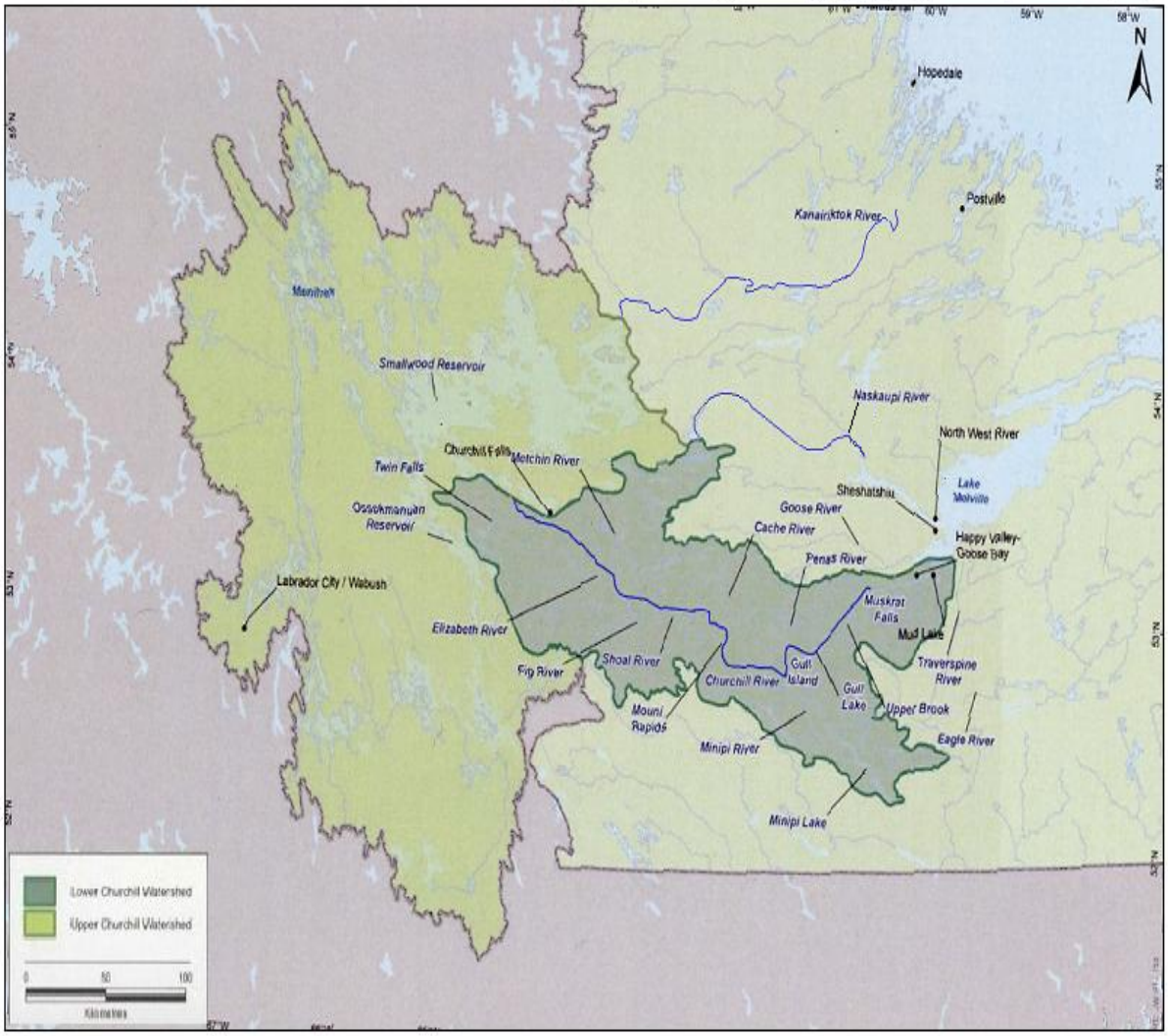
AN ASSESSMENT OF CHANGES TO THE LOCAL ECOLOGY DUE TO THE DEVELOPMENT OF THE UPPER CHURCHILL HYDROELECTRIC POWER DEVELOPMENT

H.T. (Ted) Blake, P. Eng.

Summer 2010



Central Labrador and the Churchill River Watershed LCHGP EIS Volume 1 Part A: Project Planning and Description, Figure 5-1
nalcor energy

Cover Photo: Sandbars in the Grand River, looking from above Birch Island and eastward towards the estuary. Bank erosion and subsequent siltation has made the river unnavigable for larger boats and killed food sources for all small life forms.

All photos by Clarice Blake Rudkowski unless otherwise notated

INTRODUCTION

The hydro potential of Grand Falls (a.k.a. Churchill Falls), was first discussed in the Senate in 1907 and in 1915 Wilfred Thibaudeau surveyed the Labrador Plateau and engineered a channel scheme that would use the natural capacity of the basin, thereby eliminating the need for construction of massive dams. When construction of the Upper Churchill Hydroelectric Project finally started in 1966, it was the largest civil undertaking on the North American continent.

