# Studies for Island Pond Hydroelectric Project

## FINAL REPORT

**Prepared for:**
Newfoundland & Labrador Hydro

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**Project No.**
722720

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Certified ISO 9001

SNC · LAVALIN

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# 1 INTRODUCTION

## 1.1 PREAMBLE

Preparation of this report has been undertaken in accordance with the Terms of Reference given in Newfoundland & Labrador Hydro's (NL Hydro) request for proposals dated June 21, 2006 and SNC-Lavalin's proposal dated July 6, 2006 and as subsequently revised on July 26, 2006. NL Hydro awarded this work to SNC-Lavalin Inc., by letter dated July 28, 2006.

## 1.2 PRESENT STUDY

### 1.2.1 Background

This study of the Island Pond development was preceded by six (6) previous studies as follows:

1. Desk Study – Acres Consulting Services. Date unknown, report not available;
2. Pre-Feasibility Study – 1986 – Shawmont Newfoundland Ltd;
3. Final Feasibility Study – 1988 – Shawmont Newfoundland Ltd;
4. Optimization Study – Island Pond/Granite Canal – 1988 – Shawmont Newfoundland Ltd;
5. Re-Optimization and Cost Update Study – January 1997 – Agra Shawmont Ltd;
6. Re-Optimization and Cost Update Study, Addendum No. 2 – February 1997 – Agra Shawmont Ltd.

The initial desktop study identified several alternative schemes for developing the 25 m head differential between Meelpaeg Reservoir and the Upper Salmon Development, and it recommended the Island Pond scheme. The pre-feasibility study which followed reviewed these previously-identified schemes and also confirmed Island Pond as the preferred scheme of development. The detailed feasibility study was then carried out and recommended a 3.0 km diversion canal, 3.4 km of channels through Island Pond, a forebay canal and a 23 m high earth dam with a Powerhouse complex located on the east bank of the river. The Powerhouse consisted of two 15.13 MW turbine-generators.

### 1.2.2 Scope

The Terms of Reference for this study presented the goals and objectives as follows:

- Gather field information as required;
- Identify HADD mitigation measures;
- Provide engineering support data for environmental requirements;
- Prepare Capital Cost Estimate;
- Prepare Construction Schedule;
- Prepare a Construction Ready Update Report.

The Scope of Work is summarized as follows:

- A comprehensive review of all available reports, engineering files, etc., particularly the files related to the 1988 and 1997 reports;
- Updating of 12 different engineering studies as outlined in the Terms of Reference;
- Completion of topographic surveys, including the establishment of vertical and horizontal control around the job site;
- Completion of additional geotechnical investigations at locations where existing data is lacking and at the sites of structures that have moved or had design changes since the 1987/1996 studies;
- Preparation of topographic mapping of Island Pond, based on the NAD83 grid system;
- Identification of areas with suitable size and terrain for disposal of excavated materials, including earth and rock;
- Preparation of Capital Cost Estimate;
- Preparation of Project Construction Schedule;
- Overall Project Management Services, including monthly progress reports;

- Any and all other services required to be performed;
- Preparation of a Project Update Report, submitted in draft form, followed by a detailed presentation of the key aspects of the study, the conclusions reached and recommendations made. Following the Client's comments, the Final Report shall be prepared and submitted.

To achieve cost reduction for the study, post-proposal negotiations resulted in changes to the Scope of Work as follows:

1. NL Hydro decided that a close-coupled Kaplan would be selected, and provided drawings and bid-ready specifications for same;
2. Diversion Canal/Channel Improvements – NL Hydro decided that exploring options would not be necessary. SNC-Lavalin was directed to use the preliminary design and estimated construction quantities provided in previous studies to determine cost and assess a construction strategy, considering requirements for mitigation of lost fish habitat;
3. Work related to the Intake/Dam/Powerhouse would now be limited to assessment of the type and arrangement of dam options as follows:
    a. Zoned earth-rockfill dam;
    b. Roller compacted concrete;
    c. Conventional concrete or;
    d. Some combination of the above.
4. Task 4d – Turbine Option was deleted in its entirety;
5. Switchyard – NL Hydro would provide the layout of the switchyard and the direct cost for construction. Our scope would be limited to providing the direct cost for a levelled and fenced area;
6. Capital Cost – The requirement for +/-10% accuracy was removed and replaced with a Risk Analysis of the final cost estimate;

7. The field program was reviewed and some savings identified;

8. Additional changes in the team and its organization structure resulted in a reduction of man-hours and cost.

With all the changes, the estimated cost of the study was reduced from $1.2 Million to $750,000.

During execution of the field program, our team was asked to provide accommodations, field and helicopter support to the environmental team undertaking the HADD Field Work. To cover this cost, an additional $24,500 was added to our budget, for a total of $774,500.

# 2 PREVIOUS STUDIES AND REPORTS

GEN101

GEN71

Since the early 1980's, there were six (6) different studies conducted on this Project beginning with an early **Desk Top Study** prepared by Acres Consulting Services during the design of the Upper Salmon Project. That was followed by a **1986 Pre-Feasibility Study** which investigated five alternative design schemes to develop the 25 m of head between Meelpaeg Reservoir and Crooked Lake. The Island Pond scheme was confirmed as the most economic alternative. In **1988**, a **Final Feasibility Study** was commissioned by NL Hydro and executed by Shawmont Newfoundland Limited. The purpose of this study was to confirm the viability of the Island Pond scheme, and the key features of the pre-feasibility study included hydrological assessment of the Project, site investigations including topographic surveys and geotechnical investigations. In addition, conceptual designs were prepared and optimization studies undertaken. This study confirmed that there were 22.69 m of head with an average flow of 109.3 $m^3$ per second. Island Pond would be raised three to four metres and a power complex with an earth-filled embankment dam 23 m high would be built 600 m upstream from Crooked Lake. A Tailrace would be excavated along the original riverbed to Crooked Lake. The Powerhouse would have two 15.13 MW turbine-generators. The dam would not require a spillway as flood waters would be routed from Island Pond back through to the Meelpaeg Reservoir where water can be spilled at the Ebbegunbaeg Control Structure.

GEN162

In **1988**, Shawmont Newfoundland Limited undertook an **Optimization Study of the Island Pond and Granite Canal Developments** as proposed. The optimization study was undertaken in conjunction with the **Island Pond and Granite Canal Final Feasibility Studies**, and the compilation of the results of these studies into a compendious report was requested by NL Hydro's Project team.

The purpose of these studies was to optimize the major components of each development and, for the Island Pond Development, included:

- The full supply level of Meelpaeg reservoir;
- The size and invert elevation of the diversion canal;

- The diameter of the penstocks;
- The plant capacity.

In 1990, NL Hydro prepared a Fisheries Component Study for the Environmental Impact Statement for the Project. It serves as a background document for assessing the impact on fish habitat in this feasibility study.

GEN 66

GEN66 In **January of 1997**, Agra Shawmont Limited completed a **Re-Optimization and Cost Update Study of the Island Pond/Granite Canal Developments**. The Island Pond portion was carried out to re-optimize and update costs to confirm whether "S" type turbines would be suitable at Island Pond, to re-optimize specific elements of the Project based on present worth values for energy capacity, and to update Capital Cost Estimates to reflect the current 1996 prices.

This study concluded that two vertical Francis turbines would provide the best technical and economical installations at both Island Pond and Granite Canal. This study placed the *total estimated capital cost of the Island Pond Development at $151,937,200 with an installed capacity of 36 MW resulting in a cost per kW of installed capacity of $4,220.* The average annual plant energy with the plant operated for maximum benefit in the overall Bay d'Espoir system, was 188 GWh.

GEN66A In **February of 1997**, Agra Shawmont prepared a **Re-Optimization and Cost Update Study Addendum 2 for the Island Pond/Granite Canal Developments**. GEN66A The purpose of Addendum 2 respecting the Island Pond development was to prepare a new Project planning schedule, a new Capital Cost Estimate and corresponding cost and cash flows using, as a basis, the following criteria as provided by NL Hydro:

- Project to utilize a single 36 MW unit comprising a vertical axis Francis turbine, generator and a single power transformer;
- On-power date to be June 30, 2000;
- Earliest start of engineering for turbine-generator package to be April 1, 1997;

- Earliest start of onsite construction to be June 1, 1998.

In addition to the above criteria, the new Project planning schedule was to identify the latest start of overall Project engineering to enable on-power to be achieved by June 30, 2000.

*This addendum resulted in a shorter construction time frame and a reduction in cost to $140,834,000, a reduction of $11,103,200.*

Further to this study, AMEC-SNC Joint Venture prepared the bid documents for the generator and auxiliary systems for the Island Pond Hydroelectric Development. This document included a close-coupled Intake and Powerhouse arrangement and a single fixed blade propeller type turbine.

# 3 KEY PROJECT FEATURES

## 3.1 GENERAL

### 3.1.1 Description

The proposed Island Pond development would be located on the North Salmon River within the watershed of the Bay d'Espoir development between the existing Meelpaeg Reservoir and the Upper Salmon Development. The proposed development would utilize the available head of approximately 25 m between the Meelpaeg Reservoir and Crooked Lake.

The development is composed of four key components:

- 3000 m long diversion canal between Meelpaeg Reservoir and Island Pond;
- 3400 m of channel improvements in Meelpaeg Reservoir and Island Pond;
- 750 m long Forebay Canal to pass water to the dam, Intake and Powerhouse;
- 550 m Tailrace to discharge water into Crooked Lake.

A spillway is not required for the development since floodwaters that flow from Island Pond watershed would be diverted back into the Meelpaeg Reservoir via the Diversion Canal, and stored in the combined Meelpaeg-Island Pond Reservoir to ultimately be routed through the system as regulated discharge.

The principle parameters for the Island Pond Development are:

- Installed Capacity - 36 MW
- Number of Units - 1
- Normal Full Supply Level at Intake (no flow) - 271.86 m
- Normal Operating Level at Intake (PEF) - 269.94 m
- Normal Operating Tailwater level (at PEF) - 247.32 m
- Peak Efficiency Flow (PEF) - 156 $m^3/s$
- Maximum Flow - 182 $m^3/s$

- Capacity Factor - 60.2%
- Average Generation - 188 GWh/year

### 3.1.2 Plant Operation

General Considerations

Due to the low head of about 22 m at Island Pond, when compared with the 190 m of head at Bay d'Espoir, the Island Pond units should be operated as energy producers, not as peaking units. This has been confirmed in the Bay d'Espoir Regulation Study.

Based on previous reports, the inflow to Island Pond would be relatively constant at 105.0 $m^3/s$; the head would be relatively constant at about 23 m. The Island Pond powerplant differs somewhat from other powerplants on the system due to the configuration of the upstream canal and reservoir system bringing water to the powerplant.

The Kaplan turbine was selected because it will allow operation at low flow during some periods of the year for environmental considerations. For the rest of the year, since the powerplant is designed as an energy producer, its single Kaplan turbine can be operated to maximize energy production. This would require operation at the point of peak turbine efficiency. In order to operate the unit at the peak efficiency point, it would be necessary to de-regulate the regulated flow into a daily or weekly peak efficiency flow.

Turbine Characteristics

With a Kaplan turbine, the efficiency curve is relatively flat between 40% and 100% of load flow. At the rated head of 22.3 m, full load flow of 182 $m^3/s$, and assuming a peak efficiency point at 86% of full load flow, peak efficiency flow would be around 156 $m^3/s$. This peak efficiency point has to be optimized in a next stage.

The single Kaplan turbine selected for this plant will enable energy generation over a range of flows from about 36 $m^3/s$ to the maximum flow of 182 $m^3/s$.

Figure 3-1 shows a typical efficiency curve for a Kaplan turbine.

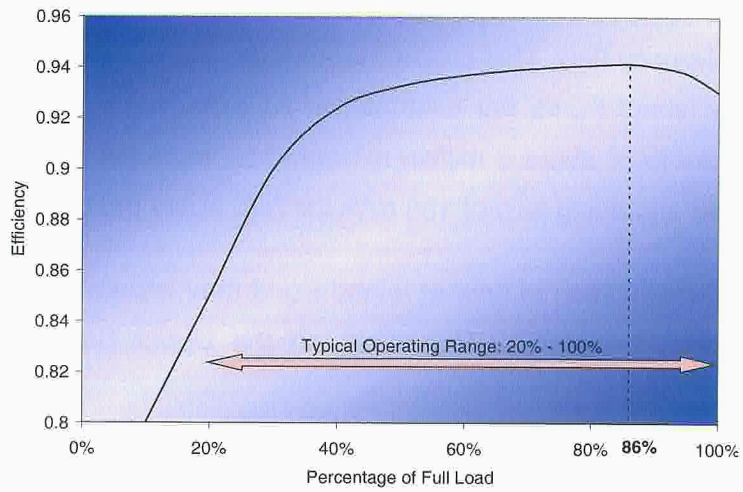



**Figure 3-1: Typical Kaplan Efficiency Curve**

Preliminary Operation Rules

Based on the foregoing, the following rules can be used to operate the Island Pond powerplant to maximize the energy output, subject to any flow requirements imposed by the requirements for fish habitat:

1. When the inflow is higher than 182 m³/s (plant maximum flow):
   - The plant could be operated continuously at full load.
2. When the inflow is between 156 m³/s (peak efficiency flow) and 182 m³/s (plant maximum flow):
   - The plant could be operated at a flow equal to the inflow.
3. When the inflow is less than 156 m³/s (peak efficiency flow):
   - The plant could be operated either: at the lower inflow (at reduced efficiency) provided it is within the operating range of the Kaplan turbine (minimum flow of 36 m³/s), or: at 156 m³/s for a period of time which would result in a total plant discharge equivalent to the average daily inflow. As the inflow

decreases, more storage is required to de-regulate the flow to the peak efficiency flow. This requirement for additional storage can be accommodated by Island Pond. For example, at an extreme low flow of 36 $m^3/s$, a storage volume of about 6 million $m^3$ would be required to convert the average flow into a peaking flow of 156 $m^3/s$ for 7.75 hours per day for five days per week.

The de-regulation of flow at Island Pond may impact the operation of the Upper Salmon powerplant. The effect on the Upper Salmon powerplant was not investigated as part of this study.

Many of the Fish Habitat Compensation strategies currently proposed do not require strenuous flow control in order to maintain the required fish habitat at all life-cycle stages. As currently anticipated, the habitat designs upstream of the powerhouse will have adequate flows while the powerhouse is in operation (i.e. the possible exception may be extended shut downs for maintenance). However, in order to mitigate the potential losses of fish spawning habitat for ouananiche in the Crooked Lake area, a modification to the tailrace area of the Island Pond Hydroelectric Development is proposed. The physical design of the tailrace habitat would most likely be similar to that currently in place at Granite Canal, without the fluctuating flow schedule required at Granite Canal.

The fluctuating flow schedule required at Granite Canal would not be needed at Island Pond since the Compensation habitat downstream of the Powerhouse, as currently anticipated, would be entirely within the tailrace. However, there would most likely be a requirement for continuous, constant flow through the tailrace so that ouananiche could successfully identify and maintain redd locations and spawn. Minimum flows will also have to be identified while eggs are in the substrates.

### 3.1.3 Service and Access

The site is accessible from the Trans Canada Highway via Route 370 from Millertown. An existing service road, which extends from Millertown to Noel Paul's Brook, was upgraded during the Granite Canal Project and is in excellent condition. From Noel Paul's Brook to Ebbegunbaeg Control Structure there is an existing access road, originally used to construct that facility. The road has deteriorated, is in very poor condition, and would require upgrading. In addition, a bridge would be required at Noel Paul's Brook.

### 3.1.4 Summary of Topography & Geology (from AMEC Report)[1]

#### *3.1.4.1 Site Topography and Surficial Geology*

The development area is in the Atlantic Upland Physiographic sub-division of the Island of Newfoundland. The whole of the area was glaciated by the last advance of the Wisconsin Glaciation and much of the pre-glacial surface has been scoured and subsequently covered by a discontinuous layer of till of varying thickness. The topography is generally comprised of gently undulating countryside with rounded hills and broad valleys. Abundant, large glacially-derived boulders cover the ground surface. Drainage is poor with numerous bogs formed and no well-defined stream drainage pattern. Ice flow direction in the study area was from the north and northwest.

Glacially-derived soils in the form of hummocky glacial till cover most of the countryside in a general veneer 2 to 3 m thick. Bedrock outcrop is generally scarce except in the higher elevations and eroded stream channels. Thick glacial till deposits exist along the northwest shore of Crooked Lake and are interpreted as crag and tail type of genesis with the crag being the low ridge between Island Pond and Crooked Lake. Minor glaciofluvial soils are recognized in the area as esker deposits at the Burnt Lake Diversion Canal and north of Burnt Lake. A small, crevasse-filling deposit of glaciofluvial soil was discovered near the location of the proposed Tailrace for the Project.

#### *3.1.4.2 Bedrock Geology*

In the area of the proposed dam site, the North Salmon River has exposed a north-south cross section through the metasediments. Contacts between the metasedimentary package and the granitoids lie to the north of the dam site at Island

[1] Geotechnical Investigation Proposed Island Pond Hydro Electric Development South Central Newfoundland, AMEC Earth & Environmental.

Pond, and south of the dam site along the southern portion of the North Salmon River where it enters Crooked Lake.

Rocks within the sedimentary package have been metamorphosed to amphiholite facies, and are represented by psammitic to semipelitic schist and gneiss, with minor migmatite. These are of Ordovician/Silurian age.

Intrusive Devonian age plutonic rocks to the north and south of the North Salmon River consist mainly of pink and grey granodiorite and granite with minor foliated granite and granodiorite.

### 3.1.5 Mapping

To prepare this study, digital mapping with 2 m contours was prepared from the latest available photography covering the diversion areas, the dam sites, the Powerhouse and the projected flood line around Island Pond. The deliverables required were DFX files of the digital map data and digital copies of the aerial photographs. Control points were established throughout the Project area for the preparation of the mapping.

Initial control was carried from Buchans where the closest Newfoundland three degree modified transverse mercator NAD 83 control markers are located. They were carried to Ebbegunbaeg and were checked into the NL Hydro benchmarks which were based on six degree universal transverse Mercator Zone 21N on the existing concrete structure, and at the far end of the dike where a control monument was established in bedrock. There was a small discrepancy between MTM and the Project control UTM. Field staff were instructed to use the horizontal and vertical control information supplied by NL Hydro. Survey equipment used for this Project was a Topcon GPS GB-500 Base and Hiper Pro Rover, which has an accuracy of +/- 15 mm.

The resulting mapping has been used to lay out all the structures for this Project.

## 3.2 CONSTRUCTION MATERIALS

AMEC Earth and Environmental (AMEC) was retained as the geotechnical consultant for this study. The primary objective of the geotechnical investigations was to review and comment on reports that were previously prepared for the Project and carry out additional investigations at the proposed dam, Powerhouse, access roads, and camp site to determine subsurface conditions and to comment on the geotechnical aspects of each area. In addition, sources for various grades of construction materials were investigated and inventoried. AMEC's report of their findings is being provided as Volume II.

The most significant finding of the geotechnical report is that rock to be excavated from the Forebay Canal and the Intake/Powerhouse is not suitable for the production of concrete coarse aggregate. In addition, rock bolting will be required at the Intake/Powerhouse excavation for stability and safety reasons. Rock suitable for aggregate is available from the Diversion Canal excavation, or from a quarry source as the timing of excavation in the Diversion Canal may not be such to permit aggregate production.

The gravel deposit along the road to the Powerhouse is not suitable for coarse aggregate, but the deposit should be suitable for the production of fine aggregate. Materials for road upgrading and construction can be found in the form of glacial till along the route in combination with rock from quarries. The Capital Cost Estimate takes these issues into consideration.

Testing was carried out to investigate the potential for rock excavated from the Intake/Powerhouse to be acid producing. The testing determined that the rock is acid producing, and a mitigation strategy will have to be developed to deal with the issue. Refer to Section 3.15.1 for Mitigation Considerations.

## 3.3 DIVERSION

### 3.3.1 General

Several routes for a canal between Meelpaeg Reservoir and Island Pond were assessed in previous studies. In the 1988 Feasibility Report, the route, as shown in Figure 3-2, was selected based on economic, as well as hydraulic, considerations. In the December 1988 optimization study, the diversion was optimized in terms of its width and depth. The alternative configurations considered were presented in Appendix 1 of the December 1988 report as shown on Page 18 of this report.

The terms of reference specified that consideration was only to be given to the design as presented in the previous studies and, therefore, the design has not been revisited for this report. Quantities used to determine the updated Capital Cost Estimate for this study were extracted from the "Island Pond/Granite Canal Re-Optimization and Cost Update Study, Addendum 2".

### 3.3.2 Diversion Canal

Drawings 722720-0000-41DD-0007 and 722720-0000-41DD-0008 show the location of the Diversion Canal. The Canal consists of two sections; one section through the Northeast Arm of Meelpaeg Reservoir, and another section overland to connect to Island Pond. The key features of the two sections are as follows:

<u>Section 1: Through Meelpaeg Reservoir</u>

As per Figure 3-2, the canal section in the Northeast Arm of Meelpaeg Reservoir is approximately 1000 m long.

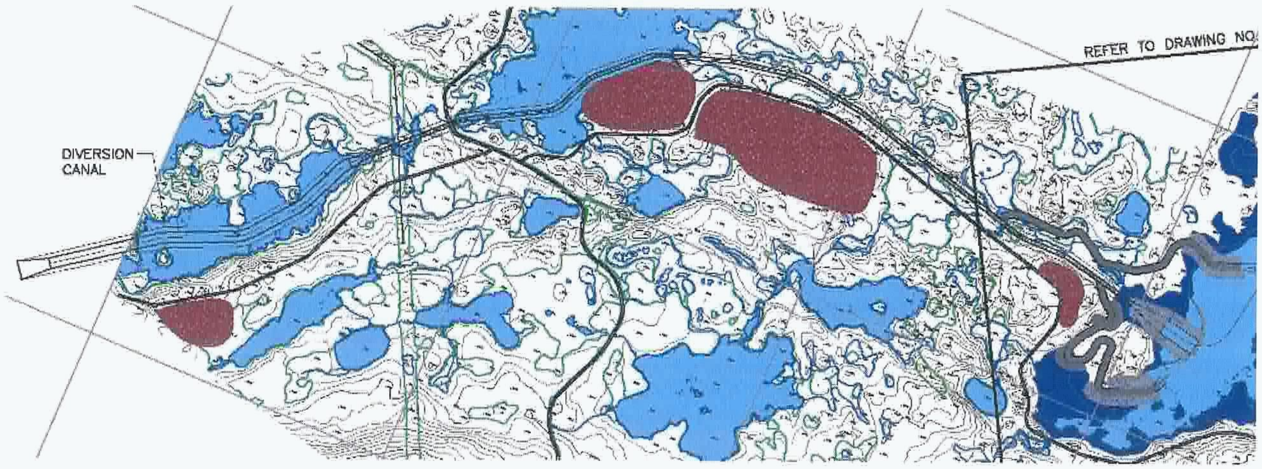


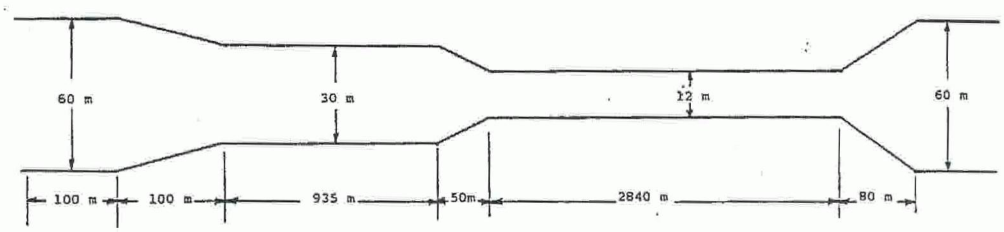

**Figure 3-2: Diversion Canal**

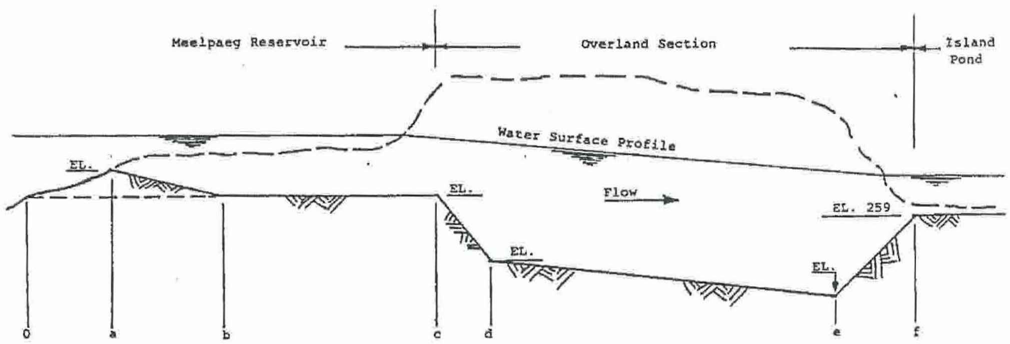
This canal section is intentionally designed to a 30-m width to minimize or possibly eliminate rock excavation in the Reservoir. The plan is to de-water the area by means of cofferdams and pumping. Any rock excavation encountered will be of a routine nature. Dykes along the Canal will facilitate the excavation of mud and prevent ice from migrating into the Canal during winter. Excavation of the Canal includes 85,000 $m^3$ of common excavation and 56,000 $m^3$ of mud. The maximum flow velocity in this section will be less than 1.68 m/s. This velocity is based on a flow of 182 $m^3/s$ at low supply level (LSL) in Meelpaeg Reservoir.

