

# Run-of-River Hydropower in BC

***A Citizen's Guide to Understanding  
Approvals, Impacts and Sustainability  
of Independent Power Projects***



**Watershed  
Watch**   
**SALMON  
SOCIETY**  
*Watching out for BC's Wild Salmon*

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August 2007

## THE NAME GAME

What's in a name? IPPs, run-of-river, green power, small hydro, are often used interchangeably to mean the same thing. Independent Power Producers (IPPs) may develop various power projects in BC. Many are 'run-of-river' (see "What is run-of-river hydropower?"), and qualify for green power status with BC Hydro. These run-of-river power projects are often 'small hydro,' i.e., they have relatively small capacities. But run-of-river projects can also be large, and include the proposed Site C dam.

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## ACKNOWLEDGMENTS

Researched and written for Watershed Watch by Tanis Douglas and edited by Peter Broomhall and Craig Orr. This Citizen's Guide was made possible through all the citizens who contribute to the Habitat Conservation Trust Fund. Photos graciously provided by the provincial Ministry of Environment, the Independent Power Producers of BC (IPPBC), and the BC Conservation Foundation. Watershed Watch also thanks the many experts who provided advice and reviews. Graphic design and production by Eye Design Inc.

**Front cover photo: Ashlu river diversion under construction.**  
Tom Rankin photo.

## What is this document about?

'Run-of-river' hydropower is promoted in British Columbia and elsewhere as an environmentally-friendly solution to humanity's ever-increasing energy demands. The rush to implement large-scale run-of-river projects (sometimes called Independent Power Producer, or, IPP projects) has prompted queries and debate about what these projects portend for people and the environment.

Development of new energy sources comes with trade-offs and environmental costs—even for renewable and 'clean' energy projects. Because the technology is relatively new, people are understandably anxious to learn more about these projects, particularly about economic and environmental costs and benefits.

**Development of new energy sources comes with trade-offs and environmental costs—even for renewable and 'clean' energy projects.**

### Watershed Watch Salmon

Society recognized the pressing need for a *Citizen's Guide* to run-of-river hydropower, and produced this document to help answer many of the questions people are now asking about these projects—particularly about how run-of-river projects work, how they affect the environment, how the projects are approved and monitored, and how citizens' input will be treated.

Watershed Watch's more technical companion document, "*Green*" *Hydro Power: Understanding Impacts, Approvals, and Sustainability of Run-of-River Independent Power Projects in British Columbia*, is available at [www.watershed-watch.org](http://www.watershed-watch.org).

## Why should citizens care?

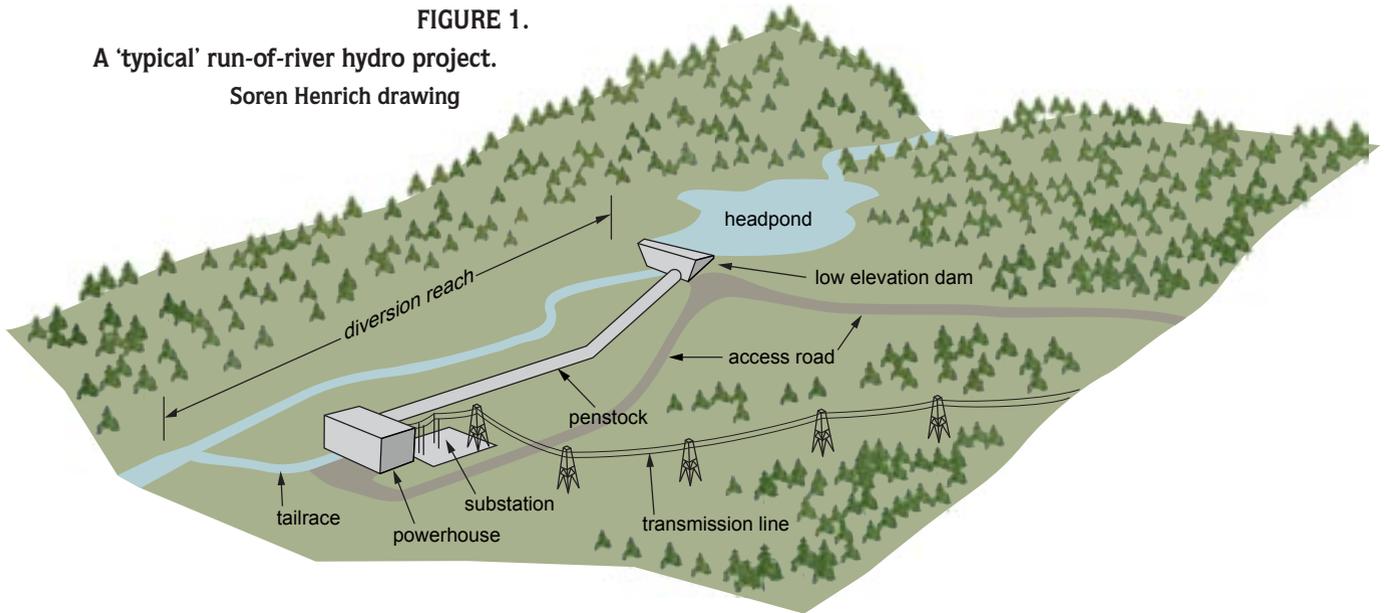
Concern about environmental and societal impacts is a natural consequence of the rush to develop IPP projects in British Columbia. BC Hydro intends to acquire another 10,000 gigawatt (GW) hours of power from IPP projects by 2015