The site of this massive development was chosen because it was located on the Height of Land Plateau, 1,500 to 1,900 feet (457.2 m. to 579.1 m.) above sea level. It was covered with muskeg, string bogs and endless interconnected lakes. Much of the watershed of approximately 36,068 sq. miles (93,415 km²) drains to the Grand River (a.k.a. Churchill River) which plunges into a deep gorge at the edge of the plateau, dropping more than 1,000 feet (304.8 m.) in less than 20 miles (32.18 km).

To engineers, it meant a unique site for a giant power project that combined at the one location, a large flow of water easily stored (in the Smallwood Reservoir, third largest made-made lake in the world) with a large drop providing the force to turn the turbines. As visualized by Thibaudeau, there are no dams. Instead the water is held back by a series of dykes (88 in the Smallwood Reservoir alone) so that it can be released through various control structures and spillways as required by the power plant. When the last of the eleven turbines was turned on in 1974 they were producing 5,428 megawatts (MW) of electricity, most of which is sold to Hydro Québec who in turn exports the bulk to the eastern seaboard of the United States.

Grand River is the longest river (530 miles, 853 km) in the Province with an enormous watershed. It is the most historic and ecologically diverse and it was the economic artery for the Upper Lake Melville region. It holds great cultural significance for all. The Innu and Metis particularly, who historically used the river, were not consulted nor was compensation offered before the Upper Churchill proceeded.

As with other developments of the time, the environment was not a prime consideration. Vast ecological changes were precipitated by the

project, affecting everything from the Height of Land, through the lower reaches of the Grand River, into Lake Melville and beyond. For instance, 36 years later, Health Canada tells us that the level of methyl mercury in Lake Winokapau, more than 62 miles (100 km) downstream from the falls, is still unacceptable and cautions us against eating too much fish. Additionally, other waterways flowing from the Plateau were impacted by the reduced and regulated flow, most notably the Naskaupi and Kanairiktok Rivers.

It is here that Ted Blake takes issue with a proposal to build two hydroelectric dams on the lower part of Grand River without taking into consideration the cumulative effects of the Upper Churchill Project. He points out that some relatively simple mitigation measures could have been taken but were instead ignored despite the proponents own predictions that some of these problems would occur. A case in point was when Churchill Falls Labrador Corporation (CFLCO) advised the North West River Town Council that they should expect salt water from Lake Melville to eventually migrate and contaminate their wells but then did nothing about it. Ted not only discusses a chronology of events but also offers solutions.

This is a valuable document in terms of public education and we are pleased to be able to make it widely available. For that we have to thank The Labrador Society of Ottawa for considering us worthy of the Zippie Ikkiatsiak-Ypma Award. Thanks also to Clarice Blake Rudkowski for her collaboration; David Sheppard, our summer student, who patiently and laboriously deciphered and transcribed our (and Ted's) hand written notes; to Robin McGrath for her editing; and Wally McLean who searched for archival photos at the National Air Photo Library in Ottawa; Chris Sampson of Sampson Photo; and Bert Pomeroy of Melville Communications.

Ted's paper is thoughtful with a good grounding in fact, experience, and traditional knowledge. It makes a valuable contribution to the debate. We hope you agree.

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Recently, there were public meetings held locally to discuss the effects of the proposed Lower Churchill power development. The impact on the local economy and ecology was examined but many questions were left unanswered. I find it unimaginable how the government plans to go ahead with the Lower Churchill Project before taking into account the cumulative effects of the Upper Churchill. Before making any final agreements, it would be wise to examine the effects that the Upper Churchill has had on the economy, the ecology, and the local wildlife.

This report is based on local observations, common and documented knowledge, as well as factual evidence. Recommendations will be made for conditions that can be corrected. Where changes cannot be corrected, alternative measures will be discussed.

Changes to the Ecosystem

Let us examine the abrupt loss to the frog and toad population that occurred shortly after the Upper Churchill project came on stream. These animals are highly sensitive to environmental change, and scientists use them as indicators of future environmental and ecological problems. The popular explanation for the demise of these animals was due to air pollution. However, this appears to be highly unlikely, as one would expect that this condition would cause the frog and toad population to decline gradually.

With the flooding of the Smallwood Reservoir, located at a high elevation and in the westerly wind zone, there was a change to the local climate. The spring break-up came earlier, the summers were cooler with more cloud coverage, and the autumns became more temperate. There is no other major event that could explain these changes.

As with all northern climates, with the coming of the spring break-up comes a microbiological bloom. The bloom consists of tiny ice worms, insects, crustaceans, etc. and is the food source for all small life forms, including frogs and their tadpoles, bay capelin, young fish, etc.

During spring, with the frost line higher, the frogs came out too early for the bloom while the bloom itself was greatly reduced by the silting of the Upper Bay (upper part of Lake Melville). The lack of food caused the frogs, toads, and their offspring to die off.

