WHENEVER. WHEREVER.
We'll be there.

NEWFOUNDLAND POWER
A FORTIS COMPANY

February 1, 2022

Board of Commissioners
of Public Utilities
P.O. Box 21040
120 Torbay Road
St. John's, NL A1A 5B2

Attention: G. Cheryl Blundon
Director of Corporate Services
and Board Secretary

Dear Ms. Blundon:

**Re: Newfoundland Power's Normal Hydroelectric Production for 2022**

***Background***

In 2000, Newfoundland Power Inc. (the "Company") retained Acres International ("Acres"), a hydrology consultant, to review its hydroelectric generating systems with a view to determining an appropriate estimate of normal hydroelectric production ("Normal Hydroelectric Production"). The resulting water management study recommended Normal Hydroelectric Production of 423.1 GWh.

The study further recommended that Newfoundland Power should undertake a formal review of Normal Hydroelectric Production approximately every five years. In addition, the study recommended that Normal Hydroelectric Production be adjusted annually to reflect the impact on production of any scheduled outages in the year, and that adjustments also be made to reflect the impact on production of physical changes to the Company's hydroelectric facilities.

In 2015, the Company retained Acres' successor firm Hatch Ltd. ("Hatch") to update the hydrology studies that were completed in 2000 and 2010. The review completed by Hatch, which was filed with the Board in February 2017, recommended a Base Normal Hydroelectric Production of 438.6 GWh. In 2020, Newfoundland Power retained Hatch to conduct an updated Hydro Production Normal Review. The review was completed in April 2021 and recommended a Base Normal Hydroelectric Production of 438.4 GWh. A copy of the Hatch report is enclosed herewith.

***Annual Adjustment***

In 2022, the Company has scheduled the replacement of generator control systems at the Sandy Brook and Lookout Brook hydro plants which were approved in Order No. P.U. 36 (2021). To reflect projected spillage during the planned work, the Base Normal Hydroelectric Production

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figure of 438.4 GWh should be adjusted downward by 1.5 GWh. The Adjusted Normal Hydroelectric Production for 2022 is therefore 436.9 GWh.

***Concluding***

For ease of reference, the calculation of the Adjusted Normal Hydroelectric Production for 2022 is shown on the attached Schedule "A".

If there are any questions with respect to this matter, please contact the undersigned at the direct number noted below.

Yours very truly,

Dominic Foley
Legal Counsel

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**SCHEDULE "A"**

**NEWFOUNDLAND POWER INC.**
**ADJUSTMENTS TO NORMAL HYDROELECTRIC PRODUCTION (GWh)**

**2022**

| | |
|---|---|
| **Base Normal Hydroelectric Production** | **438.4** |
| *Less:* Estimated Lost Production from Scheduled Outages (2022) | 1.5 |
| **Adjusted Normal Hydroelectric Production** | **436.9** |

Newfoundland Power Inc.

# Final Report

For

# 2020 Hydro Normal Production Review

H364161-00000-228-230-0001
Rev. 0
April 28, 2021

# Newfoundland Power Inc.

# Final Report

For

# 2020 Hydro Normal Production Review

H364161-00000-228-230-0001
Rev. 0
April 28, 2021

# Final Report

# 2020 Hydro Normal Production Review

## H364161-00000-228-230-0001

PROVINCE OF NEWFOUNDLAND
PERMIT HOLDER
CLASS "A"
PEG Newfoundland and Labrador PROFESSIONAL ENGINEERS AND GEOSCIENTISTS
This Permit Allows
HATCH LTD.
MIRC # 4205
To practice Professional Engineering
in Newfoundland and Labrador
Permit No. as issued by PEG-NL D0090
which is valid for the year 2021

| | | | | | |
|---|---|---|---|---|---|
| | | | Michael Rosales | T. Chislett | T. Chislett |
| **2021-04-28** | **0** | **Approved for Use** | **M. Rosales** | **T. Chislett** | **T. Chislett** |
| **DATE** | **REV.** | **STATUS** | **PREPARED BY** | **CHECKED BY** | **APPROVED BY** |
| | | | | | |

# Important Notice to Reader

This report has been prepared by Hatch Ltd. (“Hatch”) for the sole and exclusive use of Newfoundland Power Inc. (the “Client”) for the purpose of assisting the management of the Client in making decisions with respect to Hydro Normal Production. This report must not be used by the Client for any other purpose. Any use of or reliance upon this report by another person is done at their sole risk and Hatch does not accept any responsibility or liability in connection with that person’s use or reliance.

