission scenarios identified in the table. Figures 5.1 and 5.2 show the data graphically. Each scenario has both a temperature and a precipitation change, as shown in Figure 5.1; the two cannot be examined independently. Figure 5.2 compares the annual average temperature and precipitation changes of each scenario.

As illustrated, there is a significant variation in the predicted changes in precipitation and temperature defined by each scenario. The various scenarios show both increases and decreases in precipitation over the year. The temperature changes are less variable; all scenarios show increased temperature, with a somewhat similar pattern over the year.

Table 5.1
Climate Scenarios for Period Centred on 2020 (2010 to 2039)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation - Departures from 1961-1990 Normals (%)													
Wettest Scenario	7.58	22.65	7.43	18.07	2.70	3.17	16.99	14.69	21.27	13.24	12.44	6.15	12.20
Driest Scenario	-5.86	-5.14	-2.61	-5.51	-10.76	-0.76	2.35	12.30	9.56	4.23	-4.81	-15.65	-1.89
Warmest Scenario	4.32	-0.64	-2.73	4.75	7.64	12.44	-2.87	12.83	17.71	2.77	-1.06	-5.18	4.17
Coldest Scenario	0.83	-5.46	-10.09	-2.50	2.76	-4.40	-6.06	-0.55	9.83	9.25	2.00	-3.08	-0.62
Middle Scenario	-0.09	-3.81	-5.35	-1.08	-0.77	2.29	-2.43	7.72	12.37	5.39	-1.31	-8.15	0.40
Temperature - Departures from 1961-1990 Normals (^{o}C)													
Wettest Scenario	2.32	1.94	1.55	1.33	0.70	1.03	1.69	2.00	1.30	1.14	1.35	1.47	1.49
Driest Scenario	2.43	2.39	2.00	0.74	1.53	1.69	1.87	1.39	1.05	1.67	0.67	0.39	1.48
Warmest Scenario	2.91	3.32	2.30	1.02	1.89	1.63	2.35	1.58	1.42	1.24	0.67	0.68	1.75
Coldest Scenario	1.16	2.10	1.38	0.94	1.60	0.97	1.46	1.27	1.08	0.76	0.56	0.35	1.14
Middle Scenario	2.16	2.60	1.89	0.90	1.67	1.43	1.89	1.41	1.18	1.22	0.63	0.47	1.46

Note:
Wettest Scenario is Hadley CM3; SRES Emission Scenario: B11
Driest Scenario is Canadian CGCM2; SRES Emission Scenario: A23
Warmest Scenario is Canadian CGCM2; SRES Emission Scenario: A21
Coldest Scenario is Canadian CGCM2; SRES Emission Scenario: A22
Middle Scenario is Canadian CGCM2; SRES Emission Scenario: A2X

The most severe decrease in average monthly precipitation is predicted for the Driest scenario (16 percent decrease in December), and the most severe increase is predicted for the Wettest scenario (23 percent increase in February). The Wettest scenario predicts an increase in precipitation in every month. All other scenarios include some months when precipitation is predicted to increase, and some months when precipitation is predicted to decrease. Precipitation in August, September, and October is predicted to increase for almost every scenario. December, February and March precipitation is predicted to decrease for every scenario except the Wettest. Annually, the range in predicted departures from historic is a decrease of two percent for the Driest scenario and an increase of 12.2 percent for the Wettest.

There are no months for which the temperature is predicted to decrease under any of the scenarios. The Warmest and Coldest scenarios represent the largest (3.3 degrees Celsius) and smallest (0.4 degrees Celsius) predicted average monthly temperature changes, respectively. The largest predicted increases are in January or February for all scenarios, the smallest increases are generally in November or December. Annually, the range in predicted increases in temperature from historic is 1.1 degrees in the Coldest scenario to 1.75 degrees in the Warmest.

5.2 Climate-Flow Models

5.2.1 Model Development

In order to predict future hydrologic trends based on changed climate conditions, empirical climate-flow models were created for each basin. Watershed models often contain factors that are dependent on precipitation and temperature, for instance soil moisture content; snowpack accumulation, ripening and melt; and evaporation. Non-linear changes in such variables could mask or artificially accentuate the impact of change in climate on streamflow. For this reason, it was decided to use a simple regression equation approach to calculate relationships between climate variables (temperature and precipitation) and basin runoff.

A detailed description of the process used to derive the climate-flow models is included in Appendix B. This section provides a summary only.

The models were developed through multiple linear regression of historic flow and climate data. Minitab (a statistical analysis software package) was used to facilitate the analysis with the “Best Subsets” multiple regression function used to determine the combination of predictor variables (current and previous month’s temperatures and precipitation) that produced the most accurate monthly flow model. Results were assessed on the basis of the adjusted r-squared value (Minitab Inc. 2000).

Variables considered during development of the regression models for flow were the temperature and precipitation for the month being modelled and for the preceding month. The weather of the previous month often has a significant effect on the flow in the current month; particularly in transition months from fall to winter and winter to spring. Consideration was given to using rain and snow as individual predictor variables; however, a simpler model which considered only total precipitation achieved better overall results.

Results indicated that the best model of flow comprised different sets of predictor variables for each site and for each month. The variables used in the flow models were chosen with two objectives in mind; the strength of the correlation, and consistency in terms of the variables chosen to represent flow for each month and for each system. Tables 5.2 to 5.4 summarize the monthly flow models for the four NP systems, including the adjusted r-squared value describing the strength of the relationship between historic and synthetically generated flows. For all sites, the relationships for the months March through November used all four predictor variables. Relationships for the months of December, January and February use only the current month's temperature and precipitation.

The synthetic monthly flow is calculated using the constants and variables in Tables 5.2 to 5.4. For example, estimates of the flow in the Isle aux Morts River in January and July are

$$Q_{Jan} = 8.31 + (1.65\ x\ T_{Jan}) + (0.0472\ x\ P_{Jan})$$

$$Q_{Jul} = 6.35 + (0.461\ x\ T_{Jul}) - (1.65\ x\ T_{Jun}) + (0.0800\ x\ P_{Jul}) + (0.0136\ x\ P_{Jun})$$

Where Q is flow in m^3/s,
T is temperature in ºC, and
P is total precipitation in mm.

Table 5.2
Summary of Empirical Flow Equations - Isle aux Morts River for Rose Blanche Brook

Month	Constant	Coefficients				R^2 (adj)
		Temperature	Last Month's Temperature	Precipitation	Last Month's Precipitation	
January	8.31	1.65	-	0.047	-	0.26
February	9.91	1.42	-	0.042	-	0.38
March	3.97	1.84	-0.53	0.038	0.016	0.27
April	0.48	5.01	-0.47	0.107	0.022	0.61
May	14.43	3.10	-9.35	0.076	0.011	0.64
June	31.64	-0.32	-4.72	0.099	-0.013	0.60
July	6.35	0.46	-1.65	0.080	0.014	0.68
August	-5.58	0.22	0.19	0.054	0.011	0.38
September	10.61	-0.03	-0.78	0.083	0.013	0.54
October	2.30	0.13	-0.32	0.100	0.013	0.61
November	-2.73	1.30	0.08	0.092	0.023	0.57
December	-0.83	2.03	-	0.111	-	0.81

Notes: Coefficients are rounded for the purposes of presentation; more significant figures were used in the actual calculations

Monthly Flow = Constant + ($coefficient_{temp}$ *x* monthly temperature) + ($coefficient_{last\ temp}$ *x* last month's temperature) + ($coefficient_{precip}$ *x* monthly precipitation) + ($coefficient_{last\ precip}$ *x* last month's precipitation)

Table 5.3
Summary of Empirical Flow Equations – Little Barachois River near St. Georges for Lookout Brook

Month	Constant	Coefficients				R^2 (adj)
		Temperature	Last Month's Temperature	Precipitation	Last Month's Precipitation	
January	21.76	3.07	-	0.04	-	0.54
February	11.80	1.17	-	0.03	-	0.31
March	5.62	2.48	-0.58	0.06	0.03	0.54
April	3.13	2.22	-2.06	0.15	-0.06	0.49
May	36.89	-0.64	-5.09	0.05	0.01	0.69
June	11.42	-0.65	-0.29	0.07	0.00	0.54
July	7.11	-0.56	-0.10	0.04	0.02	0.51
August	19.86	-2.46	0.62	0.08	0.06	0.67
September	10.35	-0.76	-0.14	0.05	0.01	0.30
October	4.55	-1.05	0.25	0.08	0.01	0.32
November	-10.02	1.31	1.71	0.03	0.04	0.62
December	9.12	1.86	-	0.05	-	0.52

Notes: Coefficients are rounded for the purposes of presentation; more significant figures were used in the actual calculations

Monthly Flow = Constant + ($coefficient_{temp}$ *x* monthly temperature) + ($coefficient_{last\ temp}$ *x* last month's temperature) + ($coefficient_{precip}$ *x* monthly precipitation) + ($coefficient_{last\ precip}$ *x* last month's precipitation)

Table 5.4
Summary of Empirical Flow Equations - Waterford River at Kilbride for Pierres Brook and Petty Harbour

Month	Constant	Coefficients				R^2 (adj)
		Temperature	Last Month's Temperature	Precipitation	Last Month's Precipitation	
January	3.21	0.39	-	0.007	-	0.59
February	1.82	0.21	-	0.012	-	0.23
March	-2.01	0.34	-0.21	0.018	0.019	0.58
April	2.11	-0.11	-0.12	0.011	0.004	-0.02
May	1.60	-0.09	-0.41	0.015	0.005	0.69
June	0.78	-0.04	-0.06	0.008	0.003	0.64
July	1.46	-0.08	-0.07	0.010	0.005	0.82
August	1.24	-0.03	-0.06	0.007	0.001	0.74
September	-1.40	-0.02	0.09	0.007	0.006	0.40
October	1.13	-0.12	-0.07	0.018	0.001	0.67
November	-1.71	-0.08	0.09	0.022	0.005	0.84
December	1.16	0.01	-	0.010	-	0.36
November	-1.71	-0.08	0.09	0.022	0.005	0.84
December	1.16	0.01	-	0.010	-	0.36

Notes: Coefficients are rounded for the purposes of presentation; more significant figures were used in the actual calculations

Monthly Flow = Constant + ($\text{coefficient}_{\text{temp}}$ *x* monthly temperature) + ($\text{coefficient}_{\text{last temp}}$ *x* last month's temperature) + ($\text{coefficient}_{\text{precip}}$ *x* monthly precipitation) + ($\text{coefficient}_{\text{last precip}}$ *x* last month's precipitation)

The models were then used with historic (unadjusted) climate data to derive a synthetic monthly flow sequence for each system for the period of 1961 to 1990. This established the Baseline case, to which each synthetic climate change flow sequences will be compared.

5.2.2 Model Accuracy

The relationships between the synthetic and historic flow series were compared to assess the performance of the models. Table 5.3 summarizes some descriptive statistics of the synthetic and historic monthly average flow sequences, which start with the first available historic data and ending in

December 1990. Figures 5.3 to 5.5 compare historic and synthetic monthly average flows from 1980 to 1988, a period with wet, dry, and average years.

Table 5.5
Descriptive Statistics of Historic and Synthetic Monthly Flow Series

	Isle aux Morts River (Rose Blanche Brook)		Little Barachois River (Lookout Brook)		Waterford River (Pierres Brook and Petty Harbour)	
	Historic Series	Synthetic Series	Historic Series	Synthetic Series	Historic Series	Synthetic Series
Average Monthly Flow (m^3/s)	13.646	13.652	11.064	11.115	2.139	2.135
Standard Deviation	10.03	9.19	9.01	7.69	1.43	1.22
Number of observations	339		146		204	
Adjusted R-squared	81.5%		80.4%		75.8%	

Note: Statistics of series including each month within the climate normal period for which historic values were available.

Figure 5.6 and Table 5.6 illustrate the average monthly difference between the model results and the average historic monthly flows for the full 30-year period. The differences have been presented both as a percentage of the historic monthly flow, and as an absolute difference in units of flow. Reporting the difference as a percentage of the historic flow can be misleading since in a low-flow month, a small absolute difference appears large, and in high-flow months, a large difference appears small. The randomness, which is apparent on the figures, allayed concern that there may have been systematic error in the models.

Table 5.6
Difference Between Synthetic and Historic Flows

Month	Difference Between Synthetic and Historic, m^3/s			Difference Between Synthetic and Historic, %		
	Isle aux Morts River	Little Barachois River	Waterford River	Isle aux Morts River	Little Barachois River	Waterford River
January	0.43	1.08	0.15	5.9	11.5	5.9
February	0.46	1.18	0.06	7.4	19.5	3.1
March	-0.38	-0.99	0.09	-5.1	-11.0	3.2
April	0.35	-0.16	-0.29	1.7	-0.6	-6.8
May	0.10	-0.38	-0.16	0.3	-1.8	-6.3
June	-0.18	-0.03	0.00	-1.2	-0.3	-0.3
July	0.00	0.15	0.01	0.1	3.3	1.8
August	-0.47	0.47	-0.05	-5.3	6.7	-6.6
September	-0.08	0.24	0.11	-0.8	3.6	8.1
October	0.21	-0.01	0.09	1.4	-0.1	3.8
November	-0.03	-0.33	-0.04	-0.1	-2.4	-1.6
December	-0.34	-0.52	-0.01	-2.3	-4.6	-0.5

Note: Values are the averages of all the deviations, not the deviations in the averages

- The average monthly synthetic flows generated by the Isle aux Morts model are within five percent of historic values for eight months of the year. This is the most accurate of the three models.

- The Little Barachois River model was based on the fewest number of overlapping climate and hydrologic data points (18 years of monthly values) leading to relatively large deviations from historic data. The synthetic curve drops to zero for a few months at Little Barachois (Figure 5.4) due to the routine that sets all negative flows to zero. These negative synthetic flows occur as a result of statistical error in the flow models.

- The Waterford River model was derived from over 24 years of monthly values and the deviation from historic data is less than the Little Barachois model; however, the overall adjusted r-squared value for this model was the lowest of all three models.

In general, the synthetic flow sequences mirror the historic data reasonably well. The synthetic sequences generally show similar ups and downs to the historic hydrographs, and there are no consistent over or underestimates of peaks or troughs. The average synthetic flows are higher than the average historic flow for two of the three models, and the synthetic standard deviations were lower for all systems. The overall adjusted r-squared values for the Isle aux Morts, Little Barachois, and Waterford River models were 81.5 percent, 80.4 percent, and 75.8 percent, respectively.

In this study, hydroelectric generation under the climate change flow sequences is compared to generation under the synthetic flow sequence; hence, the slight error in the flow models (difference between synthetic and historic flows) is not critical. Therefore, the flow models described herein were accepted for the purpose of estimating flows under climate change conditions.

Tables showing the temperature and precipitation records for the 30-year climate normal period and the actual and synthetic (Baseline) mean monthly flows are included in Appendix C. Each of these tables includes the monthly average flow for each year between 1961 and 1990; the overall monthly average, minimum, and maximum; a weighted average for each year; and an overall annual average.

5.3 Synthetic Flow Sequences after Climate Change

The climate change scenarios described in Section 5.1 were applied to the historic 30-year temperature and precipitation sequences to produce 30-year monthly tables of climate data for each scenario. The adjusted temperature and precipitation data was then used with the flow equations summarized in Table 5.2 to create flow sequences for each system under each climate change scenario. Included in Appendix C are tables showing new flow sequences for the baseline case and each climate change scenario, along with tables showing the differences between the Baseline and the actual flows, and between each scenario's flows and the flows in the Baseline case. Table 5.7 summarizes the average annual flow under each scenario for each system.

Table 5.7
Average Annual Inflows, Baseline and Climate Change Scenarios

Scenario	Annual Average Inflow (m^3/s) and Increment from Baseline (%)							
	Rose Blanche Brook		Lookout Brook		Pierres Brook		Petty Harbour	
Baseline	3.46	-	3.22	-	4.78	-	5.60	-
Wettest	3.86	12%	3.59	12%	5.35	12%	6.27	12%
Driest	3.43	-1%	3.30	3%	4.71	-1%	5.52	-1%
Warmest	3.63	5%	3.43	7%	4.94	3%	5.79	3%
Coldest	3.43	-1%	3.20	-1%	4.68	-2%	5.49	-2%
Middle	3.49	1%	3.31	3%	4.77	0%	5.59	0%

Of the 20 scenarios examined (four systems and five climate change scenarios), 11 show increased average annual inflow, by up to 12 percent, seven show a decrease in average annual inflow, of one or two percent and two show essentially no change. The Coldest scenario decreases the average annual inflow for all four systems; the Driest scenario shows a decrease at three systems, but an increase at the fourth. This is due to the interaction between temperature and precipitation factors; as shown in Table 5.1, the Coldest scenario is also dry. The Wettest and Warmest scenarios increase the flow at all systems.

Under each climate change scenario, flows are higher than the Baseline case in the winter due to the increase in temperature. Higher temperatures cause more precipitation to fall as rain than snow, thus immediately contributing to flow in the watercourse. Snowmelt occurs earlier due to the temperature increases and there is an overall reduction in the accumulation of snow in the winter leading to decreased snowmelt volumes in the spring. The result is lower flows under the climate changed scenarios during the spring and early summer. The scenarios also produce higher flows in the fall due to the increases in precipitation. These trends are apparent in the plots included as Figures 5.7 to 5.9. Both historic and synthetic flows have been included in these figures for comparison.

5.4 Daily Inflow Sequence Development

The flow models developed provide monthly average flows as output, however daily inflows were required for the power and energy modelling. The synthetic daily flow sequences were developed based on the historic pattern of monthly flow over the days of the month. Each synthetic daily flow was derived by multiplying the synthetic monthly average flow by the ratio of the actual historic daily flow and the actual historic monthly flow, i.e. the monthly flow was distributed over the individual days in the same proportion as shown in the historic record. Similarly, to calculate the daily flow sequences under the five climate change scenarios, the monthly synthetic flows were multiplied by the ratio of the actual historic daily flow and the actual historic monthly flow.

Some additional information regarding the methods adopted to deal with missing data and other inconsistencies is included in Appendix B.

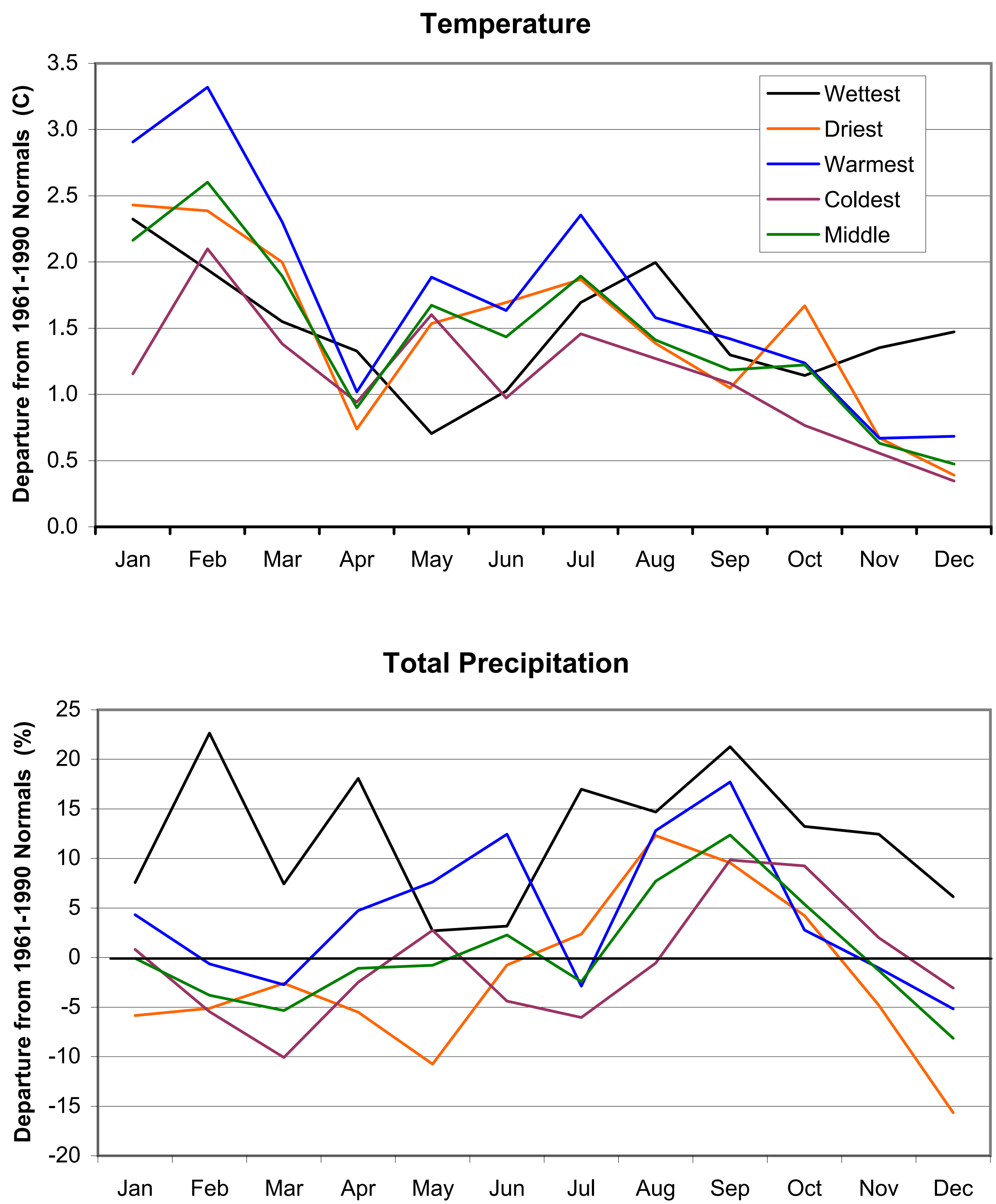

Figure 5.1

Temperature and Precipitation Changes under Climate Change Scenarios

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres

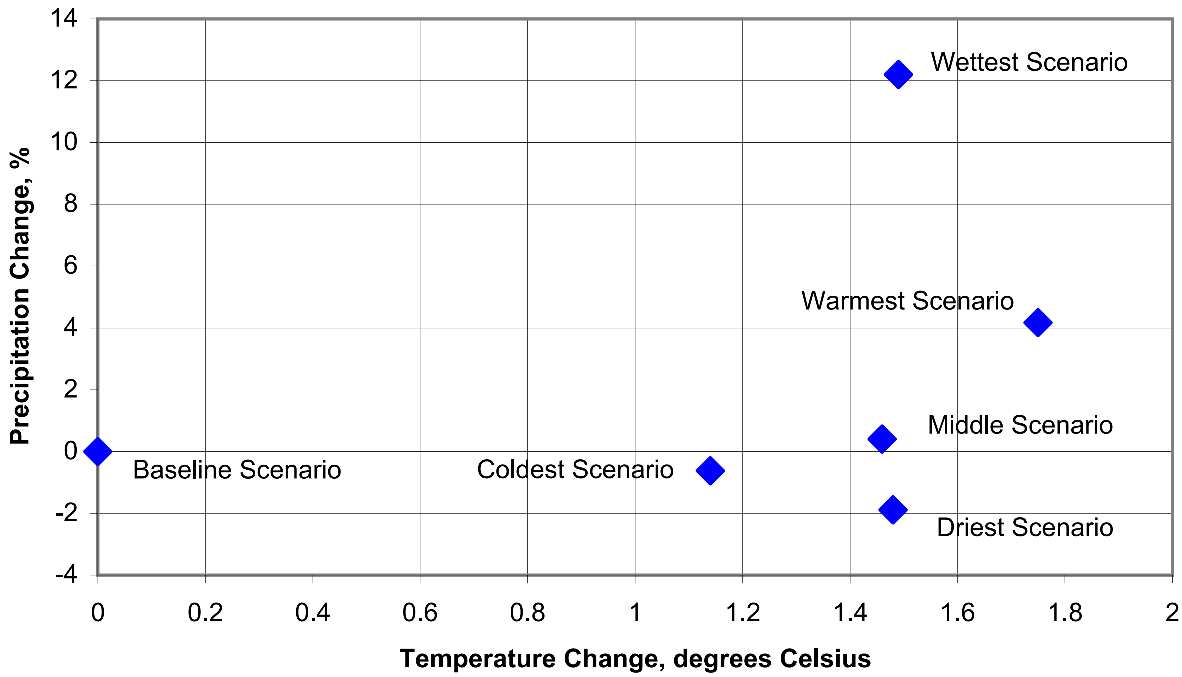

Figure 5.2

Comparison of Changes under Climate Change Scenarios

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres

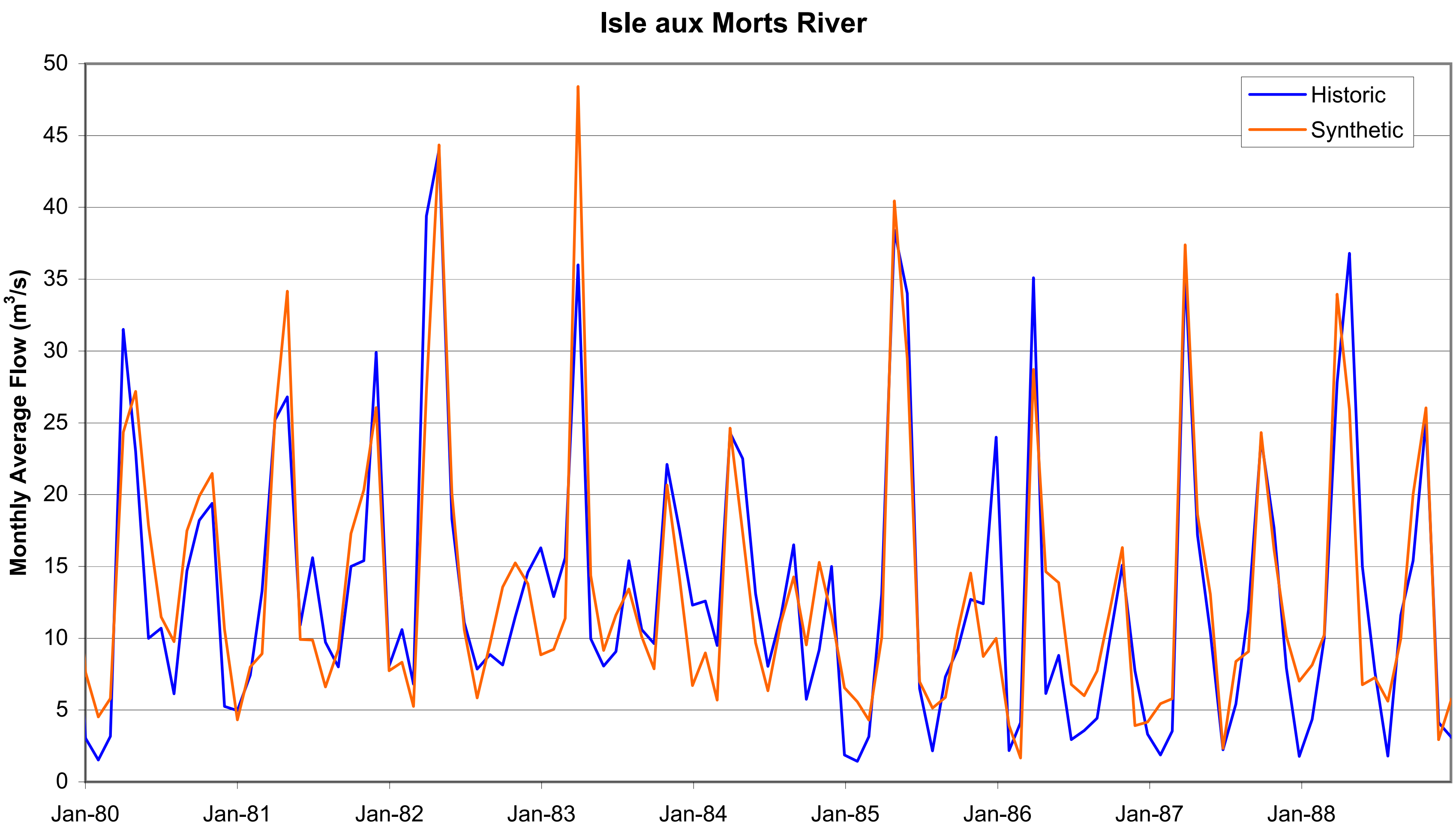

Figure 5.3

Comparison of Synthetic and Historic Monthly Flows - Isle aux Morts River

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

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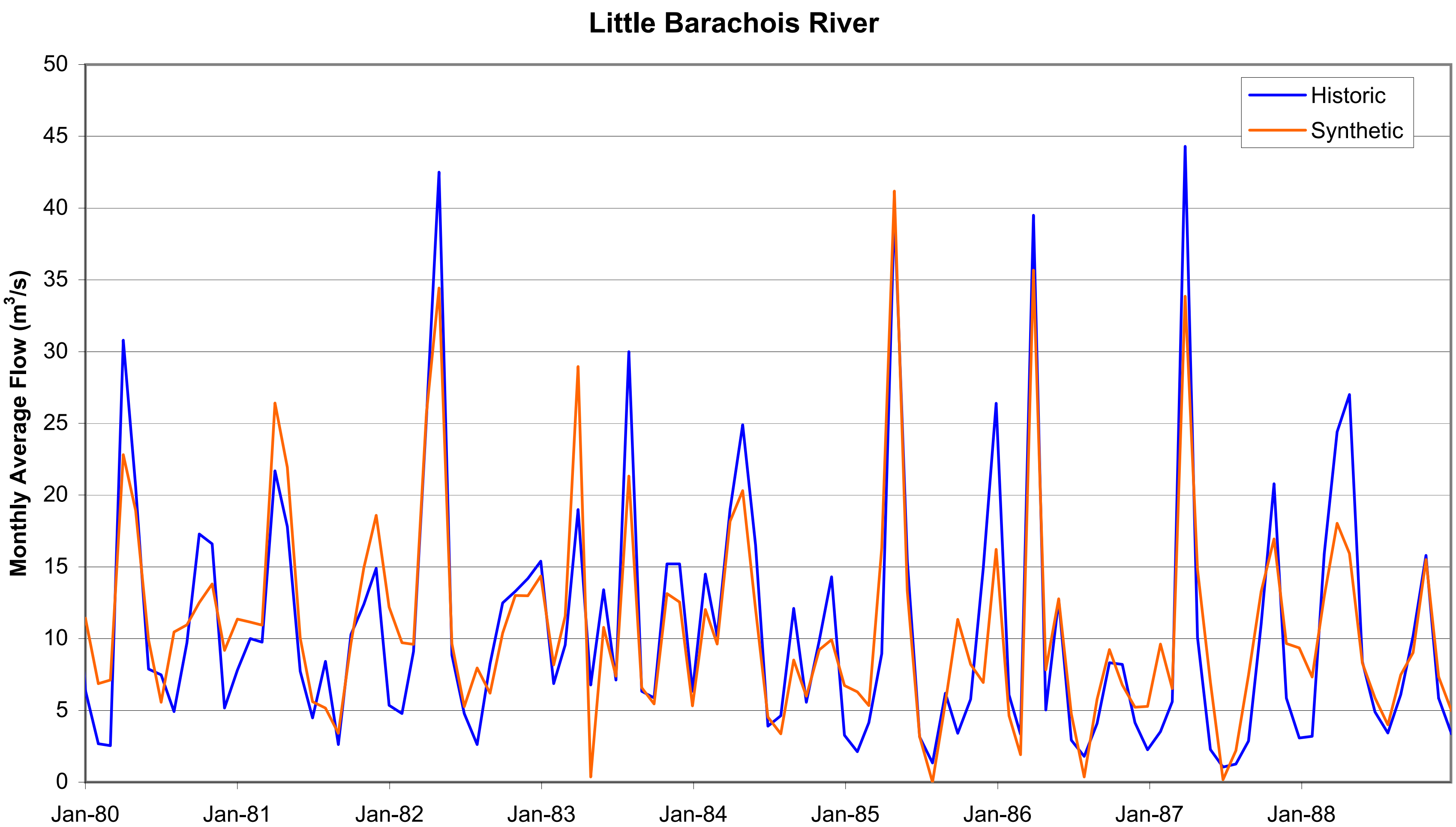

Figure 5.4

Comparison of Synthetic and Historic Monthly Flows - Little Barachois River

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

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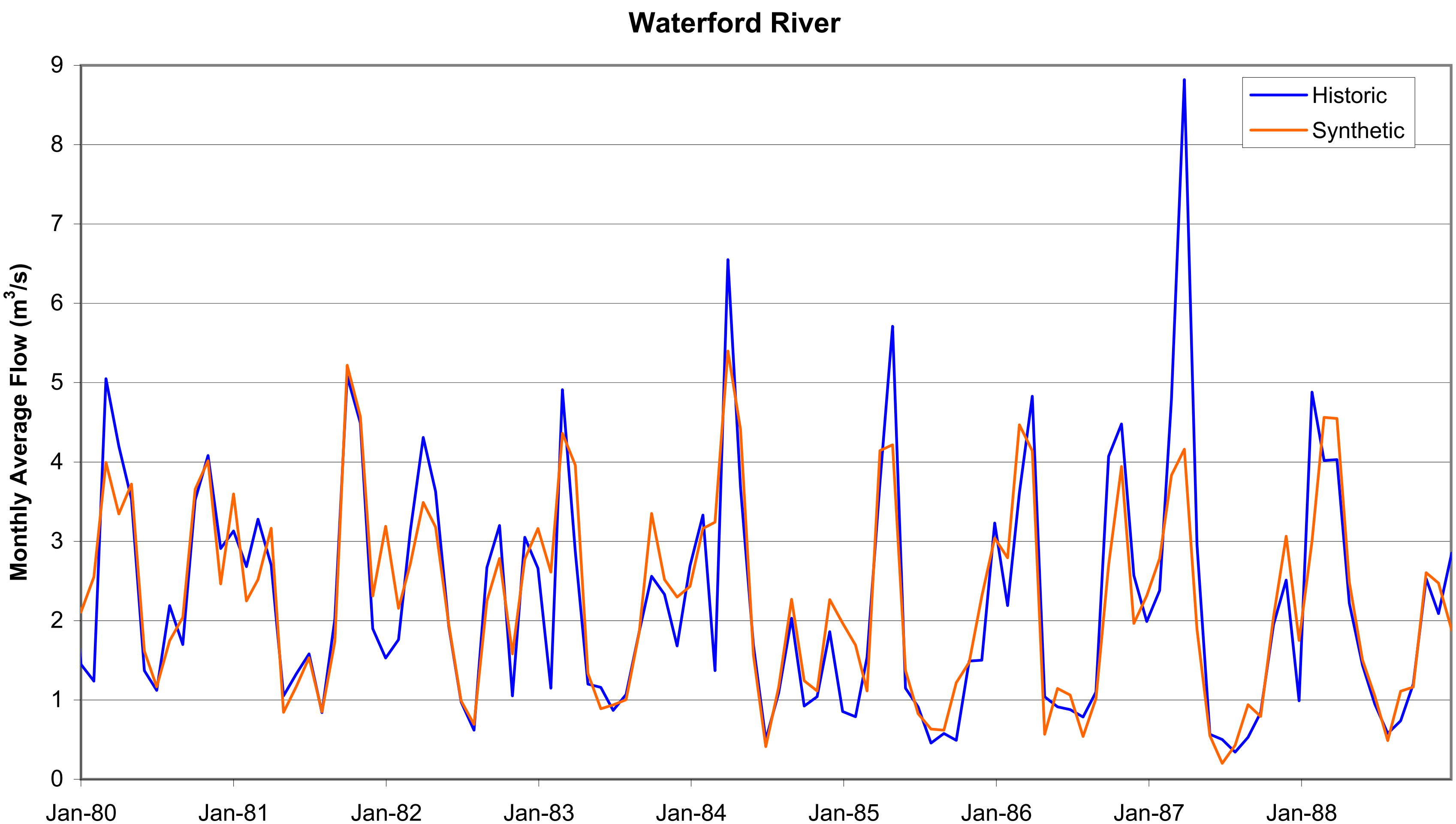

Figure 5.5

Comparison of Synthetic and Historic Monthly Flows - Waterford River

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

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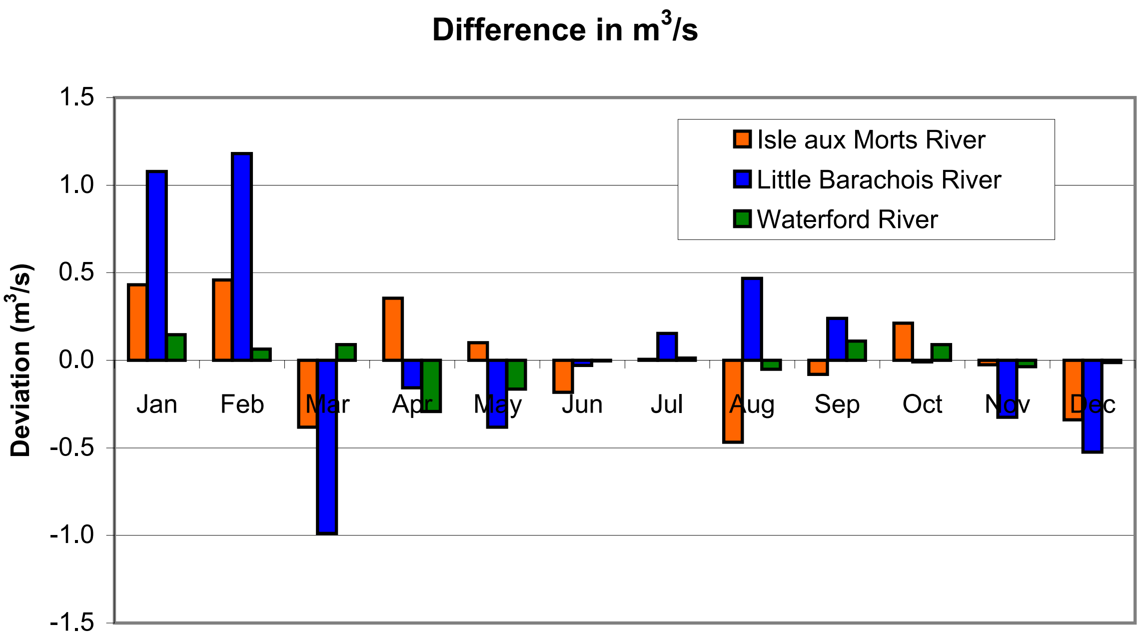

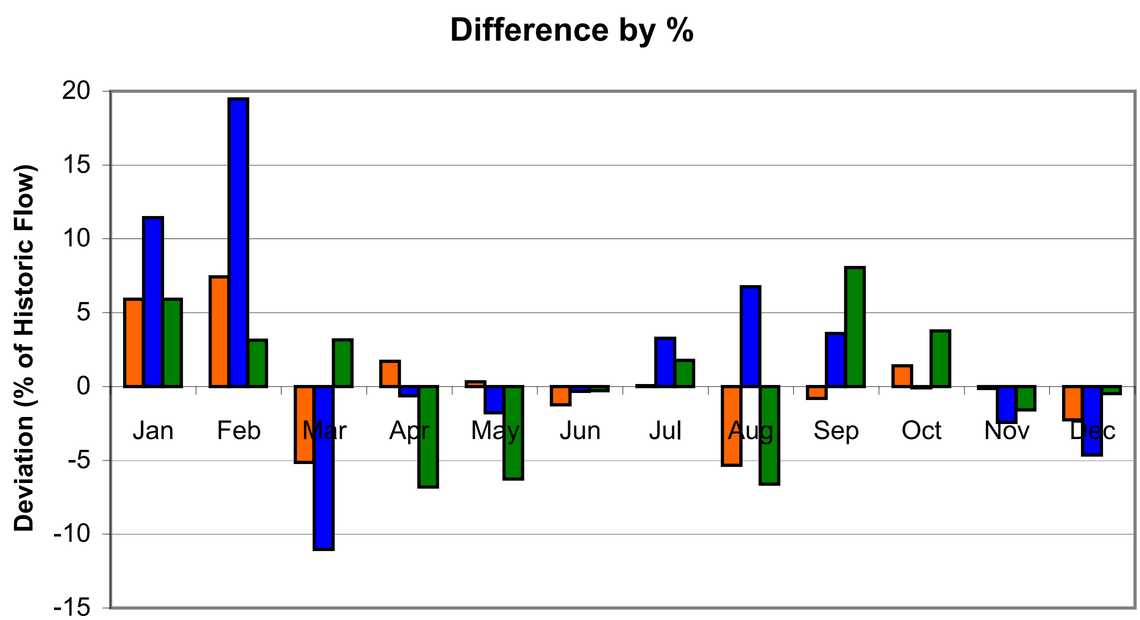

Figure 5.6

Difference Between Synthetic and Historic Monthly Average Flows

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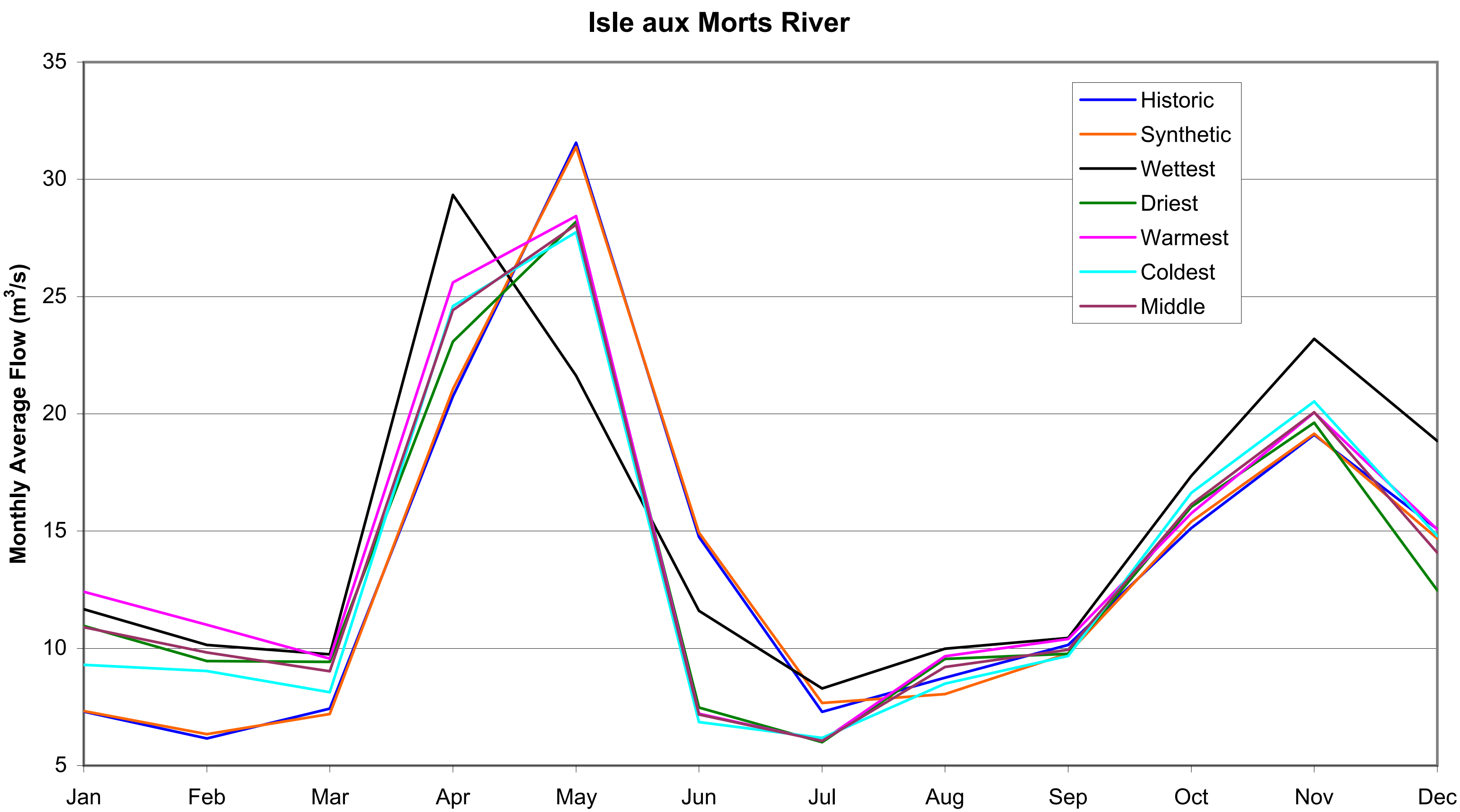

Figure 5.7

Average Monthly Flow Under All Scenarios - Isle aux Morts River

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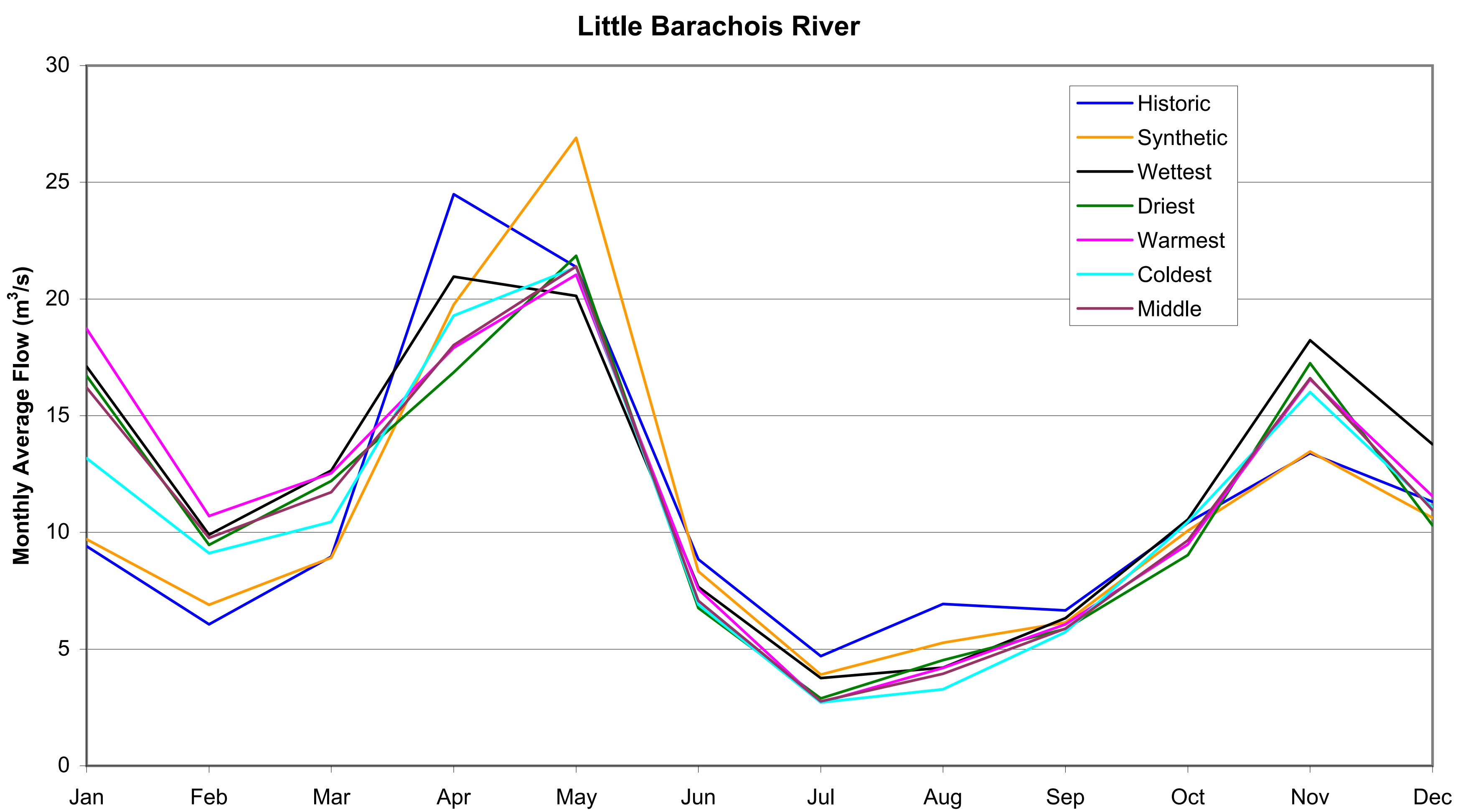

Figure 5.8

Average Monthly Flow Under All Scenarios - Little Barachois River

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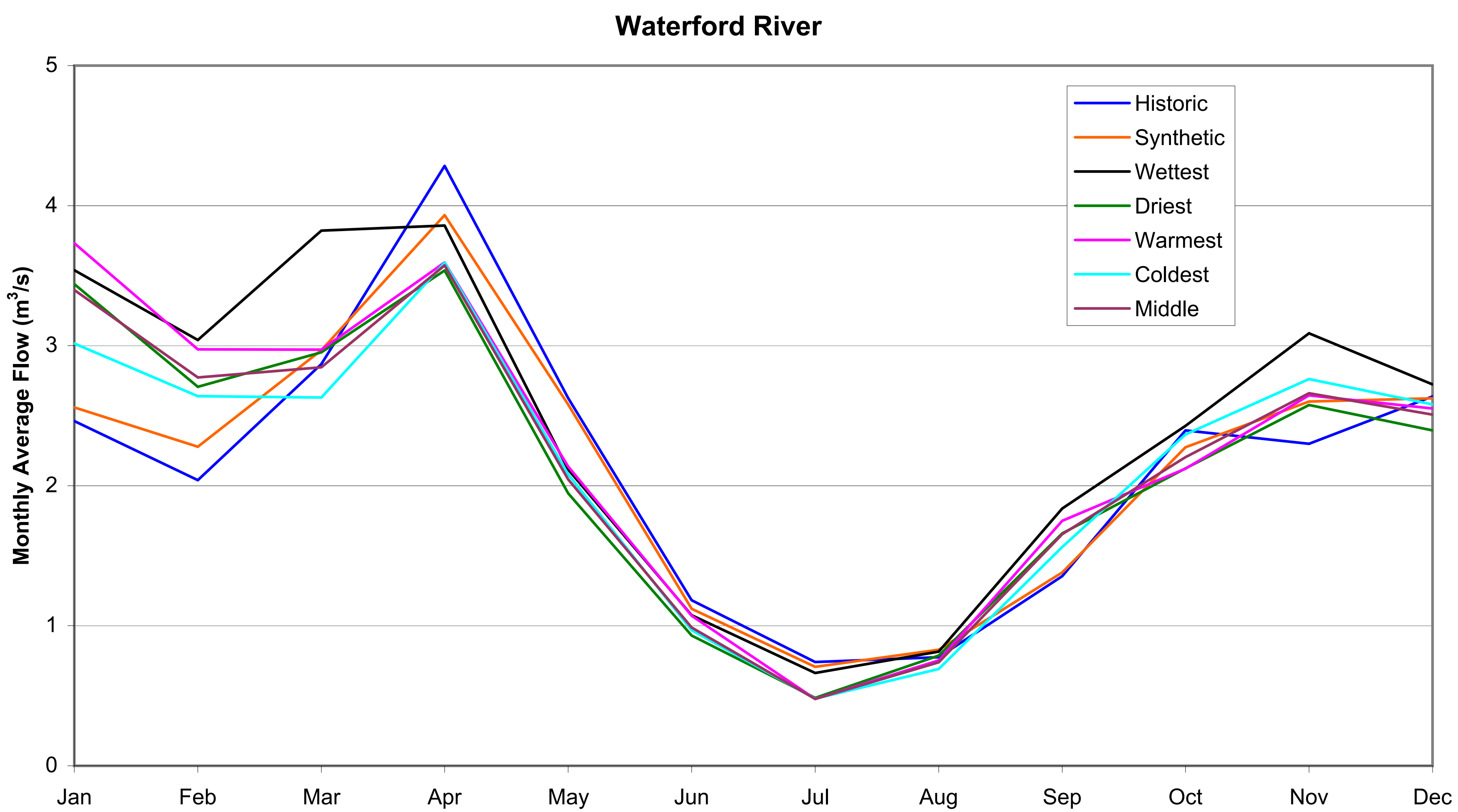

Figure 5.9

Average Monthly Flow Under All Scenarios - Waterford River

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6 Simulation of Hydroelectric Generation

The ARSP models for each of the four selected NP hydroelectric generating systems on the Island were used to model hydroelectric generation under the five climate change scenarios as well as the Baseline case, using current operating strategies and the physical characteristics of the existing facilities.

6.1 Acres Reservoir Simulation Program (ARSP)

ARSP is a general reservoir simulation program that is capable of simulating a wide range of operating policies in multipurpose, multi reservoir systems. ARSP is an in-house Acres program, but has been sold commercially and has been applied to numerous water resource systems worldwide. Water resource allocation problems involving energy production, flood control, water supply, irrigation, low-flow augmentation, diversion, navigation, environmental, and many other requirements can be modelled.

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 modelled separately from the physical system. 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.

6.2 ARSP Runs

The ARSP models of each generating system, modelling the existing facilities and operational strategies were run with each 30-year daily flow sequence derived. Historic, Baseline (synthetic) and climate changed inflow sequences were run through each model. With four systems and seven flow scenarios, 28 runs were done for the initial examination.

ARSP is set up to accept flow data from Environment Canada stations in the format used in the EC database. A proration factor is also input, to allow adjustment of the hydrometric data from the station location to the basin of interest. Proration factors for each station were provided in Section 4. The scenarios reflecting climate change were formatted to appear to the model as if they were standard observed records.

The results of the simulation are described and discussed in the following two sections of the report. Output from the models which is useful for this study includes

- daily reservoir levels and volumes in storage
- daily flows in each defined channel in the system including inflows, spill flows and power flows
- daily generation
- monthly summaries of all the daily values listed above.

7 Climate and Hydrologic Variability

Prior to examining the impact of climate change on hydroelectric generation it is necessary to understand the impact of natural climate variability, and the resulting hydrologic variability. Hydroelectric generation is dependent on basin runoff which changes every year, and therefore systems are designed to accommodate varying inflows. This makes hydroelectric systems inherently adaptable to climate change.

Table 7.1 provides information on the variation in Baseline average annual inflows to the four systems of interest and the resulting energy generation. The annual generation is shown in Figure 7.1. Generation is generally greater in the Baseline scenario than observed in the recorded data since downtime and changes to the facility over the historic period have not been modelled. The simulations also assume optimal operation. For the purposes of this study it can be assumed that the overestimation would affect all scenarios equally, and therefore the differences will be representative.

Table 7.1
Baseline Annual Variation in Inflow and Generation

	Annual Inflow (m^3/s) and Increment from Average (%)							
	Rose Blanche Brook		Lookout Brook		Pierres Brook		Petty Harbour	
Average over 30 years (Baseline)	3.46		3.22		4.78		5.60	
Driest Year of Record	2.65	-23%	2.63	-18%	3.26	-32%	3.82	-32%
Wettest Year of Record	4.15	20%	3.88	21%	6.07	27%	7.12	27%
	Annual Generation (GWh) and Increment from Average (%)							
	Rose Blanche Brook		**Lookout Brook**		**Pierres Brook**		**Petty Harbour**	
Average over 30 years (Baseline)	24.37		34.94		27.19		20.57	
Driest Year of Record	19.92	-18%	30.43	-13%	18.90	-30%	13.93	-32%
Wettest Year of Record	28.42	17%	40.77	17%	32.79	21%	26.02	26%

The generation from the four systems considered in this study can vary up 20 to 30 percent above or below average from year to year. Generation varies in a similar fashion to the inflows.

Utilities deal with the variability in generation as a result of the climate variability in various ways depending on their location and their assets. Some options are

- installing excess capacity
- selling excess energy in wet years and purchasing energy in dry years
- using over-year storage in large reservoirs to store water from wet years to use in dry years
- operating thermal resources to supplement energy generation in dry years.

These mechanisms will continue to be successful as the climate changes, up until the point where the capacities become limited.