Satellite image showing sandbars in the lower reaches of the river. See http://maps.google.com/

Sandstorm on the Grand River.

At any rate, these toads and frogs were present in the millions, and had an important ecological niche as a major food source for other wildlife. Their decrease in population due to the Upper Churchill development has had a staggering impact on the ecosystem and the surrounding environment.

Note to Bert: Sidebar
Environment Canada keeps detailed records of wind velocity and direction, temperatures, cloud coverage, rain and snow falls, snow accumulation and other climatological data dating back to 1942. This data can be analyzed as concrete support data. (End of Sidebar)

Shortly after the Upper Churchill project came on stream, there was also a drastic change to marine animal, bird and fish life. The harp seals would come to the Goose Bay narrows in large numbers to feed on the Bay Capelin (Lance). The Bay Capelin, numbering in the billions, would spawn in Terrington Basin and the Churchill River estuary. At this time, the marine ducks would come in large numbers to feed on these little fish. With the increase in river flow, the bay capelin, the harp seals and the marine birds have almost stopped coming with the spring break-up.

Increase in water flow at the Grand River was accomplished with a system of dykes. The water flow from Smallwood Reservoir to the

secondary rivers and streams was cut off. With this situation, the flow through the turbines and down the Grand was greatly increased. This flow was constant rather than seasonal. The other rivers and streams, flowing from the reservoir, were drained, affecting breeding areas for migratory birds, river fish and animals. Along the Grand the increased water flow caused extensive alluvial erosion. This erosion, which is ongoing, liberated glacial clays causing silting of the spawning areas.

If this event had occurred when I was a young boy, before World War II, the people living in the northern section of Lake Melville would have been in serious trouble.

We depended on these seals and ducks for food during that period. We also bottled seal meat for the off season. We caught seals and preserved the meat for sled dog food for the entire year. Seal skins were used to make watertight boots, tumplines and other items. Seal intestines were used to fertilize our gardens. The seaweed we collected for humus and fertilizer for our gardens was laden with small fish which added phosphorus to the soil. I am told to this day that these little fish are now seldom seen in the seaweed.

Since the Upper Churchill project, the populations of water fowl such as the Black Duck and Mallard have not seen a noticeable increase. This suggests that the rivers are not regenerating to their original breeding capabilities. It can be concluded that the Upper Churchill Project has caused permanent damage to the wildlife of the area.

Before we explain why the wildlife population was decimated, let us examine some facts. First, with the increase in river flow, there was substantial river bank erosion. These sediments that make up the river bank were deposited by glaciations thousands of years ago, and contain large quantities of glacial clay. These clays are very fine and will suspend in the water, making them very susceptible to being distributed throughout the region. This distribution is much like ash from an erupting volcano.

With the erosion, due to increased flow of the river, the spawning beds were silted. This heavily impacted the population of the marine life living in the river, and thus affected the populations of other animals that depend on the marine life for food. A similar situation occurred at the upper end of Lake Melville. The area was heavily silted due to the erosion of the river banks, and many of the lake bottom life forms were killed as a result.

We see little rejuvenation in the marine life populations, which suggests that this erosion is ongoing. In order to protect the delicate ecosystem of the river, this erosion must be stopped.

The northern and southern banks of Muskrat Falls also contain large quantities of glacial clays. With flooding, these banks will destabilize and cause the same type of damage that occurred in Lake Melville. An examination of the effects of erosion above and below Muskrat Falls, reveals that little regeneration of the marine ecosystem is occurring. The shore-washed seaweed showed no signs of dead fish entanglement, and there were very few shells on the shoreline, indicating that the lake bottom is not regenerating.

The lower end of the bay (eastern end of Lake Melville) did not seem to be affected by this process. Harp seals come up to the lower end of the bay and stay until it freezes over. Some get caught in the freeze-up and die.

To slow down the erosion at Muskrat Falls, affected areas must be identified, and the banks rip rapped as was done at Happy Valley.

Note to Bert: Sidebar

A number of surveys, testing and soil analysis should be made.

1. Make a hydrographic survey of the upper half of the lake (Melville), and compare with the survey of the mid 1950's. This will give an idea of how much sedimentation has occurred.
2. Lake-bottom core sampling should provide valuable information.
3. Soil sampling of the eroding river banks will give the clay content.
4. During the spring runoff, a water sampling program with an analysis of suspended solids will be valuable evidence. (End of Sidebar)

I suggest a rock trench be excavated adjacent to and at the east side of the falls. The water level below can be coned out and blasted to lower the upstream water elevation by approximately 26.2 ft.- 29.5 ft. (8-9 meters). While this project is in operation, a permanent bridge across the excavation should be constructed. This bridge will then serve as a crossing for a highway, and will cost no more than an average city overpass (See Plate No. 1).

In order to further curtail this erosion, I suggest lowering the falls by the construction of a by-pass trench located just south of the falls. This trench will lower the upstream water level by approximately eight meters.

