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From : "Scott, Paul G."
To : "Bown, Charles W."
Subject : Small Hydro Development as an Alternative to Muskrat Falls (6).DOC
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First of the new papers - small hydro.

Small Hydro Development as an Alternative to Muskrat Falls

Department of Natural Resources

July 2012

Key Findings

Since 1998, Newfoundland and Labrador has had a moratorium on small hydroelectric development. In the debate over whether to develop Muskrat Falls and construct a Labrador-Island transmission Link to provide power for domestic Island consumption, Labrador industrial development, and potentially export opportunities, one suggestion put forth has been to lift the moratorium and develop small hydroelectric sites on the Island. An analysis of this possibility yields the following key findings:

1. Shawmont Newfoundland completed a comprehensive review of potential small hydro sites in 1986 and identified a large number of possibilities. These are primarily very small, run-of-the-river type sites which do not contemplate storage of water. Newfoundland and Labrador Hydro completed a study on the coast of Labrador in 2009 which indicates there may be some potential to reduce or eliminate reliance on isolated diesel systems in that area.
2. There are some exceptions to the small hydro inventory being run-of-the-river – notably Island Pond, Round Pond, and Portland Creek. However, these three sites, if developed, would provide a total capacity of only 77 MW, not nearly enough to meet Island needs.
3. Without water storage, small hydro projects exhibit similar operational characteristics as wind generation in that they produce intermittent power that cannot be called upon by operators when required. However, there is a significant economic preference for wind when choosing between the two similar sources.
4. Since the Island grid is isolated, only a limited amount of this type of power can be integrated without impacting system reliability. In an Isolated Island scenario, if a large amount of small hydro energy were integrated, it would need to be supported with firm capacity, likely through increased thermal generation on the Island.
5. For the above noted technical reasons and the economic preference for wind, small hydro development is not a feasible alternative to development of Muskrat Falls and the Labrador-Island Link.

Existing Provincial Policy on Small Hydroelectric Development

In the past, the development of small hydro sites on the island of Newfoundland has met with a significant level of public opposition. In 1998, after two small hydro projects, Northwest River (12 MW) and Southwest River (7 MW), were halted prior to construction primarily in response to public opposition, the Provincial Government imposed a moratorium on small hydro projects on the Island.

The Province's subsequent energy plan, Focusing Our Energy, released in 2007, maintained the moratorium and committed to review the policy once a sanction decision on the Lower Churchill development was made. The energy plan also states that should the moratorium be lifted after a review, it will institute a policy that Nalcor Energy, the province's energy corporation, "will control and coordinate the development of small hydro projects that meet economic thresholds and are viable for an isolated island system."[1] At this time, the small hydro moratorium is still in place, pending a final sanction decision on the Muskrat Falls development.

[1] Focusing Our Energy. Government of Newfoundland and Labrador. 2007.

Potential Small Hydroelectric Sites on the Island

A comprehensive inventory of undeveloped small scale hydro sites was undertaken by Shawmont Newfoundland Ltd in 1986. The study identified 208 sites and determined that 38 were not feasible.[2] Subsequently, in 1992, Newfoundland Hydro (NLH) issued a Request for Proposals (RFP) to purchase up to 50 MW of small hydro production. There was a preliminary screening and ultimately there were eleven final submissions. Most were projects previously identified in the Shawmont Newfoundland study. NLH accepted four of the proposals and two were constructed: Star Lake (15 MW) and Rattle Brook (4 MW). As described above, the other two were halted and since the 1998 moratorium there has been very little activity around small hydro development.

The seven projects that were not chosen in the 1992 RFP can be thought of as the most attractive undeveloped small hydro projects, representing a total of 65.8 MW of capacity. Furthermore, based on technical and economic criteria, NLH carries three additional small hydro sites with a total combined capacity of 77 MW on its books for potential future development:

- **Island Pond** – 36 MW project on the North Salmon River, within the watershed of the existing Bay d'Espoir development.
- **Portland Creek** - 23 MW project on Main Port Brook, near Daniel's Harbour, on the Great Northern Peninsula.
- **Round Pond** - 18 MW project located within the watershed of the existing Bay d'Espoir development.

A more detailed description of these three sites is provided in Annex B.