Section 2: Overland to Island Pond

The overland section of the Canal is approximately 3.0 km long, as noted above. This section is designed as a deep narrow excavation (12 m wide). It requires the excavation of approximately 59,000 $m^3$ of bog, 400,000 $m^3$ of common material and 296,000 $m^3$ of rock. De-watering to excavate the overland section would be achieved by selected coffer damming and pumping and by taking advantage of lower water levels in Island Pond when the Channel Improvements in the Pond are being executed. The maximum flow velocity in this section will be less than 2.38 m/s. This velocity is based on a flow of 182 $m^3/s$ at LSL in the overland section.

# Appendix 1: Diversion Canal – Alternative Configurations[2]




PROFILE

**Profile Elevations**

| ALTER-NATIVE | Point 0 | a | b | c | d | e | f |
|---|---|---|---|---|---|---|---|
| A | - | 261 | 260 | 260 | 257.50 | 256.05 | 259 |
| B | - | 261 | 260 | 260 | 257.50 | 256.05 | 259 |
| C | 260 | 260 | 260 | 260 | 257.50 | 256.05 | 259 |
| D | 260 | 260 | 260 | 259 | 257.50 | 256.05 | 259 |
| E | 260 | 260 | 260 | 259.50 | 259.48 | 258.06 | 259 |
| F | - | 261 | 259 | 259 | 257.50 | 256.05 | 259 |
| G | - | 261 | 259.50 | 259.50 | 257.50 | 256.05 | 259 |
| H | - | 261 | 260 | 259 | 257.50 | 256.05 | 259 |
| I | - | 261 | 260 | 260 | 258 | 256.55 | 259 |
| J | - | 261 | 260 | 260 | 258.50 | 257.05 | 259 |
| K | - | 261 | 260 | 260 | 257 | 255.55 | 259 |
| L | - | 261 | 260 | 260 | 256.50 | 255.05 | 259 |
| M | - | 261 | 260 | 260 | 259 | 257.55 | 259 |
| N | - | 261 | 260 | 260 | 259.50 | 258.05 | 259 |
| O | - | 261 | 260 | 260 | 260 | 259.00 | 259 |
| P | - | 261 | 260 | 260 | 260 | 259.00 | 259 |

**Plan Widths**

| ALTER-NATIVE | Point 0 | a | b | c | d | e | f |
|---|---|---|---|---|---|---|---|
| A | - | 60 | 30 | 30 | 12 | 12 | - |
| B | - | 60 | 30 | 30 | 12 | 12 | 60 |
| C | 60 | 60 | 30 | 30 | 12 | 12 | 60 |
| D | 60 | 60 | 30 | 30 | 12 | 12 | 60 |
| E | 60 | 60 | 30 | 30 | 30 | 30 | 60 |
| F | - | 60 | 30 | 30 | 12 | 12 | 60 |
| G | - | 60 | 30 | 30 | 12 | 12 | 60 |
| H | - | 60 | 30 | 30 | 12 | 12 | 60 |
| I | - | 60 | 30 | 30 | 12 | 12 | 60 |
| J | - | 60 | 30 | 30 | 12 | 12 | 60 |
| K | - | 60 | 30 | 30 | 12 | 12 | 60 |
| L | - | 60 | 60 | 30 | 12 | 12 | 60 |
| M | - | 60 | 30 | 30 | 12 | 12 | 60 |
| N | - | 60 | 30 | 30 | 12 | 12 | 60 |
| O | - | 60 | 30 | 30 | 20 | 20 | 60 |
| P | - | 60 | 30 | 30 | 15 | 15 | 60 |

[2] Island Pond/Granite Canal Developments Optimization Study, Shawmont Newfoundland Ltd.

### 3.3.3 Channel Improvements through Island Pond

As per Drawings 722720-0000-41DD-0008 and 722720-0000-41DD-0009 (see Figure 3-3 for excerpt), the channel improvements through Island Pond consists of three specific areas of excavation in Island Pond: 1100 m, 900 m and 400 m, for a total of 2400 m. Similar to the Reservoir section in Meelpaeg, the channel improvements in Island Pond are also designed to be a wide shallow excavation (60 m wide) to minimize rock excavation. It is intended to de-water Island Pond to the invert elevation of the channel improvement (264.31 m) and, if rock is encountered, the excavation will be of a routine nature. Excavation of the channel improvements includes 242,300 $m^3$ of common material and 1400 $m^3$ of rock.

The maximum flow velocity in this section will be less than 1.0 m/s. This velocity is based on a flow of 182 $m^3/s$ at LSL in Island Pond.

The cost of the Diversion, including the Canal and Channel improvements is estimated to be $20,746,440, which represents about 17% of the direct costs of the Project.

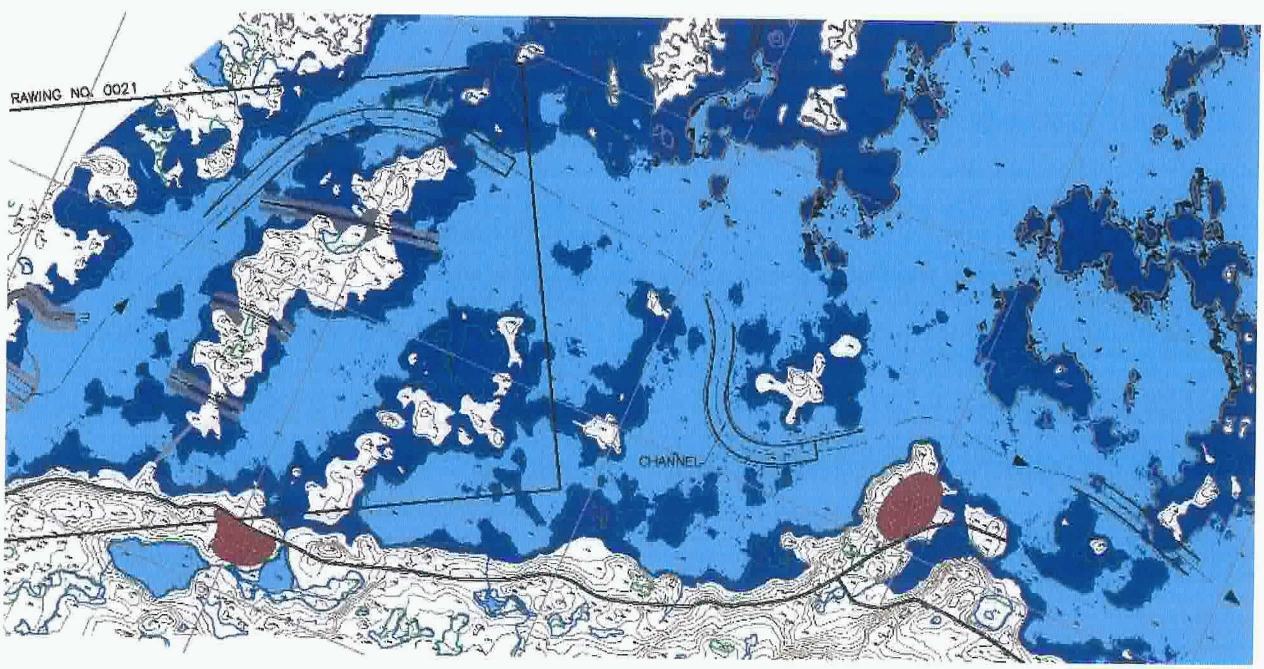



**Figure 3-3: Channel Improvements**

## 3.4 FOREBAY CANAL

The Forebay Canal is a channel improvement at the outlet of Island Pond where Island Pond flows into the North Salmon River Valley. The canal will have an invert width of 30 m and invert elevation of 262.31 m at the outlet of Island Pond. It will be approximately 750 m in length and will require the excavation of approximately 10,000 $m^3$ of other material (OM) and 132,000 $m^3$ of rock. In consideration of preserving fish habitat in North Salmon River as long as possible, the Forebay Canal has been relocated to the right bank of the river. Quantities have been revised for this new location. Drawing 722720-0000-41DD-0010 shows the new proposed location for the Forebay Canal, an excerpt of which is shown in Figure 3-4.

The estimated construction cost of the canal is $4,535,000.

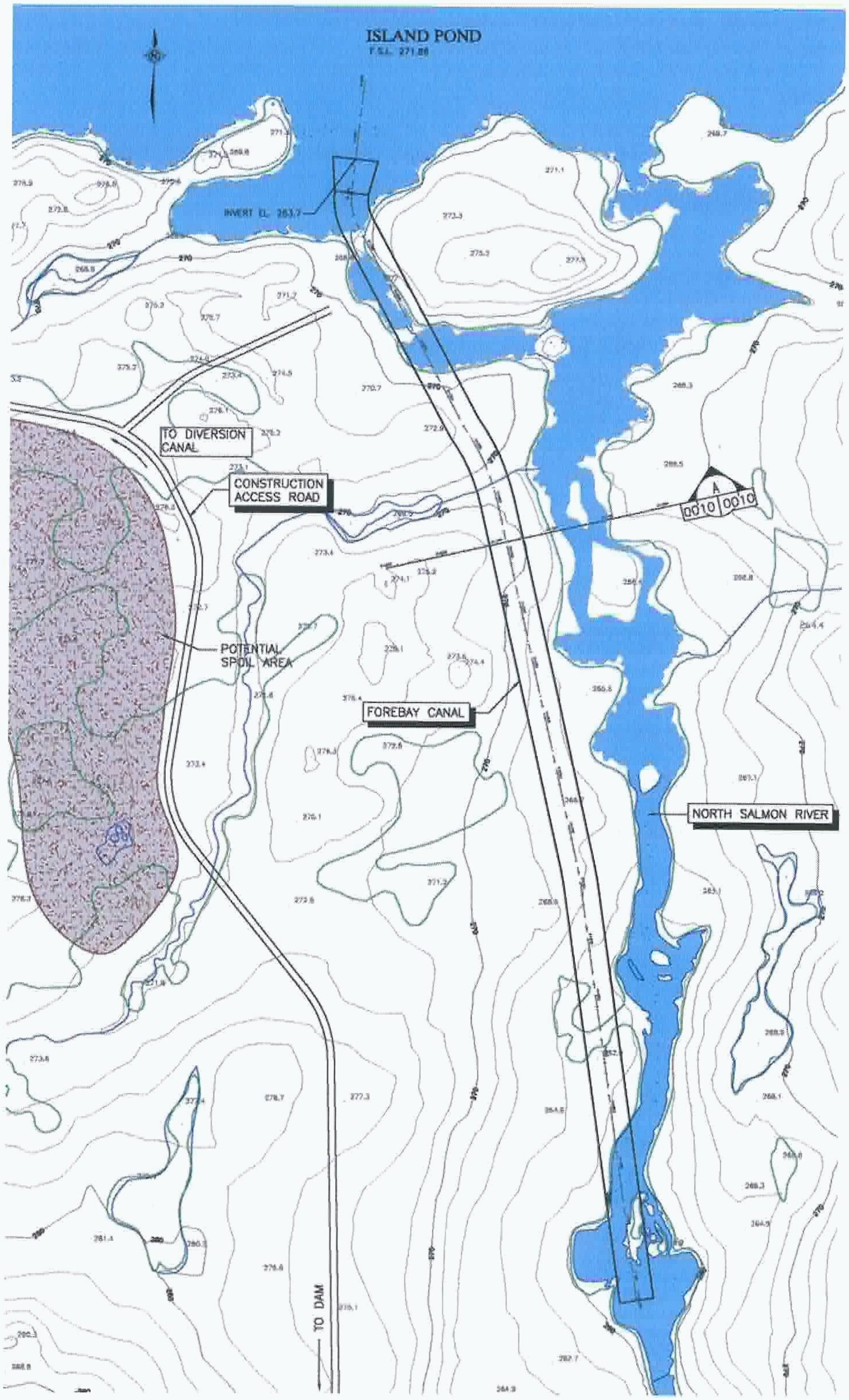



**Figure 3-4: Forebay Canal**

## 3.5 INTAKE, DAM, AND POWERHOUSE ARRANGEMENT

### 3.5.1 General

As required by the Terms of Reference, three cases have been studied for the Intake, Powerhouse and Dam Complex, namely:

1. Base Case:

   Zoned Earth-Rockfill Embankment, similar to that arrangement selected in the 1988 study. See Figure 3-5.

2. Alternative 1:

   Concrete Gravity Dam, located approximately 20 m downstream of the Base Case dam axis, a close-coupled Intake and Powerhouse structure, located in the river, near the right bank. See Figures 3-6 and 3-7.

3. Alternative 2:

   Zoned Earth-Rockfill Embankment Dam, similar to Base Case, except located approximately 20 m downstream. Similar to Alternative 1, it has a close-coupled Intake and Powerhouse structure; however, in this alternative, it is located on the left bank, separate from the zoned earth-rockfill dam. See Figure 3-9.

### 3.5.2 Base Case

The Base Case was selected from the 1988 Report, for comparative purposes only, the details of which are taken from Drawing SMR-02-88 as shown in Figure 3-5 below. Construction quantities were taken from the 1997 Cost Update Study.

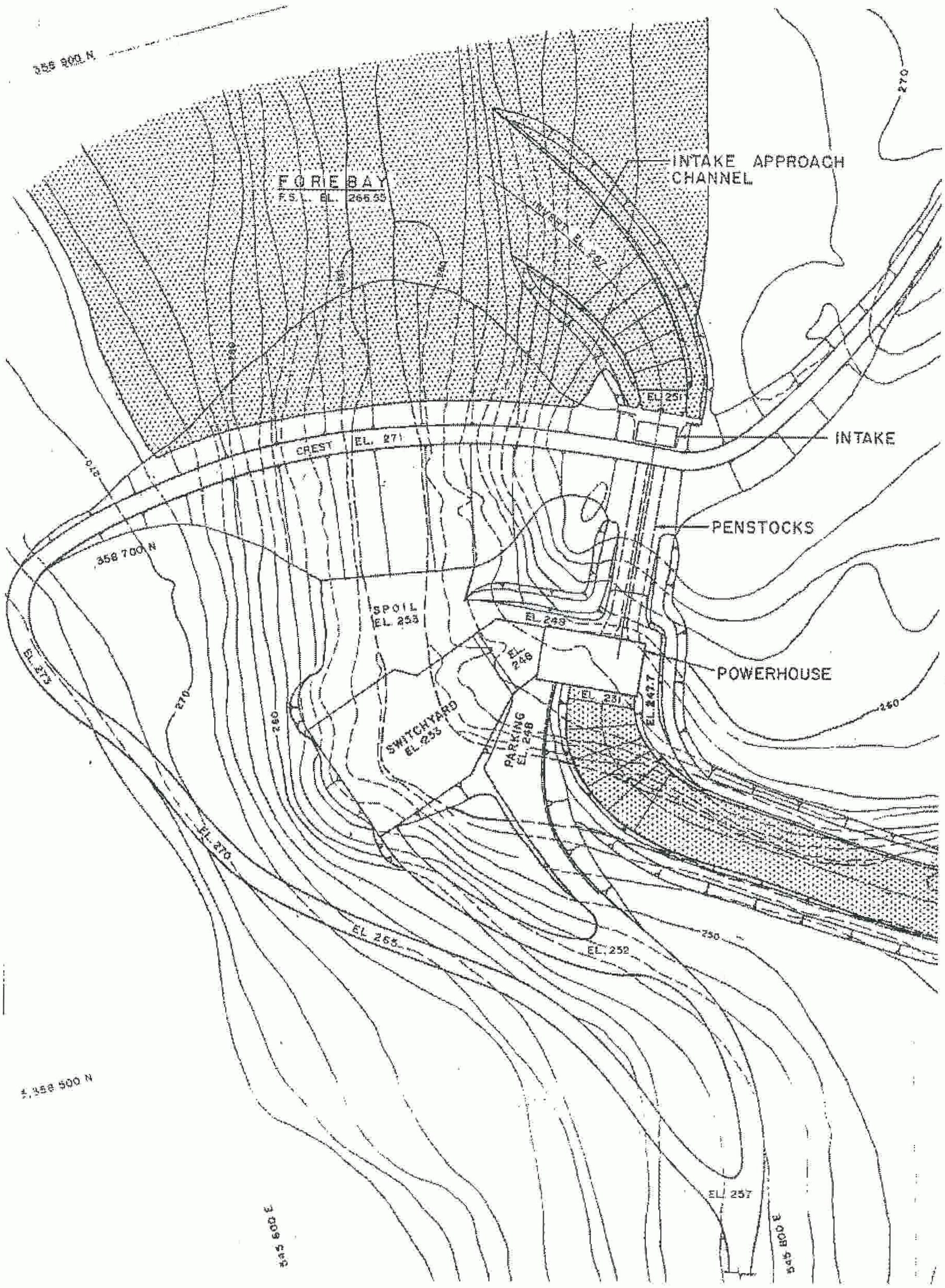



**Figure 3-5: Power Complex Layout from 1988 Report (Base Case)**

### 3.5.3 Alternative 1

Alternative 1 is the Close-Coupled Intake and Powerhouse, located in a Roller Compacted Concrete Gravity Dam, as per Figures 3-6 and 3-7 as follows.

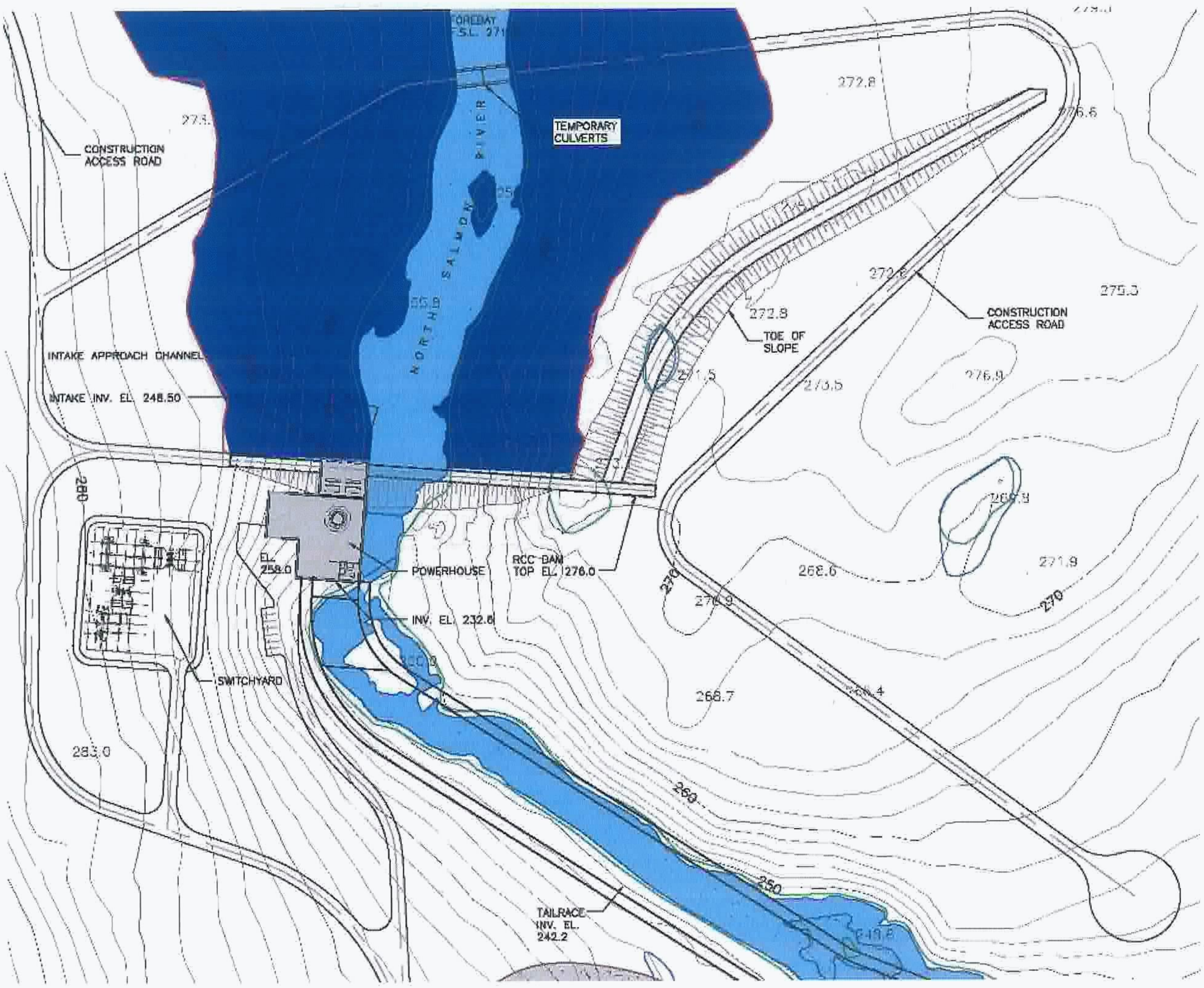



**Figure 3-6: Power Complex Layout - Alternative #1**

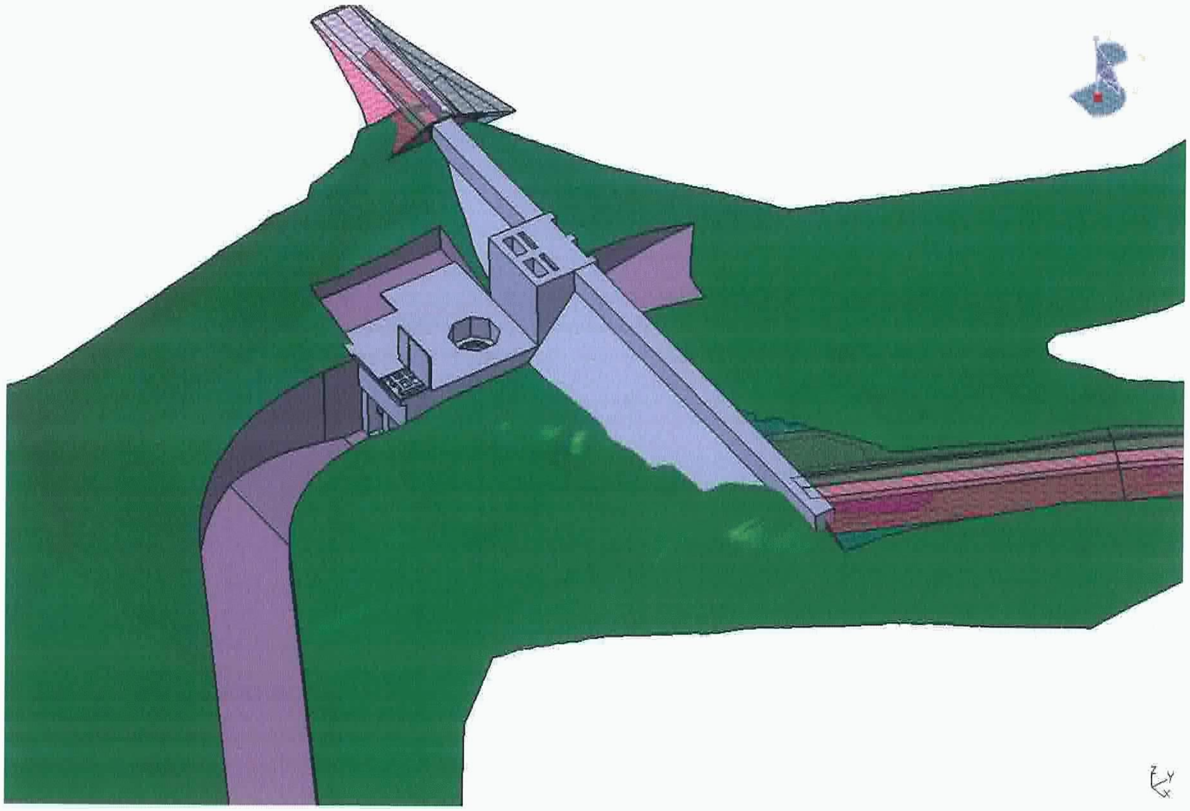


**Figure 3-7: 3-D of Power Complex/Dam - Alternative #1**

The dam is located approximately 20 m downstream of the Base Case Dam axis.

Type of Dam

A concrete gravity dam was selected for the major portion of this structure. Its shape and size eliminates the requirement for large retaining walls at each side of the intake-powerhouse and facilitates placing the intake-powerhouse in the deep part of the valley. Small earth-filled dykes would be used at each end of the concrete dam to close against impervious material at a higher level. See Figure 3-8 below.