At Muskrat Falls, the river drops 80 feet (24.3 m.) over two benches.

Changes to the River Systems

Just after the ice age, Lake Melville extended west to the Gull Island area. With the receding ice and rising land, the lake head went eastward. Salmon continued to go to their historic spawning grounds until the steep section of Muskrat Falls finally cut off their access. By lowering Muskrat Falls, salmon may once again gain access to their traditional spawning grounds at Minninipi Lake and Metchin River. These lakes will need to be restocked.

Flooding should not occur at the Metchin River/Winokapau Lake region. This is a beautiful area that supports much wildlife. It also carries cultural significance, as it was the main hunting ground for the Innu and other local trappers.

The area has potential for winter and summer recreation, as well as light industry. With good roads, affordable electrical power and an airport, it would be a favorable location for a community.

Let us look at the **North West River/Grand Lake area**. With the cut-off of the source of water to the Naskaupi River, the outflow from Grand Lake is so low that with the change in tides, the salt water from Lake Melville actually backs into Grand Lake.

This condition is also gradually salinating the water table of North West River and Sheshatshiu, and if not stopped will eventually salinate all of the water table. This salination is also affecting marine life in the area, as fish like Smelts and Tommy Cod need fresh water to live and reproduce.

Salt water entering Grand Lake must be stopped. Should the heavier salt water collect at the lake bottom, it will result in stagnation and loss of oxygen. This will kill all lake-bottom life forms. They are the bottom of the food chain, and their high population is essential for the survival of the indigenous Lake Trout. I believe the burbot (local name Ma-rye, spelled phonetically, or night fish) have already disappeared from Grand Lake because of the salt water intrusion.

To explain further, water becomes heaver as it cools to 4°C, but as it nears 0°C, it begins to expand rapidly and then freezes. This is why ice forms at the surface. With the spring melt, water at the surface warms to its heaviest at 4°C, and drops to the bottom of the lake. This water is oxygen rich and is essential for marine life. However, the salt water is heavier than the oxygen rich water, and will sink to the bottom, preventing the lake bottom life forms from having access to the oxygen that they need. It cannot be emphasized enough that THE BOTTOM IS THE LUNGS OF THE SYSTEM. (See Plate No. 2).

To establish a constant fresh water outflow from Grand Lake, the following dam construction should be considered. At Sheshatshiu, construct a breakwater dam to restrict the outflow to the deep channel. This stops recirculation and serves as a barrier for in-wind (northeasterly) storm surges (See Plate No. 3).

At the Grand Lake rapids outflow, the water should be elevated to 3-4 cm above the highest tide level. To achieve this, heavy rock dams need to be

built to narrow the channel, and bring the lake water to the desired elevation (See Plate No. 4). Fish and motorized boats should have little difficulty climbing this rise.

With these actions, the water will remain fresh at the two communities, and upstream. Eventually, the water table will desalinate to its original condition. As you can see from the above, the water table is salinated now but is easy to reverse if the will is there.

With respect to the **Naskaupi and Kanairiktok river systems**, the source of these rivers originally flowed from Michikamau Lake, now swallowed up by the Smallwood Reservoir. These river systems, in their natural state, met an ecological equilibrium. The rivers irrigated the river banks, nurturing plant life. The plant life provided food for rabbits, partridges, mice, etc. These animals were preyed upon by lynx, foxes, mink, and other predators. The river lagoons nurtured grasses, which served as nesting areas for water fowl, and supported small animals which provided nourishment for the muskrat. The beavers lived off the river bank trees, and fish such as suckers, brook trout, and white fish lived off the smaller marine life such as worms, crustaceans, clams, as well as fingerlings. River otters were also nourished on this marine life.

The creation of the Smallwood Reservoir reduced the flow of these rivers, heavily impacting the area. The delicate ecosystem of the area was damaged, and the area could no longer handle the large population of wildlife that it supported. Many animals either had to leave, or died off.

Water, which originates from the Smallwood Reservoir, flows down the Naskaupi River into Grand Lake; squeezes through The Rapids to Little Lake and North West River; ultimately emptying into Lake Melville.

Recommendations and Alternative Measures

To rehabilitate these rivers to their near-normal condition, the water sources should be opened to the Smallwood Reservoir, and at least 30 percent of their original continuous flow be reestablished. Then, along the lengths of the river at locations where the water is shallow and fast flowing, build a 1.0 meter dam across the river with a small fish ladder (this is common practice). The river will then flood to irrigate the banks and lagoons (See Plate No. 5). With a thorough survey of the rivers and the installation of dams, the river systems, over time, will approach near normality. The Naskaupi River is a salmon river with spawning areas at Salmon Lake just downstream from Seal Lake. The health of the salmon should be assessed, and a restocking program introduced, if required.

With respect to the proposed Lower Churchill Hydroelectric Development Program, before proceeding, I suggest the problem outlined above be examined, and positive action be taken.

