COLUMBIA BASIN TRUST

Water issues are at the core of the Columbia Basin Trust's (CBT) existence. The Columbia Basin Trust was created in recognition of the impacts associated with the management of water in this region.

In the early 1990s, people of the Columbia Basin became aware that a new opportunity for public involvement in the Columbia River Treaty (CRT) might present itself. The sale of the first 30 years of BC's share of the downstream benefits, through the CRT, was about to expire. Leaders from First Nations, local communities, and the Province of BC worked together on an agreement that recognized the impacts the CRT dams had on this area. This agreement led to the creation of the Columbia Basin Trust.

In 1995, the CBT was formed with a unique mandate to support the efforts of the people of the Basin to create a legacy of social, economic, and environmental well-being and to achieve greater self-sufficiency for present and future generations in the region most affected by the CRT.

The Columbia Basin Trust was endowed with $295 million from the Province of BC (approximately five percent of the downstream benefits owned by the Province of BC).

During the creation of the Columbia Basin Trust, there was extensive public consultation with Basin residents that resulted in the creation of the Columbia Basin Management Plan. This plan guided the creation of programs to support the social, economic, and environmental well-being for the residents of the Canadian Columbia Basin, and guided CBT's activities as we developed power projects.

The Columbia Basin Trust, along with our power partner, Columbia Power Corporation, jointly made investments into upgrading existing hydroelectric facilities on the Columbia River system, as well as building new generating stations on existing dams.

BC hydro — Northwest Power and Conservation Council — FORTIS BC

Columbia Basin Trust would like to recognize BC Hydro, NWPCC, Fortis BC, and Nelson Hydro for providing photos and information for this project.

WORKING ON WATER ISSUES

Basin residents have identified a broad range of concerns regarding water quality and quantity, from both human use and natural ecosystem perspectives. Currently there is not a comprehensive vision or strategic plan that incorporates a wide range of values regarding water issues in the Basin. CBT wants to involve Basin residents in building a network of organizations to address water issues in the Basin. In order to carry out this mandate, CBT has allocated staff and financial resources to its Water Initiatives Program, and is currently involved in a number of water education and public awareness initiatives across the Columbia Basin.

Public consultation with Basin residents in the creation of the CBT identified that one of the priorities of the organization should be to prepare the residents of the Columbia Basin for potential renewal, or renegotiation of the CRT. This process can start as early as 2014. The CBT is committed to ensuring that the values and views of Basin residents are a key part of the process from start to finish.

As part of this commitment, the CBT is working in partnership with a variety of community groups, local governments, First Nations, provincial organizations, and federal organizations to increase the understanding of water issues in the Columbia Basin and cooperatively work towards a common agreement for the future management of our shared water resources.

COLUMBIA BASIN TRUST
a legacy for the people

FOR MORE INFORMATION CONTACT US AT:

Suite 300, 445 – 13th Avenue • Castlegar, BC V1N 1G1
toll-free: 1-800-505-8998 • local: 250-365-6633 • e-mail: cbt@cbt.org
website: www.cbt.org

Desktop Graphics 040916

MAJOR HYDROPOWER PROJECTS
A GUIDE TO OF THE COLUMBIA RIVER BASIN

COLUMBIA BASIN TRUST
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THE COLUMBIA RIVER

The Columbia Basin (in Canada and the United States) is 671,000 square kilometres, or about the same size as the province of Alberta. It contains an incredible range of ecosystems including interior rain forests, grasslands, and deserts. The Columbia Basin is home to a huge diversity of wildlife with over 700 species of reptiles, birds, fish, and mammals.

According to archaeologists, humans have inhabited the Columbia River Basin for more than 10,000 years.

The Columbia River was visited by Robert Gray, an American explorer in 1792 and is named after his vessel, the Columbia. The River begins in 2000 kilometre journey at Columbia Lake near Canal Flats, BC and flows through British Columbia, Washington and Oregon before it enters the Pacific Ocean, west of Portland, Oregon.

Not long after Northwest pioneers established the first cities in the Basin, they began to use the river to make electricity for their homes and industries. The T.W. Sullivan Dam in Oregon City was the first hydroelectric dam in the lower Columbia Basin. It was built in 1888. The first hydroelectric dam built in the Canadian portion of the Columbia River system was the Lower Bonnington, built in 1897 on the Kootenay River.