(BC Hydro 2006)—with much of it from run-of-river hydro—so the time to be concerned is now.

## What are Independent Power Producer (IPP) Projects?

British Columbia's government has promoted large-scale development of privately-owned small hydro projects and other types of power projects since 2002. Most projects—both built and proposed—involve run-of-river hydropower, though Independent Power Producers (IPPs) are also pursuing other options.

**FIGURE 1.**  
A 'typical' run-of-river hydro project.  
Soren Henrich drawing



## What is run-of-river hydropower?

Run-of-river hydropower diverts some of a river's flow to power electricity-producing turbines, returning the water downstream of the turbines. Turbines are not installed in the river itself. Each project requires significant infrastructure, and always includes the following (as shown in Figure 1):

- A small dam to create a 'headpond.' This headpond does not store water; it merely floods a sufficient area to ensure that the intake to the penstock is under water.
- Pipes, known as 'penstocks,' deliver water from the headpond to the lower-elevation turbines. Penstocks are often three or four kilometres long.
- A powerhouse building that contains one or more turbines.

- A 'tailrace' channel through which the diverted water is returned to its river of origin.
- Access roads to the headpond and powerhouse.
- Transmission lines from the powerhouse to the nearest BC Hydro transmission line.

The construction costs of run-of-river projects are significant—as are their terrestrial and aquatic 'footprints.' The section of river between the dam and the powerhouse (see Figure 1) is sometimes called the 'diversion reach,' because significant quantities of water are diverted from this section of river. When done properly, with care given to footprint size and location, these projects can create sustainable green energy that minimizes impacts to the surrounding environment and nearby communities.

## How much power can a single project produce?

Most current and proposed projects have a maximum capacity of less than 50 megawatts (MW). Greater capacity can be produced by connecting projects across rivers and tributaries. The potential electric contribution from a 50 MW project represents only 0.0045 percent of BC Hydro's total installed capacity (11,000 MW), but is enough to power 25,000 homes (one MW powers 500 homes).



Construction of the penstock at Furry Creek. IPPBC photo.

## What do run-of-river projects mean to BC's Energy Policy?

BC is currently a net importer of electricity (though the calculation depends on how electricity trading is tracked). If BC's population

grows according to plans, the province will require new energy sources in the future. The BC government's 2002 Energy Plan highlighted a need for new energy, and promoted a goal of energy self-sufficiency.

A major policy shift

required that new energy come from the private sector. Since 2002, BC Hydro's energy development role has been restricted to purchasing power from the private sector, plus

maintaining BC's 'heritage' assets (the large dams currently providing most of the province's power).

Successful private IPPs receive a 25-year purchasing contract from BC Hydro, after which they are free to sell throughout western North America. Run-of-river projects are currently considered the most viable green energy in BC because they are the cheapest and are perceived to be environmentally benign. As a result, the majority of IPP projects are for run-of-river hydroelectricity.