The effects on the environment due to the Upper Churchill can be defined in two parts. First, there are adverse changes that can be corrected. These corrections will involve studies and initiatives, resulting in considerable expenditures. Secondly, there are the changes that are permanent and can only be settled through negotiated compensation. Before action can be taken to develop the Lower Churchill, these issues need to be addressed.

Other Sources of Energy

- **Wind power**, with modern technology, can supply electricity at attractive rates. With means to store excess energy these installations can be even more efficient. e.g. inertia wheels to store power surges.
- Newfoundland and Labrador is blessed with a possible source of energy which is yet to be exploited. This source is the Labrador Current. It is a very swift-flowing current (3.5 knots which is equivalent to an 80 mph gale) coming from the Arctic Ocean, south along the coast of Labrador and on to the Grand Banks of Newfoundland. All that is needed are properly developed sites utilizing **free-flow turbines in the sea**. The potential for this source of energy is, for practical purposes, infinite. What greater legacy could a politician want than to have more power than we could ever use for much, much less than the estimated cost of the proposed Lower Churchill Project.

Conclusion

Grand River is of immense value for all sorts of development if allowed to flow freely. We already know the damage flooding does to the local ecology.

These projects will only develop cheap power for foreign use. We already have a good example of this.

EPILOGUE

During March 2003 I prepared a report outlining the effect the Upper Churchill Hydroelectric Project and the Smallwood Reservoir had on the ecology of central Labrador. To follow up on my findings, during July 2003 and 2004, I visited some of the affected areas to survey any changes.

The Biological Changes Due to Climate Change

With regards to climate changes caused by the flooding of the Smallwood Reservoir, the toad population is on the increase. During the summer of 2003 there were sightings of the American Bittern, a bird that feeds exclusively on toads and frogs. Water fowl such as Black Ducks, Mallards, Teals, etc. are not noticeably increasing. This suggests the rivers are not regenerating their breeding habitat. On the whole one can conclude there is permanent damage resulting from the climatic change. As far as I know, the Green Frog still has not come back.

The Damage to Upper Lake Melville due to the Silting caused by Glacial Clay and other Sediments

To give an idea of the amount of river bank erosion that has occurred, one only has to visit or fly over the Grand River. The amount of river bank erosion is extensive above and below Muskrat Falls. At the north river bank, directly above and below the falls, erosion is so severe that ground water levels are lowered by pumping. This is done to prevent slumpage and further erosion.

Huge landslide caused by river bank erosion at Sand Banks, above Muskrat Falls.

This is in the cove on the north side of the river, below Muskrat Falls. Note the sandbank erosion on far shore.

All these sediments, including the clays, have choked out lake-bottom marine life, including the bay capelin, small crustaceans and worms. This process is obviously still in progress.

By examining the sea weeds washed ashore, for dead life forms, one can get an idea how bottom life is regenerating. These weeds show no sign of dead fish entanglement. There are only small amounts of shells driven on shore. This indicates the lake bottom shows little sign of regenerating.

The Loss of the Scooter Ducks

Recently I read an article in an American trade magazine, entitled "Where have all the scooter ducks gone". This article explained how these ducks have drastically declined in numbers and attributed it to environmental causes. I can certainly explain what has happened to a very large number of these ducks.

Before the advent of the Upper Churchill Hydroelectric Project, these ducks would return to their nesting areas via open fast-flowing waters at the narrows between Upper Lake Melville and Terrington Basin. These fast-flowing waters were the first to open. The ducks gathered in very large numbers at these open sections of water before the upper and lower waters were free of ice.

During this period of two to three weeks these ducks would feed on the bay capelin which had already started their spawning run.

With loss of the bay capelin the scooter ducks had no source of food and would have perished. They would have other flyways so it would not have resulted in their total demise.

After the bay (Lake Melville) cleared of ice, the ducks would proceed to their nesting areas and feed on small shells. The small shells were also decimated due to the silting of their habitat, causing further loss of these ducks. Local people still remark about the few sightings of these birds.

Hunters, recently returning from Lower Lake Melville, report sighting large numbers of scooter ducks as well as American Mergansers. Seals and otters were also observed feeding on fish.

A Survey of Muskrat Falls

On June 30, 2003 I visited Muskrat Falls to view the amount of erosion occurring to the sandy river banks. The changes to the area are profound.