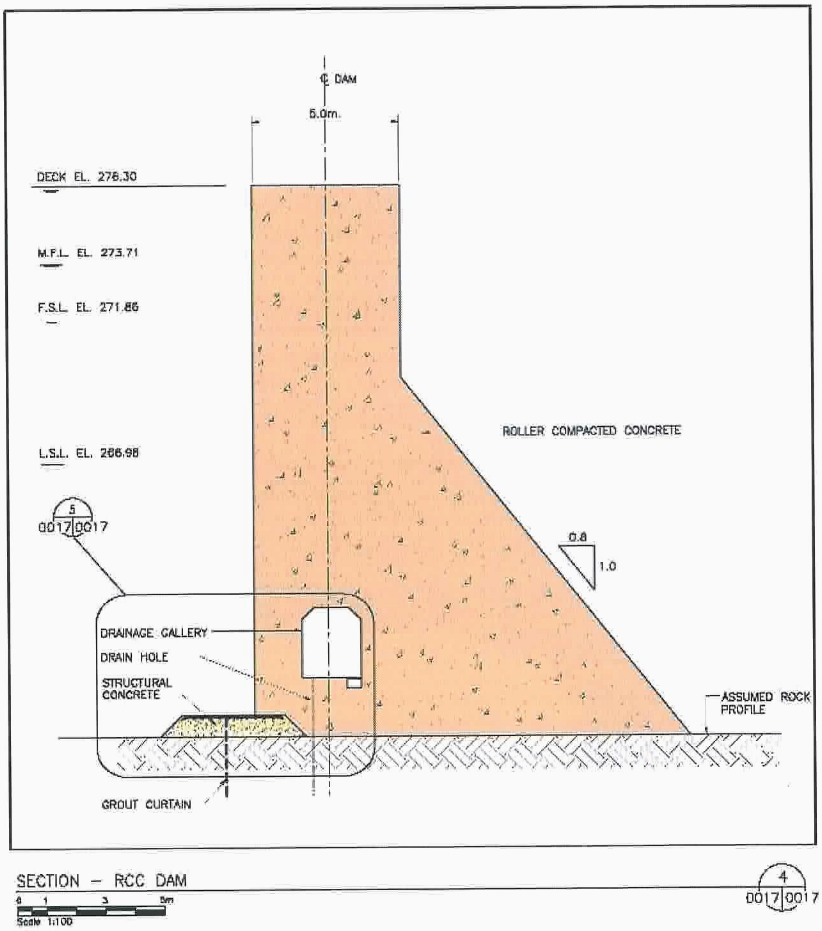



**Figure 3-8: Cross-Section Roller Compacted Concrete Dam**

## Stability

The dam is sized so that the upstream face is not subject to tension under any force, and to ensure that the structure can withstand overturning and sliding forces. The overturning and sliding forces are attributed to hydrostatic forces, ice impact, ice expansion forces and vertical uplift forces.

## Construction of the Dam

The gravity dam can either be built using conventional concrete or roller-compacted concrete. Each method has its benefits, depending on site conditions.

Conventional Concrete

Conventional concrete is economically advantageous where the volume of the concrete is not too large and where formwork is essential. For mass concrete, where the smallest block dimension is larger than 2 m, special care must be taken to minimize the risk of cracks in the concrete due to high hydration temperatures.

The latter can be controlled by using type 20 Portland cement, by reducing the amount of Portland cement, by reducing the lift sizes or by using ice in the concrete mixes. A delay between the lifts is also essential to release the heat of hydration from the mass. The use of larger aggregate size also contributes to the reduction of temperature as well as hosing down the aggregates when the ambient temperatures are excessively high.

RCC Dam Design Concept

Different design concepts and practices have evolved over the years since the construction of RCC dams began some 20 years ago. Apart from the RCC placement method developed by the Japanese and known as roller-compacted dam (RCD), and which is relatively limited to that country, three other main RCC construction concepts have been classified. The principal difference between these concepts is their total cementitious contents (i.e. cement and pozzolan/fly ash):

- Low cementitious mix (60 to 120-130 kg/m$^3$);
- Medium cementitious mix (120-130 to 180-190 kg/m$^3$);
- High cementitious mix (180-190 to $\cong$ 250 kg/m$^3$).

Apart from the varying cementitious contents, these concepts include different construction details for some of the works.

These design concepts have been used by dam designers and engineers all over the world to design dams which satisfy current international standards with regard to their safety, stability, durability and integrity. Amongst others, the decision on which concept to adopt is generally the result of the:

- Preference and experience of the designer;
- Criteria established for seepage control and dam performance (for all practical purposes, an RCC dam is impervious and drainage measures, water stops, etc. are for insurance);
- Level of comfort the dam owner/operator had with design concept;
- Cost (an RCC dam will almost always be less expensive than a conventional concrete dam).

In order to allow some flexibility in the selection of the dam design, consideration will be given to designing a dam with either a low or a medium cementitious mix.

Low cementitious mixes, with their use of an upstream geomembrane system, have a proven record of producing RCC dams with maximum seepage control. One of the drawbacks of this system is the concern some designers and owners have with regard to the long-term durability of this system. However, given the advantages this design concept offers, it should be given consideration.

In order to better deal with the reliability issue of the geomembrane, its use could be limited to the lower section of the dam (i.e. below the minimum reservoir water level). This would maximize the benefit offered by this system (i.e. seepage control) while ensuring the geomembrane is not exposed to ultraviolet rays and other potential damage, although this system is designed to withstand these exposures.

Medium cementitious mixes also have a proven record of producing dams which satisfy current safety requirements. The RCC specialists believe this concept is more economical than the high cementitious mixes. Also, some designers are concerned about the long-term thermal behavior and cracking potential of high cementitious mixes. The main drawback of this concept is the potential for seepage along some portions of the horizontal joints, vertical joints, or vertical cracks which may appear within the monoliths. The design would include recent concepts and details which enhance the:

- Quality of the bond between the RCC layers; and

- Seepage control.

This is essential in providing an RCC dam with the highest degree of monolithic behavior possible.

Design and Construction Details

In accordance with the selected RCC dam design concept, proven and appropriate design and construction details would be reviewed and selected. These details would cover but not be limited to:

- Seepage control;
- Horizontal joints/cross sloped layers;
- Vertical joints;
- Layout and arrangement of drainage gallery (if required);
- Facing treatment;
- Internal drainage system;
- Foundation preparation; and
- Longitudinal joint (if considered necessary).

Particular attention will be paid to seepage control and the quality of the bond between the RCC layers. This is the main aspect of RCC dams which designers and engineers must address.

### 3.5.4 Alternative 2

Alternative 2 is a combination of the base case and Alternative 1. In this alternative, we have the same Close-Coupled Intake and Powerhouse Structure, but located on the left bank, in bedrock, with a zone earth-rockfill dam. See Figure 3-9 below.

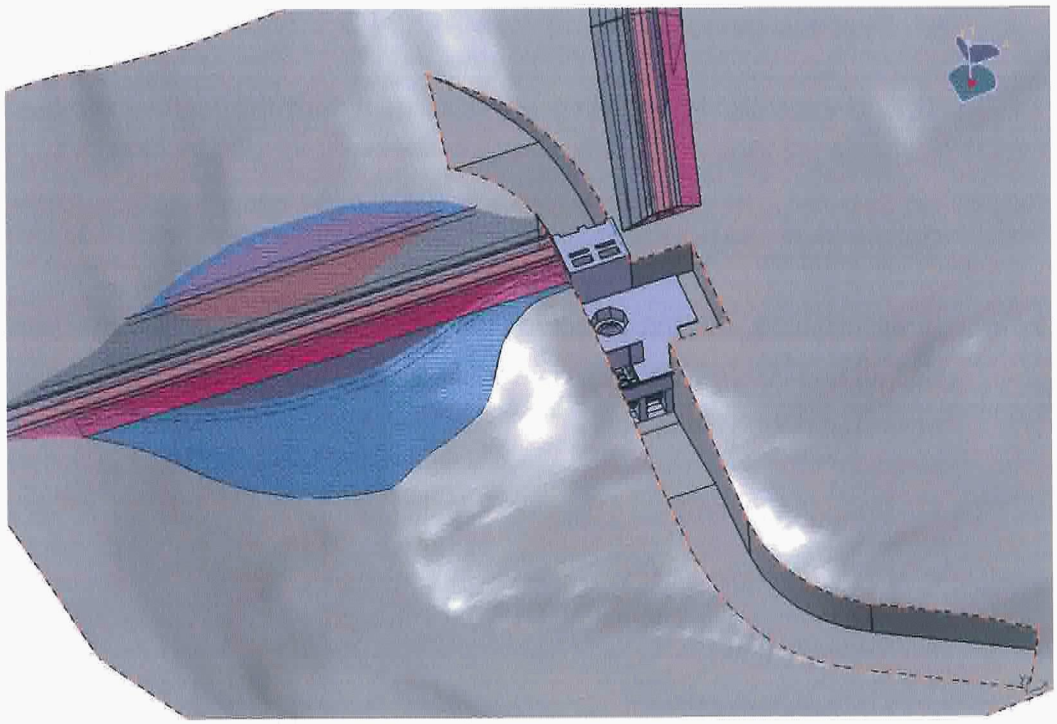


**Figure 3-9: Power Complex Layout - Alternative #2**

Type of Dam

The dam is an embankment construction with an impervious till core. On the left bank, the dam is reduced to a dyke that closes against impervious material at a higher level. The construction of this type of dam is done by placing consecutive layers of fill. Each layer is compacted by vibrating rollers or sheep foot rollers. There is no construction during freezing seasons. In case the construction of the dam cannot be completed in one season, the top layer is excavated and replaced by new material in the beginning of the following season or protected using sand and gravel or snow during winter. The riprap material, boulders of up to 1 m in size, can be quarried. Sand and till are hauled from borrow pits. There is no evidence of the presence of till in the vicinity of the job site. This makes the construction of this type of dam a primary concern, i.e. the till would have to be trucked from borrow pits that are over 50 km from the dam site.

### 3.5.5 Powerhouse

#### *3.5.5.1 General*

The Powerhouse structure combines both the intake and the generating bay into one concrete monolith. This type of arrangement is sometimes referred to as a close-coupled Powerhouse. It is normally used for low to medium head generating stations where the intake forms a part of the main dam and the plant operates under run-of-river conditions. The close proximity of the intake to the generating bay and the use of a concrete scroll case eliminate the need for steel penstocks.

Main elevations:

- Power Intake Deck — EL. 276.30 m
- Powerhouse Roof — EL. 271.50 m
- Crane — EL. 265.20 m
- Machine Hall — EL. 256.40 m
- Turbine Floor — EL. 250.40 m
- Centreline Distributor — EL. 243.20 m

#### *3.5.5.2 Power Intake*

The power intake is a concrete structure that forms part of the main dam. The intake hydraulic passages are separated by a single pier which terminates just upstream of the turbine distributor. The structure is fitted with two sets of trash racks, stoplogs and intake gates.

The stability of the power intake structure against overturning, sliding or floating is calculated in concert with the calculations for the Powerhouse.

The walls and other elements of the hydraulic passages are designed for internal and external hydraulic forces; i.e. when the hydraulic passages are full or empty.

The stoplogs and gates will be operated by electrical hoists housed in a heated shelter on top of the power intake deck. The shelter is a braced steel structure with steel cladding.

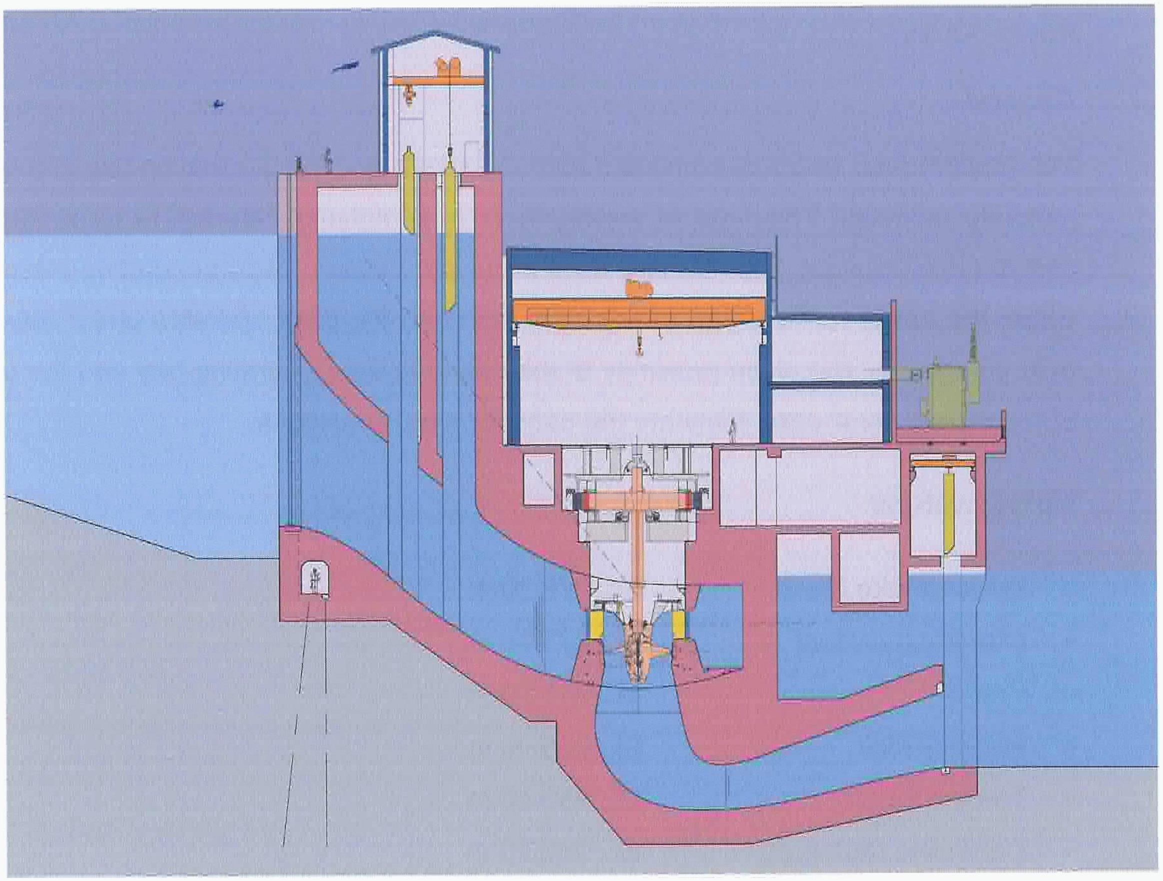


**Figure 3-10: Cross-Section Through the Intake Powerhouse Structure**

Figure 3-10 shows the major components of the intake equipment, as well as the turbine-generator scheme. The draft tube gates and the transformer are shown downstream. The dotted outline of the sloping downstream face of the dam can be seen as well.

During the final design of the Intake, it may be necessary to consider the installation of fish screens, if these are determined to be necessary as part of the Project Environmental Assessment.

The Intake Powerhouse hydraulic passages are shown in Figure 3-11.

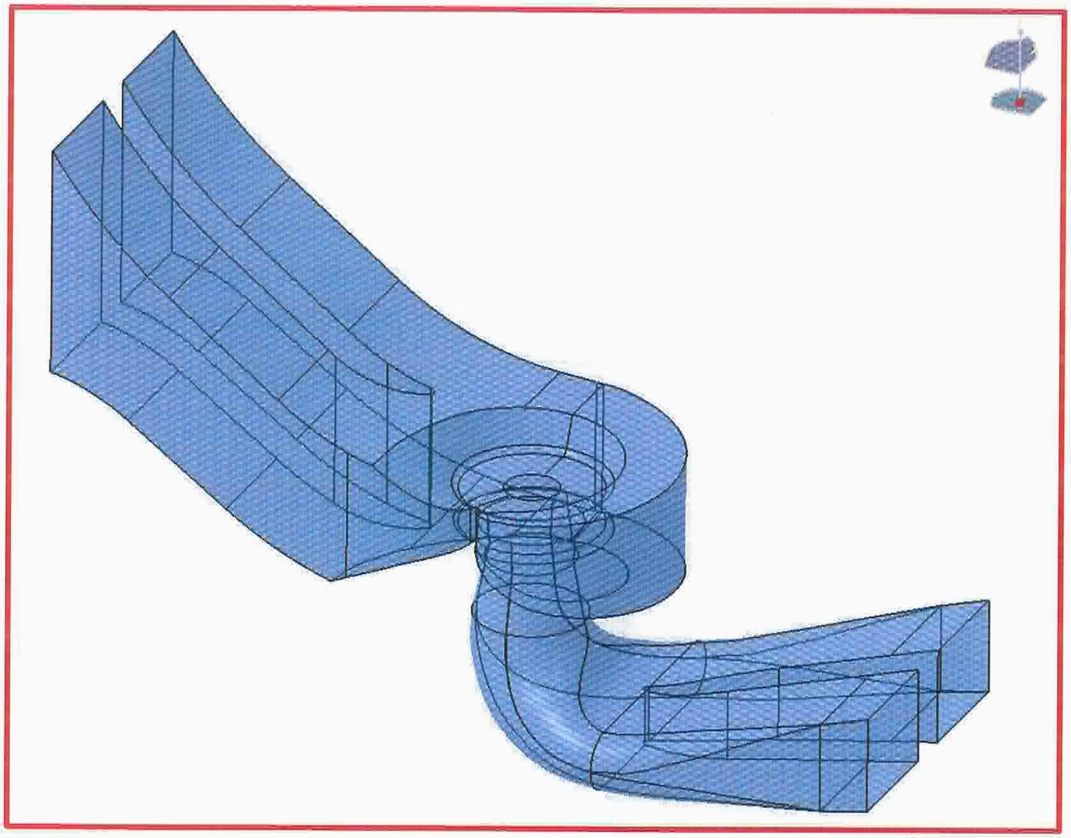


**Figure 3-11: Intake Powerhouse Hydraulic Passages**

#### *3.5.5.3 Powerhouse*

From the intake structure, the water is directed into the concrete scroll case. The type of scroll case used for this Powerhouse is referred to as a semi-frontal. The scroll case is of reinforced concrete design and is normally not steel-lined because the water velocity in the hydraulic passages are relatively low. Access to the scroll case will be provided through a water-tight steel bulkhead door located in the downstream side of the casing. The water then passes through the stay ring, the Kaplan runner and exits the Powerhouse through the draft tube. The draft tube cone is steel-lined and will be provided with a steel door to allow the installation of a temporary platform for the inspection and maintenance of the runner.

Figures 3-12 and 3-13 show typical details of a concrete scroll case.

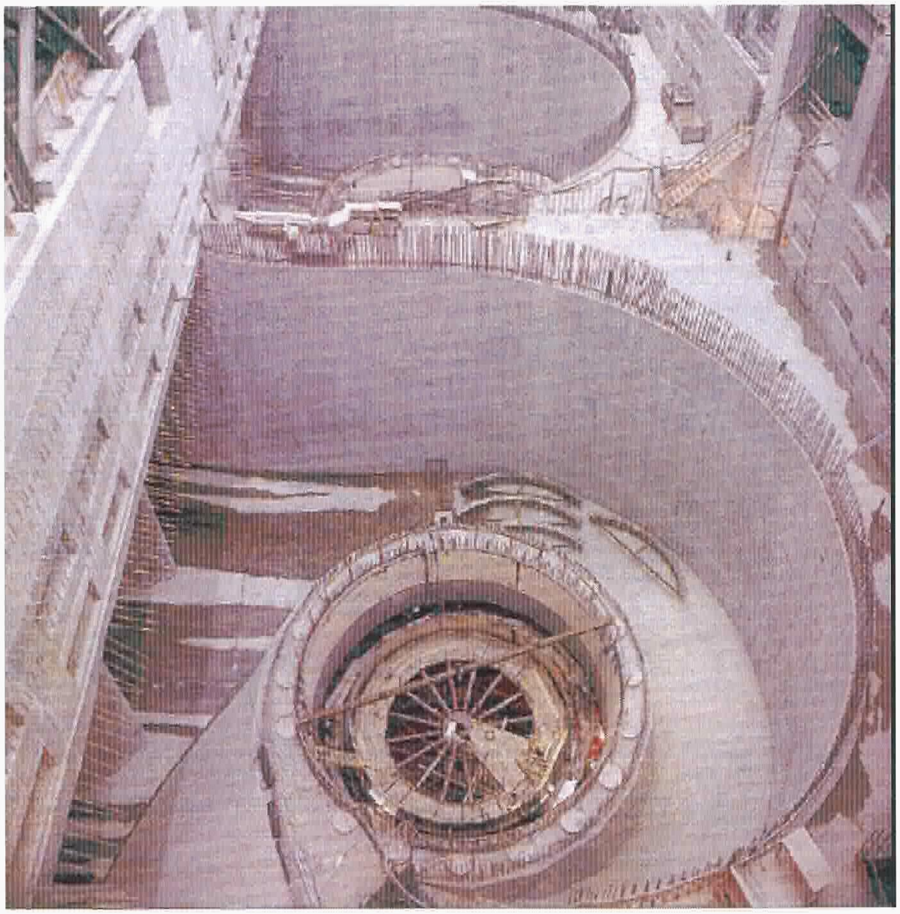


**Figure 3-12: Example of a Semi-Frontal Scroll Case showing Phase 1 Concrete Walls and the Stay Ring Foundation**

**Figure 3-13: Example of a Completed Stay Ring and Concrete Scroll Case**

The draft tube is composed of three main sections; the draft tube cone, elbow and diffuser (exit). In general, for units of this size, only the draft tube cone section is steel-lined and the remaining two sections are formed concrete surfaces. Velocities in these two sections are usually below 6 m/s. The draft tube elbow may be lined with steel depending on the preference of the client or to expedite the construction process. With respect to Island Pond, no draft tube lining was assumed. To minimize the size of the openings, a central pier was used in the draft tube.

The draft tube is fitted with two sets of gate guides and two draft tube gates. The gates are operated by electric hoists housed in the downstream part of the Powerhouse.

The Powerhouse building is a braced steel structure. The intake will provide the main lateral support for the building, and the structure will also support an overhead travelling crane. When the crane loads are extremely heavy, a separate series of columns are erected to support the crane rail beams. These columns are generally welded to the building columns to strengthen their weak axes.

#### *3.5.5.4 Construction*

The main objective of the construction schedule for a Powerhouse of this type is to have the main crane and the building enclosed to enable the installation of the stay ring. The secondary objective is to schedule the construction of the intake in advance of the construction of the RCC dam.

Rock excavation will require controlled blasting to guard against fracturing the surrounding rock. The excavation for the structures is entirely surface.

The concreting of the Powerhouse should take into account the following points:

- The placing of concrete shall cease when installing the draft tube cone and again when the stay ring is placed and anchored;
- The spiral case is formed, not steel-lined;
- Concreting is done at a slow rate around the mechanical parts;

- Provide the foundation for the steel columns that support the building and the overhead crane;
- First and second phase concreting for the gate guides.

#### 3.5.5.5 *Intake Mechanical Equipment*

Trashracks

Trashracks will be of the removable type to be installed in steel embedded parts on the face of the intake and will be handled using a mobile crane.

Following are estimated main characteristics of the trashracks:

- Quantity: 2 sets
- Hydraulic passage width: 6.4 m
- Hydraulic passage height: 12.8 m
- Sill elevation: 248.50 m

A differential pressure measuring system will be provided to monitor the degree of obstruction of the trashracks.

Stoplogs

When required, stoplogs will be installed in steel embedded parts upstream of the control gate in case the latter's embedded parts require inspection and/or maintenance. They will be downstream sealing and provided in multiple sections to be individually handled by an electric monorail under balanced hydraulic conditions.

Following are estimated main characteristics of the stoplogs:

- Quantity: 2 sets
- Hydraulic passage width: 6.4 m
- Hydraulic passage height: 9.8 m
- Sill elevation: 245.3 m

Control Gates

Control gates will be of the fixed-wheel type, with upstream sealing system and operated by a cable hoist. They will come complete with steel embedded parts and will be designed to cut the flow under emergency conditions. For handling and transportation purposes, each gate will be provided in multiple sections to be assembled once inserted into the gate slots.

Following are estimated main characteristics of the control gates:

- Quantity: 2
- Hydraulic passage width: 6.4 m
- Hydraulic passage height: 9.6 m
- Sill elevation: 243.0 m
- Hoist lifting capacity: 70 tonne

#### 3.5.5.6 *Powerhouse Mechanical Equipment*

Turbine and Governor

The Powerhouse will be equipped with one vertical-axis Kaplan turbine with the following estimated main characteristics:

- Number of units: 1
- Type: Vertical-axis Kaplan, with semi-spiral concrete case
- Rated head: 22.35 m
- Rated output: 37.1 MW
- Peak Efficiency Flow: 156 $m^3/s$
- Maximum Discharge: 182 $m^3/s$
- Synchronous speed: 133.33 rpm
- Runner outside diameter: 4.9 m

**Figure 3-14: Example of a Kaplan Turbine Assembly**

A fully homologous model test will be conducted for this Project unless the potential manufacturer can prove that he has a close reference model which could be adapted to the Project with Computational Fluid Dynamics (CFD) optimization. In addition, the manufacturer will have to prove the guaranteed performances during a field efficiency test.

The components of the turbine will be designed to withstand all static and dynamic loads resulting from continuous operation within the full range of heads and outputs.

The draft tube cone liner section will be equipped with an access door located at an elevation suitable for convenient access from a passageway in the Powerhouse substructure to the underside of the runner for installation of a maintenance platform and for dismantling and handling of runner blades.

An electro-hydraulic digital type governor, suitable for fully-automatic control, will control unit speed during start-up and synchronizing sequences, as well as generator output power after synchronization of the unit with the grid.

Draft Tube Gates

Gates of the sliding type will be provided at the exit of the draft tube in order to isolate the unit from the Tailrace in case inspection and/or maintenance is required inside the water passages. They will be provided in two or more sections to be individually handled by an electric monorail under balanced hydraulic conditions.

Following are estimated main characteristics of the draft tube gates:

- Quantity: 2
- Hydraulic passage width: 6.4 m
- Hydraulic passage height: 5.6 m
- Sill elevation: 232.6 m

Powerhouse Overhead Crane

The Powerhouse will be equipped with an overhead traveling crane. It will be provided with a main lifting hook for handling of the heaviest units of the turbine-generator unit, and with an auxiliary lifting hook for handling of other minor equipment. The main hook lifting capacity will be selected based on the weight of the rotor, which will be the heaviest piece of equipment to be handled by the crane.

Following are estimated main characteristics of the Powerhouse overhead crane:

- Main lifting capacity: 155 tonne
- Auxiliary lifting capacity: 20 tonne
- Span: 18 m

Mechanical Auxiliary Systems

The following mechanical auxiliary systems will be provided inside the Powerhouse:

- Service water system;
- Domestic water supply system;
- Plumbing, sanitary;
- Fire protection system;
- Cooling water system;
- Drainage and dewatering system;
- Low pressure compressed air system;
- Powerhouse HVAC system;
- Oil handling and purification system;
- Oil/water separation.