This report contains the expression of the opinion of Hatch using its professional judgment and reasonable care based upon information available and conditions existing at the time of preparation of this report, and information made available to Hatch by the Client or by certain other parties (the “Client or Other Information”).

The use of or reliance upon this report is subject to the following:

1. This report is to be read in the context of and subject to the terms of the relevant services agreement dated October 26, 2020 between Hatch and the Client (the “Agreement”), including any methodologies, procedures, techniques, assumptions and other relevant terms or conditions specified in the Hatch Agreement.
2. This report is meant to be read as a whole, and sections of the report must not be read or relied upon out of context.
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4. Conditions may change over time (or may have already changed) due to natural forces or human intervention, and Hatch does not accept any responsibility for the impact that such changes may have on the accuracy or validity of the opinions, conclusions and recommendation set out in this report.

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# 1. Introduction

Newfoundland Power (NP) engaged Hatch Ltd. to undertake the 2020 Hydro Normal Production Review of its hydroelectric generating stations. This report presents the scope of work, the methodology, results, conclusions, and recommendations of the review.

## 1.1 Background

NP owns 23 hydroelectric generating stations on 19 river systems on the Island of Newfoundland, as shown in Figure 1-1.

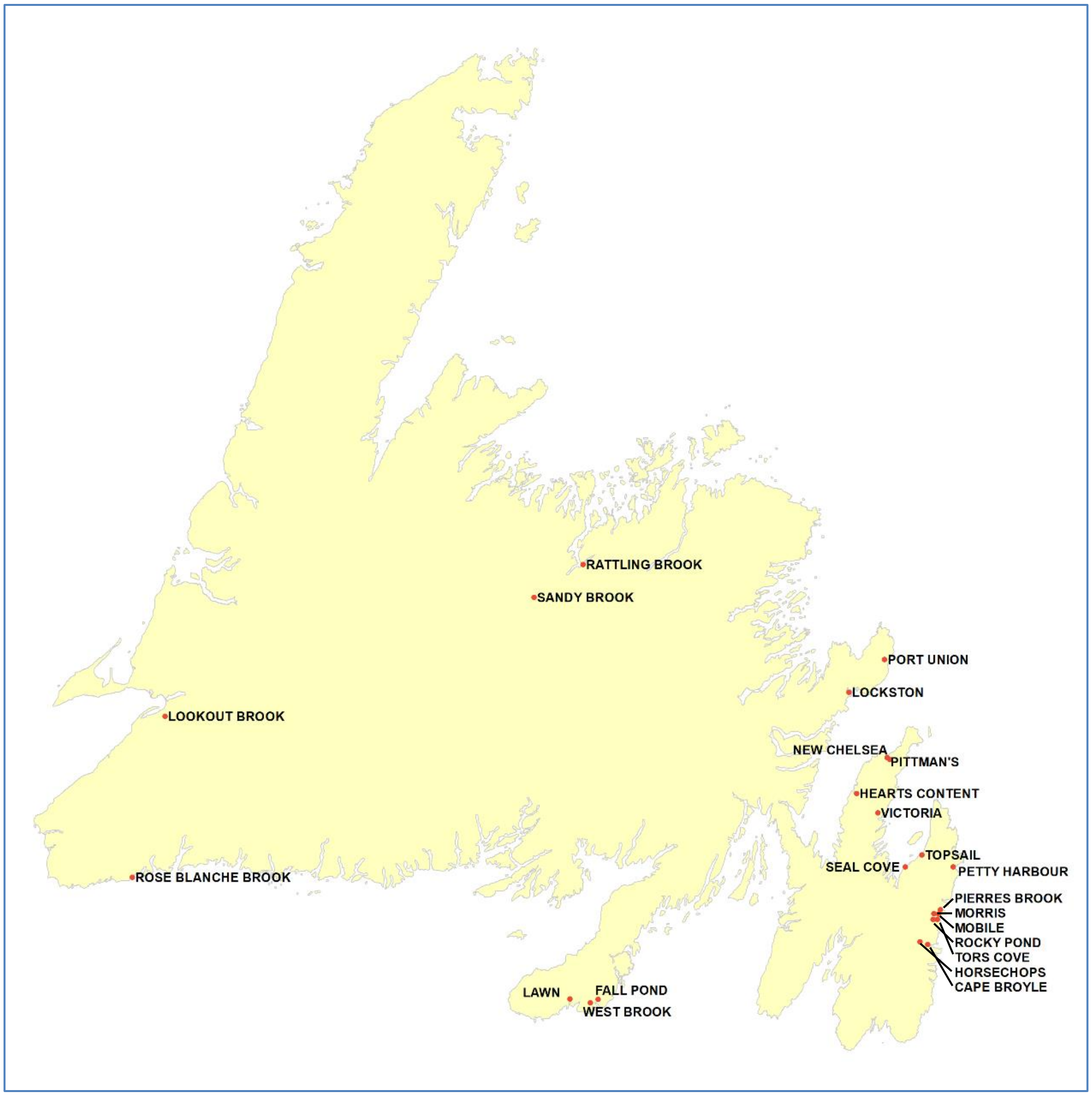


**Figure 1-1: Locations of NP Hydroelectric Generating Stations**

In 2000, Acres International (now Hatch Ltd.) carried out a Water Management Study (WMS), which included an energy assessment for the purpose of estimating the long-term average energy capability, or "normal production", available from NP's hydroelectric plants. The results were intended to be used as a benchmark against which to compare actual generation, which can vary widely on an annual basis, primarily due to the amount of water available in any given year. As part of the WMS, computer models of all 19 systems were developed using the Acres Reservoir Simulation Package (ARSP).

The variability in hydroelectric energy has a significant impact on the amount of energy NP purchases from Newfoundland and Labrador Hydro (NL Hydro) in order to meet the energy demands of its customers. In order to dampen out fluctuations in the prices it must charge, NP uses a Hydro Production Equalization Reserve, as mandated by the Board of Commissioners of Public Utilities. NP adjusts the reserve, based on the difference between recent actual generation and the estimated long-term average capability of the total system.

A recommendation from the 2000 study was that an update to the WMS be conducted every five years, to take into account any new hydrologic information as well as any recent changes to the physical or operating characteristics of the hydro systems.