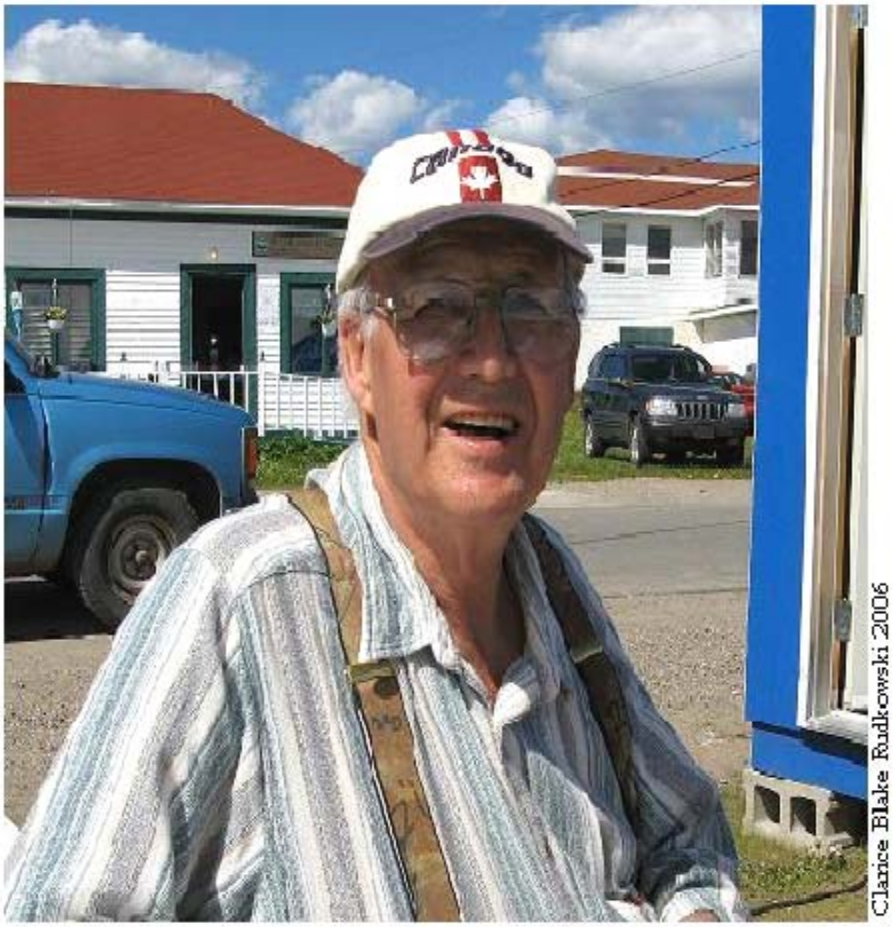
To curtail this erosion, I suggest lowering the falls by construction of a by-pass trench located just south of the falls. This trench will lower the upstream water level by some eight meters.

I am told that there are still plans to construct a hydroelectric site at the falls. This will entail raising the water by damming the river and constructing a generating station. This suggests flooding a large land area. The north and south banks consist of high unconsolidated sand containing large quantities of glacial clays. With flooding these banks will destabilize and cause the release of large quantities of suspended solids.

Most governments discourage or forbid the flooding of large land masses. The changes to the local environment were observed with the flooding of the Smallwood Reservoir. With flooding restricted to an increase of 10 to 15 percent of the original water acreage, little changes to the environment are realized.

Today a common practice is to lower the downstream by trenching and/or tunneling to increase the up-to-down stream water elevations.

At this site this practice is not feasible and should be discouraged for a hydroelectric power generating operation.



H.T. (Ted) Blake, P. Eng.
Mining Specialist

Ted was born and raised in North West River, Labrador. In 1951 he attended Mount Allison University in Sackville, N.B. where he received an engineering certificate and then went on to get his mining engineers degree from Queen's University in Kingston, Ontario. As an engineering student he worked with survey crews on the Upper Churchill Hydroelectric Project.

After graduation he worked, mostly in mine management, at various mines around the country. Then in 1980 he was hired by the Government of Ontario as a mines inspector and stayed with them until his retirement in 1995.

Ted now lives with his family in Orleans, Ontario.

Northern Leopard Frog

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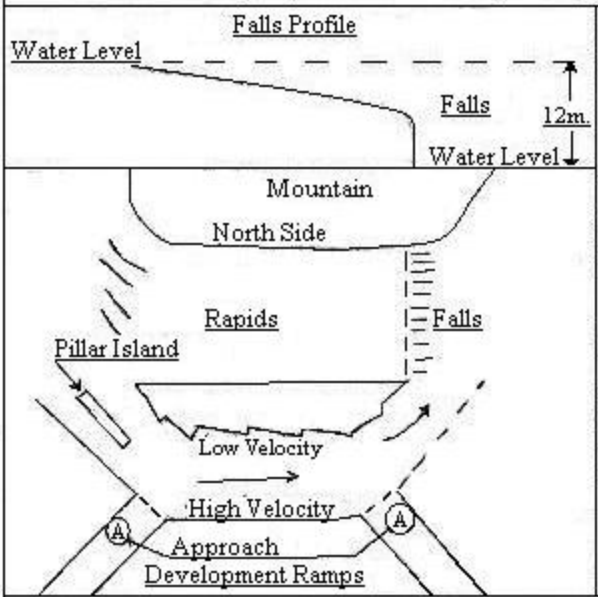
Plate No1

The Lowering of the Muskrat Falls

Schematic - N.T.S.