**Run-of-river projects are currently considered the most popular type of green energy in BC.**



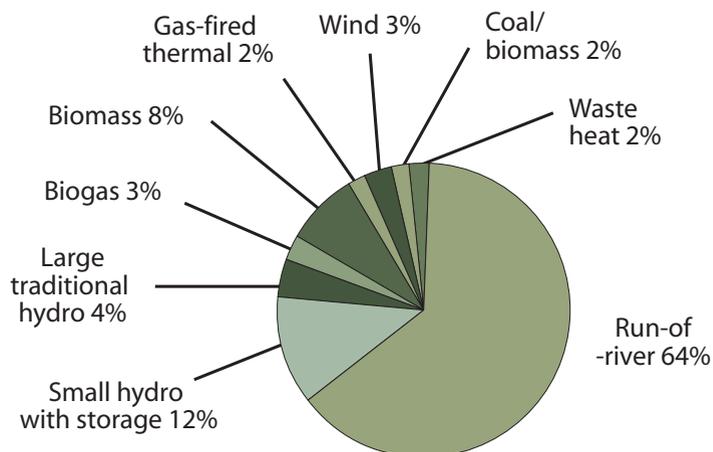
Furry Creek powerhouse. IPPBC photo.

## Who approves run-of-river IPP projects?

Currently, neither BC Hydro nor the provincial government can ensure the sustainability of run-of-river IPP development. The provincial government approves IPP projects. The process is quite complex, and is important for recognizing and protecting environmental and societal values. A review of the current process (detailed in Watershed Watch’s accompanying document) suggests the need for substantial improvement.

Here are the key steps of the current process:

- BC Hydro issues electricity purchase agreements—based on project feasibility and the likelihood of the project being completed as planned. These agreements are issued separately from provincial and federal approvals, and usually before the environmental assessments are complete.
- The BC Ministry of Environment (MOE) is responsible for:
  - issuing a water licence giving the right to divert water;
  - approvals to use Crown Land; and,
  - comments and guidance on fish, wildlife and ecosystem values.
- The Coast Guard is involved when navigable waters are of concern.
- Fisheries and Oceans Canada (DFO) is responsible for reviewing information,



**FIGURE 2.** Existing and planned (2006) IPP projects by type

and for mitigating impacts to fish. If a harmful alteration, disruption or destruction of fish habitat is expected to occur, a Fisheries Act Authorization is required. Fisheries and Oceans Canada is obliged to obtain compensatory fish habitat to assure against net loss. DFO typically defers to MOE expertise on issues involving non-anadromous fish (e.g. rainbow trout). DFO is also responsible for screening projects through the Canadian Environmental Assessment Act.

- First Nation concerns about projects on their traditional territory must be accommodated.
- Though communities have no formal power in the approvals process, they are typically consulted.

## Is there a problem with parallel BC Hydro and agency processes?

Green designation by BC Hydro is currently optional, and is obtained after the project is constructed. Even though it is optional, IPPs developing run-of-river projects work to get this designation because BC Hydro pays a premium for green power.

The approvals process would be improved if BC Hydro worked cooperatively with the agencies to ensure Hydro's green criteria were met.

BC Hydro does not work with the permitting agencies during project development, thus the agencies do not consider Hydro's "green criteria" when deciding how projects can proceed. Yet agency staff at the Ministry of Environment and Fisheries and Oceans Canada decide how a project will minimize, address and monitor potential impacts to the environment.

Once a project is constructed, BC Hydro's auditors rely on the agency-approved paper trail to decide if a project is 'green.' The whole process would be improved if BC Hydro worked cooperatively with the agencies during the planning and assessment stages to ensure BC Hydro criteria were met.

## What are the social costs and benefits from run-of-river hydropower?

We need a policy that maximizes the benefits and minimizes the impacts per unit of energy generated. It can be difficult weighing impacts against benefits for individual projects, which makes an overall strategy critical. Since BC has no such

Furry Creek penstock on its way to the powerhouse (right), and Furry Creek power sub-station (above). IPPBC photos.



vision, individual projects are currently not appropriately evaluated. It is widely agreed that the environmental and social impacts of run-of-river hydropower projects must be scrutinized and addressed.

Social costs of individual IPP run-of-river projects include impacts to recreation and tourism values. Construction and project infrastructure directly affect anglers, hunters, kayakers and hikers—as do changes to river access and water flow. Nor should declines in viewscapes or impacts on wilderness values be ignored.

Communities may benefit from construction activity, the related amenities themselves, and/or from taxes or other revenues generated by the project. But no benefit should be assumed, and no loss should be ignored.

In addition to sharing the larger community's concerns, First Nations have significant special interests and entitlements relating to their traditional territories, archaeological sites, conservation values,

specific wildlife species and fisheries, and treaty negotiations.