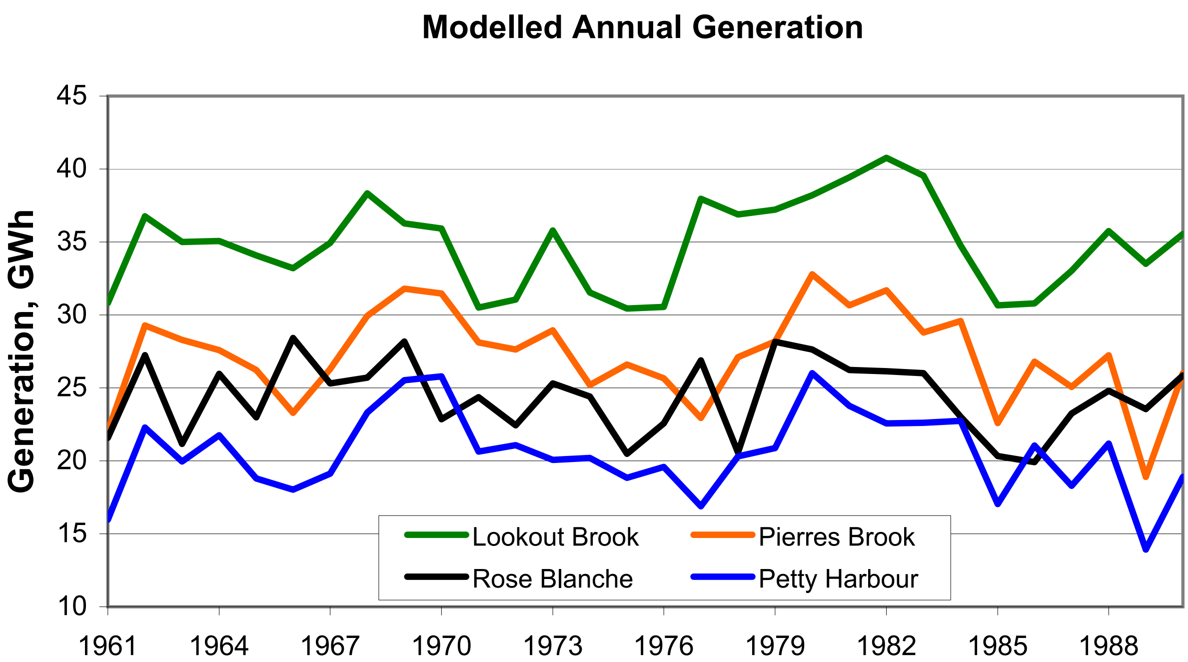

Figure 7.1

Variation in Annual Generation - Baseline Scenario

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8 Energy Simulation Results

8.1 Existing Infrastructure and Operation

8.1.1 Rose Blanche Brook System

Table 8.1 and Figure 8.1 present a summary of the generation results for each of the climate change scenarios at the Rose Blanche Brook system. Also provided are the average inflow, power flow and spill. Table 8.2 compares the inflow and generation of each climate change scenario with the Baseline scenario.

Appendix D contains tables providing the monthly energy generation over the 30-year simulation period for all scenarios. Appendix E presents more detailed data for two sample years and two climate change scenarios.

Table 8.1
Rose Blanche Brook – Average Flows and Generation

Scenario	Inflow m^3/s	Spill m^3/s	Power Flow m^3/s	Annual Generation GWh
Baseline	3.46	0.41	3.05	24.37
Wettest	3.86	0.50	3.36	26.97
Driest	3.43	0.37	3.07	24.57
Warmest	3.63	0.44	3.19	25.56
Coldest	3.43	0.40	3.03	24.26
Middle	3.49	0.40	3.10	24.79

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

Of the scenarios examined, all but the Coldest led to more generation than the Baseline case with a range of 0.2 to 2.6 GWh per year. The Coldest gave 0.12 GWh less generation.

Table 8.2
Rose Blanche Brook – Comparison of Flow and Generation

Scenario	Average Annual Inflow		Average Annual Generation	
	m^3/s	Comparison %	GWh	Comparison %
Baseline	3.46	-	24.37	-
Wettest	3.86	12%	26.97	11%
Driest	3.43	-1%	24.57	1%
Warmest	3.63	5%	25.56	5%
Coldest	3.43	-1%	24.26	0%
Middle	3.49	1%	24.79	2%

Two different factors led to the increases in generation of the various scenarios: increase inflow, and a redistribution of inflow. Under the Wettest scenario, the increase in annual average flow is 0.40 m^3/s. Of this, 0.31 m^3/s is used for generation (power flow increases from 3.05 m^3/s to 3.36 m^3/s), resulting in an additional 2.59 GWh of energy. The remainder, 0.09 m^3/s is spilled. The average annual inflow of the Driest scenario was lower than the Baseline case by 0.03 m^3/s, but the generation was greater because of the timing of the flows; the high flows were less concentrated in time, which reduced spill, and increased generation by 0.2 GWh. The Coldest scenario had the same average inflow as the Driest, but spill was greater, so generation was lower.

Overall, the difference between the natural variability of flow, as discussed in Section 7, has more effect on generation than the difference resulting from the climate change scenarios examined.

8.1.2 Lookout Brook System

As shown in Table 8.3 and Figure 8.1, every climate change scenario led to more generation than the Baseline case at the Lookout Brook system. Table 8.4 compares the inflow and generation of each climate change scenario with the Baseline scenario. Increases in annual generation ranged from 0.22 GWh (0.6 percent for the Coldest scenario) to 3.26 GWh (9.2 percent for the Wettest scenario) compared to the Baseline case.

Appendix D contains tables providing the monthly energy generation over the 30-year simulation period for all scenarios. Appendix E presents more detailed data for two sample years and two climate change scenarios.

Table 8.3
Lookout Brook – Average Flows and Generation

Scenario	Inflow m^3/s	Spill m^3/s	Power Flow m^3/s	Annual Generation GWh
Baseline	3.22	0.14	3.06	34.94
Wettest	3.59	0.18	3.39	38.20
Driest	3.30	0.10	3.19	36.16
Warmest	3.43	0.13	3.28	37.08
Coldest	3.20	0.09	3.09	35.16
Middle	3.31	0.10	3.19	36.15

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

Table 8.4
Lookout Brook – Comparison of Flow and Generation

Scenario	Average Annual Inflow		Average Annual Generation	
	m^3/s	Comparison %	GWh	Comparison %
Baseline	3.22	-	34.94	-
Wettest	3.59	11%	38.20	9%
Driest	3.30	2%	36.16	3%
Warmest	3.43	7%	37.08	6%
Coldest	3.20	-1%	35.16	1%
Middle	3.31	3%	36.15	3%

The increased generation was again a function of either additional inflows and/or a redistribution of inflows that allowed for greater generation and less spill. Inflows were greater than the Baseline case for every scenario except for the Coldest, however, the generation under the Coldest scenario was still greater than the Baseline case because of the timing of the flows. Inflows in the Wettest scenario were 11 percent higher than Baseline, but generation increased only nine percent; the remaining flow was spilled.

8.1.3 Pierres Brook System

Only the Wettest and Warmest climate scenarios led to an increase in inflow and a corresponding increase in annual generation at the Pierres Brook system. The increases in generation were 0.37 GWh (Warmest) and 1.55 GWh (Wettest) over the Baseline case, equivalent to 1.4 percent and 5.7 percent increases, respectively. The Middle, Driest, and Coldest scenarios led to respective decreases of 0.16, 0.43, and 0.45 GWh. The Driest and Middle scenarios lead to both decreased inflows, and a higher proportion of the inflows being spilled. The Wettest scenario has 12 percent more inflow than the Baseline, but only a 6 percent increase in energy; spill increased significantly. The results are summarized in Tables 8.5 and 8.6 and Figure 8.2.

Appendix D contains tables providing the monthly energy generation over the 30-year simulation period for all scenarios. Appendix E presents more detailed data for two sample years and two climate change scenarios.

Table 8.5
Pierres Brook – Average Flows and Generation

Scenario	Inflow m^3/s	Spill m^3/s	Power Flow m^3/s	Annual Generation GWh
Baseline	4.78	0.11	4.68	27.19
Wettest	5.35	0.42	4.94	28.75
Driest	4.71	0.11	4.60	26.77
Warmest	4.94	0.20	4.74	27.56
Coldest	4.68	0.09	4.60	26.74
Middle	4.77	0.13	4.65	27.03

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

Table 8.6
Pierres Brook – Comparison of Flow and Generation

Scenario	Average Annual Inflow		Average Annual Generation	
	m^3/s	Comparison %	GWh	Comparison %
Baseline	4.78	-	27.19	-
Wettest	5.35	12%	28.75	6%
Driest	4.71	-1%	26.77	-2%
Warmest	4.94	3%	27.56	1%
Coldest	4.68	-2%	26.74	-2%
Middle	4.77	0%	27.03	-1%

8.1.4 Petty Harbour System

Only the Wettest and Warmest climate change scenarios lead to an increase in annual generation over the Baseline case for the Petty Harbour System. These increases range from 0.6 GWh (Warmest scenario) to 2.2 GWh (Wettest), equivalent to 2.8 percent and 10.8 percent increases, respectively. The Middle, Driest, and Coldest scenarios all result in less generation than Baseline conditions, with reductions ranging from 0.1 GWh (Middle scenario) to 0.5 GWh (Coldest). The results are summarized in Tables 8.7 and 8.8 and Figure 8.2.

Appendix D contains tables providing the monthly energy generation over the 30-year simulation period for all scenarios. Appendix E presents more detailed data for two sample years and two climate change scenarios.

8.1.5 Summary

Table 8.9 summarizes the annual energy generation of each system under Baseline and the five climate change scenarios. A comparison of the increments in energy above the baseline, with the increments in inflow illustrates that for the most part, the change in energy is directly related to the change in flow. Where an increase in flow is not reflected in the energy generation, it likely indicates an inability of the system to store and use the additional flow, i.e. the flow is spilled.

Table 8.7
Petty Harbour – Average Flows and Generation

Scenario	Inflow m^3/s	Spill m^3/s	Power Flow m^3/s	Annual Generation GWh
Baseline	5.60	0.18	4.73	20.57
Wettest	6.27	0.31	5.27	22.79
Driest	5.52	0.18	4.65	20.20
Warmest	5.79	0.22	4.87	21.15
Coldest	5.49	0.18	4.62	20.09
Middle	5.59	0.19	4.71	20.46

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

Table 8.8
Petty Harbour – Comparison of Flow and Generation

Scenario	Average Annual Inflow		Average Annual Generation	
	m^3/s	Comparison %	GWh	Comparison %
Baseline	5.60	-	20.57	-
Wettest	6.27	12%	22.79	11%
Driest	5.52	-1%	20.20	-2%
Warmest	5.79	3%	21.15	3%
Coldest	5.49	-2%	20.09	-2%
Middle	5.59	0%	20.46	-1%

Table 8.9
Average Annual Inflows and Energy Generation, by Scenario

Scenario	Annual Average Inflow (m^3/s) and Increment from Baseline (%)							
	Rose Blanche Brook		Lookout Brook		Pierres Brook		Petty Harbour	
Baseline	3.46	-	3.22	-	4.78	-	5.60	-
Wettest	3.86	12%	3.59	11%	5.35	12%	6.27	12%
Driest	3.43	-1%	3.30	2%	4.71	-1%	5.52	-1%
Warmest	3.63	5%	3.43	7%	4.94	3%	5.79	3%
Coldest	3.43	-1%	3.20	-1%	4.68	-2%	5.49	-2%
Middle	3.49	1%	3.31	3%	4.77	0%	5.59	0%
Scenario	Annual Average Generation (GWh) and Increment from Baseline (%)							
	Rose Blanche Brook		Lookout Brook		Pierres Brook		Petty Harbour	
Baseline	24.37	-	34.94	-	27.19		20.57	-
Wettest	26.97	11%	38.20	9%	28.75	6%	22.79	11%
Driest	24.57	1%	36.16	3%	26.77	-2%	20.20	-2%
Warmest	25.56	5%	37.08	6%	27.56	1%	21.15	3%
Coldest	24.26	0%	35.16	1%	26.74	-2%	20.09	-2%
Middle	24.79	2%	36.15	3%	27.03	-1%	20.46	-1%

Though no probabilities have been assigned to the various scenarios provided by the CCIS, it would appear from the table that climate change may be more likely to have a positive effect on hydroelectric generation, than a negative one. Thirteen of the scenarios showed increases in generation, one suggested no change and only six showed decreased energy. Similarly, the potential gains posited are generally larger than the potential losses. The maximum increase in generation was 11 percent, while the maximum decrease was two percent.

Given the inherent uncertainties in each step of the research, the results of this study must be interpreted as a general indication of the effect of climate change on generation, rather than specific predictions of the effects on any one system.

8.2 Modified Infrastructure or Operation

One of the objectives of this study was to consider how the presence of other water users in the system modifies the impact of climate variability on generation. Other users would include municipalities or industries using the systems for water supply or requirements for riparian releases for fisheries.

The impact of climate change on a multi-use system was modelled at both Petty Harbour and Pierres Brook Systems. At the Petty Harbour system, the effects of climate change were considered using both present day municipal water demand and a predicted future demand. The effect of climate change on the demand for water, however, was not incorporated. For the Pierres Brook system, the effects of climate change were considered with and without the industrial water demand from the fish plant.

To investigate the adaptation options available to hydroelectric generators, the models were also used to examine whether operational or physical changes at hydroelectric facilities could reduce negative impacts of climate change and accentuate positive impacts. The effects of raising the spillways at the Rose Blanche Brook Forebay and at Joe Dennis Pond (a reservoir upstream of the Lookout Brook system) were examined. Raising spillways (and corresponding raises to dams, as required) should allow operators to store any additional runoff resulting from climate change, so that it could be used for generation, rather than spilled.

8.2.1 Rose Blanche Brook

Table 8.1 showed that there is significant spill at Rose Blanche for all scenarios. For the Baseline case, spill is as high as 12 percent of inflow. This suggests that there is potential for additional generation if the spill could be stored for later generation.

At Rose Blanche Brook, a 1 m increase in the spillway level was investigated. As noted in the results section, since Rose Blanche is essentially run-of-river, some additional flow resulting from climate change would be spilled rather than generated. Providing additional storage would, therefore, allow additional generation.

Results of the simulations are included in Table 8.10. Annual generation under the Baseline scenario increased by 0.67 GWh as a result of raising the spillway by 1 m, representing a 2.8 percent increase. Spill decreased from 11 to 13 percent of inflow, down to eight to 10 percent, depending on the scenario. All climate change scenarios produced additional increases in energy, i.e. the spillway increase becomes more valuable if any of the climate change scenarios come to pass. The maximum increase occurred under Wettest conditions, an increase in 0.86 GWh more than the same climate conditions and the existing spillway, or 2.78 GWh more than Baseline climate and the raised spillway.

Table 8.10
Rose Blanche Brook – Average Flows and Generation, Raised Spillway (by 1 m)

Scenario	Inflow m^3/s	Spill m^3/s	Power m^3/s	Annual Generation GWh	Comparison With Baseline %	Comparison With Existing %
Baseline	3.46	0.33	3.13	25.05	--	3%
Wettest	3.86	0.40	3.45	27.82	11%	3%
Driest	3.43	0.28	3.15	25.30	1%	3%
Warmest	3.63	0.35	3.28	26.34	5%	3%
Coldest	3.43	0.32	3.12	24.99	0%	3%
Middle	3.49	0.31	3.18	25.54	2%	3%

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

8.2.2 Lookout Brook

Potential modifications to increase energy generation at Lookout Brook would include raising dam and spillway levels to increase storage. A set of simulations were run with the spillway level at Joe Dennis Pond (the main upstream storage reservoir) raised by 1 m and the spillway at the forebay was left in its current configuration. The rule curve at Joe Dennis was altered so that the maximum spring and summer level was also 1 m higher.

Results of the simulations are included in Table 8.11. The annual generation under the Baseline case increased by 0.57 GWh (a 1.6 percent increase) as a result of the additional storage. Spill reduced from approximately four percent of inflow to three percent. Again, all the climate change scenarios resulted in additional energy over the Baseline case and over the scenario with the same climate change and the existing storage. Raising the spillway allowed more of the increased inflows to be generated. As expected, the value of the additional storage is most in the wettest scenario; energy generation would be 3.3 GWh greater than the Baseline with the new spillway.

Table 8.11
Lookout Brook – Average Flows and Generation, Raised Spillway (by 1 m)

Scenario	Inflow m^3/s	Spill m^3/s	Power m^3/s	Annual Generation		
				GWh	Comparison With Baseline %	Comparison With Existing %
Baseline	3.22	0.09	3.11	35.52	-	2%
Wettest	3.59	0.12	3.44	38.83	9%	2%
Driest	3.30	0.05	3.24	36.69	3%	1%
Warmest	3.43	0.08	3.33	37.67	6%	2%
Coldest	3.20	0.05	3.13	35.67	0%	1%
Middle	3.31	0.06	3.23	36.70	3%	2%

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

8.2.3 Pierres Brook

The simulations for Pierres Brook described earlier in this report were run without accounting for the water supply to the local fish plant. Additional runs were done to investigate the impact of the water supply. The demand is small (0.023 m^3/s), less than one percent of average annual inflow. Results of the simulations are included in Table 8.12.

In the Baseline scenario, accounting for the fish plant demand decreased annual energy generation by 0.11 GWh, a 0.4 percent decrease reflecting the decrease in inflow available to the generating station. As would be expected, generation with the additional demand was lower for all other scenarios also. Under the Wettest and Warmest scenarios, the additional flow made up for the loss due to the water demand, in the other scenarios, the generation is lower than Baseline, but the differences are small.

Table 8.12
Pierres Brook – Average Flows and Generation, Fish Plant Demand

Scenario	Inflow m^3/s	Spill m^3/s	Power m^3/s	Annual Generation GWh	Comparison With Baseline %	Comparison With Existing %
Baseline	4.78	0.10	4.66	27.08	-	0%
Wettest	5.35	0.41	4.92	28.66	6%	0%
Driest	4.71	0.11	4.58	26.66	-2%	0%
Warmest	4.94	0.20	4.72	27.47	1%	0%
Coldest	4.68	0.08	4.58	26.63	-2%	0%
Middle	4.77	0.12	4.63	26.92	-1%	0%

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.

8.2.4 Petty Harbour

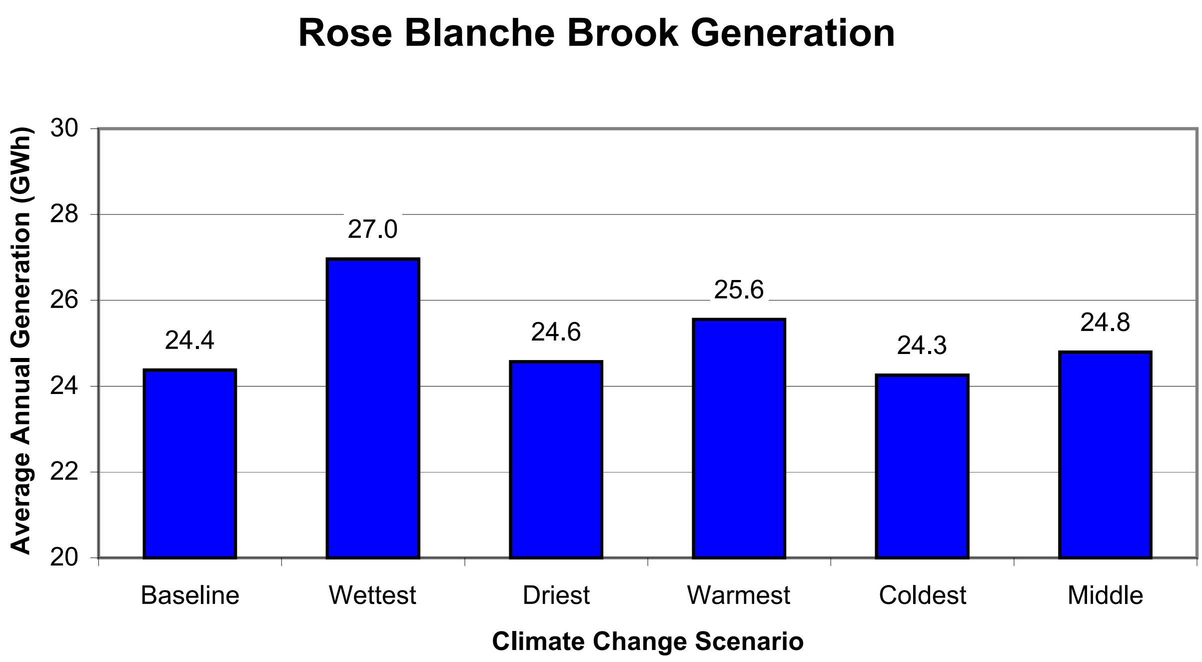
Additional simulations were done for the Petty Harbour System to model increased demand imposed by the municipal water supply. The base case model used a value of 0.69 m^3/s for municipal water demand.

Results of the simulations are included in Table 8.13. The new scenario used an additional 0.26 m^3/s, for at total of 0.95 m^3/s. This increase reflects expected growth in the town; the higher demand will occur earlier if climate change results in increased water use. As would be expected, additional water supply demand reduced the flow available for generation. The loss in generation is very similar in all scenarios. The least effect was for the Wettest scenario; it has the largest incremental inflow above Baseline and hence the increased water demand reduces the amount of spill from the reservoir.

Table 8.13
Petty Harbour – Average Flows and Generation, With Increased Municipal Demand

Scenario	Inflow m^3/s	Spill m^3/s	Power m^3/s	Annual Generation		
				GWh	Comparison With Baseline %	Comparison With Existing %
Baseline	5.60	0.18	4.43	19.26	-	-6%
Wettest	6.27	0.30	4.98	21.55	12%	-5%
Driest	5.52	0.18	4.35	18.90	-2%	-6%
Warmest	5.79	0.22	4.57	19.86	3%	-6%
Coldest	5.49	0.18	4.32	18.79	-2%	-6%
Middle	5.59	0.19	4.41	19.16	-1%	-6%

Note: Inflows may not balance outflows due to rounding errors and changes in storage over the duration of the simulation.



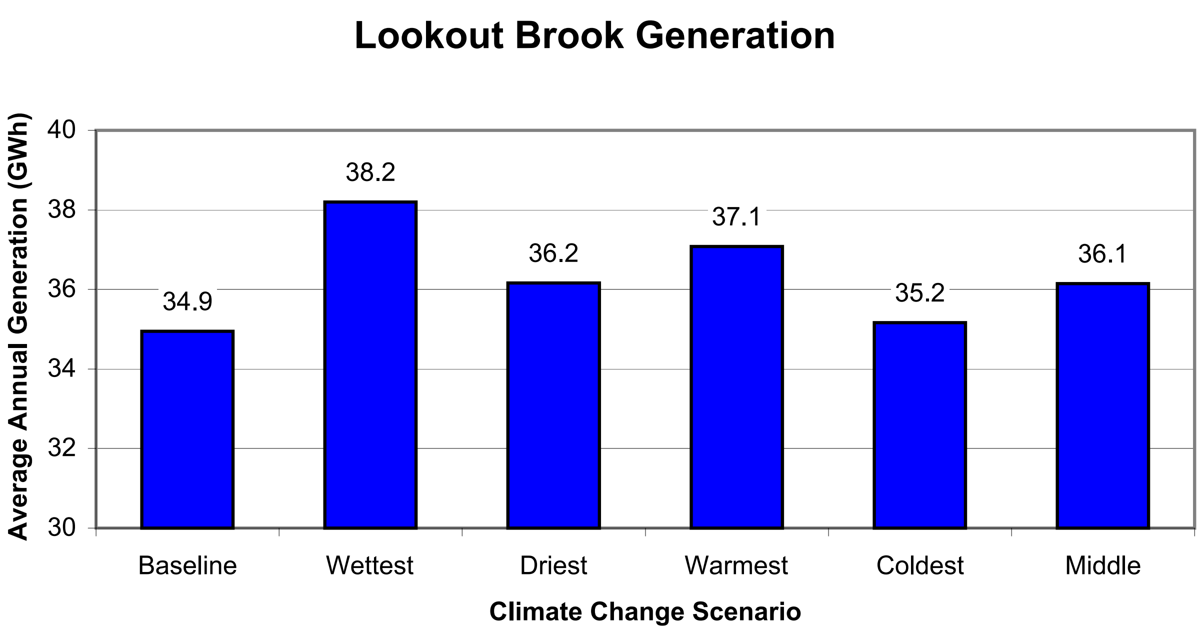


Figure 8.1

Average Annual Generation by System and Scenario (1 of 2)

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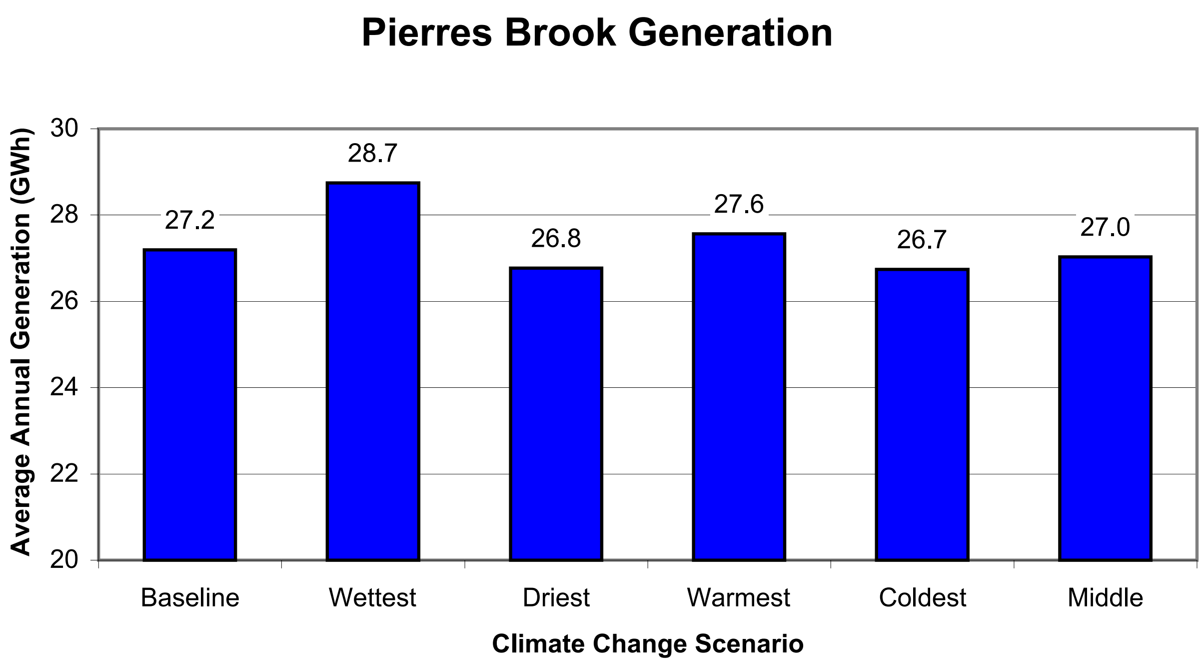

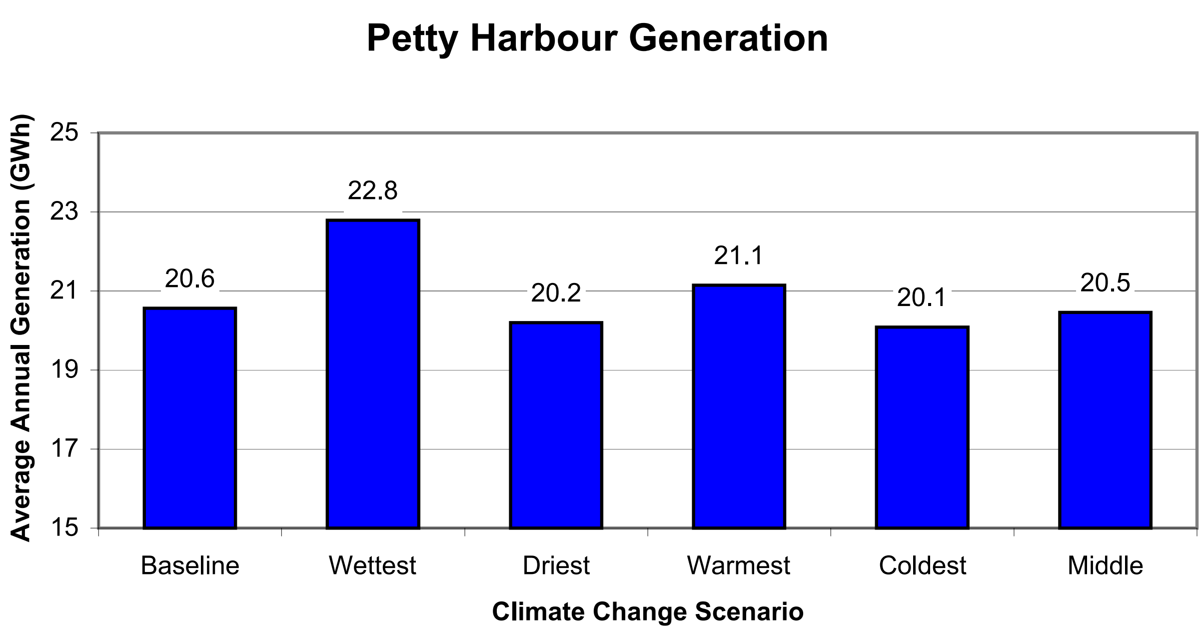

Figure 8.2
Average Annual Generation by System and Scenario (2 of 2)

Impact of Climate Change on Hydroelectric Generation in Newfoundland
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9 Conclusions and Recommendations

Watershed and operational routing has been undertaken for four Newfoundland Power Hydroelectric Systems to examine the impacts of five climate change scenarios on generation. This study has lead to the following conclusions.

9.1 Conclusions

A methodology has been developed for examining the impact of changes in temperature and precipitation on generation. Regression models relating flow to temperature and precipitation can lead to synthetic flow sequences acceptable for representing changes in flow resulting from climate. Operations models can then be used to measure the impacts of the change in flow on energy generation.

Long term changes in temperature and precipitation predicted by the global climate models vary considerably from scenario to scenario and month to month within the scenarios. Five scenarios were studied herein, chosen to bracket the range of suggested changes in monthly average values. The ranges of temperature and precipitation changes examined were as follows.

- The smallest monthly change in average temperature was an increase in temperature of 0.35º Celsius in December of the Coldest scenario.
- The maximum monthly change in average temperature was an increase of 3.32º Celsius in February of the Warmest scenario.
- The largest decrease in average total precipitation was 10.8 percent in May of the Driest scenario.
- The largest increase in average total precipitation was 22.6 percent precipitation in February of the Wettest scenario.

When run through the regression models to derive new inflow sequences for each of the NP systems, the climate change scenarios resulted in average annual inflows of between two percent less than the baseline flows up to 12 percent greater than the baseline. The Driest scenario did not necessarily result in decreased inflows; the Coldest scenario resulted in lower inflows at all systems, however. This is because the Coldest scenario is also dry.

An examination of the variation in average annual flows from the baseline 30-year period in the recorded sequences shows that the driest year on record could be up to 32 percent below average and the wettest year could have an average annual flow 27 percent above average. Climatic and hydrologic variation from year to year, therefore, leads to greater variation in energy generation than climate change over the term considered in this analysis, up to 2039.

Figure 9.1 is an overall summary of the average annual generation at each system under each climate change scenario. As would be expected, the highest generation resulted from the Wettest scenario for all systems. The Petty Harbour System realizes the greatest increase as a percentage of the Baseline case (10.8 percent), followed closely by Rose Blanche (10.6 percent) and Lookout Brook (9.3 percent).

Given the inherent uncertainties in each step of the research, however, the results of this study must be interpreted as general indicators of the effect of climate change on generation, rather than specific predictions of the effects on any one system.

At Lookout Brook, all climate change scenarios resulted in more generation than the Baseline case. Adding storage to the system would further increase the generation. At the Petty Harbour and Pierres Brook systems, only the Wettest and Warmest scenarios lead to more generation than the Baseline case. All but the Coldest scenario lead to more generation at Rose Blanche Brook.

The greatest factor in determining the extent of the impact of climate change on the individual systems appeared to be the magnitude of the change in average annual inflow. Other factors, such as the distribution of the increased inflow also had a impact, for instance when the added inflow was during the snowmelt season, it was generally spilled rather than generated.

Simulations to examine whether providing increased storage would be an effective adaptation measure for utilities generally showed that added storage would lead to additional generation, but that it would under the baseline case as well as under climate change. This is a somewhat counterintuitive result. Additional work is required to more fully examine the correlation between energy and storage during climate change.

For systems with other users in the watershed, the increase in inflow from climate change may be able to partially or fully offset potential losses to the station from increases in demand from those other users.

9.2 Recommendations for Further Study

This research has provided a preliminary indication of the impact that climate change could have on generation in Newfoundland. Further research is required before generation companies can make definitive plans for adaptation. Some ideas for future research are listed below.

- Additional systems should be modelled to improve the understanding of how available reservoir storage changes the ability of a system to take advantage of higher inflows or reduce the impact of lower inflows.

- Research into downscaling GCM results has been ongoing during the duration of this study. Once reliable results have been produced for the Island of Newfoundland, this study could be repeated with the refined temperature and precipitation change estimates.

- This study examined systems on the southwest coast and the eastern Avalon. Once downscaled scenarios are available, additional systems throughout the province should be modelled to investigate the effect of geography on the impact of climate change. This may require the inclusion of Newfoundland and Labrador Hydro systems to get the best geographic distribution.

- Additional meteorological and hydrometric data in the hydroelectric systems' basins would reduce uncertainty in the prediction of changes in flow and therefore generation, as a function of changes in temperature and precipitation.

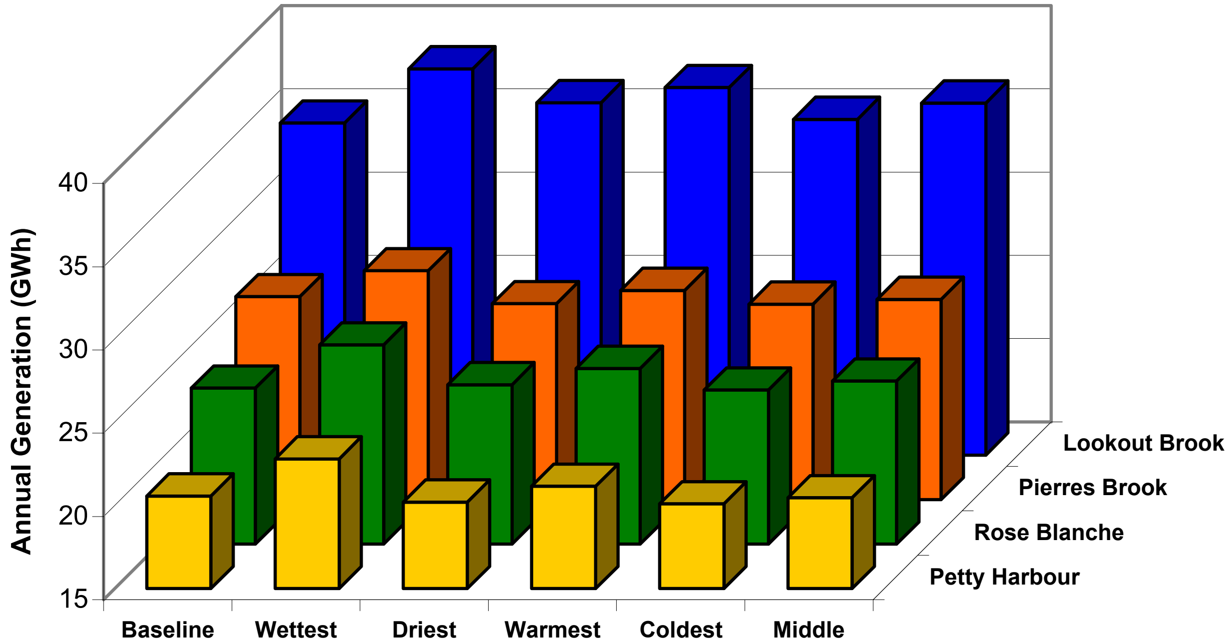

Figure 9.1

Summary of Annual Generation for Each System and Scenario

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres

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Appendix A – The SRES Emissions Scenarios

APPENDIX A

The SRES Emissions Scenarios

Forty alternative "emissions scenarios" were published in 2000 in a Special Report on Emission Scenarios (SRES), commissioned by the Intergovernmental Panel on Climate Change. These are known as the SRES scenarios. For details see http://www.grida.no/climate/ipcc/emission/index.htm Special Report on Emissions Scenarios (Nakicenovic et al., 2000). Other IPCC Special Reports including the Third Assessment Report are on the IPCC web site (http://www.ipcc.ch/).

In order to reduce the number of emission scenarios to be used in climate change studies, six marker or illustrative SRES scenarios were selected from the larger group. These six scenarios are known as the A1FI, A1T and A1B (from the A1 family), and A2, B1, and B2 emission scenarios. It should be noted that no single scenario is treated as any more, or less, probable than others in the same scenario family.

The following summarizes their major features.

A1

The A1 story line and scenario family describes a future world with very rapid economic growth, a global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Its three sub-groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B).

A2

The A2 story line and family describes a very heterogeneous world where fertility patterns converge very slowly, resulting in continuously increasing population, economic development is regionally oriented and per capita economic growth and technological change are more fragmented and slower than other story lines.

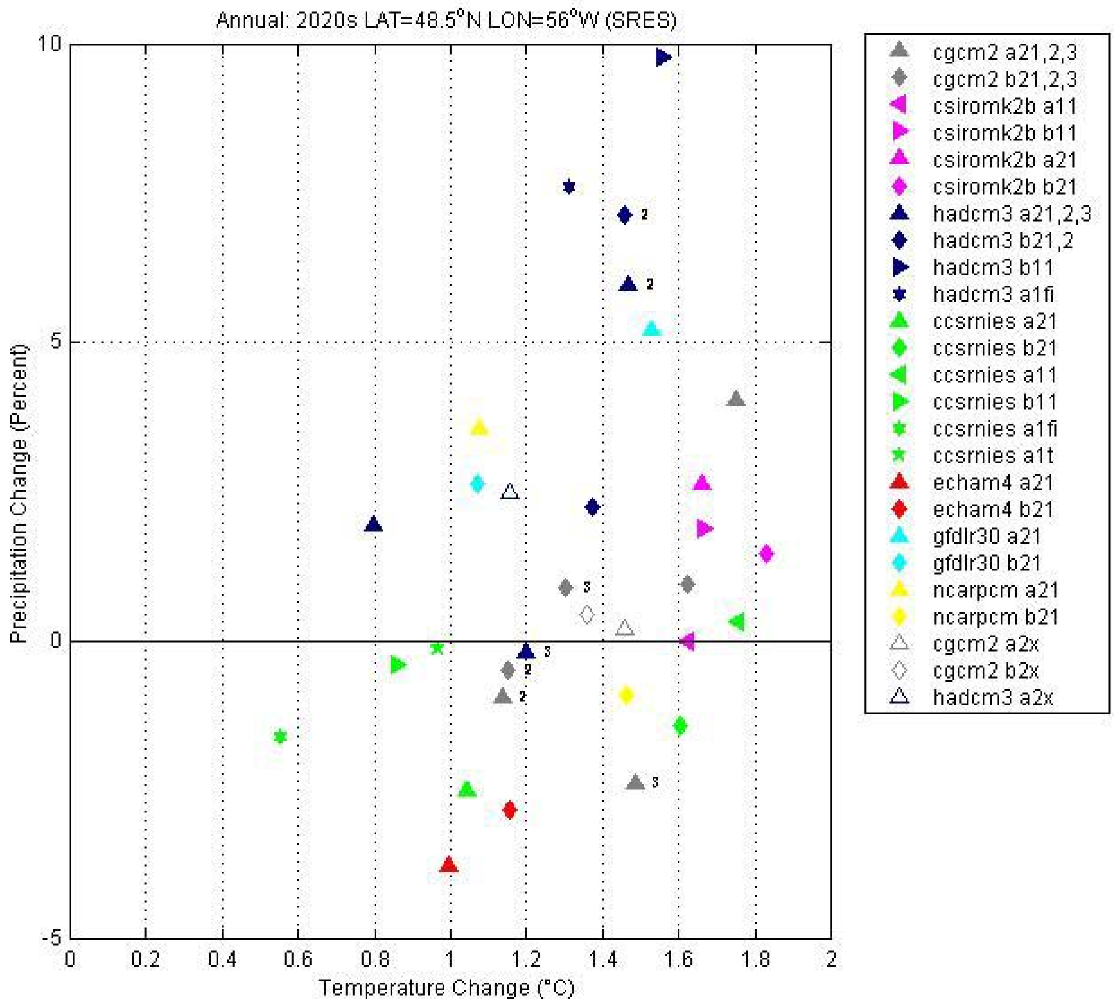
B1

The B1 story line and scenario family describes a world with the same population trend as in the A1 story line but with rapid economic change towards a service and information economy, reductions in material intensity and introduction of clean, resource-efficient technologies.

B2

The B2 story line and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is one with a continuously increasing global population at a rate lower than A2, intermediate levels of economic development and less rapid and more diverse technological change than in the B1 and A1 story lines. The GCM model outputs considered and used in this project are based on the SRES emission scenarios.

Scenarios used in this SGE Acres study were been taken from the B1 and A2 story lines.



Annual: 2020s LAT=48.5°N LON=56°W (SRES)
Precipitation Change (Percent)
Temperature Change (°C)
10
5
0
-5
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
cgcm2 a21,2,3
cgcm2 b21,2,3
csiromk2b a11
csiromk2b b11
csiromk2b a21
csiromk2b b21
hadcm3 a21,2,3
hadcm3 b21,2
hadcm3 b11
hadcm3 a1fi
ccsrnies a21
ccsrnies b21
ccsrnies a11
ccsrnies b11
ccsrnies a1fi
ccsrnies a1t
echam4 a21
echam4 b21
gfdlr30 a21
gfdlr30 b21
ncarpcm a21
ncarpcm b21
cgcm2 a2x
cgcm2 b2x
hadcm3 a2x

The following data for each experiment at 48.5°N 56°W came from grid boxes centered at the following locations for each model:

Experiment	Temperature Change (°C)	Precipitation Change (Percent)	Gridbox Center	
			Latitude	Longitude
cgcm2 a21	1.8	4	50.0995°N	56.25°W
cgcm2 a22	1.1	-1	50.0995°N	56.25°W
cgcm2 a23	1.5	-2	50.0995°N	56.25°W
cgcm2 b21	1.6	1	50.0995°N	56.25°W
cgcm2 b22	1.2	0	50.0995°N	56.25°W
cgcm2 b23	1.3	1	50.0995°N	56.25°W
csiromk2b a11	1.6	0	49.3779°N	56.25°W
csiromk2b b11	1.7	2	49.3779°N	56.25°W
csiromk2b a21	1.7	3	49.3779°N	56.25°W
csiromk2b b21	1.8	1	49.3779°N	56.25°W
hadcm3 a21	0.8	2	47.5°N	56.25°W
hadcm3 a22	1.5	6	47.5°N	56.25°W
hadcm3 a23	1.2	0	47.5°N	56.25°W
hadcm3 b21	1.4	2	47.5°N	56.25°W
hadcm3 b22	1.5	7	47.5°N	56.25°W
hadcm3 b11	1.6	10	47.5°N	56.25°W
hadcm3 a1fi	1.3	8	47.5°N	56.25°W
ccsrnies a21	1	-3	47.0696°N	56.25°W
ccsrnies b21	1.6	-1	47.0696°N	56.25°W
ccsrnies a11	1.8	0	47.0696°N	56.25°W
ccsrnies b11	0.9	0	47.0696°N	56.25°W
ccsrnies a1fi	0.6	-2	47.0696°N	56.25°W
ccsrnies a1t	1	0	47.0696°N	56.25°W
echam4 a21	1	-4	48.8352°N	56.25°W
echam4 b21	1.2	-3	48.8352°N	56.25°W
gfdlr30 a21	1.5	5	48.0733°N	56.25°W
gfdlr30 b21	1.1	3	48.0733°N	56.25°W
ncarpcm a21	1.1	4	48.8352°N	56.25°W

Experiment	Temperature Change (°C)	Precipitation Change (Percent)	Gridbox Center	
			Latitude	Longitude
ncarpcm b21	1.5	-1	48.8352°N	56.25°W
cgcm2 a2x	1.5	0	50.0995°N	56.25°W
cgcm2 b2x	1.4	0	50.0995°N	56.25°W
hadcm3 a2x	1.2	2	47.5°N	56.25°W

Appendix B – Detailed Notes on Methodology

APPENDIX B

Notes on Methodology

This appendix provides additional details of the methodology used in the SGE Acres study. It includes more details on some of the assumptions and techniques used, as well as explanations of why certain steps were necessary, and on avenues of investigation that were found to not be appropriate.

Predictor Variables in Flow Models

The ultimate flow equations used in the study related flow to the temperature and total precipitation of the current and one preceding month.

Initially, it was assumed that the independent variables in the flow models would be temperature, rain, and snow, rather than temperature and total precipitation, since the type of precipitation is known to have a significant effect on flow. Initial models generated using all three variables provided a better correlation with historic data than models of flow as a function of temperature and total precipitation only. However, the climate change scenario data from CCIS is in the form of total precipitation rather than individual adjustments for rain and snow values. Since the temperature changes under the climate change scenarios will alter the distribution of precipitation into snow and rain, adjusting the precipitation deviations to snow and rain individually would not give representative results.

The first attempt to resolve this difficulty was to develop a regression equation that related the fraction of total precipitation that fell as rain to temperature so that the amount of each type of precipitation could be determined after a climate change scenario was applied to temperature and total precipitation. However, the regression analysis resulted in poor relationships.

Using both rain and snow values in developing the flow model would involve error in dividing the precipitation between rain and snow as well as the error in the regression of climate and flow. Using total precipitation in the flow model would involve error solely from one level of the regression. Monthly relationships were developed for both options for each system and predicted values were compared to observed values to determine which method was more accurate. It was found that there was more error in the two step method because of the poor relationship found between temperature and the distribution of precipitation into snow and rain. This simplified future calculations since it eliminated the intermediate step of splitting the precipitation into rain and snow components.

Negative Flows

There were a number of months where the temperature and precipitation data were such that when used in the flow models, the equations resulted in negative or zero synthetic flows. Table B.1 summarizes these occurrences.

Table B.1
Months Resulting in Negative Flows

Flow Model	Months Resulting in a Negative Synthetic Flow
Isle aux Morts (for Rose Blanche System)	February 1975 and July 1989
Little Barachoise River (for Lookout Brook System)	February 1961, August 1967, August 1969, August 1985, and January 1974
Waterford River (for Pierre's Brook and Petty Harbour Systems)	July 1961, July 1967, July 1972 and August 1967

The negative flows were adjusted as follows. For months where historic data was available, the negative monthly average synthetic flow was replaced by the historic monthly average flow. For months where historic data was not available, the synthetic monthly average flow was assumed to be halfway between zero and the next lowest synthetic monthly average flow. Although this assumption has no hydrological justification, it was deemed acceptable since it resulted in a very low, non-zero flow and was only necessary for eight months out of three series of 30-year, 12-month data sets.

Daily Flow Sequence Development

The ARSP modelling required daily flow data for the 30-year normal period from 1961 to 1990, whereas the flow modelling provided only monthly data. Historic daily and monthly data were used to proportion the monthly estimated flows into the individual days of the month. The synthetic sequences would then have the same ratios of daily to monthly flow as the historic sequence for each day of the month.

For each of the hydrometric stations used, however, there were a number of years where historic flow records were unavailable. The synthetic daily flow sequences for these years were therefore based on other successive years of historic data. Years were chosen so that they had the same relative position to a leap year so the correct number of days was available. Table B.2 summarizes the years of missing data and the corresponding years used for the development of the daily flow sequences.

Table B.2
Years of Historic Data used in Development of Daily Flow Sequences

Flow Model	Periods Without Historic Data	Years Used for Conversion to Daily Flow
Isle aux Morts (for Rose Blanche System)	1961, 1962 (Jan to Sep)	1973, 1974 (Jan to Sep)
Little Barachoise River (for Lookout Brook System)	1961 to 1986	1981 to 1990, and 1979 to 1986
Waterford River (for Pierres Brook and Petty Harbour Systems)	1961 to 1973	1977 to 1989

ARSP Modelling Difficulties

Under the wettest climate change scenario for the Lookout Brook System, high daily flow occurrences at the end of April in 1962 and 1982 caused the routing routine in the ARSP model to become unstable. To overcome this problem, the inflow data file was modified such that excess flow from the highest flow days was distributed among the few days before and after the peak day. Since power generation would be maximized during these periods and excess flow would be spilled, these adjustments had no effect on energy generation. The adjustment was effective in stabilizing the ARSP model and allowed the analysis to continue.

Appendix C – 30-year Climate and Flow Data Tables

Table C- 1

Port aux Basques Climate Data (for Rose Blanche system) - 1961-1990 Average Monthly Temperature (^{o}C)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	-7.0	-8.9	-3.8	1.4	4.2	8.8	13.3	14.4	13.1	8.6	5.7	-0.1	4.2
1962	-5.0	-7.5	0.3	1.3	4.8	8.2	11.6	14.2	11.7	7.8	4.8	-1.3	4.3
1963	-1.1	-6.4	-4.6	0.8	5.1	8.8	13.5	14.2	10.9	8.2	4.5	-2.7	4.3
1964	-4.9	-4.0	-3.5	0.8	4.3	8.5	12.2	14.1	10.9	6.9	1.7	-2.1	3.8
1965	-4.3	-5.7	-1.9	0.2	4.4	8.7	12.6	15.0	10.4	5.7	1.2	-2.0	3.8
1966	-2.7	-4.9	-0.5	1.6	4.5	8.4	12.8	15.1	10.9	6.7	4.5	0.7	4.8
1967	-3.2	-6.1	-5.7	-0.7	3.6	8.9	14.8	16.4	12.4	7.8	4.8	-0.5	4.4
1968	-4.2	-5.7	-2.6	1.5	4.8	8.4	13.4	12.5	12.8	8.9	2.2	0.3	4.4
1969	-1.6	-1.5	-1.2	-0.1	4.6	9.8	12.4	14.8	11.3	5.8	4.3	2.3	5.1
1970	-5.5	-3.6	-1.3	0.8	5.7	9.5	14.1	17.0	10.7	8.6	5.3	-2.6	4.9
1971	-4.6	-5.4	-1.4	2.4	5.5	9.4	13.2	15.2	11.6	6.7	3.5	-3.1	4.5
1972	-5.2	-9.3	-4.8	-0.7	3.0	9.0	13.4	13.2	10.8	6.1	1.4	-5.4	2.7
1973	-5.0	-4.9	-3.2	0.4	4.6	8.7	14.5	14.6	11.0	6.5	1.9	0.3	4.2
1974	-7.3	-7.4	-5.4	-0.2	3.3	8.5	11.9	14.3	11.2	5.3	2.2	-0.9	3.0
1975	-5.6	-9.6	-3.4	-0.1	5.1	9.7	15.0	15.1	12.8	6.6	2.4	-2.6	3.9
1976	-4.4	-5.3	-4.4	1.1	5.4	9.7	13.2	14.8	12.7	6.6	1.4	-3.6	4.0
1977	-5.0	-5.8	-1.2	0.1	3.9	9.4	13.0	14.5	10.7	7.8	4.7	-1.7	4.3
1978	-4.1	-4.0	-3.7	-0.1	5.2	9.0	14.0	14.8	9.9	6.6	1.0	-2.1	3.9
1979	-2.1	-6.4	-1.0	1.5	6.1	10.2	13.5	14.1	9.9	6.8	4.0	-1.3	4.7
1980	-4.0	-5.5	-2.5	1.8	4.6	8.8	12.3	14.4	10.2	6.4	2.9	-2.5	4.0
1981	-4.4	-2.8	0.1	1.2	6.0	9.8	13.6	14.9	13.2	8.5	4.1	1.2	5.5
1982	-4.7	-6.4	-4.3	-0.4	5.8	8.4	13.6	13.9	12.1	6.7	3.7	-1.6	4.0
1983	-3.3	-3.8	-1.1	3.6	6.2	10.2	14.4	14.4	13.1	8.0	3.3	-2.2	5.3
1984	-5.7	-3.7	-2.8	2.7	6.2	9.4	14.9	17.0	12.0	6.3	2.9	-2.0	4.8
1985	-6.4	-6.1	-5.1	-0.6	4.3	9.1	14.4	15.5	12.3	6.1	1.3	-3.7	3.5
1986	-4.4	-7.1	-5.6	2.4	5.9	8.7	13.2	15.3	10.4	6.3	0.7	-3.0	3.6
1987	-5.7	-5.9	-3.0	2.6	5.6	10.4	14.8	15.2	11.9	7.9	1.3	-2.4	4.4
1988	-4.4	-5.4	-3.1	2.4	7.0	8.6	13.2	15.3	11.2	6.9	3.5	-3.1	4.4
1989	-5.6	-7.1	-5.9	0.7	5.6	11.6	13.9	15.6	11.1	5.7	1.7	-5.0	3.6
1990	-5.2	-10.1	-6.8	0.1	4.3	10.1	13.2	15.2	12.2	8.2	2.7	-1.4	3.6
mean	-4.6	-5.9	-3.1	0.9	5.0	9.2	13.5	14.8	11.5	7.0	3.0	-1.8	4.2
min	-7.3	-10.1	-6.8	-0.7	3.0	8.2	11.6	12.5	9.9	5.3	0.7	-5.4	
max	-1.1	-1.5	0.3	3.6	7.0	11.6	15.0	17.0	13.2	8.9	5.7	2.3	

Table C- 2
Port aux Basques Climate Data (for Rose Blanche system) - 1961-1990 Total Monthly Precipitation (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	83.6	80.9	98.1	43.1	180.0	111.1	47.5	52.0	63.2	170.7	132.7	123.6	99.1
1962	53.3	119.0	36.4	162.8	88.7	172.3	271.1	63.5	82.2	139.8	136.0	197.7	126.8
1963	169.8	66.9	32.6	54.2	139.3	66.3	63.3	129.0	164.0	33.7	149.5	134.9	100.5
1964	171.9	177.0	124.3	136.5	47.5	152.9	138.5	128.8	133.7	127.4	69.4	138.3	128.6
1965	168.1	286.1	49.0	78.7	48.4	70.3	109.3	149.6	70.7	101.7	237.1	97.0	121.0
1966	122.6	66.5	115.3	50.3	111.7	111.6	107.1	123.0	126.2	237.1	99.9	136.2	117.9
1967	82.4	134.7	110.1	74.6	110.9	82.3	67.6	102.5	201.7	114.2	227.4	151.8	121.3
1968	229.7	56.7	174.9	121.3	85.6	195.2	30.1	216.1	27.9	111.7	192.9	266.4	143.1
1969	156.8	152.6	113.2	116.8	88.6	77.5	139.6	83.1	95.0	122.5	214.4	251.2	134.2
1970	89.7	95.7	93.1	59.2	131.0	107.8	78.1	238.3	83.9	127.3	190.2	146.6	120.4
1971	108.4	116.9	183.0	118.0	144.2	55.5	111.0	158.5	135.3	116.2	197.0	123.3	130.8
1972	112.0	119.3	135.9	81.6	211.1	149.1	57.6	83.9	89.3	213.8	172.5	153.8	131.8
1973	149.1	214.0	79.5	41.5	182.3	97.3	149.8	182.3	85.2	86.8	120.3	184.5	130.9
1974	103.8	140.3	216.6	166.6	86.2	22.9	163.2	82.7	79.5	177.1	95.6	141.8	123.2
1975	155.3	59.8	166.2	87.6	76.9	42.0	56.7	72.5	104.7	101.8	149.9	292.7	114.4
1976	145.6	104.8	98.7	74.0	157.0	39.7	59.4	76.5	97.2	195.2	177.7	233.9	122.0
1977	159.5	58.2	91.7	93.0	94.0	180.1	151.8	95.1	181.7	187.4	140.5	196.4	136.2
1978	197.9	19.2	86.7	187.7	70.6	133.4	111.2	20.8	106.2	125.0	79.3	111.1	104.5
1979	127.6	87.1	123.1	88.0	223.9	89.0	223.9	148.1	115.1	210.7	112.3	199.7	146.6
1980	126.5	58.2	66.9	113.6	187.8	133.8	152.0	150.1	199.0	174.9	172.6	148.4	140.8
1981	70.3	48.9	63.8	161.8	143.5	118.8	146.6	86.6	115.5	166.2	144.3	219.3	124.2
1982	152.1	178.1	78.6	231.3	80.8	196.9	113.8	83.1	110.9	128.3	105.6	160.7	134.4
1983	127.9	112.3	145.7	245.7	154.6	120.0	172.2	206.4	101.8	74.2	182.5	174.0	151.6
1984	164.6	102.8	83.5	69.8	109.4	118.4	86.2	167.0	182.2	79.4	129.6	147.5	120.1
1985	186.2	104.0	124.7	71.4	82.6	220.8	74.0	69.0	82.8	103.0	138.2	154.1	117.6
1986	191.4	96.5	69.8	114.6	37.4	133.6	84.8	87.4	99.3	107.4	165.4	96.6	106.9
1987	113.2	93.0	71.4	194.6	123.4	127.4	56.6	131.6	108.8	234.0	122.4	142.9	126.7
1988	126.6	138.4	179.7	150.6	140.4	128.6	91.0	78.8	128.7	187.4	211.1	90.8	137.5
1989	141.4	153.6	73.5	58.8	84.8	99.8	30.2	234.2	153.4	166.4	210.0	193.3	133.2
1990	171.1	130.1	77.7	155.0	152.6	79.0	89.6	143.0	125.3	198.8	136.1	354.5	151.5
mean	138.6	112.4	105.5	113.4	119.2	114.4	107.8	121.5	115.0	144.0	153.7	172.1	126.6
min	53.3	19.2	32.6	41.5	37.4	22.9	30.1	20.8	27.9	33.7	69.4	90.8	
max	229.7	286.1	216.6	245.7	223.9	220.8	271.1	238.3	201.7	237.1	237.1	354.5	