In its review of Nalcor's work in deciding on Muskrat Falls as the least cost option, Navigant consulting concluded that "Nalcor appropriately included Muskrat Falls in Labrador and Island Pond, Portland Creek and Round Pond on the Island as hydroelectric generation in their generation expansion alternatives."[3]

Potential Small Hydroelectric Sites in Labrador

Apart from the large hydro sites on the Churchill River, most study of potential small hydroelectric sites in Labrador has been focused on the coast. In 2009, Nalcor Energy completed a report entitled "A Preliminary Assessment of Alternative Energy Potential in Coastal Labrador." The report focused on a variety of different generation options including solar, wind, and small hydro and limited its study to the area around key coastal communities. Nalcor identified 36 potential sites and recommended 13 for further study. It also found that there were possibilities for interconnection between some communities and the potential that in two cases, small hydro projects could completely displace the existing diesel systems. Results for the specific communities are summarized as follows:

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[2] In 2000, the Department of Natural Resources updated this study to take into account sites which had been already been developed, scheduled salmon rivers, and revised economic assumptions. This update also included an inventory map of undeveloped hydro generation. The map, which can be see in Annex A, shows a total of 196 small hydro sites (defined as being less than 20 MW capacity), with a combined total capacity of 881.6 MW and an additional 19 large hydro sites (greater than 20 MW) with a total capacity of 1, 242.4 MW. Of these sites, more than 140 fall on scheduled salmon rivers.

[3] Independent Supply Decision Review. Navigant Consulting, 2011.

- **Nain** – One site has been identified as being an economically feasible hydro site capable of serving Nain. Its cost of energy is estimated to be lower than either a diesel generation system or the predicted cost of a wind-diesel hybrid system.
- **Hopedale** – One site was identified as being an economically viable hydro plant for Hopedale. The alternative energy study indicates that it could potentially supply the community with 3.21 GWh annually at a cost of energy 2-3 ¢/kWh less expensive than diesel generation.
- **Makkovik** – Has excellent hydro resources that could potentially provide extremely cheap electricity in comparison to electricity generated using diesel fuel. Three sites were identified for the community which all showed predicted unit energy costs less than the current price of diesel generation. Two of the identified sites are too small to displace the existing diesel plant in Makkovik but a third could completely displace it, assuming additional storage solutions are considered as well.
- **Cartwright** – Small hydro sites were identified for Cartwright but the estimated high cost of energy associated with these sites makes them not economically feasible.
- **Charlottetown** – Two sites for the community have been identified which both offer lower energy costs than diesel generation. There are also options for shared interconnections with Mary's Harbour and/or Port Hope Simpson.
- **Port Hope Simpson** – Small hydro could be a promising option for Port Hope Simpson either on its own or through interconnections with Charlottetown and/or Mary's Harbour. Two sites have been identified with costs less than diesel generation which could serve Port Hope Simpson alone and two others are close to the community but too large for its own needs, making the cost of energy too high.
- **Mary's Harbour** - Mary's Harbour has potential hydro sites, both in terms of interconnection possibilities and sites that would serve Mary's Harbour alone. With respect to sites identified to serve Mary's Harbour alone there were three that merit further consideration for possible development.

As mentioned above, there are possibilities for interconnection at three sites. Two of these have annual energy outputs that could support the load of Charlottetown, Port Hope Simpson, and Mary's Harbour. Further analysis and investigation of storage solutions could possibly replace all three community diesel plants. In the analysis undertaken for the alternative energy study, the extra costs associated with interconnection did show a significantly higher unit energy cost. As a result, all the interconnection possibilities considered are economically favourable compared to the price of diesel fuel.[4]

Small Hydro as an Alternative to Muskrat Falls Development

There are two primary reasons why small hydro developments cannot be considered as a reasonable alternative to the development of Muskrat Falls and the Labrador-Island Link: technical limits to integration of small hydro capacity into an isolated electrical grid and an economic preference for other sources.

The majority of the projects identified in the Shawmont Newfoundland study that have not been developed are known as "run-of-the-river" generation projects that do not have water storage associated with them. This gives such facilities operational characteristics that are similar to wind generation – that is, in the same way that a wind turbine only generates

[4] Preliminary Assessment of Alternative Energy Potential in Coastal Labrador. Newfoundland Labrador Hydro. 2009.

electricity when the wind blows, a run-of-the-river hydro generation facility only produces electricity when there is water in the river.