The first update, in 2005, was conducted by SGE Acres (now Hatch). The second update, in 2010, was carried out "in house" by NP staff. The third update was carried out in 2015 by Hatch. The current study by Hatch is the fourth update of the original WMS estimate of the normal hydro production.

## 1.2 Scope of Work

The purpose of the current review is to update the estimate of normal production of NP's hydroelectric systems.

The scope of work includes power and energy modeling of the same ten systems (encompassing a total of 14 hydro plants) as the 2015 update. They include the eight largest systems, in terms of annual energy generation, plus two others (New Chelsea / Pittman's and Lockston) that have undergone physical or operational changes since 2010. These systems account for about 85 percent of NP's total hydro energy production:

- Horsechops / Cape Broyle
- Rattling Brook
- Morris / Mobile
- Rocky Pond / Tors Cove
- Lookout Brook
- Sandy Brook
- Pierre's Brook

- Rose Blanche
- New Chelsea / Pittman's
- Lockston

The contribution of the remaining systems (Petty Harbour, Seal Cove, Topsail, Heart's Content, Victoria, West Brook, Port Union, Lawn, and Fall Pond) to hydro normal production is assumed to be sufficiently small that any changes can be neglected for the purpose of this update.

The approach to the current update was as follows:

- Update model long-term hydrology.
- Revise ARSP models as required, including any physical or operational system changes since 2015.
- Review the "practical operation adjustment factor" by comparing simulated and recorded generation for a recent historical period.
- Estimate the normal production, based on total simulated energy of the long-term hydrology, minus the adjustment for practical operations and station service.
- Prepare a brief technical report with methodology, results, conclusions, and recommendations.

# 2. Hydrology Update

Time series of daily inflows to the various hydro systems are based on streamflow records at nearby Environment Canada (EC) gauging stations. For gauges that had insufficient record to cover the period being modelled, now 1984-2018 (35 years), the record was extended by correlating the data with nearby gauges in watersheds having similar characteristics. The 2000 WMS and subsequent reviews have not included calculation of hydro system inflows via back-calculation, as there is generally insufficient plant data to employ this method.

Once a complete record was obtained for each gauge needed, inflows at the various inflow points defined in each hydro system were calculated by applying appropriate proration factors to the streamflow records. The proration factors are based on the relative area associated with each inflow point to the drainage area of the gauge used, as well as relative differences in estimated mean annual runoff which are assumed to remain invariant over time. Thus, these factors have not changed since the original models were set up in 2000 and are not reported here.