Table C- 3

Isle aux Morts (Rose Blanche System) - Historical Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	9.3	22.1	12.5	*
1963	12.0	2.4	1.5	5.6	38.7	11.7	5.0	10.2	17.1	5.7	20.9	13.8	12.1
1964	3.4	3.4	1.3	19.1	31.3	23.9	12.7	10.7	8.9	14.8	15.5	12.2	13.1
1965	5.1	4.5	16.3	5.7	28.4	22.4	7.8	12.1	7.5	18.2	23.5	10.7	13.6
1966	4.5	5.7	8.2	18.2	27.5	12.5	12.1	6.6	11.9	26.0	16.9	13.1	13.6
1967	5.1	1.5	1.1	3.6	41.4	21.3	2.5	15.2	16.4	22.3	38.3	13.9	15.3
1968	7.8	11.8	21.3	39.8	19.8	17.6	3.0	7.4	6.1	11.5	15.0	24.2	15.4
1969	10.5	14.4	5.3	12.2	43.3	17.4	4.4	7.2	4.6	10.1	27.2	31.3	15.7
1970	3.5	11.1	2.2	9.5	35.4	7.6	4.4	13.0	7.0	14.9	21.3	9.2	11.6
1971	3.1	12.9	6.2	38.1	25.9	4.3	6.6	17.5	11.1	12.6	22.9	8.5	14.1
1972	7.2	5.5	10.9	8.3	49.3	34.7	3.7	7.9	6.9	31.0	22.7	8.0	16.4
1973	4.4	13.6	4.0	13.4	42.8	11.4	13.0	12.5	3.5	8.5	17.9	23.5	14.1
1974	3.5	6.5	10.1	19.3	29.7	18.1	10.0	5.5	10.2	15.1	12.8	9.3	12.5
1975	1.6	0.9	6.7	16.4	29.2	6.0	1.7	6.1	4.7	8.8	15.8	29.6	10.7
1976	12.3	6.4	8.6	23.9	30.8	2.6	3.9	4.4	12.9	17.8	18.4	17.9	13.4
1977	8.0	3.4	3.3	18.0	33.1	20.8	13.2	9.4	15.5	27.6	20.9	15.0	15.7
1978	17.4	2.1	2.3	12.4	43.0	23.4	10.2	1.4	6.2	14.8	11.3	6.6	12.7
1979	11.9	4.7	24.2	12.4	19.7	10.3	11.4	9.1	16.9	18.9	20.3	17.2	14.8
1980	3.1	1.5	3.2	31.5	23.0	10.0	10.7	6.1	14.7	18.2	19.4	5.3	12.2
1981	5.0	7.4	13.3	25.2	26.8	10.9	15.6	9.7	8.0	15.0	15.4	29.9	15.2
1982	8.1	10.6	6.8	39.4	44.0	18.3	11.1	7.9	8.9	8.1	11.5	14.6	15.8
1983	16.3	12.9	15.6	36.0	10.0	8.1	9.1	15.4	10.6	9.6	22.1	17.5	15.2
1984	12.3	12.6	9.5	24.3	22.5	13.1	8.0	11.5	16.5	5.8	9.2	15.0	13.3
1985	1.9	1.4	3.2	13.1	38.4	34.0	6.5	2.2	7.3	9.3	12.7	12.4	11.9
1986	24.0	2.2	4.1	35.1	6.2	8.8	3.0	3.6	4.4	9.8	15.1	7.7	10.3
1987	3.3	1.9	3.5	35.6	17.2	10.4	2.2	5.4	12.0	23.9	17.7	7.9	11.8
1988	1.8	4.4	10.0	27.8	36.8	15.0	7.7	1.8	11.6	15.4	25.2	4.1	13.5
1989	3.1	3.0	2.4	14.3	44.5	7.2	1.2	11.6	11.0	17.2	22.7	3.5	11.9
1990	4.3	3.8	3.0	22.8	45.2	11.3	3.7	13.5	11.6	18.6	19.3	43.0	16.8
mean	7.3	6.2	7.4	20.7	31.6	14.7	7.3	8.7	10.1	15.1	19.1	15.1	13.7
min	1.6	0.9	1.1	3.6	6.2	2.6	1.2	1.4	3.5	5.7	9.2	3.5	
max	24.0	14.4	24.2	39.8	49.3	34.7	15.6	17.5	17.1	31.0	38.3	43.0	

Note: * denotes missing data

Table C- 4

Isle aux Morts (Rose Blanche System) - Synthetic Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.7	0.7	6.8	15.8	28.7	17.8	3.3	3.5	4.9	17.1	21.5	12.8	11.2
1962	2.5	4.3	11.8	24.9	26.0	22.3	22.3	6.1	6.8	14.6	19.8	18.4	15.0
1963	14.5	3.7	1.2	12.9	34.2	9.7	4.1	7.8	14.4	5.3	18.3	8.6	11.3
1964	8.4	11.7	7.3	23.3	25.7	23.0	11.2	8.4	12.0	14.2	9.3	10.2	13.7
1965	9.2	13.9	10.1	12.0	30.4	14.4	7.6	9.5	6.4	10.8	23.4	6.0	12.8
1966	9.7	5.8	11.1	16.4	22.6	17.5	8.5	8.1	10.5	25.0	18.3	15.7	14.1
1967	6.9	6.9	3.1	9.8	41.8	18.4	5.0	7.2	15.5	13.3	27.7	15.0	14.2
1968	12.2	4.2	9.7	25.9	23.5	24.3	3.7	11.8	5.6	10.9	21.1	29.4	15.2
1969	13.0	14.2	9.4	15.6	37.4	13.5	8.3	6.1	7.6	12.9	25.9	31.9	16.3
1970	3.5	8.8	8.5	13.4	35.3	10.5	4.9	14.7	7.1	13.8	25.2	10.1	13.0
1971	5.9	7.2	13.0	29.8	21.1	6.4	6.6	10.1	11.7	12.8	23.1	6.5	12.8
1972	4.9	1.8	7.2	10.6	47.7	26.4	4.3	5.1	8.5	22.2	20.4	5.3	13.8
1973	7.1	12.0	7.3	10.3	39.0	14.2	12.1	11.9	8.4	9.4	13.3	20.4	13.8
1974	1.1	5.3	8.4	24.3	35.1	14.7	11.3	6.1	6.8	18.1	13.4	13.1	13.2
1975	6.4	0.0	10.0	14.3	38.4	7.6	2.4	5.2	8.0	10.6	17.1	26.6	12.3
1976	7.9	6.7	4.1	18.1	33.6	5.0	1.8	5.0	7.7	19.9	20.5	18.0	12.4
1977	7.6	4.1	9.2	13.3	34.1	26.7	11.5	6.9	15.3	20.9	21.2	17.6	15.8
1978	10.9	5.0	2.9	23.4	39.4	16.4	8.7	2.7	7.8	13.9	9.3	7.3	12.4
1979	10.8	4.5	11.6	20.5	37.3	5.4	14.9	10.6	10.7	22.6	18.2	18.9	15.6
1980	7.7	4.5	5.8	24.3	27.2	17.8	11.5	9.8	17.5	19.9	21.5	10.6	14.9
1981	4.3	8.0	8.9	25.3	34.2	9.9	9.9	6.6	9.2	17.3	20.3	26.1	15.0
1982	7.7	8.3	5.2	27.2	44.3	20.1	10.6	5.8	9.6	13.6	15.2	13.8	15.2
1983	8.8	9.2	11.4	48.4	14.4	9.2	11.6	13.4	10.1	7.9	20.7	14.2	14.9
1984	6.7	9.0	5.7	24.6	17.4	9.7	6.3	11.1	14.3	9.5	15.3	11.6	11.7
1985	6.6	5.6	4.3	10.1	40.4	29.5	7.0	5.1	5.9	10.5	14.5	8.7	12.4
1986	10.0	3.9	1.7	28.7	14.6	13.9	6.8	6.0	7.7	11.8	16.3	3.9	10.4
1987	4.2	5.5	5.8	37.4	18.6	13.1	2.3	8.4	9.1	24.3	16.2	10.1	12.9
1988	7.0	8.1	10.2	34.0	25.9	6.8	7.3	5.6	10.0	20.0	26.0	2.9	13.6
1989	5.8	6.3	2.2	14.6	32.4	10.1	0.0	13.6	13.9	18.1	23.1	10.6	12.6
1990	7.9	1.0	1.9	22.2	40.7	13.8	4.1	9.1	10.6	20.9	18.5	35.9	15.6
mean	7.3	6.3	7.2	21.1	31.4	14.9	7.7	8.0	9.8	15.4	19.2	14.7	13.6
min	0.7	0.0	1.2	9.8	14.4	5.0	0.0	2.7	4.9	5.3	9.3	2.9	
max	14.5	14.2	13.0	48.4	47.7	29.5	22.3	14.7	17.5	25.0	27.7	35.9	

Table C- 5

Isle aux Morts (Rose Blanche System) - Monthly Mean Flows under 'Wettest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	4.9	4.3	9.2	22.7	18.9	14.5	3.1	4.8	4.5	19.3	25.4	16.6	12.3
1962	6.6	8.2	14.2	34.0	16.2	19.2	25.2	7.9	6.8	16.4	23.6	22.8	16.8
1963	19.0	7.1	3.4	19.9	24.4	6.2	4.1	9.8	16.0	5.9	22.0	12.6	12.5
1964	12.8	16.2	10.1	32.1	15.8	19.9	12.2	10.4	13.0	15.9	12.3	14.2	15.4
1965	13.6	19.4	13.1	19.6	20.5	10.9	8.2	11.6	6.3	12.1	28.3	9.6	14.4
1966	14.0	9.2	13.5	23.5	12.7	14.2	9.1	10.0	11.4	28.2	22.0	19.6	15.6
1967	11.0	10.9	5.8	17.3	32.0	15.0	5.1	8.9	17.6	15.1	32.5	19.0	15.8
1968	16.8	7.5	12.2	34.4	13.6	21.3	3.3	14.4	4.9	12.2	25.5	34.3	16.7
1969	17.4	18.4	12.1	23.9	27.6	10.0	9.3	7.8	7.8	14.5	30.5	36.6	18.0
1970	7.6	12.5	11.0	20.6	25.5	7.2	5.1	17.5	7.5	15.4	29.6	14.1	14.5
1971	10.1	11.1	15.8	38.3	11.4	2.8	7.2	12.4	12.8	14.4	27.6	10.4	14.5
1972	9.2	5.7	9.8	18.4	38.1	23.2	4.2	6.6	8.6	25.0	24.9	9.4	15.3
1973	11.4	16.8	10.1	17.1	29.3	10.8	13.2	14.4	8.6	10.5	16.8	24.6	15.3
1974	5.3	9.4	11.4	33.8	25.4	11.1	12.6	7.8	6.7	20.4	16.9	17.1	14.8
1975	10.8	2.2	12.6	22.2	28.5	4.0	2.2	6.6	8.4	11.9	21.0	31.5	13.6
1976	12.3	10.5	6.6	25.6	23.8	1.4	1.7	6.5	7.9	22.4	24.9	22.6	13.9
1977	12.1	7.4	11.6	21.2	24.3	23.5	12.7	8.7	17.0	23.7	25.2	21.9	17.5
1978	15.5	8.0	5.0	33.1	29.7	13.2	9.4	3.8	8.1	15.5	12.4	11.1	13.7
1979	15.1	8.1	14.1	28.4	27.7	1.9	17.1	12.9	11.5	25.4	22.0	23.2	17.4
1980	11.9	7.8	8.0	32.6	17.6	14.6	12.7	12.0	19.7	22.5	25.8	14.6	16.7
1981	8.4	11.2	11.1	34.5	24.6	6.6	11.0	8.3	9.8	19.5	24.3	30.6	16.7
1982	12.1	12.8	8.0	37.7	34.7	17.0	11.3	7.5	10.1	15.3	18.7	17.9	16.9
1983	13.1	13.1	14.0	59.3	4.9	5.8	13.1	16.2	10.7	8.9	24.8	18.3	16.8
1984	11.1	12.7	8.1	32.0	7.5	6.4	6.7	13.3	16.2	10.8	18.9	15.6	13.2
1985	11.1	9.3	6.9	17.6	30.5	26.5	7.2	6.6	5.9	11.8	18.3	12.8	13.7
1986	14.5	7.6	4.0	37.0	4.7	10.6	7.1	7.6	8.0	13.2	20.4	7.6	11.8
1987	8.4	9.1	8.2	47.2	9.0	9.8	2.2	10.3	9.7	27.4	20.1	14.1	14.6
1988	11.3	12.2	13.1	43.1	16.3	3.5	7.6	7.2	10.8	22.6	30.9	6.6	15.4
1989	10.1	10.5	4.8	21.8	22.5	6.8	0.0	16.3	15.5	20.4	27.9	14.9	14.3
1990	12.3	5.0	4.4	31.2	31.1	10.3	4.5	11.1	11.5	23.6	22.5	41.3	17.5
mean	11.7	10.1	9.7	29.3	21.6	11.6	8.3	10.0	10.4	17.4	23.2	18.8	15.2
min	4.9	2.2	3.4	17.1	4.7	1.4	0.0	3.8	4.5	5.9	12.3	6.6	
max	19.0	19.4	15.8	59.3	38.1	26.5	25.2	17.5	19.7	28.2	32.5	41.3	

Table C- 6
Isle aux Morts (Rose Blanche System) - Monthly Mean Flows under 'Driest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	4.5	4.0	9.0	18.2	25.1	10.2	1.5	4.5	4.3	17.8	22.1	11.4	11.1
1962	6.4	7.4	14.1	26.7	23.0	14.6	20.9	7.3	6.4	15.2	20.3	15.8	14.9
1963	18.1	6.9	3.6	15.3	30.9	2.1	2.3	9.4	14.8	5.5	18.7	7.1	11.2
1964	11.9	14.7	9.5	25.2	23.1	15.2	9.5	9.9	12.2	14.7	10.1	8.6	13.7
1965	12.7	16.7	12.2	14.3	27.8	6.6	5.8	11.2	6.0	11.2	23.4	5.1	12.7
1966	13.4	9.0	13.4	18.8	19.5	9.8	6.8	9.6	10.6	26.1	19.0	14.1	14.2
1967	10.7	10.0	5.3	12.0	38.7	10.7	3.2	8.5	16.1	13.9	27.8	13.2	14.2
1968	15.5	7.5	11.9	27.8	20.5	16.5	1.9	14.0	5.0	11.3	21.4	25.6	14.9
1969	16.6	17.3	11.6	17.6	34.4	5.8	6.6	7.4	7.4	13.4	26.0	28.3	16.0
1970	7.2	12.0	10.8	15.8	32.1	2.8	3.1	17.0	7.0	14.3	25.5	8.4	13.0
1971	9.6	10.4	15.2	31.8	17.7	0.0	4.9	11.9	11.9	13.3	23.4	5.2	12.9
1972	8.6	4.9	9.4	12.8	43.8	18.8	2.5	6.3	8.2	23.1	20.9	3.5	13.6
1973	10.7	14.9	9.4	12.7	35.4	6.6	10.4	13.9	8.2	9.7	13.9	18.0	13.7
1974	4.8	8.4	10.5	26.0	32.1	7.0	9.7	7.4	6.4	18.9	14.1	11.4	13.1
1975	10.0	2.1	12.2	16.5	35.5	0.0	0.5	6.4	7.9	11.0	17.5	22.2	11.9
1976	11.5	9.9	6.3	20.4	30.1	0.0	0.0	6.2	7.5	20.7	20.9	14.7	12.4
1977	11.2	7.3	11.5	15.5	31.1	18.9	9.8	8.3	15.7	21.8	21.7	15.0	15.7
1978	14.4	8.4	5.2	25.0	36.5	8.7	7.0	3.5	7.5	14.4	10.1	6.2	12.3
1979	14.5	7.7	13.8	22.7	33.2	0.0	13.4	12.3	10.8	23.5	18.9	16.2	15.7
1980	11.3	7.8	8.1	26.4	23.5	10.2	9.8	11.5	18.2	20.8	21.9	8.8	14.9
1981	8.1	11.3	11.2	27.1	30.7	2.2	8.2	7.9	9.2	18.0	20.9	23.0	14.9
1982	11.3	11.3	7.4	28.5	41.4	12.3	8.9	7.1	9.5	14.1	15.9	11.8	15.0
1983	12.5	12.4	13.6	49.6	10.8	1.5	10.0	15.5	10.1	8.2	20.9	11.9	14.7
1984	10.3	12.2	7.9	26.9	14.3	2.0	4.6	12.9	14.9	10.0	15.8	9.8	11.7
1985	10.1	8.8	6.5	12.3	37.6	21.6	5.2	6.3	5.5	10.9	15.0	6.8	12.2
1986	13.5	7.1	3.9	30.8	12.1	6.0	5.0	7.3	7.5	12.3	16.7	3.0	10.4
1987	7.9	8.6	8.1	39.0	15.4	5.3	0.5	9.9	9.0	25.3	16.9	8.5	12.8
1988	10.7	11.2	12.3	35.7	22.5	0.0	5.5	6.8	10.0	20.8	26.3	2.2	13.6
1989	9.4	9.3	4.5	17.0	29.5	2.4	0.0	15.8	14.4	18.9	23.3	8.0	12.7
1990	11.4	4.1	4.1	24.0	37.2	6.1	2.4	10.7	10.7	21.8	19.1	30.5	15.3
mean	11.0	9.5	9.4	23.1	28.2	7.5	6.0	9.5	9.8	16.0	19.6	12.5	13.5
min	4.5	2.1	3.6	12.0	10.8	0.0	0.0	3.5	4.3	5.5	10.1	2.2	
max	18.1	17.3	15.2	49.6	43.8	21.6	20.9	17.0	18.2	26.1	27.8	30.5	

Note: A value of zero can occur if the regression equation calculates a zero or negative flow.

Table C- 7

Isle aux Morts (Rose Blanche System) - Monthly Mean Flows under 'Warmest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	5.7	5.4	9.2	20.0	26.1	9.6	1.8	4.6	4.6	17.4	22.4	13.5	11.7
1962	7.5	9.0	14.3	29.7	22.9	15.0	20.4	7.3	6.8	14.9	20.7	18.7	15.6
1963	19.7	8.4	3.7	17.2	31.3	0.9	2.5	9.5	15.8	5.5	19.2	9.3	11.9
1964	13.5	16.4	9.6	28.0	22.3	15.5	9.5	10.0	12.9	14.5	10.3	10.8	14.4
1965	14.3	18.6	12.5	16.4	27.0	5.8	5.8	11.3	6.4	10.9	24.2	6.8	13.3
1966	14.7	10.5	13.5	20.6	19.6	9.4	6.9	9.7	11.3	25.7	19.3	16.3	14.8
1967	11.9	11.6	5.5	14.1	38.8	9.9	3.4	8.7	17.3	13.8	28.5	15.5	14.9
1968	17.4	9.0	12.0	30.4	20.3	17.2	2.4	14.1	5.1	11.0	22.0	29.3	15.9
1969	18.1	18.9	11.7	20.1	34.3	4.9	6.5	7.4	7.9	13.1	26.7	31.8	16.8
1970	8.5	13.5	10.9	17.7	32.4	2.3	3.3	17.1	7.5	14.0	26.1	10.7	13.7
1971	10.9	11.9	15.3	34.3	18.3	0.0	4.8	12.0	12.7	13.1	24.0	7.2	13.7
1972	10.0	6.5	9.5	15.0	45.3	18.6	2.8	6.4	8.7	22.7	21.3	5.8	14.4
1973	12.2	16.6	9.7	14.5	36.4	5.8	10.3	14.0	8.6	9.5	14.2	20.7	14.4
1974	6.1	10.0	10.7	29.1	32.0	5.5	9.3	7.4	6.8	18.5	14.4	13.7	13.6
1975	11.5	3.6	12.3	18.7	35.2	0.0	0.7	6.5	8.4	10.8	18.0	26.3	12.7
1976	13.0	11.4	6.4	22.4	30.8	0.0	0.1	6.3	8.0	20.3	21.4	18.0	13.2
1977	12.8	8.8	11.6	17.8	31.0	19.4	9.8	8.3	16.8	21.6	22.1	17.9	16.5
1978	16.2	9.8	5.2	28.4	36.2	8.6	7.1	3.6	8.1	14.2	10.3	8.1	13.0
1979	15.9	9.2	14.0	25.0	34.9	0.0	13.0	12.3	11.4	23.1	19.2	19.1	16.5
1980	12.7	9.2	8.2	28.9	24.6	9.9	9.8	11.6	19.4	20.5	22.4	11.2	15.7
1981	9.3	12.7	11.3	30.1	31.4	1.8	8.1	8.0	9.8	17.7	21.3	26.2	15.7
1982	12.9	13.0	7.6	32.4	41.2	13.0	9.1	7.2	10.1	13.9	16.2	14.2	15.9
1983	13.9	13.9	13.7	53.6	11.7	1.1	9.8	15.6	10.7	8.0	21.5	14.5	15.6
1984	11.9	13.7	8.1	29.0	14.3	1.6	4.7	13.0	15.9	9.9	16.2	12.1	12.5
1985	11.7	10.3	6.6	14.4	37.3	22.7	5.6	6.4	5.9	10.7	15.4	9.2	13.0
1986	15.2	8.6	4.1	33.3	11.2	6.1	5.2	7.4	8.0	12.0	17.2	4.8	11.1
1987	9.2	10.2	8.2	42.4	15.8	5.1	0.8	10.1	9.6	24.9	17.2	10.7	13.6
1988	12.1	12.8	12.5	38.7	23.1	0.0	5.7	6.9	10.7	20.5	26.9	3.8	14.4
1989	10.9	10.9	4.6	18.9	29.2	1.9	0.0	16.0	15.3	18.6	24.0	10.8	13.4
1990	13.0	5.7	4.3	27.0	37.9	5.2	2.5	10.8	11.4	21.5	19.5	35.2	16.2
mean	12.4	11.0	9.6	25.6	28.4	7.2	6.1	9.7	10.4	15.8	20.1	15.1	14.3
min	5.7	3.6	3.7	14.1	11.2	0.0	0.0	3.6	4.6	5.5	10.3	3.8	
max	19.7	18.9	15.3	53.6	45.3	22.7	20.4	17.1	19.4	25.7	28.5	35.2	

Table C- 8

Isle aux Morts (Rose Blanche System) - Monthly Mean Flows under 'Coldest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.7	3.5	7.8	19.5	25.2	9.4	2.1	4.0	4.3	18.5	22.9	13.1	11.1
1962	4.5	7.0	13.0	28.4	22.2	13.7	19.9	6.5	6.4	15.8	21.1	18.5	14.8
1963	16.5	6.5	2.5	16.8	30.6	1.5	2.9	8.3	14.7	5.6	19.5	8.9	11.2
1964	10.4	14.3	8.1	26.7	21.9	14.5	9.5	8.8	12.1	15.3	10.5	10.4	13.5
1965	11.2	16.3	11.0	15.8	26.6	6.2	6.1	9.9	5.9	11.6	24.8	6.3	12.6
1966	11.6	8.6	12.0	20.1	19.0	9.1	7.0	8.5	10.5	27.1	19.7	15.9	14.1
1967	8.8	9.5	4.0	13.4	38.2	10.2	3.7	7.7	16.1	14.4	29.2	15.2	14.2
1968	14.2	7.1	10.4	29.2	19.7	15.6	2.6	12.3	4.8	11.7	22.5	29.2	15.0
1969	15.0	16.8	10.3	19.1	33.7	5.2	6.6	6.5	7.4	13.9	27.3	31.7	16.1
1970	5.4	11.6	9.5	17.1	31.7	2.1	3.6	15.1	6.7	14.8	26.6	10.3	12.9
1971	7.8	9.9	13.7	33.2	17.5	0.0	5.1	10.6	11.8	13.8	24.5	6.8	12.9
1972	6.9	4.5	8.0	14.2	44.3	17.8	3.0	5.6	8.2	24.0	22.0	5.5	13.7
1973	9.0	14.5	8.2	14.1	35.6	5.8	10.4	12.4	8.0	10.0	14.5	20.5	13.6
1974	3.0	8.0	8.9	27.5	31.4	6.7	9.6	6.5	6.4	19.6	14.7	13.3	13.0
1975	8.3	1.7	10.8	17.8	34.7	0.0	1.1	5.7	7.8	11.4	18.4	26.3	12.1
1976	9.9	9.5	5.0	21.8	30.0	0.0	0.6	5.5	7.4	21.5	22.0	17.9	12.6
1977	9.6	6.9	10.3	17.0	30.4	18.0	9.7	7.3	15.7	22.7	22.6	17.6	15.7
1978	12.9	8.0	3.9	26.8	35.6	8.0	7.2	3.2	7.6	14.9	10.5	7.7	12.2
1979	12.8	7.3	12.5	24.1	33.8	0.0	12.9	11.0	10.6	24.4	19.7	18.9	15.7
1980	9.6	7.4	6.9	28.0	23.7	9.3	9.7	10.2	18.1	21.5	22.9	10.8	14.9
1981	6.3	10.9	10.1	28.8	30.6	1.5	8.2	7.1	9.1	18.7	21.7	26.0	14.9
1982	9.7	10.9	6.2	30.5	40.6	11.3	9.0	6.3	9.5	14.6	16.5	13.9	14.9
1983	10.8	12.0	12.2	51.5	10.8	0.7	9.8	13.8	9.9	8.4	21.9	14.3	14.6
1984	8.7	11.7	6.7	28.3	13.7	1.3	4.9	11.5	14.7	10.3	16.5	11.8	11.6
1985	8.5	8.3	5.2	13.7	36.8	20.6	5.5	5.6	5.5	11.3	15.8	8.9	12.2
1986	12.0	6.7	2.7	32.3	10.8	5.4	5.4	6.5	7.5	12.7	17.6	4.3	10.3
1987	6.1	8.2	6.9	40.8	15.0	4.6	1.0	8.9	8.9	26.4	17.7	10.4	12.9
1988	9.0	10.8	10.8	37.2	22.3	0.0	5.8	6.1	10.0	21.7	27.6	3.3	13.7
1989	7.7	8.9	3.3	18.4	28.7	1.8	0.0	14.1	14.1	19.6	24.6	10.6	12.6
1990	9.8	3.7	2.9	25.7	37.1	5.5	2.7	9.5	10.6	22.7	20.0	35.4	15.5
mean	9.3	9.0	8.1	24.6	27.7	6.9	6.2	8.5	9.7	16.6	20.5	14.8	13.5
min	2.7	1.7	2.5	13.4	10.8	0.0	0.0	3.2	4.3	5.6	10.5	3.3	
max	16.5	16.8	13.7	51.5	44.3	20.6	19.9	15.1	18.1	27.1	29.2	35.4	

Table C- 9

Isle aux Morts (Rose Blanche System) - Monthly Mean Flows under 'Middle' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	4.3	4.3	8.6	19.2	25.4	9.7	1.8	4.4	4.4	17.9	22.5	12.7	11.3
1962	6.1	7.8	13.8	28.3	22.7	14.4	20.3	7.0	6.5	15.3	20.7	17.6	15.1
1963	18.1	7.3	3.3	16.4	30.9	1.5	2.5	9.0	15.1	5.5	19.1	8.4	11.4
1964	11.9	15.1	9.1	26.6	22.4	15.0	9.4	9.5	12.4	14.8	10.3	9.9	13.9
1965	12.8	17.2	11.9	15.5	27.2	6.2	5.9	10.8	6.1	11.2	24.1	6.0	12.9
1966	13.3	9.4	12.9	19.9	19.3	9.4	6.9	9.2	10.8	26.3	19.3	15.4	14.4
1967	10.5	10.4	4.9	13.2	38.5	10.3	3.5	8.3	16.5	14.1	28.5	14.6	14.4
1968	15.7	7.9	11.4	29.2	20.2	16.4	2.3	13.4	5.0	11.3	21.9	28.0	15.2
1969	16.6	17.7	11.2	18.9	34.1	5.3	6.5	7.1	7.5	13.5	26.7	30.6	16.3
1970	7.0	12.4	10.4	16.9	32.0	2.4	3.3	16.4	7.1	14.4	26.1	9.8	13.2
1971	9.5	10.7	14.7	33.1	17.8	0.0	4.9	11.4	12.1	13.4	24.0	6.4	13.1
1972	8.5	5.3	8.9	14.0	44.3	18.4	2.8	6.1	8.3	23.3	21.4	4.9	13.9
1973	10.6	15.3	9.1	13.8	35.7	6.1	10.3	13.3	8.3	9.8	14.2	19.7	13.9
1974	4.6	8.8	10.0	27.5	31.8	6.4	9.5	7.1	6.5	19.0	14.4	12.8	13.2
1975	9.9	2.4	11.8	17.7	35.1	0.0	0.8	6.2	8.0	11.1	17.9	24.9	12.2
1976	11.5	10.3	5.9	21.5	30.2	0.0	0.2	6.0	7.6	20.8	21.4	16.8	12.7
1977	11.2	7.7	11.1	16.8	30.8	18.7	9.8	7.9	16.1	22.0	22.2	16.8	16.0
1978	14.5	8.7	4.8	26.7	36.1	8.4	7.1	3.4	7.7	14.5	10.3	7.3	12.5
1979	14.4	8.1	13.4	23.9	33.9	0.0	13.0	11.8	10.9	23.7	19.3	18.0	15.9
1980	11.2	8.1	7.7	27.8	23.8	9.8	9.7	11.0	18.5	20.9	22.4	10.2	15.1
1981	7.9	11.6	10.9	28.7	30.8	1.8	8.1	7.6	9.4	18.2	21.3	25.0	15.1
1982	11.3	11.8	7.1	30.5	41.0	12.2	8.9	6.8	9.7	14.2	16.2	13.3	15.3
1983	12.4	12.8	13.1	51.6	11.0	1.1	9.8	14.9	10.2	8.2	21.5	13.5	15.0
1984	10.3	12.5	7.6	28.1	14.1	1.6	4.7	12.4	15.2	10.0	16.1	11.2	11.9
1985	10.1	9.1	6.1	13.5	37.2	21.6	5.4	6.1	5.7	11.0	15.4	8.3	12.5
1986	13.6	7.5	3.6	32.1	11.4	5.8	5.2	7.0	7.7	12.3	17.2	4.0	10.6
1987	7.7	9.0	7.7	40.7	15.3	5.0	0.8	9.6	9.2	25.5	17.2	9.8	13.1
1988	10.6	11.6	11.9	37.2	22.6	0.0	5.6	6.6	10.2	21.0	26.9	3.1	13.9
1989	9.3	9.7	4.1	18.1	29.1	2.0	0.0	15.2	14.6	19.0	24.0	9.8	12.9
1990	11.4	4.5	3.7	25.5	37.3	5.6	2.5	10.3	10.9	22.0	19.5	33.6	15.7
mean	10.9	9.8	9.0	24.4	28.1	7.2	6.1	9.2	9.9	16.1	20.1	14.1	13.8
min	4.3	2.4	3.3	13.2	11.0	0.0	0.0	3.4	4.4	5.5	10.3	3.1	
max	18.1	17.7	14.7	51.6	44.3	21.6	20.3	16.4	18.5	26.3	28.5	33.6	

Table C- 10

Isle aux Morts River (Rose Blanche System) - [Synthetic Flow - Historic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	5.3	-2.3	5.9	*
1963	2.5	1.3	-0.2	7.3	-4.5	-2.0	-0.9	-2.4	-2.7	-0.3	-2.6	-5.2	-0.8
1964	4.9	8.3	6.0	4.2	-5.6	-0.9	-1.5	-2.3	3.2	-0.6	-6.2	-2.0	0.6
1965	4.0	9.4	-6.2	6.3	2.0	-8.0	-0.2	-2.6	-1.1	-7.4	-0.1	-4.7	-0.8
1966	5.1	0.1	2.9	-1.8	-4.9	5.0	-3.6	1.5	-1.4	-1.0	1.4	2.6	0.5
1967	1.8	5.4	2.0	6.1	0.4	-2.9	2.5	-8.0	-0.9	-9.0	-10.6	1.1	-1.0
1968	4.3	-7.6	-11.6	-13.9	3.7	6.7	0.8	4.4	-0.5	-0.6	6.1	5.2	-0.2
1969	2.5	-0.2	4.1	3.4	-5.9	-3.9	3.9	-1.1	3.0	2.8	-1.3	0.6	0.7
1970	-0.1	-2.3	6.4	4.0	-0.1	2.9	0.6	1.7	0.2	-1.1	3.9	0.9	1.4
1971	2.8	-5.7	6.9	-8.3	-4.8	2.1	0.0	-7.4	0.6	0.2	0.2	-2.0	-1.2
1972	-2.3	-3.7	-3.7	2.4	-1.6	-8.3	0.6	-2.8	1.5	-8.8	-2.3	-2.7	-2.6
1973	2.7	-1.6	3.3	-3.1	-3.8	2.8	-0.9	-0.6	4.8	0.8	-4.6	-3.1	-0.3
1974	-2.4	-1.2	-1.7	5.0	5.4	-3.4	1.3	0.6	-3.4	3.0	0.6	3.9	0.7
1975	4.8	-0.9	3.3	-2.1	9.2	1.6	0.6	-0.9	3.3	1.7	1.3	-3.0	1.6
1976	-4.4	0.4	-4.5	-5.8	2.8	2.4	-2.0	0.6	-5.2	2.1	2.1	0.1	-1.0
1977	-0.3	0.6	6.0	-4.7	1.0	5.9	-1.7	-2.5	-0.2	-6.7	0.3	2.6	0.0
1978	-6.5	3.0	0.5	11.0	-3.6	-7.0	-1.5	1.3	1.6	-0.9	-2.0	0.7	-0.3
1979	-1.1	-0.2	-12.6	8.1	17.6	-4.9	3.5	1.5	-6.2	3.7	-2.1	1.7	0.8
1980	4.6	3.0	2.6	-7.2	4.2	7.8	0.8	3.6	2.8	1.7	2.1	5.4	2.6
1981	-0.7	0.6	-4.4	0.1	7.4	-1.0	-5.7	-3.1	1.2	2.3	4.9	-3.8	-0.2
1982	-0.3	-2.3	-1.6	-12.2	0.3	1.8	-0.5	-2.0	0.8	5.4	3.7	-0.8	-0.6
1983	-7.5	-3.7	-4.2	12.4	4.4	1.1	2.6	-2.0	-0.5	-1.7	-1.4	-3.3	-0.3
1984	-5.6	-3.6	-3.8	0.3	-5.1	-3.4	-1.7	-0.4	-2.2	3.8	6.1	-3.4	-1.6
1985	4.7	4.1	1.1	-3.0	2.0	-4.5	0.5	3.0	-1.4	1.3	1.8	-3.7	0.5
1986	-14.0	1.8	-2.5	-6.4	8.5	5.1	3.8	2.4	3.3	2.0	1.2	-3.8	0.1
1987	0.8	3.6	2.3	1.8	1.4	2.7	0.1	3.0	-2.9	0.4	-1.5	2.2	1.1
1988	5.2	3.8	0.2	6.2	-10.9	-8.2	-0.4	3.8	-1.6	4.6	0.8	-1.2	0.2
1989	2.7	3.2	-0.2	0.3	-12.1	2.9	-1.2	2.0	2.9	0.9	0.4	7.0	0.7
1990	3.6	-2.8	-1.1	-0.6	-4.5	2.5	0.5	-4.4	-1.0	2.3	-0.8	-7.1	-1.1
mean	0.4	0.5	-0.4	0.4	0.1	-0.2	0.0	-0.5	-0.1	0.2	0.0	-0.3	0.0
min	-14.0	-7.6	-12.6	-13.9	-12.1	-8.3	-5.7	-8.0	-6.2	-9.0	-10.6	-7.1	
max	5.2	9.4	6.9	12.4	17.6	7.8	3.9	4.4	4.8	5.4	6.1	7.0	

Note: * denotes missing data

Table C- 11
Isle aux Morts River (Rose Blanche System) - [Wettest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	4.1	3.5	2.4	6.9	-9.8	-3.4	-0.2	1.3	-0.4	2.2	3.9	3.8	1.2
1962	4.0	3.9	2.4	9.1	-9.7	-3.1	2.9	1.8	0.0	1.8	3.8	4.3	1.7
1963	4.4	3.4	2.2	7.0	-9.8	-3.5	0.0	1.9	1.5	0.6	3.7	3.9	1.3
1964	4.5	4.5	2.8	8.8	-9.9	-3.2	1.0	2.0	1.0	1.8	3.0	3.9	1.7
1965	4.4	5.5	3.0	7.5	-10.0	-3.4	0.6	2.2	-0.1	1.3	4.9	3.7	1.6
1966	4.3	3.4	2.4	7.1	-9.9	-3.3	0.6	1.9	0.9	3.2	3.7	3.9	1.5
1967	4.1	4.1	2.6	7.5	-9.8	-3.4	0.0	1.7	2.2	1.8	4.8	4.0	1.6
1968	4.7	3.3	2.5	8.6	-9.8	-3.1	-0.4	2.6	-0.7	1.3	4.4	4.8	1.5
1969	4.4	4.2	2.7	8.4	-9.8	-3.4	1.0	1.7	0.2	1.6	4.7	4.7	1.7
1970	4.2	3.7	2.4	7.2	-9.8	-3.4	0.2	2.8	0.3	1.6	4.4	4.0	1.5
1971	4.2	3.9	2.8	8.5	-9.7	-3.5	0.6	2.2	1.1	1.6	4.5	3.8	1.6
1972	4.2	3.9	2.7	7.7	-9.6	-3.3	-0.1	1.5	0.1	2.8	4.5	4.0	1.5
1973	4.4	4.8	2.8	6.9	-9.8	-3.4	1.2	2.5	0.3	1.1	3.5	4.3	1.5
1974	4.2	4.1	3.0	9.5	-9.7	-3.6	1.3	1.7	0.0	2.3	3.5	4.0	1.7
1975	4.4	2.2	2.5	7.9	-9.9	-3.5	-0.1	1.4	0.4	1.4	3.9	5.0	1.3
1976	4.4	3.8	2.5	7.5	-9.8	-3.6	-0.1	1.5	0.3	2.6	4.5	4.6	1.5
1977	4.4	3.3	2.3	7.9	-9.8	-3.1	1.2	1.8	1.8	2.7	4.0	4.3	1.7
1978	4.5	2.9	2.1	9.7	-9.7	-3.3	0.7	1.1	0.3	1.7	3.1	3.7	1.4
1979	4.3	3.6	2.5	7.8	-9.6	-3.4	2.2	2.4	0.7	2.8	3.8	4.4	1.8
1980	4.3	3.3	2.2	8.2	-9.6	-3.3	1.2	2.2	2.2	2.6	4.4	4.0	1.8
1981	4.1	3.2	2.2	9.2	-9.6	-3.3	1.1	1.7	0.6	2.2	4.0	4.5	1.6
1982	4.4	4.5	2.7	10.5	-9.6	-3.1	0.7	1.6	0.5	1.7	3.4	4.1	1.8
1983	4.3	3.8	2.7	10.9	-9.4	-3.3	1.5	2.7	0.6	1.0	4.2	4.2	1.9
1984	4.4	3.7	2.4	7.4	-9.9	-3.3	0.3	2.3	1.9	1.3	3.6	4.0	1.5
1985	4.5	3.8	2.6	7.5	-9.9	-3.0	0.2	1.5	0.0	1.3	3.7	4.0	1.3
1986	4.5	3.7	2.4	8.3	-9.9	-3.2	0.3	1.6	0.3	1.4	4.1	3.7	1.4
1987	4.2	3.7	2.4	9.8	-9.6	-3.3	-0.1	1.9	0.6	3.1	4.0	4.0	1.7
1988	4.3	4.1	2.8	9.1	-9.6	-3.3	0.4	1.6	0.8	2.6	4.8	3.6	1.7
1989	4.3	4.2	2.6	7.2	-9.9	-3.4	0.0	2.7	1.6	2.4	4.8	4.3	1.7
1990	4.5	4.0	2.5	9.0	-9.6	-3.5	0.3	2.1	0.9	2.7	4.0	5.4	1.8
mean	4.3	3.8	2.5	8.3	-9.8	-3.3	0.6	1.9	0.7	2.0	4.0	4.2	1.6
min	4.0	2.2	2.1	6.9	-10.0	-3.6	-0.4	1.1	-0.7	0.6	3.0	3.6	
max	4.7	5.5	3.0	10.9	-9.4	-3.0	2.9	2.8	2.2	3.2	4.9	5.4	

Table C- 12

Isle aux Morts River (Rose Blanche System) - [Driest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.8	3.2	2.3	2.5	-3.6	-7.6	-1.8	1.0	-0.5	0.7	0.6	-1.4	-0.1
1962	3.9	3.1	2.3	1.8	-3.0	-7.8	-1.4	1.2	-0.4	0.6	0.5	-2.7	-0.2
1963	3.5	3.3	2.3	2.4	-3.3	-7.6	-1.8	1.5	0.4	0.2	0.4	-1.6	0.0
1964	3.5	3.0	2.1	1.9	-2.6	-7.8	-1.7	1.6	0.2	0.6	0.8	-1.6	0.0
1965	3.6	2.8	2.1	2.3	-2.6	-7.8	-1.7	1.7	-0.3	0.4	0.0	-0.9	0.0
1966	3.7	3.3	2.3	2.4	-3.1	-7.7	-1.7	1.5	0.1	1.0	0.8	-1.6	0.1
1967	3.8	3.1	2.2	2.3	-3.1	-7.7	-1.8	1.4	0.6	0.6	0.1	-1.9	0.0
1968	3.4	3.3	2.2	1.9	-2.9	-7.8	-1.9	2.1	-0.5	0.4	0.3	-3.8	-0.3
1969	3.6	3.1	2.2	2.0	-2.9	-7.7	-1.7	1.3	-0.2	0.5	0.2	-3.6	-0.3
1970	3.8	3.2	2.2	2.4	-3.2	-7.7	-1.8	2.3	-0.1	0.5	0.3	-1.8	0.0
1971	3.7	3.1	2.1	2.0	-3.4	-6.4	-1.7	1.8	0.2	0.5	0.2	-1.4	0.1
1972	3.7	3.1	2.2	2.2	-3.9	-7.6	-1.8	1.2	-0.3	0.9	0.4	-1.9	-0.2
1973	3.6	2.9	2.2	2.5	-3.7	-7.6	-1.7	1.9	-0.1	0.3	0.6	-2.4	-0.1
1974	3.7	3.1	2.1	1.7	-2.9	-7.7	-1.6	1.3	-0.4	0.7	0.7	-1.7	-0.1
1975	3.6	2.1	2.2	2.2	-2.8	-7.6	-1.8	1.2	-0.2	0.4	0.4	-4.3	-0.4
1976	3.6	3.2	2.2	2.3	-3.5	-5.0	-1.8	1.2	-0.2	0.8	0.4	-3.3	0.0
1977	3.6	3.3	2.3	2.2	-3.0	-7.8	-1.7	1.3	0.5	0.9	0.6	-2.6	-0.1
1978	3.5	3.4	2.3	1.6	-2.8	-7.8	-1.7	0.8	-0.2	0.5	0.8	-1.1	-0.1
1979	3.7	3.2	2.2	2.2	-4.0	-5.4	-1.5	1.7	0.0	0.9	0.7	-2.7	0.1
1980	3.7	3.3	2.3	2.1	-3.7	-7.6	-1.7	1.7	0.7	0.9	0.4	-1.8	0.0
1981	3.8	3.3	2.3	1.8	-3.4	-7.7	-1.7	1.3	-0.1	0.7	0.5	-3.0	-0.2
1982	3.6	3.0	2.2	1.4	-2.9	-7.8	-1.7	1.2	-0.1	0.6	0.7	-2.0	-0.2
1983	3.7	3.2	2.2	1.2	-3.6	-7.7	-1.6	2.1	0.0	0.3	0.3	-2.2	-0.2
1984	3.6	3.2	2.3	2.3	-3.1	-7.7	-1.8	1.8	0.6	0.4	0.5	-1.8	0.0
1985	3.5	3.2	2.2	2.3	-2.9	-7.8	-1.8	1.1	-0.4	0.4	0.5	-1.9	-0.1
1986	3.5	3.2	2.3	2.0	-2.5	-7.8	-1.8	1.3	-0.2	0.5	0.4	-0.9	0.0
1987	3.7	3.2	2.3	1.6	-3.3	-7.7	-1.8	1.6	0.0	1.0	0.7	-1.7	-0.1
1988	3.7	3.1	2.1	1.8	-3.4	-6.8	-1.8	1.2	0.0	0.8	0.2	-0.8	0.0
1989	3.6	3.1	2.2	2.4	-2.9	-7.7	0.0	2.2	0.5	0.8	0.2	-2.6	0.1
1990	3.5	3.1	2.2	1.8	-3.5	-7.6	-1.8	1.6	0.1	0.9	0.6	-5.4	-0.4
mean	3.6	3.1	2.2	2.0	-3.2	-7.5	-1.7	1.5	0.0	0.6	0.5	-2.2	-0.1
min	3.4	2.1	2.1	1.2	-4.0	-7.8	-1.9	0.8	-0.5	0.2	0.0	-5.4	
max	3.9	3.4	2.3	2.5	-2.5	-5.0	0.0	2.3	0.7	1.0	0.8	-0.8	

Table C- 13

Isle aux Morts River (Rose Blanche System) - [Warmest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	5.0	4.7	2.4	4.2	-2.6	-8.2	-1.5	1.1	-0.3	0.3	0.9	0.7	0.5
1962	4.9	4.7	2.4	4.8	-3.1	-7.4	-1.9	1.2	0.0	0.3	0.9	0.2	0.6
1963	5.2	4.7	2.4	4.3	-2.9	-8.7	-1.6	1.7	1.3	0.2	0.8	0.6	0.6
1964	5.2	4.7	2.3	4.7	-3.3	-7.6	-1.7	1.7	0.9	0.4	1.0	0.6	0.7
1965	5.1	4.6	2.4	4.4	-3.4	-8.6	-1.7	1.8	0.0	0.1	0.8	0.8	0.5
1966	5.1	4.7	2.4	4.2	-3.0	-8.2	-1.7	1.6	0.8	0.6	1.0	0.6	0.7
1967	5.0	4.7	2.4	4.4	-3.0	-8.5	-1.6	1.5	1.9	0.5	0.8	0.5	0.7
1968	5.3	4.7	2.3	4.5	-3.1	-7.1	-1.3	2.3	-0.5	0.1	0.8	-0.1	0.6
1969	5.1	4.7	2.4	4.6	-3.1	-8.6	-1.8	1.3	0.3	0.3	0.8	-0.1	0.5
1970	5.0	4.7	2.4	4.3	-2.9	-8.2	-1.6	2.4	0.4	0.2	0.9	0.5	0.7
1971	5.0	4.7	2.3	4.5	-2.8	-6.4	-1.8	1.9	1.0	0.3	0.8	0.7	0.8
1972	5.0	4.7	2.3	4.4	-2.4	-7.8	-1.5	1.4	0.2	0.5	0.9	0.5	0.7
1973	5.1	4.7	2.4	4.2	-2.6	-8.4	-1.8	2.0	0.3	0.1	0.9	0.3	0.6
1974	5.0	4.7	2.2	4.8	-3.1	-9.2	-1.9	1.3	0.0	0.4	1.0	0.6	0.5
1975	5.1	3.6	2.3	4.4	-3.2	-7.6	-1.7	1.3	0.4	0.2	0.9	-0.3	0.4
1976	5.1	4.7	2.4	4.4	-2.7	-5.0	-1.7	1.3	0.3	0.5	0.9	0.0	0.8
1977	5.1	4.7	2.4	4.5	-3.1	-7.3	-1.6	1.4	1.5	0.6	0.9	0.3	0.8
1978	5.2	4.7	2.4	4.9	-3.2	-7.8	-1.6	0.9	0.3	0.3	1.0	0.7	0.6
1979	5.1	4.7	2.3	4.4	-2.4	-5.4	-2.0	1.8	0.7	0.5	1.0	0.2	0.9
1980	5.1	4.7	2.4	4.6	-2.5	-8.0	-1.7	1.8	1.9	0.6	0.9	0.5	0.8
1981	4.9	4.7	2.4	4.8	-2.8	-8.1	-1.7	1.4	0.6	0.4	0.9	0.1	0.6
1982	5.1	4.7	2.4	5.2	-3.1	-7.1	-1.5	1.3	0.5	0.3	0.9	0.5	0.7
1983	5.1	4.7	2.3	5.2	-2.7	-8.1	-1.8	2.2	0.6	0.1	0.8	0.4	0.7
1984	5.1	4.7	2.4	4.3	-3.0	-8.1	-1.6	1.9	1.7	0.3	0.9	0.5	0.8
1985	5.2	4.7	2.3	4.3	-3.2	-6.8	-1.4	1.3	0.1	0.2	0.9	0.5	0.7
1986	5.2	4.7	2.4	4.6	-3.4	-7.8	-1.6	1.4	0.3	0.2	0.9	0.8	0.6
1987	5.0	4.7	2.4	5.0	-2.9	-8.0	-1.5	1.7	0.5	0.6	1.0	0.6	0.7
1988	5.1	4.7	2.3	4.7	-2.8	-6.8	-1.6	1.3	0.7	0.5	0.9	0.9	0.8
1989	5.1	4.7	2.4	4.3	-3.2	-8.3	0.0	2.4	1.4	0.5	0.9	0.3	0.9
1990	5.2	4.7	2.4	4.8	-2.7	-8.6	-1.7	1.8	0.8	0.5	1.0	-0.7	0.6
mean	5.1	4.7	2.4	4.6	-2.9	-7.7	-1.6	1.6	0.6	0.4	0.9	0.4	0.7
min	4.9	3.6	2.2	4.2	-3.4	-9.2	-2.0	0.9	-0.5	0.1	0.8	-0.7	
max	5.3	4.7	2.4	5.2	-2.4	-5.0	0.0	2.4	1.9	0.6	1.0	0.9	

Table C- 14

Isle aux Morts River (Rose Blanche System) - [Coldest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	1.9	2.8	1.0	3.7	-3.5	-8.4	-1.2	0.5	-0.5	1.4	1.4	0.3	-0.1
1962	1.9	2.7	1.2	3.6	-3.7	-8.7	-2.3	0.4	-0.4	1.1	1.3	0.0	-0.2
1963	2.0	2.8	1.2	3.9	-3.6	-8.2	-1.3	0.5	0.3	0.3	1.1	0.2	-0.1
1964	2.0	2.6	0.8	3.4	-3.8	-8.6	-1.7	0.4	0.1	1.1	1.2	0.2	-0.2
1965	2.0	2.3	1.0	3.8	-3.8	-8.2	-1.5	0.4	-0.5	0.8	1.4	0.4	-0.2
1966	2.0	2.8	0.9	3.7	-3.6	-8.4	-1.5	0.5	0.0	2.1	1.5	0.2	0.0
1967	1.9	2.7	0.9	3.6	-3.6	-8.3	-1.3	0.5	0.6	1.1	1.4	0.2	0.0
1968	2.0	2.9	0.7	3.4	-3.7	-8.8	-1.2	0.5	-0.8	0.8	1.4	-0.2	-0.3
1969	2.0	2.6	0.9	3.5	-3.7	-8.2	-1.7	0.4	-0.3	1.0	1.4	-0.2	-0.2
1970	1.9	2.8	1.0	3.7	-3.6	-8.4	-1.4	0.4	-0.4	1.0	1.4	0.2	-0.1
1971	2.0	2.7	0.6	3.4	-3.6	-6.4	-1.5	0.4	0.1	1.0	1.4	0.3	0.0
1972	2.0	2.7	0.8	3.6	-3.4	-8.6	-1.3	0.5	-0.3	1.8	1.6	0.2	-0.1
1973	2.0	2.5	0.9	3.8	-3.5	-8.4	-1.7	0.4	-0.3	0.7	1.2	0.1	-0.2
1974	2.0	2.7	0.5	3.2	-3.7	-8.0	-1.7	0.4	-0.4	1.5	1.3	0.2	-0.2
1975	2.0	1.7	0.7	3.5	-3.7	-7.6	-1.2	0.5	-0.2	0.8	1.3	-0.3	-0.2
1976	2.0	2.7	1.0	3.7	-3.5	-5.0	-1.2	0.5	-0.2	1.7	1.5	-0.1	0.2
1977	2.0	2.9	1.0	3.6	-3.7	-8.7	-1.8	0.4	0.4	1.7	1.4	0.0	-0.1
1978	2.0	2.9	1.1	3.4	-3.8	-8.5	-1.5	0.5	-0.2	1.0	1.2	0.3	-0.1
1979	2.0	2.8	0.9	3.6	-3.4	-5.4	-2.1	0.4	-0.1	1.8	1.4	0.0	0.1
1980	2.0	2.9	1.1	3.6	-3.5	-8.5	-1.7	0.4	0.6	1.6	1.5	0.2	0.0
1981	1.9	2.9	1.1	3.5	-3.6	-8.4	-1.7	0.4	-0.1	1.4	1.4	0.0	-0.1
1982	2.0	2.6	1.0	3.3	-3.7	-8.8	-1.6	0.5	-0.1	1.1	1.2	0.2	-0.2
1983	2.0	2.7	0.8	3.1	-3.6	-8.5	-1.8	0.4	-0.2	0.6	1.3	0.1	-0.3
1984	2.0	2.8	1.0	3.7	-3.6	-8.4	-1.4	0.5	0.4	0.7	1.2	0.2	-0.1
1985	2.0	2.7	0.9	3.6	-3.7	-8.9	-1.4	0.5	-0.4	0.8	1.3	0.2	-0.2
1986	2.0	2.8	1.1	3.6	-3.8	-8.5	-1.4	0.5	-0.2	0.9	1.3	0.4	-0.1
1987	2.0	2.8	1.1	3.4	-3.6	-8.5	-1.3	0.5	-0.2	2.1	1.5	0.2	0.0
1988	2.0	2.7	0.6	3.3	-3.6	-6.8	-1.4	0.5	0.0	1.6	1.6	0.4	0.1
1989	2.0	2.6	1.0	3.8	-3.7	-8.3	0.0	0.5	0.2	1.5	1.5	0.0	0.1
1990	2.0	2.7	1.0	3.5	-3.6	-8.3	-1.4	0.5	0.0	1.7	1.5	-0.5	-0.1
mean	2.0	2.7	0.9	3.5	-3.6	-8.1	-1.5	0.5	-0.1	1.2	1.4	0.1	-0.1
min	1.9	1.7	0.5	3.1	-3.8	-8.9	-2.3	0.4	-0.8	0.3	1.1	-0.5	
max	2.0	2.9	1.2	3.9	-3.4	-5.0	0.0	0.5	0.6	2.1	1.6	0.4	

Table C- 15

Isle aux Morts River (Rose Blanche System) - [Middle Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.6	3.6	1.9	3.5	-3.3	-8.1	-1.5	0.9	-0.4	0.8	1.0	-0.2	0.1
1962	3.6	3.5	2.0	3.4	-3.3	-8.0	-2.0	0.9	-0.2	0.7	0.9	-0.8	0.0
1963	3.6	3.6	2.0	3.5	-3.3	-8.2	-1.6	1.2	0.7	0.2	0.8	-0.3	0.2
1964	3.6	3.4	1.8	3.3	-3.3	-8.0	-1.7	1.2	0.4	0.7	1.0	-0.3	0.2
1965	3.6	3.2	1.8	3.5	-3.3	-8.2	-1.7	1.3	-0.3	0.4	0.8	0.1	0.1
1966	3.6	3.6	1.8	3.4	-3.3	-8.1	-1.7	1.2	0.3	1.3	1.1	-0.3	0.2
1967	3.6	3.5	1.8	3.4	-3.3	-8.2	-1.6	1.1	1.0	0.7	0.8	-0.4	0.2
1968	3.6	3.6	1.7	3.3	-3.3	-7.9	-1.5	1.6	-0.6	0.4	0.8	-1.5	0.0
1969	3.6	3.5	1.8	3.4	-3.3	-8.2	-1.7	1.0	-0.1	0.6	0.8	-1.3	0.0
1970	3.6	3.5	1.9	3.4	-3.3	-8.1	-1.6	1.7	0.0	0.6	0.8	-0.4	0.2
1971	3.6	3.5	1.7	3.3	-3.3	-6.4	-1.7	1.3	0.4	0.6	0.8	-0.2	0.3
1972	3.6	3.5	1.8	3.4	-3.4	-8.0	-1.6	1.0	-0.1	1.1	1.0	-0.4	0.1
1973	3.6	3.4	1.8	3.5	-3.3	-8.1	-1.7	1.4	-0.1	0.4	0.9	-0.7	0.1
1974	3.6	3.5	1.6	3.2	-3.3	-8.3	-1.8	1.0	-0.2	0.9	1.0	-0.3	0.0
1975	3.6	2.4	1.7	3.3	-3.3	-7.6	-1.6	1.0	0.0	0.5	0.9	-1.7	-0.1
1976	3.6	3.5	1.8	3.4	-3.3	-5.0	-1.6	1.0	-0.1	1.0	0.9	-1.2	0.3
1977	3.6	3.6	1.9	3.4	-3.3	-7.9	-1.7	1.0	0.8	1.1	1.0	-0.8	0.2
1978	3.6	3.7	1.9	3.3	-3.3	-8.0	-1.7	0.7	0.0	0.6	1.0	0.0	0.1
1979	3.6	3.6	1.8	3.4	-3.4	-5.4	-1.9	1.2	0.2	1.1	1.0	-0.9	0.3
1980	3.6	3.6	1.9	3.4	-3.4	-8.0	-1.7	1.3	1.1	1.0	0.9	-0.4	0.3
1981	3.6	3.6	2.0	3.4	-3.3	-8.1	-1.7	1.0	0.1	0.9	0.9	-1.0	0.1
1982	3.6	3.4	1.8	3.3	-3.3	-7.9	-1.6	1.0	0.1	0.6	0.9	-0.5	0.1
1983	3.6	3.5	1.7	3.2	-3.3	-8.1	-1.8	1.5	0.1	0.3	0.8	-0.6	0.1
1984	3.6	3.5	1.9	3.4	-3.3	-8.1	-1.6	1.4	0.9	0.5	0.9	-0.4	0.2
1985	3.6	3.5	1.8	3.4	-3.3	-7.8	-1.6	0.9	-0.2	0.5	0.9	-0.4	0.1
1986	3.6	3.5	1.9	3.4	-3.3	-8.1	-1.6	1.0	0.0	0.5	0.8	0.1	0.1
1987	3.6	3.6	1.9	3.3	-3.3	-8.1	-1.6	1.2	0.1	1.2	1.1	-0.3	0.2
1988	3.6	3.5	1.7	3.2	-3.3	-6.8	-1.6	1.0	0.3	1.0	0.9	0.1	0.3
1989	3.6	3.5	1.9	3.5	-3.3	-8.1	0.0	1.6	0.7	0.9	0.9	-0.8	0.3
1990	3.6	3.5	1.9	3.4	-3.3	-8.2	-1.6	1.3	0.3	1.0	1.0	-2.3	0.0
mean	3.6	3.5	1.8	3.4	-3.3	-7.8	-1.6	1.2	0.2	0.7	0.9	-0.6	0.1
min	3.6	2.4	1.6	3.2	-3.4	-8.3	-2.0	0.7	-0.6	0.2	0.8	-2.3	
max	3.6	3.7	2.0	3.5	-3.3	-5.0	0.0	1.7	1.1	1.3	1.1	0.1	