### **What do we hope to gain from these projects?**

Given that the burning of fossil fuels contributes to climate change, and that clean energy is critical for a sustainable future, BC Hydro currently occupies an enviable position. It generates 90 percent of its energy at hydro sites which produce fewer harmful emissions than fossil fuel alternatives and which meet the goal of producing energy from renewable sources.

Run-of-river hydropower is touted by BC Hydro and BC as crucial to meeting future demands for clean energy. Nevertheless, such projects are not exempt from risks.

### **How do these projects affect river habitat and fish?**

Diverting large amounts of water may drastically alter aquatic habitat. Reduced flows lead to reductions in water velocity and depth

**Fish habitat is a major environmental concern with run-of-river projects. BC Conservation Foundation photo.**



Some headpond and diversion problems are immediately obvious. Note the absence of streamside vegetation and apparent lack of a defined channel and flow downstream of Rutherford Creek's diversion dam. Ministry of Environment photo.



and, consequently, to reductions in habitat quality for fish and other aquatic organisms. Reduced flows can also lead to excessively warm water for fish in summer, and excessively cold flows in winter, the formation of ice, and the stranding of fish. Likewise, projects

can also have negative impacts on the all-important streamside (riparian) vegetation.

Headpond dams can cause environmental problems, too. They can block the essential downstream movement of gravel and wood, thereby altering stream channels and

habitat quality for significant distances. Dams can even change habitat upstream of headponds by drowning the faster-flowing and more-productive habitat with still water. Additionally, dams can block movements of resident fish. Fortunately, most headpond dams are situated upstream of natural barriers to fish such as salmon, and where

salmon are present, regulatory agencies are obliged to ensure that dams do not impede fish passage.

Because fish can get drawn into the penstocks from the headpond, penstocks must be screened and water velocities must be low enough that fish cannot be pinned against the screens. Additionally, variations in water flows can cause fish to be stranded. That's why 'ramping' rate (the increasing or decreasing of water flow) is an environmental consideration for hydro projects.

### **What are the potential land-based impacts?**

Access roads and transmission lines are the most visible project impacts. They sometimes comprise most of the area affected by the project. Roads and transmission corridors have well-recognized impacts including habitat fragmentation, introduction of invasive species, and increases in undesirable

**Run-of-river projects may provide "green" energy, but still have impacts on the land and water.**

**Impacts on wildlife can be difficult to understand and measure. In general, British Columbia wildlife is less protected by laws than are fish.**

human activities, including poaching. Access roads and transmission lines can also interfere with wildlife movement and gene flow in wildlife and plant populations, affect wilderness aesthetics, and even reduce recreation and tourism values.

The impacts of projects vary and are difficult and costly to measure and monitor. Many risks and impacts are thus poorly measured or not measured at all. Terrestrial impacts are more poorly managed than are aquatic impacts. The laws governing terrestrial impacts are also much weaker.

### **What about species at risk?**

Both aquatic and land-based species are at risk in BC. By definition, being at risk means being few in numbers. A project's potential to harm any species largely depends on how well habitat needs are addressed during the project's planning stage.

Addressing habitat needs requires a great deal of information, including: whether a species is present, how it uses the area, and how the proposed project might affect it.

Unfortunately, critical information is often lacking, and current legislation fails to properly protect species at risk.



### **What are “cumulative” impacts?**

Cumulative impacts are the total of all the environmental impacts, and they constitute the most serious and least understood environmental concern. The impact of a single run-of-river project will be far less than the cumulative total for several related or unrelated projects.

When considered in isolation, the environmental risk of a single project could be deemed acceptable. The cumulative risk of several run-of-river projects in a region (considered together, or added to forestry or other impacts) might be unacceptable.

**There is currently no plan to measure or ensure acceptable overall impacts, or to maximize benefits.**

There are large numbers of run-of-river projects underway in BC, making cumulative impacts a real concern. There is currently no plan to measure or ensure acceptable overall impacts, or to maximize benefits per MW of energy generated.

A provincial-level planning framework would help to address cumulative impacts and to maximize public benefits.

### **How can ordinary citizens determine whether a project is sustainable?**

Determining whether an individual project is sustainable requires an in-depth analysis of a variety of data. Nevertheless, Watershed Watch’s “Top 10 List of Considerations” helps people reach reasonable conclusions.