The selection of gauges and descriptions of how the records were extended (in cases where that was necessary) are reported in the following sections.

## 2.1 Gauge Selection

Table 2-1 shows which EC gauge or gauges was/were used to develop the inflow series for each hydro system.

**Table 2-1: Reference Streamflow Gauges**

| Hydro System | EC Gauges |
|---|---|
| Horsechops / Cape Broyle | 02ZM009 |
| Rattling Brook | 02YO006 |
| Morris / Mobile | 02ZM009 |
| Rocky Pond / Tors Cove | 02ZM009 |
| Lookout Brook | 02ZA001<br>(extended by correlation to 02YN002) |
| Sandy Brook | 02YO008 |
| Pierre's Brook | 02ZM008<br>(extended by correlation to 02ZM009) |
| Rose Blanche | 02ZB001 |
| New Chelsea / Pittman's | 02ZL005<br>(extended by correlation to 02ZL004) |
| Lockston | 02ZJ002 |

The characteristics of these gauges are shown in Table 2-2.

**Table 2-2: Environment Canada Streamflow Gauge Characteristics**

| Gauge ID | Description | Status | Drainage Area (km$^2$) | First Year | Last Year |
|---|---|---|---|---|---|
| 02YO006 | Peters River near Botwood | Active | 177 | 1981 | 2018 |
| 02YO008 | Great Rattling Brook above Tote River Confluence | Active | 773 | 1984 | 2018 |
| 02YN002 | Lloyds River below King George IV Lake | Active | 469 | 1981 | 2018 |
| 02ZA001 | Little Barachois Brook near St. George's | Discontinued | 343 | 1978 | 1997 |
| 02ZA002 | Highlands River at Trans-Canada Hwy | Active | 72 | 1982 | 2018 |
| 02ZB001 | Isle Aux Morts River below Hwy Bridge | Active | 205 | 1962 | 2018 |
| 02ZJ002 | Salmon Cove River near Champneys | Active | 73.6 | 1983 | 2018 |
| 02ZL004 | Shearstown Brook at Shearstown | Active | 28.9 | 1983 | 2018 |
| 02ZL005 | Big Brook at Lead Cove | Active | 11.2 | 1985 | 2018 |
| 02ZM008 | Waterford River at Kilbride | Active | 52.7 | 1974 | 2017[1] |
| 02ZM009 | Seal Cove Brook near Cappahayden | Active | 53.6 | 1979 | 2018 |

*Note 1: 2018 flow data not available for 02ZM008*.

## 2.2 Data Extension

In the 2000 WMS, reference inflow series for the period 1984-1998 were used for the power and energy modelling. In the 2005 study, the model inflow series were extended to the end of 2003. In the 2010 study, a review of hydrology data to the end of 2009 was carried out, but the review determined that little had changed since the 2005 update, so ultimately, the same inflow series were used as in the 2005 update. During the 2015 study, the inflow series were extended to the end of 2013.

For the current study, the reference inflow series have been extended to the end of 2018, which is the most recent complete year of streamflow data published by EC. As noted in Table 2-1, three of the systems have inflow series developed from more than one gauge, because of gauges being discontinued or not having sufficient record length to cover the simulation period. For the current review, all data extensions have been redone using the Line of Organic Correlation (LOC) method recommended by the U.S. Geological Survey for extension and infilling of water resources data (Helsel and Hirsch, 2002).

#### 2.2.1 02ZA001 Little Barachois Brook near St. George's

The record of 02ZA001 (Little Barachois Brook near St. George's) was discontinued in June 1997. In the 2000 WMS, this record was extended (to the end of 1998) by correlating it with the record from gauge 02ZA002 (Highlands River at Trans-Canada Highway).

When the hydrology was updated during the 2005 study, the record from station 02ZA001 was extended using data from gauge 02YN002, Lloyds River below King George IV Lake, which is more hydrologically similar (notably with respect to drainage area) to 02ZA001 than 02ZA002 is. The data for 1998 was replaced with the newer estimates based on the 02YN002 gauge, but the partial year for 1997, based on 02ZA002, was retained.

For the current review, data extension of 02ZA001 was redone relying solely on correlation to 02YN002, on the grounds of having a higher correlation coefficient ($R^2$=0.816 for 02YN002 vs. 0.764 for 02ZA001). The extended record now consists of 02ZA001 recorded values from January 1, 1984 to May 31, 1997 and estimated values based on correlation to 02YN002 from June 1, 1997 to December 31, 2018.