Table C- 16

Stephenville Airport Climate Data (for Lookout Brook system) - 1961-1990 Average Monthly Temperature (^{o}C)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	-7.6	-13.6	-4.8	2.7	7.5	13.3	16.8	17.3	14.5	9.1	4.9	-0.7	5.0
1962	-6.3	-9.1	0.5	1.6	6.7	11.3	15.4	16.1	11.8	7.2	4.1	-2.7	4.8
1963	-1.8	-7.3	-5.5	1.2	6.9	10.1	15.6	14.7	10.3	7.5	3.8	-3.5	4.4
1964	-6.4	-4.4	-4.4	1.1	5.5	10.0	14.8	14.3	10.9	6.5	0.9	-2.8	3.9
1965	-5.3	-6.8	-2.2	0.3	6.1	11.5	15.3	16.0	11.4	6.3	0.7	-3.5	4.2
1966	-3.5	-5.9	0.5	2.8	7.1	11.5	16.0	16.7	11.5	8.0	4.9	-0.3	5.8
1967	-4.9	-7.8	-6.6	-1.0	5.9	11.6	18.0	19.0	13.1	8.1	4.9	-2.0	4.9
1968	-5.6	-6.1	-2.8	3.5	5.7	9.9	14.8	13.7	13.0	8.8	1.2	-0.6	4.7
1969	-2.5	-1.7	-1.3	-0.3	5.7	12.4	15.0	16.5	11.1	5.0	5.1	2.0	5.6
1970	-6.6	-4.1	-1.6	1.2	7.0	11.3	16.1	17.7	10.6	7.9	4.9	-4.2	5.1
1971	-6.4	-6.7	-1.3	4.3	9.0	10.7	15.4	16.5	12.0	6.6	3.4	-5.3	4.9
1972	-6.7	-10.7	-5.7	-0.5	4.8	13.3	15.7	14.5	11.7	5.7	0.7	-7.9	3.0
1973	-6.9	-6.4	-4.2	1.5	8.0	11.7	18.4	15.6	11.8	6.2	1.7	0.2	4.9
1974	-10.1	-8.4	-6.3	0.2	4.7	11.8	14.1	15.7	11.6	5.3	2.0	-2.0	3.3
1975	-7.4	-12.0	-3.8	0.8	6.7	12.0	18.0	16.3	12.8	6.6	2.2	-4.3	4.1
1976	-5.8	-7.6	-5.5	2.1	8.1	11.4	16.5	15.9	13.1	6.6	1.2	-4.8	4.3
1977	-5.6	-7.9	-1.3	0.4	5.4	14.1	15.2	16.2	10.8	7.8	4.7	-2.7	4.8
1978	-5.4	-4.8	-5.0	0.3	6.7	12.8	16.3	15.7	9.7	6.9	-0.1	-3.4	4.2
1979	-2.5	-8.0	0.5	3.5	10.1	13.6	16.3	16.3	11.9	7.1	3.3	-1.9	5.9
1980	-5.4	-6.6	-3.4	3.5	6.3	11.6	15.6	15.3	10.8	6.4	3.3	-3.6	4.5
1981	-4.7	-1.8	0.1	2.8	9.4	11.9	15.5	15.9	14.0	7.6	3.2	0.7	6.3
1982	-6.0	-8.6	-5.8	0.6	7.4	11.3	16.0	15.2	11.8	5.8	3.4	-2.8	4.1
1983	-4.2	-5.3	-0.7	7.4	8.2	12.7	17.0	15.1	13.4	7.8	2.9	-3.1	6.0
1984	-7.2	-3.6	-2.7	3.0	9.1	10.8	17.7	17.8	12.0	5.9	2.5	-2.7	5.3
1985	-7.0	-7.0	-5.8	-0.6	5.7	11.6	17.2	16.6	12.3	5.9	1.0	-4.1	3.9
1986	-4.4	-8.2	-6.3	5.4	7.6	10.5	14.8	16.7	10.1	5.5	0.0	-4.1	4.0
1987	-6.9	-6.1	-3.6	4.2	6.8	12.1	17.0	16.3	12.7	9.0	1.1	-2.8	5.0
1988	-5.5	-7.6	-2.4	4.0	9.2	11.0	16.3	16.5	11.9	7.3	3.7	-3.9	5.1
1989	-7.2	-8.9	-7.2	2.5	9.8	13.8	16.6	17.1	13.2	6.6	1.7	-5.4	4.4
1990	-6.5	-12.9	-8.2	1.6	6.2	12.9	15.9	17.4	13.0	8.1	2.6	-2.0	4.1
mean	-5.7	-7.2	-3.6	2.0	7.1	11.8	16.1	16.2	12.0	7.0	2.7	-2.8	4.7
min	-10.1	-13.6	-8.2	-1.0	4.7	9.9	14.1	13.7	9.7	5.0	-0.1	-7.9	
max	-1.8	-1.7	0.5	7.4	10.1	14.1	18.4	19.0	14.5	9.1	5.1	2.0	

Table C- 17
Stephenville Airport Climate Data (for Lookout Brook system) - 1961-1990 Total Monthly Precipitation (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	217.1	75.5	104.2	11.8	34.1	161.5	131.6	77.9	54.4	163.4	117.7	115.9	105.9
1962	153.3	124.8	43.4	141.5	88.7	104.8	82.1	110.9	71.0	82.7	96.2	120.5	101.5
1963	90.1	76.5	30.0	27.1	80.9	75.3	77.6	140.9	104.9	50.3	161.4	125.1	86.7
1964	97.7	110.8	76.1	119.3	31.8	117.9	121.6	70.8	83.7	108.8	62.2	97.1	91.3
1965	119.9	155.7	75.2	50.2	28.7	53.6	92.1	151.8	68.1	121.3	106.9	100.1	93.4
1966	50.8	76.1	22.8	4.8	84.7	104.9	120.2	75.8	80.3	130.3	70.6	98.5	76.8
1967	77.8	157.0	91.3	37.9	84.4	95.4	51.5	129.6	151.4	119.5	118.5	90.8	100.0
1968	164.3	83.1	145.4	103.1	58.7	129.0	71.9	88.5	67.7	133.7	144.6	111.9	108.7
1969	73.3	85.3	78.4	81.3	134.7	95.1	49.7	100.7	76.2	76.5	127.6	137.9	93.1
1970	78.0	66.9	89.9	32.6	174.9	104.8	98.4	127.8	89.5	86.8	156.7	91.3	100.1
1971	107.0	110.0	126.4	52.0	62.1	56.9	108.1	148.8	104.5	89.9	122.8	115.7	100.5
1972	85.9	67.5	89.2	57.5	103.2	140.3	65.9	111.7	103.8	205.2	94.4	113.1	103.5
1973	165.2	186.0	92.2	28.4	102.3	165.1	68.2	163.4	137.0	56.0	100.5	98.8	113.1
1974	118.4	99.0	155.9	125.0	52.2	42.7	99.2	62.9	151.6	139.3	92.4	69.2	100.6
1975	98.0	75.7	113.3	65.9	46.6	45.3	77.3	89.2	182.5	105.6	176.2	152.0	102.3
1976	119.8	89.8	85.1	53.8	67.5	40.8	75.7	67.7	85.1	167.1	120.5	171.6	95.6
1977	148.1	38.6	61.5	64.5	85.9	68.3	173.1	131.5	137.9	182.5	112.0	154.5	114.0
1978	197.1	47.0	133.8	93.0	79.6	124.5	133.6	51.3	83.2	109.6	114.7	95.3	105.7
1979	147.6	67.7	95.8	28.3	188.5	57.6	214.5	100.9	137.0	93.5	199.6	109.3	120.6
1980	145.6	78.4	65.3	60.5	68.4	122.1	128.6	148.8	176.8	142.5	105.0	124.4	114.1
1981	93.0	40.5	48.7	136.0	87.9	141.8	118.7	109.1	91.2	117.1	117.2	151.2	104.7
1982	209.2	229.9	113.4	110.1	92.6	120.7	127.3	110.3	110.1	108.4	161.4	167.1	137.8
1983	130.0	72.4	40.5	71.6	115.4	157.2	172.8	244.4	116.2	65.9	126.4	169.8	124.0
1984	137.4	129.8	82.6	53.2	86.0	158.9	110.9	133.3	157.5	49.2	147.4	105.3	112.3
1985	154.1	75.5	131.3	73.4	84.6	171.3	69.3	78.3	113.9	120.2	76.5	99.5	104.2
1986	187.1	67.7	84.7	88.1	49.5	158.5	79.1	105.7	83.4	96.6	133.1	69.3	100.3
1987	114.3	143.8	35.2	109.3	56.4	84.4	42.2	124.6	144.9	183.2	104.5	106.7	103.8
1988	105.0	126.1	89.2	44.2	103.0	107.3	151.0	82.1	143.0	107.9	148.8	99.9	108.8
1989	128.0	126.8	59.2	26.7	100.4	69.6	82.7	345.6	115.8	161.8	178.5	193.1	132.8
1990	149.3	107.0	80.0	106.4	108.4	71.1	190.9	105.8	129.1	204.2	134.6	245.4	136.5
mean	128.7	99.7	84.7	68.6	84.7	104.9	106.2	119.7	111.7	119.3	124.3	123.3	106.4
min	50.8	38.6	22.8	4.8	28.7	40.8	42.2	51.3	54.4	49.2	62.2	69.2	
max	217.1	229.9	155.9	141.5	188.5	171.3	214.5	345.6	182.5	205.2	199.6	245.4	

Note: Bold values indicate that the monthly average has been used because the record had missing data.

Table C- 18

Little Barachois River near St. George's (Lookout Brook System) - Historical Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*
1976	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	*	*	*	*	*	*	*	*	*	*	*	*	*
1978	*	*	*	*	*	*	*	*	*	*	10.8	5.7	*
1979	27.9	9.7	29.6	6.8	10.9	3.4	3.6	5.4	10.2	6.4	12.0	18.3	12.1
1980	6.4	2.7	2.5	30.8	20.6	7.9	7.5	4.9	9.7	17.3	16.6	5.2	11.0
1981	7.8	10.0	9.8	21.7	17.8	7.7	4.5	8.4	2.6	10.3	12.4	14.9	10.7
1982	5.4	4.8	9.1	25.3	42.5	8.9	4.8	2.6	8.2	12.5	13.3	14.2	12.7
1983	15.4	6.9	9.6	19.0	6.8	13.4	7.1	30.0	6.3	5.9	15.2	15.2	12.6
1984	6.3	14.5	10.2	19.0	24.9	16.5	3.9	4.6	12.1	5.6	9.9	14.3	11.8
1985	3.3	2.1	4.2	9.0	39.9	15.5	3.2	1.3	6.2	3.4	5.8	14.9	9.1
1986	26.4	6.1	3.3	39.5	5.0	12.7	2.9	1.8	4.1	8.3	8.2	4.2	10.2
1987	2.3	3.5	5.6	44.3	10.1	2.3	1.1	1.3	2.9	11.0	20.8	5.9	9.2
1988	3.1	3.2	15.9	24.4	27.0	8.4	4.9	3.4	6.1	10.2	15.8	5.9	10.7
1989	3.4	4.3	3.9	19.3	20.2	2.4	1.4	15.3	7.3	18.4	16.8	4.6	9.8
1990	5.4	5.0	3.8	34.8	30.8	7.1	11.5	4.1	4.1	15.7	16.6	23.9	13.6
mean	9.4	6.1	9.0	24.5	21.4	8.8	4.7	6.9	6.7	10.4	13.4	11.3	11.1
min	2.3	2.1	2.5	6.8	5.0	2.3	1.1	1.3	2.6	3.4	5.8	4.2	
max	27.9	14.5	29.6	44.3	42.5	16.5	11.5	30.0	12.1	18.4	20.8	23.9	

Note: * denotes missing data

Table C- 19

Little Barachois River near St. George's (Lookout Brook System) - Synthetic Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	7.5	0.0	10.1	14.2	20.1	11.3	5.7	1.0	0.5	11.6	21.6	14.1	9.9
1962	9.0	5.5	18.3	23.9	30.1	8.8	3.3	2.9	4.0	6.7	13.5	10.6	11.4
1963	20.0	5.9	0.2	19.2	30.6	7.5	2.5	8.5	7.4	3.7	14.0	9.5	10.8
1964	6.2	10.5	5.0	27.6	30.3	11.1	5.8	5.9	5.2	9.4	8.3	9.3	11.2
1965	10.6	9.2	13.0	11.2	33.2	5.6	2.6	6.7	4.5	10.6	9.3	8.1	10.4
1966	13.2	7.5	13.7	7.6	22.6	8.6	4.6	1.1	4.3	9.6	17.1	14.0	10.4
1967	10.1	8.1	3.8	14.4	42.6	8.2	0.3	0.0	7.1	9.4	18.1	10.3	11.0
1968	11.5	7.6	13.4	22.8	19.2	11.7	3.8	6.1	3.0	9.3	15.7	14.1	11.5
1969	17.2	12.8	10.4	12.2	42.4	7.5	1.8	0.0	4.6	8.4	11.6	20.3	12.5
1970	4.8	9.3	11.4	8.1	35.5	8.3	3.6	1.5	5.8	6.1	17.6	6.4	9.9
1971	6.7	7.8	17.0	15.2	12.6	5.4	3.5	6.2	5.9	8.1	12.6	5.6	8.9
1972	4.7	1.7	5.1	16.6	41.9	10.4	3.0	6.0	6.1	17.9	11.4	0.6	10.5
1973	7.6	10.8	9.8	13.5	29.3	12.1	2.3	9.1	8.2	6.0	7.7	14.8	10.9
1974	0.0	5.4	7.0	25.3	36.4	5.0	3.4	0.3	8.1	13.5	9.8	9.1	10.3
1975	3.2	0.4	12.3	15.2	31.5	4.5	0.2	2.0	9.0	10.0	13.0	9.5	9.3
1976	8.9	6.0	4.2	21.8	24.6	4.1	1.0	0.4	3.3	14.3	12.8	9.6	9.3
1977	10.8	3.9	11.8	12.3	36.5	4.9	6.3	9.0	8.6	13.9	19.8	12.5	12.6
1978	13.4	7.8	5.4	19.5	35.8	9.2	5.3	2.7	5.8	8.6	9.2	7.9	10.9
1979	20.4	4.8	19.3	7.9	22.1	2.7	7.3	9.5	7.4	8.0	15.5	11.5	11.5
1980	11.4	6.9	7.1	22.8	18.9	9.9	5.6	10.5	11.0	12.5	13.8	9.2	11.6
1981	11.4	11.1	10.9	26.4	21.9	10.0	5.6	5.2	3.4	9.7	14.9	18.6	12.4
1982	12.2	9.7	9.6	25.7	34.4	9.6	5.3	8.0	6.2	10.4	13.0	13.0	13.1
1983	14.4	8.2	11.6	29.0	0.4	10.8	7.4	21.3	6.6	5.5	13.1	12.5	11.7
1984	5.3	12.0	9.6	18.2	20.3	12.0	4.5	3.4	8.5	6.0	9.2	9.9	9.9
1985	6.7	6.3	5.3	16.3	41.2	13.3	3.2	0.0	5.5	11.4	8.2	6.9	10.4
1986	16.2	4.6	1.9	35.7	7.8	12.8	4.8	0.4	5.8	9.2	6.8	5.2	9.2
1987	5.3	9.6	6.5	33.8	14.9	7.0	0.2	2.2	7.5	13.3	17.0	9.7	10.5
1988	9.3	7.3	12.9	18.0	15.9	8.3	5.9	4.0	7.5	9.0	15.5	7.3	10.1
1989	5.0	5.8	0.1	23.8	23.0	3.8	1.7	18.8	7.4	14.1	14.7	9.6	10.7
1990	8.2	0.5	0.6	34.3	31.1	5.5	6.9	5.7	6.0	15.9	18.9	18.7	12.7
mean	9.7	6.9	8.9	19.8	26.9	8.3	3.9	5.3	6.1	10.1	13.5	10.6	10.9
min	0.0	0.0	0.1	7.6	0.4	2.7	0.2	0.0	0.5	3.7	6.8	0.6	
max	20.4	12.8	19.3	35.7	42.6	13.3	7.4	21.3	11.0	17.9	21.6	20.3	

Table C- 20

Little Barachois River near St. George's (Lookout Brook System) - Monthly Mean Flows under 'Wettest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	15.3	1.4	13.7	13.8	12.9	10.7	5.8	0.0	0.0	12.5	26.6	17.2	10.9
1962	16.6	8.8	22.0	27.2	23.2	8.1	3.0	1.0	3.7	6.8	18.0	13.8	12.7
1963	27.4	8.8	3.6	19.5	23.6	6.8	2.0	6.9	7.6	3.5	18.5	12.7	11.8
1964	13.7	13.6	8.7	30.2	23.3	10.5	5.7	4.0	5.0	9.7	12.8	12.4	12.4
1965	18.1	12.7	17.0	11.9	26.1	4.9	2.3	5.4	4.3	11.0	14.0	11.2	11.6
1966	20.4	10.4	17.0	7.4	15.5	7.9	4.5	0.0	4.1	10.2	21.8	17.1	11.4
1967	17.5	11.6	7.9	14.7	35.5	7.5	0.0	0.0	7.7	10.0	22.9	13.3	12.4
1968	19.2	10.5	17.3	24.6	12.2	11.1	3.4	3.9	2.6	9.9	20.6	17.2	12.7
1969	24.6	15.7	14.0	13.8	35.5	6.8	1.2	0.0	4.4	8.4	16.2	23.5	13.7
1970	12.1	12.1	15.0	8.3	28.6	7.6	3.4	0.0	5.8	6.2	22.3	9.4	10.9
1971	14.2	10.9	20.9	15.8	5.6	4.7	3.3	5.0	6.1	8.3	17.2	8.8	10.0
1972	12.1	4.5	8.7	17.5	34.9	9.8	2.5	4.0	6.1	19.3	16.6	3.7	11.7
1973	15.2	14.5	14.1	13.6	22.3	11.6	1.9	7.7	8.7	5.9	12.1	17.9	12.1
1974	3.4	8.5	11.1	27.7	29.5	4.2	3.1	0.0	8.7	14.2	14.5	12.1	11.4
1975	10.7	3.3	16.0	16.2	24.5	3.7	0.0	0.0	10.0	10.4	17.8	12.7	10.5
1976	16.4	9.0	7.8	22.6	17.5	3.3	0.5	0.0	3.2	15.2	17.8	13.0	10.5
1977	18.4	6.4	15.1	13.5	29.5	4.2	6.6	8.3	9.1	15.1	24.9	15.8	14.0
1978	21.2	10.4	9.0	21.1	28.9	8.6	5.4	0.7	5.5	9.0	13.9	11.0	12.1
1979	28.0	7.6	22.9	8.0	15.2	1.9	7.9	8.8	7.8	8.3	20.4	14.6	12.7
1980	19.0	9.7	10.6	23.9	11.9	9.3	5.6	9.5	12.0	13.3	18.6	12.3	13.0
1981	18.8	13.7	14.1	29.6	15.1	9.5	5.5	3.6	3.3	10.1	19.7	21.8	13.7
1982	20.0	13.8	14.3	27.8	27.5	9.0	5.2	6.5	6.3	10.7	17.8	16.3	14.6
1983	21.9	11.0	14.9	30.5	0.0	10.2	7.7	21.8	7.0	5.4	17.6	15.9	13.7
1984	12.9	15.3	13.5	19.0	13.3	11.5	4.4	2.0	9.2	5.8	13.7	13.0	11.1
1985	14.4	9.2	9.1	17.4	34.2	12.8	2.8	0.0	5.7	11.8	12.8	10.0	11.7
1986	24.0	7.4	5.4	37.4	0.8	12.2	4.4	0.0	5.6	9.5	11.4	8.2	10.5
1987	12.8	13.0	10.3	36.4	7.9	6.3	0.0	0.1	8.0	14.5	22.0	12.7	11.9
1988	16.8	10.6	16.9	18.6	8.9	7.6	6.0	2.5	8.0	9.4	20.3	10.4	11.3
1989	12.5	9.0	3.9	24.0	15.9	3.1	1.3	19.6	8.0	15.0	19.9	13.0	12.1
1990	15.9	3.6	4.4	36.6	24.2	4.8	7.3	4.8	6.4	17.2	24.2	22.3	14.3
mean	17.1	9.9	12.6	21.0	20.1	7.7	3.8	4.2	6.3	10.6	18.2	13.8	12.1
min	3.4	1.4	3.6	7.4	0.0	1.9	0.0	0.0	0.0	3.5	11.4	3.7	
max	28.0	15.7	22.9	37.4	35.5	12.8	7.9	21.8	12.0	19.3	26.6	23.5	

Table C- 21

Little Barachois River near St. George's (Lookout Brook System) - Monthly Mean Flows under 'Driest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	14.4	1.2	13.4	11.8	15.2	9.6	4.6	0.0	0.0	10.7	25.5	13.8	10.1
1962	16.1	8.1	21.7	20.3	24.8	7.2	2.2	1.8	3.5	5.5	17.3	10.3	11.6
1963	27.2	8.6	3.6	16.5	25.5	5.9	1.3	7.7	7.1	2.5	17.6	9.2	11.1
1964	13.5	13.1	8.2	24.3	25.3	9.5	4.7	4.5	4.7	8.3	12.1	9.2	11.4
1965	17.7	11.7	16.2	8.4	28.3	4.1	1.5	6.0	4.1	9.5	13.1	8.0	10.7
1966	20.5	10.2	17.1	5.1	17.4	7.0	3.5	0.0	3.8	8.6	21.0	13.9	10.7
1967	17.4	10.6	7.0	11.8	37.4	6.6	0.0	0.0	7.0	8.4	21.9	10.2	11.5
1968	18.6	10.2	16.6	19.7	14.1	10.2	2.7	4.7	2.4	8.3	19.5	13.8	11.7
1969	24.5	15.4	13.8	9.2	36.9	6.0	0.6	0.0	4.1	7.2	15.3	19.9	12.8
1970	12.0	12.0	14.8	5.5	29.8	6.7	2.5	0.6	5.5	4.9	21.2	6.3	10.1
1971	13.9	10.3	20.2	12.5	7.5	3.9	2.4	5.4	5.6	7.0	16.3	5.4	9.2
1972	11.9	4.4	8.4	13.8	36.6	8.8	1.8	4.9	5.7	17.1	15.4	0.4	10.8
1973	14.6	13.3	12.9	11.0	24.0	10.5	1.1	8.5	8.1	4.8	11.5	14.7	11.2
1974	3.1	8.1	10.2	22.1	31.3	3.4	2.3	0.0	8.0	12.5	13.6	9.3	10.3
1975	10.4	3.1	15.5	12.4	26.5	3.0	0.0	0.7	9.1	9.0	16.7	8.9	9.6
1976	16.0	8.6	7.5	19.0	19.4	2.5	0.0	0.0	2.9	13.4	16.7	8.9	9.6
1977	17.9	6.6	15.2	9.4	31.2	3.4	5.3	8.2	8.4	13.1	23.8	11.9	12.9
1978	20.4	10.5	8.7	16.4	30.6	7.6	4.2	1.1	5.3	7.5	13.0	7.9	11.1
1979	27.5	7.5	22.6	5.4	16.3	1.2	6.3	8.4	7.2	6.9	19.2	11.3	11.7
1980	18.5	9.5	10.5	20.0	13.8	8.3	4.5	9.8	11.1	11.6	17.7	8.8	12.0
1981	18.6	13.9	14.4	22.9	16.7	8.5	4.5	4.1	3.0	8.6	18.7	18.0	12.6
1982	19.1	12.1	12.7	22.5	29.1	8.1	4.2	6.9	5.9	9.3	16.7	12.3	13.2
1983	21.5	10.8	15.0	26.0	0.0	9.2	6.3	21.6	6.5	4.2	16.8	11.8	12.5
1984	12.4	14.6	12.9	15.4	15.1	10.5	3.4	2.5	8.5	4.8	12.9	9.7	10.2
1985	13.8	9.0	8.6	13.5	36.0	11.7	2.0	0.0	5.2	10.3	12.1	6.8	10.8
1986	23.2	7.3	5.2	32.6	2.8	11.2	3.6	0.0	5.3	8.1	10.5	5.4	9.6
1987	12.5	12.2	9.8	30.5	9.8	5.4	0.0	1.2	7.4	12.5	20.9	9.5	10.9
1988	16.5	9.9	16.2	15.3	10.6	6.7	4.8	2.7	7.3	8.0	19.2	7.2	10.4
1989	12.1	8.3	3.4	21.2	17.7	2.3	0.5	19.9	7.4	13.2	18.5	8.7	11.1
1990	15.3	3.0	3.9	31.1	25.7	4.0	5.9	4.6	5.8	15.1	22.9	17.3	12.9
mean	16.7	9.5	12.2	16.9	21.8	6.8	2.9	4.5	5.9	9.0	17.2	10.3	11.1
min	3.1	1.2	3.4	5.1	0.0	1.2	0.0	0.0	0.0	2.5	10.5	0.4	
max	27.5	15.4	22.6	32.6	37.4	11.7	6.3	21.6	11.1	17.1	25.5	19.9	

Table C- 22

Little Barachois River near St. George's (Lookout Brook System) - Monthly Mean Flows under 'Warmest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	16.8	2.4	13.7	12.0	13.8	11.0	4.5	0.0	0.0	11.1	24.8	15.0	10.5
1962	18.2	9.4	22.0	22.5	24.1	8.0	2.0	1.4	3.5	6.0	16.6	11.6	12.1
1963	29.1	9.8	3.9	17.0	24.6	6.5	1.1	7.3	7.3	3.0	17.0	10.5	11.4
1964	15.3	14.4	8.6	26.1	24.1	10.4	4.5	4.0	4.8	8.7	11.4	10.3	11.8
1965	19.7	13.0	16.6	9.2	26.9	4.5	1.2	5.6	4.1	10.0	12.4	9.1	11.0
1966	22.2	11.4	17.4	5.2	16.5	7.8	3.3	0.0	3.9	9.0	20.2	15.0	11.0
1967	19.2	12.0	7.4	12.3	36.5	7.4	0.0	0.0	7.4	8.9	21.2	11.3	12.0
1968	20.7	11.4	16.9	21.3	13.1	11.2	2.6	4.4	2.4	8.7	18.8	15.0	12.2
1969	26.2	16.6	14.1	10.5	36.6	6.6	0.5	0.0	4.2	7.7	14.7	21.2	13.3
1970	13.8	13.2	15.1	6.0	29.8	7.5	2.3	0.1	5.6	5.4	20.6	7.4	10.5
1971	15.8	11.6	20.5	13.3	6.5	4.3	2.0	5.0	5.8	7.5	15.6	6.6	9.5
1972	13.8	5.6	8.7	14.7	35.9	9.9	1.8	4.6	5.9	17.5	14.6	1.5	11.3
1973	16.8	14.6	13.4	11.4	23.3	11.8	1.2	8.1	8.4	5.3	10.8	15.8	11.7
1974	5.0	9.3	10.5	24.0	30.3	3.7	1.9	0.0	8.4	13.0	12.9	10.2	10.8
1975	12.3	4.3	15.8	13.4	25.3	3.3	0.0	0.3	9.6	9.5	16.0	10.3	10.0
1976	18.0	9.9	7.8	19.8	18.4	2.8	0.0	0.0	2.9	13.8	16.0	10.4	10.0
1977	20.0	7.7	15.5	10.4	30.4	3.8	4.8	7.6	8.7	13.5	23.0	13.4	13.3
1978	22.7	11.6	9.0	17.9	29.8	8.6	4.0	0.6	5.3	8.0	12.3	8.9	11.6
1979	29.6	8.7	22.9	5.8	16.4	1.5	5.7	7.7	7.5	7.4	18.6	12.5	12.1
1980	20.6	10.7	10.8	20.9	12.8	9.3	4.3	9.3	11.5	12.1	16.9	10.1	12.4
1981	20.5	15.0	14.6	25.0	15.9	9.6	4.4	3.6	3.1	9.1	18.0	19.4	13.2
1982	21.5	13.5	13.2	24.2	28.4	9.0	4.0	6.4	6.1	9.8	16.1	13.8	13.8
1983	23.5	12.0	15.3	27.1	0.0	10.5	6.1	21.0	6.7	4.8	16.2	13.3	13.0
1984	14.5	15.9	13.2	16.2	14.3	11.7	3.4	2.1	8.9	5.3	12.2	10.9	10.7
1985	15.9	10.2	8.9	14.6	35.1	13.1	2.1	0.0	5.4	10.8	11.3	7.9	11.3
1986	25.5	8.5	5.5	34.0	1.7	12.5	3.6	0.0	5.4	8.6	9.8	6.3	10.1
1987	14.4	13.5	10.2	32.2	8.7	6.1	0.0	0.9	7.7	12.9	20.1	10.6	11.4
1988	18.5	11.2	16.5	16.0	9.9	7.5	4.5	2.1	7.7	8.4	18.6	8.3	10.8
1989	14.1	9.6	3.8	21.6	16.9	2.7	0.3	19.6	7.7	13.6	17.8	10.4	11.5
1990	17.4	4.3	4.3	32.8	25.1	4.5	5.4	4.0	6.1	15.5	22.1	19.3	13.4
mean	18.7	10.7	12.5	17.9	21.0	7.6	2.7	4.2	6.1	9.5	16.6	11.6	11.6
min	5.0	2.4	3.8	5.2	0.0	1.5	0.0	0.0	0.0	3.0	9.8	1.5	
max	29.6	16.6	22.9	34.0	36.6	13.1	6.1	21.0	11.5	17.5	24.8	21.2	

Table C- 23

Little Barachois River near St. George's (Lookout Brook System) - Monthly Mean Flows under 'Coldest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	11.1	0.8	11.5	14.0	14.3	9.7	4.3	0.0	0.0	12.3	24.4	14.5	9.8
1962	12.6	7.7	20.1	22.9	24.4	7.3	2.1	0.3	3.3	6.8	15.9	11.1	11.2
1963	23.6	8.2	2.1	18.5	24.9	6.2	1.3	6.0	7.0	3.6	16.3	10.0	10.6
1964	9.8	12.7	6.5	26.9	24.5	9.6	4.4	3.3	4.6	9.7	10.7	9.8	11.0
1965	14.2	11.4	14.5	10.7	27.4	4.4	1.4	4.1	3.9	11.0	11.8	8.6	10.3
1966	16.7	9.8	15.7	7.0	16.9	7.1	3.3	0.0	3.7	10.0	19.7	14.5	10.4
1967	13.7	10.3	5.2	14.1	36.9	6.8	0.0	0.0	6.9	9.8	20.7	10.8	11.3
1968	15.1	9.9	14.6	22.6	13.4	10.3	2.6	3.6	2.3	9.8	18.3	14.5	11.4
1969	20.8	15.1	12.0	11.7	36.8	6.1	0.7	0.0	4.0	8.5	14.0	20.8	12.6
1970	8.3	11.6	13.0	7.8	29.9	6.8	2.3	0.0	5.3	6.2	20.0	6.9	9.8
1971	10.3	10.0	18.2	15.1	6.9	4.1	2.2	3.5	5.5	8.3	15.0	6.1	8.7
1972	8.3	4.0	6.7	16.2	36.2	8.8	1.8	3.5	5.6	18.9	14.3	1.0	10.5
1973	11.2	12.9	11.1	13.3	23.6	10.5	1.1	6.6	7.9	6.0	10.0	15.3	10.8
1974	0.0	7.7	8.1	25.1	30.6	3.8	2.2	0.0	7.9	14.0	12.4	9.7	10.1
1975	6.8	2.7	13.6	15.0	25.7	3.3	0.0	0.0	9.0	10.3	15.5	9.9	9.4
1976	12.5	8.3	5.7	21.4	18.8	2.8	0.0	0.0	2.8	15.0	15.5	10.0	9.4
1977	14.4	6.2	13.6	11.7	30.7	3.6	4.9	6.2	8.3	14.8	22.6	12.9	12.6
1978	17.0	10.1	6.7	19.2	30.1	7.7	4.0	0.0	5.2	8.9	11.7	8.4	10.8
1979	24.0	7.2	20.8	7.7	16.5	1.4	5.8	6.5	7.1	8.2	18.0	12.0	11.3
1980	15.0	9.2	8.8	22.3	13.2	8.5	4.2	7.7	10.9	13.1	16.4	9.6	11.6
1981	14.9	13.5	12.8	25.5	16.2	8.5	4.2	2.5	2.9	10.0	17.5	19.0	12.3
1982	15.8	11.7	10.8	25.2	28.7	8.2	3.9	5.3	5.8	10.7	15.5	13.3	12.9
1983	18.0	10.5	13.4	28.2	0.0	9.2	5.9	18.4	6.2	5.5	15.5	12.9	11.9
1984	8.9	14.2	11.1	17.7	14.6	10.5	3.2	0.7	8.3	5.9	11.5	10.4	9.7
1985	10.3	8.6	6.6	16.1	35.5	11.7	1.9	0.0	5.1	11.7	10.7	7.4	10.5
1986	19.8	6.9	3.5	35.1	2.1	11.2	3.5	0.0	5.2	9.4	9.2	5.8	9.3
1987	8.9	11.8	8.3	32.9	9.1	5.6	0.0	0.0	7.2	14.1	19.7	10.1	10.6
1988	12.9	9.5	14.4	17.7	10.2	6.9	4.5	1.2	7.2	9.3	18.0	7.8	10.0
1989	8.6	8.0	1.8	23.3	17.3	2.5	0.5	16.2	7.0	14.8	17.4	9.9	10.6
1990	11.8	2.7	2.2	33.7	25.4	4.2	5.4	2.7	5.7	16.9	21.8	18.9	12.7
mean	13.2	9.1	10.5	19.3	21.4	6.9	2.7	3.3	5.7	10.5	16.0	11.1	10.8
min	0.0	0.8	1.8	7.0	0.0	1.4	0.0	0.0	0.0	3.6	9.2	1.0	
max	24.0	15.1	20.8	35.1	36.9	11.7	5.9	18.4	10.9	18.9	24.4	20.8	

Note: A value of zero can occur if the regression equation calculates a zero or negative flow.

Table C- 24

Little Barachois River near St. George's (Lookout Brook System) - Monthly Mean Flows under 'Middle' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	14.2	1.5	12.8	12.6	14.4	10.1	4.5	0.0	0.0	11.4	24.9	14.5	10.1
1962	15.6	8.4	21.3	21.9	24.4	7.5	2.1	1.1	3.4	6.1	16.6	11.0	11.6
1963	26.6	8.9	3.2	17.4	24.9	6.2	1.2	6.9	7.1	3.0	17.0	9.9	11.0
1964	12.9	13.4	7.8	25.8	24.6	9.8	4.5	3.9	4.7	8.9	11.4	9.7	11.4
1965	17.2	12.0	15.8	9.4	27.5	4.3	1.4	5.2	4.0	10.1	12.4	8.6	10.7
1966	19.8	10.5	16.7	5.8	16.9	7.3	3.3	0.0	3.8	9.2	20.3	14.5	10.7
1967	16.7	11.0	6.5	12.7	36.9	6.9	0.0	0.0	7.1	9.1	21.3	10.8	11.6
1968	18.1	10.5	16.0	21.2	13.5	10.5	2.6	4.2	2.4	8.9	18.9	14.4	11.8
1969	23.8	15.7	13.3	10.5	36.7	6.2	0.6	0.0	4.1	7.8	14.7	20.6	12.9
1970	11.4	12.3	14.3	6.4	29.8	7.0	2.4	0.0	5.4	5.5	20.6	6.8	10.1
1971	13.4	10.6	19.6	13.7	7.0	4.1	2.2	4.6	5.6	7.6	15.6	6.0	9.1
1972	11.3	4.6	7.9	14.9	36.2	9.2	1.8	4.3	5.7	17.8	14.8	1.0	10.8
1973	14.2	13.6	12.5	11.9	23.6	10.9	1.1	7.7	8.1	5.4	10.8	15.2	11.2
1974	2.5	8.3	9.6	23.8	30.7	3.6	2.1	0.0	8.1	13.1	13.0	9.7	10.4
1975	9.9	3.4	15.0	13.6	25.8	3.2	0.0	0.1	9.2	9.6	16.1	9.7	9.7
1976	15.5	8.9	7.0	20.1	18.9	2.7	0.0	0.0	2.9	14.0	16.1	9.8	9.6
1977	17.4	6.8	14.8	10.5	30.8	3.6	5.0	7.2	8.5	13.8	23.1	12.7	12.9
1978	20.1	10.7	8.1	17.9	30.1	7.9	4.1	0.6	5.3	8.2	12.3	8.4	11.1
1979	27.0	7.8	22.1	6.3	16.4	1.3	5.9	7.5	7.3	7.5	18.6	11.9	11.7
1980	18.1	9.8	10.0	21.0	13.2	8.7	4.3	8.9	11.2	12.2	17.0	9.5	12.0
1981	18.0	14.1	13.9	24.5	16.2	8.8	4.4	3.3	3.0	9.2	18.1	18.8	12.7
1982	18.8	12.5	12.2	24.0	28.7	8.4	4.0	6.1	5.9	9.9	16.1	13.1	13.3
1983	21.0	11.1	14.5	27.1	0.0	9.6	6.1	20.2	6.4	4.8	16.2	12.7	12.5
1984	12.0	14.9	12.4	16.5	14.6	10.9	3.3	1.7	8.6	5.3	12.2	10.3	10.2
1985	13.4	9.2	8.0	14.8	35.5	12.2	2.0	0.0	5.3	10.9	11.4	7.4	10.8
1986	22.9	7.6	4.7	33.9	2.1	11.6	3.6	0.0	5.3	8.7	9.9	5.8	9.6
1987	11.9	12.5	9.4	31.9	9.2	5.7	0.0	0.6	7.4	13.2	20.2	10.1	10.9
1988	16.0	10.2	15.7	16.4	10.2	7.0	4.6	2.0	7.4	8.6	18.6	7.8	10.4
1989	11.6	8.6	3.0	22.1	17.3	2.5	0.4	18.4	7.4	13.9	17.9	9.6	11.1
1990	14.9	3.3	3.4	32.5	25.4	4.2	5.5	3.7	5.9	15.8	22.3	18.5	13.0
mean	16.2	9.8	11.7	18.0	21.4	7.1	2.8	3.9	5.9	9.7	16.6	11.0	11.2
min	2.5	1.5	3.0	5.8	0.0	1.3	0.0	0.0	0.0	3.0	9.9	1.0	
max	27.0	15.7	22.1	33.9	36.9	12.2	6.1	20.2	11.2	17.8	24.9	20.6	

Table C- 25

Little Barachois River near St. George's (Lookout Brook System) - [Synthetic Flow - Historic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*
1976	*	*	*	*	*	*	*	*	*	*	*	*	*
1977	*	*	*	*	*	*	*	*	*	*	*	*	*
1978	*	*	*	*	*	*	*	*	*	*	-1.6	2.2	*
1979	-7.5	-4.8	-10.3	1.1	11.2	-0.8	3.7	4.1	-2.8	1.6	3.5	-6.8	-0.6
1980	5.0	4.2	4.6	-8.0	-1.7	2.1	-1.9	5.5	1.2	-4.8	-2.8	4.0	0.6
1981	3.6	1.1	1.2	4.7	4.1	2.3	1.1	-3.3	0.8	-0.6	2.5	3.7	1.8
1982	6.8	4.9	0.5	0.4	-8.1	0.8	0.5	5.3	-2.0	-2.1	-0.3	-1.2	0.4
1983	-1.0	1.3	2.0	10.0	-6.4	-2.6	0.3	-8.7	0.3	-0.4	-2.1	-2.7	-0.9
1984	-1.0	-2.5	-0.6	-0.8	-4.6	-4.5	0.6	-1.3	-3.6	0.4	-0.6	-4.4	-1.9
1985	3.5	4.2	1.2	7.4	1.3	-2.2	0.0	-1.3	-0.6	7.9	2.4	-8.0	1.3
1986	-10.2	-1.5	-1.4	-3.8	2.8	0.1	1.8	-1.4	1.7	0.9	-1.4	1.1	-0.9
1987	3.0	6.1	0.9	-10.5	4.8	4.7	-0.9	0.9	4.6	2.3	-3.8	3.8	1.3
1988	6.3	4.1	-3.0	-6.4	-11.1	-0.1	1.0	0.6	1.4	-1.2	-0.3	1.5	-0.6
1989	1.6	1.5	-3.8	4.5	2.8	1.4	0.2	3.5	0.1	-4.3	-2.1	5.0	0.9
1990	2.9	-4.5	-3.2	-0.5	0.3	-1.6	-4.6	1.6	2.0	0.2	2.3	-5.2	-0.9
mean	1.1	1.2	-1.0	-0.2	-0.4	0.0	0.2	0.5	0.2	0.0	-0.3	-0.5	0.0
min	-10.2	-4.8	-10.3	-10.5	-11.1	-4.5	-4.6	-8.7	-3.6	-4.8	-3.8	-8.0	
max	6.8	6.1	4.6	10.0	11.2	4.7	3.7	5.5	4.6	7.9	3.5	5.0	

Note: * denotes missing data

Table C- 26

Little Barachois River near St. George's (Lookout Brook System) - [Wettest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	7.8	1.4	3.7	-0.4	-7.1	-0.5	0.0	-1.0	-0.5	0.9	5.0	3.1	1.0
1962	7.6	3.2	3.7	3.4	-6.9	-0.7	-0.4	-1.8	-0.3	0.1	4.5	3.1	1.3
1963	7.4	2.9	3.3	0.3	-7.1	-0.7	-0.4	-1.6	0.1	-0.2	4.5	3.2	1.0
1964	7.4	3.1	3.8	2.6	-7.0	-0.6	-0.1	-1.9	-0.2	0.3	4.5	3.1	1.2
1965	7.5	3.5	4.0	0.8	-7.1	-0.8	-0.3	-1.3	-0.3	0.4	4.7	3.1	1.2
1966	7.3	2.9	3.3	-0.2	-7.1	-0.7	-0.1	-1.1	-0.2	0.6	4.7	3.1	1.0
1967	7.4	3.5	4.1	0.3	-7.0	-0.7	-0.3	0.0	0.7	0.5	4.8	3.0	1.3
1968	7.7	2.9	3.9	1.8	-7.0	-0.6	-0.4	-2.2	-0.4	0.6	4.9	3.1	1.2
1969	7.4	2.9	3.6	1.6	-6.9	-0.7	-0.6	0.0	-0.3	0.0	4.6	3.2	1.2
1970	7.4	2.8	3.5	0.2	-6.9	-0.7	-0.2	-1.5	-0.1	0.1	4.7	3.0	1.0
1971	7.5	3.1	4.0	0.6	-7.0	-0.8	-0.2	-1.2	0.1	0.2	4.6	3.1	1.2
1972	7.4	2.8	3.5	0.9	-7.0	-0.6	-0.5	-2.0	0.1	1.4	5.1	3.1	1.2
1973	7.7	3.7	4.3	0.1	-7.0	-0.5	-0.4	-1.4	0.5	-0.1	4.4	3.1	1.2
1974	3.4	3.0	4.0	2.4	-6.9	-0.8	-0.3	-0.3	0.6	0.7	4.8	3.0	1.1
1975	7.4	2.9	3.7	1.0	-7.0	-0.8	-0.2	-2.0	1.0	0.4	4.9	3.2	1.2
1976	7.5	3.0	3.7	0.8	-7.0	-0.8	-0.5	-0.4	-0.2	0.9	5.0	3.3	1.3
1977	7.6	2.6	3.2	1.2	-7.0	-0.7	0.3	-0.8	0.5	1.2	5.1	3.3	1.4
1978	7.8	2.6	3.6	1.6	-7.0	-0.6	0.0	-2.0	-0.2	0.3	4.7	3.1	1.1
1979	7.6	2.8	3.6	0.1	-6.9	-0.8	0.6	-0.7	0.5	0.2	4.9	3.1	1.2
1980	7.6	2.9	3.5	1.1	-7.0	-0.6	0.0	-1.0	1.0	0.8	4.8	3.2	1.3
1981	7.4	2.6	3.2	3.2	-6.9	-0.6	-0.1	-1.5	-0.1	0.4	4.7	3.2	1.3
1982	7.8	4.1	4.7	2.2	-6.9	-0.6	0.0	-1.4	0.2	0.4	4.8	3.3	1.5
1983	7.5	2.8	3.4	1.5	-0.4	-0.6	0.3	0.5	0.4	-0.1	4.5	3.3	1.9
1984	7.6	3.3	3.9	0.8	-7.0	-0.5	-0.1	-1.3	0.7	-0.2	4.5	3.1	1.2
1985	7.6	2.9	3.8	1.1	-7.0	-0.5	-0.4	0.0	0.2	0.5	4.6	3.1	1.3
1986	7.7	2.8	3.5	1.7	-7.0	-0.5	-0.3	-0.4	-0.2	0.2	4.7	3.0	1.3
1987	7.5	3.4	3.8	2.5	-7.0	-0.7	-0.2	-2.1	0.6	1.2	5.1	3.1	1.4
1988	7.5	3.3	3.9	0.5	-7.0	-0.7	0.1	-1.5	0.5	0.4	4.8	3.1	1.2
1989	7.5	3.3	3.8	0.2	-7.0	-0.7	-0.4	0.8	0.5	0.9	5.2	3.4	1.4
1990	7.6	3.1	3.8	2.2	-6.9	-0.7	0.4	-0.9	0.4	1.4	5.3	3.6	1.6
mean	7.4	3.0	3.7	1.2	-6.8	-0.7	-0.2	-1.1	0.2	0.5	4.8	3.2	1.3
min	3.4	1.4	3.2	-0.4	-7.1	-0.8	-0.6	-2.2	-0.5	-0.2	4.4	3.0	
max	7.8	4.1	4.7	3.4	-0.4	-0.5	0.6	0.8	1.0	1.4	5.3	3.6	

Table C- 27

Little Barachois River near St. George's (Lookout Brook System) - [Driest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	6.9	1.2	3.3	-2.4	-4.9	-1.6	-1.1	-1.0	-0.5	-0.9	3.9	-0.3	0.2
1962	7.1	2.6	3.3	-3.6	-5.3	-1.6	-1.1	-1.1	-0.5	-1.2	3.8	-0.3	0.2
1963	7.2	2.7	3.4	-2.6	-5.2	-1.6	-1.1	-0.8	-0.3	-1.3	3.6	-0.3	0.3
1964	7.2	2.6	3.3	-3.3	-5.0	-1.6	-1.1	-1.4	-0.5	-1.1	3.8	-0.1	0.2
1965	7.2	2.5	3.2	-2.8	-4.9	-1.6	-1.1	-0.7	-0.5	-1.1	3.8	-0.1	0.3
1966	7.3	2.7	3.4	-2.5	-5.2	-1.6	-1.1	-1.1	-0.5	-1.0	3.9	-0.1	0.3
1967	7.3	2.5	3.2	-2.6	-5.2	-1.6	-0.3	0.0	-0.1	-1.0	3.8	-0.1	0.5
1968	7.1	2.6	3.2	-3.1	-5.1	-1.6	-1.2	-1.3	-0.5	-1.0	3.8	-0.2	0.2
1969	7.3	2.6	3.3	-3.0	-5.5	-1.5	-1.2	0.0	-0.5	-1.2	3.7	-0.5	0.3
1970	7.3	2.7	3.3	-2.6	-5.7	-1.5	-1.1	-0.9	-0.4	-1.2	3.7	-0.1	0.3
1971	7.2	2.6	3.2	-2.7	-5.1	-1.6	-1.1	-0.7	-0.3	-1.1	3.7	-0.3	0.3
1972	7.2	2.7	3.3	-2.8	-5.3	-1.6	-1.2	-1.1	-0.3	-0.8	4.0	-0.2	0.3
1973	7.0	2.5	3.2	-2.6	-5.3	-1.6	-1.2	-0.6	-0.1	-1.2	3.7	-0.1	0.3
1974	3.1	2.6	3.2	-3.2	-5.1	-1.5	-1.1	-0.3	-0.1	-1.0	3.9	0.1	0.0
1975	7.2	2.7	3.3	-2.8	-5.0	-1.6	-0.2	-1.3	0.1	-1.0	3.7	-0.6	0.3
1976	7.2	2.6	3.3	-2.8	-5.1	-1.5	-1.0	-0.4	-0.5	-0.9	3.9	-0.7	0.3
1977	7.1	2.7	3.4	-2.9	-5.2	-1.5	-1.0	-0.8	-0.1	-0.8	3.9	-0.6	0.3
1978	7.0	2.7	3.3	-3.0	-5.2	-1.6	-1.1	-1.6	-0.5	-1.1	3.8	-0.1	0.2
1979	7.1	2.7	3.3	-2.6	-5.8	-1.5	-1.0	-1.0	-0.2	-1.1	3.6	-0.2	0.3
1980	7.1	2.6	3.4	-2.9	-5.1	-1.6	-1.1	-0.7	0.1	-0.9	3.9	-0.3	0.4
1981	7.2	2.7	3.4	-3.5	-5.3	-1.6	-1.1	-1.1	-0.4	-1.1	3.8	-0.6	0.2
1982	6.9	2.4	3.1	-3.2	-5.3	-1.6	-1.1	-1.1	-0.3	-1.1	3.7	-0.7	0.1
1983	7.1	2.7	3.4	-3.0	-0.4	-1.6	-1.1	0.3	-0.1	-1.2	3.7	-0.7	0.8
1984	7.1	2.6	3.3	-2.8	-5.2	-1.6	-1.1	-0.9	0.0	-1.2	3.6	-0.2	0.3
1985	7.1	2.7	3.3	-2.9	-5.2	-1.6	-1.2	0.0	-0.3	-1.0	3.8	-0.1	0.4
1986	7.0	2.7	3.3	-3.1	-5.0	-1.6	-1.2	-0.4	-0.4	-1.1	3.7	0.1	0.3
1987	7.2	2.5	3.3	-3.3	-5.1	-1.6	-0.2	-1.0	-0.1	-0.8	3.9	-0.2	0.4
1988	7.2	2.6	3.2	-2.7	-5.3	-1.6	-1.1	-1.3	-0.2	-1.1	3.7	-0.1	0.3
1989	7.1	2.6	3.3	-2.6	-5.3	-1.5	-1.1	1.1	0.0	-0.9	3.8	-0.9	0.4
1990	7.1	2.6	3.3	-3.2	-5.4	-1.5	-1.0	-1.0	-0.2	-0.7	3.9	-1.4	0.2
mean	7.0	2.6	3.3	-2.9	-5.1	-1.6	-1.0	-0.7	-0.3	-1.0	3.8	-0.3	0.3
min	3.1	1.2	3.1	-3.6	-5.8	-1.6	-1.2	-1.6	-0.5	-1.3	3.6	-1.4	
max	7.3	2.7	3.4	-2.4	-0.4	-1.5	-0.2	1.1	0.1	-0.7	4.0	0.1	

Table C- 28

Little Barachois River near St. George's (Lookout Brook System) - [Warmest Flow - Historic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	9.3	2.4	3.6	-2.2	-6.3	-0.3	-1.2	-1.0	-0.5	-0.5	3.1	0.9	0.6
1962	9.2	3.8	3.7	-1.4	-6.0	-0.8	-1.3	-1.5	-0.5	-0.7	3.1	0.9	0.7
1963	9.1	3.9	3.7	-2.2	-6.1	-1.0	-1.4	-1.2	-0.1	-0.7	3.0	0.9	0.6
1964	9.1	3.9	3.6	-1.5	-6.2	-0.6	-1.3	-1.9	-0.4	-0.6	3.1	1.0	0.7
1965	9.1	3.8	3.6	-2.0	-6.3	-1.2	-1.4	-1.1	-0.5	-0.6	3.1	1.0	0.6
1966	9.0	3.9	3.7	-2.4	-6.1	-0.8	-1.3	-1.1	-0.4	-0.6	3.1	1.0	0.7
1967	9.1	3.8	3.6	-2.0	-6.1	-0.8	-0.3	0.0	0.3	-0.5	3.1	1.0	0.9
1968	9.2	3.9	3.5	-1.5	-6.1	-0.6	-1.2	-1.7	-0.5	-0.6	3.1	1.0	0.7
1969	9.1	3.9	3.6	-1.8	-5.9	-0.9	-1.3	0.0	-0.5	-0.7	3.0	0.9	0.8
1970	9.1	3.9	3.6	-2.1	-5.7	-0.8	-1.3	-1.3	-0.3	-0.7	3.0	1.0	0.7
1971	9.1	3.9	3.5	-1.9	-6.1	-1.2	-1.5	-1.2	-0.1	-0.6	3.1	0.9	0.6
1972	9.1	3.9	3.6	-1.9	-6.0	-0.5	-1.2	-1.4	-0.2	-0.4	3.2	1.0	0.7
1973	9.2	3.8	3.6	-2.1	-6.0	-0.3	-1.1	-0.9	0.2	-0.7	3.0	1.0	0.8
1974	5.0	3.9	3.5	-1.3	-6.2	-1.3	-1.5	-0.3	0.2	-0.5	3.1	1.1	0.5
1975	9.1	3.9	3.6	-1.8	-6.2	-1.3	-0.2	-1.7	0.6	-0.5	3.1	0.8	0.8
1976	9.1	3.9	3.6	-1.9	-6.1	-1.3	-1.0	-0.4	-0.4	-0.5	3.1	0.8	0.7
1977	9.2	3.9	3.7	-1.9	-6.1	-1.1	-1.5	-1.4	0.2	-0.4	3.2	0.8	0.7
1978	9.3	3.9	3.5	-1.6	-6.1	-0.6	-1.3	-2.1	-0.4	-0.6	3.1	1.0	0.7
1979	9.2	3.9	3.6	-2.1	-5.7	-1.2	-1.6	-1.8	0.1	-0.6	3.0	1.0	0.6
1980	9.2	3.9	3.7	-1.9	-6.1	-0.6	-1.3	-1.2	0.6	-0.5	3.1	0.9	0.8
1981	9.1	3.9	3.7	-1.4	-6.0	-0.5	-1.2	-1.6	-0.3	-0.6	3.1	0.8	0.7
1982	9.3	3.8	3.5	-1.5	-6.0	-0.6	-1.3	-1.6	-0.1	-0.6	3.1	0.8	0.7
1983	9.2	3.9	3.7	-1.9	-0.4	-0.3	-1.3	-0.3	0.1	-0.7	3.0	0.8	1.3
1984	9.2	3.8	3.6	-2.0	-6.1	-0.3	-1.2	-1.3	0.4	-0.7	3.0	1.0	0.8
1985	9.2	3.9	3.5	-1.7	-6.1	-0.2	-1.1	0.0	-0.1	-0.6	3.1	1.0	0.9
1986	9.3	3.9	3.6	-1.7	-6.2	-0.3	-1.1	-0.4	-0.4	-0.7	3.1	1.1	0.8
1987	9.1	3.8	3.7	-1.6	-6.1	-0.9	-0.2	-1.3	0.2	-0.4	3.2	1.0	0.9
1988	9.1	3.8	3.6	-2.0	-6.0	-0.8	-1.4	-1.9	0.2	-0.6	3.1	1.0	0.7
1989	9.2	3.8	3.7	-2.2	-6.0	-1.1	-1.4	0.8	0.2	-0.5	3.1	0.7	0.9
1990	9.2	3.9	3.6	-1.6	-6.0	-1.1	-1.5	-1.7	0.1	-0.4	3.2	0.6	0.7
mean	9.0	3.8	3.6	-1.8	-5.9	-0.8	-1.2	-1.1	-0.1	-0.6	3.1	0.9	0.7
min	5.0	2.4	3.5	-2.4	-6.3	-1.3	-1.6	-2.1	-0.5	-0.7	3.0	0.6	
max	9.3	3.9	3.7	-1.3	-0.4	-0.2	-0.2	0.8	0.6	-0.4	3.2	1.1	