The Newfoundland electricity system is currently isolated from the North American grid and this fact, coupled with the variability of energy supplied, means that integration of small hydro (or, for that matter, wind energy) into the Newfoundland electricity system requires careful planning to ensure that the electricity supply maintains acceptable standards of reliability. A run-of-the-river project may be less variable than wind energy but nevertheless, the absence of storage removes certainty that small hydro plants of this nature will be available to provide capacity during peak loads. As an example, river flows during periods of peak winter demand are typically lower than other season due to precipitation being mostly in the form of snow. As a result, a run-of-the-river project has less capacity and energy available precisely when it is needed most by the system. This limits the degree to which substantial quantities of small hydro developments can be accommodated.

In terms of transmission infrastructure, NLH's transmission system does not currently have the capacity to gather and transmit substantially more electricity from west of the Avalon Penninsula to the primary load centre on the Avalon. Significant costs would be incurred to upgrade transmission capabilities should any significant amount of small hydro be integrated into the Island grid.

From an economic perspective, the sites at Muskrat Falls and Gull Island are very attractive. They are compact, use upstream storage at Churchill Falls, and are readily accessible. Economies of scale also add to their attractiveness. Conversely, in the 1992/93 small hydroelectric RFP mentioned above, the seven unsuccessful proposals had an average bid price of approximately $67 per MWh (1993$). In 2010 dollars, this equates to approximately $102 per MWh (exclusive of transmission interconnection costs). While this price cannot be assumed to represent other potential small hydro facilities that could be developed, it does give an indication of the high unit energy cost of small hydro projects. In fact, on this basis, Navigant Consulting concluded that the cost for small hydro was approximately 20% higher than wind. Given the cost differential and the fact that the Island has exceptional wind resources, Navigant agreed that it was reasonable for Nalcor to exclude small hydroelectric facilities in its generation expansion alternatives.[5]

Conclusions

Although the 1986 Shawmont Newfoundland study and the 2009 NLH Preliminary Assessment of Alternative Energy in Coastal Labrador indicate a significant number of potential small hydro sites, small hydro cannot be considered a feasible alternative to Muskrat Falls development. Most of the sites identified by Shawmont are run-of-the-river projects which do not contemplate storage and thus have significant technical barriers in terms of integration to the existing isolated grid. The Coastal Labrador study does show great potential to displace isolated diesel systems on the coast with cleaner, cheaper hydro power and will be the subject of future study, but this still does nothing to address the forecast increase in Island demand.

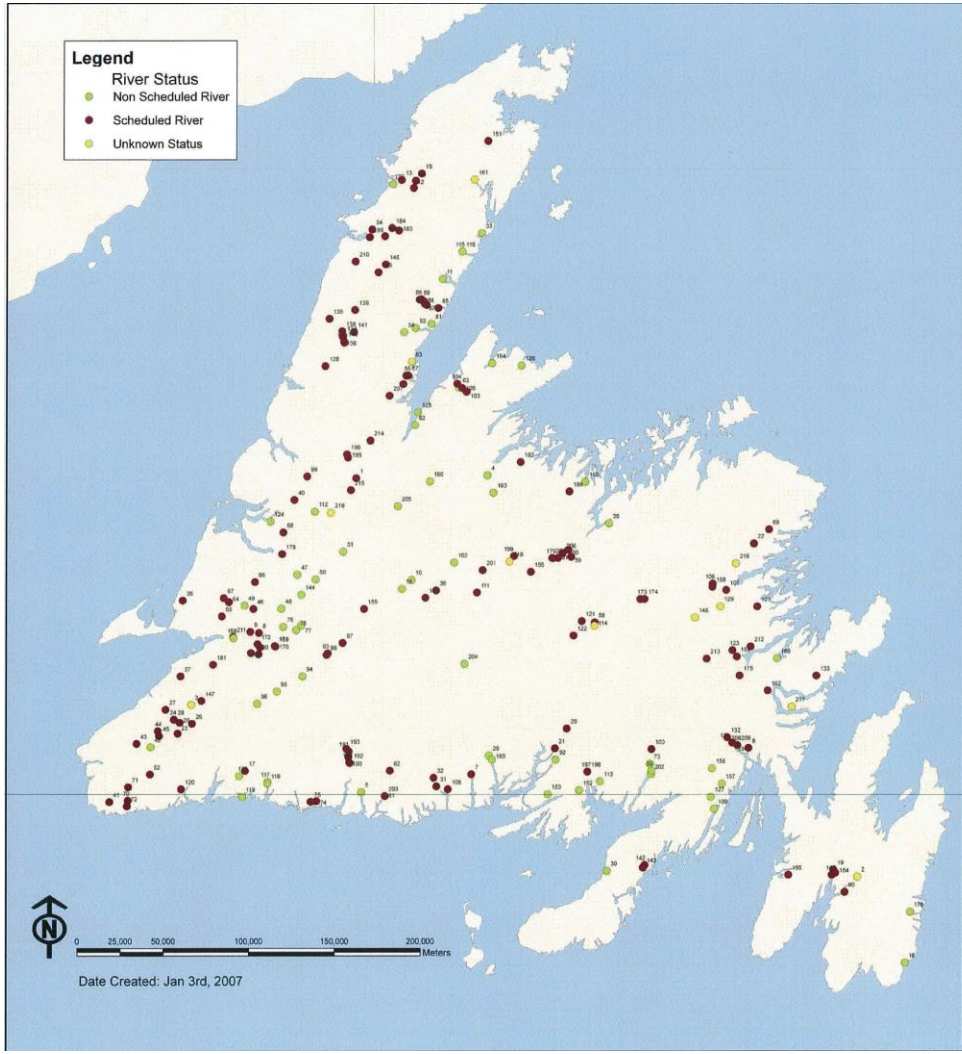
Small hydro developments that do not have significant storage capabilities produce power that cannot reliably be called upon when needed and in many respects exhibit