#### 2.2.2 02ZL005 Big Brook at Lead Cove

The streamflow record for gauge 02ZL005, Big Brook at Lead Cove, began in 1985, one year after the start of the period being simulated. In the 2000 WMS, this record was extended back to 1984 using data from gauge 02ZL004, Shearstown Brook at Shearstown.

For the current review, the 1984 values based on correlation to 02ZL004 were recomputed using the LOC method. Then, data up to 2018 for gauge 02ZL005 (which is still active) was added to the end of the record.

#### 2.2.3 02ZM008 Waterford River at Kilbride

Data for 02ZM008, Waterford River at Kilbride, was available only up to 2017 despite the gauge being listed as still active. Values for 2018 were obtained by LOC method correlation to gauge 02ZM009, Seal Cove Brook near Cappahayden.

### 2.3 Comparison of Current and Past Hydrologic Records

Figure 2-1 illustrates the changes in long-term average streamflows as the length of the record increases, for each of the reference inflow series used in the analysis. Figure 2-2 shows a similar comparison for mean annual runoff (long-term average streamflow divided by drainage area to determine the average "depth" of runoff, then converted to mm). From the plots it may be seen that the average inflows have either remained similar or slightly increased compared to those in the 2000 WMS.

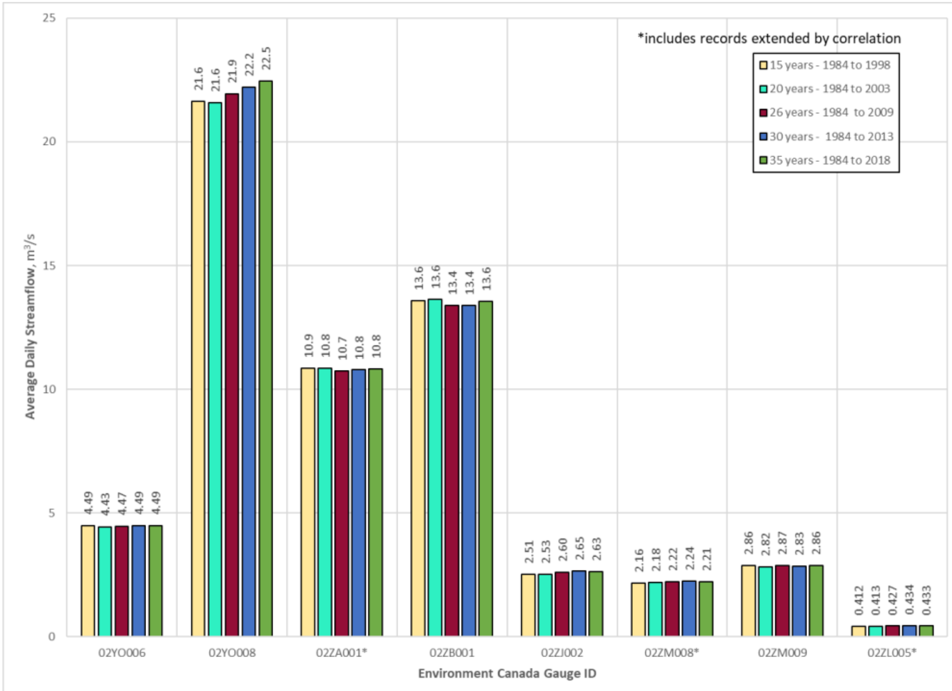


**Figure 2-1: Comparison of Streamflows**

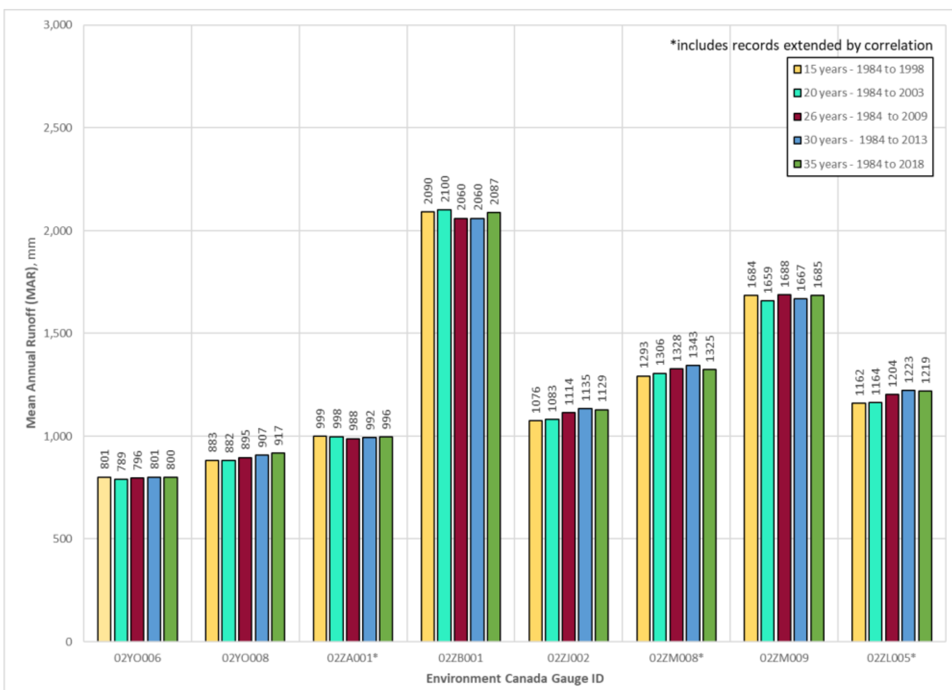


**Figure 2-2: Comparison of Mean Annual Runoff**

# 3. Power and Energy Analysis

## 3.1 ARSP

ARSP is a legacy software developed by Hatch predecessor company Acres International. It has not been regularly maintained due to increasing incompatibility with new computer operating systems and program compilers. Hatch has developed a 64-bit version that functions in Windows 10, and which was used to run the models for the current review. However, as a caveat for future reviews, it remains unclear how long ARSP will continue to be functional.

## 3.2 Physical and Operational Changes

To ensure that the energy analysis is representative of current generation capability, the models have to be updated to reflect any changes in system characteristics or operating guidelines that have occurred since the last review, or otherwise to correct any other model inputs not aligned with current conditions.

The following sections describe the changes in the model input characteristics that were made in the current review.