#### *3.5.5.7 Powerhouse Electrical Equipment*

Generator

The synchronous machine at the Island Pond Powerhouse will have the following characteristics: 40 MVA, 0.90 p.f., 13.8 kV, 3 phase, 60 Hz, 133.33 r.p.m., vertical shaft, hydro-electric generator, air-cooled by air-to-water heat exchangers, and directly coupled to a Kaplan turbine.

Static Excitation System

The excitation system will be of the static type, matching the field requirements of the 40 MVA generator. The excitation system consists of a dry-type excitation transformer, thyristor rectifier bridges, voltage regulator, DC field breaker and discharge resistor.

The power supply for the excitation system will be taken from the generator terminals through the excitation transformer.

Isolated Phase Bus (IPB)

The 13.8 kV bus will be of the isolated phase type, continuous, naturally-cooled, with each conductor completely enclosed in a metallic housing, separated from the adjacent conductor housing by an air space.

The nominal current at rated generator output and rated voltage flowing in the IPB is 1673 A. However, with a 10% voltage variation at the generator terminals, the current will increase to 1860 A. The three-phase isolated phase bus interconnecting the generator and transformer will be rated for 2000 A. The isolated phase bus will have taps to the excitation transformer and auxiliary transformer cubicles.

The current transformers for metering and protection will be provided both on the line side as well as the neutral side. These CT's will be of epoxy cast resin type with single secondaries installed either in the IPB or inside the generator terminal housing and neutral housing respectively.

Generator Circuit Breaker (GCB) Cubicle

The generator circuit breaker cubicle will be installed on the isolated phase bus between the generator and main step-up transformer. The GCB cubicle will include the generator circuit breaker with disconnect switch, surge capacitors, surge arresters, current transformers, voltage transformers and accessories. The voltage transformers will be with drawable, epoxy resin cast dry-type and be used for metering, protection and voltage regulation (AVR).

Neutral Grounding Cubicle

The neutral terminal of the generator will be connected to the generator neutral grounding cubicle. The cubicle will be equipped with a single-pole, single throw disconnect switch, a single-phase, dry-type, 13800 – 120/240 V neutral grounding transformer, and an earthing resistor connected to the secondary of this transformer. The resistor value will be calculated during the design phase in order to limit the single-phase fault current of the generator to a maximum of 15 A.

The generator neutral grounding cubicle will be installed next to the neutral terminals of the generator on the generator floor.

Generator Step-Up Transformer

The generator terminal voltage of 13.8 kV will be stepped-up to 230 kV through a generator step-up (GSU) transformer directly connected with the unit. The GSU transformer will be an oil-immersed, outdoor type, 40/50 MVA, ONAN/ONAF air-cooling system.

The GSU transformer will be located outdoors, on the downstream deck of the Powerhouse. The transformer will be installed such that its removal for repair or replacement is possible with a minimum disturbance to the IPB and to the high voltage cable connections.

The 13.8 kV bushings will be directly connected to the generator via 13.8 kV isolated phase buses. The high voltage side of the transformer will be equipped with bushings and H.V. surge arresters will be mounted on the brackets of the transformer tank. The neutral on the high voltage side of the transformer will be solidly grounded. The neutral and H.V. bushings of the transformer will be equipped with bushing type current transformers.

A fire protection system, including fire detectors and sprinklers, will be installed around the transformer to provide adequate fire protection. Firewalls will be installed where necessary.

The transformer will have its own oil recuperation basin connected to a drainage system feeding a common oil–water separation pit. The net volume of the basin will be able to contain the volume of oil of the transformer.

## Powerhouse AC and DC Auxiliary Electrical System

### *AC Powerhouse Auxiliaries*

The AC Powerhouse auxiliaries will be fed from the generating unit through a 13.8 kV:600 V, dry-type auxiliary transformer connected to the main IPB between the GSU transformer and the GCB cubicle.

The primary of the auxiliary transformer will be directly connected to 13.8 kV isolated phase bus bars through bus duct connections. The secondary of the auxiliary transformer will be connected to the 600 V, three-phase, four-wire station services switchboard through low voltage power cables.

A diesel generator (DG) set, sized to feed the essential loads, will provide station emergency power in the event of the unavailability of the generating unit and of the grid supply. The DG set is connected to the 600 V station service switchboard through three-phase power cables.

The DG set will be complete with all accessories for local and remote control starting and stopping. On loss of station supply, an undervoltage relay will start the diesel generator set to supply the essential loads for periods when the infeed from the system is not available. Upon restoration of the main supply, the switchover to the main will occur and the DG set will stop automatically.

The two incoming circuit breakers feeding the 600 V station services switchboard are electrically interlocked to prevent their inadvertent paralleling onto the station service bus.

### *DC Powerhouse Auxiliaries*

Supply for the 129 V DC auxiliaries of the Powerhouse will be derived from one 129 V battery set. The battery set will be supplied with two chargers; one main and one redundant. The basic concept being that the failure of a single charger should not put in jeopardy the operation of the control and protection relay system and, consequently, the Powerhouse.

One main DC distribution board will also be provided to feed the Powerhouse auxiliary DC loads.

The 129 V battery set and its corresponding chargers will be located in the battery room and charger room respectively.

Battery and charger sizes will be determined during detailed engineering stage.

An uninterruptible power supply (UPS) will also provide the AC supply derived from 129 V DC static inverters.

230 kV Switchyard

The installed capacity of the Island Pond Powerhouse is 36 MW. The output of the unit will be connected to the outdoor switchyard through the GSU transformer.

For the evacuation of this power, there will be two outgoing overhead transmission lines, one of them to Upper Salmon and the other to Granite Canal.

The proposed outdoor 230 kV switchyard will be located at the west end of the Powerhouse and immediately downstream of the dam. It will be constructed on a levelled area approximately 70 m x 50 m, fenced and gated for security. See Figure 3-15 on follow page, which is an excerpt from Drawing 722720-0000-41DD-0015. All structures and equipment will be installed on concrete foundations.

The switchyard will include line termination structures for TL263 from Upper Salmon and TL2XX to Granite Canal; a single 230/13.8 kV, 30/40/50 MVA power transformer; two 230 kV, SF6 circuit breakers; four 230 kV motorized disconnect switches; two 230 kV ground switches, capacitive voltage transformers and wave traps, associated bus work and grounding.

The protection and control panels for the switchyard equipment will be located in the Powerhouse control room.

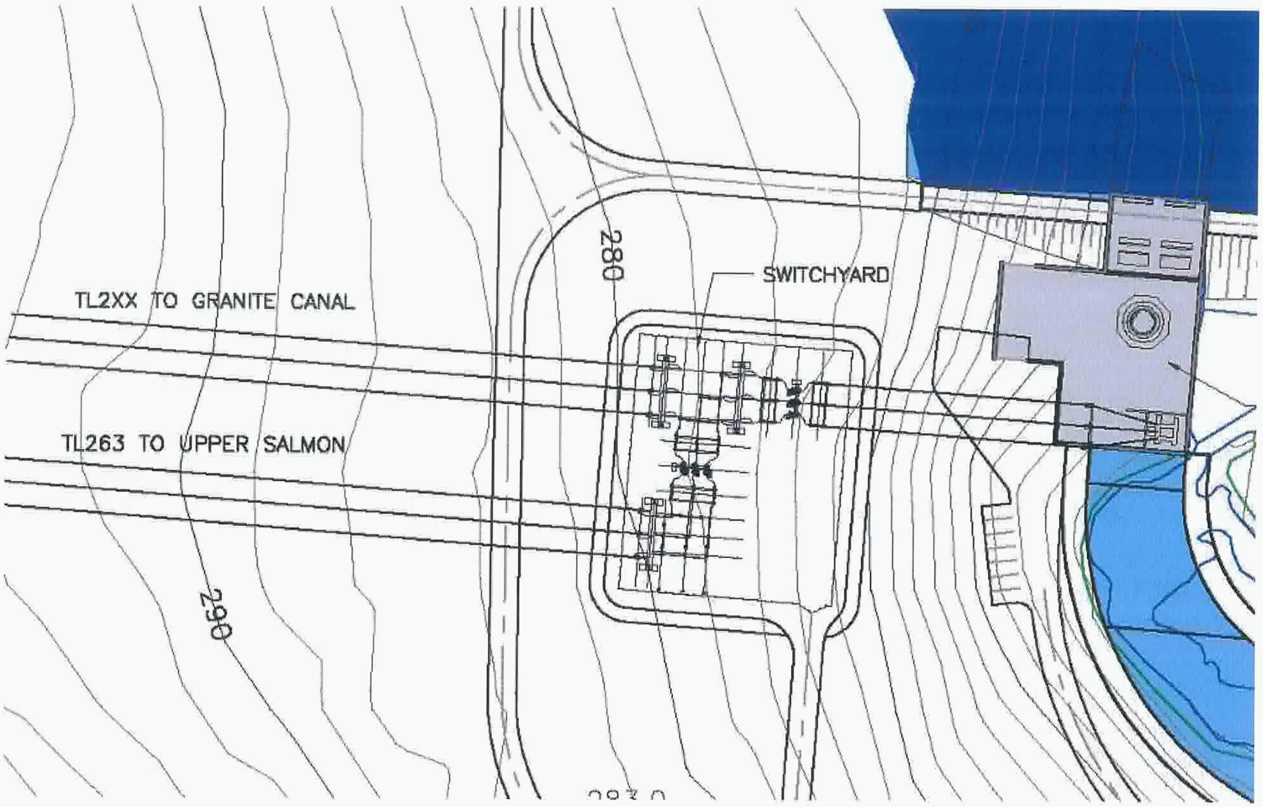



**Figure 3-15: Switchyard**

<u>Earthing System</u>

The Powerhouse and switchyard embedded earthing grid will be designed to obtain an earth resistance of one ohm or less. The step and touch potentials will be limited to acceptable limits as indicated in IEEE 80 Standard.

The earthing conductors will be dimensioned for carrying earth-fault current in any part of the plant for a minimum of half a second (0.5 s) without harm to the conductors.

During detailed design phase, ground resistivity measurements will have to be performed for the design of the earthing grid.

Indoor, Outdoor and Emergency Lighting

The lighting will be designed in line with industry practices and in conformance with the IES (Illuminating Engineering Society) lighting recommendations. The system will consist of the following:

- Indoor lighting system;
- Outdoor lighting system;
- Emergency lighting system.

## 3.6 DE-WATERING SCHEME

The de-watering scheme developed in the 1988 Feasibility Study could be realized with the present construction window; however, when the scheme was developed, concerns with disruption of fish habitat were not as prevalent as they are today. A de-watering scheme similar to the one described in the February 12, 1997 Re-Optimization and Cost Update Study (Addendum No. 2), taking into consideration fish habitat issues, is recommended as follows:

1. The Forebay Canal would be excavated prior to carrying out improvements to the channel in Island Pond so that the Forebay Canal can be used to draw down Island Pond. The most effective way to un-water for the Forebay Canal is to move the canal to the right bank of North Salmon River. This eliminates the need for a temporary bypass channel proposed in the previous scheme. Small cofferdams would be constructed at locations A and B shown on Drawing 722720-0000-41DD-0013 an excerpt of which is shown below on Figure 3-16.

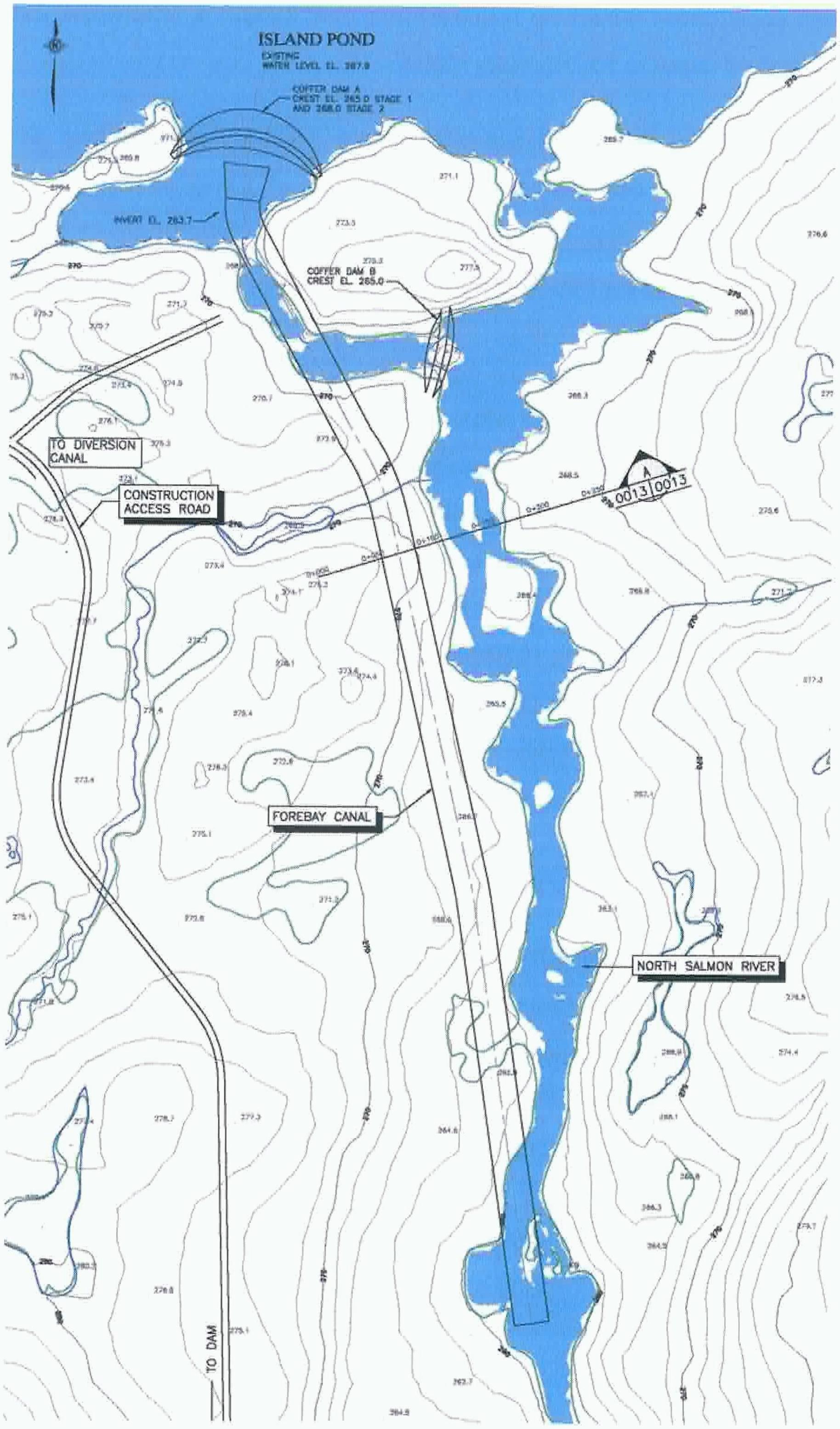



**Figure 3-16: De-Watering Scheme for Forebay**

Small cofferdams would be required at a few locations where the existing river encroaches close to the Forebay Canal.

After the spring flood and not before May 15th (fry emergence), the Forebay Canal would be opened to draw down Island Pond to the invert elevation required to do the channel improvements in Island Pond, more or less in the dry. At the same time, the HADD compensation in Island Pond would be constructed. When the channel improvements in Island Pond are completed, no later than September 15 (spawning), the cofferdam at the Forebay entrance would be re-constructed with a control structure to maintain a minimum flow of 2 $m^3/s$ in North Salmon River and to bring Island Pond up to normal levels until such time as the dam is completed and the reservoir is ready for filling. The Capital Cost Estimate includes a provision for fish relocation during de-watering of the Forebay Canal and de-watering for channel improvements in Island Pond. Also, in the case of Island Pond, a monitor is required to measure water temperature and dissolved oxygen. Boulders and some gravels would be placed in the Forebay Canal to migitate against the impact on fish habitat in North Salmon River as the re-watering of Island Pond will not be completed until late winter or spring. During the re-watering of Island Pond, the invert of the Forebay Canal can be constructed with a talweg to provide adequate water depths for fish passage.

2. De-watering of the Intake/Powerhouse is independent of the Forebay Canal and would be achieved by means of a cofferdam, concrete box culvert and diversion ditch as shown on Drawing 722720-0000-41DD-0014, an excerpt of which is shown below in Figure 3-17. The diversion ditch will be designed for the flow when Island Pond is being drawn down for the channel improvements. The concrete box culvert would be closed and sealed at such time as the dam is completed to a stage to allow removal of the cofferdam at the Forebay entrance to begin filling up the Forebay and Island Pond reservoirs.

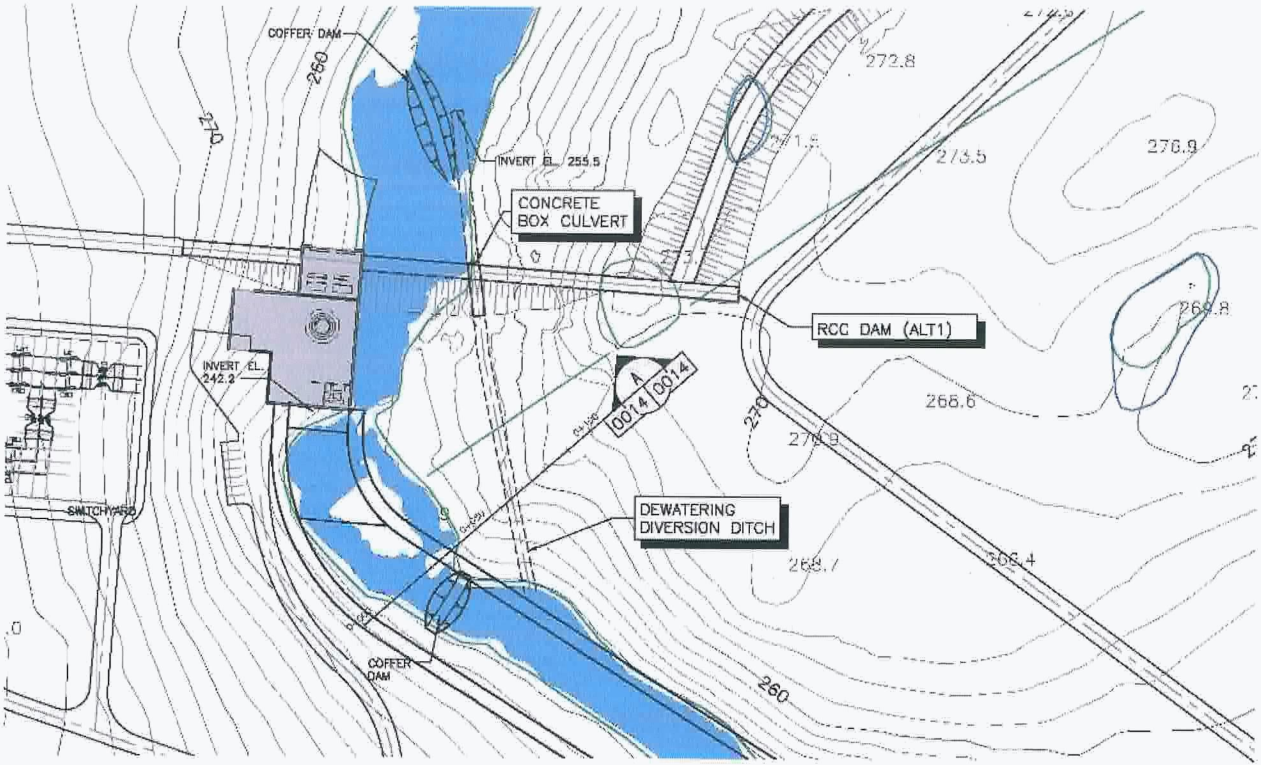



**Figure 3-17: De-Watering Scheme for Dam/Powerhouse**

3. De-watering and excavation of the Tailrace and construction of the HADD compensation structure at the end of the Tailrace takes place after flow in the North Salmon River has been cut off for filling the reservoir.

4. No change was made in the de-watering approach for the channel improvements in Meelpaeg Reservoir.

5. The Capital Cost Estimate includes a provision for fish relocation during the de-watering for Channel Improvements in Meelpaeg Reservoir and during de-watering of the Tailrace.

## 3.7 TAILRACE

The Tailrace design has been modified slightly from the previous report to accommodate the new flow criteria and the construction of a HADD compensation structure at the end of the Tailrace. See Figure 3-18 below or Drawing 722720-

0000-41DD-0022. The principle of designing the Tailrace to pass the maximum plant discharge of 182 $m^3/s$ with a minimum head loss has been maintained.

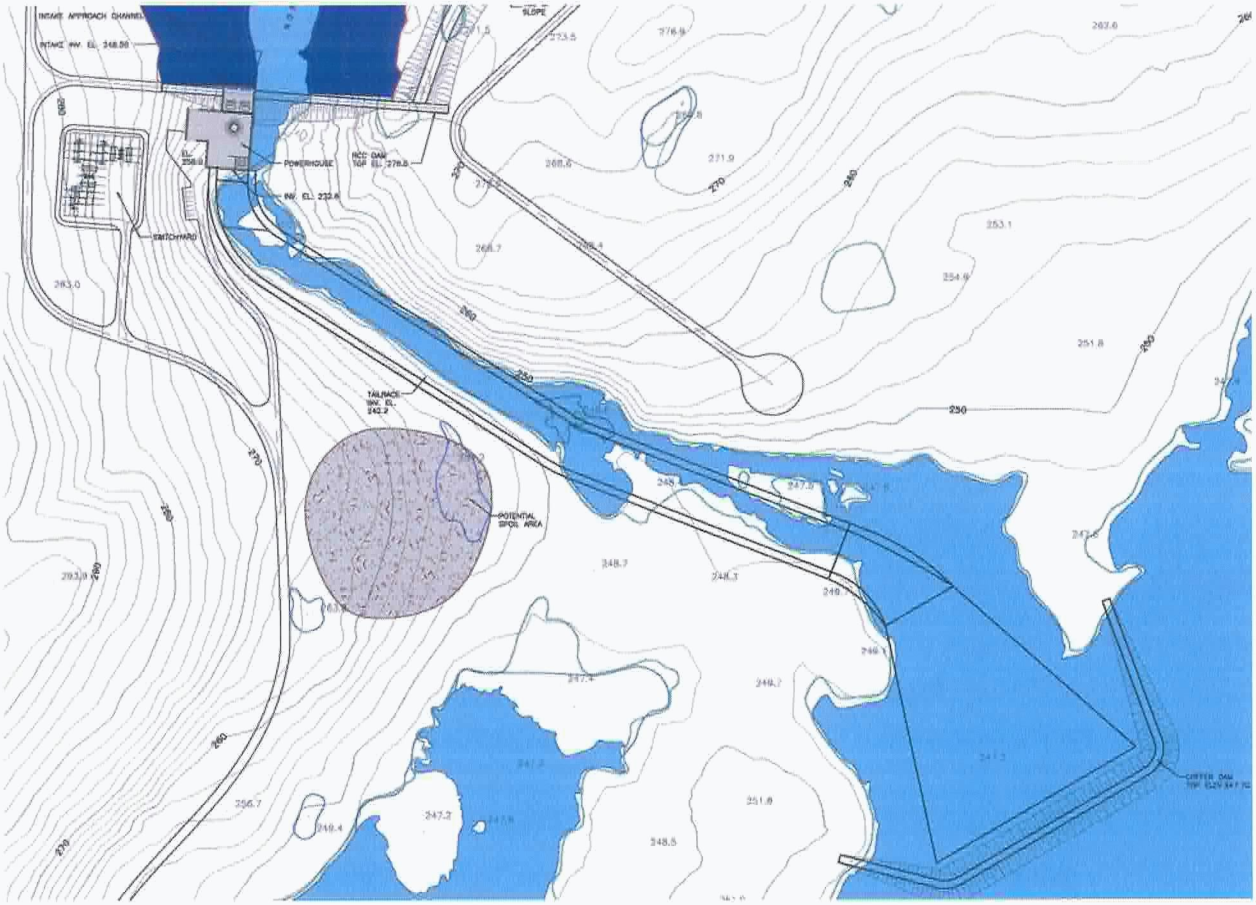



**Figure 3-18: Tailrace**

The following design criteria apply:

- Invert width – 28 m;
- Invert elevation – 242.2;
- Gradient – 0 m/m;
- Side Slopes: 6V:1H in rock cut; 1V:2H in earth cut;
- Flow depth – 4.63 m;

- Manning's Friction Co-efficient – n=0.035;
- Water Velocity – 1.2 m/sec at PEF (156 $m^3/s$);
- Head loss – 0.19 m.

New quantities were calculated for the Tailrace excavation based on new mapping. Bathymetry for the Delta at the entrance to Crooked Lake is not available and final quantities will have to be adjusted when bathymetry is available.

## 3.8 TRANSMISSION LINE

Two 7 km long, three-phase, single circuit, 230 kV transmission lines will connect the switchyard to the existing TL263 between the Granite Canal and Upper Salmon Plants. The connection to TL263 will be at a point near the intersection of the Ebbegunbaeg access road and the new road to the Powerhouse. The route of the transmission lines between the Island Pond Plant and the TL263 connection will generally parallel that of the new permanent Powerhouse access road, along the north side of Crooked Lake.

The lines will comprise double wood pole tangent structures with steel cross arms and steel towers for dead end and angle structures. The span lengths will be approximately 200 m. Overhead ground wires (OHGW) will be installed on each line for a distance of 1.6 km out from the Island Pond Plant.