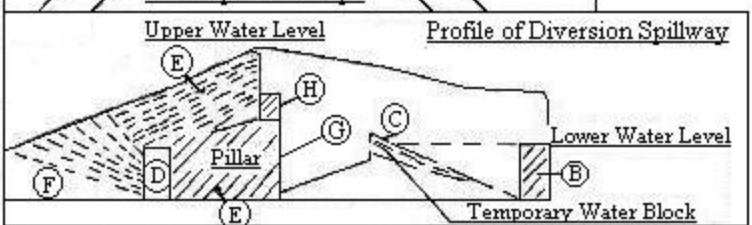
Proposed Diversion Spillway



1. At the south side of the falls, excavate a rock trench to 7 meters below water level at the discharge.

2. To excavate the intake, drill and blast enough to lower the upper water level by some 7 meters.

3. At the north wall, establish 1 meter rock slashes to facilitate fish travel and create turbulence for energy dissipation.

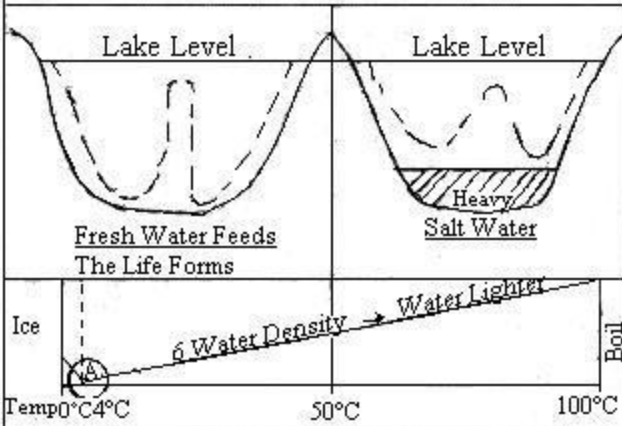


4. Diversion Spillway Development Procedure: (a) Develop approach ramps to floor level Ⓐ. (b) Develop down stream leaving pillar Ⓑ and water block Ⓒ. (c) From upstream approach ramp, develop upstream excavation and two spillway tunnels with cross gallery at far end Ⓓ. (d) Clean drill and blast pillar Ⓑ. (e) Drill hole series Ⓔ to blast upwards. (f) Drill fan hole series Ⓕ to blast upwards. (g) Do not blast center pillar Ⓖ. (h) Load and blast hole series ⒺⒻⒸⒽ in proper sequence to establish water flow.

Plate No2

Desalinate Grand Lake Bottom

Schematic - N.T.S



When cooling, water becomes heavier until reaching 4°C, and then becomes lighter as it begins to freeze. This is why ice floats.

During spring melting, the surface water temperature rises to 4°C Ⓐ , and because it is at its heaviest, drops to the lake bottom. This water is oxygen rich and essential to the lake bottom life forms.

The excess salt water is heavier than the oxygen rich water, and sinks to the bottom, killing lake bottom organisms as they are deprived of the oxygen rich water they need.

1. Test for salinity at the lower lake deep section.

2. Test oxygen content in the water at lower lake bottom.

3. If required, measures should be taken to remove the salt water.

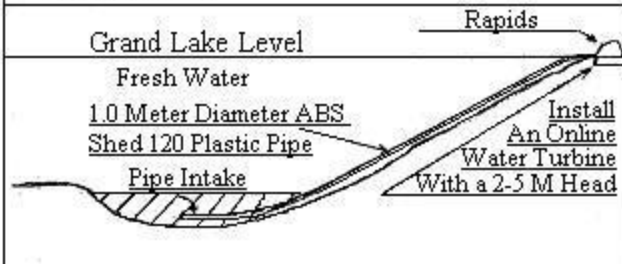
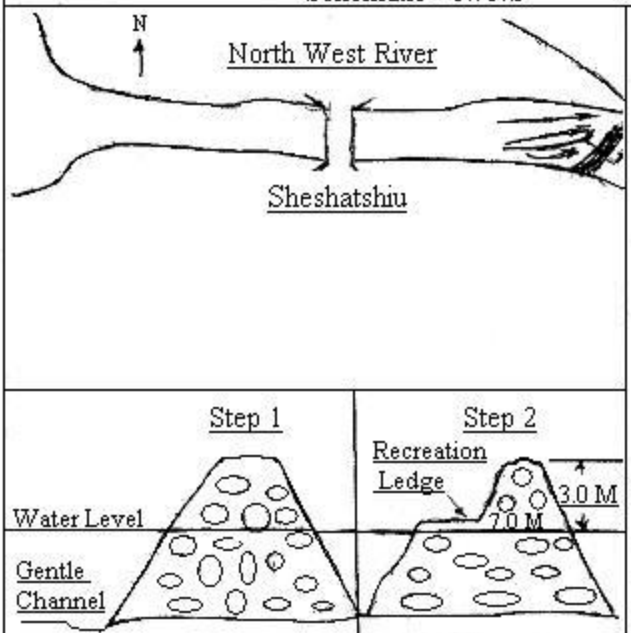