### *3.2.1 Morris/Mobile*

The model representation of Mobile First Pond had a water level varying seasonally between 150.27 m and 150.11 m. Inspection of recorded Mobile forebay levels suggested that Mobile First Pond would be modeled more accurately by a constant operating level of 150.27 m. This change was implemented in the Morris/Mobile model.

### *3.2.2 Lookout Brook*

NP informed Hatch that the Cross Pond outlet gate and the Joe Dennis Pond outlet gate are adjusted less frequently than in the past. Details of the changes are as follows:

- Cross Pond outlet: plant operators visit the site one or two times a year to make gate adjustments. Normally the gate is set at an opening of 12 inches. In the model, the outlet was represented as a “controlled” type structure (i.e., discharge is adjusted as required by the model) with a variable opening height up to its maximum of 42 inches. It was assumed that the gate representation could be changed to an “uncontrolled” (fixed) type structure with an opening height of 12 inches, and the model discharge rating curve was revised accordingly.
- Joe Dennis Pond outlet: plant operators visit the site monthly. The gate is normally set at an opening of 12 inches, but there have been winters when it has been reduced to 9 inches. In the model, the outlet was represented as a “controlled” type structure with a variable opening height up to its maximum of 42 inches. It was decided to keep the gate in the model as a “controlled” type structure but to reduce the maximum opening to 12 inches, and the model discharge rating curve was revised accordingly.

#### 3.2.3 *New Chelsea/Pittman's*

In 2013, upgrades of the Pittman's Pond Generating Station included replacement of the runner, P&C panels, switchgear, gate positioner, heating and ventilation equipment and plant electrical wiring. Based on information provided to NP from the turbine manufacturer, increases in efficiency or maximum output were not significant, and therefore no changes were made in the Pittman's Pond model characteristics during the 2015 review.

However, during the current review, it was found that the model was underrepresenting the output at Pittman's Pond since the upgrade. Following a review with NP, the following model changes were made:

- Installed capacity was increased from 640 kW to 700 kW.
- Peak unit efficiency was increased from 0.71 to 0.73.
- Head loss was assumed to be included in efficiency; the additional head loss parameter (2.2 m) was deleted.
- The operating level of Pittman's Pond was increased from 107.00 m to 109.84 m to be consistent with current operating practice.