Protection and control will be provided on the two transmission lines in and out of the switchyard. The line from Granite Canal to Island Pond (TL2XX) will have three pole trip with re-closing at the Island Pond end only. The line from Island Pond to Upper Salmon (TL263) will have single pole trip and re-close at both the Island Pond and Upper Salmon ends.

Dual redundant multi-function distance relays will be utilized to provide phase/ground distance and over-current protection. Zone 1 (Z1) reach will utilize a direct trip scheme. Zone 2 (Z2) will utilize a permissive over-reach scheme. Bi-directional teleprotection will be provided over fibre optic multiplexers.

Local and remote metering will be provided via the distance relay's metering capability. Control functions, such as re-closing and breaker fail, will be performed using logic in the distance relays.

Local and remote SCADA for the transmission line parameters will be provided from the relays via fibre optic LAN interface utilizing modbus DNP 3.0 protocol. It is anticipated that this data will be incorporated into the generating station's HMI to facilitate local and remote functionality.

## 3.9 DISTRIBUTION LINE

A new 12 km long, 3-phase, 25 kV single wood pole distribution line, with fibre optic cable, will be constructed from the Ebbegunbaeg Control Structure to the temporary construction camp and the Powerhouse locations, to provide construction power and communications during the construction period of the Project and for permanent communications after construction. The route of the distribution line will generally follow that of the existing Ebbegunbaeg access road, between the Ebbegunbaeg Control Structure and the Powerhouse intersection, and the new permanent Powerhouse access road.

The existing 21 km long, 25 kV distribution line between the Godaleigh Hill Microwave Site, located near the Upper Salmon Plant, and the Ebbegunbaeg Control Structure will be upgraded and fibre optic cable installed. This will facilitate site communications via the external communications system at Upper Salmon.

## 3.10 TELECOMMUNICATIONS

A new 33 km All-Dielectric Self-Support (ADSS) fibre optic cable will be installed between Island Pond Powerhouse and Godaleigh Hill Microwave Site. This cable will be attached to the existing 25 KV distribution line between Upper Salmon Plant and Ebbegunbaeg Control Structure, as well as the new distribution line between Ebbegunbaeg Control Structure and the new Island Pond Plant. This fibre optic connection will provide back haul communications during site construction as well as permanent Powerhouse communications. NL Hydro's Energy Control Center will have remote communications for monitoring, control and operation of the

Powerhouse, Intake, Switchyard and associated facilities over the fibre cable, via Godaleigh Hill Microwave site and NL Hydro's private microwave system. Permanent Powerhouse telecommunications will include the following: VHF mobile radio for the Powerhouse, high speed administrative and Internet access, telephone service, Supervisory Control and Data Acquisition (SCADA) and operational LAN and telecommunications for the transmission line to Granite Canal, TL2XX, and the new transmission line to Upper Salmon, TL263.

## 3.11 RESERVOIR CLEARING

New mapping was used to estimate reservoir clearing requirements. A tree line is indicated on the mapping and this was used to calculate the wooded area. However, the tree line does not give a true representation of the wooded area and the quantity was adjusted downward by 50% based on air photo interpretation and personal observations of the area. Because of the unknown implications of the impact on lacustrine habitat the estimate is based on the need to remove all trees and heavy brush (including alders, shrubs, etc., 3 m horizontally from highwater mark). All merchantable timber will be salvaged and non-merchantable trees and shrubs burnt.

## 3.12 FISH HABITAT

NL Hydro quantified fish and fish habitat within the footprint of the proposed Island Pond Project using DFO quantification guidelines in order to determine the potential for Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD). The report concluded the Project affects 583 units of Type II Riverine Habitat (using Beak Classification System) and 2713.7 ha of Lacustrine Habitat (2336.2 ha littoral and 377.5 ha profundal).

### 3.12.1 Riverine Habitat

NL Hydro directed SNC-Lavalin to investigate and provide cost estimates for constructing 583 units of Riverine Type II habitat. Various options were investigated and several locations were identified as potential HADD compensation areas. Drawings 722720-0000-41DD-0021 to 722720-0000-41DD-0022 show the locations of these areas, excerpts of which are shown in Figures 3-19 and 3-20 below. Stream 13 is located on the east side of Island Pond.

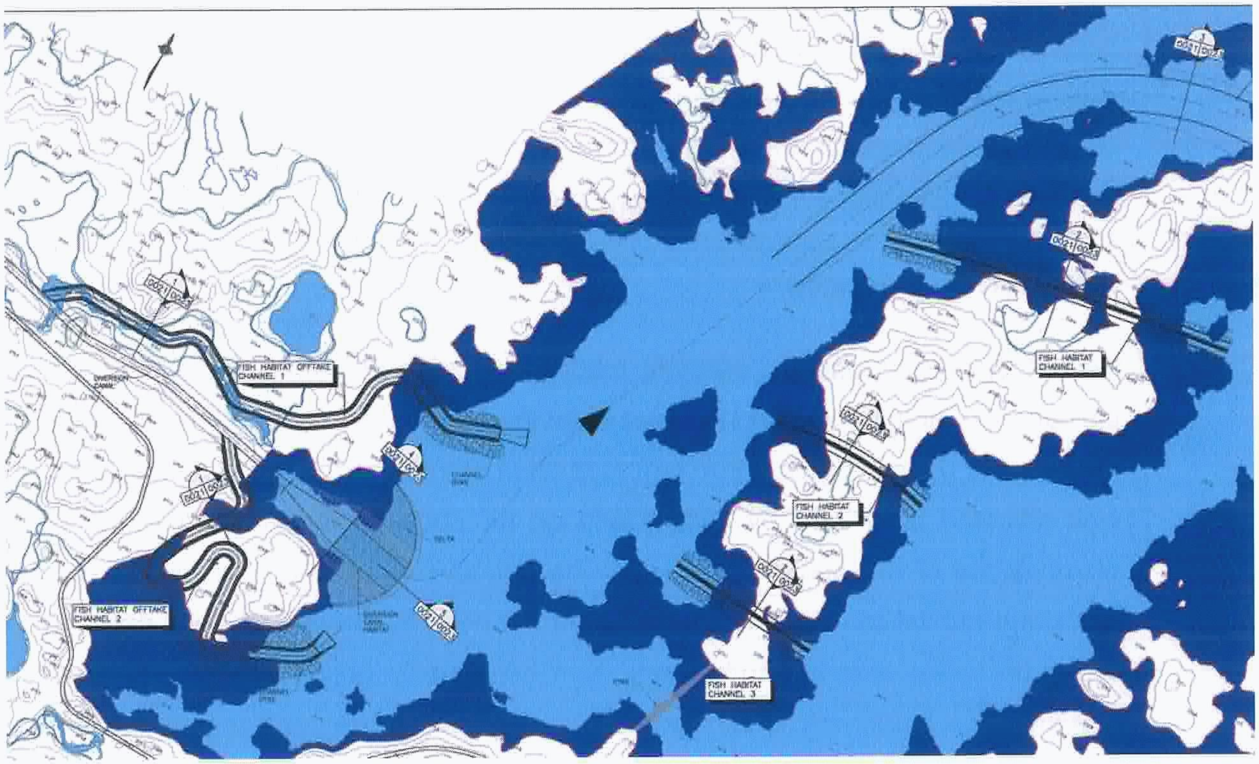



**Figure 3-19: HADD Compensation Areas**

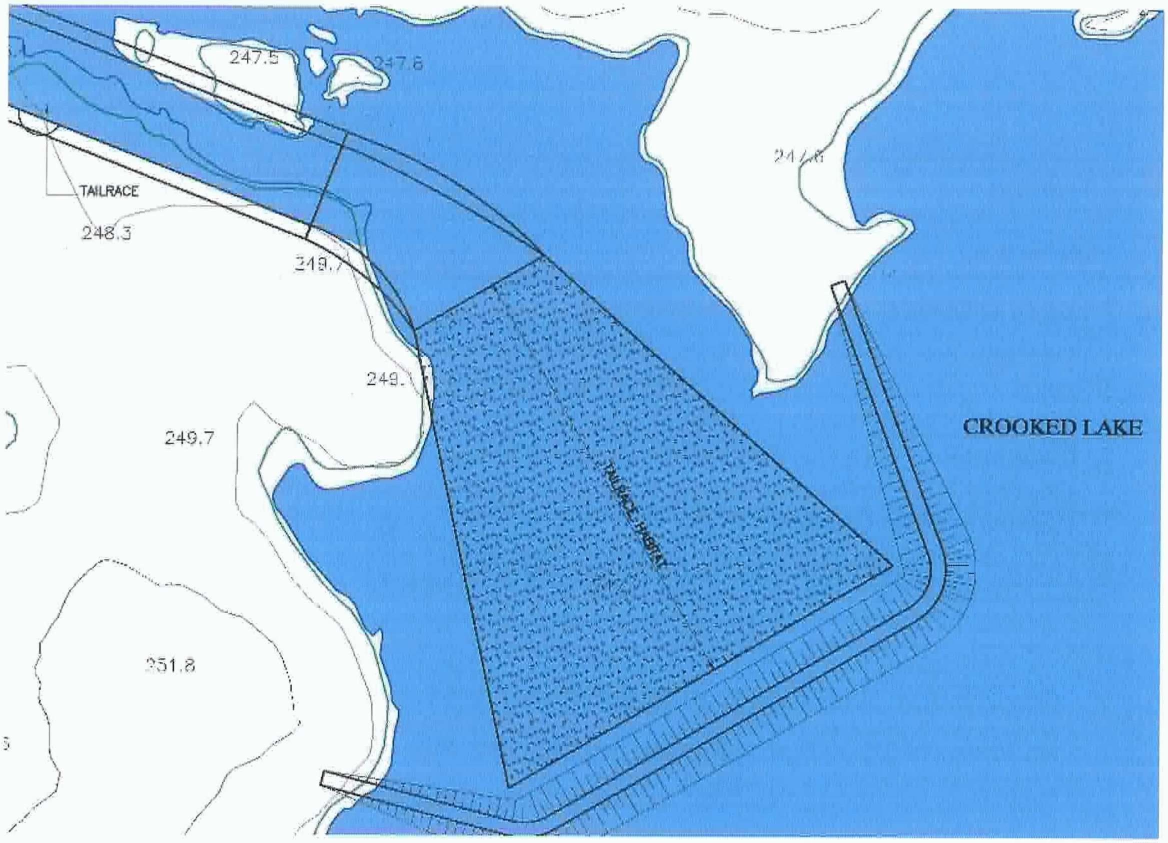



**Figure 3-20: HADD Compensation Areas in Tailrace**

Table 3.1 summarizes the number of potential units at each location and the associated estimated cost. The number of units are based on the normal minimum water levels in Island Pond and Crooked Lake, 267.31 m and 247.11 m respectively.

Table 3.1 HADD Compensation Areas and Cost Estimate

| Description | Units | Estimated Cost |
|---|---|---|
| Tailrace | | |
| Stream 13 | | |
| End of Diversion Canal from Meelpaeg | | |
| Channels across Island, or peninsula, in Island Pond:<br>Channel 1<br>Channel 2<br>Channel 3<br>Widening Main Channel | | |
| **TOTAL** | **583** | **$3,576,599** |

Graph 3 from Shawmont's 1988 report was used as the primary basis for selecting water levels for design of the fish habitat channels. Operations data for Meelpaeg Reservoir for 2003-2006 was compared with Graph 3. The recent data generally shows higher water levels than in 1988, but it is thought that this probably reflects the fact that the recent data is from a wetter than normal period. The lower levels were used in the conceptual design. It is recommended that this curve be upgraded for final design based on simulation results reflecting the way in which the system would be operated once Island Pond is put into service.

The design of fish habitat at the Tailrace and the end of the Diversion Canal takes advantage of the fact the velocity of the water as it exits these facilities has a certain reach into the respective reservoirs. At the Tailrace, the depth of flow can be controlled to meet velocity criteria resulting in 150 units of habitat. At the end of the Diversion Canal, the depth of flow is greater because of the invert elevation of the Canal and only 100 units are achievable.

Table 3.2 Optional HADD Compensation Areas

| Description | Units | Estimated Cost |
|---|---|---|
| Offtake Channels from main Diversion Canal: | | |
| Channel 1 | | |
| Channel 2 | | |
| **TOTAL** | **295** | **$3,776,162** |

These areas have been conceptually outlined on Drawings 722720-0000-41DD-0021 and 722720-0000-41DD-0022, an excerpt of which is shown in Figure 3-19. Typical sections of the channels are shown on Drawing 722720-0000-41DD-0023, an excerpt of which follows in Figure 3-21.

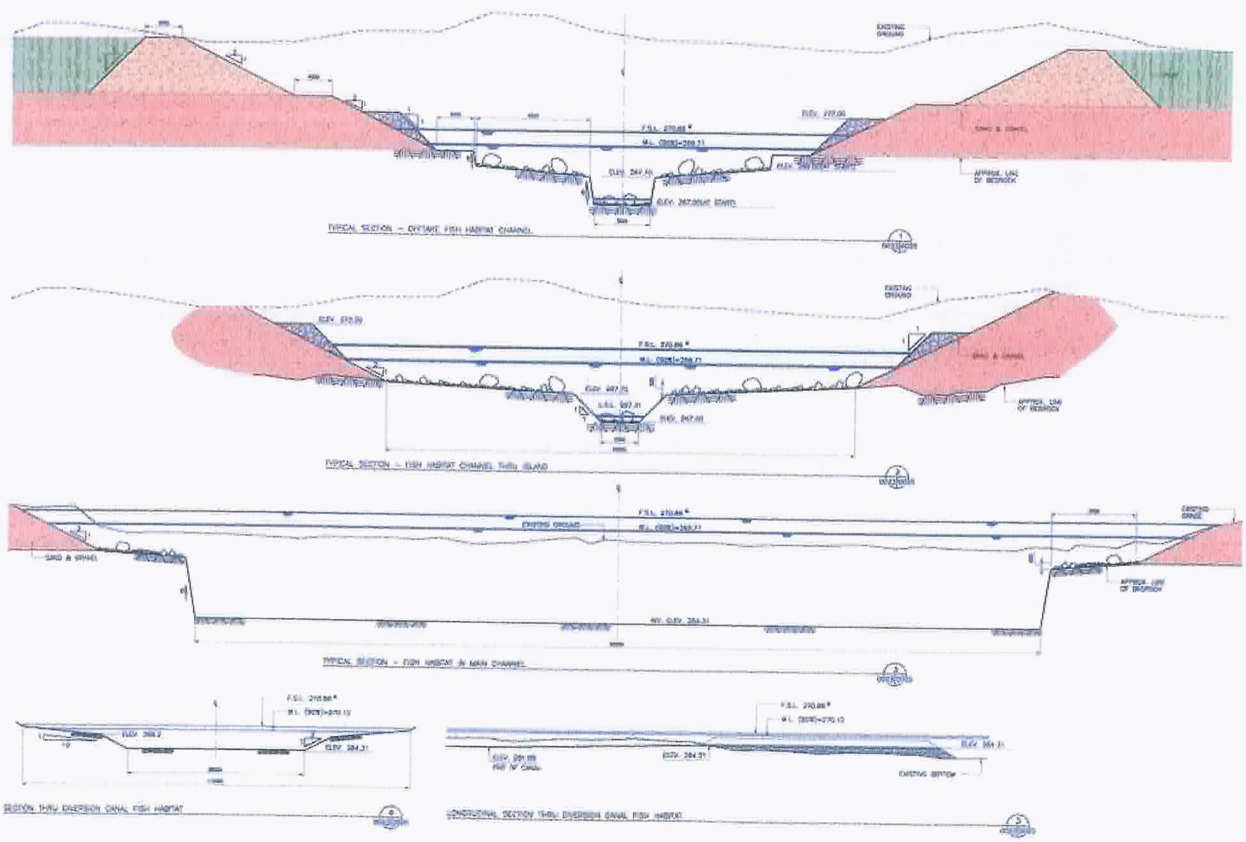


**Figure 3-21: Optional HADD Compensation Areas**

The cost estimates include a 30% contingency allowance as many assumptions had to be made in establishing the cost. In particular, information is lacking on soil types for excavating the channels, and bathymetry is lacking at the Tailrace and Diversion Channel Deltas.

The functionality of the offtake channels from the Diversion Canal and the channels across the island, or peninsula, in Island Pond are essentially the same. From a cost perspective, it is recommended that NL Hydro pursue the option of channels across the island, or peninsula, in Island Pond with the Department of Fisheries & Oceans (DFO). The total required units can be achieved without including the offtake channels.

The Delta area at the end of the Diversion Canal is the most economical to construct as it can essentially be done by filling with spoil and constructing the required 100 units of fish habitat on top of the spoil. Consideration has to be given to monitoring requirements at this location as the invert elevation of the delta cannot be higher than 264.3 m.

NL Hydro has indicated it may be able to use substantial banked HADD units from the Granite Canal Project to trade off against having to construct the full 583 units. NL Hydro should pursue this issue with the Federal Department of Fisheries and Oceans as quickly as possible as it could result in substantial cost savings for the Project.

### 3.12.2 Lacustrine Habitat

Island Pond

The quantification of Island Pond lacustrine habitat was completed by NL Hydro. Both the existing habitat as well as the future habitat created after Project completion were calculated. In an attempt to reduce any HADD associated with the inundation of Island Pond, the future habitat was calculated using the proposed reservoir elevation of 271.86 m and the assumption that the future shoreline would eventually be similar to that of the existing.

The existing habitat within Island Pond is a total of 2,710.7 hectares. When the resident species habitat preferences are used to generate habitat equivalent units for HADD determination, the total habitat area potentially required for compensation is estimated at 1,865.4 ha. When the future reservoir is treated as fish habitat and quantified similar to the existing, there would be an overall estimated increase in habitat equivalent units for all resident species; arctic char (32.5% increase), ouananiche (40.3% increase), brook trout (12.9% increase) and three-spine stickleback (42.8% increase). It is anticipated that the existing and future estimations of habitat equivalent units will be used by DFO to determine any potential HADD of lacustrine habitat.

Meelpaeg Reservoir

A field assessment of the channel improvement section in Meelpaeg Reservoir is required to determine the amount of lacustrine habitat impacted by the improvements. From mapping, the area impacted is estimated to be 15.48 hectares. In reviewing the 1988 Field Report (Shawmont Newfoundland Limited 1988) a total of three cone penetration tests were conducted in the Arm. All were fairly close to shore and had organic silts (0.3 – 2.2 m deep) over sand and gravel indicating that the majority of the area may be classified as littoral fine. Without a field assessment an accurate habitat description cannot be given, in particular where the littoral and profundal areas would be delineated.

## 3.13 ACCESS ROADS AND FACILITIES

### 3.13.1 General

"The Island Pond Development Final Feasibility Study, January 1988", had considered various alternatives for roadway access to the Project and recommended the construction of a permanent access road from the Upper Salmon Road, west towards Ebbegunbaeg Control Structure, then to the North Salmon River. It also recommended temporary construction access from Millertown to Ebbegunbaeg via an existing road, which would require upgrading, and a new bridge at Noel Paul's Brook. See Drawing 722720-0000-41DD-0001, an excerpt of which follows in Figure 3-22.

As part of this study, we have reviewed the 1988 study and prepared a cost update for all access roads which is now estimated at

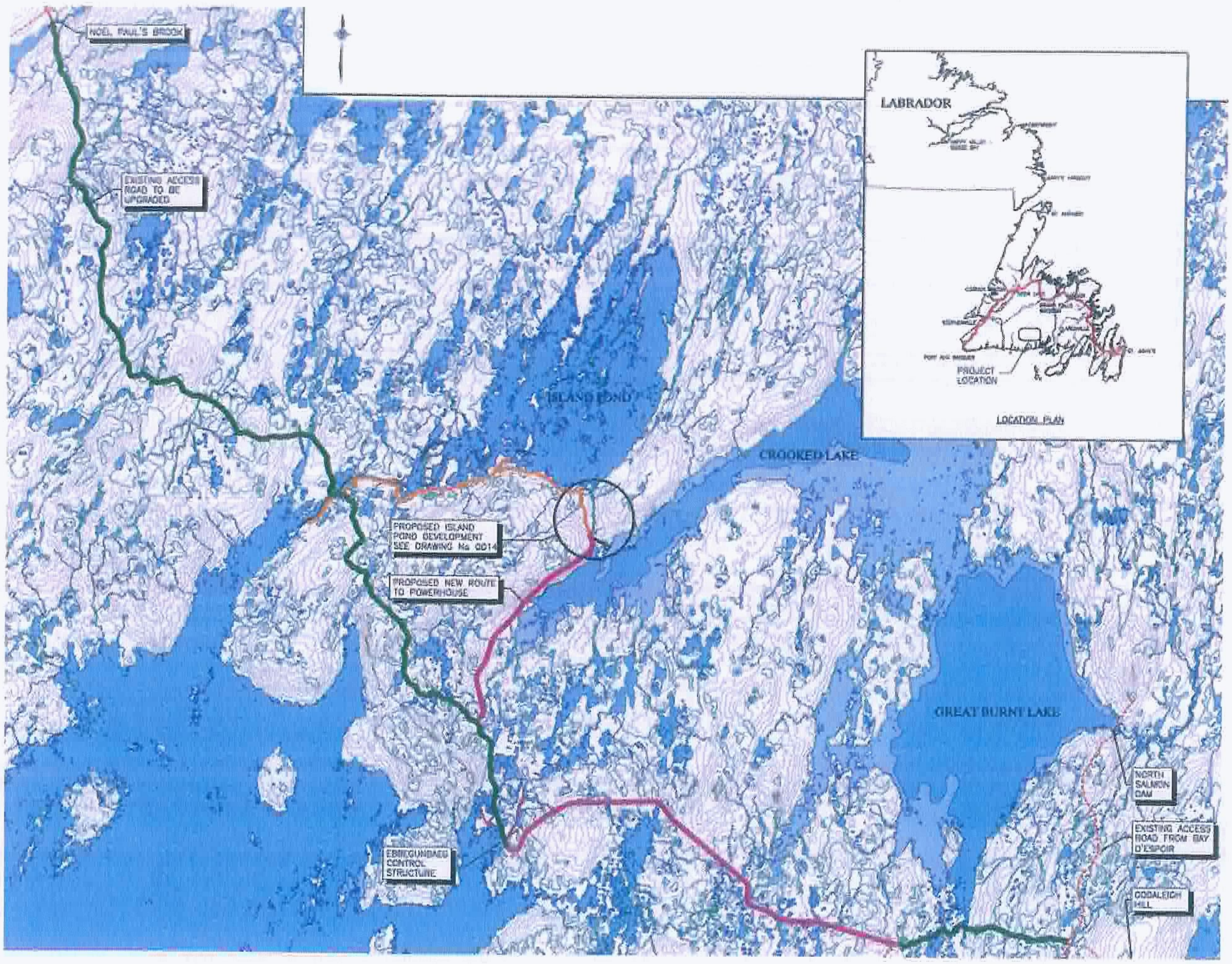



**Figure 3-22: Proposed Access Roads**

### 3.13.2 Access During Construction

Access during construction would be established by the upgrading of the existing access road from Noel Paul's Brook to the intersection of the new permanent access road to the Powerhouse, which would then be constructed to facilitate access to the Powerhouse, as per Figure 3-23.

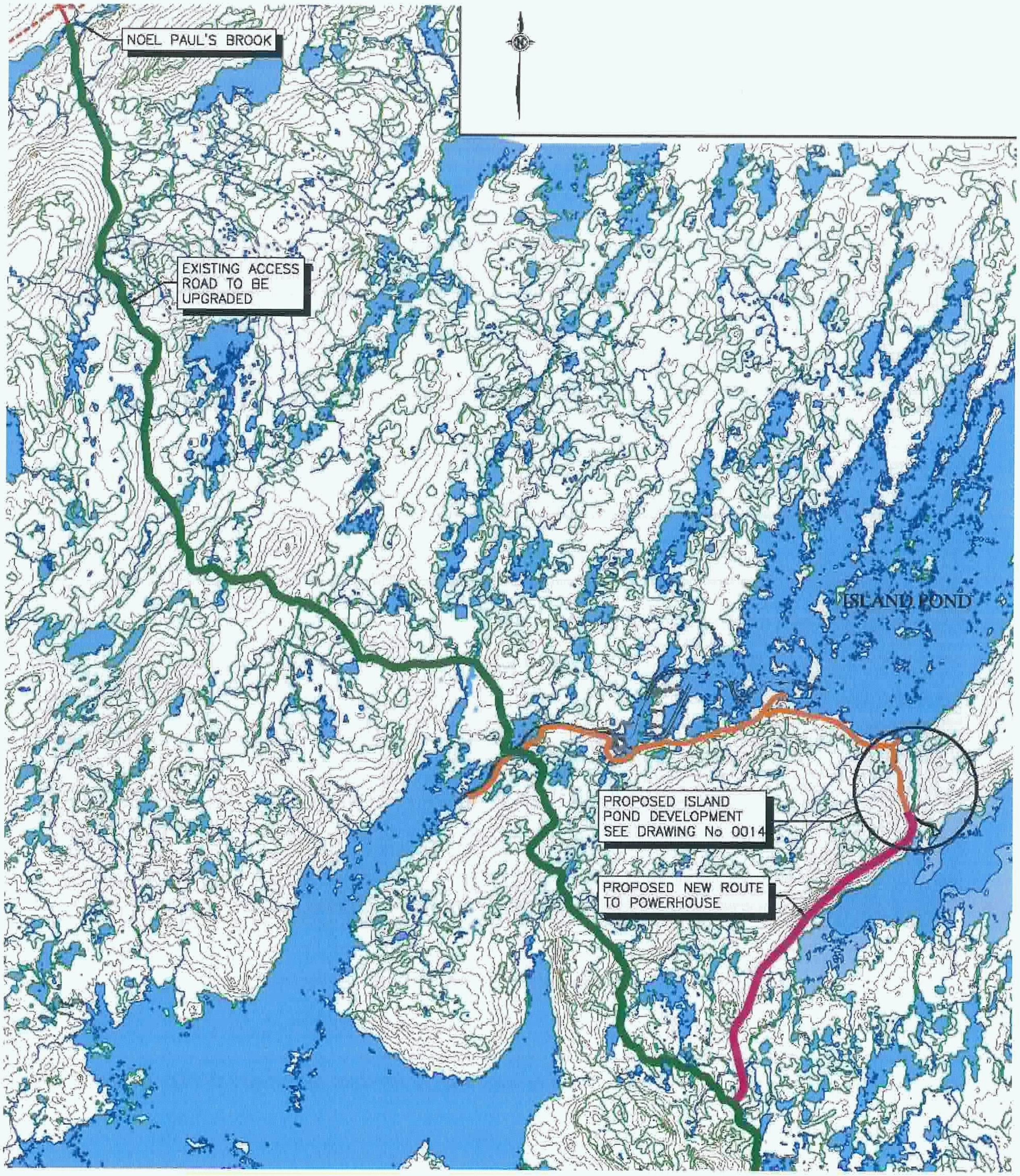



**Figure 3-23: Proposed Construction Access Roads**

The existing access road from Noel Paul's Brook was constructed in the 1960's to facilitate the construction of the Ebbegunbaeg Control Structure and adjacent dams. It is in very poor condition and requires upgrading. A temporary bridge will be required across Noel Paul's Brook, as shown in Figure 3-24.