Most of the dams on the Columbia River were built between 1950 and 1980. Currently there are more than 450 dams (hydropower, agriculture and municipal) on the Columbia mainstem and its tributaries, making it the most dammed river in the world.

The economies of the Pacific Northwest United States and British Columbia are dependent on the power and revenue generated from the hydroelectric system in the Columbia Basin.

The Canadian Columbia Basin region provides 90 percent of the total hydroelectric power produced in British Columbia. Power produced as a result of this hydroelectric infrastructure fuels the provincial economy and provides low-cost electricity to all British Columbians.

The water stored in the Canadian system provides significant additional power generation to a number of US hydroelectric facilities downstream on the Columbia River. Today, the American Northwest relies on hydropower for about two-thirds of its electricity, and 40 percent of all US hydropower comes from the Columbia River system.

The increase of human population in the Basin has placed a greater demand on the water resources, not only for hydroelectric generation, but also for industry, agriculture, and recreation. This increase in demand for water has placed a higher level of regulation on the Columbia River and its tributaries. The variety of national, provincial, First Nations, and state jurisdictions increase the complexity of managing the system.

COLUMBIA RIVER TREATY

Canada and the United States were facing two major challenges in the Columbia Basin after the Second World War – the "unmanned" Columbia River caused periodic and sometimes devastating flooding and an upswing in the economy increased the need for more energy.

In 1964, Canada and the United States ratified the Columbia River Treaty (CRT). The purpose of the CRT is to coordinate flood control and optimize electrical energy production in the Columbia River Basin in the United States and Canada. Under the CRT, Canada agreed to build three storage dams – Duncan (1968), Hugh Keenleyside (1969), and Mica (1973) – in the Columbia Basin. The CRT allowed for a fourth dam – Libby Dam (1974) to be built in the United States.

In return for the storage of water, Canada is entitled to one half of the additional power generated at the American power plants on the Columbia River. The Province of BC, which owns this "Canadian Entitlement of Downstream Benefits", sold the first 30 years of these benefits to a group of US utilities for $254 million. The province is now receiving the Canadian Entitlement for the remaining 30 years of the CRT. Although there is no official "expiry date" for the CRT, there are provisions for renewal, termination, or re-negotiation after 60 years (2024), if 10 years notice is given (2014). Regardless of termination of the CRT, Canada is obligated to continue to provide flood control, when called upon, as long as the three CRT dams are in operation.

Hydropower Dam Glossary

ancillary services are those services that are required to support transmission of capacity and energy from resources to loads, and to maintain reliability.

anadromous fish that migrate from the sea to fresh water to spawn.

available transfer capability (ATC) a measure of the transfer capability remaining in the physical transmission network for further commercial activity, over and above already committed uses.

British Columbia Utilities Commission (BCUC) an independent regulatory agency of the provincial government operating under and administering the Utilities Commission Act. Primary responsibility is the regulation of the energy utilities under its jurisdiction to ensure that the rates charged customers for energy are fair, just, and reasonable. Required to ensure that utility operations provide safe, adequate, and secure service to their customers. Approves the constriction of new facilities planned by utilities and their issuance of securities.

bypass system, bypass channel a structure in a dam that provides a route for fish to move through or around the dam without going through the turbine units. The bypass channel is the part of a system that includes a conduit built into the dam to pass fish.

capacity the maximum sustainable amount of power that can be produced or carried at any instant.

Columbia River Treaty is a binational treaty between Canada and the US, signed in 1961, and ratified in 1964, under which three dams were built in British Columbia for flood control and power production.

dam a barrier across a river designed to control water flow and/or form a reservoir.

distribution a low voltage transmission network, usually below 60,000 volts, for delivering electricity to customers' premises.

downstream benefits are the additional power generated in the United States as a result of the operation of three storage dams (Mica, Hugh Keenleyside, Duncan) built in British Columbia. BC is entitled to one-half of the downstream benefits.

draft the release of stored water from a reservoir.

drawdown releasing water from a hydroelectric project to lower the reservoir elevation. Drawdowns are used for energy production or to create additional space in the reservoir to hold back floodwaters; to reduce the cross-sectional area of the reservoir, increasing the current to aid downstream fish passage; and to expose normally submerged structures for maintenance.