Table C- 29

Little Barachois River near St. George's (Lookout Brook System) - [Coldest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.6	0.8	1.5	-0.1	-5.8	-1.6	-1.4	-1.0	-0.5	0.7	2.7	0.4	-0.1
1962	3.6	2.2	1.7	-1.0	-5.7	-1.4	-1.2	-2.5	-0.6	0.1	2.4	0.4	-0.2
1963	3.6	2.3	1.9	-0.7	-5.7	-1.3	-1.2	-2.5	-0.5	-0.1	2.3	0.4	-0.1
1964	3.6	2.2	1.6	-0.7	-5.8	-1.5	-1.3	-2.7	-0.6	0.3	2.5	0.5	-0.2
1965	3.6	2.2	1.5	-0.5	-5.8	-1.3	-1.2	-2.6	-0.7	0.4	2.5	0.5	-0.1
1966	3.6	2.3	1.9	-0.6	-5.7	-1.4	-1.3	-1.1	-0.6	0.4	2.6	0.5	0.0
1967	3.6	2.2	1.4	-0.3	-5.7	-1.4	-0.3	0.0	-0.2	0.4	2.5	0.5	0.2
1968	3.6	2.3	1.2	-0.2	-5.8	-1.5	-1.2	-2.5	-0.6	0.5	2.6	0.5	-0.1
1969	3.6	2.3	1.6	-0.5	-5.7	-1.4	-1.1	0.0	-0.6	0.1	2.4	0.4	0.1
1970	3.6	2.3	1.6	-0.3	-5.6	-1.4	-1.3	-1.5	-0.5	0.1	2.4	0.5	0.0
1971	3.6	2.2	1.3	-0.1	-5.8	-1.3	-1.2	-2.6	-0.5	0.2	2.4	0.4	-0.1
1972	3.6	2.3	1.6	-0.4	-5.7	-1.5	-1.2	-2.5	-0.5	1.0	2.9	0.5	0.0
1973	3.6	2.1	1.4	-0.3	-5.7	-1.6	-1.2	-2.5	-0.3	-0.1	2.3	0.5	-0.2
1974	0.0	2.3	1.1	-0.2	-5.8	-1.2	-1.2	-0.3	-0.2	0.5	2.6	0.5	-0.2
1975	3.6	2.3	1.4	-0.3	-5.8	-1.2	-0.2	-2.0	0.0	0.3	2.5	0.4	0.1
1976	3.6	2.3	1.5	-0.4	-5.7	-1.2	-1.0	-0.4	-0.6	0.7	2.7	0.4	0.1
1977	3.6	2.4	1.8	-0.6	-5.7	-1.3	-1.4	-2.9	-0.3	0.8	2.8	0.4	-0.1
1978	3.6	2.4	1.3	-0.2	-5.7	-1.5	-1.4	-2.7	-0.6	0.3	2.5	0.5	-0.1
1979	3.6	2.3	1.5	-0.2	-5.6	-1.3	-1.5	-3.0	-0.3	0.2	2.5	0.5	-0.1
1980	3.6	2.3	1.7	-0.6	-5.7	-1.5	-1.4	-2.7	-0.1	0.6	2.6	0.4	-0.1
1981	3.6	2.4	1.8	-0.9	-5.7	-1.5	-1.4	-2.7	-0.5	0.4	2.5	0.4	-0.2
1982	3.6	2.0	1.2	-0.4	-5.7	-1.5	-1.4	-2.7	-0.4	0.3	2.5	0.4	-0.2
1983	3.6	2.3	1.8	-0.8	-0.4	-1.6	-1.5	-2.9	-0.4	0.0	2.4	0.4	0.2
1984	3.6	2.2	1.5	-0.4	-5.7	-1.6	-1.4	-2.7	-0.2	-0.1	2.3	0.5	-0.2
1985	3.6	2.3	1.3	-0.2	-5.7	-1.6	-1.3	0.0	-0.4	0.4	2.5	0.5	0.1
1986	3.6	2.3	1.6	-0.5	-5.8	-1.6	-1.3	-0.4	-0.6	0.2	2.5	0.5	0.0
1987	3.6	2.2	1.8	-0.9	-5.8	-1.4	-0.2	-2.2	-0.2	0.9	2.8	0.5	0.1
1988	3.6	2.2	1.5	-0.3	-5.7	-1.4	-1.4	-2.8	-0.2	0.3	2.5	0.5	-0.1
1989	3.6	2.2	1.6	-0.5	-5.7	-1.3	-1.2	-2.6	-0.4	0.7	2.7	0.3	-0.1
1990	3.6	2.2	1.6	-0.6	-5.7	-1.3	-1.5	-2.9	-0.3	1.0	2.9	0.2	-0.1
mean	3.5	2.2	1.5	-0.5	-5.5	-1.4	-1.2	-2.0	-0.4	0.4	2.5	0.4	-0.1
min	0.0	0.8	1.1	-1.0	-5.8	-1.6	-1.5	-3.0	-0.7	-0.1	2.3	0.2	
max	3.6	2.4	1.9	-0.1	-0.4	-1.2	-0.2	0.0	0.0	1.0	2.9	0.5	

Table C- 30

Little Barachois River near St. George's (Lookout Brook System) - [Middle Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	6.6	1.5	2.8	-1.6	-5.7	-1.2	-1.3	-1.0	-0.5	-0.3	3.2	0.4	0.2
1962	6.6	2.9	2.9	-2.0	-5.7	-1.3	-1.2	-1.8	-0.5	-0.6	3.1	0.3	0.2
1963	6.6	2.9	3.0	-1.8	-5.7	-1.3	-1.2	-1.6	-0.3	-0.7	3.0	0.3	0.3
1964	6.6	2.9	2.8	-1.8	-5.7	-1.2	-1.3	-2.0	-0.5	-0.5	3.1	0.4	0.2
1965	6.6	2.8	2.8	-1.7	-5.7	-1.3	-1.3	-1.5	-0.5	-0.4	3.2	0.4	0.3
1966	6.6	2.9	3.0	-1.8	-5.7	-1.3	-1.3	-1.1	-0.5	-0.4	3.2	0.4	0.3
1967	6.6	2.8	2.7	-1.7	-5.7	-1.3	-0.3	0.0	0.0	-0.4	3.1	0.5	0.5
1968	6.6	2.9	2.6	-1.6	-5.7	-1.2	-1.2	-1.9	-0.6	-0.4	3.2	0.4	0.3
1969	6.6	2.9	2.8	-1.8	-5.7	-1.3	-1.2	0.0	-0.5	-0.6	3.0	0.3	0.4
1970	6.6	2.9	2.8	-1.6	-5.7	-1.3	-1.2	-1.5	-0.4	-0.6	3.1	0.5	0.3
1971	6.6	2.9	2.7	-1.6	-5.7	-1.3	-1.3	-1.6	-0.3	-0.5	3.1	0.4	0.3
1972	6.6	2.9	2.8	-1.7	-5.7	-1.2	-1.2	-1.7	-0.3	-0.1	3.3	0.4	0.3
1973	6.6	2.8	2.7	-1.6	-5.7	-1.2	-1.2	-1.4	-0.1	-0.7	3.0	0.4	0.3
1974	2.5	2.9	2.6	-1.6	-5.7	-1.4	-1.3	-0.3	0.0	-0.3	3.2	0.6	0.1
1975	6.6	2.9	2.7	-1.6	-5.7	-1.4	-0.2	-1.9	0.2	-0.4	3.1	0.2	0.4
1976	6.6	2.9	2.8	-1.7	-5.7	-1.4	-1.0	-0.4	-0.5	-0.2	3.2	0.1	0.4
1977	6.6	3.0	2.9	-1.8	-5.7	-1.3	-1.3	-1.8	-0.1	-0.1	3.3	0.2	0.3
1978	6.6	3.0	2.7	-1.6	-5.7	-1.2	-1.3	-2.2	-0.5	-0.5	3.1	0.5	0.2
1979	6.6	2.9	2.8	-1.6	-5.7	-1.3	-1.4	-2.0	-0.1	-0.5	3.1	0.4	0.2
1980	6.6	2.9	2.9	-1.8	-5.7	-1.2	-1.3	-1.6	0.2	-0.3	3.2	0.3	0.3
1981	6.6	3.0	3.0	-2.0	-5.7	-1.2	-1.2	-1.8	-0.4	-0.4	3.1	0.2	0.2
1982	6.6	2.7	2.6	-1.7	-5.7	-1.2	-1.3	-1.8	-0.3	-0.5	3.1	0.1	0.2
1983	6.6	2.9	3.0	-1.9	-0.4	-1.2	-1.3	-1.1	-0.1	-0.6	3.0	0.1	0.8
1984	6.6	2.9	2.8	-1.7	-5.7	-1.2	-1.2	-1.7	0.1	-0.7	3.0	0.4	0.3
1985	6.6	2.9	2.7	-1.6	-5.7	-1.2	-1.2	0.0	-0.3	-0.4	3.2	0.4	0.4
1986	6.6	2.9	2.8	-1.8	-5.7	-1.2	-1.2	-0.4	-0.5	-0.5	3.1	0.6	0.4
1987	6.6	2.8	2.9	-2.0	-5.7	-1.3	-0.2	-1.6	0.0	-0.1	3.3	0.4	0.4
1988	6.6	2.9	2.8	-1.7	-5.7	-1.3	-1.3	-2.0	-0.1	-0.4	3.1	0.4	0.3
1989	6.6	2.9	2.9	-1.7	-5.7	-1.3	-1.2	-0.4	-0.1	-0.2	3.2	0.0	0.4
1990	6.6	2.9	2.8	-1.8	-5.7	-1.3	-1.4	-1.9	-0.2	0.0	3.3	-0.2	0.2
mean	6.5	2.9	2.8	-1.7	-5.5	-1.3	-1.1	-1.3	-0.3	-0.4	3.1	0.3	0.3
min	2.5	1.5	2.6	-2.0	-5.7	-1.4	-1.4	-2.2	-0.6	-0.7	3.0	-0.2	
max	6.6	3.0	3.0	-1.6	-0.4	-1.2	-0.2	0.0	0.2	0.0	3.3	0.6	

Table C- 31

St. John's climate data (Pierre's Brook & Petty Harbour Systems) - 1961-1990 Average Monthly Temperature (^{o}C)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	-5.1	-9.0	-3.9	-0.2	5.6	13.4	15.3	16.1	13.0	9.0	6.2	-0.6	5.1
1962	-4.5	-4.0	-0.4	1.9	4.1	9.2	11.8	14.7	11.0	7.4	4.6	-1.5	4.6
1963	-1.9	-4.4	-3.9	-0.5	7.5	8.6	14.2	14.6	11.5	7.9	4.2	-2.7	4.6
1964	-5.2	-3.8	-4.6	1.8	4.6	9.8	15.2	13.2	11.1	7.2	1.3	-1.4	4.1
1965	-3.1	-4.6	-2.2	1.0	3.5	10.3	16.2	15.3	11.0	6.6	1.6	-1.9	4.5
1966	-2.8	-4.7	-1.1	0.8	5.9	11.2	17.0	15.1	10.9	7.2	5.6	1.4	5.6
1967	-3.9	-5.4	-4.2	-1.5	5.1	12.2	17.8	18.7	12.9	8.6	5.5	0.4	5.6
1968	-3.6	-3.8	-0.6	1.5	4.4	8.1	14.1	12.0	12.0	7.2	1.3	-0.4	4.4
1969	-2.5	-1.7	-1.0	0.8	5.0	12.4	13.5	15.1	11.2	5.7	4.7	3.0	5.6
1970	-5.6	-1.3	0.5	0.7	6.9	11.7	15.5	17.5	10.6	6.9	5.0	-2.8	5.5
1971	-5.1	-4.3	0.3	3.4	8.2	10.9	15.3	17.3	11.7	6.4	4.2	-3.6	5.4
1972	-6.1	-7.9	-3.4	0.2	4.9	14.9	14.2	14.8	10.7	6.7	1.5	-6.6	3.7
1973	-5.6	-2.7	-3.4	0.6	5.6	10.9	18.5	13.5	11.7	6.5	2.4	1.1	5.0
1974	-8.2	-5.5	-4.0	1.3	2.8	10.2	13.5	14.5	12.3	6.7	2.4	-1.0	3.8
1975	-6.5	-10.8	-2.1	0.9	4.3	8.3	18.4	14.7	13.1	6.3	3.0	-1.9	4.1
1976	-2.3	-5.1	-3.3	2.4	6.7	9.6	14.6	16.4	13.5	7.2	2.4	-3.0	5.0
1977	-3.8	-6.1	-2.2	1.8	4.7	11.5	16.1	16.1	9.8	7.5	4.6	-1.8	4.9
1978	-3.5	-3.8	-3.6	-0.3	4.7	12.5	15.6	14.7	9.5	5.7	0.6	-2.8	4.1
1979	-1.8	-7.1	0.6	0.7	7.1	12.3	15.8	15.4	10.7	7.6	3.7	-1.9	5.4
1980	-5.2	-4.9	-2.1	0.8	4.3	11.8	14.1	12.4	10.4	6.3	2.5	-1.9	4.1
1981	-2.9	-2.8	-0.7	2.9	8.9	11.0	14.5	15.1	11.6	8.1	4.0	0.4	5.9
1982	-4.2	-7.1	-3.9	1.9	5.5	7.0	15.6	15.4	12.5	5.4	3.6	-1.2	4.3
1983	-2.8	-4.2	-1.2	3.8	7.2	11.5	16.5	14.0	11.9	7.7	2.2	-1.5	5.5
1984	-5.4	-1.9	-1.5	-0.3	8.3	9.9	17.9	17.3	12.2	5.1	2.8	-2.0	5.2
1985	-5.2	-5.9	-5.1	0.0	4.4	10.4	17.5	13.9	11.0	5.8	0.3	-3.1	3.7
1986	-2.6	-5.5	-3.7	4.3	6.1	11.9	13.0	15.1	9.7	5.4	0.6	-3.9	4.2
1987	-5.5	-5.0	-3.4	2.0	7.3	9.7	15.5	14.5	11.2	9.0	1.6	-2.1	4.6
1988	-5.2	-3.8	-1.6	0.9	8.8	11.7	15.2	15.7	12.2	8.3	3.3	-3.0	5.3
1989	-6.0	-7.1	-5.0	2.6	7.9	11.8	15.3	17.3	13.1	6.3	3.2	-4.9	4.6
1990	-4.4	-9.4	-4.9	2.7	4.3	12.1	14.2	17.7	12.6	8.7	2.8	-1.1	4.7
mean	-4.4	-5.1	-2.5	1.3	5.8	10.9	15.4	15.3	11.6	7.0	3.1	-1.8	4.8
min	-8.2	-10.8	-5.1	-1.5	2.8	7.0	11.8	12.0	9.5	5.1	0.3	-6.6	
max	-1.8	-1.3	0.6	4.3	8.9	14.9	18.5	18.7	13.5	9.0	6.2	3.0	

Table C- 32
St. John's climate data (Pierre's Brook & Petty Harbour Systems) - 1961-1990 Total Monthly Precipitation (mm)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	91.4	102.4	206.5	121.0	91.9	36.9	40.7	39.9	51.1	93.8	84.4	96.3	88.1
1962	103.8	224.0	146.9	60.8	43.4	96.8	141.6	54.9	162.4	163.2	228.8	152.4	130.8
1963	220.0	97.4	56.0	150.9	107.8	86.3	69.2	167.4	112.1	85.5	134.7	180.2	122.5
1964	128.7	166.9	108.3	98.1	66.9	79.2	102.0	156.5	121.1	210.5	180.7	173.2	132.6
1965	122.2	96.2	127.5	102.9	83.7	69.4	61.3	53.3	62.2	101.0	171.6	93.3	95.3
1966	181.3	62.9	110.5	53.8	105.7	95.6	80.7	120.9	62.4	120.1	120.5	259.7	115.2
1967	181.3	166.5	99.9	110.3	112.6	20.6	31.9	47.6	108.5	119.3	120.3	74.0	99.0
1968	73.0	155.2	154.2	50.7	147.3	156.0	63.4	176.3	30.7	167.1	188.2	114.5	123.0
1969	127.0	134.0	171.2	106.6	132.7	59.2	99.1	210.2	151.0	194.3	167.2	149.1	142.1
1970	71.4	234.2	107.6	151.4	109.5	76.6	34.6	327.5	113.6	150.6	189.9	253.1	151.3
1971	214.0	75.5	94.2	193.4	42.8	94.0	146.9	150.6	87.8	107.5	243.8	136.1	132.4
1972	104.2	124.2	114.7	114.3	104.5	97.7	19.3	118.0	99.1	149.2	267.8	129.4	119.9
1973	96.4	188.2	75.9	42.3	122.5	159.2	66.0	191.6	107.4	141.7	115.4	60.3	113.4
1974	88.2	73.2	162.2	152.0	109.0	61.2	91.2	144.2	153.5	212.0	128.7	177.2	129.9
1975	116.7	90.9	85.4	106.4	144.3	56.0	54.8	146.2	117.1	205.2	98.6	87.4	109.4
1976	222.6	145.0	123.7	110.0	40.9	106.5	77.6	54.8	120.9	148.3	120.6	242.3	126.1
1977	219.4	107.6	56.7	72.1	78.0	95.3	83.0	54.4	177.0	101.3	84.2	259.4	115.9
1978	218.0	104.7	183.1	188.1	47.7	57.2	84.9	49.5	216.8	119.4	96.9	152.4	126.6
1979	213.6	80.3	138.8	109.8	107.1	61.4	61.7	128.9	108.2	227.3	104.1	148.9	124.8
1980	132.6	154.2	156.4	47.0	172.3	124.0	109.3	216.7	174.6	216.8	194.6	128.5	152.4
1981	214.8	87.9	142.4	71.4	61.2	142.8	133.3	106.0	186.9	322.0	192.3	112.4	148.2
1982	227.9	158.9	89.1	73.0	166.7	154.9	53.6	110.6	251.4	165.4	102.5	158.6	142.6
1983	150.1	146.2	176.6	136.4	87.2	85.8	121.4	140.5	190.9	214.6	118.9	111.9	140.1
1984	188.8	151.1	142.7	235.2	156.0	144.4	41.4	204.3	157.8	80.7	100.7	109.1	142.4
1985	111.7	96.4	102.3	96.2	168.6	88.9	108.8	100.9	54.2	85.9	103.7	113.8	102.8
1986	117.5	184.9	175.3	129.2	43.4	130.2	87.8	60.6	118.1	157.2	203.1	80.8	123.3
1987	174.6	175.1	149.7	120.9	79.9	37.9	50.8	70.9	112.8	80.6	123.7	187.4	113.4
1988	79.9	172.6	171.8	159.1	87.6	176.5	80.4	75.9	119.5	100.4	153.4	130.1	125.0
1989	141.8	119.0	102.5	45.8	21.3	109.4	97.8	70.7	83.4	91.7	130.4	133.4	95.5
1990	101.1	133.7	68.7	103.6	183.3	147.7	41.7	104.8	136.4	218.2	71.7	122.3	119.4
mean	147.8	133.6	126.7	110.4	100.9	96.9	77.9	121.8	125.0	151.7	144.7	144.3	123.4
min	71.4	62.9	56.0	42.3	21.3	20.6	19.3	39.9	30.7	80.6	71.7	60.3	
max	227.9	234.2	206.5	235.2	183.3	176.5	146.9	327.5	251.4	322.0	267.8	259.7	

Table C- 33

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Historical Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	0.6	0.8	2.1	5.4	3.1	1.5	0.8	1.2	1.9	3.7	2.4	3.4	2.2
1975	1.1	0.4	1.4	6.4	2.7	0.9	0.3	1.0	1.1	2.1	1.9	2.1	1.8
1976	4.2	3.5	2.1	2.7	0.9	1.0	0.4	0.4	0.8	1.5	2.0	3.5	1.9
1977	3.5	0.7	1.5	3.1	2.0	0.9	0.4	0.5	1.1	1.5	1.2	3.7	1.7
1978	3.5	1.1	2.2	4.1	3.9	0.8	0.5	0.4	1.7	1.6	1.3	1.9	1.9
1979	5.5	2.6	3.8	3.1	2.5	0.4	0.4	0.7	0.8	3.4	2.7	3.1	2.4
1980	1.5	1.2	5.1	4.2	3.5	1.4	1.1	2.2	1.7	3.5	4.1	2.9	2.7
1981	3.1	2.7	3.3	2.7	1.1	1.3	1.6	0.8	2.0	5.1	4.5	1.9	2.5
1982	1.5	1.8	3.1	4.3	3.6	1.9	1.0	0.6	2.7	3.2	1.1	3.1	2.3
1983	2.7	1.2	4.9	2.9	1.2	1.2	0.9	1.1	1.9	2.6	2.3	1.7	2.0
1984	2.7	3.3	1.4	6.6	3.7	1.7	0.5	1.1	2.0	0.9	1.0	1.9	2.2
1985	0.9	0.8	1.5	3.7	5.7	1.2	0.9	0.5	0.6	0.5	1.5	1.5	1.6
1986	3.2	2.2	3.6	4.8	1.0	0.9	0.9	0.8	1.1	4.1	4.5	2.6	2.5
1987	2.0	2.4	4.8	8.8	3.0	0.6	0.5	0.3	0.5	0.8	2.0	2.5	2.3
1988	1.0	4.9	4.0	4.0	2.2	1.4	0.9	0.6	0.7	1.2	2.5	2.1	2.1
1989	2.9	2.9	1.9	3.8	0.8	0.9	0.9	0.6	0.7	1.3	2.0	3.6	1.8
1990	2.3	2.2	2.1	2.2	3.8	2.2	0.6	0.6	1.8	3.8	2.3	3.5	2.3
mean	2.5	2.0	2.9	4.3	2.6	1.2	0.7	0.8	1.4	2.4	2.3	2.6	2.1
min	0.6	0.4	1.4	2.2	0.8	0.4	0.3	0.3	0.5	0.5	1.0	1.5	
max	5.5	4.9	5.1	8.8	5.7	2.2	1.6	2.2	2.7	5.1	4.5	3.7	

Note: * denotes missing data

Table C- 34

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Synthetic Monthly Mean Flows (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	1.9	1.1	4.1	4.7	3.1	0.5	0.0	0.1	0.4	0.8	0.9	2.1	1.7
1962	2.2	3.6	5.5	3.1	1.4	1.1	1.7	0.7	1.2	2.5	4.4	2.7	2.5
1963	4.0	2.0	0.4	4.5	3.4	1.1	0.8	1.2	1.5	1.0	2.0	3.0	2.1
1964	2.1	3.0	2.3	3.9	1.9	1.0	0.9	1.2	1.4	3.3	3.9	2.9	2.3
1965	2.9	1.9	2.3	3.9	2.6	1.0	0.4	0.2	0.5	1.4	3.0	2.1	1.8
1966	3.4	1.5	1.7	3.1	2.6	1.1	0.6	0.7	0.9	1.7	1.7	3.8	1.9
1967	3.0	2.6	2.6	4.3	4.0	0.6	0.0	0.0	1.1	1.4	1.8	1.9	1.9
1968	2.3	2.8	4.2	3.1	3.1	1.9	1.1	1.4	0.7	2.4	3.8	2.3	2.4
1969	3.1	3.0	3.5	3.9	3.3	0.9	0.8	1.6	2.1	3.2	3.1	2.7	2.6
1970	1.5	4.3	4.8	4.0	3.1	0.9	0.1	2.2	2.7	2.3	3.4	3.7	2.7
1971	2.7	1.8	2.1	4.2	1.0	0.8	1.4	1.1	1.5	1.5	4.4	2.5	2.1
1972	1.6	1.6	2.9	4.2	3.2	1.0	0.0	0.8	1.1	2.3	5.3	2.4	2.2
1973	1.7	3.4	2.3	3.2	2.9	1.7	0.6	1.2	1.5	2.1	1.9	1.8	2.0
1974	0.6	1.5	2.0	4.7	3.2	1.1	0.8	1.2	1.6	3.4	2.6	3.0	2.1
1975	1.5	0.6	2.7	3.7	3.5	1.1	0.2	0.8	1.4	3.2	1.8	2.0	1.9
1976	3.9	2.4	2.9	3.9	1.1	1.0	0.9	0.3	1.0	2.0	2.1	3.6	2.1
1977	3.3	1.8	1.6	3.2	2.0	1.1	0.6	0.3	1.5	1.5	0.9	3.8	1.8
1978	3.4	2.2	2.8	5.3	2.9	0.6	0.4	0.3	1.7	2.1	1.5	2.7	2.2
1979	4.0	1.2	3.6	3.7	2.8	0.7	0.2	0.8	1.3	3.6	2.1	2.7	2.2
1980	2.1	2.5	4.0	3.3	3.7	1.6	1.2	1.7	2.0	3.7	4.0	2.5	2.7
1981	3.6	2.2	2.5	3.2	0.8	1.2	1.5	0.9	1.7	5.2	4.6	2.3	2.5
1982	3.2	2.2	2.7	3.5	3.2	2.0	1.0	0.7	2.2	2.8	1.6	2.8	2.3
1983	3.2	2.6	4.4	4.0	1.3	0.9	0.9	1.0	1.9	3.4	2.5	2.3	2.4
1984	2.4	3.2	3.2	5.4	4.4	1.6	0.4	1.2	2.3	1.2	1.1	2.3	2.4
1985	2.0	1.7	1.1	4.1	4.2	1.4	0.8	0.6	0.6	1.2	1.5	2.3	1.8
1986	3.0	2.8	4.5	4.1	0.6	1.1	1.1	0.5	1.0	2.7	3.9	2.0	2.3
1987	2.3	2.8	3.8	4.2	1.9	0.5	0.2	0.4	0.9	0.8	2.1	3.1	1.9
1988	1.8	3.0	4.6	4.5	2.5	1.5	1.0	0.5	1.1	1.2	2.6	2.5	2.2
1989	1.9	1.7	1.8	3.3	0.4	0.8	0.9	0.4	0.9	1.1	1.9	2.5	1.5
1990	2.2	1.4	2.0	3.8	3.4	1.8	0.6	0.6	1.6	3.2	1.5	2.4	2.0
mean	2.6	2.3	3.0	3.9	2.6	1.1	0.7	0.8	1.4	2.3	2.6	2.6	2.2
min	0.6	0.6	0.4	3.1	0.4	0.5	0.0	0.0	0.4	0.8	0.9	1.8	
max	4.0	4.3	5.5	5.4	4.4	2.0	1.7	2.2	2.7	5.2	5.3	3.8	

Table C- 35

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Monthly Mean Flows under 'Wettest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.8	1.8	5.0	4.6	2.7	0.5	0.0	0.0	0.7	0.8	1.2	2.2	1.9
1962	3.1	4.6	6.8	3.0	0.8	1.0	1.8	0.6	1.7	2.7	5.1	2.8	2.8
1963	5.0	2.7	1.0	4.5	3.0	1.0	0.7	1.3	1.9	1.0	2.4	3.1	2.3
1964	3.1	3.8	3.3	3.8	1.4	0.9	0.9	1.2	1.8	3.6	4.5	3.0	2.6
1965	3.8	2.6	3.0	3.8	2.2	1.0	0.3	0.2	0.8	1.4	3.5	2.2	2.0
1966	4.4	2.1	2.3	3.0	2.1	1.1	0.5	0.7	1.3	1.7	2.1	4.0	2.1
1967	4.0	3.5	3.6	4.2	3.5	0.5	0.0	0.0	1.5	1.5	2.2	2.0	2.2
1968	3.3	3.6	5.2	2.9	2.6	1.9	1.1	1.4	1.0	2.6	4.4	2.4	2.7
1969	4.1	3.8	4.5	3.8	2.9	0.9	0.7	1.7	2.6	3.5	3.6	2.8	2.9
1970	2.5	5.3	6.0	4.0	2.6	0.9	0.0	2.4	3.3	2.5	4.0	3.9	3.1
1971	3.7	2.4	2.6	4.3	0.6	0.7	1.4	1.1	1.9	1.6	5.1	2.6	2.3
1972	2.5	2.3	3.7	4.1	2.7	1.0	0.0	0.8	1.6	2.4	6.2	2.5	2.5
1973	2.7	4.3	3.3	3.0	2.4	1.7	0.5	1.3	2.0	2.3	2.3	1.8	2.3
1974	1.6	2.1	2.7	4.7	2.7	1.0	0.8	1.2	2.2	3.7	3.1	3.1	2.4
1975	2.5	1.2	3.4	3.6	3.1	1.1	0.1	0.8	1.8	3.5	2.2	2.1	2.1
1976	4.9	3.2	3.8	3.8	0.6	0.9	0.8	0.3	1.4	2.2	2.6	3.8	2.4
1977	4.3	2.5	2.2	3.0	1.4	1.0	0.6	0.2	2.0	1.6	1.2	4.0	2.0
1978	4.4	2.9	3.6	5.4	2.5	0.6	0.4	0.2	2.2	2.2	1.8	2.8	2.4
1979	5.1	1.9	4.3	3.6	2.3	0.7	0.1	0.8	1.8	3.9	2.6	2.8	2.5
1980	3.1	3.4	5.0	3.2	3.2	1.6	1.2	1.8	2.7	4.0	4.7	2.6	3.0
1981	4.6	2.9	3.2	3.0	0.3	1.1	1.6	0.8	2.3	5.8	5.3	2.4	2.8
1982	4.2	3.0	3.6	3.3	2.7	1.9	0.9	0.7	2.9	3.0	2.0	2.9	2.6
1983	4.1	3.4	5.3	4.0	0.9	0.8	0.9	1.0	2.4	3.7	3.0	2.4	2.7
1984	3.4	4.0	4.2	5.6	4.1	1.5	0.3	1.2	2.8	1.2	1.4	2.3	2.7
1985	2.9	2.4	1.8	4.0	3.8	1.3	0.8	0.6	0.9	1.2	1.8	2.4	2.0
1986	4.0	3.7	5.6	4.1	0.1	1.1	1.0	0.5	1.4	2.9	4.6	2.0	2.6
1987	3.3	3.7	4.9	4.1	1.4	0.5	0.1	0.4	1.3	0.8	2.4	3.2	2.2
1988	2.7	3.9	5.6	4.6	2.1	1.5	1.0	0.4	1.5	1.2	3.1	2.6	2.5
1989	2.9	2.4	2.6	3.1	0.0	0.8	0.9	0.4	1.3	1.1	2.3	2.6	1.7
1990	3.2	2.1	2.8	3.7	2.9	1.8	0.4	0.6	2.0	3.5	1.9	2.5	2.3
mean	3.5	3.0	3.8	3.9	2.1	1.1	0.7	0.8	1.8	2.4	3.1	2.7	2.4
min	1.6	1.2	1.0	2.9	0.0	0.5	0.0	0.0	0.7	0.8	1.2	1.8	
max	5.1	5.3	6.8	5.6	4.1	1.9	1.8	2.4	3.3	5.8	6.2	4.0	

Note: A value of zero can occur if the regression equation calculates a zero or negative flow.

Table C- 36

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Monthly Mean Flows under 'Driest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.8	1.5	4.1	4.2	2.5	0.4	0.0	0.0	0.6	0.6	0.9	2.0	1.6
1962	3.1	3.9	5.4	2.8	0.8	0.9	1.5	0.6	1.5	2.4	4.3	2.5	2.5
1963	4.9	2.5	0.5	4.1	2.8	0.9	0.5	1.2	1.8	0.8	2.0	2.7	2.0
1964	3.0	3.4	2.3	3.5	1.3	0.8	0.7	1.2	1.7	3.2	3.8	2.6	2.3
1965	3.7	2.4	2.3	3.5	2.0	0.8	0.1	0.1	0.7	1.2	2.9	2.0	1.8
1966	4.3	2.0	1.8	2.8	1.9	0.9	0.3	0.7	1.1	1.5	1.7	3.4	1.9
1967	3.9	3.0	2.6	3.9	3.3	0.4	0.0	0.0	1.3	1.2	1.8	1.8	1.9
1968	3.3	3.2	4.2	2.8	2.4	1.7	0.9	1.4	0.9	2.2	3.7	2.1	2.4
1969	4.0	3.4	3.5	3.5	2.6	0.7	0.5	1.7	2.4	3.1	3.0	2.5	2.6
1970	2.4	4.6	4.7	3.6	2.4	0.7	0.0	2.3	3.1	2.2	3.3	3.3	2.7
1971	3.6	2.3	2.1	3.7	0.5	0.6	1.1	1.1	1.7	1.3	4.2	2.3	2.0
1972	2.5	2.0	2.9	3.8	2.5	0.8	0.0	0.7	1.4	2.1	5.2	2.2	2.2
1973	2.6	3.8	2.2	2.8	2.2	1.5	0.4	1.2	1.8	2.0	1.9	1.7	2.0
1974	1.5	2.0	2.1	4.3	2.5	0.9	0.6	1.1	1.9	3.3	2.6	2.7	2.1
1975	2.4	1.0	2.8	3.4	2.8	0.9	0.0	0.8	1.7	3.1	1.9	1.9	1.9
1976	4.7	2.8	2.8	3.5	0.6	0.8	0.6	0.2	1.3	1.9	2.1	3.2	2.1
1977	4.1	2.2	1.6	2.8	1.4	0.9	0.4	0.2	1.8	1.3	1.0	3.4	1.7
1978	4.2	2.7	2.8	4.8	2.3	0.5	0.2	0.2	1.9	1.9	1.5	2.5	2.1
1979	4.9	1.7	3.7	3.3	2.1	0.5	0.0	0.8	1.6	3.5	2.2	2.4	2.2
1980	3.0	3.0	3.9	3.0	3.0	1.4	0.9	1.8	2.4	3.6	4.0	2.3	2.7
1981	4.5	2.7	2.5	2.8	0.3	1.0	1.3	0.8	2.0	5.2	4.5	2.1	2.5
1982	4.0	2.6	2.7	3.1	2.4	1.7	0.7	0.6	2.6	2.7	1.6	2.5	2.3
1983	4.0	3.0	4.3	3.5	0.7	0.7	0.7	1.0	2.2	3.3	2.5	2.1	2.3
1984	3.3	3.6	3.2	4.9	3.6	1.4	0.1	1.2	2.6	1.0	1.1	2.1	2.3
1985	2.9	2.1	1.1	3.8	3.5	1.2	0.6	0.6	0.8	1.0	1.5	2.1	1.8
1986	3.9	3.2	4.4	3.7	0.0	1.0	0.8	0.4	1.2	2.6	3.9	1.8	2.2
1987	3.2	3.2	3.8	3.8	1.3	0.4	0.0	0.3	1.2	0.6	2.0	2.8	1.9
1988	2.7	3.4	4.5	4.1	1.9	1.3	0.8	0.4	1.4	1.0	2.6	2.3	2.2
1989	2.8	2.1	1.8	3.0	0.0	0.6	0.6	0.3	1.2	0.9	1.9	2.3	1.5
1990	3.1	1.8	2.0	3.4	2.6	1.6	0.3	0.6	1.8	3.1	1.6	2.2	2.0
mean	3.4	2.7	3.0	3.5	1.9	0.9	0.5	0.8	1.7	2.1	2.6	2.4	2.1
min	1.5	1.0	0.5	2.8	0.0	0.4	0.0	0.0	0.6	0.6	0.9	1.7	
max	4.9	4.6	5.4	4.9	3.6	1.7	1.5	2.3	3.1	5.2	5.2	3.4	

Note: A value of zero can occur if the regression equation calculates a zero or negative flow.

Table C- 37

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Monthly Mean Flows under 'Warmest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.0	1.8	4.1	4.3	2.7	0.4	0.0	0.0	0.6	0.6	0.9	2.1	1.7
1962	3.3	4.3	5.5	2.8	0.9	1.0	1.5	0.5	1.6	2.4	4.4	2.6	2.5
1963	5.2	2.7	0.5	4.2	3.0	1.0	0.5	1.2	1.9	0.8	2.0	2.9	2.2
1964	3.3	3.6	2.3	3.6	1.4	0.9	0.6	1.1	1.8	3.2	3.9	2.8	2.4
1965	4.0	2.6	2.3	3.5	2.2	0.9	0.1	0.1	0.8	1.2	3.0	2.1	1.9
1966	4.6	2.2	1.7	2.8	2.1	1.1	0.3	0.7	1.2	1.5	1.8	3.7	2.0
1967	4.2	3.3	2.6	4.0	3.5	0.4	0.0	0.0	1.4	1.2	1.9	1.9	2.0
1968	3.5	3.5	4.2	2.7	2.7	1.9	0.9	1.4	0.9	2.2	3.8	2.3	2.5
1969	4.3	3.7	3.5	3.6	2.9	0.8	0.5	1.6	2.5	3.1	3.1	2.6	2.7
1970	2.7	4.9	4.8	3.7	2.6	0.8	0.0	2.3	3.2	2.2	3.4	3.6	2.8
1971	3.9	2.5	2.1	3.9	0.5	0.7	1.1	1.0	1.8	1.3	4.4	2.5	2.1
1972	2.7	2.3	2.9	3.8	2.7	1.0	0.0	0.7	1.5	2.1	5.4	2.4	2.3
1973	2.9	4.1	2.3	2.8	2.5	1.7	0.4	1.2	1.9	2.0	2.0	1.8	2.1
1974	1.8	2.2	2.0	4.4	2.7	1.0	0.6	1.1	2.1	3.2	2.7	2.9	2.2
1975	2.7	1.3	2.8	3.4	3.1	1.0	0.0	0.8	1.7	3.1	1.9	2.0	2.0
1976	5.1	3.1	2.9	3.5	0.6	0.9	0.6	0.2	1.4	1.9	2.2	3.5	2.2
1977	4.5	2.5	1.6	2.8	1.5	1.0	0.3	0.1	1.9	1.3	1.0	3.7	1.8
1978	4.6	2.9	2.8	5.0	2.4	0.5	0.1	0.2	2.1	2.0	1.5	2.6	2.2
1979	5.2	1.9	3.6	3.3	2.3	0.7	0.0	0.8	1.7	3.5	2.2	2.6	2.3
1980	3.3	3.2	4.0	3.0	3.3	1.6	0.9	1.8	2.5	3.5	4.1	2.4	2.8
1981	4.8	2.9	2.5	2.8	0.3	1.2	1.3	0.8	2.2	5.2	4.6	2.3	2.6
1982	4.4	2.8	2.7	3.1	2.8	2.0	0.8	0.6	2.8	2.7	1.6	2.7	2.4
1983	4.3	3.3	4.3	3.6	0.9	0.8	0.6	0.9	2.3	3.2	2.6	2.2	2.4
1984	3.6	3.9	3.2	5.1	4.1	1.6	0.2	1.2	2.7	1.1	1.2	2.2	2.5
1985	3.1	2.4	1.1	3.8	3.8	1.3	0.5	0.5	0.9	1.0	1.5	2.2	1.9
1986	4.2	3.5	4.4	3.8	0.1	1.1	0.8	0.4	1.3	2.5	4.0	1.9	2.3
1987	3.5	3.5	3.8	3.8	1.4	0.4	0.0	0.3	1.3	0.6	2.1	3.0	2.0
1988	2.9	3.7	4.5	4.2	2.0	1.5	0.8	0.4	1.4	1.0	2.6	2.4	2.3
1989	3.1	2.4	1.9	2.9	0.0	0.8	0.6	0.3	1.2	0.9	1.9	2.4	1.5
1990	3.4	2.1	2.1	3.5	3.0	1.8	0.3	0.5	1.9	3.1	1.6	2.3	2.1
mean	3.7	3.0	3.0	3.6	2.1	1.1	0.5	0.8	1.7	2.1	2.6	2.6	2.2
min	1.8	1.3	0.5	2.7	0.0	0.4	0.0	0.0	0.6	0.6	0.9	1.8	
max	5.2	4.9	5.5	5.1	4.1	2.0	1.5	2.3	3.2	5.2	5.4	3.7	

Table C- 38

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Monthly Mean Flows under 'Coldest' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.3	1.5	3.7	4.3	2.6	0.4	0.0	0.0	0.5	0.8	1.0	2.1	1.6
1962	2.6	3.9	5.0	2.8	0.9	0.9	1.4	0.5	1.5	2.6	4.6	2.7	2.4
1963	4.5	2.4	0.3	4.1	2.9	0.9	0.6	1.1	1.6	1.0	2.1	2.9	2.0
1964	2.6	3.3	2.0	3.6	1.4	0.8	0.7	1.1	1.5	3.5	4.1	2.9	2.3
1965	3.3	2.3	2.0	3.5	2.1	0.9	0.1	0.1	0.7	1.4	3.1	2.1	1.8
1966	3.9	2.0	1.5	2.8	2.1	1.0	0.3	0.6	1.0	1.7	1.8	3.7	1.9
1967	3.4	2.9	2.3	4.0	3.5	0.4	0.0	0.0	1.3	1.4	2.0	1.9	1.9
1968	2.8	3.2	3.8	2.8	2.6	1.7	0.9	1.3	0.8	2.5	4.0	2.3	2.4
1969	3.6	3.4	3.1	3.6	2.8	0.8	0.5	1.5	2.3	3.4	3.3	2.7	2.6
1970	2.0	4.6	4.3	3.7	2.6	0.8	0.0	2.1	2.9	2.4	3.6	3.7	2.7
1971	3.2	2.2	1.8	3.8	0.5	0.6	1.1	0.9	1.6	1.5	4.5	2.5	2.0
1972	2.0	1.9	2.5	3.8	2.7	0.9	0.0	0.7	1.3	2.4	5.6	2.4	2.2
1973	2.2	3.8	2.0	2.9	2.4	1.5	0.4	1.1	1.6	2.2	2.1	1.8	2.0
1974	1.1	1.9	1.7	4.3	2.7	0.9	0.6	1.0	1.8	3.6	2.8	2.9	2.1
1975	2.0	1.0	2.5	3.4	3.1	1.0	0.0	0.7	1.5	3.4	2.0	2.0	1.9
1976	4.4	2.8	2.5	3.5	0.6	0.8	0.6	0.2	1.2	2.1	2.3	3.5	2.0
1977	3.7	2.1	1.4	2.9	1.4	0.9	0.4	0.1	1.7	1.5	1.0	3.7	1.7
1978	3.8	2.6	2.4	4.9	2.4	0.5	0.2	0.2	1.9	2.2	1.6	2.7	2.1
1979	4.5	1.6	3.3	3.3	2.3	0.6	0.0	0.7	1.5	3.8	2.3	2.6	2.2
1980	2.6	2.9	3.6	3.0	3.3	1.5	0.9	1.6	2.3	3.9	4.2	2.4	2.7
1981	4.1	2.6	2.2	2.8	0.3	1.0	1.2	0.7	2.0	5.6	4.8	2.3	2.5
1982	3.7	2.5	2.4	3.2	2.7	1.8	0.7	0.6	2.5	2.9	1.7	2.7	2.3
1983	3.6	3.0	3.9	3.6	0.8	0.7	0.7	0.9	2.1	3.6	2.7	2.3	2.3
1984	2.9	3.5	2.9	5.0	3.9	1.4	0.2	1.0	2.5	1.2	1.2	2.2	2.3
1985	2.4	2.1	0.9	3.8	3.7	1.2	0.6	0.5	0.8	1.2	1.6	2.3	1.7
1986	3.5	3.1	4.0	3.8	0.0	1.0	0.8	0.4	1.2	2.8	4.1	1.9	2.2
1987	2.8	3.1	3.4	3.8	1.4	0.4	0.0	0.3	1.1	0.8	2.2	3.0	1.8
1988	2.2	3.3	4.1	4.2	2.0	1.3	0.8	0.3	1.3	1.2	2.7	2.4	2.1
1989	2.3	2.1	1.6	3.0	0.0	0.6	0.6	0.3	1.1	1.1	2.0	2.5	1.4
1990	2.7	1.7	1.8	3.5	2.9	1.7	0.3	0.5	1.8	3.4	1.7	2.4	2.0
mean	3.0	2.6	2.6	3.6	2.1	1.0	0.5	0.7	1.6	2.4	2.8	2.6	2.1
min	1.1	1.0	0.3	2.8	0.0	0.4	0.0	0.0	0.5	0.8	1.0	1.8	
max	4.5	4.6	5.0	5.0	3.9	1.8	1.4	2.1	2.9	5.6	5.6	3.7	

Table C- 39

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - Monthly Mean Flows under 'Middle' Climate Scenario (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.7	1.6	4.0	4.3	2.6	0.4	0.0	0.0	0.6	0.7	1.0	2.1	1.7
1962	3.0	4.0	5.3	2.8	0.8	1.0	1.5	0.5	1.5	2.5	4.4	2.6	2.5
1963	4.8	2.5	0.4	4.1	2.9	0.9	0.5	1.2	1.8	0.8	2.1	2.8	2.1
1964	2.9	3.4	2.2	3.6	1.4	0.8	0.7	1.1	1.6	3.3	3.9	2.8	2.3
1965	3.7	2.5	2.2	3.5	2.1	0.9	0.1	0.1	0.7	1.3	3.0	2.0	1.8
1966	4.2	2.1	1.7	2.8	2.0	1.0	0.3	0.6	1.1	1.6	1.8	3.6	1.9
1967	3.8	3.1	2.5	4.0	3.4	0.4	0.0	0.0	1.4	1.3	1.9	1.9	2.0
1968	3.2	3.3	4.1	2.8	2.5	1.8	0.9	1.3	0.9	2.3	3.8	2.2	2.4
1969	4.0	3.5	3.4	3.5	2.8	0.8	0.5	1.6	2.4	3.2	3.1	2.6	2.6
1970	2.4	4.7	4.6	3.7	2.5	0.8	0.0	2.2	3.0	2.3	3.4	3.5	2.7
1971	3.6	2.3	2.0	3.8	0.5	0.6	1.1	1.0	1.7	1.4	4.4	2.4	2.1
1972	2.4	2.1	2.7	3.8	2.6	0.9	0.0	0.7	1.4	2.2	5.4	2.3	2.2
1973	2.5	3.9	2.2	2.8	2.4	1.6	0.4	1.1	1.8	2.0	2.0	1.7	2.0
1974	1.5	2.0	1.9	4.3	2.6	0.9	0.6	1.1	1.9	3.3	2.7	2.8	2.1
1975	2.3	1.1	2.7	3.4	3.0	1.0	0.0	0.7	1.6	3.2	1.9	2.0	1.9
1976	4.7	2.9	2.7	3.5	0.6	0.9	0.6	0.2	1.3	2.0	2.2	3.4	2.1
1977	4.1	2.3	1.5	2.8	1.4	0.9	0.4	0.1	1.8	1.4	1.0	3.6	1.8
1978	4.2	2.7	2.6	4.9	2.4	0.5	0.2	0.2	2.0	2.0	1.5	2.6	2.1
1979	4.9	1.8	3.5	3.3	2.2	0.6	0.0	0.7	1.6	3.6	2.2	2.5	2.3
1980	2.9	3.0	3.8	3.0	3.2	1.5	0.9	1.7	2.4	3.7	4.1	2.4	2.7
1981	4.4	2.8	2.4	2.8	0.3	1.0	1.3	0.7	2.1	5.3	4.7	2.2	2.5
1982	4.0	2.6	2.6	3.1	2.6	1.8	0.7	0.6	2.6	2.7	1.7	2.6	2.3
1983	4.0	3.1	4.2	3.6	0.8	0.8	0.7	0.9	2.2	3.3	2.6	2.2	2.4
1984	3.3	3.6	3.1	5.0	3.9	1.4	0.2	1.1	2.6	1.1	1.2	2.2	2.4
1985	2.8	2.2	1.0	3.8	3.7	1.2	0.6	0.5	0.8	1.1	1.5	2.2	1.8
1986	3.9	3.3	4.3	3.8	0.0	1.0	0.8	0.4	1.3	2.6	4.0	1.9	2.3
1987	3.2	3.3	3.7	3.8	1.4	0.4	0.0	0.3	1.2	0.7	2.1	2.9	1.9
1988	2.6	3.5	4.4	4.2	1.9	1.4	0.8	0.4	1.4	1.0	2.6	2.4	2.2
1989	2.7	2.2	1.7	3.0	0.0	0.7	0.6	0.3	1.2	1.0	1.9	2.4	1.5
1990	3.0	1.9	2.0	3.4	2.8	1.7	0.3	0.5	1.8	3.2	1.6	2.3	2.1
mean	3.4	2.8	2.8	3.6	2.0	1.0	0.5	0.7	1.7	2.2	2.7	2.5	2.1
min	1.5	1.1	0.4	2.8	0.0	0.4	0.0	0.0	0.6	0.7	1.0	1.7	
max	4.9	4.7	5.3	5.0	3.9	1.8	1.5	2.2	3.0	5.3	5.4	3.6	

Note: A value of zero can occur if the regression equation calculates a zero or negative flow.