It is unlikely that any project in British Columbia will meet all the criteria on the list—simply because the existing BC process does not allow for all the criteria to be met.



The access road to the Rutherford run-of-river power project. Terrestrial impacts of run-of-river power projects are usually much more extensive than aquatic impacts.

Ministry of Environment photo.

# Watershed Watch's Top 10 List of Considerations

- 1. THE PROJECT IS LOCATED WISELY**—where adding roads, power lines, human activity and a river diversion will not significantly compromise existing wilderness refuge areas, species of concern, or established recreational opportunities.
- 2. CUMULATIVE EFFECTS HAVE BEEN SERIOUSLY CONSIDERED**, and the project does not create an unacceptable incremental impact, including effects cumulative to other power projects, water diversions, forestry, mining, and agriculture.
- 3. AFFECTED FIRST NATIONS, COMMUNITIES AND STAKEHOLDERS HAVE BEEN CONTACTED** early enough in the planning process to become well informed, have been given ample opportunity to provide meaningful input to the project, and their input has been taken seriously, and incorporated where appropriate.
- 4. POTENTIAL RISKS TO SPECIES AND ECOSYSTEMS HAVE BEEN IDENTIFIED** (appropriate surveys have established animal and plant status and potential threats), and impacts have been avoided or mitigated.
- 5. SUFFICIENT MONITORING DATA ON STREAM FLOWS AND BIOTA** (e.g. fish or wildlife populations that might be affected) have been collected for a reasonable period of time prior to construction (i.e., two or more years), and these baseline data are used in the planning and mitigation processes, as appropriate.
- 6. A QUALIFIED PROFESSIONAL HAS PARTICIPATED IN THE SETTING OF CONDITIONS** and criteria to mitigate impacts associated with ongoing operations, including: low flow thresholds in the diversion reach (to support local fish populations and other aquatic life), ramping rate, and maintenance operations. Input from the Ministry of Environment and Fisheries and Oceans Canada has been considered, and any concerns regarding minimum flows, aquatic habitat requirements, mitigation, and compensation have been incorporated.
- 7. THE HEADPOND, WEIR AND INTAKE** associated with the diversion are designed to minimize impacts, including those affecting fish migration, sediment movement, and flooding.

- 8. THE LOCATIONS AND EXTENT OF ROADS AND POWER LINES HAVE BEEN IDENTIFIED**, their individual and cumulative impacts on wildlife habitat and plant and animal species of concern have been considered, and qualified professionals decide whether the impacts are acceptable, how mitigation should be incorporated, and how they will work with appropriate Ministry of Environment staff.
- 9. THE POWERHOUSE INCLUDES FISH BY-PASS VALVES** to mitigate river stage impacts and fish stranding associated with unplanned and forced power outages.
- 10. POST-CONSTRUCTION MONITORING OCCURS**, and includes provisions for modifying plant operations when unacceptable impacts are revealed.

This location at the confluence of the Green and Rutherford Rivers south of Whistler suffers from cumulative impacts of the sea-to-sky highway, a railway, transmission lines, and infrastructure for the Rutherford run-of-river power project. The cleared area in the foreground was a former gravel pit, and was re-opened to become a staging area for plant construction. This area was permanently impacted when it was converted to a cement plant. The Rutherford power plant is visible in the middle distance.

Ministry of Environment photo.



## How can citizens and communities make a difference?

In addition to conducting their own checklist surveys, individuals and communities have other means of influencing run-of-river projects. While it's unlikely projects can be halted, public scrutiny and involvement can greatly improve a project's quality. Independent power producers are required to engage in community and stakeholder consultation and to reasonably address issues raised. Because of unceded rights to traditional territories, First Nations must be consulted during project development, and can have a major influence on how a project unfolds.

There are four key subjects around which individual and collective contributions can be particularly effective:

- The land-based impacts on wildlife species. Neither BC's legislation, nor its agencies, adequately address the public's concerns about the impact of roads, power lines, construction and increased human activity.
- The impacts on recreational, cultural and wilderness/aesthetic values. Independent power producers are required to address conflicts over land use, loss of biodiversity, and concerns about scenic, recreational and cultural values. It is up to the public to make these concerns known to the IPP as well as to the agencies in charge of issuing project approvals.
- The impacts on non-fish and species at risk. Though agencies do deal with these concerns, strong expression of public concern

is needed to ensure that these concerns are properly addressed. This is particularly true of species at risk, which are dealt with inconsistently due to weak legislation.