drawdown/drafting the distance that the water surface of a reservoir is lowered as water is released from the reservoir.

electricity demand the amount of electricity required by consumers or by the system.

energy capability the amount of energy the electric system can produce over a given time.

firm energy the assured energy contribution of the electric system over one year.

firm transmission service transmission service that is reserved and/or scheduled with a priority that will not be interrupted for economic reasons.

fish ladder a series of ascending pools, similar to a staircase, that enables fish to migrate up a river past dams. Also called a fishway.

flow release the release of water through a hydroelectric facility at a prescribed flow rate.

forebay the part of a dam's reservoir that is immediately upstream of the powerhouse.

freshet the rise in streamflow caused by rain or snowmelt.

full pool maximum reservoir operating level permitted in the water license.

gatewell the slot on the upstream face of a concrete dam where hydraulic gates are stored when not used to close the turbine intakes. (The gatewell also typically houses the fish screening device.)

generator a machine that converts mechanical energy into electric energy.

generating capacity the maximum power that a power plant, such as a hydroelectric dam, can produce under specific conditions.

gigawatt-hour (GW.h) one million kilowatt-hours.

gigawatt-hours per annum (GW.h/a) the number of gigawatt-hours produced by the electric system in one year. One GW.h will serve about 100 residential customers for one year.

grid network of transmission lines.

head (hydraulic head) the vertical distance between the water level in the reservoir above a generating station, and the water level immediately below the turbine outlet. Power output is proportional to head.

headpond small reservoir.

hydraulic capacity the maximum amount of water that goes through the powerhouse at a project.

hydroelectric the production of electricity using the power of falling water or streamflow.

independent power producer (IPP) an entity which produces electricity for market to utilities or other customers, and is not governed by utility regulations.

inflow water that flows into a reservoir.

intake the entrance to a turbine unit at a hydroelectric dam.

kilovolt (kV) one thousand volts.

kilowatt (kW) one thousand watts; the commercial unit of electric power. A kilowatt is the flow of electricity required to light ten 100-watt light bulbs.

live storage water storage that can be released from the reservoir.

load centre the region where the majority of electricity customers are located.

load forecasting the determination of an estimate of average and maximum load requirements for some future time.

lock a chamber with watertight gates at each end used to lift or lower watercraft between the downstream tailrace water level and the upstream reservoir level.

long-term transmission service transmission service that is reserved and/or scheduled for one year or longer.

mainstem the main channel of the river, as opposed to the streams and smaller rivers that feed into it. In the fish and wildlife program, mainstem refers to the Columbia and Snake rivers.

megawatt (MW) one thousand kilowatts. This term is commonly used to measure the capacity of generating stations; also the rate at which energy can be delivered.

network integration transmission service a transmission service that allows the transmission customer to integrate, plan, economically dispatch, and regulate its network resources to serve its network load, both of which are distributed within a service area.

non-firm transmission service point-to-point transmission service that is scheduled and paid for on an as available basis and is subject to interruption.

non-power those features of electric system operations that are not related to the production of electricity.

peak capacity the maximum amount of electrical power that generating stations can produce in any instant.

penstock the tube through which water flows from the reservoir to the turbines in a hydroelectric generating system.

point-to-point transmission service the reservation and/or transmission of energy on either a firm basis and/or a non-firm basis from point(s) of receipt to point(s) of delivery.

power the rate of delivery of energy measured in watts.

powerhouse the building or structure containing generators and ancillary equipment, and where power is produced by the action of the water on the turbine blades.

pumped storage a hydroelectric project designed to store electrical energy on a short-term basis. A pumped storage project is typically used to store electricity during nighttime periods of low demand for use during daily peak demand periods.

real time pricing market-based electricity prices for consumption beyond a customer's base load.

reservoir the lake or body of stored water formed by a dam.

river basin the geographic area drained by a river.

river miles miles calculated from the mouth of the river or, for upstream tributaries, from the confluence with the main river.

run-of-river a hydroelectric facility that operates using only available stream flow. This means they also have limited control of their outflow and power generation

short-term transmission service transmission service under WTS that is reserved and/or scheduled for a term of less than one year.

sluiceway a channel designed to collect ice and trash in the river (e.g., logs) before they get into the turbine units and cause damage.