## 3.3 Practical Operation Adjustment Factor

ARSP simulates energy generation based on certain assumptions of "ideal operating conditions", including, for example:

- Perfect foreknowledge of inflows that will be received each day.
- Assumption that spillway gates can be changed as soon and as often as necessary.
- Assumption that plants typically operate at best efficiency except when higher output is required in order to avoid spill.

Since these conditions are not always achievable in practice, the simulated energy results for any given period are typically higher than the actual recorded generation. The model output accounts for hydraulic and electromechanical losses, and availability based on an assumed rate for outages. After deducting station service, any remaining discrepancy is attributed to practical limitations in operation compared to the "idealized" operation represented in the model. An appropriate adjustment factor can be determined by comparing the modelled results to the historical generation. This adjustment factor is then applied to the long-term simulated energy, as a step in the process to estimate the normal production.

In the original 2000 WMS, a "practical operations adjustment factor" of 7 percent was determined to be reasonable for NP's total system. In the 2005 study, this value was updated to 7.5 percent. The 2010 and 2015 studies did not include quantitative reviews of the practical operations adjustment factor; the value of 7.5 percent was retained in both studies. The 2015 study recommended that the practical operations adjustment factor be reassessed in the next update.

To reassess the practical operations adjustment factor, the ARSP models were run for recent periods of available hydrology that were assumed to be representative of current operation, and the difference between total simulated and total recorded energy of all 14 plants in this review was determined. NP provided the monthly energy records for each plant. Certain monthly values of recorded energy at various plants were not considered representative of normal operation, due to planned and unplanned outages; these values were identified by NP and were excluded from the comparison, along with the corresponding simulated values.

Also, following an initial review, it was agreed with NP to omit Morris Generating Station from the comparison because its generation in recent years had been severely impacted by temporary operating restrictions related to debris problems. NP advised that for number of years Morris was operating only at half capacity because debris in Morris Canal would often trip the unit when operating at full load. The unit was reduced to operate at half capacity which seemed to resolve the problem. Excluding Morris does not greatly impact the comparison exercise because it accounts for a relatively small portion of NP's total hydro generation.

After exclusion of the non-representative values from the comparison, the total recorded energy was found to be approximately 5 percent less than the total simulated energy over the most recent ten years of available hydrology. However, a large amount of variability in the difference in simulated and recorded energy was noted between the results of individual plants. It is possible that physical, operational, and hydrological changes in the systems over the years have resulted in some "drift" despite the model revisions made during successive reviews, and that some of the models would benefit from recalibration. It is recommended that model calibration be reassessed during the next review. For the purpose of the current review it was agreed with NP to retain a practical operations adjustment factor of 7.5 percent until model calibration can be re-evaluated in a future update.

## 3.4 Plant Availability

The long-term model runs used to estimate normal production consider a reduction in plant availability to account for unit outages. In the 2000 WMS, an availability factor of 0.95 was applied to all NP generating stations when calculating the normal production using the models. This factor was based on comprehensive unit availability data collected by NP. The allowance of 5 percent downtime was indicative of the average percentage of total annual hours that NP units were unavailable for any reason except for scheduled outages. Scheduled outages were therefore not considered in the estimated normal production. It was assumed that such outages could be planned to coincide with periods of low inflow.

This approach to modeling plant availability was revisited as part of the current review. Unit outage data provided by NP for 2014 to 2018 indicated an unscheduled outage rate of only about 2 percent, while scheduled outages made up a comparatively larger share of total downtime. In consultation with NP it was agreed to allow for total downtime (planned and unplanned) of 7 percent, i.e., a plant availability factor of 0.93. This value was used in the long-term simulation runs to estimate the normal production.

## 3.5 Station Service Loads

"Station service" refers to the power consumed at the hydro plants themselves for the purpose of providing heat, light and auxiliary power for computer systems, protection and control systems and other needs. The amount of electricity consumed for station service is metered. The station service loads must be subtracted from the long-term simulated energy (after practical operations adjustment) to estimate the normal production.

Records provided by NP show that the total energy consumed for station service in the 14 hydroelectric systems that are the focus of this study averaged about 2.2 GWh/year since 2014. Extrapolating to consider all 23 plants in 19 river systems, the total station service load is estimated to be approximately 2.6 GWh/year.

## 3.6 Normal Production

To estimate the normal production, each model was run for the full period of 35 years of inflow.

During this step of the analysis, a slight problem was encountered when modeling the Lookout Brook system. Due to the way ARSP evaluates spill flows for free overflow structures, combined with very small storage volumes in the reservoirs in this system, ARSP was unable to find a solution (model crashed) on certain days when very large inflows were encountered. These periods occurred in May 1992, January 2006, and May 2013.