**Figure 3-24: Noel Paul's Brook - River Crossing**

It is proposed to construct the access roads to the standard noted in the cross-section shown in Figure 3-25.

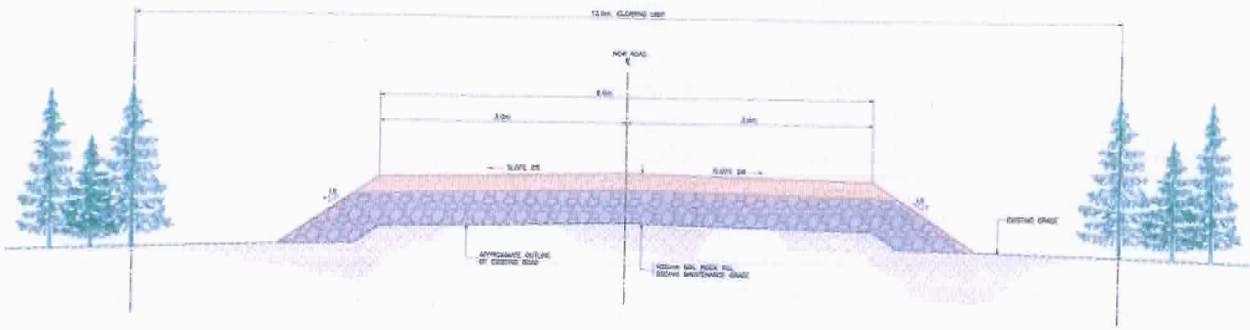


**Figure 3-25: Typical Temporary Road Section**

The estimated cost for these portions of the access road are as follows:

- Noel Paul's Brook to Powerhouse Access Rd Intersection
- Bridge at Noel Paul's Brook (assuming temporary installation)

  For an additional , this bridge could be a permanent structure.

In addition to the above noted roads, 15.4 km of temporary construction access roads will be required to access the Diversion Canal, Channel Improvements in Island Pond, and the Forebay Canal, as shown on Figure 3-26, at a cost of

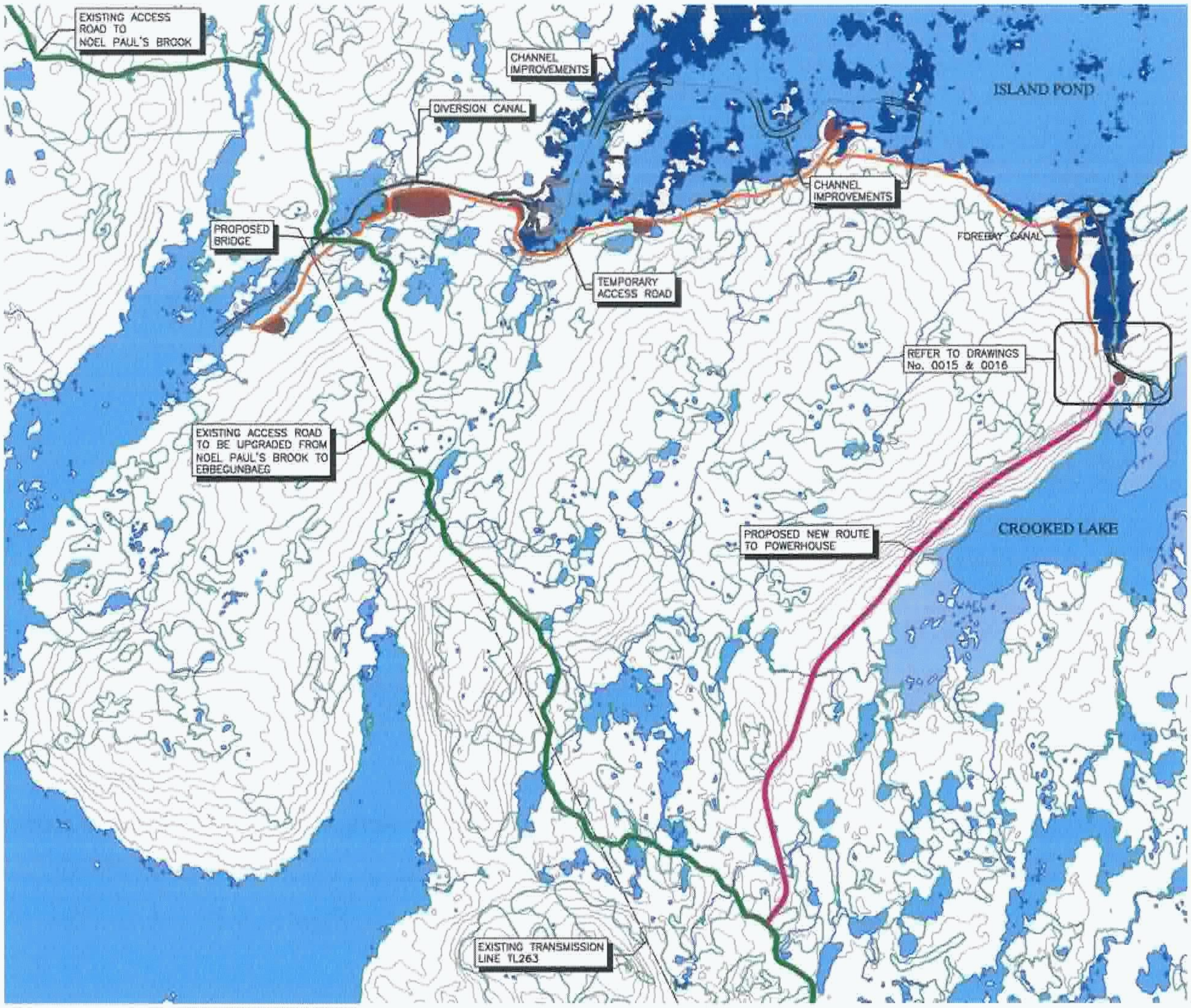



**Figure 3-26: Access Roads for Construction**

### 3.13.3 Permanent Access

The terms of reference requirements are for the provision of a newly constructed access road from the Upper Salmon Access Road to the Ebbegunbaeg Control Structure and then to the Powerhouse, as shown on Figure 3-27 below. This road will be constructed to a standard as shown in Figure 3-28 below.

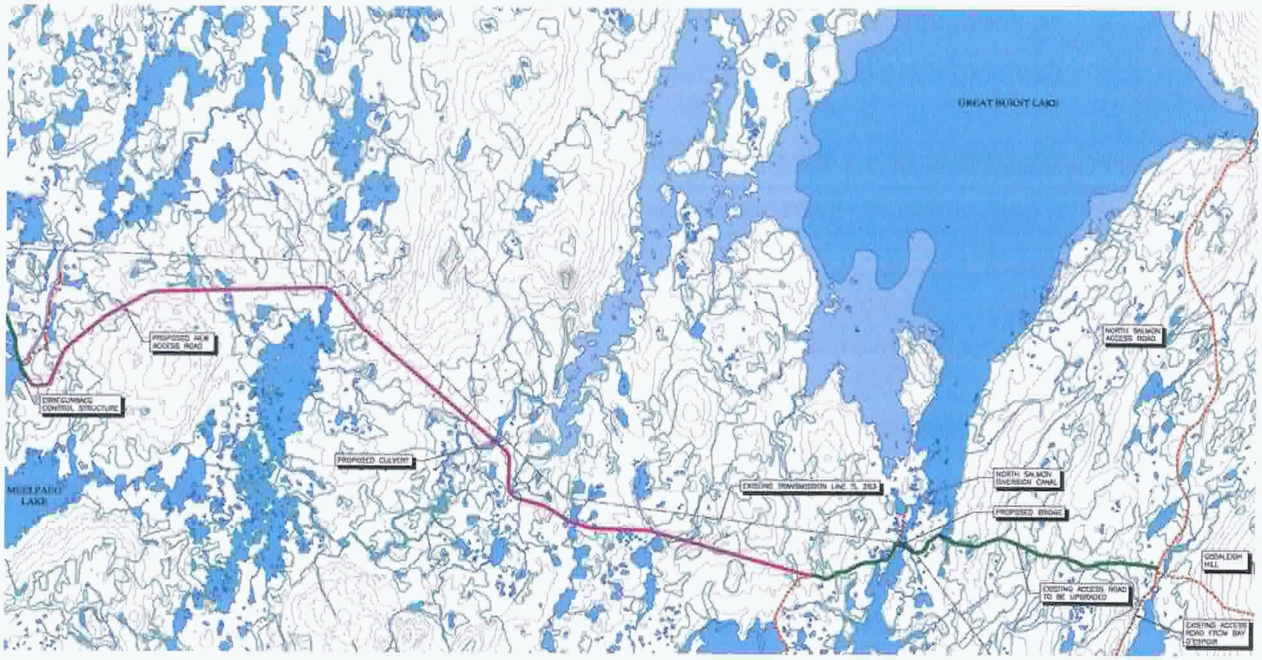



**Figure 3-27: Proposed Permanent Access Road from Upper Salmon to Ebbegunbaeg**

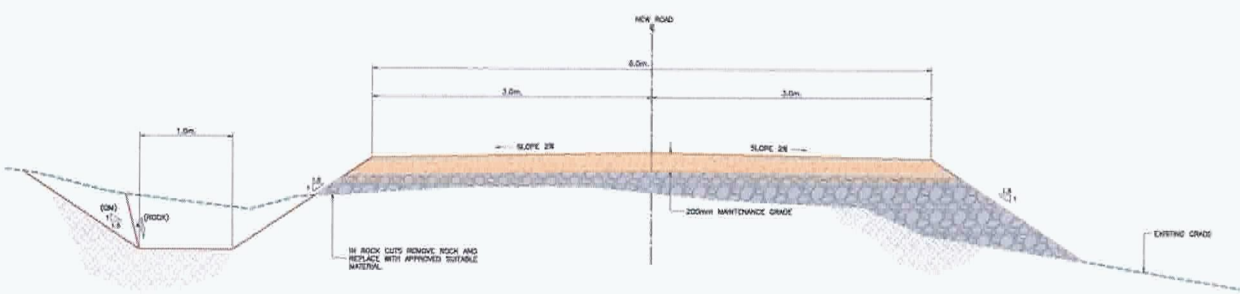


**Figure 3-28: Typical Permanent Road Section**

The permanent access road is comprised of the following components:

- Upgrading of approximately 13.3 km of existing North Salmon Road from the Upper Salmon Plant to the intersection of North Salmon Road and road to Upper Salmon Diversion Canal;

- Upgrading of approximately 5.7 km of existing road from the Upper Salmon Road to the Upper Salmon Diversion Canal;

- New construction of 14.4 km of access road from the Upper Salmon Diversion Canal to the Ebbegunbaeg Control Structure;
- Upgrading of 4.2 km of existing road from Ebbegunbaeg Control Structure to the Powerhouse Road Intersection;
- New construction of 7.4 km of permanent road from the Ebbegunbaeg Road Intersection to the Powerhouse.

### 3.13.4 Bridge Structures

A total of three bridges and a large culvert are required for the temporary and permanent access roads as follows:

1. Noel Paul's Brook (temporary structure)

   For an additional , this bridge could be a permanent structure;
2. Diversion Canal (Meelpaeg – Island Pond)
3. Upper Salmon Diversion Canal
4. Culvert between Upper Salmon Diversion Canal & Ebbegunbaeg

Estimates for these bridges are based on panel-type bridges, which are more commonly referred to as Bailey Bridges. Panel bridges are the most economical and can be installed quickly. The estimate for Noel Paul's Brook bridge is based on outright purchase with a buy-back option by the supplier.

### 3.13.5 Spoil Areas

Potential spoil areas have been identified for the various excavation areas and are located on the drawings as follows:

- Meelpaeg/Diversion Canal - 722720-0000-41DD-0007;
- Diversion Canal/Island Pond Channel Improvements - 722720-0000-41DD-0008;
- Island Pond Channel Improvements – 722720-0000-41DD-0009;

- Forebay Canal – 722720-0000-41DD-0010;
- Intake/Powerhouse/Tailrace – 722720-0000-41DD-0014 and 0015.

The areas were selected based on minimizing environmental issues such as inundation of streams, runoff, sedimentation, etc. These areas will have to be evaluated on a more rigid field assessment basis during the design process.

The Diversion Canal cuts through a pond between Meelpaeg Reservoir and Island Pond. During the design process, consideration should be given to filling in this area with spoil. Any fish habitat which may exist in the pond at present would be virtually destroyed, so infilling may not be an issue.

## 3.14 SUPPORT FACILITIES

It is envisaged that both temporary and permanent construction camps would be required to carry out the work. The first construction activity would be to upgrade the existing road from Noel Paul's Brook to the Powerhouse Intersection and construct the new access road from the Intersection into the Powerhouse with construction access extended to the Forebay Canal. The contractor engaged in this first year's activity would have to construct a temporary camp to accommodate his work crews. Included in this contract would be site preparatory work for the permanent camp.

The permanent camp would likely be located approximately 4 km west of the Powerhouse site and adjacent to the Powerhouse access road. Power to the campsite would be provided by NL Hydro. In addition, fibre optic cable would be provided to the camp by NL Hydro to facilitate back-haul communications during construction. Telecommunications equipment would be supplied and installed by the contractor.

The estimate is for a 200 man camp as described in the 1988 Feasibility Report. A slightly different approach was used to arrive at the capital cost of operating the camp. The unit prices developed for all of the construction activities did not include catering cost. This cost is now included in the camp maintenance cost. The figure of

$10.00/man-hour for the camp maintenance cost is based on the contractors' experience in operating similar camps on other large civil projects.

## 3.15 ENVIRONMENTAL CONSIDERATIONS

### 3.15.1 General

Since the original feasibility report was prepared for this Project, environmental considerations have evolved to play a much greater role in deciding on the construction methodology and planning for the Project. The most significant of these is the impact the Project would have on fish and fish habitat both during construction and operation of the plant.

With respect to construction of the Project, an estimate was prepared for the replacement of fish habitat destroyed or altered by the Project. This is estimated to cost $3.58 million.

During construction, the control of sedimentation from excavation activities warrants special attention. In developing the cost estimate, allowances have been made for silt fences, rip rap, turbidity curtains, properly constructed settlement basins, containment of run-off from spoil areas and the relocation of fish during de-watering. The handling and storage of fuels and other hazardous materials in an environmentally safe manner is also included in the cost.

One of the outcomes of the Environmental Assessment process will be a requirement on the Owner to develop a detailed Environmental Protection Plan (EPP) for the Project. An EPP generally outlines the Owner's policy with respect to environmental protection, the Owner's responsibility, the contractor's responsibility, compliance monitoring requirements, effects monitoring requirements, and contractor/sub-contractor education, etc. In addition, during the detailed design stage, environmental mitigation requirements are determined, outlined in the EPP, and incorporated into the work activities. Allowances have been made in the cost estimate for the types of mitigation anticipated for the Project.

### 3.15.2 Environmental Considerations for Excavated Material [3]

Acid Generating Rock (AGR) is expected within the Forebay, Dam, Powerhouse, and Tailrace areas, due to the observed high pyrite concentration in the rock core and experience from previous sites located within this type of rock formation. All rock exceeding the limits for the potential for acid drainage are to be properly disposed of and mitigated. Acid Base Accounting was performed on a sample of the rock collected from BH-06-001. Its sulphide content was 0.9 ppm and is considered to be a net acid generator. Because of the potential of AGR, a bedrock sampling and testing program should be carried out prior to construction and also during the construction stage when more thorough sampling can be completed at rock excavation sites.

Areas of AGR should be identified in advance through the sampling and testing program described above. Where rock cuts and/or rock ditching is required in areas confirmed to contain AGR, all efforts must be made to reduce or eliminate acid run off. The following procedures should be followed in AGR areas:

<u>Excavation</u>

- All excavation in areas of AGR should be conducted so as to minimize the exposure of AGR;
- All excavated AGR should be removed to an AGR storage area;
- A suitable low-permeability soil source for covering AGR storage areas should be identified and developed before excavation of AGR takes place;
- Excavation into AGR below the low water level will not cause acid drainage provided the water coming in contact with the rock is anoxic.
- Excavations above the low water mark in AGR should be treated as described above and all efforts must be made to minimize exposure of AGR to the environment and to allow for the covering and stabilization of the exposed AGR.

[3] Geotechnical Site Investigation proposed Island Pond Hydroelectric Development, South Central Newfoundland, January 3, 2007, AMEC Earth & Environmental

Mitigation

- Prior to excavation, identify the area of influence of the AGR site and evaluate the areas capacity to receive acid drainage and estimate the volume of AGR to be exposed and the volume of acidic drainage expected from the exposure.

- Depending on the sensitivity of the area of influence as determined by the site specific evaluation, temporary drainage containment will be required to prevent acid drainage from entering the area of influence.

- All AGR rock cuts should be sloped to a stable grade in order that such areas can receive a suitable thickness of low-permeability soil cover that will minimize oxygen infiltration and thus acid drainage. The final slopes, amount and type of cover required will be site specific in accordance with the potential for the rock to produce acid and the sensitivity of the area of influence.

- All temporary vertical cuts in AGR areas should be sprayed with an approved coating to reduce oxygen exposure and run off.

- AGR excavations below the low water mark will not require mitigation.

- AGR excavations above the low water mark will be covered with an appropriate amount of low-permeability soil and stabilized in accordance with the specific characteristics of the site.

The stockpiling of any acid generating rock should only take place for very short periods; one week or less. Otherwise a lay down pad, engineered and approved to contain all run-off from the AGR by way of an impermeable membrane should be used.

The disposal of AGR will take place only at an approved site and only by an approved method. There are several acceptable methods used to dispose of AGR such as submerging in water or blending AGR with appropriate volumes of non-AGR in accordance with the acid generating potential of the rock to create a net zero acid drainage. The best method to use is dependent upon various factors such as the characteristics of the AGR, the location of the site, etc. All relevant factors must be considered in order to determine the best disposal method.

It is the goal of the measures described above to; identify, plan and mitigate against acid drainage. However, it is advisable to collect baseline water quality data in areas confirmed to contain AGR through an advanced sampling program and to monitor water quality in the areas of influence of AGR excavations.

A provision has been made in the Capital Cost Estimate for special mitigative measures to deal with AGR in the Forebay, Powerhouse and Tailrace.

# 4 CONSTRUCTION PROGRAM

## 4.1 CONSTRUCTION SCHEDULE

### 4.1.1 General

The construction methodology for this Project is typical for heavy civil construction projects in this province involving various types of earthworks, concrete structures and major de-watering efforts.

Environmental considerations will play a major role in executing the work especially fish habitat. Allowances have been made in estimating the cost of road upgrading and construction to include silt fences, rip rap, etc. to minimize siltation of streams both during construction and operation of the road. Grubbing should be confined to cut areas or in low fills to minimize siltation associated with runoff.

### 4.1.2 Suggested Schedule

The Construction Schedule, as prepared in Microsoft Project, is presented on pages 73 and 74, the basis for which is summarized as follows:

Year 1:

Environmental approval process initiated April 1st of Year 1 and completed March 31st of Year 2.

Undertake a winter field program, final Project optimizations, and update the Capital Cost Estimate.

Engineering/Procurement of major equipment.

EPCM Contractor appointed.

Year 2:

Construction of temporary and permanent construction access roads.

Construction of camp site and installation of water and sanitation facilities.

Upgrading of the existing 25 kV distribution line from Godaleigh Hill to Ebbegunbaeg with fibre optic cable.

Construction of 25 kV distribution line from Ebbegunbaeg to Powerhouse Site, to supply construction power and fibre optic cable for back haul communications during construction.

Supply and installation of camp trailers and final commissioning of water and sanitation systems.

Construction of the Forebay Canal in preparation for dewatering parts of Island Pond early the following year.

Commence excavation of the Powerhouse, and start the placement of concrete.

Complete concrete in the Powerhouse sufficient to facilitate the enclosure of the building, installation of the crane, and key milestone of stay ring and discharge ring installation.

Year 3

Delivery and installation of key Powerhouse mechanical and electrical components.

Start of construction of the Diversion Canal and channel improvements in Meelpaeg and in Island Pond, including HADD mitigation. (Note: Channel improvements in Island Pond and Meelpaeg and HADD work must be finished between May 15$^{th}$ and September 15$^{th}$).

Start construction of the RCC Dam.

Year 4

Completion of the Diversion Canal.

Completion of the Dam and related facilities.

Completion of Tailrace and HADD Compensation Facilities.

Construction of the Switchyard and Transmission Line.

Completion of the Powerhouse mechanical and electrical.

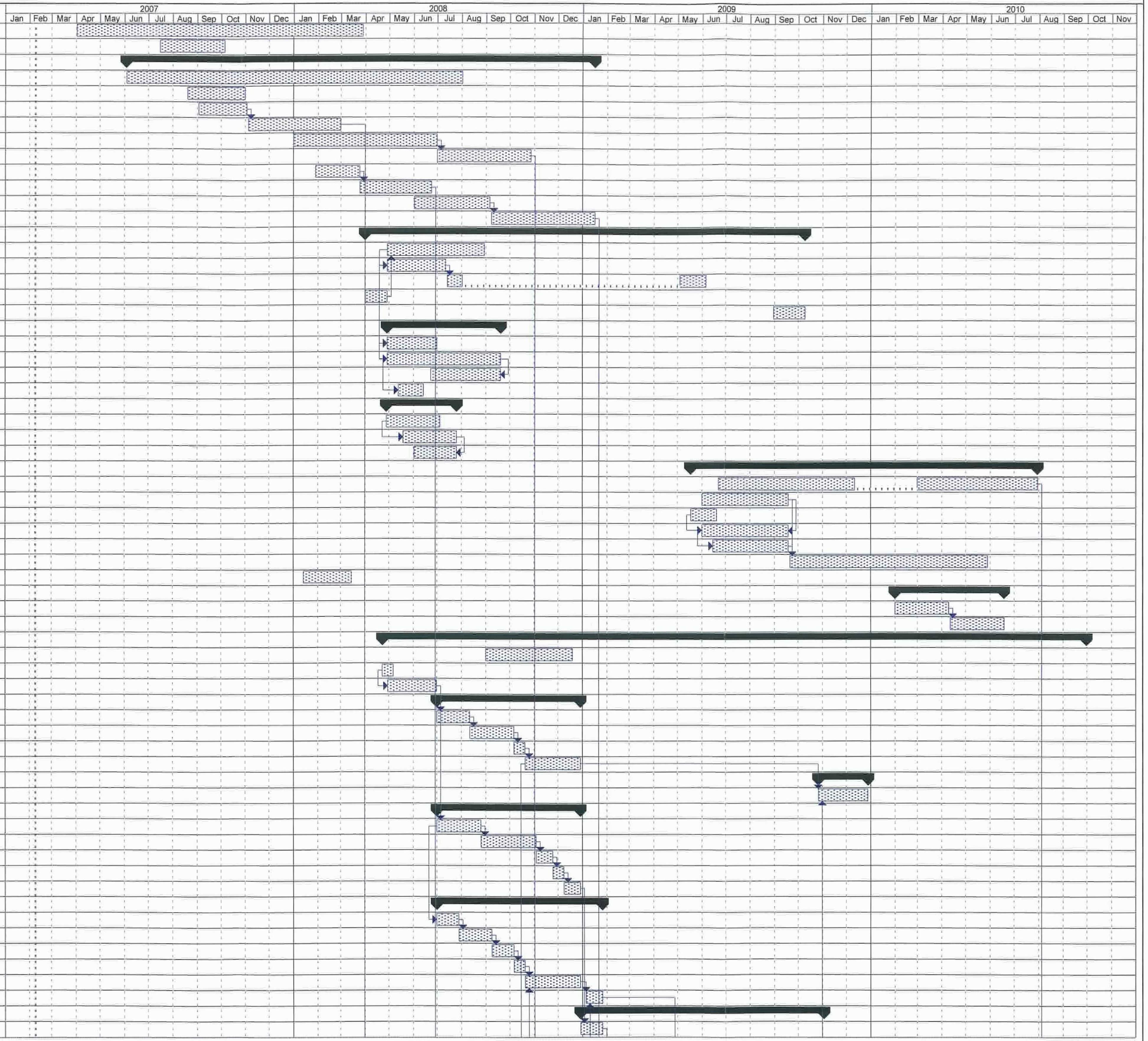
Final testing and commissioning of the turbine-generator.