spill, spillbay releasing water out the spillbays rather than through the turbine units. The spillbay is the dam's safety valve. Without it, excess water can damage the dam's structure or overflow the dam. Dams without bypass systems spill water laden with fish to carry them away from turbines.

storage the water held in a reservoir for power generation or flood control.

storage dam a dam with a large reservoir that can hold water over from the annual high-water season to the following low-water season.

streamflow the rate at which flowing water passes a given point, measured in cubic feet per second (cfs) or cubic metres per second (m^3/s).

substation an electrical switching station to terminate transmission lines and/or a station at which transmission voltage is reduced to a level suitable for subtransmission or distribution systems.

synchronous condenser a motor or generator operated at synchronous speed to provide voltage support.

system control centre the central location for supervisory control of the generation and transmission systems.

tailrace the channel through which water exits a powerhouse.

tailwater the water surface immediately downstream from a dam.

thermal generation the generation of electricity by means of the conversion of heat energy into electric energy; generation through the burning of fossil fuels or biomass.

time-shift the use of reservoir storage and peaking capability of hydroelectric systems to store water when available and generate electricity when needed.

total transfer capability (TTC) the amount of electric power that can be transferred over the interconnected transmission network in a reliable manner while meeting all of a specified set of defined pre- and post-contingency system conditions.

transmission the transportation or conveyance of electricity in bulk at voltages over 60 kV.

turbine a rotary device caused to turn by the movement of gases, steam or water.

unbundling the separation of various services associated with power delivery.

water licences a legal document issued by the Water Management Branch which specifies the terms and conditions under which a right to use water is granted.

Western Systems Coordinating Council (WSCC) the body that sets electric system operating performance and reliability standards for members in western Canada and US.