A similar problem had been encountered in the 2015 review, and it was resolved with a similar workaround, to manually adjust the inflows during the affected periods. The daily inflows were redistributed slightly while keeping the total inflow volume unchanged. The impact on the long-term average energy is small, due to the relatively small adjustments made to the inflows and to the very short timeframe out of the entire simulation period when such adjustments had to be made.

The results of the energy modelling are shown in Table 3-1. Results of the previous reviews are provided for comparison.

**Table 3-1: Estimate of Hydro Normal Production**

| Hydroelectric System | System Energy Estimate (GWh/yr) | | | |
|---|---|---|---|---|
| | 2005 Review | 2010 Review | 2015 Review | 2020 Review |
| Horsechops/Cape Broyle | 87.7 | 87.7 | 88.1 | 88.6 |
| Rattling Brook | 63.9 | 72.8 | 72.6 | 72.4 |
| Morris/Mobile | 51.4 | 51.4 | 51.3 | 51.8 |
| Rocky Pond/Tors Cove | 45.2 | 45.2 | 48.3 | 48.9 |
| Lookout Brook | 34.7 | 34.7 | 35.5 | 34.2 |
| Sandy Brook | 30.5 | 30.5 | 32.2 | 32.0 |
| Pierre's Brook | 24.7 | 26.6 | 27.2 | 26.9 |
| Rose Blanche | 22.6 | 23.5 | 23.5 | 23.8 |
| New Chelsea/Pittman's | 18.4 | 18.4 | 19.7 | 20.3 |
| Lockston | 8.8 | 8.8 | 9.3 | 9.2 |
| Total, 2020 Review Systems | 387.7 | 399.6 | 407.7 | 408.1 |
| Total, Remaining Systems | 68.7 | 68.7 | 68.7 | 68.7 |
| Total, All Systems | 456.4 | 468.3 | 476.4 | 476.8 |
| Less Adjustment for Practical Operations (%) | 7.5% | 7.5% | 7.5% | 7.5% |
| Less Adjustment for Practical Operations | 34.2 | 35.1 | 35.7 | 35.8 |
| Less Station Service | 2.6 | 2.7 | 2.1 | 2.6 |
| Normal Production after Adjustments | 419.6 | 430.5 | 438.6 | 438.4 |

As Table 3-1 shows, the updated estimate of hydro normal production after adjustment for practical operations and station service is 438.4 GWh/year.

As recommended in the 2000 WMS, each year the estimate should be revised to reflect any scheduled outages in the coming year that may affect generation, as well as any physical changes to the facilities over the preceding year. Scheduled outages could lead to spill or to deferral of generation to a later year. Physical changes to the facilities could temporarily or permanently increase or decrease the expected generation.

# 4. Conclusions and Recommendations

## 4.1 Conclusions

The conclusions of the study are as follows:

1. The updated estimate of hydro normal production of NP’s 19 hydroelectric systems is 438.4 GWh/year.
2. Hydrologic data was successfully updated using readily available streamflow records from Environment Canada.
3. ARSP was successfully applied to generate new estimates of the long-term average energy production potential of the 14 NP hydro plants that were the focus of this study. However, ARSP is a legacy software that has not been maintained regularly due to its increasing incompatibility with new computer operating systems and program compilers. Although ARSP is currently still functional, it is unclear how long it might remain so.

## 4.2 Recommendations

The recommendations of the study are as follows:

1. NP should adopt the value of 438.4 GWh/year as the current hydro normal production. Each year the estimate should be revised to reflect any scheduled outages in the coming year that may affect generation, as well as any physical changes to the facilities over the preceding year. Scheduled outages could lead to spill or to deferral of generation to a later year. Physical changes to the facilities could temporarily or permanently increase or decrease the expected generation.
2. The next five-year review should include a detailed recalibration and validation of the models against available plant data.

# 5. References

Acres International Limited (2000). *Water Management Study*. P13474.00. Prepared for Newfoundland Power Inc., December 2000.

Hatch Ltd. (2017). *2015 Hydro Normal Production Review*. H350314-00000-200-066-0001, Rev. 4. Prepared for Newfoundland Power Inc., March 20, 2017.

Helsel, D.R. and Hirsch, R.M. (2002). *Statistical Methods in Water Resources*. United States Geological Survey.

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