Final testing and commissioning of remote control of the Powerhouse from NL Hydro's Energy Control Centre.

"Power On" date of September 30, 2010.

Island Pond Construction Schedule

| ID | Indicators | Task Name | Duration | Start | Finish | Predecessors |
|---|---|---|---|---|---|---|
| 1 | | **Environmental Approval** | 52 wks | Mon 4/2/07 | Fri 3/28/08 | |
| 2 | | **Field Program** | 60 days | Mon 7/16/07 | Fri 10/5/07 | |
| 3 | | **Design/Engineering** | **425 days** | **Mon 6/4/07** | **Fri 1/16/09** | |
| 4 | | Design (Roads, Camp Fac., Div Canal, Power Comp., Dam & Tailrace) | 305 days | Mon 6/4/07 | Fri 8/1/08 | |
| 5 | | Design HADD Compensation Strategy | 53 days | Mon 8/20/07 | Wed 10/31/07 | |
| 6 | | Turbine & Generator Engineering & Package Definition | 45 days | Mon 9/3/07 | Fri 11/2/07 | |
| 7 | | Turbine & Generator Procurement Cycle to Award | 85 days | Mon 11/5/07 | Fri 2/29/08 | 6 |
| 8 | | Hydraulic Gates - Engineering | 130 days | Tue 1/1/08 | Mon 6/30/08 | |
| 9 | | Hydraulic Gates - Procurement Cycle | 85 days | Tue 7/1/08 | Mon 10/27/08 | 8 |
| 10 | | Powerhouse Crane - Engineering & Package Definition | 40 days | Tue 1/29/08 | Mon 3/24/08 | |
| 11 | | Powerhouse Crane - Procurement Cycle | 65 days | Tue 3/25/08 | Mon 6/23/08 | 10 |
| 12 | | Power Transformer - Engineering | 70 days | Mon 6/2/08 | Fri 9/5/08 | |
| 13 | | Power Transformer - Procurement Cycle | 95 days | Mon 9/8/08 | Fri 1/16/09 | 12 |
| 14 | | **Construction Access Roads** | **399 days** | **Tue 4/1/08** | **Fri 10/9/09** | |
| 15 | | Noel Paul's to Powerhouse Intersection | 89 days | Tue 4/29/08 | Fri 8/29/08 | 18 |
| 16 | | Powerhouse Intersection to Powerhouse | 54 days | Tue 4/29/08 | Fri 7/11/08 | 15SS |
| 17 | | Misc Tote Roads | 40 days | Mon 7/14/08 | Fri 6/5/09 | 16 |
| 18 | | Noel Paul's Brook Bridge | 20 days | Tue 4/1/08 | Mon 4/28/08 | |
| 19 | | Diversion Canal Bridge | 30 days | Mon 8/31/09 | Fri 10/9/09 | |
| 20 | | **Permanent Access** | **104 days** | **Tue 4/29/08** | **Fri 9/19/08** | |
| 21 | | Upgr. Ex. N.S. Road from U.S. Plant to Int N.S. Road to U.S. Div Canal | 45 days | Tue 4/29/08 | Mon 6/30/08 | 22SS |
| 22 | | Upper Salmon to Ebbegunbaeg | 104 days | Tue 4/29/08 | Fri 9/19/08 | 15SS,16SS |
| 23 | | Ebbegunbaeg to Powerhouse Intersection | 65 days | Mon 6/23/08 | Fri 9/19/08 | 22FF |
| 24 | | Upper Salmon Diversion Canal Bridge | 24 days | Tue 5/13/08 | Fri 6/13/08 | 22SS+10 days |
| 25 | | **Construction Camp** | **65 days** | **Mon 4/28/08** | **Fri 7/25/08** | |
| 26 | | Site Preparation | 50 days | Mon 4/28/08 | Fri 7/4/08 | |
| 27 | | Water and Sanitation | 50 days | Mon 5/19/08 | Fri 7/25/08 | 26SS+15 days |
| 28 | | Camp Trailers (Installation) | 40 days | Mon 6/2/08 | Fri 7/25/08 | 27FF |
| 29 | | **Diversion Canal** | **315 days** | **Mon 5/18/09** | **Fri 7/30/10** | |
| 30 | | Overland Section | 235 days | Mon 6/22/09 | Fri 7/30/10 | |
| 31 | | Meelpaeg Reservoir Section | 80 days | Mon 6/1/09 | Fri 9/18/09 | |
| 32 | | Dewatering - Island Pond Channel Improvements | 25 days | Mon 5/18/09 | Fri 6/19/09 | |
| 33 | | Island Pond Channel Improvements | 80 days | Mon 6/1/09 | Fri 9/18/09 | 32SS+10 days,31FF |
| 34 | | HADD Compensation Construction in Island Pond | 70 days | Mon 6/15/09 | Fri 9/18/09 | 33SS+10 days |
| 35 | | Watering Up Island Pond | 180 days | Mon 9/21/09 | Fri 5/28/10 | 31,34 |
| 36 | | **HADD Compensation - Stream 13** | 45 days | Mon 1/14/08 | Fri 3/14/08 | |
| 37 | | **Reservoir Clearing** | **100 days** | **Mon 2/1/10** | **Fri 6/18/10** | |
| 38 | | Clearing Island Pond | 50 days | Mon 2/1/10 | Fri 4/9/10 | |
| 39 | | Clearing Forebay | 50 days | Mon 4/12/10 | Fri 6/18/10 | 38 |
| 40 | | **Power Complex** | **637 days** | **Wed 4/23/08** | **Thu 9/30/10** | |
| 41 | | Forebay Canal | 80 days | Mon 9/1/08 | Fri 12/19/08 | |
| 42 | | Dewatering/Cofferdam/By-pass Channel | 10 days | Wed 4/23/08 | Tue 5/6/08 | |
| 43 | | Powerhouse/Intake Rock Excavation | 44 days | Wed 4/30/08 | Mon 6/30/08 | 42SS+5 days |
| 44 | | **Intake** | **130 days** | **Tue 7/1/08** | **Mon 12/29/08** | |
| 45 | | Intake - Base Slab | 30 days | Tue 7/1/08 | Mon 8/11/08 | 43 |
| 46 | | Intake - Intake Walls (Piers) | 40 days | Tue 8/12/08 | Mon 10/6/08 | 45 |
| 47 | | Intake - Formwork for Intake Vault | 10 days | Tue 10/7/08 | Mon 10/20/08 | 46 |
| 48 | | Intake - Concreting to El. 276.3 | 50 days | Tue 10/21/08 | Mon 12/29/08 | 47 |
| 49 | | **Intake - Concrete for Hydraulic Gates Installation** | **45 days** | **Tue 10/27/09** | **Mon 12/28/09** | |
| 50 | | Intake - Concrete for Hydraulic Gates Installation | 45 days | Tue 10/27/09 | Mon 12/28/09 | 48,119 |
| 51 | | **Powerhouse T/G Section Phase 1** | **130 days** | **Tue 7/1/08** | **Mon 12/29/08** | |
| 52 | | Concrete Draft Tube Slab | 40 days | Tue 7/1/08 | Mon 8/25/08 | 43 |
| 53 | | Install Draft Tube Elbow | 50 days | Tue 8/26/08 | Mon 11/3/08 | 52 |
| 54 | | Concrete Draft Tube Elbow to El. 236 | 15 days | Tue 11/4/08 | Mon 11/24/08 | 53 |
| 55 | | Concrete to Stayring Bottom Ring | 10 days | Tue 11/25/08 | Mon 12/8/08 | 54 |
| 56 | | Install Draft Tube Cone | 15 days | Tue 12/9/08 | Mon 12/29/08 | 55 |
| 57 | | **Powerhouse D/S Section** | **150 days** | **Tue 7/1/08** | **Mon 1/26/09** | |
| 58 | | Draft Tube Piers | 20 days | Tue 7/1/08 | Mon 7/28/08 | 52SS |
| 59 | | Draft Tube Vault | 30 days | Tue 7/29/08 | Mon 9/8/08 | 58 |
| 60 | | Walls and Slab to El. 256.4 | 20 days | Tue 9/9/08 | Mon 10/6/08 | 59 |
| 61 | | Concrete Firewalls | 10 days | Tue 10/7/08 | Mon 10/20/08 | 60 |
| 62 | | Install Building Structure and Closure | 50 days | Tue 10/21/08 | Mon 12/29/08 | 61,122 |
| 63 | | Install Powerhouse Crane | 15 days | Tue 1/6/09 | Mon 1/26/09 | 62,120 |
| 64 | | **Powerhouse T/G Section Phase 2** | **220 days** | **Tue 12/30/08** | **Mon 11/2/09** | |
| 65 | | Concrete Spiral Case Base | 20 days | Tue 12/30/08 | Mon 1/26/09 | 56,62 |

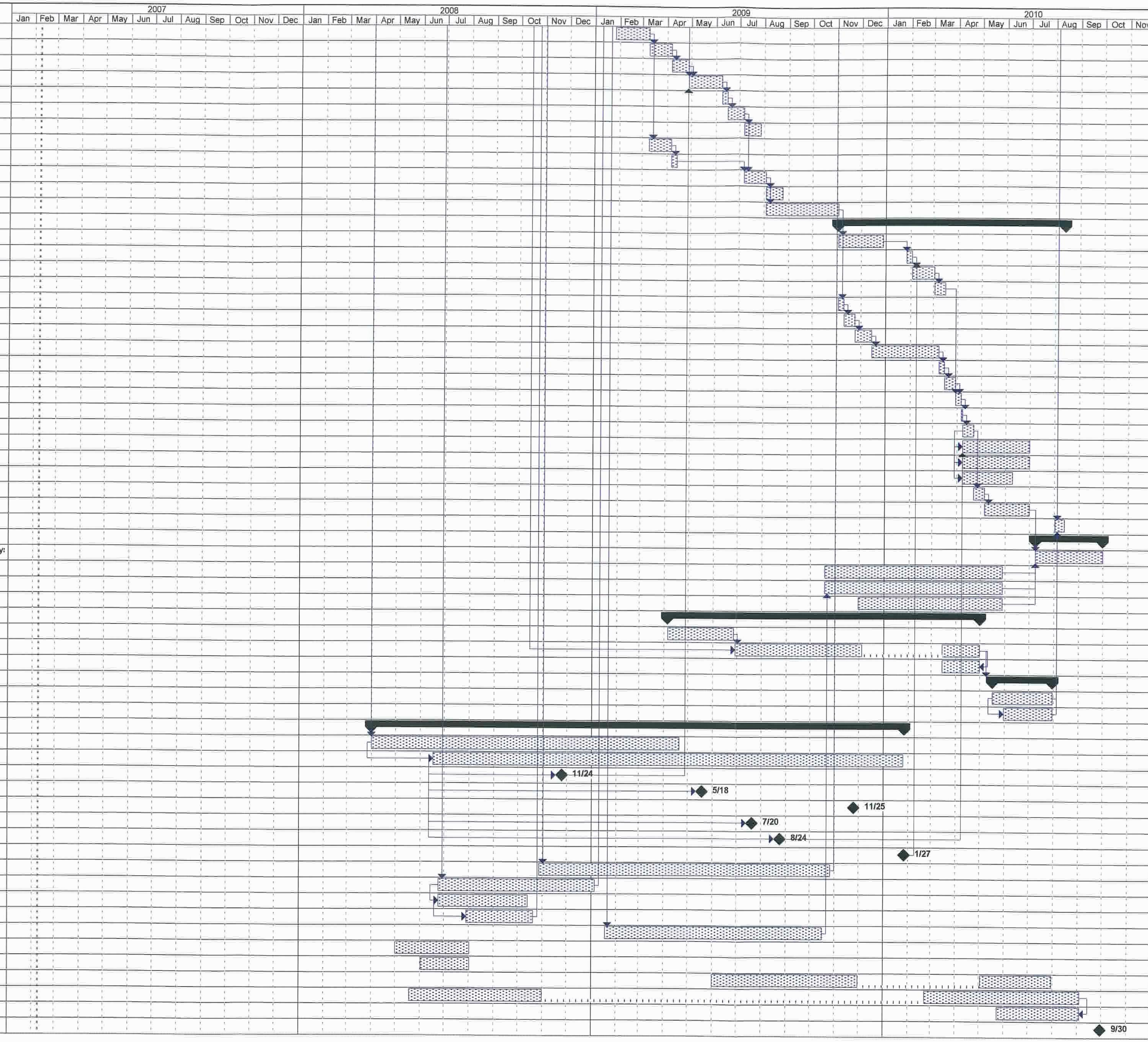



Project: Island Pond Hydro Development

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

Island Pond Construction Schedule

| ID | Indicators | Task Name | Duration | Start | Finish | Predecessors |
|---|---|---|---|---|---|---|
| 66 | | Concrete Spiral Case Invert | 30 days | Tue 1/27/09 | Mon 3/9/09 | 65 |
| 67 | | Concrete Stayring Bottom Ring to El. ________ | 20 days | Tue 3/10/09 | Mon 4/6/09 | 66 |
| 68 | | Concrete Stayring Bottom Ring to El. ________ | 15 days | Tue 4/7/09 | Mon 4/27/09 | 67 |
| 69 | | Erect Stayring | 30 days | Tue 4/28/09 | Mon 6/8/09 | 68,113,63 |
| 70 | | Complete Bottom Ring Concreting | 5 days | Tue 6/9/09 | Mon 6/15/09 | 69 |
| 71 | | Erection of Pit Liner and Misc. Parts | 15 days | Tue 6/16/09 | Mon 7/6/09 | 70 |
| 72 | | Concrete Bottom Deflector | 15 days | Tue 7/7/09 | Mon 7/27/09 | 71 |
| 73 | | Concrete Spiral Case Walls | 20 days | Tue 3/10/09 | Mon 4/6/09 | 66 |
| 74 | | Injection of D/S Spiral Case Walls | 5 days | Tue 4/7/09 | Mon 4/13/09 | 73 |
| 75 | | Concrete of Spiral Case Vault to El. 245 approx. | 20 days | Tue 7/7/09 | Mon 8/3/09 | 74,71 |
| 76 | | Concrete Upper Deflectore | 15 days | Tue 8/4/09 | Mon 8/24/09 | 75 |
| 77 | | Concrete to El. 256.4 | 65 days | Tue 8/4/09 | Mon 11/2/09 | 75 |
| 78 | | **T/G Erection** | **204 days** | **Tue 11/3/09** | **Fri 8/13/10** | |
| 79 | | Machining of Stayring and DT Cone | 40 days | Tue 11/3/09 | Mon 12/28/09 | 77 |
| 80 | | Install Runner | 5 days | Wed 1/27/10 | Tue 2/2/10 | 79,118 |
| 81 | | Install Guide Vanes, Top Cover, Reg Ring and Reg Gear | 20 days | Wed 2/3/10 | Tue 3/2/10 | 80 |
| 82 | | Install Turbine Shaft | 10 days | Wed 3/3/10 | Tue 3/16/10 | 81 |
| 83 | | Install Winding Platform | 5 days | Tue 11/3/09 | Mon 11/9/09 | 77 |
| 84 | | Install Stator Frame | 10 days | Tue 11/10/09 | Mon 11/23/09 | 83 |
| 85 | | Pile Generator Core | 15 days | Tue 11/24/09 | Mon 12/14/09 | 84 |
| 86 | | Install Coils and Complete End Windings | 60 days | Tue 12/15/09 | Mon 3/8/10 | 85 |
| 87 | | Install Lower Bracket | 5 days | Tue 3/9/10 | Mon 3/15/10 | 86 |
| 88 | | Install Thrust Bearing | 10 days | Tue 3/16/10 | Mon 3/29/10 | 87 |
| 89 | | Install Rotor | 5 days | Tue 3/30/10 | Mon 4/5/10 | 88,82 |
| 90 | | Install Upper Shaft | 2 days | Tue 4/6/10 | Wed 4/7/10 | 89 |
| 91 | | Install Oil Tubes | 10 days | Thu 4/8/10 | Wed 4/21/10 | 90 |
| 92 | | Install Governor and Control System | 60 days | Thu 4/8/10 | Wed 6/30/10 | 91SS,117 |
| 93 | | Build and Complete all Auxiliaries | 60 days | Thu 4/8/10 | Wed 6/30/10 | 92SS |
| 94 | | Complete Generator Build | 45 days | Thu 4/8/10 | Wed 6/9/10 | 93SS |
| 95 | | Install Oil Head | 10 days | Thu 4/22/10 | Wed 5/5/10 | 91 |
| 96 | | Complete Turbine Build | 40 days | Thu 5/6/10 | Wed 6/30/10 | 95 |
| 97 | | Removal of Cofferdams and Filling Reservoir | 10 days | Mon 8/2/10 | Fri 8/13/10 | 30,108,109 |
| 98 | | **T/G POVT & Commissioning** | **60 days** | **Fri 7/9/10** | **Thu 9/30/10** | |
| 99 | | Powerhouse T/G POVT & Commissioning | 3 mons | Fri 7/9/10 | Thu 9/30/10 | 100,101,102,96FS+6 day: |
| 100 | | Mechanical | 160 days | Mon 10/19/09 | Fri 5/28/10 | |
| 101 | | Electrical | 160 days | Mon 10/19/09 | Fri 5/28/10 | 123 |
| 102 | | Switchyard | 130 days | Mon 11/30/09 | Fri 5/28/10 | |
| 103 | | **Dam** | **280 days** | **Mon 4/6/09** | **Fri 4/30/10** | |
| 104 | | Dam Site Preparation | 60 days | Mon 4/6/09 | Fri 6/26/09 | |
| 105 | | Dam Concrete (RCC) | 150 days | Mon 6/29/09 | Fri 4/30/10 | 104,48SS+40 days |
| 106 | | Earth Fill Dyke | 35 days | Mon 3/15/10 | Fri 4/30/10 | 105FF |
| 107 | | **Tailrace** | **55 days** | **Mon 5/17/10** | **Fri 7/30/10** | **105FS+10 days** |
| 108 | | Tailrace Construction | 55 days | Mon 5/17/10 | Fri 7/30/10 | |
| 109 | | HADD Compensation Construction in Tailrace | 45 days | Mon 5/31/10 | Fri 7/30/10 | 108SS+10 days |
| 110 | | **Major Equipment (Engineering, procurement, mfg & del'y)** | **476 days** | **Tue 4/1/08** | **Wed 1/27/10** | |
| 111 | | Turbine & Generator Supplier Engineering | 275 days | Tue 4/1/08 | Mon 4/20/09 | 7FS+21 days |
| 112 | | Turbine & Generator Manufacturing & Del'y | 420 days | Tue 6/17/08 | Mon 1/25/10 | 111SS+55 days |
| 113 | | T/G Del'y - Stay Ring & Discharge Ring Del'y on Site | 0 days | Mon 11/24/08 | Mon 11/24/08 | 112SS+115 days |
| 114 | | T/G Del'y - Stator & Winding Mfg & Del'y on Site | 0 days | Mon 5/18/09 | Mon 5/18/09 | 112SS+240 days |
| 115 | | T/G Del'y - Turbine Covers Mfg & Del'y on Site | 0 days | Wed 11/25/09 | Wed 11/25/09 | |
| 116 | | T/G Del'y - Rotor, Shaft & Pole Mfg & Del'y on Site | 0 days | Mon 7/20/09 | Mon 7/20/09 | 112SS+285 days |
| 117 | | T/G Del'y - Controls & Governors Mfg & Del'y on Site | 0 days | Mon 8/24/09 | Mon 8/24/09 | 112SS+310 days |
| 118 | | T/G Del'y - Runner & Shaft Mfg & Del'y on Site | 0 days | Wed 1/27/10 | Wed 1/27/10 | |
| 119 | | Hydraulic Gates - Mfg & Del'y on Site | 260 days | Tue 10/28/08 | Mon 10/26/09 | 9 |
| 120 | | Powerhouse Crane - Mfg & Del'y on Site | 140 days | Tue 6/24/08 | Mon 1/5/09 | 11 |
| 121 | | Powerhouse Crane - Steel Rail Procurement | 80 days | Tue 6/24/08 | Mon 10/13/08 | 120SS |
| 122 | | Powerhouse Crane - Steel Rail Del'y | 60 days | Tue 7/29/08 | Mon 10/20/08 | 121SS+5 wks |
| 123 | | Power Transformer - Mfg & Del'y on Site | 195 days | Mon 1/19/09 | Fri 10/16/09 | 13 |
| 124 | | **Distribution Line** | 67 days | Thu 5/1/08 | Fri 8/1/08 | |
| 125 | | **Upg. Ex. Distribution Line from Godaleigh Hill to Ebbe Control St.** | 45 days | Mon 6/2/08 | Fri 8/1/08 | |
| 126 | | **Transmission Line** | 196 days | Mon 6/1/09 | Fri 7/30/10 | |
| 127 | | **Telecommunication Construction** | 260 days | Mon 5/19/08 | Fri 9/3/10 | |
| 128 | | **Protection & Control Construction** | 75 days | Mon 5/24/10 | Fri 9/3/10 | 127FF |
| 129 | | **On-Power Date** | 0 days | Thu 9/30/10 | Thu 9/30/10 | |




Project: Island Pond Hydro Development

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

In NL Hydro's opinion, model testing will not be required for the single unit and as such approximately seven months has been eliminated from the turbine manufacture/delivery period. The critical path for the Project is now based on gaining access to the Powerhouse Site and enclosing the Powerhouse prior to winter.

In analyzing the schedule, construction activity will begin in April of Year 2 and finish the end of September in Year 4 for a total of 30 months. In order to achieve this schedule, engineering field work, design work and tendering for the first contract must run concurrently with the Environmental Assessment Process. April 1 is the latest a contract can be awarded in order to have the Powerhouse enclosed prior to winter. If the first contract is awarded any later than April 1, it effectively will add a full year to the schedule. There will be insufficient time to do the Powerhouse enclosure, resulting in a shutdown of the project during the first winter of the construction period. It is possible to work through the winter but it would add substantially to the Capital Cost of the Project.

Equally as important as enclosing the Powerhouse the first winter, September 30 is a milestone date for completing the work and having the plant operational because of fish habitat requirements. HADD compensation is a major consideration and the compensation structures proposed for the end of the Diversion Canal, channels in Island Pond and the Tailrace require flow to function. The actual date that flow is required is September 15 but it probably could be pushed to September 30 as a limit. If the Project is not completed by September 30, the Department of Fisheries and Oceans could possibly insist on waiting until May 15 of the following year to resume work. The de-watering scheme described in Section 3.6 is based on maintaining fish habitat between September 15 and May 15 each year during the construction period.

The turbine engineering and tendering must also take place during the Environmental Assessment period. Award of the contract must also be no later than April 1. This gives 30 months from award of the contract to on-power and assumes turbine model testing will not be required.

## 4.2 CONSTRUCTION PROGRAM

To undertake this Project, it is suggested that it be separated into four packages, namely:

Package 1: Temporary access roads, Forebay Canal, camps and Powerhouse excavation.

Construction of a permanent access road from the Upper Salmon Access Road to Ebbegunbaeg control structure, then to the Powerhouse site.

Package 2: Powerhouse, Dam, Intake, Tailrace and the HADD in the Tailrace (A separate package for the Turbine-Generator supply and installation would have a proviso that the contractor for this package would be a nominated sub to the above-noted contract for the Powerhouse.

Package 3: Diversion Canal, including the Channel Improvements in Island Pond, reservoir clearing and construction of HADD facilities for same.

Package 4: NL Hydro Contracts:

- Transmission Lines;
- Distribution Line;
- Switchyard;
- Protection and Control;
- Telecommunications.

Note: It is assumed that in Year 1, NL Hydro will construct the 25 kV distribution line from Ebbegunbaeg Control Structure to the campsite and the Powerhouse site, in order to provide construction power to the site.

# 5 CAPITAL COST ESTIMATES

## 5.1 COST ESTIMATING METHODOLOGY

### 5.1.1 Background

The Island Pond/Granite Canal re-optimization and cost update study (Addendum No. 2) presented in report SMR-02-97 dated February 12, 1997, included a Capital Cost Estimate (CCE). The basis for the estimate is described in detail in that report. It should be noted the CCE reflected a single turbine-generator unit. This estimate is for a Close-Coupled Powerhouse Complex with a single Kaplan Unit and a Roller Compacted Concrete (RCC) Dam instead of the Earth-Rockfill Dam presented in the previous report.

### 5.1.2 Update of Quantities

Quantities were revised to reflect the RCC dam and new Powerhouse arrangement. New quantities were developed for the upgrading of existing roads and the construction of new and temporary access roads. Quantities include provisions for the replacement of all existing culverts, plus an allowance for additional culvert requirements, plus 200 mm of maintenance grade material was added for topping on the roads.

Updated mapping was used to re-calculate quantities for the Forebay Canal, Intake, Powerhouse and Tailrace. Quantities for the Diversion Canal were based on the 1997 Report.

### 5.1.3 Update of Cost

The Project team included employees of Pennecon Ltd., a major heavy civil construction company with extensive experience in Newfoundland and, in recent years, nationally. These employees were also experienced with the Granite Canal Hydroelectric Development Project and other NL Hydro projects. This provided a solid and current basis for developing new unit prices. In some cases, unit prices increased, others remained relatively the same, and in some cases the unit prices are actually lower. Unit prices for the major components, such as turbine-generators, transformers, electrical and mechanical equipment, were revised based on enquiries to suppliers and the experience of SNC-Lavalin Inc., staff.