1. Kootenay Canal


2. Seven Mile


3. Mica


4. Revelstoke


5. Spillimacheen


6. Duncan


7. Aberfeldie


8. Elko


9. Brilliant


10-a. Hugh Keenleyside


10-b. Arrow Lakes

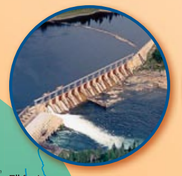

11. Walter Hardman


12. South Slocan


13. Upper Bonnington

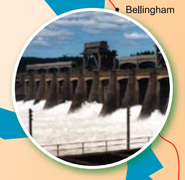

14. Lower Bonnington


15. Bonnington Falls


16. Corra Linn


17. Whatshan


18. Waneta


19. Bonneville


20. The Dalles


21. John Day


22. McNary


23. Priest Rapids


24. Wanapum


25. Rock Island


26. Rocky Reach

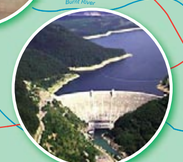

27. Wells


29. Grand Coulee


31. Libby


28. Chief Joseph


30. Albenie Falls


32. Hungry Horse


33. Ice Harbor


34. Lower Monumental


35. Little Goose


36. Lower Granite


37. Dworshak


38. Boundary


39. Hells Canyon

40. Oxbow

41. Brownlee

Canadian Hydropower Projects

	Name	Completed	Operator	Type	Location	Generating Capacity (MW)
1	Kootenay Canal	1976	BC Hydro	Powerhouse	Kootenay River 20 km W of Nelson	580
2	Seven Mile	1979	BC Hydro	Run of river reservoir, concrete gravity dam	Pend d'Oreille River 20 km SE of Trail	790
3	Mica Dam	1973	BC Hydro	Earth fill dam	Columbia River 135 km N of Revelstoke	1805
4	Revelstoke	1983	BC Hydro	Concrete gravity dam	Columbia River Lake Revelstoke	1980
5	Spillimacheen	1955	BC Hydro	Run of river with small dam	Spillimacheen River 40 km N of Radium	4
6	Duncan	1967	BC Hydro	Storage facility earth fill dam	10 km N of N end of Kootenay Lake	–
7	Aberfeldie	1922, rebuilt 1953	BC Hydro	Run of river concrete gravity dam	Bull River 30 km E of Cranbrook	5
8	Elko	1924	BC Hydro	Run of river	Elk River 70 km SE of Cranbrook	12
9	Brilliant	1944	CPC/CBT	Concrete gravity	Kootenay River at Castlegar	145
10-a	Hugh Keenleyside	1968	BC Hydro	Earth and concrete structure	Arrow Lakes Reservoir 8 km W of Castlegar	–
10-b	Arrow Lakes Generating Station	2002	CPC/CBT	Run of river, concrete dam	Adjacent to Hugh Keenleyside Dam near Castlegar	185
11	Walter Hardman	1960's	BC Hydro	Run of river	Shore of Arrow Lakes reservoir • 30 km S of Revelstoke	8
12	South Slocan	1928	FortisBC	Concrete gravity dam run of river	Kootenay River	57
13	Upper Bonnington	1907	FortisBC	Concrete gravity dam run of river	Kootenay River	53
14	Lower Bonnington	1897, rebuilt 1924	FortisBC	Concrete gravity dam run of river	Kootenay River	50
15	Bonnington Falls	1906/1908/1928 1950/1995	City of Nelson/ Nelson Hydro	Run of river/diversion, vertical turbine Francis runner, horizontal turbine Kaplan runner	Upper Bonnington Falls	16
16	Corra Linn	1932	FortisBC	Concrete gravity dam run of the river	Kootenay Lake	45
17	Whatshan	1971	BC Hydro	Concrete dam	Whatshan Lake (shore of Arrow reservoir)	54
18	Waneta	1954	Teck Cominco	Concrete gravity dam	Pend d'Oreille	450

There is no fish passage infrastructure on Canadian dams because there are no anadromous fish in the mainstem Columbia river in Canada. Anadramous fish passage into Canada was blocked by the construction of Grand Coulee Dam in 1941. Both the CBT and the Northwest Power and Conservation Council (NWPCC) support investigating anadromous fish passage where feasible (such as Chief Joseph and Grand Coulee) noting that there are a number of issues that need to be resolved in order to achieve this objective.