[5] Independent Supply Decision Review. Navigant Consulting, 2011.

characteristics that are similar to wind-powered generation. Insofar as both wind and small hydro can only be integrated to a limited degree in the Isolated Island system, the question of economics arises as to which one is cheaper. It has been independently confirmed by Navigant Consulting that in the Newfoundland Island context, where the wind resources are so plentiful, wind is a cheaper alternative by some 20% and thus there is a substantial economic preference for wind over small hydro, to the degree that either intermittent source can be integrated without compromising system reliability.

In summary, although the Island has a considerable number of small hydro sites, they are largely run-of-the-river projects with limited or no storage capacity. This renders them intermittent sources of energy which require underlying firm capacity - likely through increasing thermal generation on the Island - to maintain system reliability. There are exceptions to this, such as at Island Pond, Round Pound, and Portland Creek but these do not have near the capacity required to meet Island needs. There is potential for small hydro to reduce or even eliminate some use of isolated diesel generation on the coast of Labrador, but again, this does not meet Island needs. For these reasons, small hydro is not a feasible alternative to Muskrat Falls development.

APPENDIX A
Inventory of Potential Small Hydro Sites



Site	River	Capacity (MW)	Capability (GWh)
SMALL HYDROS <20 MW		881.6	4043.8
1	Adies Pond (Upper Humber)	10.2	50.2
2	Back River (Salmonier)	1.1	5.2
3	Barachois Brook	1.2	5.5
4	Barneys Brook	3.8	17.4
5	Bay ds Vieux Brook	3.0	17.5
6	Black River	3.2	14.7
7	Bottom Brook	8.7	39.6
8	Bottom Brook	3.1	14.0
9	Bottom Brook	2.9	13.0
10	Buchans Brook	1.2	5.5
11	Cascade River	6.8	29.5
12	Castors River	4.5	20.6
13	Castors River	8.0	34.4
14	Castors River	1.9	8.1
15	Castors River	1.4	6.1
16	Chance Cove Brook	3.5	16.0
17	Cinq Cerf Brook	7.4	33.7
18	Clench Brook	2.5	11.2
19	Colinet River	1.3	6.1
20	Conne River	2.8	12.8
21	Conne River	7.8	35.7
22	Cooks Brook	1.2	5.2
23	Crabbes River	7.3	33.1
24	Crabbes River	10.4	47.3
25	Crabbes River	6.8	30.8
26	Crabbes River	9.7	44.0
27	Crabbes River	11.8	53.8
28	Crabbes River	4.2	19.2
29	D'Espoir Brook	10.8	49.3
30	Devil Brook	3.3	15.0
31	Dolland Brook	14.7	67.0
32	Dolland Brook	11.2	51.2
33	East Arm Brook (Hooping Harbour)	8.2	36.2
34	East River	2.5	10.9
35	Eel Brook	1.8	8.8
36	Exploits River at Exploits Dam	1.0	5.8
37	Fischells Brook	2.4	11.1
38	Fox Island River	4.8	22.5
39	Gisborne Lake	10.8	62.9
40	Goose Arm Brook	2.2	9.3
41	Grand Bay River	1.7	7.9
42	Grand Codroy River	3.7	17.0
43	Grand Codroy River	1.8	8.0
44	Grand Codroy River	1.2	5.6
45	Grand Codroy River	1.0	4.7
46	Grand Lake	3.5	17.6
47	Grand Lake	3.4	14.6