## 5.2 CAPITAL COST ESTIMATE

A summary of the CCE follows.

| Description | 2006 Estimate |
|---|---|
| Reservoir Clearing | |
| Access Roads | |
| Diversion Canal | |
| Forebay Canal | |
| Dam | |
| Intake | |
| Penstock | |
| Powerhouse | |
| Tailrace | |
| Switchyard | |
| Project Support | |
| HADD Compensation | |
| | |
| Sub Total Before Contingency | 102,945,275 |
| Contingency | |
| Total | |
| | |
| **NL Hydro Contracts** | |
| Transmission Line | |
| Distribution Line | |
| Switchyard (Hydro's Estimate) | |
| Protection & Control | |
| Telecommunications | |
| Sub Total Before Contingency | 8,738,666 |
| Contingency (10%) | |
| Total | |
| | |
| Total Direct Cost | |
| Management & Engineering (12.5%) | |
| Owner's Costs (8.7% of Total Direct Cost) | |
| Escalation | |
| AFUDC | |
| Total Indirect Costs | |
| **TOTAL ESTIMATE CAPITAL COST** | |

The detailed CCE is included in Appendix A. The CCE is based on December 2006 prices with escalation effective the beginning of 2007. The CCE is based on the Project schedule included in Section 4.1.2 of this report. Escalation factors applied to the CCE are as follows:

| | | |
|---|---|---|
| 2007 | - | 1.4% |
| 2008 | - | 2.6% |
| 2009 | - | 2.6% |
| 2010 | - | 2.6% |
| 2011 | - | 2.6% |

Allowance for Funds Utilized During Construction (AFUDC) is calculated at 7.53% for 2007 – 2011.

The following summarizes the CCE for the Project and provides the cost per kilowatt (kW) of installed capacity and the cost per kilowatt hour (kWh) of energy.

- Total Direct Cost (including contingency) - $123,402,582
- Total Indirect Cost - $50,189,780
- Total Estimated Capital Cost - $173,592,362
- Installed Capacity (kW) – 36,000
- Cost per kW of installed capacity - $4,822/kW
- Annual Energy – 188 GWh

The total estimated capital cost includes transmission line and switchyard cost.

## 5.3 CONTRACT VALUES AND CASH FLOWS

The entire Project can be broken into the following contract packages as described in Section 4.2:

| | |
|---|---|
| Package 1: | $16,077,100. |
| Package 2: | $69,080,200. |

| | |
|---|---|
| Package 3: | $28,632,750. |
| Package 4: | $ 9,612,533. |

## 5.4 RISK ANALYSIS

### 5.4.1 Introduction

NL Hydro and SNC-Lavalin agreed, during post proposal negotiations, that a Risk Analysis of the Capital Cost Estimate should be prepared. The exercise would facilitate the decision making process for NL Hydro in its assessment of the Project and the Project risk factors. It would also assist in the determination of the Project Budget Allocation.

The analysis is based on the identification of the main anticipated risk areas and quantifying the maximum overall range of likely outcomes for each. This should pull out the very best and very worst scenarios for a particular cost centre. The elements and the risk factors are entered in a program called "@ Risk" where they are processed by iteration using Monte Carlo Simulation.

The types of Risks to be considered were grouped into two categories:

- Technical Risks:
  - Level of Engineering completed at the time of the estimate;
  - Proven / Unproven Technology;
  - Geotechnical / Site Conditions;
  - Scheduling Considerations;
  - Environmental Considerations;
  - Major Equipment – Supply and Demand Considerations.
- Commercial Risks:
  - Labour Market Conditions;

- o Financing Variables;
- o Insurance and Bonds;
- o Legal Considerations;
- o Labour Union Issues.

The Risk Analysis consisted of three key steps:

A. An assessment, by the Project team, of the Cost Estimate line-by-line, to establish the "least cost" and "highest cost" cases, with the "most likely" cost case being the estimate itself; no contingency considered.

B. An analysis of the two categories of risk as noted above.

C. An analysis of the above information using a Monte Carlo Simulation using "@ Risk" software.

### 5.4.2 The Risk Analysis

#### *5.4.2.1 Step One: Assessment of Cost Estimate*

A line-by-line analysis of the Capital Cost Estimate as presented in the following table.

## RISK IDENTIFICATION TABLE

**NOTE: ALL COST IN CAN$ AS PER DECEMBER 2006**

| Risk Identification | Minimum Value % | Most Likely Cost $ | Maximum Value % | Minimum Cost $ | Maximum Cost $ |
|---|---|---|---|---|---|
| Reservoir Clearing | | | | | |
| Access Roads | | | | | |
| Diversion Canal Excavation | | | | | |
| Diversion Canal Others | | | | | |
| Forebay Canal Excavation | | | | | |
| Forebay Canal Others | | | | | |
| Dam | | | | | |
| Intake | | | | | |
| Powerhouse | | | | | |
| Mechanical | | | | | |
| Electrical | | | | | |
| Tailrace | | | | | |
| Switchyard | | | | | |
| Project Support Construction Camp (200 Men) | | | | | |
| Project Support Provisional Allowances | | | | | |
| Hadd Compensation | | | | | |
| Direct Costs Contingencies | | | | | |
| Hydro Contracts | | | | | |
| Hydro Contract Contingencies | | | | | |
| Indirect Costs | | | | | |
| Other Risks | | | | | |
| Environmental Approval | | | | | |
| Powerhouse enclosure | | | | | |
| Fisheries issues | | | | | |
| Powerhouse rock | | | | | |
| Construction labour | | | | | |
| ADJUSTMENTS | | | | | |
| TOTAL | | 173 592 362 | | 152 709 284 | 203 922 787 |
| | | | | | |
| Most probable cost | | | | | |
| Percent increase | | | | | |

### 5.4.3 Technical Risk

The Technical Risk for this Project are assessed as follows:

Level of Engineering

The level of engineering for this Project is considered to be at the Feasibility Stage, which is sufficient to provide an accurate estimate for budgeting purposes. The diversion canal and the channel through Island Pond estimates were based on quantities calculated in the 1988 Study. There appears to be a discrepancy between the 1988 calculations and quantities calculated from the topographic mapping prepared for this study. The 1988 values were higher for which a risk factor was attached in the "line-by-line" analysis of the estimate.

Proven / Unproven Technology

The technology incorporated into this Project is consistent with that of previously completed projects of a similar nature. The risk related to this factor is considered minimal.

Geotechnical / Site Conditions

*Powerhouse Cofferdam*

The powerhouse cofferdam is the only critical dewatering item that may be exposed in the event of an unforeseen flood event. It is expected that any delay would be minor and damage can be mitigated by protection of the works.

*Powerhouse Rock*

Indications are that the rock in the area of the powerhouse is of poor quality and may be acid generating. This is not expected to impact the schedule but there could be some cost associated with rock over-break and protection against acid leaching into the surrounding watercourse. An allowance of one million dollars ($1,000,000) is entered in the estimate to cover unforeseen cost. Again, this has been taken into consideration in the line-by-line analysis of the estimate.

## Scheduling

Scheduling is the key risk Item identified in this Project and is one that particular attention should be paid too, both by the Owner and the engineers. In detail, the key items are:

*Environmental Approval*

For scheduling purposes, it was assumed that the Environmental Approval Process would require one year. This time limit can be achieved if careful attention is paid to the process having in mind that the Project registration, documentation, etc., will need to be expedited in every way possible. A delay in the approval would result in a one-year delay in the Project. An earlier start on the EA Process, as well as careful planning in the setup of the team, the strategy and the schedule can alleviate this risk.

*Installation of the Construction Camp*

The schedule requires the camps to be on site, ready for installation by June 2008. Due to the high demand for camp units, it may be necessary to pre-order these units, prior to the final environmental approval of the Project. This issue can be better assessed during the detailed design.

*Turbine Generator Package*

Eighteen months are allowed for design, fabrication and delivery of the turbine generator assembly with some items delivered to site during this time frame. For example:

- Stay ring and discharge ring less than 8 months;
- Stator and winding less than 14 months;
- Turbine covers 16 months;
- Runner and shaft less than 17 months.

A delay in this item, or if model testing becomes necessary, could impact the completion date of the Turbine/Generator erection activities, the Powerhouse mechanical and electrical, commissioning and overall project completion – perhaps by as much as seven months.

*Powerhouse Enclosure*

Although the powerhouse construction will require intricate scheduling to allow for the installation of mechanical equipment, expediting the construction of the steel structure so that the erection would be limited to two months is of paramount importance. The building enclosure should be in place by the end of December 2008. This time frame is considered tight and is on the critical path of the schedule. Any delay may result in winter construction which will delay construction until the following spring. It is expected that such a delay can be handled with some extra cost for winter hoarding or by rescheduling activities in the spring with no major cost impact.

*Crane Delivery*

The installation of items such as the stay ring and the discharge ring is contingent on the preparedness of the crane. The schedule shall account for the installation of the crane immediately after the erection of the building structure.

<u>Environmental Considerations</u>

*Fisheries Issues*

There are many activities such as the HADD compensation, lowering the water levels in Island Pond and Meelpaeg, and the excavation of the canals and tailrace that have to be scheduled to meet fisheries requirements. Approvals will have to be expedited. Any delays in these items could impact the completion of the project by up to a year.

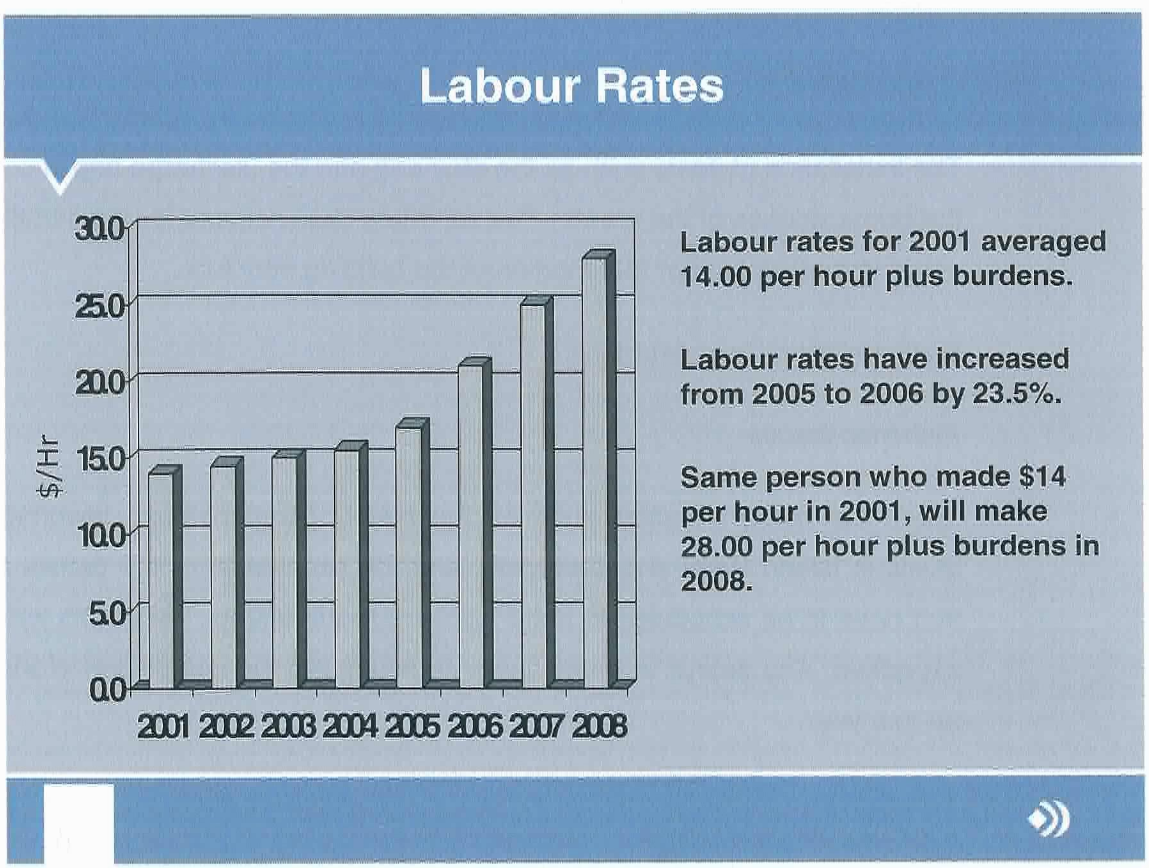
Major Equipment – Supply and Demand Considerations

Given the major energy and infrastructure construction boom that is going on around the world, the manufacturers of major components for this project are very busy, and on time delivery of components could be a problem. This will be difficult to assess until the detailed engineering stage. However, it can be mitigated by an early start, and thus an early assessment of the problem and preordering of the affected components where necessary.

### 5.4.4 Commercial Risk

Labour Market Conditions

Labour Market conditions have changed considerably in the last 12 to 18 months in this Province, as our labour force comes under the effect of the significant labour shortage in Western Canada. This effect is outlined on the following chart:



To mitigate this, we have allowed for a significant cost of wages increase in the Capital Cost Estimate. This was done in consultation with our construction industry advisors. It is also expected that there will be several major projects proposed to be built in this province, (i.e., new nickel processing plant at Long Harbour, a new refinery at Come By Chance, etc.) that may compete with this Project for available skilled labour. Some element of cost is built into the estimate to cover this but it may be insufficient if all these projects occur simultaneously.

Financing Variables

The financial information used in the economic evaluation of this Project was limited to information supplied by the Owner. Other more detailed analysis we assume is the responsibility of the Owner.

Insurance and Bonds

This item is also the responsibility of the Owner, who provided a number in the Owner's cost of the Project.

Legal Considerations

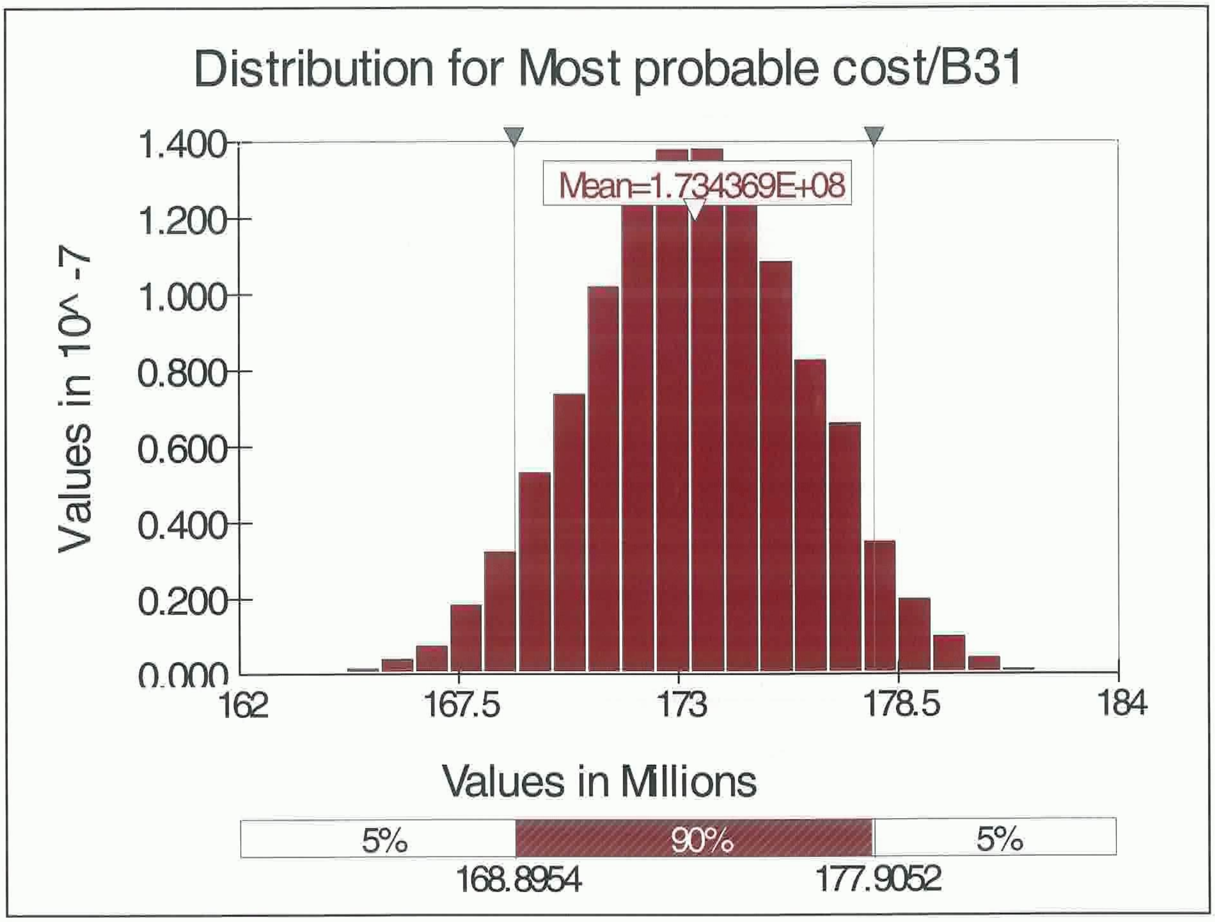
Same as above.

Labour Union Issues

The Owner instructed the team to assume that the Building Trades Council Agreement would apply to this project.

### 5.4.5 Simulation Results to determine most Probable Cost

The Monte Carle Simulation was preformed based on the above noted information and the simulation produced the following results.


Distribution for Most probable cost/B31
Mean=1.734369E+08
Values in 10^ -7
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
162
167.5
173
178.5
184
Values in Millions
5%
90%
5%
168.8954
177.9052

# 6 CONCLUSIONS AND RECOMMENDATIONS

Based on a thorough analysis of this Project, its key components and the client's Terms of Reference, the following conclusions and recommendations are presented.

## 6.1 CONCLUSIONS

It has been concluded that:

1. This Project is technically feasible, can be readily constructed, for an estimated capital cost of $173.6M including Owner's costs; interest charges during construction, and allowance for escalation.

2. A roller-compacted concrete dam with a Powerhouse Complex on the right bank as per Drawing 722720-0000-41DD-0015 is the best technical solution for this Project.

3. Geotechnical problems identified in the AMEC report do not appear to present technical challenges outside the norm for a Powerhouse Complex of this type.

4. Based on the findings in the AMEC Report, blasted rock excavated from the Diversion Canal or from a quarry will be required for the production of concrete aggregates. The sand can be produced from gravel deposits identified near the site of the Powerhouse Complex.

5. Construction access to the site will be via the existing road from Noel Paul's Brook to the site.

6. The location, layout and mitigation of HADD is conceptual. Further extensive discussion between all parties is required and there is a possibility of further fieldwork being required.

7. The Project Construction Schedule is presented as a four-year schedule based on a 35-month design, manufacturing, installation and commissioning period for the turbine-generator.

This assumes that physical modelling of the Turbine will not be necessary.

To stay within a four-year time frame, it is proposed to parallel the one-year environmental approval process with the upfront engineering and fieldwork required in Year 1. This poses some risk to the owner.

## 6.2 RECOMMENDATIONS

1. Following Project release and prior to final design, further field investigation work is required as follows:

A) Topographic Surveys of the following Project components:

i) Diversion – both the Diversion Canal and the Channel Improvements in the pond;
ii) HADD mitigation areas;
iii) Bedrock at the centre line of the dam;
iv) Tailrace;
v) Forebay Area;
vi) Bridge locations;
vii) Centre line of new road construction;
viii) Switchyard area;
ix) Campsite.

B) Bathymetric Surveys of the following:

i) Channel Improvements in Island Pond including the examination of alternate routes;
ii) Tailrace at Crooked Lake;
iii) Meelpaeg Reservoir along the Diversion Canal.

C) Geotechnical

i) Drilling of additional boreholes at the centreline of the turbine and at several locations along the dam centreline.

ii) Proving the depth to bedrock along:
   i. Diversion;
   ii. HADD areas;
   iii. Dam;
   iv. Forebay;
   v. Tailrace.

iii) Bedrock sampling and testing programs to determine acid generating potential of rock at Forebay, Powerhouse and Tailrace.

D) Other Studies as follows:

i) Collection of baseline water quality data in areas confirmed to contain AGR and in areas of influence of proposed AGR excavations;

ii) Field Assessment of lacustrine habitat impacted by channel improvements in Meelpaeg Reservoir;

iii) Graph 3 from Shawmont's 1988 report be upgraded, for final design of the fish habitat channels, based on simulation results reflecting the way in which the system would be operated once Island Pond is put in service.

2. At the beginning of Year 1, it is recommended that a Project team be put in place to:

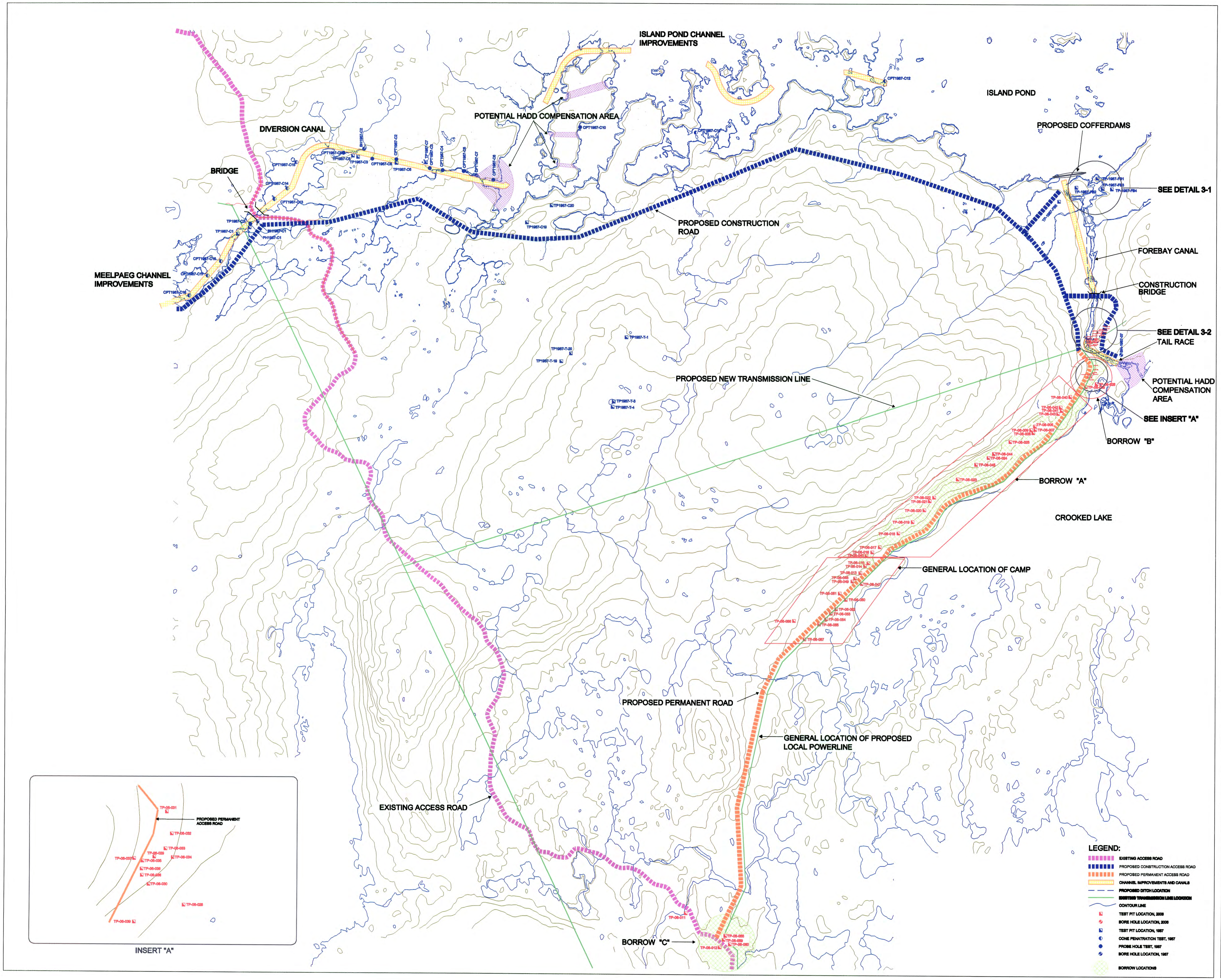
   a) Undertake the field program as outlined in Appendix D. This program can be carried out most cost effectively during late winter;

   b) To review the design of the Diversion, based on the new topographic survey data and geotechnical information gathered during the Year 1 field program;

   c) To advance the design engineering on all key components of the Project;

d) To prepare a tender ready package for the construction access roads as required for Year 2, including camp site preparation, installation of camps and related infrastructure;

e) To prepare a tender ready package for the Turbine-Generator and auxiliary systems.




## NOTES

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2. DO NOT SCALE FROM DRAWING.
3. THIS DRAWING IS INTENDED TO SHOW RELATIVE LOCATIONS AND CONFIGURATION OF THE STUDY AREA IN SUPPORT OF THIS REPORT.
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| No. | Date | Description | Drawn | Chk'd | App'd |
|---|---|---|---|---|---|
| | | | | | |

## REVISIONS

Stamp

Reference North

AMEC Earth and Environmental

CLIENT

BAE • NEWPLAN GROUP

HYDRO

PROJECT

GEOTECHNICAL SITE INVESTIGATION
ISLAND POND, NL.

DRAWING TITLE

SITE AND TEST LOCATION PLAN

| SCALE | PROJECT NUMBER | |
|---|---|---|
| 0 m 250 500 m | TF6316540 | |
| DRAWN BY | REVIEWED BY | APPROVED BY |
| J. YOUNG | K. PENNEY | C. MILES |
| DRAWING NO. | DATE | REV |
| 2 | January 2007 | 0 |