Revelstoke Dam

American Hydropower Projects

	Name	Completed	Operator	Type	Location	Generating Capacity (MW)	Fish Passage Facilities	Additional Information
19	Bonneville	1938	U.S. Army Corps of Engineers (USACoE)	Run of river dam and reservoir	Lower Columbia River – Oregon/Washington border	1087	Screens on all turbine units with a bypass system to tailwater • fish ladders with fish counting stations at both powerhouses	A juvenile bypass was completed in 1999 for powerhouse II
20	The Dalles	1957	USACoE	Run of river dam and reservoir	Lower Columbia River – Oregon/Washington border	1807	Ice and trash sluiceway • two fish ladders with fish counting stations	Surface bypass system studies are ongoing at this project; however, spill and the ice and trash sluiceway will continue to be the primary juvenile passage routes
21	John Day	1968/1971	USACoE	Run of river dam and reservoir	Lower Columbia River	2160	Screens on all turbines with bypass system to tailwater • two fish ladders with fish counting stations	Between 1985 and 1987, the Corps installed screens in all powerhouse units.
22	McNary	1953/1952	USACoE	Run of river dam and reservoir	Lower Columbia River – Oregon/Washington border	980	Screens on all units • bypass system to tailwater • fish collection and transportation facilities • fish run monitoring station • two fish ladders with fish counting stations and adult PIT tag detection were installed in 2002	McNary's juvenile fish bypass system was completed in 1981, upgraded in 1994, and longer screens were installed in 1997
23	Priest Rapids	1959	Grant County Public Utility District (PUD)	Run of river dam and reservoir	Mid Columbia River	778	Spill and turbines provide good survival past the dam • flow management protects fall chinook in the Hanford Reach • two fish ladders • fish counting and trapping facilities	Grant County PUD's relicensing studies identified new surface flow bypass systems, turbine passage improvements, and habitat and hatchery programs to offset losses
24	Wanapum	1963	Grant County PUD	Run of river dam and reservoir	Mid Columbia River	950	Spillway deflectors and top spill bulkhead installed • two fish ladders with video fish counting facilities	Grant County PUD's relicensing studies identified new surface flow bypass systems • turbine passage improvements • and habitat and hatchery programs to offset unavoidable losses
25	Rock Island	1933	Chelan County PUD	Run of river dam and reservoir	Mid Columbia River	660	Gatewell bypass system with no screens at Powerhouse II • Chelan County PUD is evaluating a notched spillgate for providing downstream passage at the spillway • three fish ladders with counting stations	Rock Island was the first dam built on the mainstem Columbia River • spill is an integral part of the long-term plan for safely providing fish passage at the project
26	Rocky Reach	1961	Chelan County PUD	Run of river dam and reservoir	Mid Columbia River	1213	Currently a bypass system with screens on two units and a surface collection system in the forebay cul-de-sac pass fish to a monitoring facility and the tailrace • spill also provided if needed • fish ladder with fish counting station	
27	Wells	1967	Douglas County PUD	Run of river dam and reservoir	Mid Columbia River	774	Unique spillbay design (modified in 1991) which lies over the turbine intakes to provide a bypass route for juvenile migrants • two fish ladders (one with trapping facility) • adult PIT-tag detectors were evaluated in 2002, determined to be 100 percent efficient, and were installed	The unique hydrocombine design of Wells Dam enables the spillway to function as an extremely efficient fish bypass system
28	Chief Joseph	1955/1958	USACoE	Run of river dam and reservoir	Upper Columbia River – Central Washington	2614		Chief Joseph and Grand Coulee dams lack any fish passage facilities and thus permanently block anadromous fish from the upper Columbia River Basin
29	Grand Coulee	1941 (18) 1982 (6)	U.S. Bureau of Reclamation	Dam and storage, reservoir, pumped storage reservoir	Grand Coulee, WA Columbia River mile 596.6	6,620		See Chief Joseph Dam
30	Albenie Falls	1955	USACoE		Pend d'Oreille River	49		
31	Libby	1973	USACoE	Dam and storage, reservoir	Columbia River mile 221.9	525		Libby Dam is a major upriver storage dam for the Columbia River hydropower system
32	Hungry Horse	1953	U.S. Bureau of Reclamation	Dam and storage, reservoir	South Fork, Flathead River above Flathead Lake	428		Hungry Horse Dam is the most upstream major storage project in the United States for the Columbia River hydroelectric system
33	Ice Harbor	1962 (3) 1976 (3)	USACoE	Run of river dam and reservoir	Lower portion of Snake River mile 9.7 Pasco, Washington	603	Intake screen bypass system was completed in 1993 • spill is also provided • two fish ladders with fish counting stations	
34	Lower Monumental	1970 (3) 1978 (3)	USACoE	Run of river dam and reservoir	Lower portion of Snake River mile 41.6 Kahlotus, Washington	810	Intake screen bypass system completed in 1992 • collection and transport facilities • spill is also provided during the spring • two fish ladders	
35	Little Goose	1970 (3) 1978 (3)	USACoE	Run of river dam and reservoir	Lower portion of Snake River mile 70.3 Starbuck, Washington	810	Extended screens on all units with bypass system to tailwater • collection and transportation facilities • spill is provided in the spring • fish ladder	
36	Lower Granite	1975 (3) 1978 (3)	USACoE	Run of river dam and reservoir	Lower portion of Snake River mile 107.5 Almota, Washington	810	Extended screens on all units with bypass system to tailwater • collection and transportation facilities • fish passage monitoring facility • spill is provided in the spring • fish ladder, monitoring, and trap facilities	
37	Dworshak	1973	USACoE	Dam and storage reservoir	North Fork Clearwater River mile 1.9 Ahsahka, Idaho	400		Dworshak Dam permanently blocks salmon and steelhead from the North Fork Clearwater River
38	Boundary	1967/1985	City of Seattle	Dam and storage reservoir	Pend d'Oreille River mile 17 • Metaline Falls, Washington	1024		
39	Hell's Canyon	1967	Idaho Power Company	Run of river dam and reservoir	Snake River mile 247 • Oxbow, Oregon	450		The Hells Canyon complex (Hells Canyon, Oxbow, and Brownlee projects) permanently blocks salmon from the upper Snake River Basin
40	Oxbow	1961 (4) 1978 (3)	Idaho Power Company	Run of river dam and reservoir	Snake River mile 273 between Oregon & Idaho • Oxbow, Oregon	220		
41	Brownlee	1959 (4) 1983 (1)	Idaho Power Company	Dam and storage reservoir	Snake River mile 285 between Oregon & Idaho • Cambridge, Idaho	675		Brownlee Reservoir is the major storage reservoir in the Hells Canyon complex