48	Grand Lake	4.1	18.8
49	Grand Lake	2.8	12.1
50	Grand Lake (Conners Brook)	5.0	22.7
51	Grand Lake (Little Pond Brook)	4.1	18.7
52	Grandys Brook (Burnt Island)	4.1	18.5
53	Great Cat Arm River	5.1	21.8
54	Great Cat Arm River	1.5	6.7
55	Great Coney Arm River	5.9	25.5
56	Great Coney Arm River	1.1	4.8
57	Great Coney Arm River	2.4	10.5
58	Great Gull River	5.4	24.5
59	Great Rattling Brook	5.6	25.5
60	Great Rattling Brook	13.6	62.1
61	Grey River	19.6	89.5
62	Grey River	13.8	62.7
63	Gull Pond (White Bay)	2.9	12.4
64	Harry's River	5.4	24.5
65	Harry's River	6.3	28.9
66	Harry's River	1.0	4.7
67	Harry's River (North Brook)	3.2	14.5
68	Hughes Brook	1.9	9.6
69	Indian Bay Brook	2.3	11.3
70	Isle aux Morts River	2.0	9.0
71	Isle aux Morts River	1.4	7.5
72	Isle aux Morts River	2.6	11.8
73	Kane Brook	2.9	13.2
74	Kings Harbour River	15.3	69.8
75	Kings Harbour River	4.5	20.8
76	Lewaseechjeech Brook	4.9	28.8
77	Lewaseechjeech Brook	4.6	21.1
78	Lewaseechjeech Brook	3.2	15.1
79	Little Barachois Brook	1.6	7.6
80	Little Barachois Brook	1.6	7.3
81	Little Cat Arm River	2.5	10.6
82	Little Chouse Brook	1.3	5.7
83	Little Coney Arm River	1.6	7.6
84	Little Harbour Deep River	9.5	40.9
85	Little Harbour Deep River	7.1	30.6
86	Little Harbour Deep River	8.1	35.2
87	Little Harbour Deep River	3.7	15.9
88	Little Harbour Deep River	3.6	15.4
89	Little Harbour Deep River	1.4	6.1
90	Little Harbour River	4.3	19.6
91	Little Rattling Brook	1.6	7.2
92	Little River	4.9	22.6
93	Lloyds River	17.3	82.6
94	Lloyds River	10.2	46.4
95	Lloyds River	4.4	22.2
96	Lloyds River	2.4	10.9
97	Lloyds River (Otter Brook)	2.2	11.1
98	Lloyds River (Portage Lake)	6.9	34.8
99	Lomond River	2.5	10.8
100	Long Harbour River (Fortune Bay)	12.3	56.2
101	Macoles Lake	3.8	21.5
102	Mary March's Brook	3.1	17.8
103	Middle Arm Brook (White Bay)	2.3	11.4
104	Middle Arm Brook (White Bay)	4.8	20.8
105	Middle Arm Brook (White Bay)	3.9	17.0
106	Middle Brook	2.8	12.6
107	Mint Brook	1.8	7.5
108	Morgan Brook	3.8	17.3
109	Nameless River (near Paradise River)	4.2	19.3
110	New Bay River (Point Leamington)	1.8	9.9
111	Noel Paul's Brook	6.6	30.2
112	North Brook (Deer Lake)	1.5	6.5
113	North East Brook (East Bay)	4.2	21.8
114	North West River (Great Gull River)	3.3	14.9
115	Northern Arm River (Fourche Hr.)	13.0	56.2
116	Northern Arm River (Fourche Hr.)	2.4	10.8
117	Northwest Arm Brook (Connoire B.)	8.4	38.2
118	Northwest Arm Brook (Connoire Bay)	2.6	11.9
119	Northwest Brook (Bay le Moine)	2.9	13.0
120	Northwest Brook (Garia B.)	10.3	47.0
121	Northwest Gander	9.5	43.1
122	Northwest Gander	7.6	34.8
123	Northwest River (Clode Sound)	4.0	29.3
124	Old Mans Brook	5.3	22.8
125	Otter Point Brook	1.1	4.8
126	Pacquet Brook	1.4	6.3
127	Paradise River	6.4	29.2
128	Parsons Pond	9.6	46.2
129	Parsons Pond (Gambo Pond)	1.3	6.1
130	Phillips Brook	1.8	8.0
131	Pipers Hole River	9.8	44.7
132	Pipers Hole River	1.1	4.9