Table C- 40

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Synthetic Flow - Historic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*
1963	*	*	*	*	*	*	*	*	*	*	*	*	*
1964	*	*	*	*	*	*	*	*	*	*	*	*	*
1965	*	*	*	*	*	*	*	*	*	*	*	*	*
1966	*	*	*	*	*	*	*	*	*	*	*	*	*
1967	*	*	*	*	*	*	*	*	*	*	*	*	*
1968	*	*	*	*	*	*	*	*	*	*	*	*	*
1969	*	*	*	*	*	*	*	*	*	*	*	*	*
1970	*	*	*	*	*	*	*	*	*	*	*	*	*
1971	*	*	*	*	*	*	*	*	*	*	*	*	*
1972	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*
1974	0.1	0.7	-0.1	-0.7	0.1	-0.4	0.1	0.0	-0.2	-0.3	0.2	-0.4	-0.1
1975	0.4	0.2	1.3	-2.6	0.9	0.3	-0.1	-0.2	0.3	1.1	0.0	-0.1	0.1
1976	-0.3	-1.1	0.8	1.2	0.2	0.0	0.5	0.0	0.3	0.5	0.1	0.1	0.2
1977	-0.2	1.0	0.1	0.1	0.0	0.2	0.2	-0.2	0.4	0.1	-0.2	0.2	0.1
1978	-0.1	1.1	0.6	1.2	-1.0	-0.2	-0.1	-0.1	0.0	0.5	0.2	0.8	0.2
1979	-1.4	-1.4	-0.2	0.5	0.2	0.3	-0.2	0.1	0.5	0.2	-0.6	-0.4	-0.2
1980	0.7	1.3	-1.1	-0.9	0.2	0.2	0.0	-0.4	0.3	0.1	-0.1	-0.4	0.0
1981	0.5	-0.4	-0.8	0.5	-0.2	-0.2	0.0	0.0	-0.3	0.1	0.1	0.4	0.0
1982	1.7	0.4	-0.4	-0.8	-0.5	0.0	0.0	0.1	-0.4	-0.4	0.5	-0.3	0.0
1983	0.5	1.5	-0.5	1.1	0.1	-0.3	0.1	-0.1	0.0	0.8	0.2	0.6	0.3
1984	-0.3	-0.2	1.9	-1.2	0.7	-0.1	-0.1	0.1	0.2	0.3	0.1	0.4	0.2
1985	1.1	0.9	-0.4	0.4	-1.5	0.2	-0.1	0.2	0.0	0.7	0.0	0.8	0.2
1986	-0.2	0.6	0.9	-0.7	-0.5	0.2	0.2	-0.2	-0.1	-1.4	-0.5	-0.6	-0.2
1987	0.3	0.4	-1.0	-4.7	-1.1	0.0	-0.3	0.1	0.4	-0.1	0.1	0.6	-0.4
1988	0.8	-1.9	0.5	0.5	0.3	0.1	0.1	-0.1	0.4	0.0	0.1	0.4	0.1
1989	-1.0	-1.2	0.0	-0.5	-0.5	-0.1	0.0	-0.2	0.2	-0.2	-0.1	-1.1	-0.4
1990	-0.1	-0.8	-0.1	1.6	-0.4	-0.4	0.0	0.0	-0.2	-0.6	-0.7	-1.1	-0.2
mean	0.1	0.1	0.1	-0.3	-0.2	0.0	0.0	-0.1	0.1	0.1	0.0	0.0	0.0
min	-1.4	-1.9	-1.1	-4.7	-1.5	-0.4	-0.3	-0.4	-0.4	-1.4	-0.7	-1.1	
max	1.7	1.5	1.9	1.6	0.9	0.3	0.5	0.2	0.5	1.1	0.5	0.8	

Note: * denotes missing data

Table C- 41

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Wettest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	1.0	0.7	0.8	0.0	-0.5	-0.1	0.0	-0.1	0.3	0.0	0.3	0.1	0.2
1962	1.0	1.0	1.3	-0.2	-0.5	-0.1	0.0	-0.1	0.5	0.2	0.7	0.1	0.3
1963	1.0	0.7	0.6	0.0	-0.4	0.0	-0.1	0.0	0.5	0.0	0.4	0.1	0.2
1964	1.0	0.8	1.0	-0.1	-0.5	-0.1	0.0	0.0	0.5	0.3	0.6	0.1	0.3
1965	1.0	0.7	0.7	-0.1	-0.5	-0.1	-0.1	-0.1	0.3	0.0	0.5	0.1	0.2
1966	1.0	0.6	0.5	-0.2	-0.5	0.0	-0.1	0.0	0.4	0.1	0.4	0.2	0.2
1967	1.0	0.8	1.0	-0.1	-0.5	-0.1	0.0	0.0	0.4	0.1	0.4	0.1	0.3
1968	0.9	0.8	1.0	-0.2	-0.5	0.0	-0.1	0.0	0.4	0.2	0.6	0.1	0.3
1969	1.0	0.8	0.9	-0.1	-0.5	-0.1	0.0	0.1	0.6	0.3	0.6	0.1	0.3
1970	0.9	1.0	1.3	0.0	-0.4	-0.1	-0.1	0.2	0.6	0.1	0.6	0.2	0.4
1971	1.0	0.6	0.6	0.1	-0.4	-0.1	0.1	0.0	0.4	0.0	0.7	0.1	0.3
1972	1.0	0.7	0.8	-0.1	-0.5	0.0	0.0	0.0	0.4	0.1	0.8	0.1	0.3
1973	1.0	0.9	1.0	-0.2	-0.5	0.0	-0.1	0.1	0.5	0.1	0.4	0.0	0.3
1974	0.9	0.6	0.6	0.0	-0.4	-0.1	0.0	0.0	0.5	0.3	0.5	0.1	0.3
1975	1.0	0.7	0.6	-0.1	-0.5	-0.1	-0.1	0.0	0.5	0.3	0.4	0.1	0.2
1976	1.0	0.8	0.9	-0.1	-0.5	0.0	-0.1	-0.1	0.4	0.1	0.4	0.2	0.3
1977	1.0	0.7	0.7	-0.2	-0.5	0.0	-0.1	-0.1	0.5	0.0	0.3	0.2	0.2
1978	1.0	0.7	0.8	0.1	-0.4	-0.1	-0.1	-0.1	0.5	0.1	0.3	0.1	0.3
1979	1.0	0.6	0.6	-0.1	-0.5	-0.1	-0.1	0.0	0.4	0.3	0.4	0.1	0.2
1980	1.0	0.8	1.0	-0.2	-0.5	0.0	0.0	0.1	0.6	0.3	0.7	0.1	0.3
1981	1.0	0.6	0.7	-0.1	-0.5	0.0	0.0	0.0	0.5	0.6	0.7	0.1	0.3
1982	1.0	0.8	0.9	-0.2	-0.5	0.0	-0.1	0.0	0.6	0.2	0.4	0.1	0.3
1983	1.0	0.8	1.0	0.0	-0.5	-0.1	0.0	0.0	0.6	0.3	0.5	0.1	0.3
1984	1.0	0.8	0.9	0.2	-0.3	0.0	-0.1	0.1	0.6	0.0	0.3	0.1	0.3
1985	1.0	0.7	0.7	-0.1	-0.5	0.0	0.0	0.0	0.3	0.0	0.3	0.1	0.2
1986	1.0	0.9	1.1	0.0	-0.5	0.0	0.0	-0.1	0.4	0.2	0.6	0.1	0.3
1987	1.0	0.9	1.1	0.0	-0.5	-0.1	-0.1	-0.1	0.4	0.0	0.4	0.1	0.2
1988	0.9	0.9	1.1	0.0	-0.4	0.0	0.0	-0.1	0.4	0.0	0.5	0.1	0.3
1989	1.0	0.7	0.8	-0.2	-0.4	0.0	0.0	-0.1	0.3	0.0	0.4	0.1	0.2
1990	1.0	0.8	0.8	-0.1	-0.4	0.0	-0.1	0.0	0.5	0.3	0.3	0.1	0.2
mean	1.0	0.8	0.9	-0.1	-0.5	0.0	0.0	0.0	0.5	0.2	0.5	0.1	0.3
min	0.9	0.6	0.5	-0.2	-0.5	-0.1	-0.1	-0.1	0.3	0.0	0.3	0.0	
max	1.0	1.0	1.3	0.2	-0.3	0.0	0.1	0.2	0.6	0.6	0.8	0.2	

Table C- 42

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Driest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.9	0.4	0.0	-0.4	-0.6	-0.2	0.0	-0.1	0.2	-0.2	0.0	-0.2	0.0
1962	0.9	0.4	-0.1	-0.4	-0.5	-0.2	-0.2	-0.1	0.3	-0.1	-0.1	-0.2	0.0
1963	0.9	0.5	0.1	-0.4	-0.7	-0.2	-0.3	0.0	0.3	-0.2	0.0	-0.3	0.0
1964	0.9	0.4	0.0	-0.4	-0.6	-0.2	-0.3	0.0	0.3	-0.1	0.0	-0.3	0.0
1965	0.9	0.5	0.0	-0.4	-0.6	-0.2	-0.3	-0.1	0.2	-0.2	-0.1	-0.1	0.0
1966	0.9	0.5	0.1	-0.4	-0.6	-0.2	-0.3	0.0	0.2	-0.2	0.0	-0.4	0.0
1967	0.9	0.4	0.0	-0.4	-0.7	-0.2	0.0	0.0	0.2	-0.2	0.0	-0.1	0.0
1968	0.9	0.4	0.0	-0.4	-0.7	-0.2	-0.3	0.0	0.2	-0.1	-0.1	-0.2	0.0
1969	0.9	0.4	0.0	-0.4	-0.7	-0.2	-0.3	0.0	0.4	-0.1	0.0	-0.2	0.0
1970	0.9	0.4	-0.1	-0.4	-0.7	-0.2	-0.1	0.1	0.4	-0.2	-0.1	-0.4	0.0
1971	0.9	0.5	0.1	-0.4	-0.6	-0.2	-0.2	0.0	0.3	-0.2	-0.1	-0.2	0.0
1972	0.9	0.4	0.0	-0.4	-0.6	-0.2	0.0	-0.1	0.3	-0.2	-0.2	-0.2	0.0
1973	0.9	0.4	0.0	-0.3	-0.7	-0.2	-0.3	0.0	0.3	-0.2	0.0	-0.1	0.0
1974	0.9	0.5	0.0	-0.4	-0.7	-0.2	-0.3	0.0	0.3	-0.1	0.0	-0.3	0.0
1975	0.9	0.5	0.0	-0.4	-0.7	-0.2	-0.2	0.0	0.3	-0.1	0.0	-0.1	0.0
1976	0.9	0.4	0.0	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	-0.2	0.0	-0.4	0.0
1977	0.9	0.4	0.0	-0.4	-0.6	-0.2	-0.3	-0.1	0.3	-0.2	0.0	-0.4	0.0
1978	0.9	0.4	0.0	-0.4	-0.6	-0.2	-0.3	-0.1	0.3	-0.2	0.0	-0.2	0.0
1979	0.9	0.5	0.0	-0.4	-0.6	-0.2	-0.2	0.0	0.3	-0.1	0.0	-0.2	0.0
1980	0.9	0.4	0.0	-0.4	-0.7	-0.2	-0.3	0.0	0.4	-0.1	-0.1	-0.2	0.0
1981	0.9	0.5	0.0	-0.4	-0.6	-0.2	-0.2	-0.1	0.3	0.0	0.0	-0.2	0.0
1982	0.8	0.4	0.0	-0.4	-0.7	-0.2	-0.3	-0.1	0.4	-0.1	0.0	-0.3	0.0
1983	0.9	0.4	0.0	-0.4	-0.6	-0.2	-0.2	0.0	0.3	-0.1	0.0	-0.2	0.0
1984	0.9	0.4	0.0	-0.5	-0.8	-0.2	-0.3	0.0	0.4	-0.2	0.0	-0.2	0.0
1985	0.9	0.5	0.0	-0.4	-0.7	-0.2	-0.3	-0.1	0.2	-0.2	0.0	-0.2	0.0
1986	0.9	0.4	-0.1	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	-0.1	-0.1	-0.1	0.0
1987	0.9	0.4	-0.1	-0.4	-0.6	-0.2	-0.2	-0.1	0.2	-0.2	0.0	-0.3	0.0
1988	0.9	0.4	-0.1	-0.4	-0.6	-0.2	-0.3	-0.1	0.2	-0.2	0.0	-0.2	0.0
1989	0.9	0.4	0.0	-0.4	-0.4	-0.2	-0.3	-0.1	0.2	-0.2	0.0	-0.2	0.0
1990	0.9	0.4	0.0	-0.4	-0.8	-0.2	-0.3	-0.1	0.3	-0.1	0.1	-0.2	0.0
mean	0.9	0.4	0.0	-0.4	-0.6	-0.2	-0.2	0.0	0.3	-0.2	0.0	-0.2	0.0
min	0.8	0.4	-0.1	-0.5	-0.8	-0.2	-0.3	-0.1	0.2	-0.2	-0.2	-0.4	
max	0.9	0.5	0.1	-0.3	-0.4	-0.2	0.0	0.1	0.4	0.0	0.1	-0.1	

Table C- 43

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Warmest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	1.2	0.7	0.0	-0.3	-0.5	-0.1	0.0	-0.1	0.2	-0.2	0.0	0.0	0.1
1962	1.2	0.7	0.0	-0.4	-0.5	-0.1	-0.3	-0.1	0.4	-0.1	0.0	-0.1	0.0
1963	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.3	0.0	0.4	-0.2	0.0	-0.1	0.1
1964	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.4	-0.1	0.0	-0.1	0.1
1965	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.2	-0.2	0.0	0.0	0.0
1966	1.2	0.7	0.0	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	-0.2	0.0	-0.1	0.1
1967	1.2	0.7	0.0	-0.3	-0.4	-0.1	0.0	0.0	0.3	-0.2	0.0	0.0	0.1
1968	1.2	0.7	0.0	-0.4	-0.4	0.0	-0.2	0.0	0.3	-0.2	0.0	-0.1	0.1
1969	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.3	0.0	0.5	-0.1	0.0	-0.1	0.1
1970	1.1	0.7	0.0	-0.3	-0.4	-0.1	-0.1	0.1	0.5	-0.2	0.0	-0.1	0.1
1971	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.3	-0.2	0.0	-0.1	0.1
1972	1.2	0.7	0.0	-0.3	-0.4	0.0	0.0	-0.1	0.3	-0.2	0.0	-0.1	0.1
1973	1.2	0.7	0.0	-0.4	-0.4	0.0	-0.2	0.0	0.4	-0.2	0.0	0.0	0.1
1974	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.3	-0.1	0.4	-0.1	0.1	-0.1	0.1
1975	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.2	-0.1	0.4	-0.1	0.1	0.0	0.1
1976	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.3	-0.2	0.0	-0.1	0.0
1977	1.2	0.7	0.0	-0.4	-0.5	-0.1	-0.3	-0.1	0.4	-0.2	0.0	-0.1	0.1
1978	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.2	0.4	-0.2	0.0	-0.1	0.1
1979	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.2	-0.1	0.4	-0.1	0.1	-0.1	0.1
1980	1.2	0.7	0.0	-0.4	-0.4	0.0	-0.3	0.0	0.5	-0.1	0.0	-0.1	0.1
1981	1.2	0.7	0.0	-0.4	-0.5	0.0	-0.3	-0.1	0.4	-0.1	0.1	-0.1	0.1
1982	1.2	0.7	0.0	-0.4	-0.4	0.0	-0.2	-0.1	0.5	-0.1	0.1	-0.1	0.1
1983	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.5	-0.1	0.1	-0.1	0.1
1984	1.2	0.7	0.0	-0.3	-0.4	0.0	-0.2	0.0	0.5	-0.2	0.0	-0.1	0.1
1985	1.2	0.7	0.0	-0.3	-0.4	0.0	-0.3	-0.1	0.3	-0.2	0.0	-0.1	0.1
1986	1.2	0.7	0.0	-0.3	-0.5	0.0	-0.3	-0.1	0.3	-0.2	0.0	0.0	0.1
1987	1.2	0.7	0.0	-0.3	-0.5	-0.1	-0.2	-0.1	0.3	-0.2	0.0	-0.1	0.1
1988	1.2	0.7	0.0	-0.3	-0.5	0.0	-0.2	-0.1	0.3	-0.2	0.0	-0.1	0.1
1989	1.2	0.7	0.0	-0.4	-0.4	-0.1	-0.3	-0.1	0.3	-0.2	0.0	-0.1	0.1
1990	1.2	0.7	0.0	-0.3	-0.4	0.0	-0.2	-0.1	0.4	-0.1	0.1	-0.1	0.1
mean	1.2	0.7	0.0	-0.3	-0.4	-0.1	-0.2	-0.1	0.4	-0.2	0.0	-0.1	0.1
min	1.1	0.7	0.0	-0.4	-0.5	-0.1	-0.3	-0.2	0.2	-0.2	0.0	-0.1	
max	1.2	0.7	0.0	-0.3	-0.4	0.0	0.0	0.1	0.5	-0.1	0.1	0.0	

Table C- 44

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Coldest Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.5	0.4	-0.4	-0.4	-0.5	-0.1	0.0	-0.1	0.1	0.0	0.1	0.0	-0.1
1962	0.5	0.3	-0.5	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.1	0.2	0.0	-0.1
1963	0.5	0.4	-0.2	-0.3	-0.5	-0.1	-0.2	-0.1	0.2	0.0	0.1	-0.1	0.0
1964	0.5	0.3	-0.3	-0.3	-0.5	-0.1	-0.3	-0.1	0.2	0.2	0.2	-0.1	0.0
1965	0.5	0.4	-0.3	-0.3	-0.5	-0.1	-0.2	-0.1	0.1	0.0	0.1	0.0	-0.1
1966	0.5	0.4	-0.2	-0.3	-0.5	-0.2	-0.3	-0.1	0.1	0.0	0.1	-0.1	0.0
1967	0.5	0.3	-0.3	-0.3	-0.5	-0.1	0.0	0.0	0.2	0.0	0.1	0.0	0.0
1968	0.5	0.3	-0.4	-0.3	-0.5	-0.2	-0.3	-0.1	0.1	0.1	0.2	0.0	-0.1
1969	0.5	0.4	-0.4	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	0.2	0.2	0.0	0.0
1970	0.5	0.3	-0.4	-0.3	-0.5	-0.1	-0.1	-0.1	0.2	0.1	0.2	-0.1	0.0
1971	0.5	0.4	-0.2	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	0.0	0.2	0.0	0.0
1972	0.5	0.4	-0.3	-0.3	-0.5	-0.2	0.0	-0.1	0.2	0.1	0.2	0.0	0.0
1973	0.5	0.3	-0.3	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.1	0.1	0.0	0.0
1974	0.5	0.4	-0.3	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	0.2	0.2	-0.1	0.0
1975	0.5	0.4	-0.2	-0.3	-0.5	-0.1	-0.2	-0.1	0.2	0.2	0.2	0.0	0.0
1976	0.5	0.4	-0.3	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.1	0.1	-0.1	-0.1
1977	0.5	0.4	-0.2	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.0	0.1	-0.1	0.0
1978	0.5	0.4	-0.4	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	0.0	0.1	0.0	-0.1
1979	0.5	0.4	-0.3	-0.3	-0.5	-0.1	-0.2	-0.1	0.2	0.2	0.2	0.0	0.0
1980	0.5	0.3	-0.4	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.2	0.2	0.0	0.0
1981	0.5	0.4	-0.3	-0.3	-0.5	-0.2	-0.3	-0.1	0.2	0.4	0.3	0.0	0.0
1982	0.5	0.3	-0.3	-0.3	-0.5	-0.2	-0.3	-0.1	0.3	0.1	0.1	0.0	0.0
1983	0.5	0.4	-0.4	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	0.2	0.2	0.0	0.0
1984	0.5	0.4	-0.4	-0.4	-0.5	-0.2	-0.2	-0.1	0.2	0.0	0.1	0.0	-0.1
1985	0.5	0.4	-0.3	-0.3	-0.5	-0.1	-0.3	-0.1	0.1	0.0	0.1	0.0	-0.1
1986	0.5	0.3	-0.5	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	0.1	0.2	0.0	-0.1
1987	0.5	0.3	-0.4	-0.4	-0.5	-0.1	-0.2	-0.1	0.2	0.0	0.1	-0.1	-0.1
1988	0.5	0.3	-0.5	-0.4	-0.5	-0.2	-0.3	-0.1	0.2	0.0	0.1	0.0	-0.1
1989	0.5	0.4	-0.3	-0.3	-0.4	-0.2	-0.3	-0.1	0.2	0.0	0.1	0.0	0.0
1990	0.5	0.4	-0.2	-0.3	-0.5	-0.2	-0.2	-0.1	0.2	0.2	0.2	0.0	0.0
mean	0.5	0.4	-0.3	-0.3	-0.5	-0.2	-0.2	-0.1	0.2	0.1	0.2	0.0	0.0
min	0.5	0.3	-0.5	-0.4	-0.5	-0.2	-0.3	-0.1	0.1	0.0	0.1	-0.1	
max	0.5	0.4	-0.2	-0.3	-0.4	-0.1	0.0	0.0	0.3	0.4	0.3	0.0	

Table C- 45

Waterford River at Kilbride (Pierre's Brook & Petty Harbour Systems) - [Middle Flow - Synthetic Flow] (m^3/s)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.8	0.5	-0.2	-0.4	-0.5	-0.1	0.0	-0.1	0.2	-0.1	0.1	-0.1	0.0
1962	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.0	-0.1	0.0
1963	0.8	0.5	0.0	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.0	-0.1	0.0
1964	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	0.0	0.1	-0.1	0.0
1965	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0
1966	0.8	0.5	-0.1	-0.3	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.1	-0.2	0.0
1967	0.8	0.5	-0.1	-0.4	-0.5	-0.1	0.0	0.0	0.2	-0.1	0.1	-0.1	0.0
1968	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.1	-0.1	0.0
1969	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	0.0	0.3	0.0	0.1	-0.1	0.0
1970	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.1	0.0	0.4	-0.1	0.0	-0.2	0.0
1971	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.0	-0.1	0.0
1972	0.8	0.5	-0.1	-0.4	-0.5	-0.1	0.0	-0.1	0.2	-0.1	0.0	-0.1	0.0
1973	0.8	0.5	-0.1	-0.3	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.1	0.0	0.0
1974	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	0.0	0.1	-0.1	0.0
1975	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.2	-0.1	0.3	0.0	0.1	-0.1	0.0
1976	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.1	-0.2	0.0
1977	0.8	0.5	0.0	-0.3	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.1	-0.2	0.0
1978	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	-0.1	0.1	-0.1	0.0
1979	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.2	-0.1	0.3	0.0	0.1	-0.1	0.0
1980	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	0.0	0.4	0.0	0.1	-0.1	0.0
1981	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	0.1	0.1	-0.1	0.0
1982	0.8	0.5	-0.1	-0.3	-0.5	-0.1	-0.3	-0.1	0.4	0.0	0.1	-0.1	0.0
1983	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.3	0.0	0.1	-0.1	0.0
1984	0.8	0.5	-0.2	-0.4	-0.6	-0.1	-0.3	0.0	0.3	-0.1	0.1	-0.1	0.0
1985	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.1	-0.1	0.0
1986	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0
1987	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.2	-0.1	0.2	-0.1	0.0	-0.2	0.0
1988	0.8	0.5	-0.2	-0.4	-0.5	-0.1	-0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0
1989	0.8	0.5	-0.1	-0.3	-0.4	-0.1	-0.3	-0.1	0.2	-0.1	0.0	-0.1	0.0
1990	0.8	0.5	-0.1	-0.3	-0.6	-0.1	-0.3	-0.1	0.3	0.0	0.1	-0.1	0.0
mean	0.8	0.5	-0.1	-0.4	-0.5	-0.1	-0.2	-0.1	0.3	-0.1	0.1	-0.1	0.0
min	0.8	0.5	-0.2	-0.4	-0.6	-0.1	-0.3	-0.1	0.2	-0.1	0.0	-0.2	
max	0.8	0.5	0.0	-0.3	-0.4	-0.1	0.0	0.0	0.4	0.1	0.1	0.0	

Appendix D – 30-year Energy Generation Tables

Table D - 1
Rose Blanche Brook - Period Average Energy (GWH), Baseline

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.0	0.4	1.2	2.1	4.0	3.4	0.5	0.5	0.6	3.0	3.4	2.4	21.6
1962	0.3	1.0	2.1	3.5	4.0	3.3	3.1	1.2	1.1	2.4	3.3	2.0	27.2
1963	2.4	1.0	0.1	2.0	4.0	2.1	0.6	1.3	2.2	1.1	2.9	1.5	21.2
1964	1.5	2.3	1.3	2.2	4.0	3.8	1.9	1.5	1.9	2.4	1.7	1.4	26.0
1965	2.0	1.5	2.1	1.9	3.5	2.8	1.3	1.6	1.1	1.8	2.4	0.9	23.0
1966	1.5	1.4	1.7	2.9	3.1	3.3	1.4	1.4	1.7	3.7	3.5	2.7	28.4
1967	1.3	1.5	0.5	1.5	4.0	3.2	0.9	1.2	2.4	2.5	3.8	2.5	25.3
1968	2.6	1.0	1.6	3.0	3.5	3.1	1.0	1.4	1.2	1.8	2.4	3.1	25.7
1969	1.2	3.1	1.5	2.6	3.9	2.6	1.4	1.0	1.2	2.3	3.4	3.9	28.2
1970	1.0	1.7	1.5	1.9	4.0	2.1	0.8	2.4	1.2	2.4	1.8	2.2	22.8
1971	1.0	1.5	1.6	3.8	3.9	1.0	1.1	1.7	1.9	2.3	3.0	1.6	24.4
1972	0.8	0.6	1.2	1.6	3.9	3.7	0.7	0.8	1.4	3.4	2.8	1.4	22.4
1973	1.2	2.2	1.3	1.6	3.8	2.9	2.1	2.0	1.2	1.9	2.2	2.9	25.3
1974	0.0	1.2	1.5	3.5	4.0	2.6	1.9	1.0	1.1	3.2	2.1	2.3	24.4
1975	1.2	0.5	1.5	1.9	4.0	1.6	0.3	0.8	1.3	2.0	2.7	2.9	20.5
1976	1.3	1.5	0.5	2.9	3.8	0.8	0.3	0.6	1.5	3.0	3.5	3.0	22.6
1977	1.5	1.0	1.6	2.1	3.9	3.6	1.9	1.3	2.5	3.3	2.6	1.6	26.9
1978	2.0	1.2	0.4	1.8	4.0	3.0	1.5	0.3	1.2	2.4	1.6	1.3	20.6
1979	1.7	1.2	2.0	3.0	4.0	1.1	2.2	1.8	2.0	3.4	3.2	2.6	28.2
1980	1.8	1.2	1.0	2.4	3.8	3.0	2.0	1.7	2.8	3.4	2.7	1.9	27.6
1981	0.9	1.6	1.5	3.5	4.0	1.8	1.7	1.0	1.2	3.0	3.2	2.8	26.2
1982	1.4	1.7	0.9	2.8	4.0	3.4	2.1	1.0	1.6	2.3	2.6	2.4	26.1
1983	1.2	1.6	1.9	3.6	2.8	1.5	2.0	2.4	1.7	1.4	3.3	2.6	26.0
1984	1.1	1.8	0.9	3.2	3.1	1.6	1.1	1.9	2.0	1.7	2.4	2.3	23.0
1985	1.2	1.3	0.7	1.5	4.0	3.0	1.2	0.9	0.9	1.8	2.5	1.4	20.3
1986	1.4	1.3	0.2	3.2	2.7	2.3	1.2	0.9	1.3	2.1	2.3	1.0	19.9
1987	0.7	1.3	0.9	3.7	3.2	2.2	0.3	1.5	1.5	3.1	3.2	1.7	23.2
1988	1.2	1.7	1.3	3.8	4.0	1.4	1.2	0.9	1.7	3.2	3.5	0.8	24.8
1989	1.0	1.3	0.2	2.4	4.0	2.0	0.1	2.1	2.2	3.1	3.3	1.9	23.6
1990	1.2	0.6	0.3	3.3	4.0	2.6	0.6	1.4	1.7	3.3	3.4	3.5	25.8
mean	1.3	1.4	1.2	2.6	3.8	2.5	1.3	1.3	1.6	2.5	2.8	2.2	24.4
min	0.0	0.4	0.1	1.5	2.7	0.8	0.1	0.3	0.6	1.1	1.6	0.8	19.9
max	2.6	3.1	2.1	3.8	4.0	3.8	3.1	2.4	2.8	3.7	3.8	3.9	28.4

Table D - 2
Rose Blanche Brook - Period Average Energy (GWH) under Wettest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.81	1.03	1.61	2.48	3.80	2.49	0.44	0.75	0.58	3.35	3.45	2.90	23.68
1962	1.17	1.58	2.55	3.71	3.31	3.00	3.12	1.55	1.12	2.68	3.56	2.19	29.54
1963	2.90	1.52	0.53	2.76	3.97	1.34	0.63	1.64	2.40	1.22	3.19	2.39	24.49
1964	2.10	3.20	1.82	2.30	3.24	3.31	1.93	1.94	1.98	2.71	2.12	1.92	28.56
1965	2.80	1.85	2.30	2.83	3.49	2.00	1.39	1.93	1.07	2.08	2.66	1.60	25.99
1966	2.09	2.14	1.91	3.78	1.96	2.38	1.52	1.69	1.92	3.88	3.83	3.31	30.40
1967	2.15	2.07	1.01	2.14	3.98	2.96	0.89	1.51	2.52	2.81	3.85	2.86	28.74
1968	3.15	1.85	2.07	3.26	2.68	2.94	0.91	1.61	1.13	1.95	2.78	3.32	27.65
1969	1.36	3.45	1.67	3.36	3.97	1.90	1.57	1.27	1.29	2.53	3.56	3.98	29.90
1970	1.85	2.14	1.77	2.60	3.97	1.43	0.81	2.54	1.32	2.56	1.94	2.57	25.49
1971	1.78	2.11	1.91	3.83	2.33	0.35	1.25	2.10	2.05	2.47	3.31	2.19	25.68
1972	1.64	1.27	1.63	2.57	3.97	3.51	0.67	1.09	1.45	3.64	3.10	2.01	26.53
1973	2.04	2.98	1.77	2.21	3.97	2.33	2.31	2.48	1.20	2.09	2.73	3.26	29.37
1974	0.93	1.69	2.17	3.71	3.98	2.22	2.18	1.38	1.11	3.51	2.46	2.63	27.97
1975	1.95	0.70	1.62	2.84	3.98	0.81	0.26	1.05	1.30	2.23	3.06	3.01	22.80
1976	1.88	2.25	0.71	3.31	3.37	0.09	0.25	0.80	1.64	3.08	3.58	3.51	24.48
1977	2.45	1.57	1.82	2.85	3.98	3.38	2.01	1.67	2.80	3.61	2.78	1.97	30.88
1978	2.46	1.69	0.83	2.03	3.97	2.36	1.57	0.57	1.31	2.58	2.07	1.95	23.38
1979	2.15	1.95	2.42	3.20	3.98	0.29	2.31	2.22	2.23	3.44	3.69	2.91	30.78
1980	2.51	1.67	1.41	2.51	3.21	2.50	2.24	2.12	2.90	3.62	3.05	2.58	30.31
1981	1.88	2.15	1.89	3.77	3.64	1.06	1.84	1.37	1.23	3.18	3.41	3.11	28.52
1982	2.16	2.40	1.38	3.21	3.98	2.93	2.14	1.26	1.73	2.55	2.94	3.24	29.91
1983	1.59	1.79	2.36	3.66	1.35	0.84	2.19	2.72	1.82	1.57	3.41	3.23	26.53
1984	1.90	2.16	1.34	3.22	1.72	1.04	1.13	2.31	2.17	1.90	2.88	3.04	24.80
1985	1.98	1.88	1.18	2.22	3.98	2.84	1.24	1.18	0.91	2.03	3.10	2.03	24.57
1986	2.01	1.95	0.59	3.35	1.16	1.75	1.23	1.10	1.54	2.33	2.67	1.72	21.37
1987	1.50	1.82	1.30	3.76	2.04	1.59	0.23	1.79	1.58	3.20	3.73	2.19	24.73
1988	2.03	2.34	1.60	3.86	3.33	0.50	1.28	1.23	1.83	3.41	3.59	1.51	26.50
1989	1.76	1.57	1.27	3.36	3.74	1.06	0.00	2.44	2.26	3.30	3.42	2.61	26.78
1990	1.64	1.67	0.67	3.50	3.98	2.25	0.67	1.51	1.81	3.48	3.71	3.79	28.68
mean	1.95	1.95	1.57	3.07	3.33	1.91	1.34	1.63	1.67	2.77	3.12	2.65	26.97
min	0.81	0.70	0.53	2.03	1.16	0.09	0.00	0.57	0.58	1.22	1.94	1.51	21.4
max	3.15	3.45	2.55	3.86	3.98	3.51	3.12	2.72	2.90	3.88	3.85	3.98	30.9

Table D - 3
Rose Blanche Brook - Period Average Energy (GWH) under Driest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.74	0.97	1.58	2.28	3.98	2.22	0.13	0.70	0.56	3.12	3.38	2.18	21.83
1962	1.13	1.52	2.49	3.55	3.97	2.59	3.04	1.37	1.06	2.51	3.36	1.87	28.45
1963	2.81	1.50	0.56	2.26	3.97	0.72	0.25	1.58	2.23	1.11	2.96	1.24	21.19
1964	2.00	2.91	1.71	2.23	3.96	3.05	1.49	1.77	1.90	2.48	1.82	1.33	26.64
1965	2.46	1.70	2.22	2.25	3.50	1.59	0.95	1.88	1.02	1.92	2.44	0.76	22.71
1966	2.01	2.12	1.90	3.39	2.88	1.78	1.08	1.63	1.76	3.77	3.65	2.43	28.39
1967	1.95	1.96	0.92	1.72	3.97	2.32	0.49	1.44	2.40	2.58	3.83	2.39	25.97
1968	2.80	1.76	2.01	3.06	3.28	2.69	0.30	1.58	1.15	1.82	2.45	2.91	25.80
1969	1.32	3.38	1.63	3.11	3.93	1.34	1.09	1.19	1.22	2.37	3.45	3.80	27.82
1970	1.76	2.11	1.74	2.24	3.98	0.76	0.43	2.52	1.22	2.42	1.81	1.90	22.89
1971	1.69	1.99	1.85	3.82	3.35	0.00	0.80	2.01	1.89	2.33	3.00	1.33	24.07
1972	1.54	1.15	1.59	1.90	3.95	3.27	0.31	1.04	1.38	3.47	2.87	0.96	23.42
1973	1.89	2.70	1.65	1.83	3.95	1.61	1.81	2.37	1.15	1.95	2.29	2.76	25.96
1974	0.81	1.60	1.94	3.53	3.99	1.66	1.64	1.29	1.05	3.29	2.16	2.14	25.10
1975	1.82	0.68	1.61	2.39	3.99	0.35	0.00	0.99	1.24	2.03	2.70	2.67	20.46
1976	1.74	2.20	0.67	3.03	3.65	0.00	0.00	0.76	1.54	3.05	3.47	2.66	22.78
1977	2.02	1.57	1.82	2.42	3.94	3.01	1.52	1.52	2.60	3.39	2.63	1.52	27.95
1978	2.28	1.75	0.87	1.82	3.98	1.71	1.13	0.51	1.19	2.44	1.72	1.06	20.46
1979	2.08	1.91	2.37	3.09	3.98	0.19	2.05	2.00	2.08	3.41	3.33	2.32	28.81
1980	2.36	1.66	1.42	2.41	3.63	1.75	1.73	2.03	2.84	3.49	2.81	1.66	27.79
1981	1.62	2.16	1.91	3.68	3.97	0.27	1.37	1.26	1.16	3.07	3.20	2.63	26.29
1982	2.02	2.17	1.30	2.81	3.99	2.42	1.58	1.18	1.62	2.41	2.68	2.08	26.27
1983	1.46	1.77	2.28	3.64	2.34	0.17	1.72	2.63	1.72	1.44	3.33	2.22	24.72
1984	1.75	2.12	1.30	3.19	2.67	0.19	0.70	2.23	2.05	1.75	2.45	1.95	22.35
1985	1.82	1.79	1.11	1.83	3.95	2.61	0.89	1.12	0.84	1.87	2.56	1.08	21.45
1986	1.73	1.86	0.56	3.24	2.44	0.91	0.81	1.05	1.42	2.15	2.34	0.92	19.43
1987	1.40	1.75	1.28	3.75	3.09	0.82	0.00	1.73	1.47	3.13	3.34	1.40	23.15
1988	1.94	2.17	1.54	3.85	3.97	0.16	0.88	1.17	1.68	3.26	3.52	0.71	24.84
1989	1.64	1.50	1.06	2.77	3.96	0.51	0.00	2.37	2.19	3.18	3.34	1.47	23.99
1990	1.56	1.47	0.63	3.40	3.98	1.53	0.27	1.48	1.75	3.35	3.49	3.33	26.23
mean	1.80	1.86	1.52	2.82	3.67	1.41	0.95	1.55	1.58	2.62	2.88	1.92	24.57
min	0.74	0.68	0.56	1.72	2.34	0.00	0.00	0.51	0.56	1.11	1.72	0.71	19.4
max	2.81	3.38	2.49	3.85	3.99	3.27	3.04	2.63	2.84	3.77	3.83	3.80	28.8

Table D - 4
Rose Blanche Brook - Period Average Energy (GWH) under Warmest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.97	1.21	1.60	2.36	3.98	2.11	0.18	0.72	0.59	3.07	3.39	2.55	22.74
1962	1.33	1.65	2.63	3.63	3.97	2.62	3.03	1.35	1.13	2.46	3.38	2.01	29.21
1963	2.97	1.72	0.58	2.48	3.97	0.55	0.29	1.59	2.37	1.13	3.01	1.66	22.33
1964	2.17	3.23	1.74	2.26	3.95	3.04	1.50	1.78	1.97	2.50	1.83	1.53	27.50
1965	2.88	1.81	2.24	2.54	3.53	1.44	0.95	1.89	1.09	1.88	2.48	1.05	23.77
1966	2.19	2.26	1.91	3.57	2.89	1.71	1.10	1.64	1.89	3.75	3.69	2.75	29.34
1967	2.22	2.15	0.96	1.90	3.98	2.17	0.53	1.47	2.49	2.58	3.83	2.58	26.85
1968	3.20	2.12	2.02	3.14	3.27	2.77	0.42	1.59	1.16	1.78	2.48	3.13	27.07
1969	1.39	3.48	1.64	3.21	3.97	1.20	1.06	1.21	1.29	2.33	3.47	3.94	28.19
1970	1.99	2.21	1.76	2.40	3.98	0.66	0.47	2.53	1.30	2.39	1.83	2.24	23.74
1971	1.93	2.24	1.86	3.83	3.48	0.00	0.80	2.04	2.02	2.32	3.04	1.69	25.25
1972	1.78	1.39	1.60	2.15	3.97	3.26	0.36	1.06	1.46	3.42	2.90	1.47	24.81
1973	2.18	2.98	1.69	1.98	3.97	1.47	1.79	2.39	1.21	1.92	2.34	2.96	26.86
1974	1.07	1.74	2.09	3.62	3.99	1.37	1.58	1.30	1.12	3.23	2.18	2.37	25.65
1975	2.07	0.96	1.61	2.56	3.99	0.34	0.00	1.02	1.30	2.02	2.75	2.84	21.46
1976	1.91	2.33	0.69	3.15	3.69	0.00	0.00	0.78	1.63	3.04	3.49	3.02	23.73
1977	2.44	1.78	1.83	2.61	3.96	3.05	1.52	1.53	2.76	3.39	2.65	1.68	29.20
1978	2.45	1.96	0.88	1.91	3.98	1.69	1.15	0.53	1.31	2.41	1.75	1.41	21.41
1979	2.23	2.05	2.39	3.13	3.98	0.22	2.01	1.99	2.19	3.40	3.31	2.64	29.55
1980	2.60	1.89	1.43	2.45	3.71	1.69	1.72	2.04	2.89	3.52	2.82	2.01	28.78
1981	1.91	2.38	1.93	3.72	3.97	0.22	1.35	1.28	1.23	3.05	3.21	2.82	27.06
1982	2.29	2.44	1.32	2.98	3.99	2.53	1.63	1.20	1.72	2.38	2.72	2.51	27.72
1983	1.54	1.83	2.30	3.65	2.49	0.10	1.69	2.64	1.81	1.41	3.35	2.73	25.52
1984	2.04	2.22	1.33	3.20	2.76	0.14	0.73	2.25	2.15	1.73	2.51	2.37	23.43
1985	2.10	2.02	1.13	2.10	3.96	2.65	0.97	1.14	0.91	1.83	2.63	1.54	22.97
1986	1.88	2.12	0.59	3.29	2.32	0.92	0.85	1.06	1.52	2.11	2.39	1.20	20.25
1987	1.64	1.98	1.30	3.75	3.15	0.78	0.03	1.75	1.57	3.12	3.39	1.84	24.29
1988	2.12	2.45	1.59	3.86	3.98	0.23	0.92	1.19	1.81	3.23	3.53	1.03	25.92
1989	1.90	1.60	1.27	3.06	3.96	0.41	0.00	2.40	2.25	3.17	3.35	1.95	25.29
1990	1.70	1.79	0.65	3.46	3.98	1.34	0.28	1.49	1.81	3.32	3.50	3.54	26.84
mean	2.04	2.07	1.55	2.93	3.69	1.36	0.96	1.56	1.66	2.60	2.91	2.23	25.56
min	0.97	0.96	0.58	1.90	2.32	0.00	0.00	0.53	0.59	1.13	1.75	1.03	20.25
max	3.20	3.48	2.63	3.86	3.99	3.26	3.03	2.64	2.89	3.75	3.83	3.94	29.55

Table D - 5
Rose Blanche Brook - Period Average Energy (GWH) under Coldest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.28	0.90	1.35	2.34	3.98	2.07	0.25	0.62	0.56	3.23	3.40	2.49	21.47
1962	0.75	1.48	2.27	3.60	3.97	2.51	3.02	1.19	1.06	2.58	3.41	1.99	27.82
1963	2.64	1.44	0.23	2.43	3.97	0.62	0.38	1.40	2.21	1.12	3.03	1.60	21.07
1964	1.80	2.74	1.49	2.24	3.94	2.80	1.49	1.54	1.89	2.55	1.88	1.51	25.88
1965	2.32	1.67	2.14	2.45	3.51	1.51	0.99	1.67	0.99	2.00	2.51	0.97	22.74
1966	1.79	1.97	1.80	3.51	2.83	1.62	1.13	1.45	1.73	3.82	3.73	2.70	28.08
1967	1.68	1.90	0.67	1.84	3.98	2.22	0.60	1.29	2.39	2.66	3.84	2.56	25.61
1968	2.85	1.59	1.75	3.10	3.22	2.57	0.37	1.45	1.12	1.88	2.54	3.13	25.58
1969	1.26	3.35	1.56	3.00	3.96	1.24	1.09	1.04	1.21	2.45	3.50	3.93	27.58
1970	1.41	2.08	1.58	2.26	3.98	0.63	0.51	2.40	1.11	2.48	1.84	2.21	22.49
1971	1.35	1.92	1.69	3.82	3.33	0.00	0.85	1.76	1.87	2.38	3.09	1.63	23.69
1972	1.22	1.08	1.35	2.04	3.96	3.20	0.40	0.91	1.37	3.60	2.94	1.41	23.47
1973	1.59	2.63	1.43	1.94	3.96	1.47	1.80	2.09	1.12	2.00	2.38	2.95	25.34
1974	0.40	1.57	1.61	3.57	3.99	1.59	1.62	1.13	1.04	3.41	2.22	2.34	24.49
1975	1.55	0.61	1.55	2.29	3.99	0.33	0.02	0.87	1.24	2.10	2.79	2.84	20.18
1976	1.55	2.04	0.55	3.11	3.65	0.00	0.05	0.67	1.50	3.07	3.50	3.03	22.72
1977	1.88	1.50	1.68	2.44	3.95	2.93	1.50	1.34	2.59	3.48	2.67	1.68	27.66
1978	2.19	1.69	0.58	1.87	3.98	1.55	1.16	0.44	1.21	2.51	1.83	1.34	20.35
1979	1.89	1.84	2.13	3.12	3.98	0.20	2.00	1.80	2.01	3.43	3.46	2.62	28.46
1980	2.10	1.60	1.20	2.44	3.64	1.60	1.72	1.80	2.83	3.52	2.93	1.99	27.36
1981	1.35	2.09	1.71	3.70	3.96	0.12	1.36	1.09	1.16	3.12	3.26	2.82	25.73
1982	1.74	2.11	1.08	2.90	3.99	2.27	1.60	1.04	1.62	2.48	2.78	2.46	26.05
1983	1.35	1.75	2.02	3.64	2.33	0.03	1.68	2.41	1.68	1.48	3.36	2.70	24.43
1984	1.46	2.09	1.08	3.20	2.62	0.08	0.78	1.99	2.04	1.80	2.56	2.31	22.01
1985	1.56	1.73	0.85	2.00	3.95	2.56	0.96	0.99	0.84	1.94	2.68	1.47	21.54
1986	1.58	1.78	0.37	3.27	2.27	0.79	0.88	0.94	1.34	2.23	2.43	1.13	19.00
1987	1.08	1.69	1.09	3.75	3.02	0.69	0.05	1.54	1.45	3.17	3.45	1.77	22.74
1988	1.62	2.10	1.40	3.85	3.97	0.13	0.94	1.02	1.67	3.33	3.54	0.93	24.50
1989	1.34	1.48	0.77	2.97	3.95	0.37	0.00	2.13	2.18	3.24	3.37	1.91	23.70
1990	1.43	1.25	0.43	3.43	3.98	1.41	0.32	1.40	1.73	3.41	3.59	3.59	25.96
mean	1.57	1.79	1.31	2.87	3.66	1.30	0.98	1.38	1.56	2.68	2.95	2.20	24.26
min	0.28	0.61	0.23	1.84	2.27	0.00	0.00	0.44	0.56	1.12	1.83	0.93	19.00
max	2.85	3.35	2.27	3.85	3.99	3.20	3.02	2.41	2.83	3.82	3.84	3.93	28.46

Table D - 6
Rose Blanche Brook - Period Average Energy (GWH) under Middle Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	0.68	1.03	1.51	2.33	3.98	2.13	0.18	0.68	0.57	3.14	3.39	2.41	22.03
1962	1.08	1.55	2.46	3.59	3.97	2.58	3.03	1.30	1.08	2.52	3.38	1.96	28.49
1963	2.81	1.55	0.51	2.39	3.97	0.63	0.30	1.52	2.27	1.12	3.00	1.50	21.56
1964	2.00	2.97	1.65	2.24	3.95	2.98	1.48	1.69	1.92	2.51	1.84	1.46	26.69
1965	2.59	1.73	2.20	2.41	3.52	1.51	0.96	1.82	1.03	1.94	2.48	0.91	23.09
1966	2.00	2.16	1.87	3.49	2.86	1.70	1.10	1.59	1.78	3.78	3.70	2.62	28.64
1967	1.94	2.01	0.85	1.82	3.98	2.24	0.54	1.39	2.43	2.61	3.83	2.51	26.13
1968	2.95	1.82	1.92	3.10	3.25	2.68	0.36	1.54	1.14	1.82	2.49	3.06	26.12
1969	1.32	3.41	1.61	3.10	3.95	1.25	1.08	1.14	1.24	2.38	3.47	3.91	27.86
1970	1.72	2.13	1.70	2.30	3.98	0.68	0.47	2.51	1.18	2.43	1.83	2.15	23.07
1971	1.66	2.05	1.80	3.82	3.37	0.00	0.81	1.93	1.93	2.34	3.04	1.56	24.32
1972	1.51	1.21	1.53	2.02	3.96	3.24	0.35	1.00	1.40	3.49	2.90	1.28	23.89
1973	1.89	2.77	1.59	1.91	3.96	1.52	1.80	2.27	1.15	1.96	2.33	2.89	26.03
1974	0.78	1.64	1.87	3.58	3.99	1.54	1.61	1.24	1.07	3.32	2.18	2.28	25.09
1975	1.81	0.75	1.59	2.41	3.99	0.34	0.01	0.96	1.26	2.06	2.75	2.78	20.69
1976	1.73	2.23	0.63	3.10	3.66	0.00	0.01	0.73	1.56	3.05	3.49	2.92	23.11
1977	2.13	1.62	1.77	2.49	3.95	3.00	1.51	1.46	2.65	3.42	2.65	1.63	28.27
1978	2.31	1.80	0.77	1.86	3.98	1.65	1.14	0.49	1.24	2.45	1.77	1.27	20.73
1979	2.07	1.95	2.30	3.11	3.98	0.20	2.02	1.93	2.08	3.41	3.37	2.53	28.95
1980	2.35	1.71	1.35	2.43	3.66	1.67	1.72	1.95	2.86	3.52	2.85	1.88	27.95
1981	1.63	2.21	1.84	3.70	3.97	0.19	1.35	1.21	1.18	3.08	3.22	2.75	26.33
1982	2.02	2.24	1.24	2.90	3.99	2.41	1.60	1.13	1.65	2.42	2.72	2.34	26.65
1983	1.45	1.78	2.19	3.64	2.37	0.10	1.69	2.57	1.73	1.45	3.35	2.54	24.86
1984	1.75	2.14	1.24	3.20	2.68	0.14	0.73	2.15	2.08	1.76	2.51	2.21	22.57
1985	1.83	1.85	1.03	1.98	3.95	2.61	0.94	1.08	0.87	1.88	2.63	1.35	21.98
1986	1.74	1.92	0.50	3.26	2.35	0.87	0.85	1.00	1.42	2.16	2.39	1.07	19.52
1987	1.38	1.81	1.22	3.75	3.08	0.76	0.02	1.67	1.50	3.14	3.40	1.68	23.39
1988	1.92	2.22	1.49	3.85	3.97	0.16	0.91	1.13	1.72	3.27	3.53	0.87	25.06
1989	1.62	1.53	1.02	2.93	3.96	0.43	0.00	2.30	2.20	3.20	3.35	1.78	24.31
1990	1.56	1.54	0.57	3.43	3.98	1.43	0.28	1.45	1.78	3.36	3.53	3.49	26.39
mean	1.81	1.91	1.46	2.87	3.67	1.35	0.96	1.49	1.60	2.63	2.91	2.12	24.79
min	0.68	0.75	0.50	1.82	2.35	0.00	0.00	0.49	0.57	1.12	1.77	0.87	19.52
max	2.95	3.41	2.46	3.85	3.99	3.24	3.03	2.57	2.86	3.78	3.83	3.91	28.95

Table D - 7
Lookout Brook - Period Average Energy (GWH), Baseline

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.77	0.07	2.87	3.04	3.41	3.14	3.25	1.96	0.15	3.09	3.36	3.70	30.82
1962	3.25	2.93	3.70	3.67	3.92	3.40	3.25	3.25	1.28	1.97	2.89	3.25	36.75
1963	3.45	3.02	1.51	2.94	3.92	3.49	3.25	3.25	2.92	1.12	2.88	3.25	35.00
1964	2.41	2.67	1.61	3.37	3.92	3.66	3.25	3.25	3.15	2.76	2.24	2.80	35.06
1965	3.07	2.37	3.53	2.33	3.55	3.44	3.25	3.25	1.60	2.11	3.15	2.45	34.08
1966	3.00	2.93	3.12	3.15	3.24	3.20	3.25	0.88	1.23	2.80	3.11	3.29	33.19
1967	3.25	2.96	2.40	3.09	3.92	3.28	3.25	1.78	1.95	2.51	3.23	3.32	34.93
1968	3.25	2.93	3.48	3.79	3.72	3.27	3.32	3.25	2.23	2.74	3.02	3.35	38.34
1969	3.54	3.08	3.91	3.64	3.92	3.48	3.25	1.83	1.09	2.68	2.55	3.30	36.26
1970	3.25	2.93	3.47	2.96	3.76	3.47	3.27	2.98	1.59	1.87	3.15	3.25	35.93
1971	2.29	2.09	3.39	3.53	3.24	3.14	1.72	1.82	1.71	2.39	2.83	2.35	30.50
1972	1.40	0.48	1.50	2.21	3.92	3.75	3.25	3.25	2.81	3.32	3.28	1.90	31.06
1973	2.22	2.70	2.92	3.01	3.76	3.41	3.25	3.25	3.15	2.78	2.21	3.13	35.80
1974	1.65	1.48	2.07	2.52	3.92	3.29	3.25	1.87	2.29	3.24	3.15	2.81	31.54
1975	1.05	0.13	2.85	3.21	3.91	3.36	3.25	1.10	2.54	2.93	2.85	3.25	30.43
1976	2.88	1.65	1.23	3.13	3.89	3.14	3.25	0.77	0.96	3.25	3.15	3.25	30.55
1977	3.25	1.80	3.33	2.23	3.57	3.39	3.25	3.25	3.15	3.27	3.80	3.67	37.95
1978	3.37	3.54	3.38	2.99	3.92	3.65	3.25	3.25	2.10	2.53	2.40	2.52	36.89
1979	3.18	3.06	3.76	3.51	3.35	3.14	3.25	3.12	2.26	2.35	2.98	3.25	37.22
1980	3.25	2.93	2.36	2.57	3.81	3.17	3.25	3.27	3.16	3.67	3.53	3.25	38.21
1981	3.27	3.23	3.91	3.79	3.83	3.20	3.25	3.25	2.45	2.66	3.15	3.44	39.42
1982	3.44	3.44	3.86	3.21	3.92	3.52	3.28	3.26	3.19	3.25	3.15	3.25	40.77
1983	3.38	3.08	3.53	3.79	3.48	3.14	3.25	3.40	3.15	3.25	2.85	3.25	39.54
1984	2.80	2.70	2.99	3.01	3.45	3.38	3.25	3.25	2.70	1.76	2.29	3.18	34.76
1985	2.00	1.70	1.60	2.46	3.84	3.76	3.25	3.06	1.58	2.22	3.15	2.05	30.66
1986	3.07	2.93	0.74	3.54	3.67	3.45	3.25	2.31	1.64	2.70	1.92	1.56	30.78
1987	1.58	2.55	1.65	3.79	3.85	3.14	3.25	1.45	2.04	3.16	3.25	3.31	33.02
1988	3.25	2.93	2.92	3.55	3.24	3.14	3.25	2.42	2.10	2.67	3.02	3.25	35.73
1989	1.70	1.06	0.52	3.59	3.83	3.14	3.25	3.22	3.15	3.42	3.39	3.25	33.51
1990	3.25	1.58	0.19	3.53	3.92	3.36	3.27	3.25	2.86	2.95	3.46	3.93	35.55
mean	2.78	2.36	2.61	3.17	3.72	3.35	3.20	2.65	2.20	2.71	2.98	3.06	34.81
min	1.05	0.07	0.19	2.21	3.24	3.14	1.72	0.77	0.15	1.12	1.92	1.56	
max	3.54	3.54	3.91	3.79	3.92	3.76	3.32	3.40	3.19	3.67	3.80	3.93	

Table D - 8
Lookout Brook - Period Average Energy (GWH) under Wettest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.25	2.16	3.34	3.33	3.24	3.14	3.03	0.01	0.00	3.22	3.54	3.93	32.18
1962	3.93	3.54	3.91	3.79	3.90	3.29	3.25	2.53	1.05	1.98	2.98	3.39	37.54
1963	3.71	3.54	3.91	3.54	3.85	3.35	3.25	3.16	2.16	1.06	3.05	3.40	37.96
1964	3.40	3.44	3.91	3.79	3.90	3.60	3.25	3.25	2.46	2.83	2.48	3.26	39.56
1965	3.32	3.52	3.91	3.74	3.69	3.38	3.25	2.94	1.23	2.18	3.15	3.25	37.55
1966	3.38	3.54	3.91	3.68	3.35	3.16	3.25	0.18	1.16	2.95	3.26	3.93	35.75
1967	3.93	3.54	3.91	3.68	3.92	3.18	3.25	1.46	2.10	2.66	3.40	3.82	38.85
1968	3.90	3.54	3.91	3.79	3.84	3.32	3.28	3.25	1.37	2.90	3.19	3.90	40.18
1969	3.93	3.55	3.91	3.79	3.92	3.35	3.25	1.40	1.06	2.65	2.85	3.93	37.57
1970	3.67	3.54	3.91	3.68	3.89	3.43	3.25	2.34	1.58	1.89	3.29	3.31	37.78
1971	3.52	3.54	3.91	3.79	3.41	3.14	1.31	1.48	1.75	2.43	3.00	3.25	34.54
1972	3.25	2.57	2.21	2.55	3.92	3.63	3.25	3.25	2.05	3.36	3.62	3.27	36.93
1973	3.25	3.35	3.91	3.62	3.72	3.25	3.25	3.25	3.07	2.01	3.04	3.31	39.03
1974	3.21	2.26	2.86	2.87	3.92	3.21	3.25	1.46	2.45	3.25	3.15	3.30	35.17
1975	3.33	2.60	3.22	3.38	3.83	3.16	3.18	0.00	2.79	3.06	3.01	3.38	34.92
1976	3.51	3.43	3.83	3.62	3.44	3.14	2.42	0.00	0.91	3.25	3.33	3.67	34.55
1977	3.93	3.54	3.91	3.45	3.59	3.34	3.26	3.25	3.15	3.29	3.80	3.93	42.44
1978	3.93	3.54	3.91	3.79	3.92	3.63	3.25	3.07	1.57	2.63	2.76	3.25	39.25
1979	3.81	3.54	3.91	3.79	3.56	3.14	3.25	3.01	2.29	2.42	3.11	3.42	39.25
1980	3.93	3.54	3.91	3.70	3.74	3.16	3.25	3.25	3.15	3.52	3.69	3.77	42.60
1981	3.93	3.54	3.91	3.79	3.77	3.18	3.25	3.25	1.35	2.75	3.24	3.86	39.82
1982	3.93	3.54	3.91	3.79	3.92	3.38	3.25	3.25	3.15	3.25	3.18	3.45	42.00
1983	3.69	3.54	3.91	3.79	3.57	3.18	3.25	3.60	3.15	3.25	3.24	3.57	41.73
1984	3.53	3.48	3.91	3.79	3.76	3.34	3.25	3.02	2.61	1.72	2.52	3.28	38.21
1985	3.27	3.09	3.91	2.93	3.66	3.76	3.25	2.52	1.62	2.29	3.15	3.25	36.69
1986	3.44	3.54	3.91	3.64	3.57	3.27	3.25	0.69	1.59	2.76	2.87	2.76	35.27
1987	3.25	2.93	2.88	3.79	3.74	3.14	2.93	0.04	2.16	3.25	3.47	3.86	35.45
1988	3.89	3.54	3.91	3.79	3.57	3.14	3.25	1.74	2.22	2.79	3.16	3.40	38.41
1989	3.26	3.02	2.85	3.60	3.61	3.14	1.88	2.93	3.15	3.69	3.47	3.93	38.52
1990	3.64	3.54	3.12	3.54	3.92	3.28	3.27	3.25	2.54	3.13	3.78	3.93	40.94
mean	3.60	3.32	3.68	3.59	3.72	3.29	3.09	2.23	2.03	2.75	3.19	3.53	38.02
min	3.21	2.16	2.21	2.55	3.24	3.14	1.31	0.00	0.00	1.06	2.48	2.76	32.18
max	3.93	3.55	3.91	3.79	3.92	3.76	3.28	3.60	3.15	3.69	3.80	3.93	42.60

Table D - 9
Lookout Brook - Period Average Energy (GWH) under Driest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.25	1.85	3.30	3.24	3.24	3.14	2.54	0.01	0.00	2.88	3.47	3.93	30.84
1962	3.93	3.54	3.91	3.79	3.92	3.26	3.25	2.33	0.99	1.63	2.93	3.28	36.76
1963	3.67	3.54	3.91	3.24	3.83	3.24	3.25	2.98	2.04	0.75	2.99	3.25	36.68
1964	3.25	3.31	3.77	3.68	3.90	3.56	3.25	3.25	2.13	2.42	2.45	3.25	38.20
1965	3.25	3.14	3.91	3.46	3.50	3.14	3.25	2.53	1.18	1.95	3.15	3.25	35.71
1966	3.32	3.54	3.91	3.49	3.24	3.14	2.17	0.00	1.09	2.51	3.21	3.58	33.20
1967	3.79	3.54	3.91	3.35	3.92	3.19	3.25	1.24	1.93	2.28	3.35	3.49	37.25
1968	3.64	3.54	3.91	3.79	3.74	3.19	3.27	3.25	0.83	2.44	3.13	3.52	38.25
1969	3.80	3.54	3.91	3.79	3.92	3.31	3.25	1.09	1.02	2.27	2.80	3.69	36.40
1970	3.34	3.54	3.91	3.55	3.75	3.18	3.25	1.90	1.54	1.46	3.28	3.25	35.95
1971	3.25	3.14	3.79	3.77	3.24	2.82	0.71	1.62	1.63	2.07	2.99	3.15	32.15
1972	3.25	1.41	2.18	2.30	3.92	3.48	3.25	3.25	1.94	3.27	3.40	2.62	34.25
1973	3.25	2.95	3.84	3.40	3.54	3.21	3.25	2.97	2.43	1.63	3.01	3.25	36.72
1974	2.12	2.15	2.73	2.54	3.92	3.22	3.25	1.05	2.26	3.24	3.15	3.25	32.85
1975	3.13	1.24	3.18	3.29	3.74	3.14	2.79	0.21	2.56	2.65	2.97	3.25	32.13
1976	3.27	3.06	3.44	3.04	3.45	3.14	2.19	0.00	0.83	3.23	3.20	3.29	32.14
1977	3.31	3.13	3.91	3.38	3.55	3.18	3.25	3.25	3.15	2.69	3.78	3.78	40.35
1978	3.70	3.54	3.91	3.79	3.92	3.59	3.25	2.73	1.49	2.22	2.69	3.24	38.08
1979	3.45	3.54	3.91	3.72	3.26	3.14	2.62	2.44	2.09	2.04	3.06	3.32	36.60
1980	3.72	3.54	3.91	3.40	3.58	3.15	3.25	3.25	3.15	3.25	3.29	3.25	40.74
1981	3.51	3.47	3.91	3.79	3.79	3.17	3.25	3.25	0.93	2.41	3.20	3.81	38.49
1982	3.93	3.54	3.91	3.79	3.92	3.36	3.25	3.25	3.04	2.71	2.93	3.30	40.93
1983	3.67	3.54	3.91	3.79	3.54	3.14	3.25	3.41	3.15	2.91	2.97	3.28	40.55
1984	3.27	3.40	3.91	3.66	3.24	3.32	3.25	1.69	2.40	1.41	2.48	3.25	35.29
1985	3.25	2.93	3.34	2.27	3.61	3.73	3.25	2.24	1.49	2.07	3.15	2.94	34.26
1986	3.32	3.54	3.12	3.57	3.52	3.17	3.25	0.11	1.51	2.38	2.79	1.77	32.04
1987	3.25	2.93	2.53	3.79	3.67	3.14	2.31	0.35	2.01	3.03	3.37	3.50	33.88
1988	3.43	3.54	3.91	3.79	3.28	3.14	2.96	0.82	2.05	2.36	3.12	3.34	35.74
1989	3.25	2.47	1.97	3.40	3.57	3.14	1.48	2.93	3.15	3.41	3.47	3.58	35.81
1990	3.36	3.08	2.37	3.52	3.92	3.27	3.25	3.25	1.89	2.88	3.68	3.93	38.39
mean	3.40	3.11	3.54	3.44	3.64	3.23	2.93	2.02	1.86	2.41	3.11	3.32	36.02
min	2.12	1.24	1.97	2.27	3.24	2.82	0.71	0.00	0.00	0.75	2.45	1.77	30.84
max	3.93	3.54	3.91	3.79	3.92	3.73	3.27	3.41	3.15	3.41	3.78	3.93	40.93