Plate No3

Rock Barrier at North West River and Sheshatshiu

Schematic - N.T.S



1. To restrict the river flow, build a storm quay with quarry rock.

2. This will restrict the flow to the deep channel.

3. It also protects against storm surges which occur during in-winds.

4. A restriction at the upstream rapids will desalinate the area and maintain normal access.

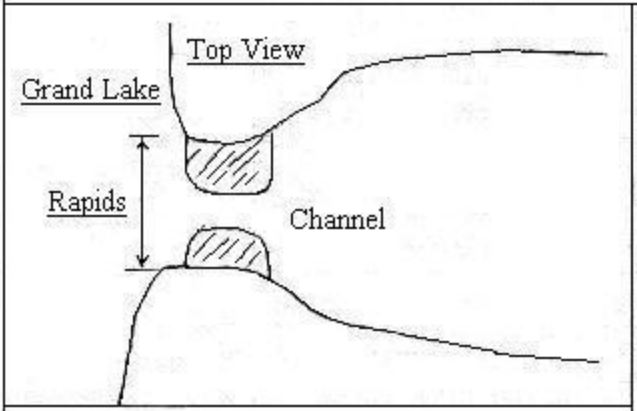
5. The gentle channel at the toe of the barrier will direct river flow and minimize silting.

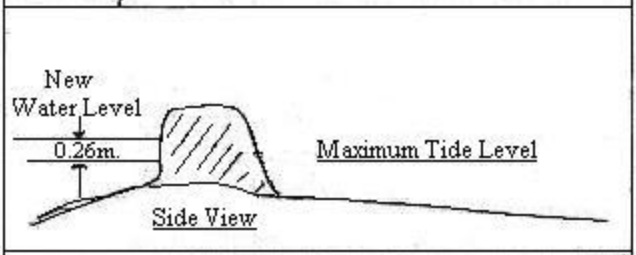
Salt water must not be allowed to flow into Grand Lake. If there is an accumulation, it must be removed.
The salt water, being heavier, will lie on the lake bottom, losing its oxygen and killing lake bottom life forms.

Plate No4

Restricting Flow at the Grand Lake Rapids

Schematic - N.T.S.





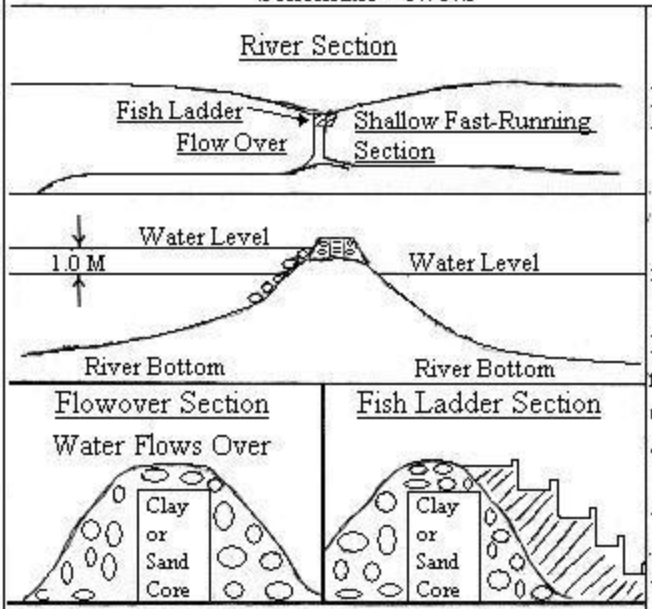
By raising the Grand Lake water level by approximately 3 to 4 cm above the maximum tide level at North West River, we create a positive outflow. This will prevent the inflow of salt water. The new channel that is created is navigable for normal motorized boats.
This arrangement must be done as soon as possible.

1. With quarry rock, build a north and south rock barrier to raise the Grand Lake water level as indicated.

2. These two structures must withstand the annual ice flow.

Plate No5

Assessment of the Kanairiktok
Naskaupi River Sources and Systems
Schematic - N.T.S



1. Make a complete environmental and hydraulic survey of the river systems.
2. At all shallow fast running sections, install 0.7 meter dams with small fish ladders.
3. Allow water to run over all sections of the dam.
4. Fish ladder with 0.15 meter steps will allow small fish such as river trout, white fish, and suckers to climb the ladder.

As an alternative, weirs may be installed, as in the Rupert's River Diversion Project. An on-site assessment will dictate the proper weir.

To rehabilitate these rivers, establish a run-off, where at its source, allow 30 percent of original flow to run all year. Then, install low level 1.0 meter dams at shallow pinch points along the river. This will allow enough flooding to irrigate the river bank vegetation required for mice, rabbits, partridges, etc, in order to maintain the populations of the foxes, lynx, beavers, mink, etc.

The dams will aerate the water for river fish, clams, water worms, etc, in order to maintain the populations of the otters and water fowl during the spring break-up.