133	Popes Harbour River	1.0	4.4
134	Portland Creek	11.5	52.6
135	Portland Creek	9.1	43.7
136	Portland Creek	8.4	36.3
137	Portland Creek	4.6	21.0
138	Portland Creek	4.3	18.4
139	Portland Creek	2.6	11.3
140	Portland Creek	3.7	16.0
141	Portland Creek	1.1	5.4
142	Red Harbour River #1	2.0	9.0
143	Red Harbour River #2	1.9	8.4
144	Red Indian Brook (Grand Lake)	17.7	80.7
145	River of Ponds	2.8	12.2
146	River of Ponds	3.1	13.8
147	Robinsons River	2.4	11.3
148	Rocky Brook (Gambo Pond)	2.5	11.3
149	Rocky River	2.3	10.8
150	Salmon River (Clode Sound)	1.1	4.8
151	Salmon River (Main Brook)	2.3	10.2
152	Salmon River (Pool's Cove)	2.3	11.9
153	Salmonier Cove River	3.0	13.7
154	Salmonier River (Pinsents Fall)	1.2	5.4
155	Sandy Brook via Diversion Lake	2.5	13.1
156	Sandy Harbour River	1.4	6.4
157	Sandy Harbour River	5.9	27.0
158	Second Burnt Pond	2.8	12.8
159	Shanadithit Brook	6.4	29.0
160	Sheffield Lake	5.8	30.5
161	Shoal Brook (Chimney Bay)	5.8	24.1
162	Shoal Harbour River	1.5	6.7
163	South Brook	2.8	12.7
164	South Brook (Baie Verte)	1.3	5.7
165	Southeast River (Placentia)	3.2	14.9
166	Southwest Brook (Bloomfield)	1.1	5.1
167	Southwest Brook (St. Georges Bay)	2.5	11.3
168	Southwest Brook (St. Georges Bay)	10.3	46.7
169	Southwest Brook (St. Georges Bay)	1.3	6.2
170	Southwest Brook (St. Georges Bay)	1.9	9.1
171	Southwest Brook (St. Georges Bay)	3.7	16.7
172	Southwest Brook (St. Georges Bay)	3.0	13.7
173	Southwest Gander	5.3	24.1
174	Southwest Gander (Dead Wolf Brook)	1.8	8.3
175	Southwest River (Port Blandford)	8.1	37.1
176	Spout River	3.5	15.9
177	Squid Cove Brook	2.0	8.4
178	Steady Brook	5.6	24.2
179	Stony Brook	1.6	7.4
180	Thoney Cove Brook	1.8	8.0
181	Three Brooks	4.0	18.1
182	Tommys River	2.7	12.3
183	Torrent River	9.2	41.4
184	Torrent River	3.4	14.5
185	Torrent River	4.8	21.7
186	Torrent River (2 sites)	7.4	34.8
187	Victoria River	10.6	48.5
188	West Arm Brook	3.8	16.6
189	White Bear River	6.7	30.5
190	White Bear River	5.1	23.1
191	White Bear River	11.0	50.0
192	White Bear River	17.0	77.4
193	White Bear River	1.6	7.3
194	White Hills	1.4	6.4
195	Whites River (Upper Humber)	12.0	51.8
196	Whites River (Upper Humber)	7.8	33.7
LARGE HYDROS >20MW		1242.4	3357.0
197	Bay du Nord	63.0	367.0
198	Bay du Nord	175.0	
199	Exploits (Badger Chute)	22.0	175.0
200	Exploits (Grand Falls Extension)	21.0	125.0
201	Exploits (Red Indian Falls)	28.0	157.0
202	Gisborne Lake	172.0	
203	Grey River	29.6	142.0
204	Island Pond (Bay d'Espoir)	30.0	167.0
205	Kitty's Brook	25.7	121.6
206	Lower Exploits	23.0	180.0
207	Main River	110.0	490.0
208	Pipers Hole	126.0	
209	Pipers Hole	80.0	
210	River of Ponds	35.0	108.0
211	Southwest Brook (St. George's Bay)	30.0	98.0
212	Terra Nova River (Clode Sound)	100.0	543.0
213	Terra Nova River (Mollygujeck)	44.0	236.0
214	Upper Humber	100.0	327.0
215	Upper Humber (Little Falls)	30.1	98.0