Table D - 10
Lookout Brook - Period Average Energy (GWH) under Warmest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.25	2.85	3.33	3.27	3.24	3.14	2.57	0.01	0.00	2.97	3.45	3.93	32.00
1962	3.93	3.54	3.91	3.79	3.92	3.29	3.25	2.34	0.99	1.77	2.92	3.29	36.95
1963	3.69	3.54	3.91	3.40	3.85	3.36	3.25	2.98	2.09	0.91	2.98	3.26	37.21
1964	3.35	3.44	3.91	3.79	3.89	3.60	3.25	3.25	2.05	2.55	2.41	3.25	38.74
1965	3.27	3.38	3.91	3.66	3.56	3.32	3.25	2.60	1.18	2.02	3.15	3.25	36.54
1966	3.32	3.54	3.91	3.64	3.32	3.14	2.85	0.00	1.10	2.63	3.20	3.59	34.24
1967	3.88	3.54	3.91	3.51	3.92	3.20	3.25	1.42	2.02	2.41	3.35	3.49	37.89
1968	3.81	3.54	3.91	3.79	3.83	3.33	3.27	3.25	1.25	2.57	3.09	3.55	39.19
1969	3.89	3.55	3.91	3.79	3.92	3.35	3.25	1.19	1.03	2.42	2.77	3.82	36.87
1970	3.37	3.54	3.91	3.68	3.89	3.44	3.25	2.07	1.55	1.63	3.27	3.27	36.86
1971	3.36	3.54	3.87	3.79	3.31	3.05	0.60	1.49	1.67	2.20	2.98	3.25	33.11
1972	3.25	2.29	2.23	2.37	3.92	3.66	3.25	3.25	1.94	3.31	3.36	2.85	35.67
1973	3.25	3.30	3.91	3.48	3.61	3.26	3.25	3.25	2.66	1.82	2.98	3.18	37.96
1974	2.92	2.46	2.77	2.66	3.92	3.21	3.25	1.00	2.36	3.24	3.15	3.25	34.18
1975	3.27	2.12	3.21	3.32	3.78	3.14	2.78	0.09	2.69	2.79	2.95	3.25	33.40
1976	3.44	3.35	3.79	3.30	3.35	3.14	2.16	0.00	0.85	3.24	3.19	3.31	33.12
1977	3.82	3.39	3.91	3.42	3.57	3.31	3.25	3.25	3.15	2.67	3.80	3.80	41.34
1978	3.86	3.54	3.91	3.79	3.92	3.63	3.25	2.66	1.51	2.35	2.64	3.25	38.31
1979	3.64	3.54	3.91	3.79	3.35	3.14	3.12	2.25	2.16	2.18	3.05	3.32	37.45
1980	3.82	3.54	3.91	3.61	3.70	3.16	3.25	3.25	3.15	3.31	3.41	3.26	41.37
1981	3.91	3.54	3.91	3.79	3.78	3.19	3.25	3.25	1.02	2.52	3.17	3.86	39.19
1982	3.93	3.54	3.91	3.79	3.92	3.39	3.25	3.25	3.08	2.85	2.92	3.32	41.14
1983	3.68	3.54	3.91	3.79	3.57	3.18	3.25	3.42	3.15	3.25	2.99	3.32	41.05
1984	3.43	3.45	3.91	3.79	3.50	3.34	3.25	2.27	2.51	1.57	2.45	3.25	36.71
1985	3.25	3.05	3.91	2.58	3.63	3.76	3.25	2.34	1.55	2.14	3.15	3.00	35.60
1986	3.34	3.54	3.90	3.59	3.54	3.23	3.25	0.34	1.53	2.51	2.63	2.00	33.40
1987	3.25	2.95	3.41	3.79	3.69	3.14	2.51	0.28	2.09	3.11	3.36	3.49	35.06
1988	3.64	3.54	3.91	3.79	3.48	3.14	3.25	1.03	2.14	2.51	3.07	3.34	36.84
1989	3.25	3.00	2.61	3.44	3.54	3.14	1.44	2.93	3.15	3.43	3.47	3.64	37.04
1990	3.36	3.54	3.03	3.53	3.92	3.27	3.25	3.25	1.69	2.94	3.67	3.93	39.37
mean	3.51	3.31	3.68	3.52	3.68	3.29	2.98	2.06	1.91	2.53	3.10	3.35	36.93
min	2.92	2.12	2.23	2.37	3.24	3.05	0.60	0.00	0.00	0.91	2.41	2.00	32.00
max	3.93	3.55	3.91	3.79	3.92	3.76	3.27	3.42	3.15	3.43	3.80	3.93	41.37

Table D - 11
Lookout Brook - Period Average Energy (GWH) under Coldest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.25	0.80	3.09	3.20	3.26	3.14	2.57	0.00	0.00	3.19	3.47	3.93	29.90
1962	3.82	3.42	3.77	3.79	3.92	3.26	3.25	1.92	0.96	1.99	2.91	3.25	36.25
1963	3.67	3.54	3.26	2.91	3.85	3.31	3.25	2.54	1.99	1.09	2.95	3.25	35.62
1964	3.25	2.96	3.18	3.36	3.89	3.56	3.25	3.25	1.70	2.81	2.37	3.25	36.83
1965	3.25	2.95	3.83	3.29	3.46	3.14	3.25	1.60	1.12	2.16	3.15	3.25	34.44
1966	3.27	3.07	3.85	3.38	3.24	3.14	1.91	0.00	1.06	2.92	3.20	3.44	32.48
1967	3.50	3.52	3.59	3.14	3.92	3.19	3.25	1.28	1.90	2.60	3.32	3.45	36.65
1968	3.29	3.54	3.91	3.79	3.67	3.19	3.27	2.71	0.67	2.86	3.07	3.47	37.46
1969	3.72	3.54	3.91	3.79	3.92	3.32	3.25	1.13	1.00	2.61	2.73	3.63	36.56
1970	3.32	3.54	3.77	3.38	3.56	3.14	3.25	1.52	1.51	1.84	3.25	3.25	35.31
1971	3.25	2.93	3.74	3.61	3.24	2.16	0.66	1.05	1.58	2.43	2.97	3.01	30.63
1972	2.44	1.11	1.87	2.25	3.92	3.48	3.25	3.14	1.62	3.33	3.44	2.87	32.73
1973	3.24	2.78	3.50	3.19	3.50	3.21	3.25	2.63	2.07	1.95	2.83	3.13	35.30
1974	1.31	2.05	2.37	2.51	3.92	3.22	3.25	1.09	2.24	3.25	3.15	3.25	31.60
1975	2.67	0.75	3.02	3.25	3.81	3.14	2.98	0.00	2.53	3.02	2.94	3.25	31.34
1976	3.25	2.93	2.36	3.10	3.53	3.14	2.25	0.00	0.81	3.25	3.23	3.30	31.15
1977	3.26	2.93	3.83	3.29	3.55	3.16	3.25	3.25	2.67	2.69	3.80	3.80	39.47
1978	3.64	3.54	3.91	3.75	3.92	3.60	3.25	2.35	1.48	2.61	2.59	3.13	37.76
1979	3.35	3.53	3.81	3.68	3.26	3.14	2.36	1.92	2.04	2.41	3.04	3.32	35.85
1980	3.30	3.50	3.65	3.05	3.61	3.15	3.25	3.24	2.83	3.25	3.24	3.25	39.32
1981	3.37	3.37	3.91	3.79	3.79	3.17	3.25	2.76	0.83	2.74	3.15	3.82	37.93
1982	3.93	3.54	3.91	3.63	3.92	3.36	3.25	3.25	2.47	3.10	2.91	3.28	40.56
1983	3.64	3.45	3.91	3.79	3.52	3.14	2.90	3.27	3.15	2.35	2.93	3.28	39.33
1984	3.25	3.20	3.66	3.51	3.24	3.30	3.25	0.88	2.36	1.74	2.41	3.25	34.04
1985	3.25	2.61	1.98	2.46	3.65	3.73	3.25	2.21	1.47	2.28	3.15	2.89	32.91
1986	3.32	3.04	2.46	3.55	3.56	3.21	3.25	0.17	1.48	2.76	2.50	1.82	31.10
1987	2.60	2.81	2.09	3.79	3.67	3.14	2.34	0.00	1.98	3.25	3.37	3.51	32.56
1988	3.25	3.23	3.91	3.78	3.24	3.14	2.63	0.37	2.03	2.76	3.07	3.31	34.72
1989	3.25	1.36	1.42	3.55	3.61	3.14	1.75	2.80	3.15	3.32	3.47	3.39	34.20
1990	3.29	2.96	0.92	3.53	3.92	3.27	3.25	2.93	1.57	2.96	3.76	3.93	36.28
mean	3.24	2.88	3.21	3.37	3.64	3.21	2.91	1.78	1.74	2.65	3.08	3.30	35.01
min	1.31	0.75	0.92	2.25	3.24	2.16	0.66	0.00	0.00	1.09	2.37	1.82	29.90
max	3.93	3.54	3.91	3.79	3.92	3.73	3.27	3.27	3.15	3.33	3.80	3.93	40.56

Table D - 12
Lookout Brook - Period Average Energy (GWH) under Middle Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	3.25	1.84	3.24	3.24	3.24	3.14	2.56	0.01	0.00	3.03	3.45	3.93	30.92
1962	3.93	3.54	3.91	3.79	3.92	3.27	3.25	2.18	0.98	1.80	2.92	3.26	36.75
1963	3.67	3.54	3.91	3.22	3.83	3.25	3.25	2.76	2.04	0.91	2.97	3.25	36.60
1964	3.25	3.29	3.74	3.66	3.89	3.58	3.25	3.25	1.93	2.60	2.41	3.25	38.09
1965	3.25	3.15	3.91	3.44	3.50	3.14	3.25	2.28	1.15	2.04	3.15	3.25	35.52
1966	3.32	3.54	3.91	3.47	3.24	3.14	2.12	0.00	1.08	2.69	3.21	3.55	33.26
1967	3.77	3.54	3.91	3.33	3.92	3.19	3.25	1.32	1.95	2.43	3.35	3.47	37.42
1968	3.62	3.54	3.91	3.79	3.74	3.19	3.27	3.25	0.77	2.63	3.10	3.51	38.32
1969	3.79	3.54	3.91	3.79	3.92	3.33	3.25	1.13	1.02	2.43	2.77	3.72	36.59
1970	3.34	3.54	3.91	3.53	3.77	3.22	3.25	1.75	1.54	1.64	3.27	3.26	36.00
1971	3.25	3.15	3.79	3.79	3.24	2.75	0.65	1.37	1.62	2.24	2.98	3.14	31.96
1972	3.25	1.31	2.11	2.27	3.92	3.54	3.25	3.25	1.77	3.32	3.40	2.75	34.14
1973	3.25	2.95	3.82	3.40	3.54	3.22	3.25	3.02	2.27	1.80	2.98	3.17	36.66
1974	2.05	2.22	2.68	2.50	3.92	3.21	3.25	1.04	2.29	3.24	3.15	3.25	32.79
1975	3.21	1.18	3.14	3.29	3.77	3.14	2.84	0.03	2.59	2.82	2.95	3.25	32.22
1976	3.25	3.07	3.43	3.09	3.42	3.14	2.21	0.00	0.83	3.24	3.19	3.30	32.17
1977	3.33	3.21	3.91	3.38	3.55	3.24	3.25	3.25	3.15	2.56	3.80	3.79	40.42
1978	3.75	3.54	3.91	3.79	3.92	3.61	3.25	2.58	1.49	2.39	2.64	3.25	38.11
1979	3.46	3.54	3.91	3.72	3.26	3.14	2.66	2.19	2.09	2.21	3.05	3.32	36.56
1980	3.68	3.54	3.91	3.41	3.59	3.15	3.25	3.25	3.14	3.25	3.24	3.25	40.66
1981	3.48	3.47	3.91	3.79	3.79	3.18	3.25	3.12	0.86	2.56	3.17	3.85	38.42
1982	3.93	3.54	3.91	3.79	3.92	3.37	3.25	3.25	2.84	2.88	2.92	3.30	40.89
1983	3.67	3.54	3.91	3.79	3.57	3.14	3.25	3.35	3.15	2.86	2.95	3.28	40.45
1984	3.26	3.42	3.91	3.69	3.24	3.32	3.25	1.52	2.42	1.57	2.45	3.25	35.31
1985	3.25	2.93	3.17	2.35	3.63	3.73	3.25	2.27	1.50	2.16	3.15	2.94	34.33
1986	3.32	3.54	3.04	3.57	3.54	3.21	3.25	0.20	1.50	2.55	2.64	1.86	32.22
1987	3.25	2.93	2.43	3.79	3.67	3.14	2.36	0.17	2.03	3.14	3.36	3.49	33.77
1988	3.41	3.54	3.91	3.79	3.33	3.14	2.99	0.59	2.07	2.54	3.07	3.32	35.71
1989	3.25	2.42	1.90	3.46	3.57	3.14	1.55	2.86	3.15	3.35	3.47	3.56	35.67
1990	3.36	3.08	2.25	3.52	3.92	3.27	3.25	3.25	1.59	2.92	3.73	3.93	38.07
mean	3.39	3.11	3.51	3.45	3.64	3.24	2.94	1.95	1.83	2.53	3.10	3.32	36.00
min	2.05	1.18	1.90	2.27	3.24	2.75	0.65	0.00	0.00	0.91	2.41	1.86	30.92
max	3.93	3.54	3.91	3.79	3.92	3.73	3.27	3.35	3.15	3.35	3.80	3.93	40.89

Table D - 13
Pierre's Brook - Period Average Energy (GWH), Baseline

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.51	2.24	2.26	2.94	3.04	2.87	1.76	0.17	1.07	0.83	0.82	1.50	22.02
1962	2.47	2.25	2.68	2.94	3.04	2.66	2.50	1.20	1.97	2.37	2.46	2.74	29.28
1963	2.90	2.75	2.66	2.86	3.04	2.80	2.36	1.36	2.10	1.10	2.16	2.20	28.29
1964	2.49	2.23	2.50	2.66	2.90	2.42	1.24	1.31	1.75	2.48	2.60	3.04	27.59
1965	3.04	2.68	2.84	2.91	3.04	2.65	1.41	0.35	1.21	1.44	2.16	2.48	26.22
1966	2.49	2.26	2.49	2.40	2.61	2.41	0.71	0.81	1.62	1.84	1.14	2.51	23.28
1967	2.92	2.75	2.88	2.92	3.04	2.91	1.84	0.19	1.70	1.08	2.05	2.03	26.30
1968	2.46	2.24	2.76	2.89	3.04	2.94	2.61	2.16	1.51	2.43	2.39	2.52	29.93
1969	2.71	2.57	3.04	2.94	3.04	2.94	2.52	1.79	2.40	2.48	2.62	2.74	31.78
1970	2.57	2.45	3.04	2.94	3.04	2.89	1.89	2.39	2.25	2.49	2.49	3.04	31.48
1971	3.04	2.75	2.51	2.94	2.90	2.18	1.49	1.18	2.05	1.79	2.40	2.88	28.10
1972	2.50	2.23	2.49	2.73	3.04	2.72	1.36	0.78	1.73	2.45	2.56	3.04	27.62
1973	2.85	2.34	3.04	2.92	3.04	2.65	2.29	1.31	2.00	2.44	1.65	2.40	28.94
1974	0.68	1.11	2.18	2.50	3.04	2.73	2.02	0.74	2.38	2.47	2.42	2.92	25.20
1975	2.66	2.08	1.97	2.45	3.04	2.73	1.47	0.85	2.10	2.42	2.40	2.46	26.61
1976	2.50	2.40	2.66	2.94	2.95	2.42	1.22	0.37	1.75	1.63	2.38	2.46	25.67
1977	2.90	2.42	2.49	2.42	2.50	2.37	0.68	0.37	1.88	1.94	0.85	2.13	22.94
1978	2.84	2.73	2.66	2.94	3.04	2.79	1.81	0.35	2.20	2.44	1.48	1.84	27.10
1979	2.55	2.55	2.78	2.94	3.04	2.72	1.46	0.86	2.02	2.35	2.42	2.49	28.18
1980	2.56	2.25	2.88	2.94	3.04	2.94	2.74	2.50	2.39	2.64	2.86	3.04	32.79
1981	3.04	2.75	3.04	2.94	2.90	2.42	1.94	0.94	1.96	2.75	2.94	3.04	30.65
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.76	1.70	2.00	2.60	2.39	2.48	31.68
1983	2.62	2.55	3.01	2.94	3.04	2.56	1.78	1.09	2.37	1.73	2.50	2.62	28.81
1984	2.72	2.68	3.04	2.94	3.04	2.94	2.66	1.67	2.20	2.23	1.18	2.31	29.59
1985	2.19	1.71	1.26	2.15	2.99	2.89	2.50	0.92	1.34	1.31	1.55	1.80	22.60
1986	2.47	2.27	3.04	2.94	2.87	2.41	1.16	0.59	1.48	2.46	2.47	2.66	26.81
1987	2.50	2.61	2.71	2.94	3.04	2.66	1.12	0.43	1.60	0.84	2.12	2.48	25.05
1988	2.46	1.82	2.95	2.94	3.04	2.82	2.50	0.88	1.70	1.41	2.25	2.46	27.22
1989	2.47	1.28	2.46	2.40	1.77	0.26	0.92	0.45	1.65	1.23	1.56	2.47	18.90
1990	2.47	1.95	2.27	2.27	2.69	2.58	2.12	0.68	1.59	2.48	2.42	2.49	26.00
mean	2.59	2.32	2.65	2.78	2.93	2.61	1.83	1.01	1.87	2.00	2.12	2.51	27.22
min	0.68	1.11	1.26	2.15	1.77	0.26	0.68	0.17	1.07	0.83	0.82	1.50	18.90
max	3.04	2.75	3.04	2.94	3.04	2.94	2.76	2.50	2.40	2.75	2.94	3.04	32.79

Table D - 14
Pierre's Brook - Period Average Energy (GWH) under Wettest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.74	2.30	2.73	2.94	3.04	2.83	1.61	0.14	1.20	0.88	0.99	1.66	23.05
1962	2.49	2.69	3.04	2.94	3.04	2.47	2.48	0.79	2.20	2.46	2.53	3.04	30.18
1963	3.04	2.75	2.81	2.94	3.04	2.78	2.21	1.40	2.35	1.34	2.37	2.45	29.47
1964	2.50	2.44	3.04	2.94	3.04	2.62	1.94	1.34	1.91	2.51	2.83	3.04	30.16
1965	3.04	2.75	3.04	2.94	3.04	2.77	1.66	0.26	1.49	1.49	2.23	2.50	27.20
1966	2.82	2.75	2.85	2.77	2.87	2.41	0.78	0.78	1.72	2.17	1.29	2.68	25.88
1967	2.99	2.75	3.04	2.94	3.04	2.87	1.65	0.10	2.08	1.12	2.32	2.35	27.24
1968	2.48	2.61	3.04	2.94	3.04	2.94	2.70	2.32	1.91	2.45	2.47	2.84	31.73
1969	3.04	2.75	3.04	2.94	3.04	2.91	2.50	1.73	2.42	2.65	2.94	3.04	32.98
1970	3.04	2.75	3.04	2.94	3.04	2.79	1.49	2.47	2.38	2.50	2.80	3.04	32.26
1971	3.04	2.75	3.04	2.94	2.97	2.39	1.57	1.22	2.18	2.15	2.55	3.04	29.84
1972	2.77	2.38	3.04	2.94	3.04	2.75	1.37	0.76	2.06	2.46	2.67	3.04	29.28
1973	3.04	2.75	3.04	2.94	3.04	2.94	2.50	1.38	2.14	2.47	2.27	2.47	30.97
1974	2.03	1.22	2.47	2.82	3.04	2.75	2.03	0.75	2.39	2.62	2.91	3.04	28.06
1975	3.04	2.38	2.58	2.94	3.04	2.84	1.67	0.85	2.38	2.48	2.42	2.49	29.11
1976	2.89	2.75	3.04	2.94	2.88	2.36	0.91	0.33	2.05	1.73	2.40	2.55	26.82
1977	3.04	2.75	3.04	2.94	2.92	2.41	0.93	0.27	2.03	2.34	1.01	2.30	25.98
1978	3.02	2.75	3.04	2.94	3.04	2.75	1.58	0.27	2.22	2.47	2.35	2.01	28.42
1979	2.58	2.75	3.04	2.94	3.04	2.68	1.23	0.80	2.24	2.46	2.54	2.64	28.94
1980	3.04	2.59	3.04	2.94	3.04	2.94	2.71	2.50	2.40	2.94	2.94	3.04	34.12
1981	3.04	2.75	3.04	2.94	2.92	2.41	1.88	0.90	2.03	2.84	2.94	3.04	30.74
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.73	1.47	2.17	2.85	2.41	2.56	31.93
1983	2.94	2.75	3.04	2.94	3.04	2.42	1.37	1.10	2.40	2.39	2.65	2.94	29.97
1984	3.04	2.75	3.04	2.94	3.04	2.94	2.64	1.55	2.25	2.48	1.84	2.32	30.82
1985	2.46	2.23	2.48	2.43	3.04	2.77	2.39	0.66	1.67	1.31	1.86	1.88	25.17
1986	2.55	2.63	3.04	2.94	2.80	1.93	1.12	0.51	1.70	2.47	2.57	3.04	27.30
1987	3.04	2.75	3.04	2.94	3.04	2.56	0.61	0.38	1.92	0.92	2.24	2.49	25.91
1988	2.49	2.34	3.04	2.94	3.04	2.79	2.50	0.64	2.03	1.54	2.26	2.48	28.09
1989	2.53	2.25	2.68	2.92	2.50	0.43	0.85	0.37	1.95	1.31	1.66	2.49	21.94
1990	2.50	2.30	2.81	2.78	3.02	2.94	2.35	0.65	1.74	2.54	2.48	2.61	28.73
mean	2.81	2.57	2.94	2.91	2.99	2.61	1.80	0.96	2.05	2.14	2.32	2.64	28.74
min	2.03	1.22	2.47	2.43	2.50	0.43	0.61	0.10	1.20	0.88	0.99	1.66	21.94
max	3.04	2.75	3.04	2.94	3.04	2.94	2.73	2.50	2.42	2.94	2.94	3.04	34.12

Table D - 15
Pierre's Brook - Period Average Energy (GWH) under Driest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.72	2.28	2.67	2.94	3.04	2.79	1.41	0.12	1.13	0.64	0.82	1.45	22.00
1962	2.49	2.58	2.96	2.94	3.04	2.44	2.11	0.64	2.19	2.40	2.39	2.67	28.83
1963	2.87	2.75	2.69	2.89	3.04	2.49	1.17	1.36	2.25	1.08	2.10	2.09	26.76
1964	2.50	2.29	2.73	2.86	2.81	2.13	0.74	1.29	1.85	2.48	2.61	3.01	27.29
1965	3.04	2.75	3.04	2.94	3.04	2.53	0.95	0.21	1.38	1.21	2.15	2.48	25.70
1966	2.61	2.45	2.54	2.42	2.60	2.10	0.38	0.71	1.69	1.82	1.14	2.48	22.92
1967	2.87	2.75	3.04	2.94	3.04	2.84	1.49	0.10	1.92	1.04	1.95	1.92	25.88
1968	2.48	2.42	3.04	2.94	3.04	2.82	2.50	1.55	1.77	2.42	2.29	2.50	29.76
1969	2.78	2.75	3.04	2.94	3.04	2.87	2.20	1.55	2.41	2.49	2.65	2.80	31.51
1970	2.71	2.73	3.04	2.94	3.04	2.69	1.11	2.46	2.36	2.50	2.52	3.04	31.14
1971	3.04	2.75	2.90	2.94	2.82	1.69	1.16	1.17	2.14	1.79	2.39	2.76	27.56
1972	2.51	2.26	2.72	2.79	3.04	2.63	0.97	0.72	1.93	2.45	2.50	3.04	27.56
1973	2.90	2.38	3.04	2.94	3.04	2.56	1.57	1.33	2.09	2.45	1.72	2.30	28.31
1974	1.67	1.19	2.46	2.50	2.84	2.44	0.99	0.73	2.39	2.48	2.47	2.90	25.04
1975	2.87	2.25	2.47	2.48	3.04	2.47	0.64	0.75	2.37	2.45	2.39	2.45	26.62
1976	2.64	2.73	2.81	2.94	2.83	2.05	0.67	0.31	1.90	1.63	2.38	2.45	25.33
1977	2.92	2.70	2.50	2.45	2.51	1.62	0.40	0.24	2.00	1.90	0.86	1.99	22.09
1978	2.94	2.75	2.88	2.94	3.04	2.73	1.26	0.30	2.20	2.45	1.48	1.81	26.76
1979	2.55	2.75	3.04	2.94	3.04	2.65	0.95	0.76	2.17	2.45	2.42	2.49	28.19
1980	2.70	2.43	3.03	2.94	3.04	2.94	2.57	2.47	2.14	2.64	2.87	3.04	32.80
1981	3.04	2.75	3.04	2.94	2.82	2.03	1.39	0.87	2.01	2.82	2.94	3.04	29.68
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.64	1.07	2.10	2.66	2.39	2.48	31.08
1983	2.81	2.75	3.04	2.94	2.99	2.41	0.76	1.07	2.39	2.06	2.47	2.56	28.24
1984	2.92	2.75	3.04	2.94	3.04	2.94	2.45	1.29	2.23	2.37	1.18	2.27	29.42
1985	2.38	2.22	1.88	2.11	2.70	2.56	1.64	0.61	1.54	1.10	1.55	1.70	22.00
1986	2.51	2.45	3.04	2.94	2.78	1.66	0.87	0.49	1.61	2.46	2.42	2.58	25.81
1987	2.78	2.75	2.83	2.94	3.04	2.50	0.22	0.32	1.83	0.67	2.12	2.47	24.46
1988	2.46	2.23	3.02	2.94	3.04	2.74	2.24	0.44	1.88	1.26	2.25	2.45	26.95
1989	2.47	2.07	2.47	2.41	1.45	0.11	0.63	0.35	1.77	0.98	1.56	2.46	18.74
1990	2.48	2.24	2.49	2.40	2.52	2.42	1.25	0.61	1.68	2.49	2.42	2.49	25.48
mean	2.69	2.49	2.82	2.80	2.88	2.39	1.31	0.86	1.98	1.99	2.11	2.47	26.80
min	1.67	1.19	1.88	2.11	1.45	0.11	0.22	0.10	1.13	0.64	0.82	1.45	18.74
max	3.04	2.75	3.04	2.94	3.04	2.94	2.64	2.47	2.41	2.82	2.94	3.04	32.80

Table D - 16
Pierre's Brook - Period Average Energy (GWH) under Warmest Climate Change Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.84	2.35	2.71	2.94	3.04	2.82	1.57	0.10	1.17	0.65	0.86	1.49	22.54
1962	2.49	2.73	3.04	2.94	3.04	2.45	2.17	0.57	2.20	2.45	2.44	2.74	29.25
1963	3.04	2.75	2.71	2.92	3.04	2.61	1.56	1.32	2.31	1.13	2.18	2.16	27.73
1964	2.50	2.45	3.03	2.94	2.91	2.41	0.77	1.26	1.89	2.49	2.61	3.04	28.29
1965	3.04	2.75	3.04	2.94	3.04	2.77	1.42	0.18	1.44	1.25	2.16	2.48	26.50
1966	2.77	2.68	2.65	2.51	2.69	2.41	0.44	0.65	1.70	1.86	1.15	2.48	23.99
1967	2.94	2.75	3.04	2.94	3.04	2.86	1.61	0.10	1.99	1.04	1.99	2.03	26.32
1968	2.48	2.64	3.04	2.94	3.04	2.94	2.66	2.11	1.77	2.42	2.31	2.52	30.86
1969	2.78	2.75	3.04	2.94	3.04	2.91	2.34	1.52	2.42	2.49	2.69	2.87	31.78
1970	2.85	2.75	3.04	2.94	3.04	2.78	1.42	2.46	2.35	2.50	2.53	3.04	31.68
1971	3.04	2.75	3.04	2.94	2.91	2.11	1.16	1.12	2.15	1.86	2.40	2.87	28.33
1972	2.59	2.34	3.04	2.87	3.04	2.73	1.34	0.69	1.99	2.45	2.55	3.04	28.67
1973	3.04	2.55	3.04	2.94	3.04	2.91	2.30	1.29	2.10	2.46	1.80	2.41	29.88
1974	1.93	1.23	2.46	2.52	3.04	2.56	1.26	0.70	2.39	2.49	2.54	2.99	26.09
1975	3.01	2.26	2.49	2.67	3.04	2.72	1.23	0.74	2.37	2.47	2.39	2.45	27.83
1976	2.68	2.75	3.04	2.94	2.87	2.26	0.68	0.25	1.98	1.64	2.38	2.45	25.92
1977	2.95	2.75	2.76	2.64	2.61	2.21	0.38	0.20	2.02	2.06	0.87	2.10	23.53
1978	3.02	2.75	3.04	2.94	3.04	2.74	1.28	0.22	2.21	2.45	1.69	1.86	27.23
1979	2.57	2.75	3.04	2.94	3.04	2.68	1.10	0.74	2.22	2.45	2.42	2.49	28.44
1980	2.98	2.45	3.04	2.94	3.04	2.94	2.71	2.49	2.39	2.64	2.90	3.04	33.55
1981	3.04	2.75	3.04	2.94	2.83	2.28	1.39	0.82	2.03	2.84	2.94	3.04	29.93
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.71	1.34	2.14	2.72	2.40	2.48	31.53
1983	2.81	2.75	3.04	2.94	3.02	2.42	1.00	1.04	2.40	2.20	2.47	2.62	28.70
1984	2.94	2.75	3.04	2.94	3.04	2.94	2.64	1.40	2.24	2.47	1.24	2.30	29.93
1985	2.46	2.24	2.42	2.12	2.84	2.70	1.96	0.57	1.61	1.10	1.59	1.77	23.36
1986	2.55	2.68	3.04	2.94	2.78	1.84	0.87	0.43	1.66	2.46	2.47	2.65	26.36
1987	2.90	2.75	2.99	2.94	3.04	2.54	0.42	0.26	1.86	0.71	2.13	2.48	25.01
1988	2.48	2.32	3.04	2.94	3.04	2.80	2.49	0.42	1.95	1.29	2.25	2.46	27.48
1989	2.49	2.24	2.50	2.44	2.06	0.19	0.62	0.32	1.83	1.03	1.56	2.47	19.74
1990	2.49	2.26	2.56	2.54	2.74	2.78	2.06	0.59	1.70	2.49	2.42	2.50	27.12
mean	2.76	2.55	2.90	2.83	2.93	2.54	1.52	0.86	2.02	2.02	2.14	2.51	27.59
min	1.93	1.23	2.42	2.12	2.06	0.19	0.38	0.10	1.17	0.65	0.86	1.49	19.74
max	3.04	2.75	3.04	2.94	3.04	2.94	2.71	2.49	2.42	2.84	2.94	3.04	33.55

Table D - 17

Pierre's Brook - Period Average Energy (GWH) under Coldest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.61	2.26	2.52	2.94	3.04	2.75	1.31	0.10	1.11	0.82	0.88	1.53	21.86
1962	2.48	2.52	2.75	2.94	3.04	2.45	2.08	0.58	2.17	2.42	2.51	2.81	28.75
1963	3.02	2.75	2.68	2.82	3.04	2.52	1.28	1.21	2.19	1.17	2.28	2.20	27.15
1964	2.50	2.24	2.50	2.72	2.76	2.07	0.73	1.16	1.82	2.48	2.63	3.04	26.66
1965	3.04	2.75	3.04	2.94	3.04	2.52	0.98	0.21	1.32	1.44	2.18	2.49	25.93
1966	2.63	2.37	2.51	2.41	2.52	2.04	0.38	0.61	1.66	1.95	1.19	2.52	22.80
1967	2.94	2.75	3.04	2.94	3.04	2.86	1.59	0.10	1.88	1.10	2.20	2.10	26.52
1968	2.47	2.25	2.97	2.94	3.04	2.65	2.45	1.35	1.50	2.44	2.39	2.59	29.03
1969	2.78	2.75	3.04	2.94	3.04	2.89	2.30	1.40	2.41	2.49	2.69	2.92	31.64
1970	2.73	2.64	3.04	2.94	3.04	2.75	1.30	2.17	2.30	2.50	2.53	3.04	30.96
1971	3.04	2.75	2.95	2.94	2.80	1.64	1.10	1.02	2.10	1.92	2.42	2.92	27.59
1972	2.50	2.25	2.59	2.75	3.04	2.61	0.91	0.63	1.86	2.45	2.57	3.04	27.20
1973	3.04	2.43	3.04	2.94	3.04	2.54	1.54	1.16	2.04	2.45	1.89	2.46	28.56
1974	1.22	1.17	2.39	2.43	2.77	2.45	1.02	0.65	2.39	2.48	2.65	2.99	24.60
1975	2.83	2.25	2.45	2.41	3.03	2.44	0.61	0.64	2.27	2.45	2.41	2.47	26.26
1976	2.66	2.75	2.81	2.94	2.76	1.84	0.66	0.26	1.88	1.68	2.39	2.47	25.10
1977	2.95	2.75	2.52	2.42	2.50	1.71	0.40	0.20	2.00	2.11	0.91	2.14	22.61
1978	2.97	2.75	2.80	2.94	3.04	2.73	1.29	0.25	2.20	2.45	1.74	1.89	27.04
1979	2.55	2.75	2.86	2.94	3.04	2.61	0.80	0.64	2.12	2.45	2.42	2.53	27.70
1980	2.80	2.43	3.01	2.94	3.04	2.94	2.62	2.38	2.03	2.64	2.92	3.04	32.78
1981	3.04	2.75	3.04	2.94	2.76	1.79	1.34	0.77	2.00	2.83	2.94	3.04	29.23
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.66	1.10	2.07	2.74	2.40	2.49	31.19
1983	2.82	2.75	3.04	2.94	3.01	2.42	0.89	0.94	2.39	2.00	2.65	2.74	28.57
1984	2.94	2.75	3.04	2.94	3.04	2.94	2.56	1.10	2.22	2.41	1.28	2.30	29.51
1985	2.33	2.16	1.23	2.12	2.82	2.66	1.81	0.54	1.46	1.31	1.66	1.79	21.88
1986	2.47	2.29	3.04	2.94	2.78	1.67	0.86	0.44	1.58	2.46	2.53	2.76	25.83
1987	2.80	2.73	2.79	2.94	3.04	2.52	0.37	0.26	1.77	0.86	2.16	2.48	24.72
1988	2.47	2.22	2.99	2.94	3.04	2.75	2.26	0.39	1.84	1.46	2.25	2.46	27.07
1989	2.48	1.96	2.46	2.40	1.11	0.11	0.62	0.32	1.71	1.19	1.59	2.47	18.44
1990	2.48	2.23	2.47	2.38	2.49	2.42	1.27	0.54	1.64	2.50	2.42	2.50	25.35
mean	2.69	2.47	2.75	2.79	2.86	2.37	1.33	0.77	1.93	2.05	2.19	2.54	26.75
min	1.22	1.17	1.23	2.12	1.11	0.11	0.37	0.10	1.11	0.82	0.88	1.53	18.44
max	3.04	2.75	3.04	2.94	3.04	2.94	2.66	2.38	2.41	2.83	2.94	3.04	32.78

Table D - 18
Pierre's Brook - Period Average Energy (GWH) under Middle Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.70	2.28	2.64	2.94	3.04	2.81	1.51	0.10	1.13	0.71	0.86	1.48	22.20
1962	2.49	2.59	2.99	2.94	3.04	2.44	2.12	0.59	2.19	2.44	2.44	2.74	29.01
1963	2.97	2.75	2.69	2.86	3.04	2.54	1.33	1.29	2.24	1.13	2.20	2.15	27.17
1964	2.50	2.36	2.70	2.86	2.81	2.22	0.73	1.23	1.85	2.48	2.61	3.04	27.38
1965	3.04	2.75	3.04	2.94	3.04	2.66	1.14	0.20	1.40	1.28	2.17	2.48	26.13
1966	2.67	2.50	2.55	2.42	2.62	2.22	0.37	0.64	1.68	1.88	1.16	2.48	23.17
1967	2.94	2.75	3.04	2.94	3.04	2.86	1.57	0.10	1.93	1.05	2.04	2.02	26.26
1968	2.48	2.41	3.04	2.94	3.04	2.88	2.50	1.60	1.68	2.43	2.39	2.52	29.89
1969	2.78	2.75	3.04	2.94	3.04	2.89	2.27	1.47	2.41	2.49	2.65	2.86	31.58
1970	2.76	2.75	3.04	2.94	3.04	2.73	1.28	2.37	2.33	2.50	2.53	3.04	31.31
1971	3.04	2.75	2.99	2.94	2.87	1.86	1.14	1.10	2.12	1.84	2.41	2.87	27.91
1972	2.51	2.26	2.78	2.78	3.04	2.68	1.13	0.67	1.93	2.45	2.56	3.04	27.82
1973	3.04	2.45	3.04	2.94	3.04	2.59	1.79	1.23	2.09	2.46	1.82	2.39	28.86
1974	1.59	1.20	2.46	2.48	2.87	2.45	1.09	0.69	2.39	2.48	2.54	2.97	25.20
1975	2.89	2.26	2.47	2.49	3.04	2.54	0.83	0.71	2.36	2.46	2.40	2.46	26.90
1976	2.66	2.75	2.87	2.94	2.86	2.14	0.67	0.26	1.91	1.65	2.38	2.46	25.54
1977	2.95	2.75	2.56	2.47	2.55	1.86	0.38	0.20	2.01	2.03	0.87	2.07	22.71
1978	3.01	2.75	2.91	2.94	3.04	2.73	1.28	0.27	2.20	2.45	1.62	1.84	27.03
1979	2.57	2.75	3.04	2.94	3.04	2.66	1.02	0.71	2.15	2.45	2.42	2.50	28.25
1980	2.83	2.45	3.04	2.94	3.04	2.94	2.66	2.48	2.17	2.64	2.89	3.04	33.11
1981	3.04	2.75	3.04	2.94	2.81	2.01	1.37	0.82	2.01	2.82	2.94	3.04	29.59
1982	3.04	2.75	3.04	2.94	3.04	2.94	2.67	1.16	2.12	2.69	2.40	2.48	31.27
1983	2.81	2.75	3.04	2.94	3.01	2.42	0.87	1.00	2.39	2.09	2.55	2.61	28.47
1984	2.94	2.75	3.04	2.94	3.04	2.94	2.60	1.20	2.23	2.42	1.24	2.30	29.61
1985	2.43	2.22	1.78	2.11	2.77	2.65	1.80	0.57	1.53	1.15	1.59	1.75	22.34
1986	2.51	2.47	3.04	2.94	2.78	1.70	0.87	0.46	1.62	2.46	2.48	2.68	26.00
1987	2.81	2.75	2.87	2.94	3.04	2.52	0.33	0.27	1.82	0.75	2.13	2.48	24.69
1988	2.47	2.25	3.02	2.94	3.04	2.77	2.34	0.40	1.89	1.33	2.25	2.46	27.15
1989	2.48	2.23	2.47	2.41	1.41	0.12	0.62	0.32	1.76	1.09	1.56	2.47	18.94
1990	2.49	2.25	2.49	2.40	2.69	2.43	1.58	0.59	1.68	2.49	2.42	2.50	26.00
mean	2.71	2.51	2.82	2.80	2.89	2.44	1.39	0.82	1.97	2.02	2.15	2.51	27.05
min	1.59	1.20	1.78	2.11	1.41	0.12	0.33	0.10	1.13	0.71	0.86	1.48	18.94
max	3.04	2.75	3.04	2.94	3.04	2.94	2.67	2.48	2.41	2.82	2.94	3.04	33.11

Table D - 19
Petty Harbour - Period Average Energy (GWH), Baseline

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	1.71	1.02	2.36	3.15	3.09	1.03	0.37	0.25	0.31	0.75	0.61	1.31	15.96
1962	1.68	2.37	2.41	2.58	1.79	1.24	1.58	0.77	1.01	2.06	2.69	2.10	22.29
1963	2.26	1.98	0.83	3.00	2.71	1.28	0.97	1.12	1.19	1.00	1.51	2.11	19.96
1964	1.84	1.78	2.00	2.88	1.72	1.12	0.96	1.02	1.05	2.51	2.63	2.25	21.76
1965	2.63	1.63	2.08	2.86	2.29	1.20	0.58	0.33	0.40	1.15	1.90	1.76	18.80
1966	2.55	1.35	1.50	2.34	2.03	1.13	0.70	0.65	0.69	1.30	1.06	2.74	18.03
1967	2.32	1.97	2.20	3.09	3.21	1.06	0.37	0.19	0.82	1.10	1.32	1.47	19.12
1968	1.78	1.77	3.09	2.41	2.48	1.85	1.31	1.26	0.71	2.01	2.59	2.06	23.32
1969	2.52	2.21	2.92	2.67	2.84	1.34	0.95	1.37	1.69	2.57	2.35	2.11	25.54
1970	1.59	2.35	3.08	3.14	2.87	1.23	0.44	1.76	1.68	2.22	2.51	2.93	25.79
1971	2.43	1.64	1.73	3.03	1.20	0.90	1.21	0.96	1.12	1.37	2.89	2.15	20.64
1972	1.50	1.24	2.26	2.85	2.59	1.27	0.37	0.72	0.88	1.88	3.17	2.38	21.09
1973	1.71	1.67	2.15	2.51	2.45	1.64	0.87	1.09	1.18	1.83	1.46	1.52	20.06
1974	0.70	1.01	1.56	2.98	2.55	1.33	0.97	0.75	1.38	2.50	2.16	2.33	20.21
1975	1.54	0.67	1.97	2.63	2.68	1.34	0.51	0.69	1.08	2.48	1.53	1.71	18.84
1976	2.67	1.92	2.20	2.87	1.27	1.07	0.89	0.41	0.77	1.57	1.64	2.31	19.59
1977	2.71	1.59	1.44	2.38	1.73	1.10	0.70	0.33	1.00	1.35	0.71	1.83	16.89
1978	2.57	1.91	2.01	2.74	2.96	1.09	0.68	0.41	1.22	1.79	1.18	1.76	20.31
1979	2.09	1.44	2.56	2.89	2.39	1.02	0.46	0.73	1.00	2.28	1.98	2.05	20.89
1980	1.90	1.69	2.89	2.78	2.83	1.78	1.30	1.51	1.59	2.77	2.78	2.20	26.02
1981	3.07	1.86	2.33	2.57	1.03	1.15	1.34	0.82	1.27	2.99	2.83	2.53	23.77
1982	2.70	1.87	2.21	2.72	2.52	1.70	1.22	0.78	1.56	1.85	1.19	2.25	22.57
1983	2.42	2.00	3.09	3.22	1.62	1.09	0.96	0.90	1.40	1.89	2.11	1.93	22.62
1984	2.07	1.97	2.68	2.93	3.38	2.00	0.83	1.07	1.73	1.34	0.96	1.77	22.74
1985	1.64	1.30	1.04	2.44	2.89	1.59	1.03	0.71	0.59	1.08	1.10	1.64	17.04
1986	2.15	1.87	2.82	2.98	1.01	1.18	1.05	0.59	0.75	2.14	2.69	1.86	21.06
1987	2.00	2.04	2.24	3.29	1.98	0.86	0.41	0.41	0.67	0.75	1.43	2.21	18.30
1988	1.45	1.69	3.21	3.16	2.49	1.59	1.19	0.61	0.89	1.11	1.83	1.98	21.20
1989	1.61	1.19	1.56	2.40	0.51	0.75	0.77	0.38	0.66	0.99	1.27	1.86	13.93
1990	1.66	1.07	1.52	2.61	2.07	1.79	0.84	0.65	0.96	2.26	1.51	1.97	18.92
mean	2.05	1.67	2.20	2.80	2.24	1.29	0.86	0.77	1.04	1.76	1.85	2.04	20.57
min	0.70	0.67	0.83	2.34	0.51	0.75	0.37	0.19	0.31	0.75	0.61	1.31	13.93
max	3.07	2.37	3.21	3.29	3.38	2.00	1.58	1.76	1.73	2.99	3.17	2.93	26.02

Table D - 20
Petty Harbour - Period Average Energy (GWH) under Wettest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.29	1.55	2.52	3.33	2.96	0.97	0.35	0.15	0.48	0.77	0.79	1.34	17.48
1962	2.27	2.92	2.71	2.91	1.51	1.19	1.61	0.71	1.32	2.23	2.93	2.28	24.59
1963	2.60	2.44	1.36	3.10	2.55	1.24	0.89	1.12	1.51	1.03	1.81	2.21	21.86
1964	2.48	2.06	2.71	3.08	1.56	1.10	0.95	1.04	1.37	2.68	2.85	2.57	24.44
1965	3.29	2.12	2.71	2.97	2.08	1.15	0.51	0.24	0.60	1.18	2.13	1.89	20.86
1966	3.10	1.80	1.97	2.37	1.78	1.10	0.66	0.63	0.93	1.33	1.27	2.91	19.84
1967	2.86	2.59	2.90	3.29	3.13	1.00	0.35	0.14	1.05	1.16	1.60	1.54	21.62
1968	2.36	2.07	3.62	2.70	2.34	1.84	1.25	1.27	0.96	2.16	2.84	2.18	25.58
1969	3.07	2.70	3.56	2.89	2.75	1.27	0.91	1.41	2.03	2.74	2.70	2.24	28.26
1970	2.23	2.78	3.51	3.19	2.59	1.15	0.35	1.87	1.91	2.36	2.82	3.20	27.96
1971	3.08	2.16	2.10	3.24	0.99	0.87	1.26	1.00	1.41	1.45	3.18	2.31	23.05
1972	2.18	1.70	2.92	3.01	2.52	1.24	0.36	0.69	1.14	2.01	3.35	2.63	23.73
1973	2.35	1.90	2.97	2.64	2.19	1.61	0.80	1.10	1.49	1.96	1.73	1.60	22.33
1974	1.42	1.40	2.06	3.05	2.48	1.32	0.95	0.76	1.68	2.67	2.51	2.46	22.76
1975	2.23	1.23	2.34	2.80	2.65	1.31	0.44	0.69	1.40	2.67	1.84	1.82	21.42
1976	3.07	2.48	2.56	3.18	1.05	1.04	0.86	0.35	1.04	1.68	1.94	2.42	21.67
1977	3.18	2.13	1.95	2.44	1.45	1.09	0.68	0.26	1.25	1.47	0.91	1.91	18.71
1978	2.89	2.49	2.27	3.07	2.89	1.03	0.63	0.35	1.57	1.90	1.42	1.85	22.36
1979	2.39	1.88	2.89	3.06	2.19	0.94	0.37	0.70	1.28	2.43	2.26	2.17	22.56
1980	2.52	2.01	3.33	3.09	2.72	1.73	1.29	1.55	1.88	2.94	2.98	2.60	28.64
1981	3.53	2.40	2.95	2.65	0.69	1.10	1.35	0.79	1.61	3.13	3.14	2.82	26.17
1982	3.30	2.49	2.77	2.85	2.38	1.67	1.13	0.73	1.83	1.95	1.41	2.44	24.95
1983	2.93	2.60	3.47	3.47	1.47	1.05	0.97	0.91	1.71	1.98	2.37	2.07	24.97
1984	2.63	2.42	3.38	3.12	3.35	1.95	0.74	1.10	2.07	1.39	1.20	1.86	25.19
1985	2.29	1.80	1.65	2.51	2.78	1.57	1.02	0.68	0.82	1.10	1.33	1.73	19.29
1986	2.53	2.36	3.29	3.20	0.73	1.12	1.01	0.52	0.98	2.29	2.90	2.10	23.02
1987	2.63	2.59	2.44	3.43	1.77	0.81	0.33	0.36	0.93	0.77	1.69	2.32	20.05
1988	2.11	2.01	3.57	3.40	2.41	1.58	1.16	0.55	1.15	1.17	2.15	2.08	23.35
1989	2.22	1.51	2.19	2.42	0.36	0.74	0.77	0.35	0.89	1.02	1.53	1.96	15.96
1990	2.18	1.54	1.97	2.68	2.03	1.81	0.78	0.64	1.13	2.40	1.85	2.09	21.10
mean	2.61	2.14	2.69	2.97	2.08	1.25	0.82	0.75	1.31	1.87	2.11	2.19	22.79
min	1.42	1.23	1.36	2.37	0.36	0.74	0.33	0.14	0.48	0.77	0.79	1.34	15.96
max	3.53	2.92	3.62	3.47	3.35	1.95	1.61	1.87	2.07	3.13	3.35	3.20	28.64

Table D - 21
Petty Harbour - Period Average Energy (GWH) under Driest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.27	1.40	2.42	3.13	2.66	0.82	0.31	0.12	0.41	0.62	0.63	1.27	16.06
1962	2.15	2.60	2.43	2.53	1.29	1.06	1.35	0.64	1.15	1.97	2.64	2.01	21.80
1963	2.44	2.22	0.91	2.87	2.30	1.07	0.71	1.05	1.36	0.87	1.47	1.94	19.19
1964	2.35	1.92	2.04	2.71	1.36	0.93	0.72	0.96	1.21	2.46	2.61	2.11	21.37
1965	3.07	1.89	2.20	2.71	1.89	1.01	0.33	0.20	0.51	1.02	1.84	1.61	18.29
1966	2.99	1.68	1.62	2.19	1.64	0.93	0.45	0.56	0.82	1.21	1.03	2.53	17.65
1967	2.71	2.25	2.26	2.96	2.81	0.83	0.31	0.11	0.94	0.99	1.28	1.38	18.82
1968	2.29	1.94	3.13	2.29	2.05	1.67	1.05	1.20	0.84	1.90	2.55	1.93	22.83
1969	2.95	2.47	3.08	2.58	2.45	1.09	0.71	1.33	1.88	2.51	2.33	2.02	25.39
1970	2.05	2.52	3.17	3.07	2.41	1.03	0.32	1.81	1.83	2.14	2.48	2.71	25.54
1971	2.85	1.96	1.81	2.85	0.77	0.73	1.00	0.91	1.29	1.25	2.82	2.00	20.23
1972	2.04	1.52	2.33	2.72	2.22	1.07	0.30	0.64	1.02	1.77	3.11	2.23	20.96
1973	2.21	1.78	2.24	2.37	2.01	1.47	0.60	1.03	1.35	1.73	1.45	1.45	19.66
1974	1.34	1.30	1.66	2.85	2.13	1.11	0.71	0.68	1.52	2.45	2.15	2.18	20.08
1975	2.10	1.03	2.06	2.52	2.30	1.13	0.30	0.63	1.24	2.41	1.55	1.60	18.87
1976	2.98	2.19	2.27	2.80	0.87	0.91	0.66	0.29	0.89	1.46	1.62	2.15	19.09
1977	2.93	1.90	1.54	2.22	1.29	0.92	0.47	0.20	1.11	1.24	0.69	1.71	16.21
1978	2.80	2.22	2.06	2.68	2.63	0.89	0.44	0.29	1.36	1.67	1.18	1.67	19.88
1979	2.29	1.71	2.63	2.77	1.98	0.82	0.25	0.64	1.15	2.24	1.99	1.90	20.37
1980	2.41	1.87	2.91	2.67	2.47	1.55	1.06	1.48	1.74	2.74	2.76	2.08	25.74
1981	3.38	2.20	2.48	2.39	0.59	0.96	1.11	0.72	1.44	2.99	2.82	2.39	23.47
1982	3.15	2.18	2.29	2.55	2.11	1.55	0.96	0.67	1.67	1.82	1.19	2.10	22.25
1983	2.79	2.30	3.15	3.08	1.09	0.88	0.72	0.83	1.55	1.87	2.10	1.82	22.18
1984	2.49	2.17	2.75	2.91	3.06	1.67	0.56	1.03	1.92	1.19	0.95	1.64	22.34
1985	2.19	1.64	1.16	2.33	2.56	1.35	0.78	0.58	0.69	0.92	1.07	1.52	16.79
1986	2.46	2.17	2.87	2.93	0.57	1.00	0.80	0.47	0.86	2.04	2.64	1.75	20.55
1987	2.49	2.30	2.29	3.18	1.51	0.68	0.22	0.31	0.81	0.62	1.39	2.00	17.80
1988	2.00	1.84	3.27	3.09	2.02	1.40	0.93	0.49	1.00	0.97	1.79	1.81	20.61
1989	2.12	1.42	1.65	2.24	0.25	0.61	0.55	0.29	0.79	0.86	1.25	1.68	13.69
1990	2.09	1.34	1.59	2.45	1.80	1.56	0.56	0.55	1.03	2.23	1.52	1.84	18.54
mean	2.48	1.93	2.28	2.69	1.84	1.09	0.64	0.69	1.18	1.67	1.83	1.90	20.21
min	1.34	1.03	0.91	2.19	0.25	0.61	0.22	0.11	0.41	0.62	0.63	1.27	13.69
max	3.38	2.60	3.27	3.18	3.06	1.67	1.35	1.81	1.92	2.99	3.11	2.71	25.74

Table D - 22
Petty Harbour - Period Average Energy (GWH) under Warmest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.40	1.59	2.44	3.18	2.82	0.89	0.33	0.13	0.43	0.63	0.65	1.30	16.77
1962	2.30	2.78	2.50	2.63	1.33	1.14	1.34	0.60	1.22	1.98	2.69	2.08	22.58
1963	2.54	2.41	0.96	2.92	2.47	1.21	0.73	1.04	1.43	0.89	1.53	2.07	20.21
1964	2.52	2.02	2.13	2.78	1.45	1.04	0.73	0.95	1.28	2.46	2.64	2.22	22.22
1965	3.24	2.10	2.28	2.76	2.02	1.10	0.34	0.19	0.54	1.02	1.89	1.71	19.19
1966	3.15	1.86	1.65	2.22	1.77	1.06	0.48	0.55	0.85	1.22	1.06	2.70	18.57
1967	2.85	2.46	2.33	3.03	3.00	0.92	0.33	0.13	0.99	1.00	1.33	1.45	19.82
1968	2.38	2.03	3.20	2.34	2.25	1.84	1.12	1.20	0.88	1.91	2.60	2.02	23.76
1969	3.10	2.64	3.17	2.64	2.63	1.22	0.70	1.32	1.95	2.52	2.38	2.09	26.35
1970	2.25	2.65	3.28	3.14	2.58	1.14	0.35	1.81	1.86	2.15	2.53	2.88	26.60
1971	3.06	2.20	1.83	2.97	0.85	0.82	0.99	0.88	1.33	1.26	2.89	2.10	21.18
1972	2.23	1.65	2.41	2.79	2.39	1.21	0.34	0.64	1.07	1.78	3.17	2.35	22.03
1973	2.36	1.87	2.42	2.42	2.17	1.63	0.68	1.04	1.42	1.74	1.49	1.50	20.73
1974	1.52	1.44	1.68	2.89	2.31	1.25	0.73	0.69	1.59	2.46	2.18	2.29	21.04
1975	2.28	1.23	2.10	2.57	2.50	1.26	0.34	0.63	1.31	2.42	1.57	1.68	19.90
1976	3.09	2.42	2.33	2.87	0.91	1.00	0.68	0.27	0.95	1.47	1.65	2.27	19.90
1977	3.12	2.11	1.60	2.26	1.40	1.04	0.48	0.19	1.18	1.28	0.72	1.79	17.17
1978	2.90	2.44	2.10	2.75	2.74	0.97	0.42	0.24	1.46	1.69	1.21	1.73	20.66
1979	2.40	1.87	2.67	2.84	2.14	0.92	0.28	0.64	1.21	2.24	2.02	2.00	21.22
1980	2.58	1.97	3.00	2.74	2.66	1.73	1.09	1.48	1.81	2.75	2.80	2.20	26.79
1981	3.51	2.41	2.57	2.42	0.65	1.09	1.13	0.70	1.52	2.99	2.85	2.51	24.34
1982	3.32	2.42	2.38	2.59	2.34	1.69	1.05	0.67	1.76	1.84	1.23	2.23	23.51
1983	2.94	2.51	3.20	3.17	1.25	1.00	0.72	0.82	1.63	1.87	2.13	1.91	23.13
1984	2.61	2.33	2.85	2.95	3.28	1.93	0.64	1.04	2.00	1.23	0.99	1.73	23.56
1985	2.37	1.80	1.20	2.37	2.74	1.53	0.81	0.59	0.75	0.94	1.10	1.60	17.80
1986	2.56	2.30	2.96	3.01	0.63	1.10	0.83	0.44	0.91	2.05	2.68	1.83	21.29
1987	2.66	2.47	2.32	3.27	1.67	0.75	0.25	0.28	0.85	0.63	1.44	2.14	18.73
1988	2.18	1.95	3.35	3.16	2.20	1.58	1.00	0.49	1.07	0.99	1.84	1.92	21.72
1989	2.29	1.50	1.73	2.26	0.28	0.69	0.57	0.27	0.83	0.86	1.28	1.78	14.33
1990	2.20	1.49	1.65	2.51	1.97	1.79	0.66	0.57	1.07	2.25	1.54	1.94	19.63
mean	2.63	2.10	2.34	2.75	1.98	1.22	0.67	0.68	1.24	1.68	1.87	2.00	21.16
min	1.52	1.23	0.96	2.22	0.28	0.69	0.25	0.13	0.43	0.63	0.65	1.30	14.33
max	3.51	2.78	3.35	3.27	3.28	1.93	1.34	1.81	2.00	2.99	3.17	2.88	26.79

Table D - 23
Petty Harbour - Period Average Energy (GWH) under Coldest Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.00	1.31	2.34	3.00	2.67	0.85	0.31	0.12	0.39	0.75	0.68	1.31	15.71
1962	1.96	2.55	2.36	2.47	1.27	1.06	1.32	0.59	1.10	2.14	2.75	2.12	21.69
1963	2.37	2.20	0.76	2.89	2.38	1.12	0.73	0.96	1.26	0.97	1.58	2.10	19.32
1964	2.11	1.90	1.86	2.70	1.38	0.95	0.71	0.87	1.13	2.57	2.71	2.27	21.14
1965	2.92	1.84	1.98	2.71	1.93	1.04	0.36	0.19	0.48	1.15	1.94	1.74	18.28
1966	2.79	1.63	1.41	2.18	1.71	0.97	0.45	0.49	0.74	1.28	1.11	2.73	17.49
1967	2.58	2.20	2.08	2.94	2.89	0.90	0.32	0.12	0.92	1.12	1.41	1.46	18.94
1968	2.07	1.89	2.93	2.24	2.15	1.70	1.06	1.10	0.74	2.06	2.66	2.05	22.65
1969	2.76	2.41	2.81	2.53	2.53	1.15	0.72	1.21	1.76	2.65	2.46	2.12	25.10
1970	1.87	2.48	3.08	3.05	2.51	1.08	0.34	1.62	1.72	2.27	2.60	2.91	25.51
1971	2.70	1.91	1.67	2.84	0.77	0.73	0.96	0.80	1.18	1.36	2.97	2.13	20.02
1972	1.80	1.47	2.16	2.70	2.25	1.11	0.31	0.58	0.95	1.92	3.21	2.40	20.85
1973	1.99	1.76	2.06	2.35	2.11	1.50	0.61	0.92	1.24	1.86	1.53	1.51	19.43
1974	1.04	1.25	1.40	2.84	2.20	1.15	0.71	0.63	1.44	2.57	2.27	2.32	19.82
1975	1.85	0.97	1.91	2.51	2.39	1.18	0.31	0.57	1.16	2.58	1.65	1.70	18.78
1976	2.84	2.14	2.10	2.74	0.85	0.91	0.66	0.26	0.86	1.60	1.72	2.29	18.96
1977	2.86	1.87	1.39	2.24	1.35	0.94	0.47	0.19	1.10	1.38	0.76	1.81	16.34
1978	2.71	2.18	1.92	2.61	2.58	0.90	0.44	0.25	1.33	1.81	1.25	1.75	19.73
1979	2.21	1.67	2.51	2.73	2.06	0.86	0.26	0.57	1.08	2.35	2.10	2.03	20.40
1980	2.18	1.83	2.74	2.57	2.57	1.61	1.06	1.37	1.66	2.84	2.84	2.28	25.55
1981	3.30	2.15	2.24	2.38	0.61	0.96	1.07	0.65	1.37	3.07	2.93	2.58	23.30
1982	2.98	2.10	2.14	2.55	2.25	1.59	0.99	0.62	1.63	1.88	1.26	2.27	22.27
1983	2.66	2.24	2.97	3.01	1.14	0.92	0.71	0.74	1.48	1.91	2.21	1.93	21.94
1984	2.34	2.13	2.52	2.90	3.17	1.74	0.60	0.93	1.82	1.30	1.02	1.74	22.20
1985	1.93	1.57	0.92	2.33	2.66	1.40	0.77	0.55	0.63	1.05	1.16	1.62	16.59
1986	2.32	2.08	2.74	2.88	0.55	0.99	0.79	0.43	0.82	2.19	2.75	1.89	20.42
1987	2.29	2.25	2.24	3.09	1.54	0.71	0.23	0.27	0.77	0.74	1.49	2.17	17.80
1988	1.74	1.81	3.13	3.05	2.09	1.41	0.93	0.46	0.96	1.11	1.91	1.94	20.52
1989	1.89	1.38	1.44	2.23	0.23	0.59	0.53	0.25	0.76	0.99	1.34	1.82	13.45
1990	1.93	1.29	1.46	2.46	1.89	1.62	0.60	0.51	0.99	2.32	1.67	1.97	18.69
mean	2.30	1.88	2.11	2.66	1.89	1.12	0.64	0.63	1.12	1.79	1.93	2.03	20.10
min	1.04	0.97	0.76	2.18	0.23	0.59	0.23	0.12	0.39	0.74	0.68	1.31	13.45
max	3.30	2.55	3.13	3.09	3.17	1.74	1.32	1.62	1.82	3.07	3.21	2.91	25.55

Table D - 24

Petty Harbour - Period Average Energy (GWH) under Middle Climate Scenario

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1961	2.22	1.43	2.40	3.10	2.71	0.86	0.32	0.12	0.41	0.67	0.65	1.29	16.17
1962	2.16	2.64	2.43	2.54	1.29	1.09	1.33	0.61	1.16	2.03	2.69	2.06	22.03
1963	2.45	2.28	0.87	2.89	2.38	1.13	0.72	1.01	1.34	0.91	1.53	2.04	19.55
1964	2.33	1.95	2.01	2.72	1.39	0.97	0.72	0.92	1.20	2.50	2.66	2.20	21.55
1965	3.08	1.95	2.14	2.73	1.94	1.06	0.34	0.19	0.51	1.06	1.89	1.68	18.56
1966	2.99	1.71	1.55	2.19	1.70	0.99	0.46	0.53	0.80	1.24	1.06	2.66	17.87
1967	2.71	2.30	2.22	2.97	2.89	0.89	0.32	0.12	0.95	1.03	1.34	1.44	19.18
1968	2.27	1.96	3.07	2.29	2.14	1.74	1.07	1.17	0.82	1.96	2.60	1.98	23.05
1969	2.94	2.51	3.02	2.58	2.54	1.15	0.71	1.27	1.86	2.55	2.38	2.07	25.57
1970	2.05	2.55	3.17	3.08	2.50	1.08	0.34	1.75	1.80	2.18	2.54	2.83	25.87
1971	2.88	2.03	1.77	2.88	0.79	0.76	0.98	0.86	1.26	1.29	2.89	2.08	20.45
1972	2.03	1.55	2.29	2.73	2.28	1.12	0.32	0.61	1.01	1.83	3.17	2.33	21.27
1973	2.19	1.80	2.23	2.38	2.09	1.52	0.62	0.98	1.34	1.78	1.49	1.48	19.89
1974	1.30	1.33	1.57	2.86	2.21	1.17	0.71	0.66	1.51	2.49	2.20	2.26	20.28
1975	2.08	1.09	2.03	2.53	2.39	1.19	0.31	0.61	1.24	2.47	1.58	1.66	19.17
1976	2.99	2.24	2.23	2.81	0.88	0.93	0.66	0.27	0.89	1.51	1.66	2.23	19.28
1977	2.97	1.96	1.51	2.24	1.34	0.96	0.46	0.19	1.13	1.30	0.72	1.76	16.54
1978	2.81	2.27	2.04	2.67	2.66	0.92	0.43	0.26	1.39	1.73	1.21	1.71	20.09
1979	2.30	1.74	2.60	2.77	2.05	0.86	0.26	0.62	1.14	2.28	2.03	1.98	20.62
1980	2.39	1.89	2.89	2.66	2.56	1.63	1.07	1.43	1.73	2.78	2.80	2.18	26.01
1981	3.40	2.24	2.42	2.39	0.61	1.00	1.10	0.69	1.44	3.02	2.86	2.50	23.65
1982	3.16	2.24	2.26	2.56	2.24	1.61	1.00	0.65	1.69	1.85	1.23	2.20	22.68
1983	2.80	2.36	3.10	3.09	1.15	0.94	0.71	0.79	1.55	1.89	2.15	1.89	22.42
1984	2.51	2.21	2.70	2.92	3.15	1.77	0.60	0.99	1.90	1.24	0.99	1.71	22.69
1985	2.17	1.68	1.09	2.34	2.65	1.43	0.78	0.57	0.68	0.96	1.10	1.58	17.02
1986	2.46	2.19	2.84	2.94	0.58	1.03	0.81	0.45	0.86	2.09	2.69	1.82	20.76
1987	2.49	2.34	2.28	3.19	1.56	0.71	0.23	0.28	0.81	0.67	1.44	2.11	18.10
1988	1.96	1.86	3.25	3.09	2.09	1.47	0.95	0.47	1.01	1.02	1.84	1.90	20.91
1989	2.11	1.43	1.60	2.24	0.25	0.62	0.55	0.27	0.79	0.91	1.28	1.75	13.80
1990	2.09	1.37	1.57	2.48	1.89	1.65	0.60	0.54	1.03	2.26	1.58	1.92	18.97
mean	2.48	1.97	2.24	2.69	1.90	1.14	0.65	0.66	1.17	1.72	1.88	1.98	20.47
min	1.30	1.09	0.87	2.19	0.25	0.62	0.23	0.12	0.41	0.67	0.65	1.29	13.80
max	3.40	2.64	3.25	3.19	3.15	1.77	1.33	1.75	1.90	3.02	3.17	2.83	26.01

Appendix E – Detailed Simulation Results

APPENDIX E

Detailed Simulation Results

This appendix provides more detailed descriptions of the ARSP simulation results. Two example years from two selected scenarios for each hydroelectric system are presented and discussed.