- The planning which addresses the cumulative effects of development, the exclusion of development in sensitive areas, and the maximizing of public benefits.

## How can interested citizens educate themselves?

This document is a short version of a much more detailed document. Both versions and other information—including a Google Earth Map showing the locations of current project applications and water licences for power production—are available online from Watershed Watch at [www.watershed-watch.org](http://www.watershed-watch.org).

More information can also be found at the following websites, or from your local library:

**BC Hydro** [www.bchydro.com/environment/greenpower/greenpower1652.html](http://www.bchydro.com/environment/greenpower/greenpower1652.html)

**BC Ministry of Energy, Mines and Petroleum Resources** [www.gov.bc.ca/empr/popt/energyplan.htm#eof](http://www.gov.bc.ca/empr/popt/energyplan.htm#eof)

**BC Ministry of Environment** [www.env.gov.bc.ca/wsd/water\\_rights/waterpower](http://www.env.gov.bc.ca/wsd/water_rights/waterpower)

**Environmental Choice Program (Green energy certification)**  
[www.environmentalchoice.com](http://www.environmentalchoice.com)

**BC Citizens for Public Power**  
[www.citizensforpublicpower.ca](http://www.citizensforpublicpower.ca)

**Independent Power Producers of BC**  
[www.ippbc.com](http://www.ippbc.com)

**Low Impact Hydropower Institute**  
[www.lowimpacthydro.org](http://www.lowimpacthydro.org)

**Pembina Institute** [www.pembina.org](http://www.pembina.org)

**BC Creek Protection Society**

[www.bc-creeks.org](http://www.bc-creeks.org)

This document does not address overarching electricity policy, such as public concerns about energy ownership, electricity rates, public input, and the public costs versus benefits of these projects. Information on these issues is available from other non-profit groups.

## Glossary of terms

**Clean energy:** energy from renewable sources (e.g. wind, solar, hydropower).

**Cumulative impact:** the sum total of all effects of multiple projects or land uses.

**Diversion reach:** the section of river in a run-of-river hydropower project between the intake to the penstocks and the tailrace. The diversion reach is the river section with reduced water flows.

**Electricity Purchase Agreement:** 25-year agreement between BC Hydro and an Independent Power Producer that describes the terms under which BC Hydro will purchase electricity.

**Green energy:** energy that is renewable and has low environmental impacts. Green energy is often certified according to specific criteria, e.g. EcoLogo criteria (see [www.environmentalchoice.com](http://www.environmentalchoice.com)).

**Groundwater:** water located underground, in the cracks and spaces in soil, sand and rock.

**HADD:** harmful alteration, disruption or destruction. Refers to temporary or permanent negative changes to fish habitat under the Federal Fisheries Act.

**Headpond:** area flooded upstream of a small dam on a river to ensure sufficient flow at the penstock.

**Independent Power Producer (IPP):** any corporation or entity potentially eligible for an electricity purchase agreement with BC Hydro.

**Megawatt (MW):** energy sufficient to power 500 homes.

**Penstock:** pipe that brings water from the river to power turbines located at a lower elevation.

**Powerhouse:** a building that contains turbines.

**Renewable energy:** energy sources that can be replenished on a human time scale such as biomass (wood) or sources that are essentially inexhaustible such as wind, solar or geothermal energy.

**Riparian:** pertaining to the banks of a stream. Often used to refer to plant communities and species influenced and sustained by nearby water.

**Run-of-River:** a type of hydropower project with little or no reservoir storage capacity. Power is derived from only the river's natural flow.

**Small hydro:** the threshold between small and large hydro is not well defined, but small hydro projects generally have a generating capacity of less than 50 megawatts.

**Species at Risk:** species designated as threatened, endangered, or 'of concern' by the provincial and/or federal governments.

**Tailrace:** short man-made channel between the powerhouse (that contains the turbines) and the river to which diverted water is returned.

**Transmission line:** the wires (usually overhead, but sometimes buried) that convey electricity from its point of production to population centers.

**Turbine (water):** a rotary engine that converts power from moving water into electric energy.

**Water Licence:** a licence granted by the Province of BC's water comptroller that allows for the diversion, use and/or storage of a predetermined quantity of surface water. Water licences are currently granted for a renewable term of 40 years, and were formerly granted in perpetuity.



A dam on the Lower Mamquam River. Ministry of Environment photo.