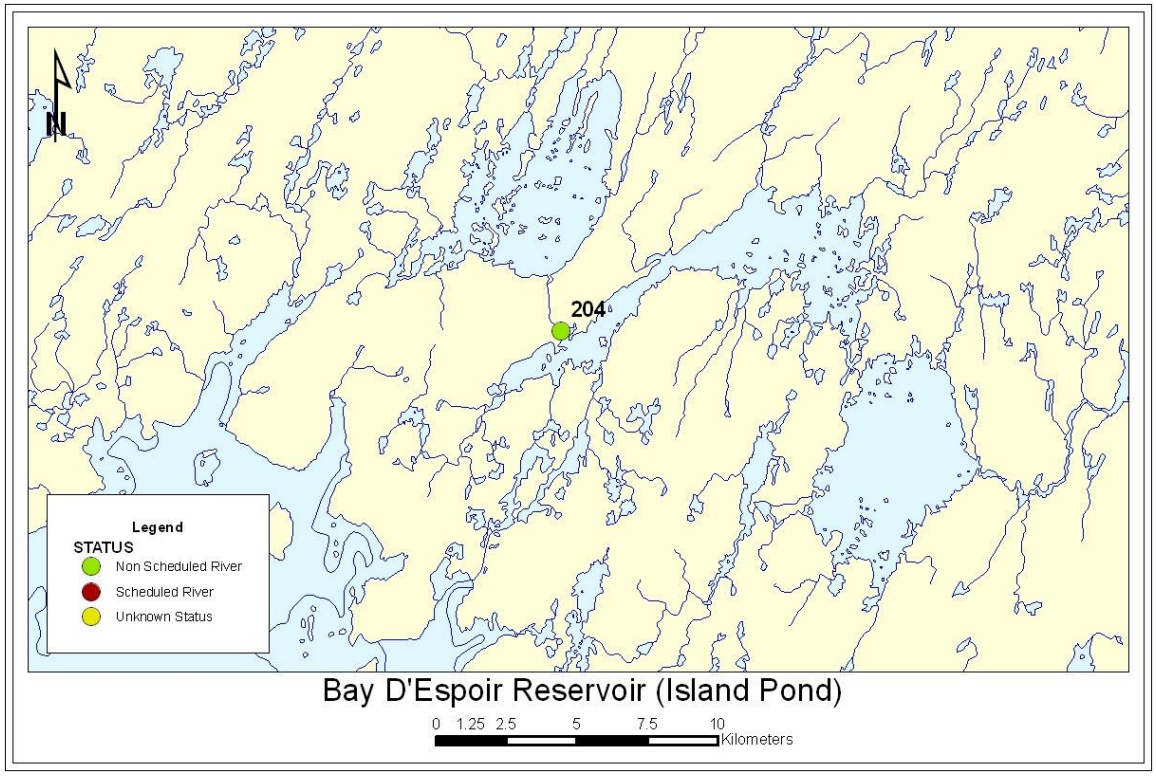
ANNEX B
Project Descriptions of Preferred Isolated Island Small Hydro Project as Carried by NLH