E.1 Description of Example Plots

Daily results of the ARSP model are generally best understood by examining operation in example years. In each of the following sections, examples of operation in wet and dry years under the Wettest and Coldest (maximum and minimum generation) scenarios are presented for comparison. This section describes the plots to assist the reader's understanding.

Each plot shows the operation of one system for one year in the normal period of analysis. The left axis of each plot is used for flow – inflow, power generation flow and spill, in units of m^3/s. The right axis is used to plot the reservoir level, in metres. The scales of the axis have been selected so that there is minimal overlap between values plotted on the two axes. All the plots for any one system are plotted with the same scales on the axes.

ARSP operates the reservoirs to keep the storage at a specified target or "rule curve" level. When the plots show a straight line for the reservoir level, this means the reservoir is at the rule curve, and is being operated to balance outflow with inflow. At NP systems, the rule curve is generally lower in spring than during the rest of the year, in anticipation of the known high spring inflows that will occur during snowmelt.

In stations with upstream storage reservoirs, inflow to the forebay can be set equal to power flow and the forebay level with then remain constant. When systems have only one reservoir, or just a small forebay, such as Rose Blanche, flows and levels vary more widely over time.

If inflow is above the power flow, such that the water level rises above the rule curve level, the reservoir spills to release the excess water. Thus, high inflows and high spillway flows in the bottom half of the graph are generally associated with high water levels in the top half of the graph.

When the reservoir level is at the rule curve, power flow will equal the inflow to the reservoir. During times of high inflows and spills, power flow would always be at a maximum, as operators would rather generate than spill. Some stations will have both a best-efficiency power flow and a maximum power flow. Ideal operation would have flows at the former, but during periods of spill, the maximum power flow would be routed.

E.2 Rose Blanche Brook System

Figures E.1 and E.2 provide examples of the operation of the Rose Blanche Brook generating station under two climate change scenarios (Wettest and Coldest) for two years (1969, a wet year and 1961, a dry year).

During 1969, the higher inflows in the Wettest scenarios lead to more generation, as well as higher and longer periods of high water levels. Because 1969 is already a wet year, the higher inflows as a result of climate change cannot always be used for generation – often the higher flows just lead to more spill.

During the dry year, 1961, there is actually more inflow and spill in the Coldest spring than in the Wettest, but the fall is drier. Again, most of the additional flow occurs during high reservoir levels and therefore is spilled rather than generated. Simulations investigating options to reduce spill by providing additional storage is investigated later in this report.

E.3 Lookout Brook System

Figures E.3 and E.4 show the operation of the Lookout Brook System under the Wettest and Coldest scenarios for both a wet (1969) and a dry (1961) year. The Lookout Brook system has an upstream reservoir (Joe Dennis Pond) which controls the amount of flow released into the forebay. As noted in the introductory section, upstream storage allows for more control over water level and flow in the forebay.

In the wet year, the difference in annual generation between the two scenarios was only 1.01GWh. The higher spring flows during the Wettest scenario are generally spilled rather than generated. The increase in generation comes from higher flows under the Wettest scenario from November to January. During the dry year, there was little spill under either scenario. The additional inflow in the Wettest Scenario can therefore be stored or generated, and the difference in generation between scenarios is more pronounced, 2.28 GWh.

E.4 Pierres Brook System

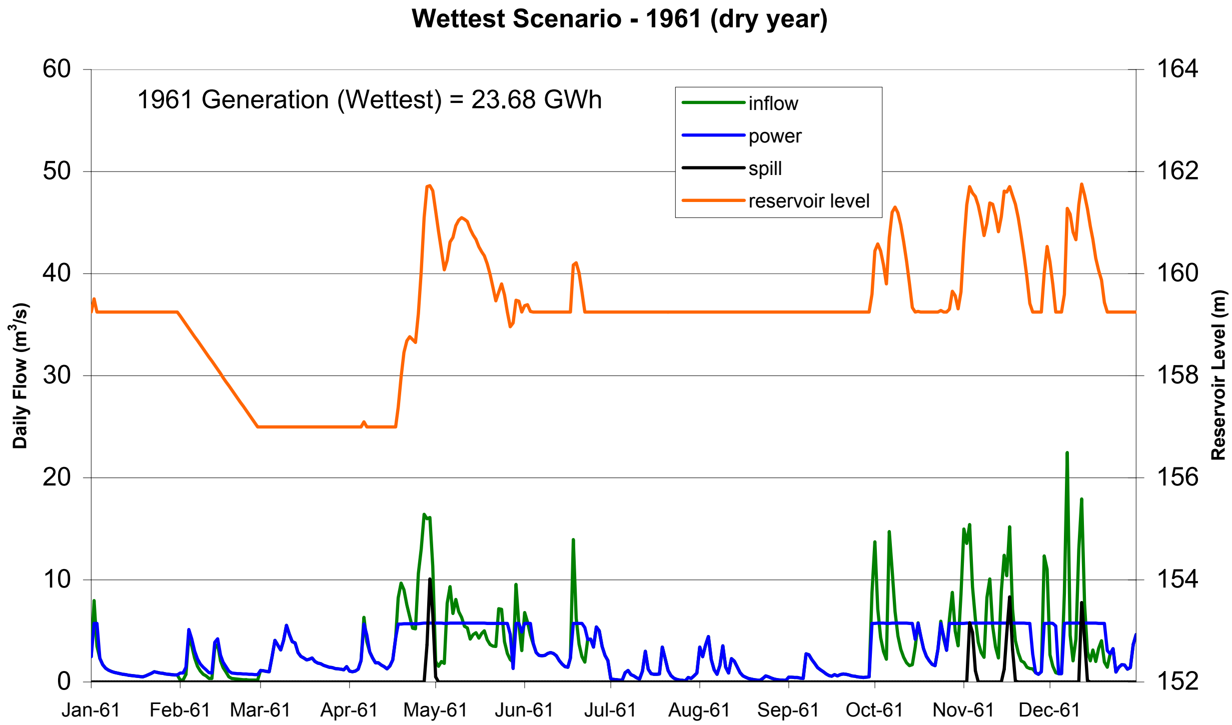
Figures E.5 to E.6 illustrate the operation of the Pierres Brook system under the Wettest and Coldest scenarios for both a wet (1969) and a dry (1961) year. In the wet year, the difference in annual generation between the two scenarios is 1.19 GWh. The higher spring inflows under the Wettest scenario are either spilled or generated. In the dry year, the difference in annual generation between the two climate change scenarios is 1.34 GWh. The extra generation realized under the Wettest scenario is produced mainly in early spring, since higher flows enable the system to generate at the maximum level earlier than under the Coldest scenario. Much of the excess water is still spilled in the Wettest case. There is no spill in the Coldest scenario.

E.5 Petty Harbour System

Figures E.7 to E.8 depict the annual operation of the Petty Harbour system under the Wettest and Coldest scenarios during a historically wet year (1969) and a historically dry year (1961). As shown, there is very little spill in either of the cases and this is true of most years under most scenarios.

In the wet year, higher flows throughout the year lead to 3.15 GWh more generation in the Wettest scenario than the Coldest scenario. This is the first case analyzed whereby the difference in generation among the climate change scenarios is greater than the natural variability over the 30-year period. During the wet year, storage allows the higher inflows experienced under the Wettest scenario to be stored or generated. Reservoir levels above the rule curve are short duration events.

During the dry year, 1961, the additional flow in the Wettest scenario is generally stored or generated, there is little spill under either scenario. Again the difference between generation in the two climate scenarios is quite high, 1.77 GWh.



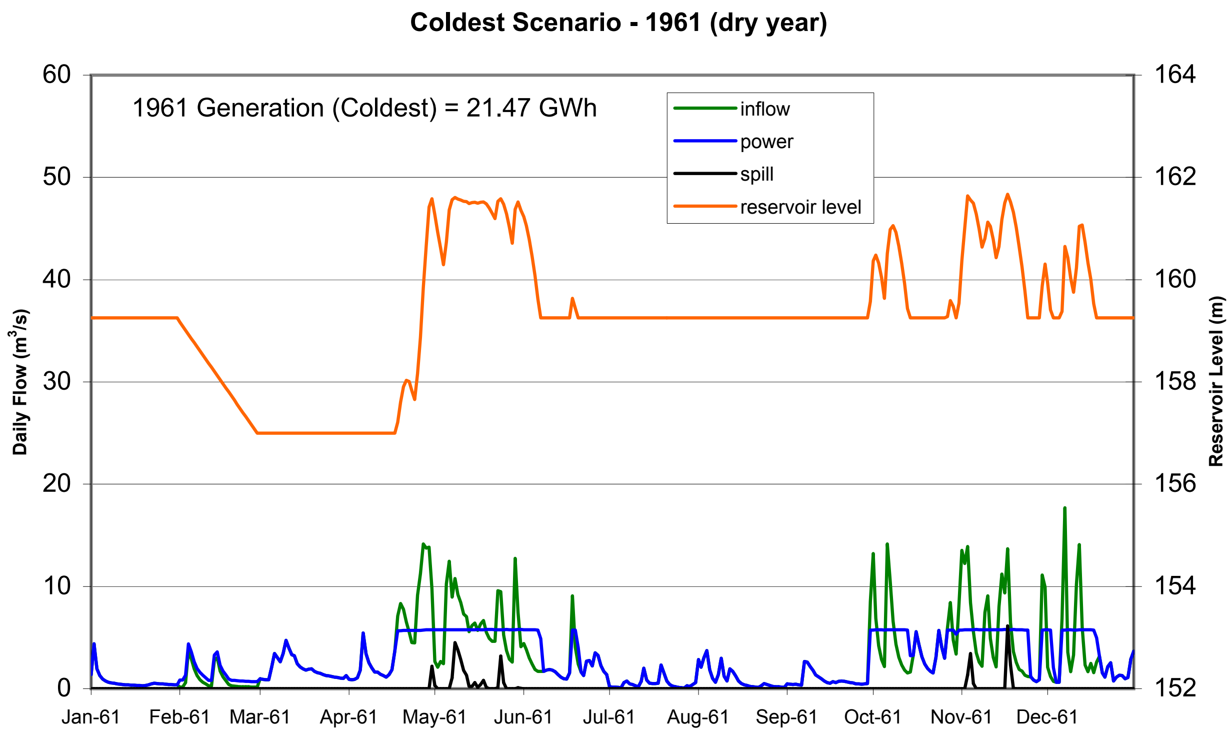


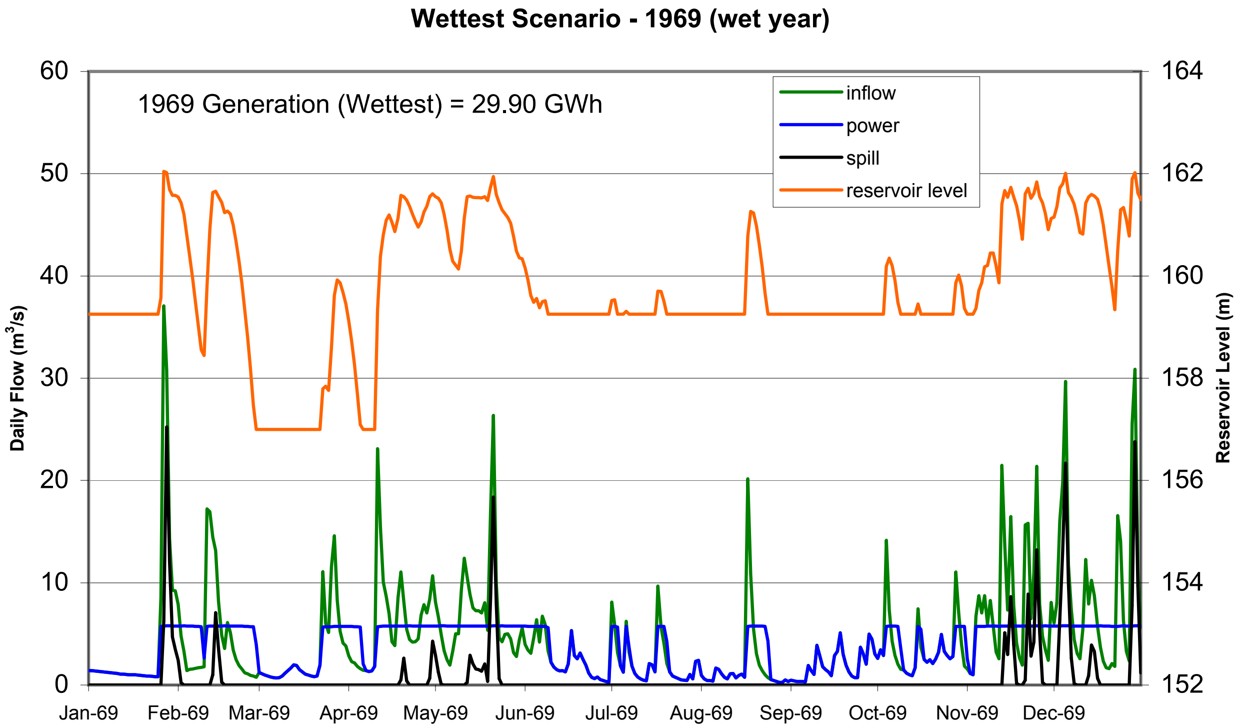
Figure E.1

Rose Blanche Brook Example Operation: Dry Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres



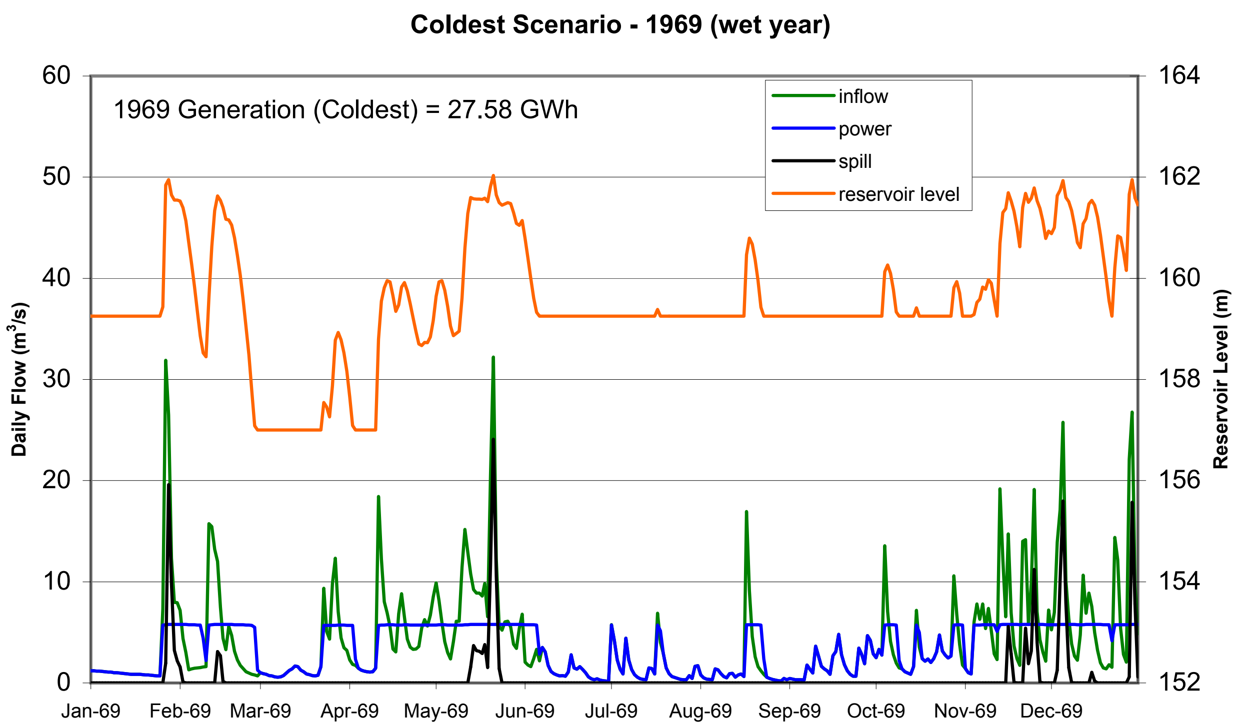


Figure E.2

Rose Blanche Brook Example Operation: Wet Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres

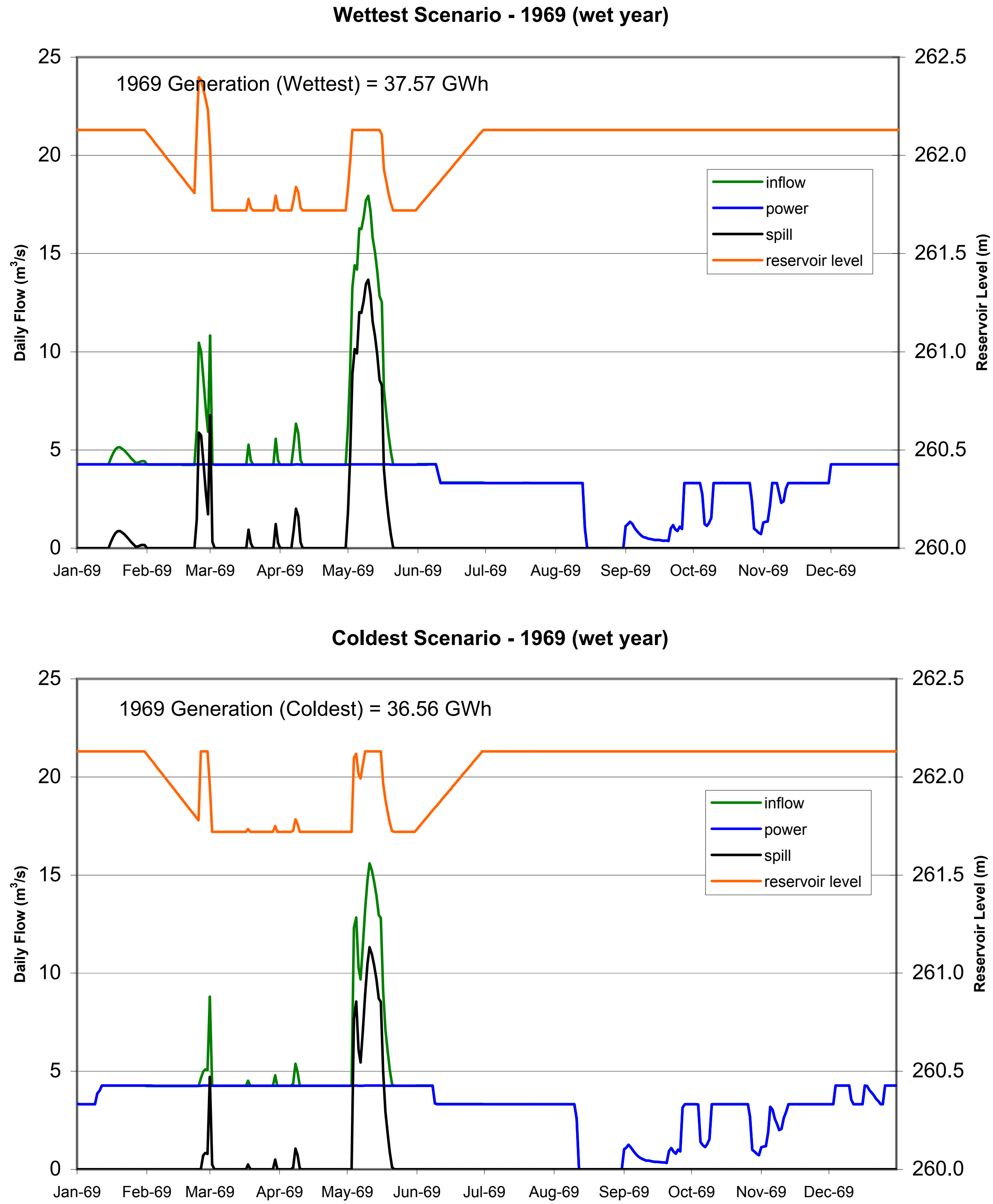


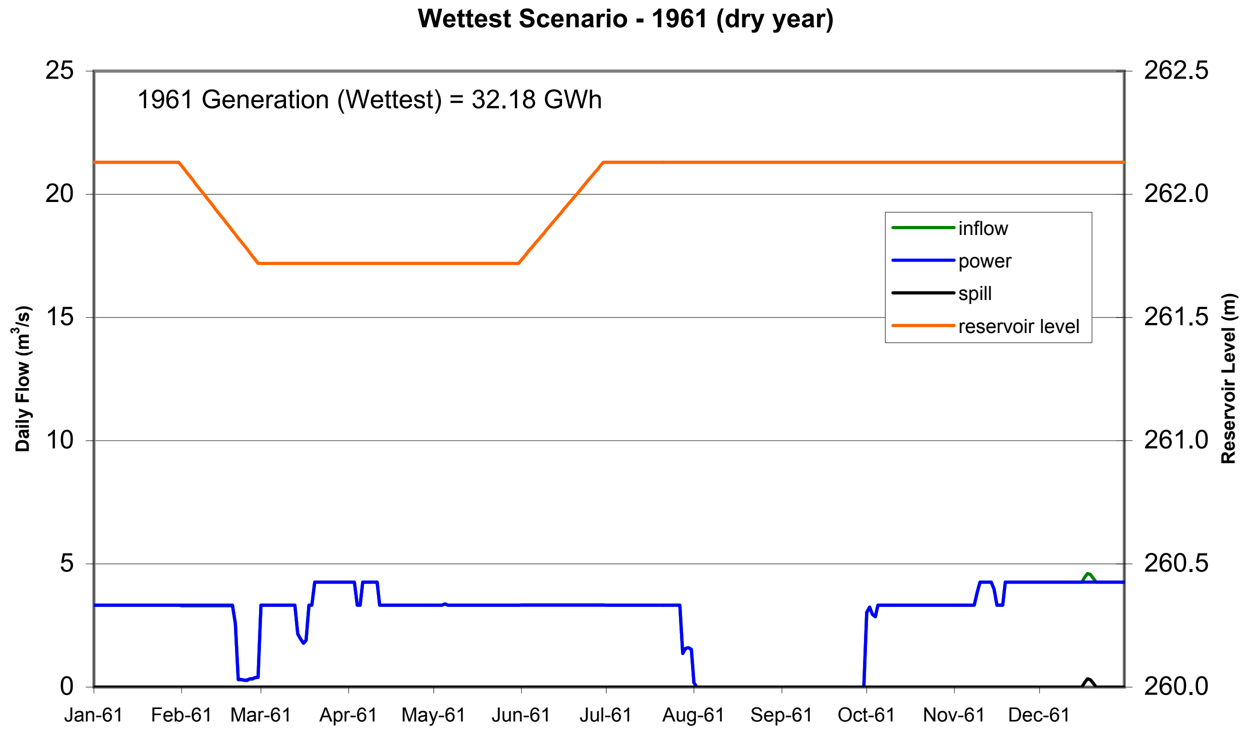
Figure E.3

Lookout Brook Example Operation: Wet Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres



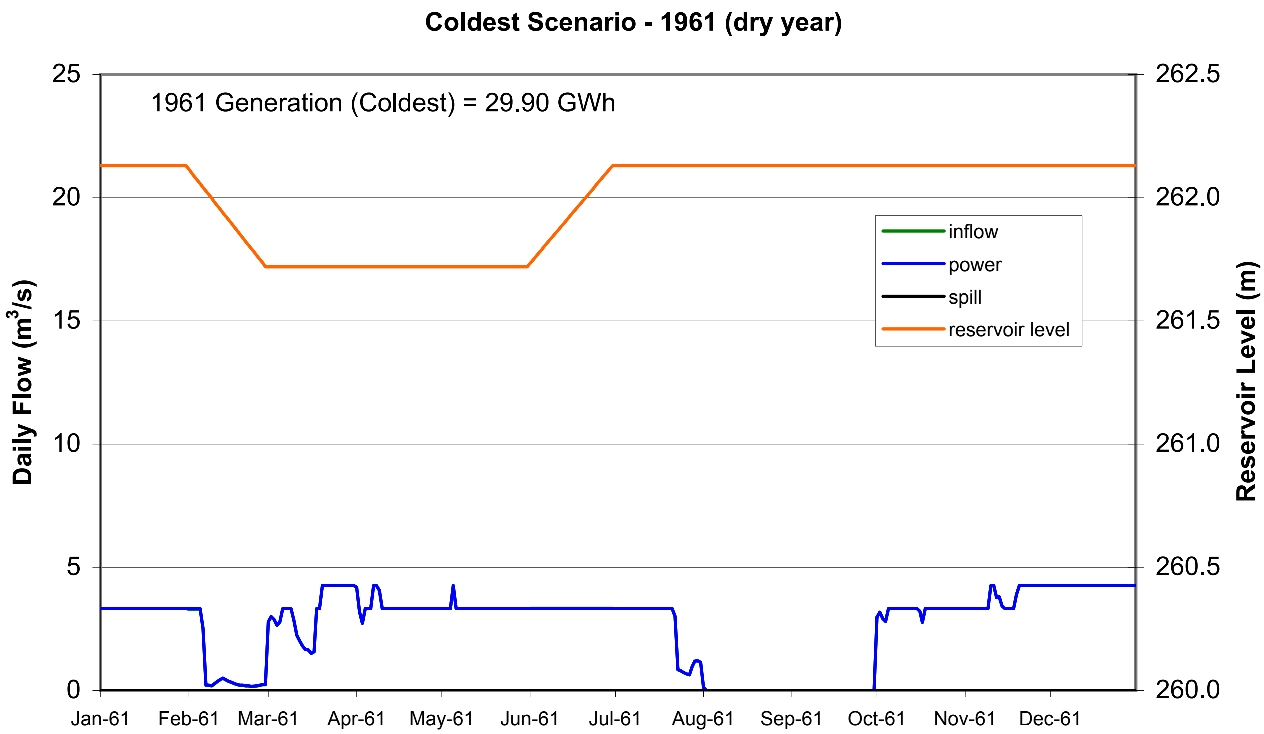


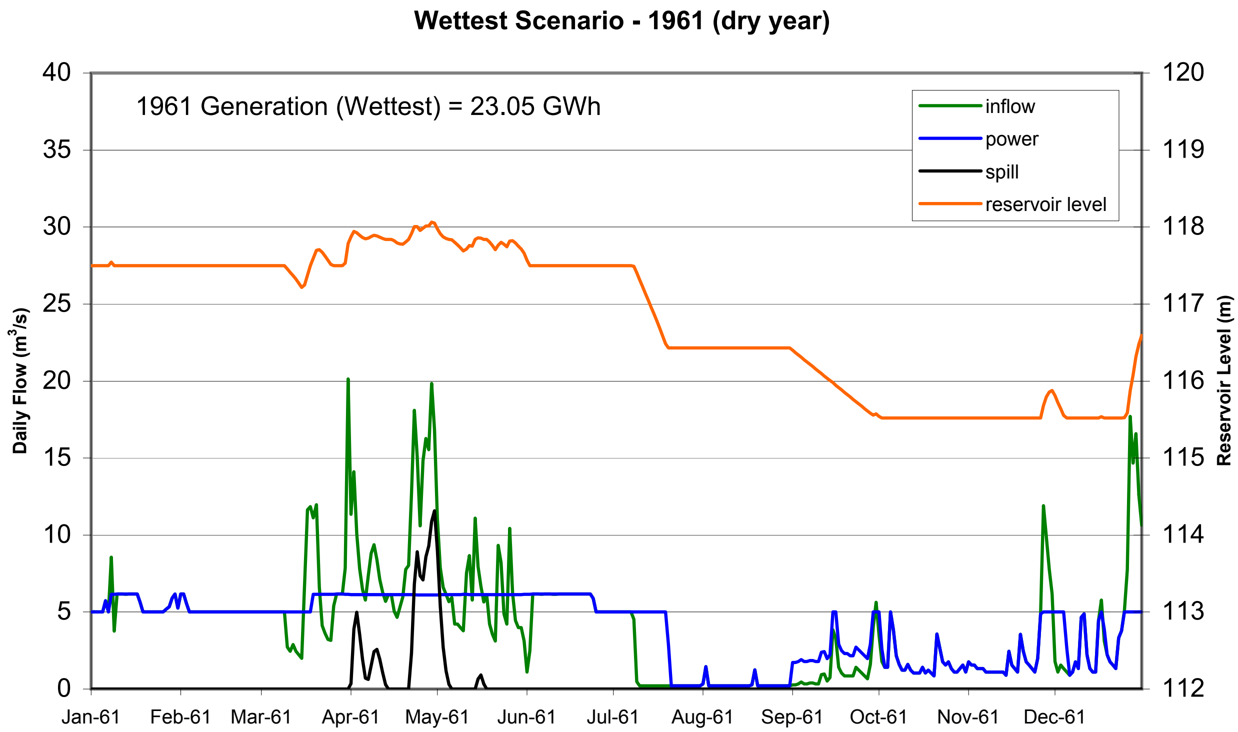
Figure E.4

Lookout Brook Example Operation: Dry Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

SGE Acres



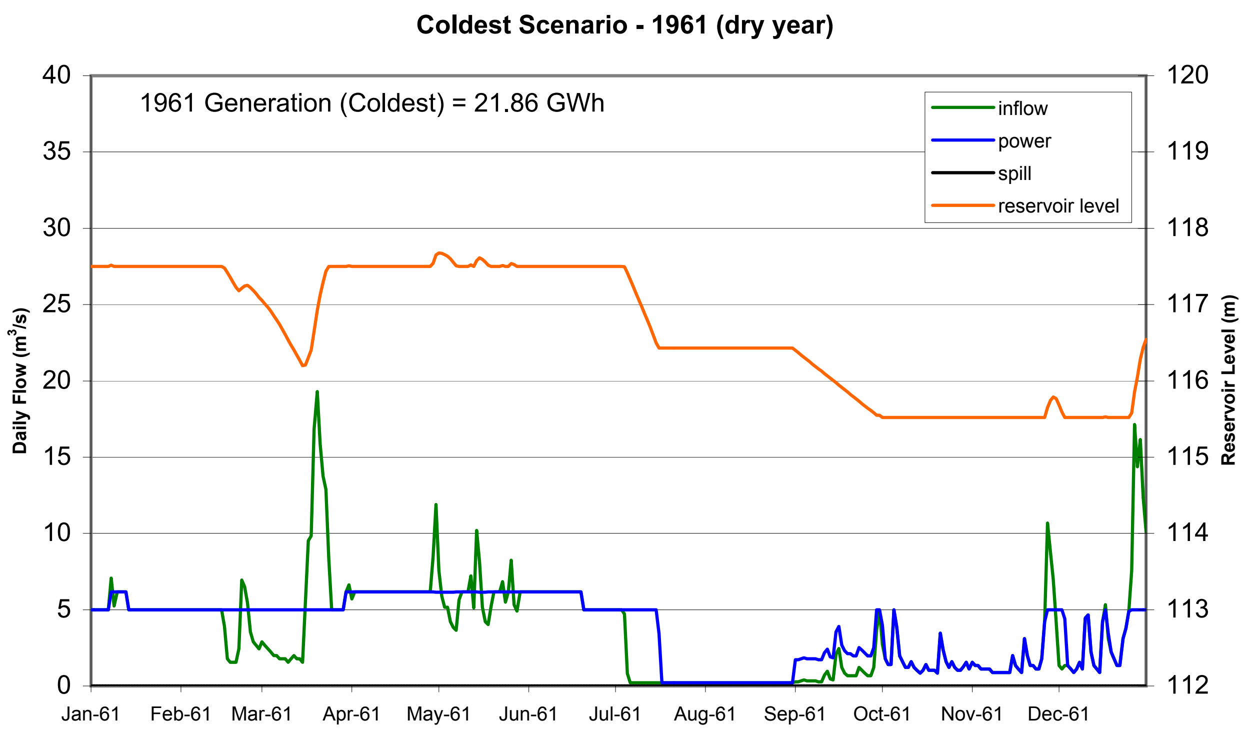


Figure E.5

Pierres Brook Example Operation: Dry Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

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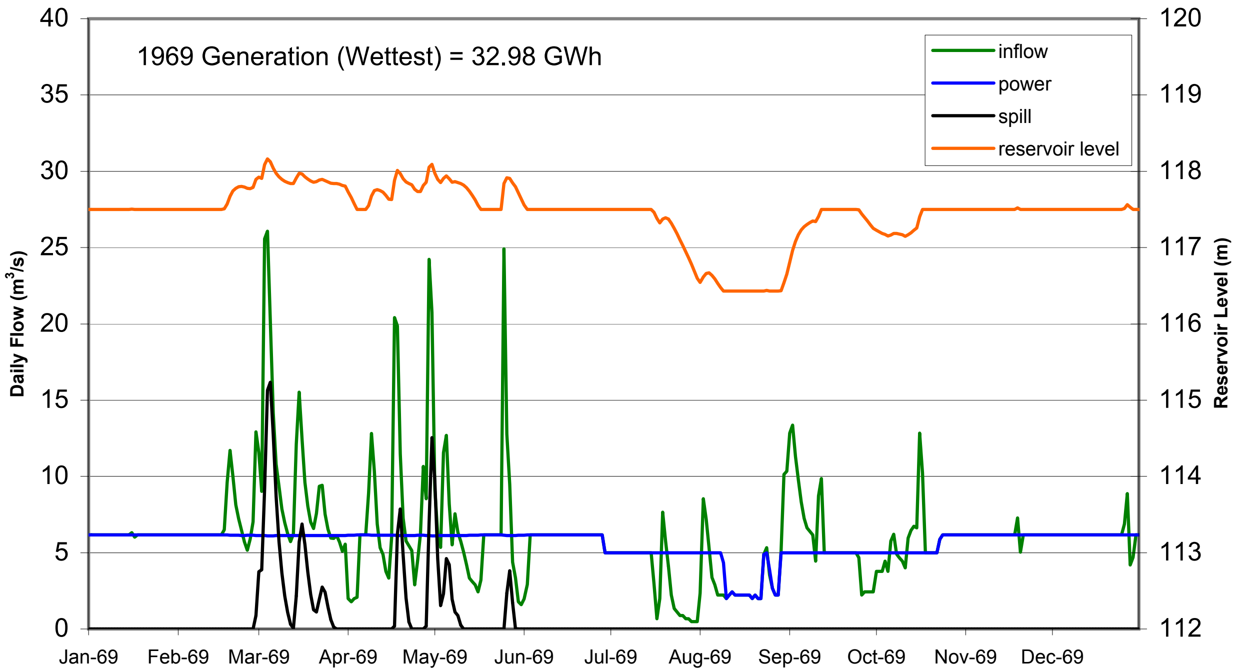
Wettest Scenario - 1969 (wet year)



Coldest Scenario - 1969 (wet year)

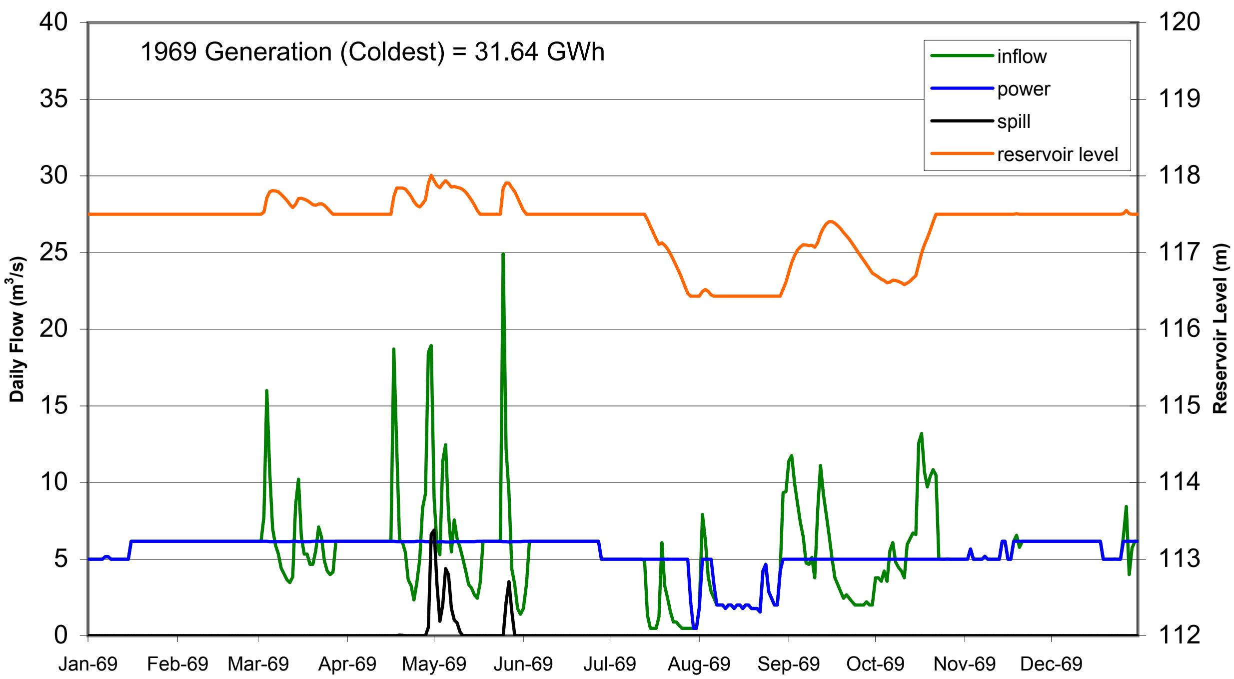


Figure E.6
Pierres Brook Example Operation: Wet Year
Impact of Climate Change on Hydroelectric Generation in Newfoundland
Climate Change Impacts and Adaptation Directorate

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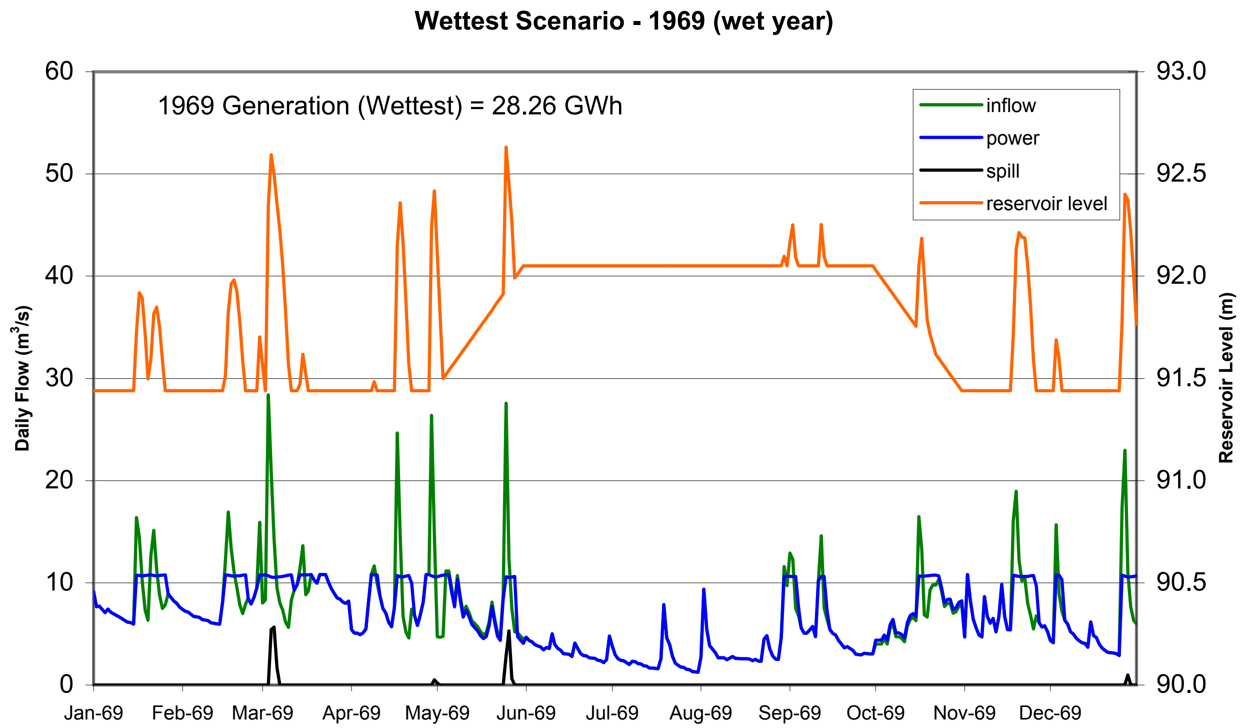

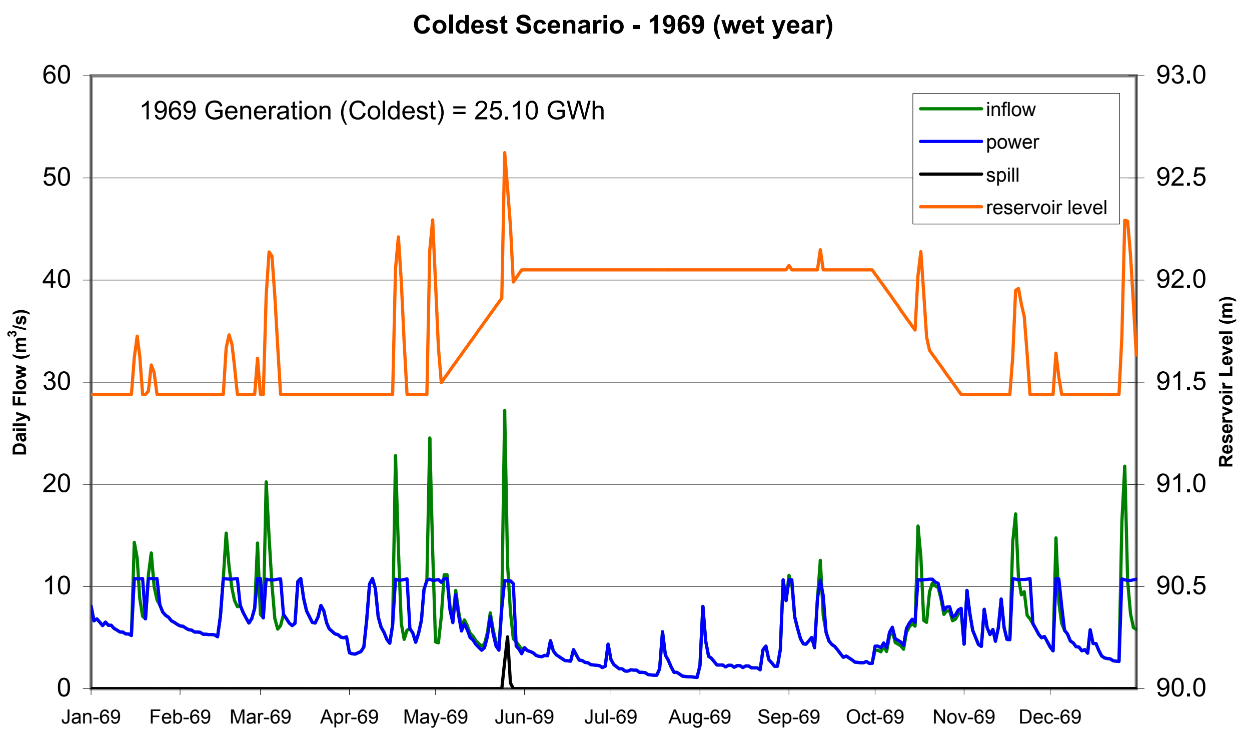

Figure E.7

Petty Harbour Example Operation: Wet Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

Climate Change Impacts and Adaptation Directorate

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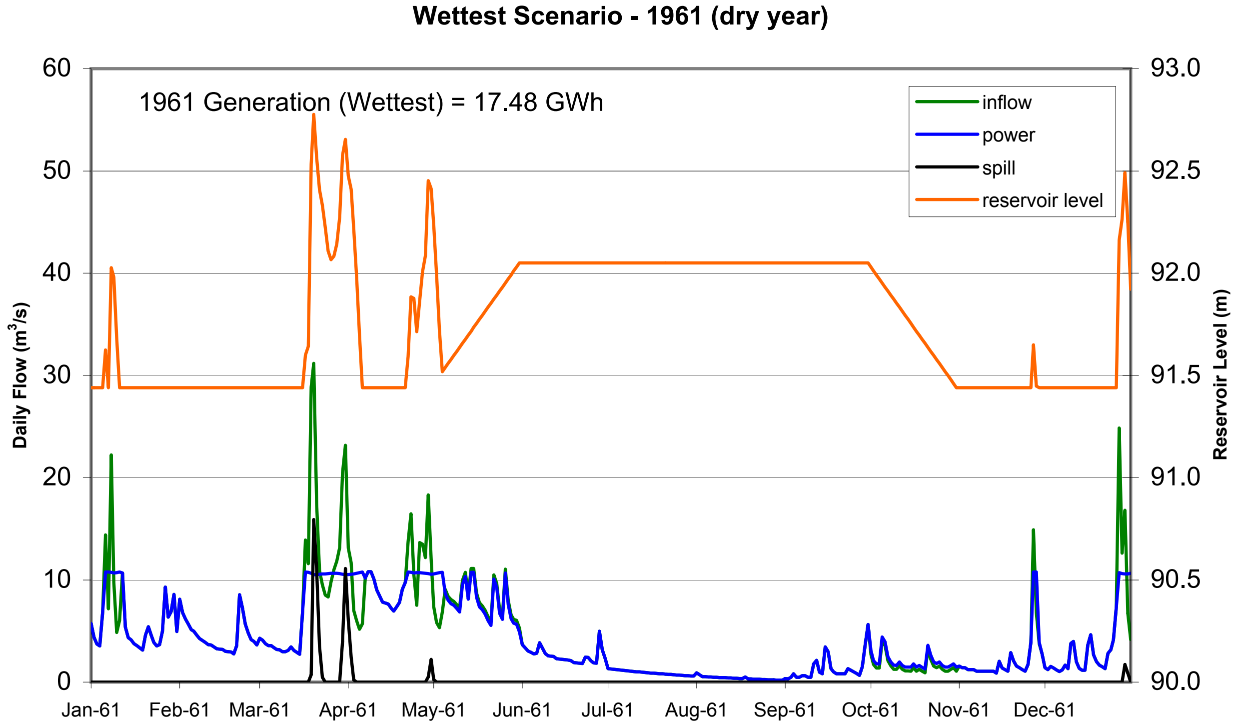

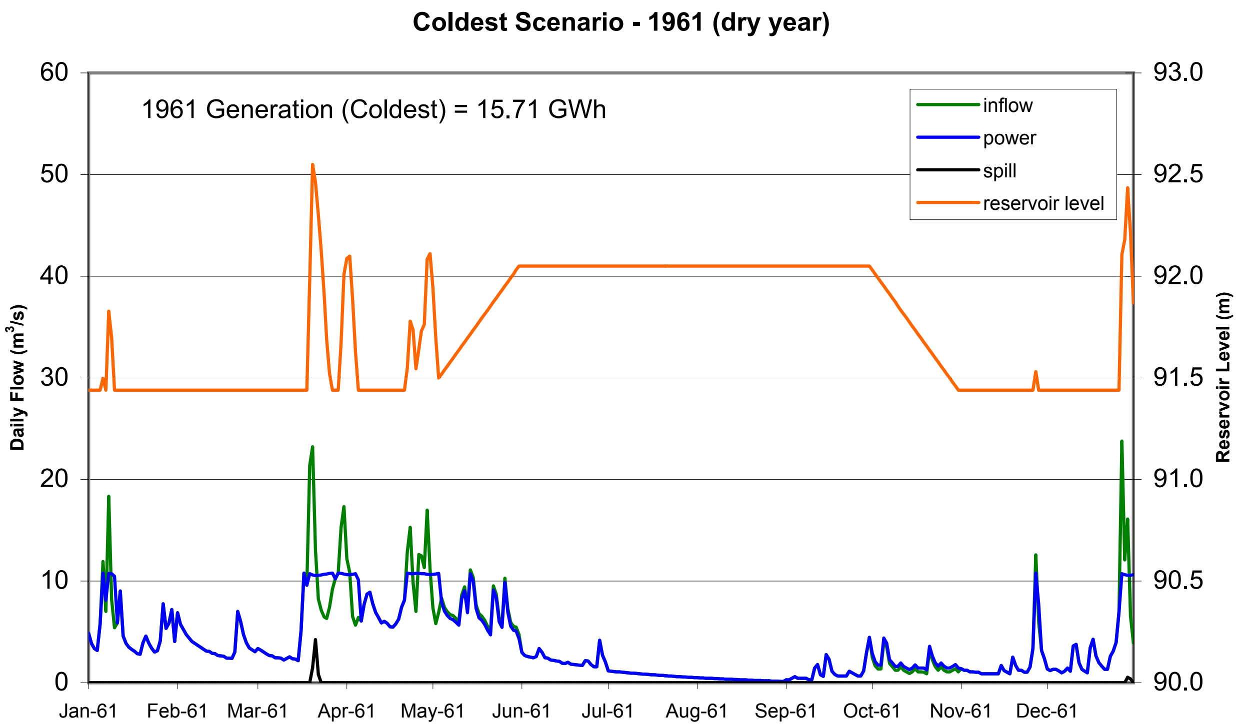

Figure E.8

Petty Harbour Example Operation: Dry Year

Impact of Climate Change on Hydroelectric Generation in Newfoundland

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