Island Pond

Island Pond is a proposed 36 MW hydroelectric project located on the North Salmon River, within the watershed of the existing Bay d'Espoir development. The project would utilize approximately 25 metres of net head between the existing Meelpaeg Reservoir and Crooked Lake to produce an annual firm and average energy capability of 172 GWh and 186 GWh, respectively.

The development would include the construction of a three kilometre (km) diversion canal between Meelpaeg Reservoir and Island Pond, which would raise the water level in Island Pond to that of the Meelpaeg Reservoir. Also, approximately 3.4 kilometres of channel improvements would be constructed in the area. At the south end of Island Pond, a 750 m long forebay would pass water to the 23 m high earth dam, and then onto the intake and powerhouse finally discharging it into Crooked Lake via a 550 m long tailrace. The electricity would be produced by one 36 MW Kaplan turbine and generator assembly

The facility would be connected to TL263, a nearby 230 kV transmission line connecting the Granite Canal Generating Station with the Upper Salmon Generating Station.

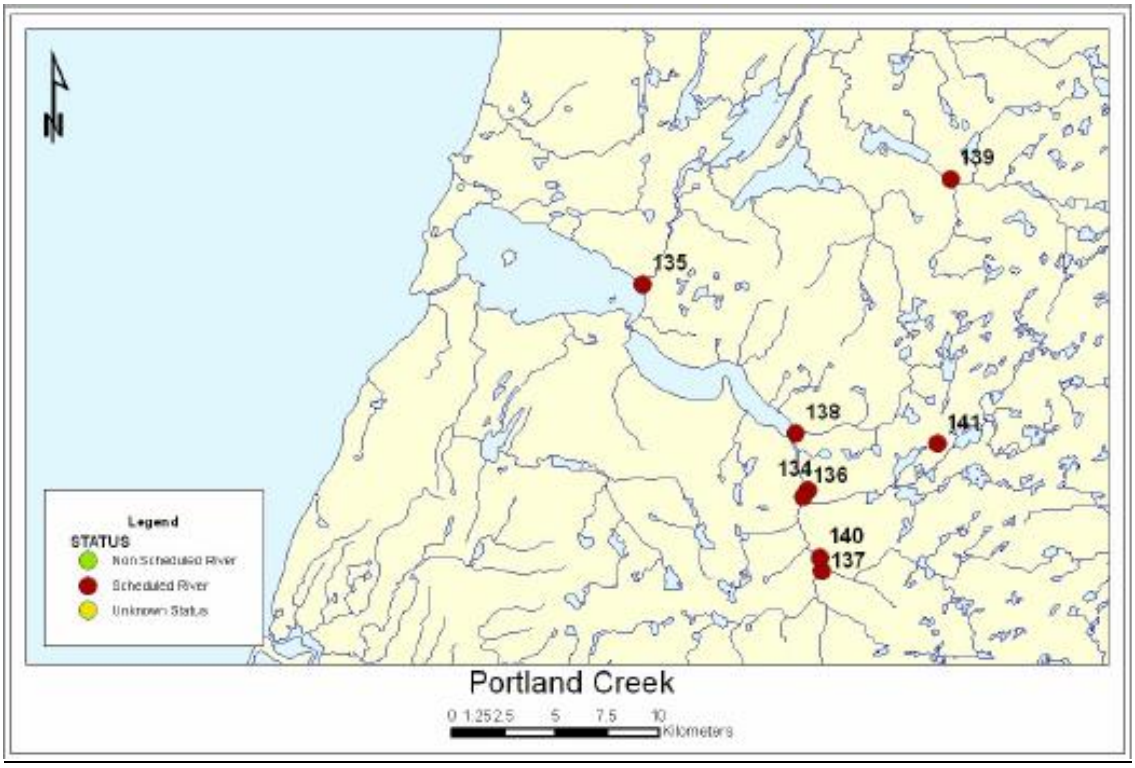


Portland Creek

Portland Creek is a proposed 23 MW hydroelectric project located on Main Port Brook, near Daniel's Harbour, on the Great Northern Peninsula. The project would utilize approximately 395 metres of net head between the head pond and outlet of Main Port Brook to produce an annual firm and average energy capability of 99 GWh and 142 GWh, respectively.

The project would require: a 320 m long diversion canal; three concrete dams; a 2,900 metre penstock; a 27 km 66 kV transmission line from the project site to Peter's Barren Terminal Station; and the construction of access roads. The electricity would be produced by two 11.5 MW Pelton turbine and generator assemblies.

The current schedule and capital cost estimate for Portland Creek is based on a January 2007 feasibility study, Feasibility Study for: Portland Creek Hydroelectric Project prepared for NLH by independent consultants. The proposed construction schedule indicates a construction period of 32 months from the project release date to the in-service date.



Round Pond

Round Pond is a proposed 18 MW hydroelectric project located within the watershed of the existing Bay d'Espoir development. The project would utilize the available net head between the existing Godaleich Pond and Long Pond Reservoir to produce an annual firm and average energy capability of 108 GWh and 139 GWh, respectively

The current schedule and capital cost estimate for Round Pond is based on the 1988 feasibility study, Round Pond Hydroelectric Development, prepared for NLH by independent consultants, and the associated 1989 Summary Report based on the same. In the absence of any further work beyond what was identified in this study, the overall program for the Round Pond development is estimated to be completed in 33 months, including detailed engineering design.